MEDICINE LAKE HIGHLANDS AREA

WATERSHED ANALYSIS

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Doublehead Ranger District
Modoc National Forest

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Cover: View across the Medicine Lake Watershed Area from Lyon's Peak toward Mt. Shasta (Source — Modoc National Forest Photo Gallery, January 1999. Available: http://www.r5.fs.fed.us/modoc/photos/gallerymedlake.html)

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INTRODUCTION

ANALYSIS OVERVIEW

Watershed analysis is ecosystem analysis at the watershed scale. It is both an analysis and an information gathering process. The purpose of this type of analysis is to provide a means by which the watershed can be understood as an ecological system. This will develop and document an understanding of the processes and interactions occurring within the watershed.

This analysis focuses on certain *Issues* and *Key Questions* that have been specifically identified for the Medicine Lake Highlands Area Watershed (Watershed). The issues covered in this analysis are assessed in terms of biological, physical, and social importance. Additional aspects of the *Issues and Key Questions* discussed include beneficial uses, vegetative patterns and distribution, wind, fire, wildlife, migration routes, dispersal habitat, human use patterns, vegetative corridors, streams, and riparian corridors. The analysis also includes an identification of management opportunities. This will provide background for the development of management decisions in the future.

The analysis process is also intended to be used as a vehicle for the implementation of Forest planning direction. It is an intermediate analysis between land management planning and project planning. It is purely an analysis step and does not involve *National Environmental Policy Act (NEPA)* decisions. A watershed analysis provides a means of refining the desired condition of the watershed, given the Goals and Objectives, Management Areas and Standards, Guidelines from the Modoc National Forest Land and Resource Management Plan (LRMP or Forest Plan; USFS 1991), current policy, and other applicable state and federal regulations.

The LRMP was amended in 1994 to reflect direction contained in the *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl — Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl* (USFS and BLM 1994) (a.k.a. Northwest Forest Plan, Record of Decision (Record of Decision)) and the associated Final Supplemental Environmental Impact Statement (FSEIS).

Process and Document Organization

The analysis was conducted by a National Forest Interdisciplinary Team (IDT) and an expanded team of resource specialists. During the analysis phase, participation and involvement of other Federal agencies was encouraged.

The six steps utilized in the preparation of the following watershed analysis include:

Step 1 — Characterization:

The purpose of this step is to identify the dominant physical, biological, and human processes and features of the watershed that affect ecosystem function or condition.

Step 2 — Issues and Key Questions:

This step identifies the variety of uses and values associated with the watershed. It focuses the analysis on key elements of the ecosystem that are most relevant to the management questions, human values, or resource conditions within the watershed. Key analysis questions are also formulated in this step from indicators commonly used to measure or interpret the key ecosystem elements.

Step 3 — Current Conditions:

This step documents the current range, distribution, and conditions of the relevant ecosystem elements.

Step 4 — Reference Conditions:

This step develops a historic reference for comparison with current conditions. This step explains how existing conditions from Step 3 have changed over time as the result of human influence and natural disturbances.

Step 5 — Interpretation:

This step compares existing, historical, and reference conditions of specific landscape elements, and explains significant differences, similarities or trends, and their causes. Desired conditions for each issue are included.

Step 6 — Recommendations:

This step identifies those management activities that could move the ecosystem towards management objectives or desired conditions as appropriate. Management Opportunities specified in Step 6 are expressed in general terms; they identify what needs to be done and why, but not how. This step ultimately provides the purpose and need for implementation of individual projects designed to achieve desired conditions. Data gaps and limitations of the analysis are also documented.

Appendices included in support of information and findings contained within the analysis are provided as follows:

Appendix A — Soils
Appendix B — Fire and Fuels
Appendix C — Conifer Size and Canopy Closure Crosswalks
Appendix D — Road Functional Classifications and Road Maintenance Levels
Appendix E — Concordance of RSL, Reference Vegetation, and EUI Data
Appendix F — Arrangement of Seral Stages within Associations
Appendix G — MLSA Fire Management Plan

Relationship to Other Analyses and Planning

The watershed level of analysis occurs between the *Forest Plan* and project level analysis. A more detailed assessment is necessary for *NEPA* sufficiency, therefore, individual project analysis will be needed to focus on site-specific issues and their potential effects.

Information and Data Sources

Data and information used in this analysis have come from several different sources. The following Geographic Information Systems (GIS) data was used: Modoc National Forest Remote Sensing Laboratory (RSL) located near Sacramento, California (1993); an Ecological Unit Inventory (EUI) undertaken in 1995; and a Reference Vegetation data set created from 1944-1946 aerial photographs. From this data, information such as fire hazard, current vegetation communities, and late-successional habitat were plotted for analysis. The RSL data was created by using Landsat TM imagery, SPOT imagery, orthophotos and aerial photos. Hyrodologic features in the RSL data were created using cartographic feature files [CFF (derived from USGS digital line graphs)] and 7.5 minute quadrangle maps.

Other principal, non-GIS, sources of information were utilized during the analysis, including the Modoc National Forest LRMP and associated Final Environmental Impact Statement (USFS 1991); the *Medicine Lake Highlands Managed Late-Successional Area Assessment* (Modoc National Forest 1998), and baseline information developed during the preparation of the *Telephone Flat Geothermal Development Project Environmental Impact Statement/Environmental Impact Report* (BLM *et al.* 1999).

An Iterative Process

Ecosystem analysis at the watershed scale will be an ongoing process. This initial analysis report will serve as a foundation onto which new information will be added in the future. In addition, the analysis process will continue to be refined as new methods and strategies are developed and applied.

STEP 1 — CHARACTERIZATION

INTRODUCTION

The Medicine Lake Highlands Area Watershed has been defined to encompass an area near the northwest corner of the Modoc National Forest. It is an irregular-shaped area bounded on the north and west by the Lava Beds National Monument and the Klamath and Shasta-Trinity National Forests, respectively. The northeastern and southern boundaries of the Watershed were defined to approximate the 4,800-foot elevation contour of the Medicine Lake Highlands, while the majority of the eastern boundary of the Watershed is defined by adjacent private land located to the east. The total area of the Watershed is 85,433 acres. Figure 1.1 identifies the location of the Watershed within the region and its relative location within Modoc National Forest. Major features within and in the vicinity of the Watershed are shown on Figure 1.2.

Physiographically, the Watershed is located entirely within the Medicine Lake Highlands, west of the Modoc Plateau. The Watershed crosses the hydrologic divide that topographically separates the North Coast and Central Valley Basins of California. The area north of the Medicine Lake basin is located within the Klamath River Hydrologic Unit of the California North Coast Basin. While the Medicine Lake basin and the areas east and south are located within the Pit River Hydrologic Unit of the Central Valley Basin. However, surface water runoff is very limited within the volcanic Watershed, and there are no streams or surface waters that flow out of the Watershed into either of these regional water drainage basins.

The Watershed contains lower lying lava flows and geologic areas, as well as various forested peaks and buttes ranging around 5,000 to 7,000 feet. The highest elevations in the Watershed reach above 7,900 feet at the summits of Mt. Hoffman and Lyons Peak. Both of these peaks are in the central section of the Watershed. Lowest elevations are found near the Burnt Lava Flow Geologic Area in the southern section of the Watershed and near the 4,800 foot contour along the northeastern boundary of the Watershed.

Primary Forest Road 97 crosses the middle of the Watershed from east to west, from State Highway 139, near Tionesta, to Medicine Lake. Primary Forest Road 49 runs north to south, from the Lava Beds National Monument at the northern boundary of the Watershed, near the eastern end of Medicine Lake, and south toward Bartle. Access to other parts of the Watershed is provided by secondary Forest roads. Other developed roads are limited in number. Road construction has primarily occurred to provide access for timber sales or to the developed recreation sites and private property around Medicine Lake.

Land ownership within the Watershed is 78.4% National Forest and 21.6% private lands.

There are portions of five different Modoc National Forest Management Areas located within the Watershed. The Medicine Lake and Black Mountain Management Areas are almost entirely contained within the Watershed; while small portions of the Long Bell, Tionesta, and Clear Lake Management Areas are also located within the Watershed (see Figure 1.3).

Special management areas have been designated within the Watershed and include the Mt. Hoffman Roadless Area and the Medicine Lake Managed Late-Successional Area (MLSA). Most, but not all, of the Watershed is also located within the management area subject to the NFMP ROD. The Mt. Hoffman Roadless Area extends east-west across the length of the Watershed approximately one-mile north of Medicine Lake, and it encompasses the Mt. Hoffman area and the Glass Mountain Lava Flow. The MLSA covers the central area of the Watershed south and east of Medicine Lake and reaches south to the southeast corner of the Watershed.

Geologic Features

The Medicine Lake Highlands originally formed as the Medicine Lake volcano, which was a gently sloping shield volcano measuring approximately 20 miles (32 kilometers) across and approximately 2,500 feet (762 meters) high above the surrounding lands (BLM 1995). The volcanic shield collapsed approximately 500 feet

(152 meters) early in the history of the volcano, probably as a result of repeated extrusions of mostly mafic lava (Dzurisin, *et al.* 1991). The resulting elliptical basin measures approximately 6 miles (12 kilometers) long by 4 miles (7 kilometers) wide (BLM 1995; Donnelly-Nolan 1990).

After the collapse of the caldera, numerous volcanic eruptions resulted in the formation of eight separate rim volcanos which completely hide the former caldera boundaries (California Division of Mines and Geology 1966). Recent volcanic activity in the Medicine Lake Highlands has included the eruption of basalt flows, obsidian flows and domes, and pyroclastic pumice (BLM 1995).

Special Interest Areas (SIAs) have been designated in the Watershed, to protect these features for recreational, scientific, cultural, and educational uses. Each formally designated SIA is managed with its own set of guidelines and standards. The following SIAs have been established in the Watershed on the basis of their unique geologic features:

Burnt Lava Flow:

The Burnt Lava Flow encompasses about 8,760 acres and is located in Siskiyou County. The flow consists of three separate recent basalt flows: a highly oxidized lava, a fairly smooth pahoehoe lava, and a broken pahoehoe lava. At the time of eruption, the flows were most likely very viscous and merged together without forming easily observable boundaries. The lava surrounded three older cinder cones as it flowed to the surface. The three older cinder cones now appear as "islands" in the flow area, and are covered with conifer vegetation (USFS 1991a). The Burnt Lava Flow is believed to be between 2,660±60 years and 2,800±60 years old (Donnelly-Nolan et al. 1990).

Medicine Lake Glass Flow:

The Medicine Lake Glass Flow encompasses 570 acres and is located in Siskiyou County. The flow is a recent stony to glassy black dacite flow which formed on the floor of the Medicine Lake caldera. The flow varies in thickness from 50 to 150 feet and is very blocky (USFS 1991a).

Glass Mountain Glass Flow:

The Glass Mountain Glass Flow encompasses about 4,210 acres and is located in Siskiyou County with a small extension located in Modoc County. The formation is a very recent example of multi-stage volcanic activity which has not been modified by weathering, erosion, or vegetative cover (USFS 1991a). This flow is estimated to be 885±40 years old (Donnelly-Nolan *et al.* 1990). The steep-sided rhyolite and dacite obsidian flow erupted just outside of the eastern caldera rim and flowed down the steep eastern side of Medicine Lake Volcano (Donnelly-Nolan *et al.* 1990). The initial eruption created steep-sided cones and was followed by a pumice eruption of lava extrusions. The lava extrusions started as a stoney to blocky dacite, followed by a glassy dacite and rhyolite, and then a rhyolite obsidian. As the lava extruded from the walls of the pumice cones, the cones were destroyed except for those located at the extreme southern edge of the flow (USFS 1991a).

Climate

The climate can be characterized as montane Mediterranean, with cold wet winters and typically hot and dry summers with occasional thunder showers. Average annual precipitation levels range from 20 inches at the lowest elevations, to greater than 45 inches at the highest elevations (see Figure 1.4). Winter precipitation is mostly rain at the lower elevations, and snow in the higher elevations. The higher elevations typically have short summers and relatively long winters with deep snowpacks.

Hydrology

Medicine Lake is the principal surface water feature in the Watershed. Stream flow-related issues within the Watershed are nearly non-existent due to local geography, soil type and the high degree of soil permeability. Within the entire Watershed there are only two perennial streams, one a short stream segment associated with Crystal Springs which flows less than 1/4-mile into Medicine Lake, and the second is Paynes Creek. Paynes Creek meanders south for approximately 1.5 miles from its source at Paynes Springs before infiltrating below the surface. As the source of these streams are springs, the stream flow is fairly constant throughout the year and is only

minimally impacted by annual precipitation. The majority of the precipitation falls as snow and percolates into the soil profile or collects in one of the several seasonal ephemeral ponds. Surface water drainage within the Medicine Lake basin flows toward the Lake, but most infiltrates before reaching the Lake. Surface water outside the Medicine Lake basin generally flows to the south before infiltrating beneath the surface.

Vegetation

Vegetation within the Watershed is primarily characterized into conifer forests, non-conifer forests, and herbaceous communities. Barren or non-vegetated areas also exist within the Watershed (see Figure 1.5).

Conifer Vegetation Series:

The climate and edaphic features of the Medicine Lake Highlands are conducive to the development of forest communities with overstories dominated exclusively by conifers. Ecological associations representing monotypes and mixtures of a dozen different conifer species, potentially occupy 82.5% of the Watershed.

The primary environmental factors governing the distribution of these species, and their various ecological associations, are elevation, aspect, soil, geomorphology, and precipitation. The dominant factor determining microclimate and forest composition is elevation. The conifer communities of the Watershed may be divided into subalpine, high montane, transition and mid-montane groupings. Within each of these groups there are representative series (types) which are identified by their dominant overstory species. Within each series there are distinct associations, which are unique ecological combinations of overstory and understory species. In the following characterization of the conifer forests of the Watershed the forest communities representing each elevation grouping are identified, whenever possible, at the broader series level. However, because some series occur within more than a single elevation grouping, it is necessary to identify the appropriate association(s) within each group.

In Step 3 of this analysis, all communities within the conifer ecosystem are identified and assessed at the association level. In the following characterization the acreage designated to each series or association represents the potential total area occupied by the ecological type. Some of these areas have been modified by natural events and management activities that have occurred over time. Such actions may have resulted in portions of the potential habitat of some associations being now dominated by understory species, or colonized by pioneer associations of shrubs and/or herbs. This may have resulted in short- or long-term conversion of these parcels to a different type. The current stratification of each conifer association relative to both seral stages and atypical inclusions, is identified and quantified in Step 3 of this analysis.

Subalpine Group: The subalpine group is represented by a single series, the hemlock series. Mountain hemlock (*Tsuga mertensiana*) dominates several different associations within the subalpine zone of the Watershed. Secondary species include Shasta red fir (*Abies magnifica shastensis*), lodgepole pine (*Pinus contorta ssp. murrayana*) and/or western white pine (*Pinus monticola*). Hemlock forests occur primarily on northerly aspects of the upper slopes of the highest buttes and peaks of the area, generally at elevations exceeding 7,000 feet. The Hemlock series currently occupies approximately 4,377 acres in the Watershed. This includes 4 acres of privately owned land.

High Montane Group: The high montane group occupies slopes and flats primarily between 6,300 and 7,000 feet (7,500 feet on south and west aspects). Characterizing this climate zone are both the red fir and lodgepole pine series as well as one association of the eastside mixed conifer series. Shasta red fir and lodgepole pine most commonly occur in even-aged monotypic stands containing only minor inclusions of other species. These secondary components include western white pine, white fir (*Abies concolor*), and infrequently Jeffrey pine (*Pinus jeffreyi*). However, both the red fir and lodgepole series also contain co-dominant associations of the fore-mentioned species. For example, lodgepole pine and western white pine form an open woodland on exposed sites with shallow, rocky soils formed from weathered lava rock (western end of Glass Mountain lava flow). Also occurring within the high montane zone is an association identified by an overstory mix of Washoe pine (*Pinus washoensis*), red fir, and western white pine. This

association of the eastside mixed conifer series occurs in several locations where the microclimate approaches that of the subalpine zone. Within the high montane forest zone of the Watershed, the red fir series occupies approximately 10,687 acres (the acreage of the red fir-white fir/wintergreen association (RF-2) is not accounted for in this total, but rather included among the transition group of forest communities). The lodgepole series occupies approximately 7,310 acres (of which 128 acres are private land) and the Washoe-red fir western white pine/greenleaf manzanita association (EM3) occupies 2,907 acres.

Both the subalpine and the high montane zones occur primarily in the Medicine Lake basin but the high montane zone also extends south along the west side of the Watershed to include a block of land approximately nine square miles in size (Medicine Mountain is at the northwest corner of this square block).

At the lower elevation limits of the high montane forests are forest communities which appear to represent a transition between typical high montane series and mid-montane series. Since the elevation drops off to both the northeast and southeast from the Medicine Lake basin, bands of transition vegetation are found in both the north and south halves of the Watershed. Each half is represented by two conifer associations; however, their species composition is quite different.

Northern Transition Group: Composing the northern transition group is one association included in the eastside pine series and one association included in the eastside mixed conifer series. The former is characterized by a co-dominance of ponderosa pine (*Pinus ponderosa*) and lodgepole pine, an atypical combination of an upper montane and a low to mid-montane species. This association occurs on relatively gentle slopes, with northerly exposures, at elevations between 5,600 and 6,400 feet. The microclimate in this zone is considerably cooler than the sites within the Watershed which are occupied by other associations identified with the eastside pine series. The east side mixed conifer association located within this same zone is dominated by lodgepole pine, ponderosa pine, and sugar pine (*Pinus lambertiana*). This association occurs primarily on east to northeast exposures at elevations between 5,200 and 6,200 feet. The microclimate is slightly cooler than is typical of sites occupied by other associations in the eastside mixed conifer series, some of which are found adjacent to this association on lower slopes. The ponderosa-lodgepole/bitterbrush association (PP4) occupies approximately 7,098 acres (of which 693 acres are private land) within the Watershed. The lodgepole-ponderosa-sugar pine/jewel flower association (EM5) occurs upon approximately 2,002 acres (of which 397 acres are private land).

In the southern half of the Watershed, the forest vegetation characterizing the transition zone includes a red fir-white fir association (RF2) and a white fire monotype (WF1). The latter is the only association of the white fir series that occurs within the Watershed. The relatively pure white fir stands occur between 5,600 and 6,800 feet in elevation, primarily on southerly aspects. Most of the red fir-white fir stands occur within a similar elevation band but are located on various aspects and range as high as 6,900 feet on south facing slopes. The white fir/chinquapin association (WF1) occupies approximately 6,775 acres within the Watershed and the red fir-white fir/wintergreen association (RF2) occurs on approximately 3,412 acres.

Mid-Montane Group: The mid-montane group of conifer communities includes typical associations of the eastside mixed conifer series, the eastside pine series and the pine/juniper series.

Growing at elevations typically between 5,000 and 6,000 feet are two associations of the eastside mixed conifer series that ordinarily contain four species: ponderosa pine, white fir, incense cedar (*Colocedrus decurrens*), and sugar pine (*Pinus lambertiana*). Dominance may vary but is usually shared by two or more of these species. On mesic sites white fir is commonly the predominant stand component while on arid sites ponderosa pine assumes that role. The two eastside mixed conifer associations recognized as occurring within the Watershed are the ponderosa-white fir-cedar/squaw carpet (EM1), and ponderosa-white fir-sugar pine/bitterbrush (EM4). The Watershed contains approximately 6,193 acres of the former and 6,008 acres (of which 1033 acres are private land) of the latter.

Also occurring at mid-montane elevations, most commonly below 5,000 feet (to 5,700 on arid

sites), are associations of the eastside pine series. This series ranges into lower montane elevations outside the Watershed on the Modoc Plateau, McCloud flats and elsewhere. Stands of this series are characterized by a dominance of ponderosa pine which frequently occurs in almost pure stands but in certain associations may have up to 50% of other species, particularly on the moist sites. Associates include white fir, incense cedar, Jeffrey pine, and sugar pine. Within the Watershed there are approximately 12,855 acres (of which 1,322 acres are private land) of the eastside pine series within the mid-montane zone. This includes three distinct associations: ponderosa pine/bitterbrush (PP1), ponderosa-white fir/bitterbrush (PP2), and ponderosa-white fir/snowberry (PP3). A fourth association (PP4) is included in the transition group of conifer communities and additional acreage of eastside pine is accounted for in the description of that group. The east side pine series is concentrated near the north and north easterly boundaries of the Watershed.

Pine-Juniper Series: Occurring at the lowest elevation limits (<4,500 feet), and on the most arid of the sites within the Watershed that support conifers, is the pine-juniper series. This series is represented by a single association, the juniper-ponderosa/bitterbrush (PJ1). This association has a sparse to moderate canopy of western juniper (*Juniperus occidentalis*) associated with bitterbrush, mountain mahogany and sage. A scattered component of ponderosa pine is also present. Approximately 951 acres of this association/series occurs within the boundaries of the Watershed in the extreme northeast corner.

Non-Conifer Vegetation Series:

Stabilized communities of both woody and herbaceous species occupy approximately 769 acres (0.9%) of the Watershed. These associations represent unique and small ecological niches in the landscape. In addition, certain of these series currently occupy disturbed areas within conifer associations. The latter may be quite extensive.

Mountain Mahogany-Bitterbrush (MM): This shrub community occurs in concentrated patches and linear strings on the north central fringe of the Watershed, closely associated with the eastside pine and pine-juniper series. Moderately open to very dense stands occupy rocky undulating slopes, ravines, dikes, and cones with coarse textured soils overburdened with pumice. The climate is relatively dry (20-25 inches of annual precipitation). Curl leaf mountain mahogany (*Cercocarpus ledifolius*) and/or bitterbrush (*Purshia tridentata*) dominate the sites. Secondary scrub species include rubber rabbitbrush (*Chrysothamnus nauseosus*), and big sage (*Artemesia tridentata*). Forbs and grasses include scabland penstemon (*Penstemon deustus*), and cheat grass (*Bromus tectorum*). Approximately 479 acres (of which 83 acres are private land) of this association occur within the Watershed.

Montane Mixed Shrub Series (CM): This shrub community occupies small patches on harsh exposed ridges and upper slopes in the high montane and subalpine zones, commonly associated with rock outcrop. Typical shrub components include: greenleaf manzanita (*Arctostaphylos patula*), snowbrush (*Ceanothus velutinus*), chinquapin (*Chrysolepsis sempervirens*), bittercherry (*Prunus emarginata*), pinemat manzanita (*Arctostaphylos nevadensis*), and rock spiraea (*Holodiscus microphylus*). As a result of the harsh microclimate, these species typically exhibit a dwarfed or horizontal growth form. Small climax patches of this series occur within the Medicine Lake caldera, occupying a total of approximately 76 acres. Additional small acreage has resulted from fires and is identified in the Step 3 analysis.

Montane Chaparral Series (CX): This shrub series occurs in small to very large concentrations in the transition and mid-montane zones of the Watershed. It varies from the preceding series more in terms of its characteristic environment and growth form than it does in composition. The lower elevation sites in general provide a more moderate microclimate and improved nutritional status, resulting in a more vigorous growth form, as well as additional species. Stands are characteristically quite dense and dominants relatively tall and upright. The first five species listed for the montane mixed shrub series commonly also occur in montane chaparral, the first four as dominants or co-dominants. Mountain whitethorn (*Ceanothus cordulatus*) may also assume this role. Any of these species may occur locally in pure stands or in various mixtures,

depending on elevation, microsite, and seed sources. Other associates commonly included are: serviceberry (*Amelanchier pallida*), and mahala mat (*Ceonothus prostratus*). Approximately 77 acres of this series is resident within the Watershed, but less than 100 of the montane chaparral series polygons identified in RSL mapping can actually be typed as climax montane chaparral. Most of the sites presently occupied by this series formerly supported conifer stands of various species, and in this chapter (Step 1) the acreage representing these sites is included in the acreage totals given for the preceding conifer associations. Montane chaparral has colonized these timber sites following disturbance, principally by fire. The actual acreage of this series presently occupying portions of specific timber associations is identified in the Step 3 analysis. Associated with these invasive patches may be small areas of climax montane chaparral, but these inclusions have not been differentiated.

Herbaceous Communities:

Wet Meadows (WM): Meadow barley-baltic rush-primrose-monkey flower association. This association occupies unique areas of saturated soils (sediments) in the vicinity of a few springs located on the floor and at the margin of the Medicine Lake caldera at 6,300-6900 feet in elevation. Characteristic species include meadow barley (*Hordeum brachyantherum*), baltic rush (*Juncus balticus*), primrose monkey flower (*Mimulus primuloides*), great basin clover (*Trifolium longipes*), and western aster (*Aster occidentalis*). Additional component species are identified in the discussion of riparian reserves, where also the locations and other characteristics of this unique association are given. This association is limited to only 96 acres within the Watershed. Approximately 27 acres of this habitat type occurs on private land.

Dry Meadows (DM): Western needlegrass-pussytoes association. This association occurs in a few scattered locations within the white fir and lodgepole series at elevations between 5,800 and 6,800 feet in elevation. These sites are open and relatively flat, and are characterized by a moderately dense to open herbaceous layer composed of grasses and forbs common throughout the region. The surrounding conifer stands form a rather abrupt boundary within this herbaceous community. These contrasting patches probably represent inclusions of atypical soils with physical and/or chemical properties that seriously limit woody plant growth. Thus, for the most part, local shrub and tree species are excluded. One exception is rabbitbrush goldenbush (*Ericameria bloomeri*). The dominant grasses and forbs include western needlegrass (*Achnatherum occidentalis*), pine woods pussytoes (*Antennaria geyeri*), and onion grass (*Melica bulbosa*). Additional forbs commonly found include hoary aster (*Machaeranthera canescens*) and Ross' sedge (*Carex rossii*). Within the Watershed, this association occupies approximately 113 acres.

Pumice Flat (PF): Marumleaf buckwheat-pussy paws association. This association is concentrated on the floor of the Medicine Lake caldera at two locations, the principal one being Arnica sink. This site is flat, located in the center of a basin, at 6,700 feet elevation. A deep overburden of rhyolitic pumice blankets the area and gravels of pumice and cinders form a highly reflective, droughty, and strongly acid surface pavement which only a few perennial subshrubs and forbs can tolerate as a growing medium. Species adapted to this tough microsite include Marumleaf buckwheat (*Eriogonum marifolium*), pussy paws (*Calyptridium umbellatum*), dwarf lupine (*Lupinus lepidus*), Parry's rush (*Juncus parryi*), and California aster (*Lessingia filaginifolia*). This association forms only a sparse cover that is most visible in early summer. The total area occupied in Arnica sink is approximately 153 acres.

Non-Vegetated Landscape Features:

Within the Watershed there are lava beds, talus slopes, and hydrologic features. The sizes of these areas are outlined below.

Barrens (Natural):

Lava — 12,952 acres (of which 231 acres are private land)
Talus — 150 acres

[Note: Manmade barrens also exist in the Watershed and are identified and quantified in Step 3 analysis.]

Water:

Lakes (perennial) — 440 acres (of which 41 acres are private land)
Ephemeral ponds (seasonal) — 33 acres

[Note: Acreages given are for the bodies of water only. For area of total riparian reserves, including protective buffer zones, see Riparian Reserves in Step 3 analysis for additional discussion of acreage.]

The total area occupied by non-vegetated features in the Watershed is 13,874 acres.

Wildlife

The Watershed provides habitat for a wide variety of wildlife species including habitat suitable for Federally listed species. Nearly 160 species of wildlife may utilize the habitats within the Watershed. Even though the structural attributes of suitable habitat are present, the lack of standing water and moist soil conditions to promote herbaceous growth during summer months may be a limiting factor to the utilization of the Highlands by wildlife in significant numbers. Human activities have caused a minimum of disturbance to the habitats of the Medicine Lake Highlands.

Late-Successional Habitat

There are approximately 6,500 acres of late-successional habitat within the Watershed. According to Remote Sensing Lab data this late-successional habitat is comprised of 12 plant associations (see Figure 1.6). A managed late-successional area (MLSA) has been established in the southern portion of the area for the purpose of retaining northern spotted owl (NSO) habitat. The Medicine Lake Highlands MLSA was created to meet the requirements of the Record of Decision, and located in an area that has had detections of NSO; however, no nesting sites or roost areas have been located. The MLSA contains six plant communities including subalpine conifer (1241 acres), red fir (7335 acres), lodgepole pine (469 acres), eastside mixed conifer (3715 acres), ponderosa pine (2732 acres), and white fir (3625 acres). In addition there is montane chaparral (15 acres), dry meadows (51 acres), and water (17.5 acres).

Not all late-successional habitat occurring within the Watershed is found in the MLSA.

Fire History

Fire suppression/prevention activities probably were not very effective prior to the 1920s. The available fire history records show one fire prior to the 1920s occurring in 1919. The area of California in which the Medicine Lake Watershed is located was relatively unsettled until the build-up of agriculture in the area of the valleys around Tulelake.

Fire has played an important role in the ecosystem processes throughout the southern Cascades and the Sierra Nevada for thousands of years. The frequency and severity of these fires varied (Skinner and Chang 1996). The natural process of lightning and relatively recent volcanic activity, as well as the Native American use of fire practices have played a major role in the development of the ecosystem of the Medicine Lake Watershed. This role was not impacted by suppression until the early part of this century.

The long dry summers and the low precipitation rates in the Watershed indicate potential for numerous low intensity fires prior to the settlement of the area by EuroAmericans. The relatively recent volcanic activity of the area would also suggest that lava and volcanoes added to the pre-history fire regimes of the area covered by the Watershed. Medicine Lake in the basin beneath Mt. Hoffman and the lava flows throughout the Watershed are a result of previous volcanic activity and probably resulted in wildfires that were not suppressed.

The *Modoc National Forest Land and Resource Management Plan* shows that the annual acreage burned in the Forest varies widely. Particularly in the past two decades. The Forest has recorded 6,094 fires burning 705,334 acres from 1910 to 1979. Twenty-three percent of these fires were human caused, and 77 percent were started by lightning (Modoc National Forest, Land Resource Management Plan). See Table 7 of Appendix B for additional information on acreage amounts burned in lightning started fires in the Medicine Lake Highlands.

During the 1970s an increase in annual average acreage burned is attributed to the unusually

large fires in 1973 and 1978. In 1977 a severe drought in California and the west also affected the Modoc National Forest. It was during this time that dry lightning bombarded the Modoc National Forest and started numerous small fires. These small fires burned together causing large fires. Most noteworthy of the large fires were the Gerig and Scarface fires. Over 100,000 acres burned that year. Even though these large fires occurred outside of the Medicine Lake Watershed they still give the fire manager a glimpse at the potential for large fire inside the Watershed. They are also indicative of the difficulty in controlling numerous fires ignited by dry lightning in the Modoc National Forest.

Human Uses

Most human development in the Medicine Lake Watershed is found in the area directly surrounding Medicine Lake. Approximately 40 privately owned houses and cabins are located near the lake, and several public campgrounds, provide the primary developed summer recreation. Dispersed recreation occurs in other portions of the Watershed, most commonly in the forms of hunting and hiking. Wintertime recreation includes snowmobiling. The Door Knob Snowmobile Park is located in the northern end of the Watershed, and a series of groomed (and ungroomed) snowmobile trails and play areas are located within the Watershed which is part of the Tri-Forest Snowmobile Trail System.

Timber harvests have historically occurred in the Watershed. Timber management and periodic timber harvests continue. Similarly, mining claims and active mines exist in the Watershed. Mineral resources of interest include cinder, pumice, and gravel. The potential for development of geothermal resources within the Watershed has been recognized since the mid-1960s, and most of the Watershed is located within the Glass Mountain Known Geothermal Resource Area (Glass Mountain KGRA). Geothermal leases have been issued for much of the lands within the Watershed and, to date, only geothermal resource exploration activities have been conducted. The Glass Mountain KGRA is shown on Figure 1.7.

Native American groups use the Medicine Lake area for traditional activities and continue to recognize the spiritual values inherent in the entire Medicine Lake Highlands area (Theodoratus and Emberson 1996).

STEP 2 — ISSUES AND KEY QUESTIONS

INTRODUCTION

Nine topics have been identified for ecosystem analysis, including: Upslope Hydrologic Processes, Riparian Reserves, Fire Management, Late-Successional Habitat, Terrestrial Wildlife, Roads, Silviculture, Survey and Managed Species, and Human Uses.

ISSUES AND KEY QUESTIONS

Upslope Hydrologic Processes

Upslope hydrologic processes are a function of the geographic location of the Watershed, precipitation, soil types, soil disturbance, soil erosion potential, permeability, and degree of slope. The geographic location of the Watershed is generally at the upper elevations of the Medicine Lake Highlands and therefore not appreciably susceptible to upslope hydrologic processes except at localized locations within the assessment area. Within the Watershed there are 19 soil types in association with 18 vegetative communities. Sixteen of these soil types have moderately rapid to rapid soil permeability as evidenced by precipitation infiltrating rapidly into the soils rather than running off. These soil types account for the occurrence of only two perennial streams within the Watershed. Even though the majority of the soils within the Watershed have a relatively high erosion rating, upslope hydrologic processes may be characterized as localized events and occurring only occasionally on the slopes of the numerous buttes and cones within the area.

This analysis will discusses the important hydrologic and erosion processes, reevaluates cumulative watershed effects, and makes recommendations for future management in sub-watersheds potentially impacted by Forest activities.

The analysis addresses the following key questions:

Step 3 — Current Conditions:

Key Questions: What are the dominant hydrologic, both surface and subsurface, characteristics and processes within this Watershed?

Step 4 — Reference Conditions:

Key Questions: What were historical (pre-EuroAmerican settlement) dominant hydrologic, both surface and subsurface, characteristics and processes within this Watershed and what disturbances have effected them?

Step 5 — Interpretation:

Key Questions: Are there changes between the historical and current dominant hydrologic, both surface and subsurface, characteristics and processes within this Watershed and what are their causes?

Riparian Reserves

The Northwest Forest Management Plan, Record of Decision (NFMP ROD), incorporated into the Forest Plan, establishes Riparian Reserves as a land allocation where riparian dependent sources receive primary emphasis. Riparian Reserves are also intended to provide habitat connectivity for late-seral dependent species. Interim Riparian Reserves are described in the NFMP ROD, and subject to refinement recommendations made through the analysis process for the Watershed. The analysis discusses current and reference conditions of riparian areas and makes recommendations for field delineation and management of Riparian Reserves in the Watershed.

The analysis will address the following key questions:

Step 3 — Current Conditions:

Key Questions: What are the current conditions and widths of riparian reserves?

Step 4 — Reference Conditions:

Key Questions: What are the historic and reference riparian conditions in the Watershed?

Step 5 — Interpretation:

Key Questions: What are the natural and human causes of change between the historical/reference and current riparian area conditions?

Fire Management

This part of California has a rich history of lightning activity and relatively recent volcanic activity that for thousands of years started fires throughout the region. It should be recognized that this area had numerous fires that went unsuppressed.

True fire suppression and management probably didn't begin to occur until the 1920s when the Forest Service took an active role in fire suppression throughout the western United States.

Prior to active fire suppression activities on National Forests in California during the early 1900s, and most likely up until the 1940s, suppression activities were confined to protection of developments and the important natural resources. Many of the fires were started by lightning, but were not suppressed, particularly in the higher elevations.

The analysis evaluates the effects of human usage, fire fuels management, and fire protection agencies. Recommendations for fuels management, and suppression and prevention strategies are provided.

The analysis addresses the following key questions:

Step 3 — Current Conditions:

Key Question (1): What are current fuel characteristics, fire hazard potential, and fire risks in the Watershed?

Key Question (2): What are the fire protection agencies and where are their response areas within the Watershed?

Key Question (3): What are current fire risks in the Medicine Lake homeowner and the proposed geothermal power plant interface areas?

Step 4 — Reference Conditions:

Key Question (1): What was the historic fire regime for each vegetation community?

Key Question (2): What have the historical fire protection agencies been and where have their response areas been located within the Watershed?

Key Question (3): What have historic fire risks in the Medicine Lake homeowner and the proposed geothermal power plant interface areas been?

Step 5 — Interpretation:

Key Question (1): What has changed and what have been the agents of change for fuel characteristics, fire hazard potential, and fire risks in the Watershed?

Key Question (2): How have the fire protection agencies and their response areas within the Watershed changed?

Key Question (3): How have current fire risks in the Medicine Lake homeowner and the proposed geothermal power plant interface areas changed?

Key Question (4): Are there high risk areas in or bordering high fire behavior potential areas and what are the management implications?

Key Question (5): What are the trends for fire risks and fire behavior potential?

Late-Successional Habitat

Areas of this Watershed have the characteristics of a late-successional habitat, which is suitable for late-successional associated wildlife species, specifically the northern spotted owl.

This analysis evaluates the current and sustaining late-successional habitat. The analysis assesses the existing condition of late-successional connectivity and recommended ways to provide connectivity across the Watershed and to adjacent watersheds.

The analysis addresses the following key questions:

Step 3 — Current Conditions:

Key Question (1): How much of the Watershed is currently late-successional habitat, where is it located, and what is the block size?

Key Question (2): Where is the existing connectivity and dispersal habitat across the Watershed and to adjacent watersheds?

Step 4 — Reference Conditions:

Key Question (1): How much of the Watershed has historically been late-successional habitat, where was it located, and what was the block size?

Key Question (2): Where was the historic connectivity and dispersal habitat across the Watershed and to adjacent watersheds?

Step 5 — Interpretation:

Key Question (1): What has caused the amount of the Watershed that is late-successional habitat, its location, and its block size to change?

Key Question (2): How has the location of the connectivity and dispersal habitat across the Watershed and to adjacent watersheds changed?

Terrestrial Wildlife

The Watershed is home to many wildlife species. In the analysis the following species are assessed:

- Bald Eagle (Federal Threatened),
- Northern Spotted Owl (Federal Threatened),
- Northern Goshawk (Forest Service Sensitive),
- Pacific Fisher (Forest Service Sensitive),
- Mule Deer (Management Indicator Species),
- Sierran Red Fox (Forest Service Sensitive),
- Osprey (Management Indicator Species),
- American Marten (Forest Sensitive Species),
- Wolverine (Forest Service Sensitive),
- Great Gray Owl (Buffer Protection Species),
- Pallid Bat (Forest Service Sensitive, Buffer Protection Species),
- Townsend's Big-Eared Bat (Forest Service Sensitive, Buffer Protection Species),
- Long-Eared Myotis (Record of Decision Survey and Management Species, Buffer Protection Species),
- Long-Legged Myotis (Record of Decision Adaptive Management Species, Buffer Protection Species),
- Fringed Myotis (Record of Decision Adaptive Management Species, Buffer Protection Species), and
- Silver-Haired Bat (Record of Decision Adaptive Management Species).

The analysis addresses the following key questions:

Step 3 — Current Conditions:

Key Questions: For the species identified in this Watershed:
(a) What are the habitat needs?
(b) Where is the habitat in the Watershed based on existing information?
(c) How much habitat is in the Watershed?

Step 4 — Reference Conditions:

Key Questions: For the species identified in this Watershed:
(a) What were the vegetative associations that constituted habitat for each specie?

(b) Where was the habitat in the Watershed based on existing information?
(c) Based on available information, how much habitat was in the Watershed?

Step 5 — Interpretation:

Key Question (1): For the species identified in this Watershed:
(a) How has the habitat changed within the Watershed?
(b) How much has the amount of habitat in the Watershed changed?

Key Question (2): What are future trends for these habitats?

Key Question (3): Based on current direction, what are the implications for forest management in providing habitat for these species?

Roads

Major roads in the Watershed include Primary Forest Road 97 crossing east-west through the middle of the Watershed and Primary Forest Road 49 providing access to the Watershed from the Lava Beds National Monument adjacent to the northern boundary of the Watershed and from the southern boundary of the Watershed to Medicine Lake. Secondary forest roads and unimproved four-wheel drive roads also exist in the Watershed. These predominantly former logging roads provide access for dispersed recreation activities. This section addresses existing road density levels in the Watershed.

The analysis addresses the following key questions:

Step 3 — Current Conditions:

Key Questions: Where do roads exceed density standards?

Step 4 — Reference Conditions:

Key Questions: Why and how was the road system developed?

Step 5 — Interpretation:

Key Questions: How has the amount of roads changed and what have been the causes for exceeding density standards?

Silviculture

The silviculture analysis addresses the following key questions:

Step 3 — Current Conditions:

Key Question (1): What are current characteristics of the physical and botanical elements of the landscape, and what identifiable practices and natural events, of the past 50 years, have contributed to this current status with respect to:
(a) Distribution of ecological associations with unique management requirements;
(b) Species composition of associations;
(c) Percent distribution of seral stages;
(d) Average stand size;
(e) Spatial arrangement of stands;
(f) Occurrence and location of stands at risk of catastrophic loss from insects, disease and fire; and
(g) Occurrence and location of stands where stocking exceeds the long-term capacity of the site for sustained growth?

Key Question (2): What is the current status of Northern Spotted Owl nesting, roosting, and foraging habitat?
(a) What is the extent of habitat?
(b) Where is it located?
(c) Is current seral stage distribution appropriate to sustain nesting, roosting, and foraging habitat?

Step 4 — Reference Conditions:

Key Question (1): What were the characteristics of the Watershed prior to the introduction of intensified management activities, including harvesting, fire suppression, and silvicultural treatments? With respect to:
(a) Distribution of ecological associations;
(b) Species composition of associations;
(c) Percent distribution of seral stages within associations;
(d) Average stand size of each seral stage;

(e) Spatial arrangement of stands;
(f) Occurrence and location of stands where stocking exceeds the long term capacity of the site for sustained growth;
(g) Occurrence and location of stands at risk of catastrophic loss from insects, disease, or fire.

Key Question (2): What was the capacity of the Watershed Analysis Area for Northern Spotted Owl nesting, roosting, and foraging habitat under reference conditions?
(a) What was the extent of such habitat?
(b) Where was it located?
(c) Was the seral stage distribution appropriate to sustain nesting, roosting, and foraging habitat?

Step 5 — Interpretation:

Key Question (1): How have timber harvest, fire exclusion, and other management activities changed the biological and physical elements of the landscape from the reference condition? With respect to:
(a) Percent distribution seral stages;
(b) Average stand size;
(c) Amount of Northern Spotted Owl nesting, roosting, and foraging habitat;
(d) Spatial arrangement of stands; and
(e) Species composition of stands.

Key Question (2): How have changes in management practices caused forest health and sustainability to change from reference conditions?
(a) How has the amount of stands at risk of catastrophic loss from disease, insects, or fire changed; and where are they located changed?
(b) Has management caused stands where current stocking has reduced growth and vigor, compromising the Forest's ability to achieve both late seral habitat development or timber output expectations?
(c) How has current seral stage distribution appropriate to nesting, roosting, and foraging habitat changed?

Survey and Managed Species

The Northwest Forest Management Plan, Record of Decision (NFMP ROD) amends the planning documents of 19 National Forest and 7 Bureau of Land Management Districts relative to the conservation and management of late-successional stage and old growth forest on USFS and BLM lands within the range of the northern spotted owl. The comprehensive ecosystem management strategy that is presented supersedes guidance provided in other federal land management plans including the Modoc National Forest LRMP. The ROD identifies plant and animal species to be protected through survey and management standards and guidelines. The "survey and manage" guidelines are intended to provide benefits to listed amphibians, mammals, bryophyte, mollusks, vascular plants, fungi, lichens, and arthropods dependent on late-successional forest.

The analysis addresses the following key questions:

Step 3 — Current Conditions:

Key Questions: What is the status of known information of survey management?

Step 4 — Reference Conditions:

Key Questions: What known information of survey management was historically used?

Step 5 — Interpretation:

Key Questions: How has the status of known information of survey management changed?

Human Uses

The Watershed has a diverse cultural heritage from Native Americans and pioneering loggers. More recently, varied land uses including recreation, industrial forestry, and mineral extraction have occurred in the Watershed. In addition, two proposals for large-scale geothermal developments for electrical energy production from existing geothermal leases, including the construction of an electrical transmission line, are

currently being processed in the Glass Mountain KGRA. This analysis discusses important heritage resources, non-timber commodities, private land uses and recreational activities, and recommends ways to enhance or protect these uses.

The analysis addresses the following key questions:

Step 3 — Current Conditions:

Key Questions — Heritage Resources: What heritage resources exist within the Watershed?

Key Questions — Non-Timber Commodities: What non-timber commodities are utilized in the Watershed?

Key Questions — Recreation: What are the primary recreational uses in the Watershed?

Step 4 — Reference Conditions:

Key Questions — Heritage Resources: What prehistoric and historic resources exist within the Watershed?

Key Questions — Non-Timber Commodities: What non-timber commodities were historically utilized in the Watershed?

Key Questions — Recreation: What have the primary recreational uses in the Watershed historically been?

Step 5 — Interpretation:

Key Questions — Heritage Resources: What are the causes of change between historical heritage resources and heritage resources existing within the Watershed?

Key Questions — Non-Timber Commodities: What are the causes of change between historical and current utilization of non-timber commodities in the Watershed?

Key Questions — Recreation: What are the causes of change between historical and current primary recreational uses in the Watershed?

STEP 3 — CURRENT CONDITIONS

INTRODUCTION

This step describes the current range, distribution and condition of ecosystem elements. It is organized by the topics presented in Step 2 and answers Key Questions identified for each topic.

UPSLOPE HYDROLOGIC PROCESSES

Key Questions

What are the dominant hydrologic, both surface and subsurface, characteristics and processes within this Watershed?

Summary Response

Upslope hydrologic processes are of concern to the quality of the downstream uses for many geographic areas. Within the Medicine Lake Highlands, the dominant hydrologic processes are precipitation, snowmelt and soil permeability. Specifically for the Watershed the hydrologic processes are a function of the geographic location of the Watershed, soil types (inclusive of soil erosion factor, permeability, water run-off potential) precipitation, soil disturbance and degree of slope.

Background Information

Geographic Location

The Watershed is located in what is known as the Medicine Lake Highlands. The Highlands is a broad shield volcano approximately twenty miles in diameter rising almost four thousand feet above the level of the surrounding plateau. It is composed primarily of andesitic lava flows. The original peak of the volcano collapsed to form an elliptical caldera measuring four by six miles. The caldera rim was subsequently surmounted and entirely obscured by a rampart of small secondary parasitic volcanoes including Glass Mountain, Mount Hoffman, Medicine Mountain, Little Mount Hoffman, Red Shale Butte, and Lyons Peak. These geological events resulted in the Medicine Lake Highlands being the highest geographical feature in the region, characterized by domes and buttes of volcanic origin. The upslope hydrologic processes that effect the Watershed occur locally on the side slopes of the domes and buttes within the area. The degree of effect is conditional on the soil types, degree of slope, and amount of precipitation.

Soil Types

There are sixteen soil families within the Watershed including: Lapine-divers, Divers-Lupine-Kinzel, Lapine-Weksi-Divers, Yallani-Sheld, Kinzel-Lapine-Divers, Stonewell, Inville-Yallani, Stonewell-Yallani, Sheld-Ahart, Alcot-Sadie, Alcot, Stonewell-Yallani, Alcot-Neer, Yallani-Inville, Stonewell-Yallani-Zynbar and Stukel-Los Gatos-Pass Canyon (see Figure 3.1). These soils were formed by the weathering and mechanical breakdown of extruded volcanic rocks. Generally, the soils consist of 2-12 inches of pumice overburden on slopes of 1-40%. Soils inventory has determined that there are nineteen surface soil types within the Watershed (USFS and Soil Conservation Service 1983). Table 3.1 describes the characteristics of the respective soils and their relationship to potential upslope hydrologic processes and plant associations. With respect to hydrologic processes, twenty-three of these soils have a moderate to rapid soil permeability, nineteen have slow to very slow run-off potential while only seven have a moderately high to high erosion hazard. These characteristics result in soils of a very cohesive and porous nature, yielding little surface run-off or sediment transportation. Essentially soil transportation is minimal throughout the Watershed.

The parasitic volcanoes are composed mainly of andesite flows. Some are apparently composite cones consisting of both flows and pyroclastics. In more recent geologic time eruptions on the floor of the caldera and from some of the secondary volcanoes have released an acidic suite of rocks including spectacular domes and flows of rhyolitic obsidian, rhyodacite, and dacite as well as a relatively thin to thick extensive mantle or rhyolitic pumice. In addition, basalts of the Modoc Basalt series have erupted on the flanks of the volcano in recent time. The side slopes of these geographic features are generally stable and evidence little surface erosion.

Precipitation

Precipitation falls within the Watershed as either rain, snow or hail. Records show that between one-half and two-thirds of the annual precipitation in the region occurs between the months of December and March. In all but extreme instances of particularly warm storms, precipitation in the area during the winter is in the form of snow. Snow course measurements are taken once a year at the beginning of April in a meadow adjacent to the Medicine Lake Ranger Station. Snow depths have ranged from a minimum of approximately 27 inches in 1988 to nearly 160 inches (water equivalent of 65 inches of rain) in 1983 (BLM *et al.* 1998). The occurrence of snow with its resultant slow melting characteristics enhances the potential for water to slowly percolate into the soil strata. The average annual precipitation in the Watershed is plotted on Figure 1.4.

Soil Disturbance

Soil disturbance, either naturally occurring or man caused, can be a factor of upslope hydrology. Within the Watershed there has been some soil disturbance resultant of human activities including road building, timber harvesting, mining, geothermal exploration, campgrounds, and housing. Road construction as well as dust resultant of vehicular traffic and erosion of loose road surface soils contributes to soil transportation. Within the Watershed there is presently 199.4 miles of improved roads and 169.4 miles of unimproved roads which contribute to surface erosion. Timber harvest, with associated soil disturbance, is also a contributor to surface erosion depending on the type of harvesting practiced, degree of slope and soil type. However, the last timber harvest in the area was conducted in 1990, and therefore timber harvest activities are not presently a contributing factor to soil movement. Soil disturbance from mining, geothermal exploration, campgrounds and housing are minimal and this disturbance is not a significant factor over the majority of the Watershed. The impacts from man caused soil disturbance generally have minimal effects on the upslope hydrology of the area due to the minor amount of disturbance and the porous nature of the soils within the area which yields little surface run-off or sediment transportation.

Degree of slope

The topography of the Highlands may be characterized as a high plateau with volcanic formations including cinder cones, caldera basins, craters, irregular rhyolite lava flows, volcanic side slopes, recent lava flows, and a basalt capped plateau. The volcanic origin of the area results in the side slopes of the cones and hills being of a moderate gradient with porous soil and lava surface strata. Degree of slope ranges between 0 and 60% with the average slopes between 20 and 30%. The area has a low risk of slope movement due to the gentle slopes (less than 30% average), stable parent material (volcanic bedrock), and a large percentage of cohesive soils (see Figure 3.2).

RIPARIAN RESERVES

Key Questions

What are the current conditions and widths of riparian reserves?

Summary Response

Riparian reserves make up a relatively small and localized portion of the Medicine Lake Highlands Area Watershed Analysis Area. The hydrology of the area results in a general lack of permanent surface water channels, and only a few areas where internal drainage is ponded on the surface. In general, the moderately deep to very deep soils, many of which have surface covers of pumice or course ash, are characterized by rapid infiltration and percolation rates. The majority of water percolating through the soil profile is then routed deeper, through jointed volcanic bedrock or unconsolidated tefra, to underground aquifers.

ations

Erosion Factor (K)*	Maximum Erosion Hazard*	Soil Permeability*	Drainage Class*	Water Runoff Potential*	Watershed Sensitivity*	Hydrological Soil Group*
.20	High	Rapid	Somewhat excessive	Mod.	7 (Mod.)	A
.17	Mod.-High	Mod. Rapid-Rapid	Somewhat excessive	Mod.	7 (Mod.)	A
.17	Mod.	Rapid-Mod. Rapid	Somewhat excessive	Very slow	8 (Low)	A
.20	Low-Mod.	Rapid	Somewhat excessive	Very slow	8 (Low)	A
.20	Low-Mod.	Mod.-Rapid	Well drained	Slow	8 (Low)	B
.20	High	Rapid	Somewhat excessive	Mod.	7 (Mod.)	A
.17	Mod.	Rapid-Mod. Rapid	Somewhat excessive	Very slow	8 (Low)	A
.17	Low-Mod	Mod. Rapid	Well drained	Very slow	7 (Low)	C
.17	Low-Mod	Mod. Rapid	Well drained	Very slow	7 (Low)	C
.17	Mod.	Rapid-Mod. Rapid	Somewhat excessive	Very slow	8 (Low)	A
.17	Mod. - High	Mod. Rapid-Rapid	Somewhat excessive	Mod.	7 (Mod.)	A
.15	Mod.	Rapid	Somewhat excessive	Very slow	8 (Low)	A
.17	Mod. - High	Mod. Rapid-Rapid	Somewhat excessive	Mod.	7 (Mod.)	A
.17	Low-Mod.	Rapid-Mod. Rapid	Well drained	Slow - Very slow	8 (Low)	B
.15	Mod.	Rapid	Somewhat excessive	Very slow	8 (Low)	A
.20	Mod. - High	Mod. Rapid	Somewhat excessive	Mod.	7 (Mod)	B
.20	Mod. - High	Mod. Rapid	Somewhat excessive	Mod.	7 (Mod)	B
.20	Mod-High	Mod. Rapid	Somewhat excessive	Mod.	7 (Mod)	B
.20	Low-Mod.	Mod.	Well drained	Slow	9 (Low)	B
.20	Low-Mod.	Mod. Rapid	Somewhat excessive	Very slow	9 (Low)	A
.15	Mod.	Rapid	Somewhat excessive	Very slow	8 (Low)	A
.15	Low-Mod.	Rapid	Somewhat excessive	Very slow	9 (Low)	A
.15	Low-Mod.	Rapid-Mod. Rapid	Somewhat excessive	Very slow	9 (Low)	A
.15	Low-Mod.	Rapid-Mod. Rapid	Somewhat excessive	Very slow	9 (Low)	A
.15	Low-Mod.	Rapid	Somewhat excessive	Very slow	9 (Low)	A
.20	Mod-High	Mod. Rapid	Somewhat excessive	Mod.	7 (Mod)	B
.15	Low-Mod.	Rapid-Mod. Rapid	Well drained	Slow	8 (Low)	B
.20	Mod-High	Mod. Rapid	Somewhat excessive	Mod.	7 (Mod)	B
.15	Low-Mod.	Rapid-Mod. Rapid	Somewhat excessive	Very slow	9 (Low)	A
.20	Low-Mod.	Mod. Rapid	Somewhat excessive	Very slow	9 (Low)	A
.20	Mod-High	Mod. Rapid	Somewhat excessive	Mod.	7 (Mod)	B
.20	Low	Mod. Rapid	Somewhat excessive	Very slow	9 (Low)	B
.37	Mod.	Mod.	Well drained	Slow	6 (Mod)	D

Iniversity of California (Agricultural Experiment Substation).

Within the Medicine Lake basin, a good portion of the internal water drains into Medicine Lake and its immediate environs. Thus this basin contains the majority of the limited riparian reserves. A second concentration is found in the Paynes Springs area (Section 19, T43N, R4E) and immediately west in the vicinity of Bullseye Lake (Section 24, T43N, R3E). The balance of the reserves include a narrow strip bordering several miles of the perennial and intermittent portion of Paynes Creek, several ephemeral ponds in the vicinity of Alcohol Crater, and an isolated pond about a mile north of the Medicine Lake Glass Flow (Section 26, T44N, R3E). Each of these locations are shown on Figure 3.3. The total area of these riparian reserves approaches 1,000 acres, including 392 acres of lake surface (see Table 3.2).

In addition to the wetlands included in Table 3.2, the following potential wetlands exist in the Watershed. The following wet meadows are currently not included in the Modoc National Forest inventory of wetlands:

(1) A small meadow of approximately ⅔-acre between FS road 43N48 and Medicine Lake in the NE1/4, Section 10, T43N, R3E.

(2) A large meadow forest complex (mosaic) of approximately 30 acres immediately south of Medicine Lake in the S1/2 of Section 11 and the N1/2 of Section 14, T43N, R3E.

(3) A small wet meadow of approximately 1 acre, 350 feet south of the intersection of Forest Road 97 and Forest Road 43N21 in the SW1/4 of Sec 18, T43N, R4E. This meadow is at the head of the Paynes Creek drainage, though the three springs feeding the perennial portion of the creek are further south.

Table 3.2: Riparian Reserves

Riparian Type	Approximate Acreage	
	Reserve	Water Surface
Lakes (with 300 ft. buffer zone):		
Medicine Lake	50	375
Little Medicine Lake	16	3.8
Bullseye Lake	19	5.6
Blanche Lake	16	3.8
Lake (SW1/4, Sec 6, T44N, R3E)	15	2.0
Total Lakes Acreage	566	390.2
Perennial Ponds (Crystal Springs) - (acreage includes 300-foot buffer zone with associated wet meadows and perennial stream)		33
Ephemeral Ponds (with 300-foot buffer zones):		
SE1/4 Sec 2, T43N, R3E		3
NE1/4, NW 1/4 Sec 24, T43N, R3E		5
SE1/4, SW1/4, Sec 24, T43N, R3E		5.6
SE1/4, SE1/4, Sec 24, T43N, R3E		14.4
NW1/4, Sec 8, T43N, R4E		10
Sec 7, T43N, R4E middle		20
Alcohol Crater		19
Total Ephemeral Pond Acreage		**77**
Meadows catagorize as wetlands with 150 buffer zone:*		
Border SW1/4 Sec 2, NW1/4 Sec 11, T43N, R3E		16.3*
NE1/4, NW1/4, Sec 10, T43N, R3E		3.7*
SE1/4, NW1/4, Sec 10, T43N, R3E		8
SW1/4, SW1/4, Sec 18, T43N, R4E		3.8
S1/2, Sec 19, T43N, R4E		1.9
Total Meadows Acreage		**33.7**
Perennial stream (Paynes Creek) with 300 ft buffers		140
Intermittent stream (Paynes Creek) with 120 ft buffers		142
Total Riparian Reserves		**991.7**

Source: Modoc National Forest Remote Sensing Lab (RSL) Data (1993).

*The duration of saturated soil condition is probably insufficient for these areas to qualify as wetlands.

Background Information

Lakes:

Composition: Lakes in the Watershed are typically encircled by a narrow band of herbaceous riparian vegetation with a rather abrupt transition to lodgepole pine forest or dry grassland openings. In rocky areas, and on moderately sloping shorelines, where the lake bottom drops off relatively abruptly, the forest may extend almost to the water's edge. Typical riparian borders include:

(1) Shoreline and marshy inclusions occupied by graminoids growing partially submersed in shallow water or on perennially saturated soils near the water's edge. Dominant species include: *Carex vesicaria* var *vesicaria, C. Aquatalis, Eleocharis acicularis* var *bella,* and *Scripus acutus* var *occidentalis.*

(2) Low gradient outer beaches with seasonally saturated soils. Dominant species include: *Juncus balticus, J.sp* (annual), *Carex microptera, Hordeum brachyantherum,* and *Calamagrastis Stricta inexpansa.* These areas are commonly less than 15 feet in width but in local flats may occur up to several hundred feet in width (northwest shore of Medicine Lake).

(3) Moist interior low gradient beaches and transition into dry soils of adjacent Lodgepole pine forest. Common species include: *Achnatherum occidentalis sp. Pubescens Elymus trachycaulis, Hordeum brachyantherum, Achillea millefolium,* and *Poa scunda ssp. juncifolia.*

Condition: Shorelines are well stabilized by vegetation or rock with no significant washing or undercutting. Little disturbance has occurred to riparian vegetation which is relatively resistant to impacts. The exceptions to this general condition are occasional and limited trails for recreational access. Some compaction of riparian vegetation and soil does occur around the perimeter of Bullseye Lake. The surrounding lodgepole pine forests are intact, thinned only for campground development. There is no significant runoff from campground facilities to the lake. The designated buffer zones appear to be more than adequate for the protection and health of the riparian ecosystem.

Perennial Ponds (Crystal Springs Area):

Composition: The Crystal Springs pond area is a complex riparian association consisting of two spring-fed marshy ponds, a branched perennial stream which feeds into Medicine Lake, a wet meadow of varying width on the perimeter of these water bodies and courses (portion of Brownell Meadow), and a surrounding forested buffer of lodgepole pine forest on the north and west sides and red fir-mt. hemlock forest on the south and east sides. Typical riparian vegetation includes:

(1) Aquatic plants occupying the shallow ponds and adjacent marshy areas dominated by species similar to those identified for shoreline vegetation of lakes.

(2) Wet meadow species similar to those identified for low gradient outer beaches of lakes.

(3) Grass species occupying moist peripheral soils (transition to forest) including: *Calamogrostis canadensis, Elymus trachycaulis, Achnatherum nelsonii, A. occidentalis, Poa secunda,* and *Trisetum spicatum.*

Condition: This area is buffered from recreational users of Medicine Lake by a quarter-mile of private land, and consequently there is no evidence of recent human impacts. A single debris slide above the reserve on the southern mountainside is separated from riparian vegetation by a band of red fir-Mt. hemlock. The stream bank is well stabilized with a dense border of graminoids. It has maintained a stable meandering course with no evidence of erosion or accelerated down cutting. The present buffer zone appears to be quite adequate. Some past cutting of individual lodgepole has occurred within the stand on the north side, but this thinning has only extended the herbaceous border on the moist to dry perimeter of the reserve.

Ephemeral Ponds

Composition: Ephemeral ponds in the Watershed are a type of riparian reserve that occurs in unique topographical depressions where fine grained sediments (glacial and alluvial) have accumulated over time, resulting in relatively impervious soil horizons that impede water infiltration and percolation. Spring snow melt accumulates in these basins and persists for two or three months before it gradually evaporates or seeps into the underlying rock strata. The slowly receding water line results in a soil moisture gradient of several regimes supporting a unique variety of plant species. Emergent species (i.e., plants initially rooted underwater but with tops extending above) include: *Isoetes howellii, Eleocharis acicularis* var *bella*, and species of *Carex* and *Juncus*. They become terrestrial as the water recedes and additional annuals such as *Claytonia sp.* also occupy the wet pond bottom as it drains and slowly dries. Plants noted on the seasonally moist periphery of some ponds included *Penstemon cinicola, Carex halliana, Juncus spp.* and in drier areas, *Calypfridium umbellatum.*

All these reserves include an outer ring of lodgepole pine within the 300-foot buffer. In dry years the ephemeral ponds in Alcohol Crater and two nearby basins contain little or no water, and thus the riparian vegetation in these reserves is limited. The three ponds in close proximity to Bullseye and Blanche Lakes (Section 24, T43N, R3E) contain water more frequently and for longer periods (approaching perennial ponds). Thus the two larger southerly ponds are bordered by relatively wide bands of graminoid vegetation similar to that described for lakes.

Condition: No alteration of natural conditions have occurred within any of the ephemeral pond reserves with the exception of the one in the SE1/4 of Section 24, T43N, R3E. In that reserve, past harvesting has removed approximately ½ of the trees from the outer portion of the lodgepole pine stand included within the 300-foot buffer on the SW side, leaving a ring of trees screening the pond area. Vehicle access to the pond for water trucks has also been provided.

The side walls of Alcohol Crater are very steep and include an exposed scarp of rock from an old debris avalanche on the south end. This scarp, as well as most of the vegetated portion of the wall, are outside the reserve. Only on the west side are some steep slopes included within the 300-foot buffer. The pond is elsewhere buffered by gentle slopes supporting lodgepole pine. No significant erosion into the basin is occurring.

These ponds are accessed by only occasional recreational users and human impacts upon surrounding natural resources are for the most part negligible.

Wetlands (Wet Meadows):

Composition: Wetland areas in the Watershed occur in seasonally wet depressions with inclusions of soils that remain saturated for a sufficient duration to support a plant community with a dominance of species adapted to survive and grow under zero oxygen conditions. The areas designated as wetlands within the Watershed seem to vary considerably relative to their hydrological status, and at best are marginal wetlands. The best examples of wet meadows actually occur within the Crystal Springs riparian reserve, included under the description of Perennial Ponds in this section, and associated with the perennial portion of Paynes Creek which is described in later portions of this section.

Within the Watershed a typical wet meadow includes some or all of the following species: *Juncus balticus, Hordeum brachyantherum, Trifolium longipes ssp. Longipes, Aster occidentalis, Mimulus primuloides, Calamagrostis canadensis, C. Stricta inexpansa, Juncus bufonios, Juncus ensifolius,* and *Carex microptera, Muhlenbergia filiformis, Luzula sp.*

The wetland identified just west of the Medicine Lake guard station (SE1/4, NW1/4, Section 10, T43N, R3E) appears to be a relatively typical wet meadow.

The wetland identified near Schonchin Springs (NE corner, NE1/4, Section 10, T43N, R3E) appears to be a complex of wet and dry with atypical composition. The entire area is dominated by rushes and sedges prominently including, in most areas, *Carex lanuginosa* and *Juncus balticus*. Among the secondary grasses is *Hordeum brachyantherum*. However, dry meadow grass species are also scattered throughout much of the area. These include *Achnatherum*

occidentalis, A. Thurberianum, and *Elymus elymoides.* The wetland status of this area needs to be verified by further observation. It is possible that less than one acre of this area is actually saturated for an extended period of time.

The wetland identified north of the Medicine Lake campground (border between Section 2 and Section 11, T43N, R3E) occurs under a canopy of large, vigorous lodgepole pine which require an aerated soil medium to achieve such growth. The entire area is perennially moist and characterized by dense herbaceous understory unlike surrounding lodgepole pine stands. Species prominent in this understory include *Danthonia californica, Juncus howellii, Hordeum brachyantherum, Achnatherum nelsonii,* and *Aster occidentalis.* The wetland status of this area is questionable though the ecosystem is indeed unique.

Condition: All these interim wetlands occur in close proximity to areas of high recreational use, but there is no evidence of current detrimental impacts upon them. No grazing occurs in these areas. An old unimproved road, presently revegetating, does pass through the area of potential wetland in the open flat south east of Schonchin Springs. The roads used for access to the springs area appears to have been discontinued. Forest Service road 43N48 passes through the 150-foot buffer area of the meadow west of the Medicine Lake guard station, but does not impact riparian vegetation.

Perennial Stream (Paynes Creek and Associated Riparian Areas):

Composition: The Paynes Creek riparian reserve includes three springs (Paynes Springs 1, 2, and 3); two perennial branch drainages by these springs, and totaling approximately 3/4 mile in length; a perennial stream channel below the confluence of the branches that continues south for approximately another 1.5 miles before disappearing underground; and associated stringer seeps and wet meadows. The latter are most concentrated near Paynes Spring 1 and adjacent to the brook it feeds. A narrow band of riparian vegetation occurs on the banks of most of the remainder of the perennial portion of the creek. This band widens in several openings and essentially disappears in certain areas where the stream channel is overtopped by a dense forest canopy.

The associated wet meadows in the SW1/4, NW1/4 of Section 19, T43N, R4E are floristically the richest in the entire Watershed. In addition to the species already listed for typical wet meadows in the Watershed (Section 4), a few graminoids and a number of species of forbs are present. The most characteristic graminoid is *Carex angustata.* Unique forbs include *Ranunculus alismifolius, Veronica sp., Sidalcea oregana ssp. spicata, Mimulus primuloides, Mimulus bereweri, Claylonia palustris, Delphinium sp., Viola macloskeyi, Fragaria virginiana, Platanthera stricta,* and *Senecio hydrophylloides.* The subshrub *Potentilla fruiticosa* is also a component.

Condition: Springs 2 and 3 and approximately 3/4-mile of the eastern creek branch fed by these springs are located in a narrow canyon with a very steep inner gorge. Approximately a third of these side slopes are stabilized by timber stands but the remainder consists of exposed rock, consolidated bedrock and loose scree near the angle of repose. Some surface raveling has occurred and a portion of the wall near the bottom of the canyon is actually undercut. The inner gorge is completely included within the protective buffer zone that extends to the rim on each side. Consideration should also be given to extending the boundary on the steep and rocky western slope above Spring 1 to the immediate ridge line.

The wet meadow ecosystems appear to be quite pristine despite the fact that an unimproved camping area occurs immediately adjacent to a portion of the meadow system near the confluence of the two branches.

The stream course does not exhibit any recent down-cutting or bank erosion, and in general the banks are well vegetated.

Intermittent Stream (Paynes Creek):

Composition: Approximately 1/4-mile of intermittent stream occurs at the north commencement of the drainage, above Paynes Spring 3. The starting point is a small wet meadow area just south of Road 97 in the SW1/4 of Section 18, T43N, R4E. Within 1/8 of a mile the intermittent portion falls off into and includes the extreme upper end of the canyon identified in the

description of the previously described perennial portion of Paynes Creek. However, the major portion of the intermittent section of Paynes Creek includes all of the southern 2/3 of the drainage. Beginning where the summer flow becomes subterranean, the channel continues south for roughly 4.5 miles through Sections 9, 30, and 31 T43N, R4E, and Section 1, T42N, R3E. This intermittent channel, which flows in the spring, has little riparian vegetation, and for the most part is overtopped by a corridor of timber of varying forest communities including: red fir-lodgepole, red fir-white fir, red fir, and mixed conifer (ponderosa pine-white fir and incense cedar).

Condition: A major portion of the adjacent forest stands have been logged but, for most of the Creek's length, the 240-foot buffer zone is still protected by a corridor of mature trees. Minor exceptions occur at occasional small openings and several crossings by roads. A major exception occurs in a half-mile segment below Road 43N54 near the terminus of Paynes Creek where less than 40% cover of mixed conifer forest remains, and no protective stream side corridor is evident. Even in this area, no significant degradation of the stream channel has occurred. The stream gradient is gentle throughout except at the very terminus near Burnt Lava Flow. This terminus and the canyon near the northern origin are the only locations where an inner gorge area occur along the intermittent portion of Paynes Creek.

FIRE MANAGEMENT

Key Question (1):

What are current fuel characteristics, fire hazard potential, and fire risks in the Watershed?

Summary Response

Fire Behavior Potential assessment is a method used to determine the relative flammability of specific areas. To determine the Fire Behavior Potential Classes, each fuel model is run through a program that uses fuel model, slope, and weather parameters to predict fire behavior and resistance to control for fire suppression purposes. Table 3.3 shows that 24% of the Watershed is high fire behavior potential, 40% is moderate, 24% is low, and 12% is non-flammable. Figure 3.4 maps the Fire Behavior Potential Classes for the Watershed.

Table 3.3: Fire Behavior Potential (FBP) Percentages by Ownership

Fire Behavior Potential	Ownership		Total Analysis Area
	Forest Service	Private Land	
Non-flammable	13.8	1.6	11.7
Low	24.5	22.5	24.2
Moderate	39.9	39.2	39.8
High	21.7	36.6	24.3
Total	100	100	100
Source: Modoc National Forest Remote Sensing Lab (RSL) Data (1993) Villegas and Sinclear.			

Background Information

Fire behavior potential modeling is done in order to estimate the severity and resistance to control that can be expected when a fire occurs during what is considered the worst case weather conditions. Late summer weather conditions are referred to as the 90th percentile weather data, which is a standard used when calculating fire behavior (90th percentile weather is defined as the severest 10% of the historical fire weather, i.e., hot, dry, windy conditions occurring on mid-afternoons during the fire season). The modeling incorporates fuel condition, slope class, and 90th percentile weather conditions in calculating projections on flame lengths and rates of spread. Fires known to have occurred in the Watershed are shown on Figure 3.5.

The fuel models that have been assigned to the Watershed are fuel models 1, 2, 5, 6, 8, 9, 10, and 11. See Appendix B for a description of each fuel model and Figure 3.6 for a map of the different fuel models in the Medicine Lake Watershed. The fuel model utilized in this analysis was the Fire Behavior Predictive Fuel Model. This coincides with the fuel model utilized in the MLSA.

A low rating indicates that fires can be attacked and controlled directly by ground crews building fireline and will be limited to burning in understory vegetation. A moderate rating indicates that hand built firelines alone would not be sufficient in

controlling fires and that heavy equipment and retardant drops would be more effective. Areas rated as high represent the most hazardous conditions in which serious control problems would occur (i.e., torching, crowning, and spotting). Control lines must be established well in advance of flaming fronts with heavy equipment and backfiring may be necessary to widen control lines. For more information on fuel modeling and the development of fire behavior potential for this analysis, refer to Appendix B.

Key Question (2):

> **What are the fire protection agencies and where are their response areas within the Watershed?**

Response

The primary fire protection agency in the Watershed is the USFS. The fire station that provides protection is the Engine Station located in the Lava Beds National Park. This station company is run by the USFS and the National Park Service. Two other fire stations in the area are located at Dry Lake and Long Bell.

Key Question (3):

> **What are current fire risks in the Medicine Lake homeowner and the proposed geothermal power plant interface areas?**

Summary Response

The Medicine Lake home owners present only minor fire risks. The number of occupants is small in size and the location of the home tract is at the higher elevation primarily in low and moderate fire hazard area. Greater risks of fire come from dispersed camping activity and lightning strikes.

Geothermal exploration activities have occurred at multiple well sites in the Watershed. These exploration activities represent only a minimal fire risk. However, long-term geothermal development projects have been proposed within and adjacent to the Watershed.

Background Information

An analysis of the Automatic Lightning Detection System (ALDS) shows over a period from 1985 to 1996 there were at least 698 lightning strikes that could have started fires. This resulted in 344 fires occurring due to lightning strikes during the same time period. There are no recorded fires resulting from the developed homes constructed near Medicine Lake.

The proposed Telephone Flat Geothermal Development Project would be constructed within the Medicine Lake basin (BLM *et al.* 1999). Increased human activity during site construction, well drilling activities, power plant operations, and eventual decommissioning activities would all increase the fire risk in the area. However, the project would be required to maintain fire fighting equipment at the power plant site and train all operating personnel to fight potential fires.

LATE-SUCCESSIONAL HABITAT

Late-successional habitats (LSH's) are forest stands with specific structural attributes usually associated with advanced tree age. These habitats are comprised of stands of late seral stages (forest stand structure) that include mature and old-growth forest (Modoc National Forest 1998, p 1). "Late-successional" is defined by the Modoc National Forest as any stand in which the overstory trees have a mean diameter breast height (dbh) greater than 24 inches and provide canopy cover (stand density) greater than 40%. Seral stages with timber stands of average dbh larger than 25 inches and canopy closure greater than 40% are coded as 4N, 4G, 5N, and 5G by Region 5 vegetative code, or California Department of Fish and Game Wildlife Habitat Relationship (WHR) codes 4M, 4D, 5M, 5D (see Appendix C — Conifer Size and Canopy Closure Crosswalks, for additional information on tree size and density code relationships). Twelve plant associations comprise the late-successional habitat in the Watershed. This habitat is distributed primarily across the southern 2/3 of the Watershed. Figure 1.6 shows the location of these twelve plant associations' LSH.

Key Question (1):

How much of the Watershed is currently late-successional habitat, where is it located, and what is the block size?

Summary Response

The net amount of lands capable of being late-successional habitat consists of 60,974 acres within the Watershed. Of this number, presently 6,451 acres of this capable land is LSH. These acres are arranged in various size blocks ranging in size from under one acre to the largest, a hemlock-red fir stand of 479.9 acres. There are 344 separate stands within the Watershed that may be characterized as LSH with an average size of 18.7 acres.

Background Information

When viewed at the Watershed scale the condition of LSH can only be described in general terms. Without field verification of individual stands, the condition of LSH appears to be adequate to provide for spotted owls and other late-successional dependent wildlife species.

According to RSL mapping data, within the Watershed there are twelve plant associations containing LSH. Through aerial photo interpretation, an additional three plant associations have been determined to contain some LSH. Figure 1.6 contains the locations of LSH according to the RSL data for the following associations: Hemlock-Red Fir/Ross's Sedge (SC1), Hemlock/Pityopus (SC2), Hemlock-Lodgepole/Ross's Sedge (SC3), Ponderosa-White Fir-Cedar Squaw Carpet (EM1), Washoe-Red Fir-Western White/Greenleaf Manzanita (EM3), Lodgepole-Ponderosa-Sugar/Jewel Flower (EM5), Ponderosa-White Fir/Bitterbrush (PP2), Ponderosa-White Fir/Snowberry (PP3), Red Fir/Ross's Sedge (RF1), Red Fir-White Fir/Wintergreen (RF2), Red Fir-Lodgepole/Western Needlegrass (RF3), White Fir/Chinquapin (WF1). Plant associations that have had LSH acres incorporated through analysis other than the RSL data are Ponderosa - White Fir - Sugar/Bitterbrush (EM4), Ponderosa/Bitterbrush (PP1), and Ponderosa-Lodgepole/Bitterbrush (PP4). For specific acreage amounts for each plant association see Table 3.8, and for complete description of these associations see the silviculture discussion in this section of the analysis. For the purpose of this analysis, "stand" will be considered that area (polygon) that is distinguishable in terms of vegetative compositions.

Hemlock-Red Fir/Ross's Sedge (SC1):

Within this association there are 1071 acres of LSH located primarily in Sections 14 and 15 of T43N, R3E. There are 40 individual stands which range in size from less than an acre to 480 acres. This largest stand is the second largest block of contiguous LSH within the Watershed. Of the 40 individual stands, 27 are larger than 5 acres. There are lesser amounts of this association in Sections 25 and 26, T44N, R3E and in Sections 29 and 30, T44N, R4E.

Hemlock/Pityopus (SC2):

There are approximately 92 acres of late-successional hemlock located in the Watershed located in approximately ten stands Sections 25 and 26, T44N, R3E, and Section 9 T43N, R4E.

Hemlock-Lodgepole/Ross's Sedge (SC3):

Although there are 1,571 acres of this association only 129 acres (8%) may be classified as LSH. These acres are found in 24 individual stands ranging in size from less than one acre to 37 acres, with only four stands greater than 5 acres. This association is primarily found in Section 14 of T43N, R3E, and is part of a late-successional hemlock-red fir stand.

Ponderosa-White Fir-Cedar Squaw Carpet (EM1), Washoe-Red Fir-Western White/Greenleaf Manzanita (EM3), White Fir - Sugar/Bitterbrush (EM4), *Lodgepole-Ponderosa-Sugar/Jewel Flower (EM5):*

Within all the eastside mixed conifer stands there are 1296 acres of LSH habitat. Large stands of EM3 are found in the northern half of the Watershed in the Mt. Hoffman Roadless Area. Other significant amounts of eastside mixed conifer LSH are found in the southeast corner of the Watershed (Sections 10, 11, 14, and 13,

T43N, R4E). In total, there are approximately 60 stands of LSH eastside mixed conifer.

Ponderoas-White Fir/Bitterbrush (PP2), Ponderosa-White Fir/Snowberry (PP3):

Within the ponderosa pine stands (19,953 acres) there are 393 (1.9%) acres that are classified as late-successional. Although the pine stands are scattered across the north, east and southern areas of the Watershed, the late-successional stands of pine are only found in the southern portions of the Watershed in association with 3G pine stands. There are 36 individual stands that meet the late-successional criteria, of which 31 are larger than 5 acres, the largest being 47 acres.

Red Fir/Ross's Sedge (RF1), Red Fir-White Fir/Wintergreen (RF2), Red Fir-Lodgepole/Western Needlegrass (RF3):

There are approximately 3,035 acres of late-successional red fir within the Watershed, approximately 2% of the total amount of red fir associations within the Watershed. These acres are located in 184 stands of red fir associations ranging in size from less than one acre to 139 acres. They are primarily located within the west central portion of the Watershed, often in association with red fir 3G and 3P stands.

White Fir/Chinquapin (WF1):

Within the Watershed there are approximately 435 acres (6% of the total amount of white fir in the Watershed) of late-successional white fir. There are a total of 48 white fir stands that range in size from less than one acre to 42.8 acres, with 27 stands being over 5 acres. The white fir associations are located in the southern half of the Watershed.

Lands Incapable of Producing Late-Successional Habitats:

Within the Watershed there are a number of areas that are not capable of growing LSH. The inability to grow LSH is a factor of soil type, or lack of surface features, vegetative species composition and moisture. See Table 3.4 for areas that are not capable of growing forest structure suitable for inclusion as LSH.

Table 3.4: Land Incapable of Growing Late-Successional Habitat

Code	Vegetative Type	Acres
DM	Dry meadow series	90
PJ1	Pine-juniper	951
LAVA	Lava	12,976
LP2	Lodgepole/pinemat manzanita assoc.	96
LP1	Lodgepole/western needlegrass assoc.	4,598
LP3	Lodgepole-western white pine/cream bush assoc.	2,616
PF	Marumleaf buckwheat-pussy paws assoc.	153
WM	Wet meadows	96
TALUS	Talus	210
WATER	Water	473
ST	Bitterbrush non-stocked areas within eastside pine	1,274
Total		23,533

Source: Remote Sensing Lab (1993), Ecological Unit Inventory (1996).

Key Question (2):

Where is the existing connectivity and dispersal habitat across the Watershed and to adjacent watersheds?

Summary Response

"Connectivity" or "connectors" are defined as strips or patches of vegetation that may be used by wildlife to move between habitats (Thomas 1979). These strips or patches may not necessarily be composed of the same vegetative type or stand composition that characterize the habitats that they are connecting. Connectivity may be any vegetative composition or structure that facilitates the movement of a species from one occupied habitat to another. With respect to this ecosystem analysis, connectivity refers to suitable Northern Spotted Owl (NSO) foraging and dispersal habitat.

Background Information

Within the Watershed there are an estimated 23,615 acres of suitable NSO foraging and dispersal habitat (Modoc NF data). Foraging and dispersal habitats on the Modoc National Forest are defined as lands which have canopy closures of 40 percent or greater and mean tree dbh between 11-24 inches. Nesting habitat is also considered suitable dispersal habitat. Nesting habitat is defined as stands that have canopy closures of 40 percent or greater and mean tree dbh of greater than 24 inches (Modoc National Forest 1998, p. 2). The combined total of those habitats classified as nesting and foraging/dispersal within the Watershed is 53,894 acres (63%). These acres may be considered as dispersal (connective) NSO habitat.

TERRESTRIAL WILDLIFE

The Watershed is comprised of 85,433 acres that, with the exception of 13,186 acres of non-habitat areas (12,976 acres of lava, 210 acres of talus), provide diverse wildlife habitat. As described in Step 1, there are eight major plant associations within the Watershed. These associations include: meadows, hemlock associations, juniper, lodgepole associations, mountain mahogany, ponderosa pine associations, red fir associations and white fir associations. These plant associations provide a variety of habitats for wildlife species as generally described below.

Wildlife Habitat Plant Associations

Meadows:

Meadows within the Watershed may be either wet, mesic, or dry. They are generally small and comprise only 181 acres of habitat within the entire Watershed. Small mammals such as gophers, voles and paramiscus species will utilize the drier sites and, in turn, provide prey for predators such as foxes, coyotes, owls, and hawks. Larger mammals such as deer and elk utilize meadow areas for foraging. Wet meadows are especially important for lactating does seeking perineal grasses and forbs. Various frog species, as well as some snake species such as the striped racer, may be found in the wet meadows associated with water courses.

Hemlock (Sub-Alpine Conifer) Series:

The hemlock series is represented by three ecological associations, all occurring in close proximity to one another (see Step 3 - Current Conditions: Silviculture). Such high elevation habitats typically support fewer species of amphibians, reptiles, birds, and mammals than any other major forest type. Conditions such as a short growing season, lower primary productivity, and moisture stress lower the overall production of insects and other invertebrates that provide food resources of many vertebrates. Laudenslayer (1982) found optimum conditions for only 17 species of birds and 15 species of mammals in these areas. Lack of water limits amphibians and reptiles.

Juniper:

Juniper berries are an important food source, especially for wintering birds. Old and young juniper trees produce berries. Maser and Gashwiler (1978) found that 17 bird species use juniper berries in winter. As the trees age and die, the tops break and the trunk and limbs become hollow, providing nesting and denning opportunities. Juniper foliage is also consumed by several mammals. The juniper associations are utilized by 11 amphibian, 8 reptile, 52 bird and 37 mammal species.

Lodgepole Associations:

Lodgepole pine stands have low structural diversity and are relatively low in animal species. Many species found in lodgepole pine stands are associated with the meadow edge. The lodgepole habitat provides suitable habitat for 6 reptile and amphibian, 49 bird and 35 mammal species (Verner and Boss 1980). These species include goshawk, bald eagle and prairie falcon.

Mountain Mahogany:

Mountain mahogany is a shrub habitat most often associated with the eastside pine vegetative association. Mountain mahogany is primarily considered a browse species for deer. When in association with water it can become important fawning habitat. The absence of water within the Watershed diminishes the quality of mountain mahogany as fawning habitat. In association with

pine, these areas have a high diversity of wildlife species use. See Ponderosa pine associations.

Ponderosa Pine Associations:

Pine associations with shrub understories have a high degree of vertical diversity, especially when other conifers are present. Large pine branches form good nesting substrates for large raptors. Sites supporting the larger shrub species may become suitable forage habitat for large mammals (deer). Pine stands within the Watershed are utilized by deer for summer ranges. Other species that utilize the pine stands are bald eagles, falcons, goshawks, owls and a number of mammals. As many as 9 amphibian, 7 reptile, 102 bird and 45 mammal species may be associated with the pine associations (Thomas 1979).

Red Fir Associations:

Red fir habitats throughout California provide food and/or cover during at least one season to a total of 169 wildlife species (8 amphibian, 4 reptile, 104 bird, and 53 mammal species). In addition, red fir habitats can be considered very important for 28 birds and 26 mammals. Of special interest are goshawk, blue grouse, great gray owl, red fox, pine marten and, if present, wolverine (Mayer and Laudenslayer 1988).

White Fir Associations:

White fir habitat is the coolest, moistest, non-riparian habitat within the Watershed. Pure stands have a high percentage of defective live trees which are a result of windthrow and heart rot fungus. Excellent habitat is provided for snag and cavity dependent wildlife species. White fir is the preferred tree species for insect-gleaning yellow-rumped warblers and western tanagers and is also commonly used by other insect gleaning birds such as the mountain chickadee, chestnut backed chickadee, golden-crowned kinglets and black-headed grosbeaks. The white fir associations may support as many as 6 amphibian, 2 reptile, 72 bird and 41 mammal species (Thomas 1979).

The California Habitat Relationship program lists the common wildlife species associated with the vegetative series and respective seral stages found within the Watershed. See *California Wildlife and their Habitats: Western Sierra Nevada* (Barrett *et al.* 1980).

Key Questions:

For the species identified in this Watershed:

(a) What are the habitat needs?

(b) Where is the habitat in the Watershed based on existing information?

(c) How much habitat is in the Watershed?

Summary Response

For the Medicine Lake Highlands Area Watershed Analysis selected wildlife species were chosen as representative of the wildlife issues within the Watershed. The species selected were those most likely impacted by management decisions due to their specific and unique habitat requirements or their sensitivity to habitat manipulation. A species' sensitivity to habitat manipulation is a function of the species' degree of versatility (adaptability) in the number of plant communities and successional stages it can use for feeding and reproduction. The sensitivity of each species to habitat change is directly related to that versatility. The most versatile species are the least sensitive to habitat manipulation; the least versatile are most sensitive. The location of suitable habitat for some of the species covered in this analysis can be found on Figure 3.7 (Bald Eagle and Northern Spotted Owl), Figure 3.8 (Goshawk, Mule Deer, and Osprey), and Figure 3.9 (Marten and Wolverine).

The species selected to represent the management issues within the Watershed have a relatively low degree of versatility. They include: the bald eagle (threatened), Northern spotted owl (threatened), Northern goshawk (sensitive), pacific fisher (sensitive), mule deer (indicator), Sierran red fox (sensitive), osprey (indicator), American marten (sensitive), wolverine (sensitive), great gray owl (buffer protection), pallid bat (sensitive), Townsend's big eared bat (sensitive), long eared myotis (ROD survey and manage), long legged myotis (ROD survey and manage), fringed myotis (ROD survey and manage), and silver-haired bat (ROD survey and manage). These species were selected as either protected by the Endangered Species Act, listed

as Forest Service sensitive, or they have high social interest. These species are also included as part of the Forest Management Indicator Species (MIS) in the Modoc National Forest Land and Resource Management Plan.

Background Information

Bald Eagle (Haliaeetus leucocephalus)
Status - Federal Threatened

Habitat Requirements: This species breeds at scattered locations in northern California in the vicinity of lakes, reservoirs, or large rivers where large live trees provide nesting habitat (Zeiner *et al.* 1990a). They feed primarily on fish which are taken live or scavenged. They will also take waterfowl and small mammals when available. Eagles utilize snags, trees, and rocks as feeding perches, which are usually located near water. Bald eagles make their nests in large, tall trees with stout limbs that are capable of supporting the heavy stick platform nest. Nests are located within the live crown which provides shade to the incubating adult and nestling. Nest trees are usually found near bodies of water that provide foraging habitat. Traditional winter roosts are often utilized by groups of bald eagles and are frequently located in conifer stands that provide shelter from adverse weather.

Regional Status: Bald eagles are regularly observed in the summer in the Medicine Lake Highlands where the species has successfully reproduced at Medicine Lake (Modoc National Forest, wildlife data files). The north-facing slope of Medicine Mountain has been designated as a Bald Eagle Management Area to protect the preferred nesting habitat. Three bald eagle winter roosting sites are located on the Modoc Plateau 10-15 miles to the north and northeast of Medicine Lake (BioSystems Analysis, Inc. 1996).

Amount of Habitat: Although eagles are present in the Watershed they are not found in concentrated numbers. This indicates that there is not extensive eagle habitat within the area. Bald eagle nesting habitat is localized around the southern side of Medicine Lake. This area combines suitable nesting structure within conifers in association with the foraging habitat of the Medicine Lake area. Nesting habitat is comprised of live large trees, greater than 24 inches dbh which will support the large stick nests. There are approximately 333 acres of this type of structure in the area where eagles have nested. No other nesting sites are known within the Watershed. There is no information available on the amount of foraging habitat within the Watershed. Eagles are opportunistic foragers, and have been seen foraging around Medicine Lake and perched in trees near Alcohol Crater. Undoubtedly, they feed along the lake, along the numerous roads in the areas and at other areas of opportunity.

Northern Spotted Owl (Strix occidentalis caurina)
Status - Federal Threatened

Habitat Requirements: Northern spotted owls (NSO's) are primarily associated with conifer forests in northern California at elevations from sea level to approximately 7,500 feet (NSO Recovery Plan 1992. p 12). They utilize a variety of forest stand structures for nesting, roosting, and foraging behavior. Typically, nesting habitat is within multi-layered canopies of greater than 50 percent canopy closure, usually within the vicinity of ponded water. NSO's do not construct their nests but rather rely on either pre-constructed nests of raptors, squirrels or voles or natural structures such as trash piles, witches brooms, cavities, and broken or forked topped trees.

Roosting and foraging habitats are typically interspersed and may vary in stand structure and canopy closure. Such stands may have less than 20 percent to near 100 percent canopy closure. They may be comprised of second growth and residual conifer stands, deciduous hard and soft wood stands, riparian alder and willow thickets, and old growth forests. Canopy closure is greater than 60 percent in roosting areas, and they are frequently comprised of clusters of larger trees within foraging areas.

Of critical importance is the abundance of prey items and suitable perches from which to locate and attack prey. NSO's in northern California typically prey on terrestrial mammals rather than aboreal species (Barrows 1980; Solis 1983; Forsman *et al.* 1984; Kerns 1989; Thomas *et al.* 1990). Woodrats and brush rabbits have been found to comprise much of the diet of NSO in northern California, though they will also take small rodents, flying squirrels, mice, voles and on occasion, reptiles and birds. Home range size is primarily dependent on prey availability. NSO's in old growth forests of Oregon typically have home

range sizes of nearly 3,000 acres while NSO's in some second growth forests along the coast of northern California have home ranges of under 1,000 acres (USDA 1990).

Regional Status: The Medicine Lake Highlands are at the eastern edge of the range of the NSO, and at the upper limit of the species elevational range (NSO Recovery Plan 1992). Three NSO activity centers have been identified to the south of the Forest Road 97 area (USFS data) (see Figure 3.7). Since 1989 a number of NSO surveys have been conducted within the Medicine Lake Basin. As a result of these surveys, no NSO breeding activity has been detected within the basin area (Villegas, 1991; Gutierrez, 1993; Galea, 1996).

Amount of Habitat Available: Generally NSO's utilize forest complexes with tree sizes greater than 11 inches dbh. Within the Watershed there are approximately 30,330 acres that meet this description. Of these, 6,500 acres may be structurally suitable as nesting habitat, being of structure greater than 24 inches or greater in dbh. However, suitable nesting habitat is a function of forest structure in association with foraging opportunities and ponded water. The absence of ponded water in the Watershed limits the amount of suitable nesting habitat. Ponded water is limited to the Paynes Creek - Bullseye Lake area, the areas around Medicine Lake and scattered springs and seeps. It is probable that truly suitable NSO nesting habitat may be limited to less than 1,000 acres.

Northern Goshawk (Accipiter gentilis)
Status - Forest Service Sensitive

Habitat Requirements: The northern goshawk breeds in coniferous forest habitats throughout the mountainous areas of northern California (Zeiner *et al.* 1990a). A breeding pair requires a large nesting home range (5,000 acres or more) with an adequate prey base that includes a variety of bird and small mammal species (Reynolds *et al.* 1992). Foraging areas are typically characterized by a mosaic of habitat types including a range of forest successional stages along with openings and meadows. Important habitat features within the foraging area include an open understory with well-developed herbaceous or shrubby vegetation and abundant snags and coarse woody debris that support a diverse prey base. Northern goshawk nests are constructed from sticks and twigs, and are located within the canopy of conifer stands of varying canopy closure and age class. The typical nest stand is 30 acres or more in size, with live trees of dbh greater than 12 inches. Nest sites are often located near water and on a northern aspect. Goshawk pairs typically have two to four alternate nest sites, within the nest stand, that may be used in different years. Goshawks utilize "plucking posts," large rocks, stumps, down or leaning logs, to strip their prey prior to consumption.

Post-fledgling areas are also an import habitat component. These areas usually contain patches of dense, large trees that provide protection for fledglings and small trees for hiding cover near the ground, interspersed with small open areas with herbaceous vegetation and the associated prey base. Because newly fledged young fly poorly, their spatial movements tend to be centered around the nest. With time, fledglings become proficient foragers and are fed less by their parents. To provide learning to hunt opportunities, prey needs to be abundant (Reynolds *et al.* 1992).

Regional Status: As indicated by a number of northern goshawk sightings over the past 10 years (Modoc National Forest, wildlife data files), all forested areas in the Medicine Lake Highlands should be considered as suitable foraging habitat for this species. Two northern goshawk nest territories managed by the USFS are located south of Forest Road 97. Another is located approximately 3 miles northwest of Medicine Lake. Goshawk sightings have been made on numerous occasions at many locations within the Medicine Lake Basin (Modoc National Forest, wildlife data files). These sightings probably included adult goshawks from nesting territories outside the basin as well as young dispersing animals. No confirmed nest sites have yet been identified within the Medicine Lake Basin despite surveys conducted according to USFS protocol (Galea 1996; Kerns 1997).

Amount of Habitat Available: It may be assumed that all forested lands within the Watershed may be considered goshawk habitat. This would amount to approximately 65,977 acres. Nesting habitat is more limited to those areas of larger trees and canopy closure of greater than 50%. This would limit suitable nesting habitat to

approximately 7,000 acres. The Modoc National Forest has identified eight goshawk territories within the Watershed totaling 1,152 acres (Modoc Nation Forest data).

Pacific Fisher (Martes pennanti pacifica)
Status - Forest Service Sensitive

Habitat Requirements: Pacific fishers utilize coniferous or mixed deciduous/coniferous forests with canopy closure provided by either the overstory or midstory. Large trees, intermittent mid and understory vegetation, snags, and abundant coarse woody debris characterize fisher habitat (Zeiner *et al.* 1990b; Self and Kerns 1993). In the Pacific Northwest, there is considerable evidence that they are associated with low and mid-elevation forests in which deep snowpack does not accumulate (USFS and BLM 1994a). Fishers are medium-sized forest carnivores weighing between 5 and 12 pounds, with males larger than females. Fishers are generalized predators of small to medium sized mammals, birds, and carrion; with snowshoe hares, squirrels, mice and porcupines important prey species. Fishers are heavier than martens and not as well adapted to moving and pursuing prey in deep snow. Fishers tend to avoid higher elevation conifer forest habitats that receive heavy snowfall.

Regional Status: There are three historic records (1978 to 1981) of this species in the Medicine Lane Highlands (Modoc National Forest, wildlife data files). These records may pertain to dispersing juveniles from a population to the south and southwest on the Shasta-Trinity National Forest. There is no evidence of a resident fisher population in the Medicine Lake Highlands.

Amount of Habitat Available: Within the Watershed there are approximately 65,900 acres that may be structurally suitable for fisher habitat. However, elevations within the Watershed are generally above the range of the fisher. Depth of winter snows limit the availability of the Watershed to sustain fishers.

Mule Deer (Odocoileus hemionus)
Status - Management Indicator Species

Habitat Requirements: Mule deer are abundant in the early- to mid-successional stages of shrubland, woodland, and forest habitats of eastern California (Zeiner *et al.* 1990b). Their habitat requirements are best met where there is a vegetation mosaic that includes dense brush and thickets of small trees for cover, meadows or other openings with herbaceous feed, and shrub patches with preferred browse species such as ceanothus, bitterbrush and mountain mahogany. Fawning habitat is provided by woody cover (shrubs or small trees) adjacent to meadows with abundant herbaceous forage. Surface water is also an important requirement.

Regional Status: The Medicine Lake Highlands serve as summer range for mule deer of the McCloud Flats Deer Herd (California Department of Fish and Game 1985). High quality fawning habitat is found around Medicine Lake itself and to the south of Forest Road 97 where interspersed meadows and forest stands provide a good combination of forage and cover. Mule deer also migrate through this region in spring and fall while moving between winter range and other areas of summer range. Many mule deer that use the Medicine Lake area as summer range move downslope to the east onto the Modoc Plateau for the winter. Annual herd composition counts suggest mule deer numbers are declining over the northeastern portion of California including the Medicine Lake Highlands.

Amount of Habitat Available: With the exception of the barren lava areas and lake, the rest of the Watershed, an area of 71,856 acres, may be considered suitable deer foraging habitat. Fawning habitat is limited to the areas around the wet meadows associated with the Paynes Springs and Creek, and other isolated meadow areas.

Sierran Red Fox (Vulpes vulpes necator)
Status - Forest Service Sensitive

Habitat Requirements: The Sierran Red Fox is considered indigenous to the Sierra Nevada by the California Department of Fish and Game and the Forest Service (Jurek 1992, DFG Report). Additionally, the red fox were introduced from England to New York, New Jersey, Maryland, Delaware and Virginia in the 18th century. The red fox that now populate almost all of the states are combined strains derived from the interbreeding of imported foxes with native species (Whitaker *et al.* 1988). Red foxes are found primarily in upper elevation forests

associated with the Sierra Nevada crest. During summer months they may be found in associations with mature Jeffrey pine, lodgepole pine and red fir forests, interspersed with meadows. In winter they appear to move downslope to be found in association with mixed conifers and Ponderosa pine forests. Specific habitat features include rock outcrops, hollow logs, and stumps for denning habitat and forest openings for hunting opportunities (Verner and Boss 1980).

Regional Status: The California Natural Diversity Data Base (CNDDB) lists one occurrence of a red fox being trapped in the Medicine Lake Highlands. This occurred in the 1930's. No other sitings have occurred since that time in the Highlands. Actual numbers and distribution of the Sierran red fox are not known.

Amount of Habitat Available: All vegetative communities within the Watershed may be considered suitable habitat for the fox. Only the barren lava flows and lake areas would not be suitable. Within the Watershed there is approximately 72,000 acres of suitable fox habitat.

Osprey (Pandion haliaetus)
Status - Management Indicator Species

Habitat Requirements: This species nests near large rivers, lakes, and reservoirs in Northern California (Zeiner et al. 1990a). Ospreys feed mostly on fish which they capture in open, clear waters by diving from flight or perches. They construct stick platform nests at the top of large snags and trees or on human structures. Nest sites may be near foraging habitat or up to several miles distant. Ospreys have been regularly observed in the Medicine Lake Highlands for many years (Modoc National Forest, wildlife data files). Medicine Lake itself and a few smaller lakes in the region provide summer foraging habitat for as many as four adult ospreys. The only known osprey nest site in the Medicine Lake Highlands was discovered in 1996 approximately 1 mile east of Medicine Lake. This nest was active again in the summer of 1997.

Regional Status: Ospreys have been regularly observed in the Medicine Lake Highlands for many years (Modoc National Forest, wildlife data files). Medicine Lake itself and a few smaller lakes in the region provide summer foraging habitat for as many as four adult ospreys.

Amount of Habitat Available: The area in immediate vicinity of Medicine Lake is the only area within the Watershed that combines foraging and nesting habitat for osprey.

American Marten (Martes americana)
Status - Forest Sensitive Species

Habitat Requirements: This species is found in montane coniferous forest communities in northern California. It utilizes a number of conifer-dominated habitats including red fir and lodgepole pine forests (Zeiner *et al.* 1990b; Self and Kerns 1993). American martens are found associated with conifer stands of varying canopy closures (Self and Kerns 1993). Such habitats provide large trees, snags, and logs for denning cover and abundant coarse woody debris that support a good prey base of small mammals (USFS and BLM 1994a). Small clearings, rocky outcrops, and talus slopes are also suitable foraging habitat for American martens.

Regional Status: These small carnivores are present throughout the Medicine Lake Highlands and are active year-around. The highest quality habitat appears to consist of the larger remaining stands of late-successional red fir forest on Mt. Hoffman, Red Shale Butte, Lyons Peak, and Medicine Mountain. There are many reports of American marten observations in the Medicine Lake Highlands by USFS personnel and others (Modoc National Forest, wildlife data files). A number of these records describe sightings around Medicine Lake in lodgepole pine forest and in logged red fir forest. They are also present in the logged over areas south of Alcohol crater along Forest Service Road 97. It is clear that the species utilizes a wide range of habitats in this region including areas affected by timber harvests and recreational activities.

The American Marten is a forest carnivore about the size of a small cat. Martens are found in climax conifer and mixed forests, at higher elevations usually above 5,000 feet. Martens prey on small animals, especially mice and voles. Other small mammals including ground squirrels, flying squirrels, chipmunks, snowshoe hares are also important prey species. Seasonally, martens utilize insects, fruits, nuts, and small birds.

Amount of Habitat Available: The entire Watershed may be classified as suitable marten habitat with the exception of barren lava flows, lakes, and developed areas (housing development, powerline rights-of-ways, roads, etc). It is estimated that there is approximately 72,000 acres within the Watershed that are suitable marten habitat.

Wolverine (Gulo gulo)
Status - Forest Service Sensitive

Habitat Requirements: In the west, wolverines are found from northern Canada to northwest Washington with spotty distribution in Oregon and the higher elevation zones of California. The wolverine is a powerful predator capable of driving even a bear or cougar from its kill. It prefers carrion but eats anything it can kill or find including moose, elk, beavers, deer, porcupines, birds, squirrels, eggs, roots and berries. It dens under uprooted trees or in a crevice, thicket or other protected place. Home range size may be as large as 1,000 square miles of diverse habitat in which one male may occupy with two or three females. Wolverines can cover great distances at a slow lope, swim capably and climb quickly, often pouncing on prey from a tree. Optimum habitat appears to be areas with large trees having moderate to dense canopy cover in red fir or lodgepole pine forests with alpine meadows. Special habitat features include rocky areas, caves, logs and snags as den sites (Whitaker 1988).

Regional Status: There have been no reported sightings of wolverine within the Watershed. The nearest sighting to the area is south of Little Glass Mountain and 7 miles to the southeast in Section 1, T42N, R2E (MDM&M; USFS data). It is probable that the wolverine is an infrequent visitor to the Medicine Lake Highlands.

Amount of Habitat Available: The presence of lodgepole pine and red fir complexes in association with caves, crevices, small meadow areas and high elevations qualifies the Medicine Lake Highlands as suitable wolverine habitat. Actual presence within the area may be limited by the amount of vehicle and human disturbance. The existing road density, and the amount of traffic, especially on Primary Forest Road 49 and Primary Forest Road 97, coupled with the human disturbance associated with the Medicine Lake facilities and Paynes Creek camping may have the effect of making those areas unsuitable for wolverine, as wolverines are thought to be very sensitive to human activity.

Great Gray Owl (Strix nebulosa)
Status - Buffer Protection Species

Habitat Requirements: Great gray owls require dense conifer forests for roosting cover and reproduction (Zeiner *et al.* 1990a). They often nest in large snags within dense stands dominated by red fir or lodgepole pine that are in association with meadows.

These owls typically forage in wet and mesic meadows and open pine forests that adjoin nest stands where they take small rodents such as voles and pocket gophers. Voles are most often found in moist grass/sedge meadows and open forest with a herbaceous ground cover, where as pocket gophers are found on dryer sites. Food supply is believed to regulate great gray owl abundance and home range size. A scarcity of prey can lead to great gray owls abandoning areas within their range.

Regional Status: Suitable habitat is located on the south side of Medicine Lake where there are interspersed forests and wet meadows. There are confirmed records of great gray owls along the south shore of Medicine Lake and north of Mt. Hoffman (National Forest, wildlife data files) but no nesting pairs have been found.

Amount of Habitat Available: Actual amounts of suitable habitat may be limited to just several hundred acres located around Medicine Lake and the Paynes Springs area, because of the lack of meadows in associations with large conifers. No specific habitat quantitative information is available.

Pallid bat (Antrozous pallidus)
Status - Forest Service Sensitive Species, Buffer Protection Species

Habitat Requirements: This species is widely distributed in California and occurs in a wide variety of habitats including deserts, grasslands, chaparral, woodlands, and forests (Zeiner *et al.* 1990b). It is often encountered in open, semi-arid regions but has also been found in montane coniferous forest habitats at 7,000 feet and above

(Brown and Pierson 1996). Pallid bats typically forage by flying low over open areas where they often land to capture large arthropods from the ground or vegetation. Day roosts are usually in cliffs, rock crevices, caves, and cavities in large trees and snags although human structures such as buildings, bridges, and mines are used as well. They often consume prey in night roosts located in relatively open sites under bridges or rock overhangs. Pallid bats probably make only local movements to hibernaculums which may be in rock crevices.

Regional Status: There are no specific records of pallid bats in the Medicine Lake Highlands. However, the region is within the known geographic range of the species and there is suitable habitat in the form of montane coniferous forest with large trees and snags. It is reasonable to assume that pallid bats are resident here (Leitner 1997).

Amount of Habitat Available: Suitable foraging habitat is found throughout the Watershed specifically within areas mapped as red fir-lodgepole pine forest. Pallid bats would not be expected to forage extensively in closed canopy areas such as the red fir forest and mountain hemlock-red fir forest associations. Suitable diurnal roosting habitat includes rock outcrops in the form of lava flows and crater walls, as well as large trees and snags with cavities, crevices, and exfoliating bark. Within the Watershed there may be as many as 50,000 acres of suitable foraging habitat and nearly as many acres of suitable diurnal roosting habitats, as these acres would also include the lava areas with caves and crevices.

Townsend's big-eared bat (Corynorhinus townsendii)
Status - Forest Service Sensitive Species, Buffer Protection Species

Habitat Requirements: Townsend's big-eared bat is sparsely distributed throughout California from low desert to montane coniferous forest (Zeiner *et al.* 1990b). Townsend's big-eared bats feed mostly on small moths which are captured in flight or gleaned from foliage. These bats may travel up to 6 miles between diurnal roosts and nocturnal foraging sites. The species is highly dependent on caves and mines for roost sites although it does utilize abandoned buildings with large interior spaces (Brown and Pierson 1996). Suitable roost sites are probably limiting for this species since roosts must be secure from disturbance and have the proper thermal characteristics (Leitner 1997). For example, warm maternity roosts are needed to facilitate development of the young while hibernaculum must be cold for energy conservation but not below freezing. Bats of this species do not migrate but may move up to 20 miles to reach appropriate hibernation sites.

Regional Status: There are well-known populations of Townsend's big-eared bats in Lava Beds National Monument, about 8 to 10 miles north of the Medicine Lake Basin, where they utilize lava tubes and caves as both summer and winter roosting habitat. In addition, there is documentation of this species from caves on the Modoc Plateau about 10 to 12 miles east of the Medicine Lake Highlands (CNDDB 1997). A record also exists for a cave about 4 miles southeast of Medicine Lake (J. Villegas, personal communication). Based upon this information, it is reasonable to assume that Townsend's big-eared bats are present throughout the region.

Amount of Habitat Available: Lava areas may provide suitable tubes and caves for summer and winter roosting habitat. As such, there may be nearly 12,500 acres that may provide such habitat within the Watershed. Most of the Watershed may be suitable foraging habitat as this species is known to travel several miles while foraging.

Long-eared myotis (Myotis evotis)
Status - ROD Survey and Management Species, Buffer Protection Species

Habitat Requirements: In California, this species is usually associated with coniferous and mixed deciduous/coniferous forests and ranges in elevation from sea level to 9,000 feet (Zeiner *et al.* 1990b). It forages within the forest canopy and over streams and ponds, capturing moths and beetles in flight or gleaning its insect prey from vegetation. Long-eared myotis use day roosts in trees and snags where they shelter in cavities or under exfoliating bark (Brown and Pierson 1996). Diurnal roosts in rock outcrops, cliff crevices, and mines, caves, and buildings have also been documented. Night roosts have been found in caves, mines, and under bridges. Habitat requirements for hibernation are not well known.

It is assumed that the species is non-migratory and hibernates in the vicinity of summer roosts.

Regional status: There are no specific records of the long-eared myotis in the Medicine Lake 'Highlands. However, the region is within the known geographic range of the species and there is suitable habitat in the form of montane coniferous forest with large trees and snags. It is reasonable to assume that long-eared myotis are resident in the Watershed.

Amount of Habitat Available: It is probable that the forested acres of the Watershed are suitable foraging habitat for this species. This would amount to approximately 48,016 acres of suitable habitat within the Watershed. Lava areas may also be utilized for roosting and hibernating. If so, then this species may be utilizing as many as 83,594 acres within the Watershed.

Long-legged myotis (Myotis volans)
Status - ROD Adaptive Management Species, Buffer Protection Species

Habitat Requirements: This species is typically found in montane woodland and forest habitats although it is also present along the California coast in forested areas (Zeiner *et al.* 1990b). It is more commonly encountered at higher elevations (4,000 feet and above). The long-legged myotis often hunts for flying insects at canopy height over water and in forest openings rather than within forest stands themselves. Day roosts are predominantly in large snags and trees where hollows and cavities under bark are often utilized (Brown and Pierson 1996). Caves and mines are sometimes used as night roosts and as hibernaculum. In general, little is known of the ecology of this species in California.

Regional Status: There are no specific records of the long-legged myotis in the Medicine Lake Highlands. However, the region is within the known geographic range of the species and there is suitable habitat in the form of montane coniferous forest with large trees and snags. It is reasonable to assume that long-legged myotis are resident in the Watershed.

Amount of Habitat Available: With the exception of the water bodies, the entire Watershed provides suitable foraging habitat for long-legged myotis although high quality foraging habitat appears to be restricted to existing sumps, natural ephemeral ponds, and a few wet meadows where insect abundance is greatest and surface water is available. This species would probably forage more extensively in forest habitats that have been opened up by selective timber harvest (e.g., red fir-lodgepole pine forest) than in habitats with higher canopy closure, such as the 4G areas of red fir. There appears to be limited diurnal roosting habitat for long-legged myotis within the Watershed. As with other species, these bats typically use large defective trees and snags (18 inch dbh or greater) with cavities or exfoliating bark. Large red fir snags are the most important resources of this type.

Fringed myotis (Myotis thysanodes)
Status - ROD Adaptive Management Species, Buffer Protection Species

Habitat Requirements: This species is widely distributed in California - from deserts to montane coniferous forest (Zeiner, *et al.* 1990b). The species is most commonly found from 4,000 to 7,000 feet. They forage over open habitats, forest edges, streams, and ponds where insect prey are captured in flight and by gleaning from vegetation (Brown and Pierson 1996). Most diurnal roosting sites in California have been buildings or mines although there is evidence that they use hollows in trees and snags and crevices in rock outcrops. Night roosts and hibernaculums appear to be in mines, caves, and buildings.

Regional Status: There are no specific records of the fringed myotis in the Medicine Lake Highlands; however, the region is within the known geographic range of the species and there is suitable habitat in the form of montane coniferous forest with large trees and snags. It is reasonable to assume that fringed myotis are resident in the Watershed.

Amount of Habitat Available: With the exception of the lava flows it is expected that the entire Watershed is suitable foraging habitat for the fringed myotis. The species probably prefers to forage in forest habitats that have been opened up by selective timber harvest (e.g., red fir-lodgepole pine habitats). Suitable diurnal roosting habitat includes large trees and snags with cavities, crevices, and exfoliating bark as has been previously described, as well as rock outcrops in the form of lava flows and crater walls.

Silver-haired bat (Lasionycteris noctivagans)
Status - ROD Adaptive Management Species

Habitat Requirements: In the summer this species is closely associated with montane forests, both coniferous and mixed deciduous/coniferous, generally below 9,000 feet (Zeiner *et al.* 1990). They forage on flying insects, often concentrating their feeding efforts around streams and ponds. Foraging areas could be a considerable distance (up to nine miles) from diurnal roost sites. Maternity roosts are usually located in cavities in large trees or snags while exfoliating bark is used by smaller groups. Silver-haired bats apparently migrate to lower elevations or more southerly regions for the winter where they could hibernate in trees, snags, rock crevices, caves, mines and buildings.

Regional Status: There are no specific records of the silver-haired bat in the Medicine Lake Highlands; however, the region is within the known geographic range of the species and there is suitable habitat in the form of montane coniferous forest with large trees and snags. It is reasonable to assume that silver-haired bats are resident in the Watershed.

Amount of Habitat Available: It is likely that the forested areas within the Watershed are suitable habitat for this species.

ROADS

Key Questions:

Where do roads exceed density standards?

Summary Response

The USFS sets standards for the amount of roads desirable for every square mile of forest. These are known as Road Density Standards. In the Modoc National Forest, Road Density Standards are set at 2.5 miles per square mile.

The average road density for the entire 133.5 square mile Watershed is approximately 2.7 miles per square mile. Although this exceeds the goal of the Forest Service, it is apparent that certain areas of the Watershed are much greater than the 2.5 mile standard, whereas other areas are well below this standard. The Mt. Hoffman Roadless Area and the Burnt Lava Flow Geologic Area are well below the road density standard. Areas well above the road density standard include the MLSA and the area north of Mt. Hoffman.

Road conditions within the Watershed primarily are unimproved roads supported by few maintained, improved roads.

Background Information

Within the entire 133.5 square mile Watershed there are approximately 370 miles of roads. Table 3.5 displays miles of road by development type and the percent of all roads in the analysis area that they represent. Of the 368.68 miles in the analysis area, 20.7 miles are located on private land.

Table 3.5: Roads in the Watershed

CFF Code	Road Type	Length (miles)	% of Roads
89	Road-Unimproved 4WD	16.43	4.46
95	Road-Unimproved Dirt	6.50	1.76
96	Road-Unimproved Approx. Location	1.60	0.43
106	Road-Unimproved/+4 WDS	136.46	37.00
107	Trail (Low Standard Road)	8.42	2.28
515	Road-Improved Dirt	101.41	27.50
517	Road-Improved, Paved	29.88	8.10
518	Road-Improved, Gravel	68.06	18.46
	Total miles	368.76	
	Watershed Area (square miles)	133.49	
	Road Density (road/mile^2)	2.76	

Source: Modoc National Forest Remote Sensing Lab (RSL) Data (1993).

Assessing management areas in the Watershed derives valuable road density values. In the Watershed four primary areas have been analyzed for road density. These areas include the Matrix Lands, the MLSA, the Mt. Hoffman Roadless Area, and the Road Management Area. Figure 3.10 identifies the respective management areas individually evaluated for road density, as well as the roads located in the Watershed.

Of primary importance for road density analysis are the Matrix Lands, and the MLSA. Table 3.6 includes the number of miles for each specific road type and the road density for these areas. The Matrix Lands are 2.9 miles per square mile and the MLSA is 3.3 miles per square mile. Secondary areas to conduct road density analysis are the Mt. Hoffman Roadless Area and the areas surrounding Medicine Lake. Table 3.7 includes the number of miles for each specific road type and the road density for these areas. The Mt. Hoffman Roadless Area is well below the Road Density standard with 0.7 miles per square mile and the area surrounding Medicine Lake is above standards with 2.8 miles per square mile.

A primary concern regarding roads within the Watershed is that increased road density may lead to increased erosion. By determining which roads are really necessary erosion levels can be reduced by closing certain roads and revegetating those areas of previous surface disturbance.

Depending on road type, State and County roads provide primary access to the Watershed. In the analysis area this comes from Primary Forest Route 97 (aka Modoc County Road 97) and Primary Forest Route 49. Forest Service system roads provide recreational and administrative use of the National Forest lands in the Watershed, while private roads provide land access, and access to other developments such mining claims and residences.

In the Watershed certain management areas have specific rules regarding the construction and existence of roads. The Mt. Hoffman Roadless Area occupies approximately 9,800 acres of the Watershed. USFS decision making regarding road construction and reconstruction in some unroaded areas was temporarily suspended by the adoption of an interim rule, made effective March 1, 1999 (36 CFR Part 212). The temporary suspension will remain effective pending USFS revision of its regulations for managing roads in the National Forest System. Roadless areas that are subject to the NFMP ROD are exempted from the interim rule.

Essentially all but about 12 acres of the Mt. Hoffman Roadless Area is located within the management area of the NFMP ROD and is not subject to the temporary suspension on road construction. There are no other roadless areas in the Watershed.

Table 3.6: Matrix and MLSA Management Area Road Density

Units	Management Area Size	
	Matrix Lands	**MLSA**
Sq. Miles	54.00	31.22
Area (acres)	34557.64	19981.81
CFF Code	**Road Length (miles)**	
89	9.06	4.21
95	2.53	3.45
96	0.84	0.00
106	61.95	26.73
107	7.95	0.27
515	41.20	35.48
517	13.27	8.86
518	17.19	22.69
Total	154.01	101.69
Road Density	**2.85**	**3.26**

Source: Modoc National Forest Remote Sensing Lab (RSL) Data (1993).

The Modoc National Forest LRMP provides the following guidance for road management in its Forest Standards and Guidelines (p. 4-14):

> *(1) (S) Provide and manage a Forest transportation system to achieve resource management objectives while protecting resource values.*
>
> *A. Plan, design, and construct local roads to the lowest standard commensurate with intended use.*
>
> *B. Plan and construct arterial and collector roads to the standard appropriate for safe and economic use, and commensurate with the road development guidelines in Appendix G of the Forest Plan, and multiple resource management.*

Table 3.7: Medicine Lake and Mt. Hoffman Management Area Road Density

Units	Management Area Size	
	Medicine Lake Recreation Area	Mt. Hoffman Roadless Area
Sq. Miles	18.52	15.31
Area (acres)	11849.89	9797.82
CFF Code	**Road Length (miles)**	
89	2.05	0.27
95	4.55	0.00
96	0.00	0.00
106	12.60	1.72
107	0.00	7.90
515	18.60	0.20
517	13.06	0.00
518	1.25	0.44
Total	52.11	10.53
Road Density	**2.81**	**0.69**

Source: Modoc National Forest Remote Sensing Lab (RSL) Data (1993).

C. Maintain all Forest roads to their objective maintenance levels (as defined in Appendix G [provided as Appendix D to this Ecosystem Analysis].

D. Provide for signing in accordance with road management objectives and MUTCD (Manual on Uniform Traffic Control Devices) standards.

(2) (G) Cooperate with federal, State and county agencies, and private companies to construct, reconstruct, and maintain roads under their jurisdiction, if needed. Review location and design specifications for roads built under permit or license, and require protection of all resources. Coordinate road management and closure with local agencies.

(3) (G) Manage and maintain the transportation system to protect soil, water and all other resource values. Close local roads as needed to meet these objectives. Develop road closure and OHV plans (Appendix A of the Forest Plan).

The *Northeastern Siskiyou Coordinated Road Management Plan* (USDA 1991) identifies Road Management Units in Modoc, Klamath, and Shasta Trinity National Forests. This generally equates to travel opportunities in the northeastern Siskiyou County vicinity. The purpose of this plan is to safeguard forest resources and reduce land use conflicts. As part of the plan, controls were established regarding the use of some areas, roads, and trails. The resources that could be damaged due to conflicts with vehicle use include land, water quality and wildlife habitat. Within the Road Management Units, only designated roads and the adjacent areas within 300 feet of these roads, are open to motorized vehicles during closure periods specified by the Plan. Motorized vehicle travel is prohibited on all other roads and trails. In the Medicine Lake Highlands Area Watershed, year-round road closures exist around Medicine Lake and the area surrounding Alcohol Crater, and an area south of Bullseye and Blanche Lakes is a designated Management Unit and subject to seasonal road closure during the period from August 15th through March 31st.

In the area surrounding Medicine Lake (extending outward between 1.25 to 1.75 miles from the shoreline in an irregular shape), the closure period is year-round. In the area surrounding Alcohol Crater (extending outward from the rim approximately 0.5 miles north, west and east, and approximately 1.5 miles south in an irregular shape), the closure period extends from 3 days prior to the X-1 archery deer season to the end of the X-1 general deer season. In 1997, the archery season for deer buck in zone X-1 was from August 16th to August 31st. The general deer hunting season in zone X-1 was from September 20th to October 5th (CDFG 1997).

Modoc National Forest LRMP *Road Functional Classifications* and *Road Maintenance Levels* are provided in Appendix D. The current road closure areas within the Watershed are identified on Figure 3.11.

SILVICULTURE

Key Question (1)

What are current characteristics of the physical and botanical elements of the landscape, and what identifiable practices and natural events, of the past 50 years, have contributed to this current status with respect to:

(a) Distribution of ecological associations with unique management requirements;
(b) Species composition of associations;
(c) Percent distribution of seral stages;
(d) Average stand size;
(e) Spatial arrangement of stands;
(f) Occurrence and location of stands at risk of catastrophic loss from insects, disease and fire; and
(g) Occurrence and location of stands where stocking exceeds the long-term capacity of the site for sustained growth?

Summary Response

In Step 1 the conifer series and associations of the Watershed were characterized in a general way. In this step a more detailed description of the composition and ecological setting of these associations incorporate information on their present status resultant of previous management activities and natural disturbances. The current composition, proportions, and distribution of seral stages are identified for each association. In addition, the acreage of stands that would benefit from thinning are identified. In associations where the primary purpose of thinning is to promote sustained growth, these stands are identified as "overstocked." In mid-elevation associations containing white fir, the primary purpose of thinning are to reduce biomass and thus lower the risk of fir engraver mortality. The portion of those associations in which this goal could best be achieved are designated "stands at risk." In both cases, these are stands in which current density of stocking exceeds the long-term capacity of the site, and where silvicultural treatments will be most beneficial. The following descriptions are based on data acquired from several sources including: The Modoc National Forest Ecological Unit Inventory (EUI) maps and plot data sheets; the remote sensing laboratory (RSL) maps; interpretation of aerial photographs; and ground truthing in certain associations (see Appendix E for further explanation of how the EUI and RSL data sets were utilized in this analysis).

In Step 5, this information on the current condition of conifer associations is compared with the reference conditions (Step 4) to identify significant changes and to determine more specifically the effect that past and current management practices have had upon these changes. Thus, key questions relating current management with the health and sustainability of conifer associations are reserved to be answered after Step 5 interpretations have been made.

Background Information

The following section describes the current conditions of each vegetative series and plant association found in the Watershed. The current area occupied by each of the described plant associations have been tabulated (see Table 3.8) and plotted by GIS (see Figure 6.10). Figure 3.13 shows the location of each of the respective land management plan units derived from crown cover and tree dbh. Figure 3.14 shows the location of timber sales that have occurred in the Watershed.

The analysis is presented by elevation zones or groups with plant series and corresponding plant associations relevant to silviculture found within the Watershed as follows:

Subalpine Zone (above 7,000 feet):
- Hemlock Series
  - Associations SC1, SC2, and SC3

High Montane Zone (6,300-7,000 feet):
- Red Fir Series
  - Associations RF1 and RF3
- Lodgepole Pine Series
  - Associations LP1, LP2, and LP3
- Eastside Mixed Conifer Series
  - Association EM3

Northern Transition Group (5,200-6,400 feet):
- Ponderosa Pine Series
  - Association PP4
- Eastside Mixed Conifer Series
  - Association EM5

Southern Transition Group (5,600-6,900 feet):
- Red Fir Series
  - Association RF2
- White Fir Series
  - Association WF1

Mid-Montane Zone (<5,000-6,000 feet):
Eastside Mixed Conifer Series
Associations EM1 and EM4
Ponderosa Pine Series
Associations PP1, PP2, PP3, and PP4
Pine-Juniper Series (<4,500 feet)
Association PJ1

The plant associations in the Watershed contain a total of 11,184 acres of "overstocked" stands, (i.e., stands whose stocking presently does or will eventually exceed site capability over time). These stands include 283 acres of poles (early seral) that would benefit from precommercial thinning, and 10,901 acres of mid-mature (mid seral) trees that would benefit from commercial thinning.

Subalpine Zone:
Hemlock Series:

Hemlock-Red Fir/Ross's Sedge Association (SC1), Hemlock/Pityopus Association (SC2), and Hemlock-Lodgepole/Ross's Sedge Association (SC3): This series occurs above 7,000 feet on the summits, ridges, and upper slopes of prominent mountains in three distinct areas of the Watershed: (a) Mt. Hoffman and an adjacent northwesterly ridge, (b) the Red Shale Butte - Lyon's peak complex, and (c) Medicine Mountain. Small outlying stands occur elsewhere. The total area of occupancy is approximately 4,373 acres, of which greater than 98% is currently occupied by conifers. The balance consists of rock outcrop, climax montane mixed shrub, intermittent drainages, and a single road. Precipitation in all three of these areas ranges between 40 and 45 inches annually. Soils are deep, or gravelly coarse loamy sands, with moderate AWC and productivity (Forest Survey Site Class 5). Limiting factors for timber management include 2-24 inch pumice overburden, slopes exceeding 40%, and 30-60% coarse fragments greater than 3/4-inch in the top 20 inches of soil.

The Hemlock Series is represented by three ecological associations, all occurring in close proximity to one another, forming a single integral unit in each representative area. The internal distribution pattern of the associations within the series units is dictated by differences in micro-climate and soil. The Hemlock-Lodgepole/Ross's Sedge Association (SC3) occupies the shallower soils and more exposed sites on summits, ridgetops, and limited southerly aspects. Stands of this association are characteristically moderately dense (40-60% canopy cover), but more open (25-40%) on arid rocky ridges. Lodgepole pine usually provides the greater cover throughout this association, and western white pine is commonly a co-dominant along with hemlock. Mature overstory trees are typically 50 to 70 feet tall. The Hemlock-Red Fir/Ross's Sedge Association (SC1) is prevalent on deeper soils and northerly aspects, and characterized by a taller overstory (70-90 feet) and dense stands (>70% crown closure) of the two co-dominants. Western white pine is usually a secondary stand component. The Hemlock/Pityopus Association (SC2) occurs on limited intermediate microsites which favor monotypic stands of hemlock. Stands in the latter association are very dense but overstory height is usually limited to 75 feet.

The typical understory surface cover in all three hemlock associations consists of a sparse (<2%) distribution of forbs and grasses. Sparse natural regeneration of component species are consistently found in the understory as well. Shade tolerant hemlock and red fir seedlings and saplings are more common in SC1 and SC2, while lodgepole regeneration is more likely to occur in SC3. Shrubs are a rarity in this ecosystem except on inclusions of rock outcrop. Moderate increase in herbaceous cover follows disturbance with little or no shrub competition to inhibit seedling growth.

Few impacts have been imposed upon the Hemlock Series by either natural causes or management. Logging in this series has been confined to a portion of Lyons Peak and has involved only a few small shelterwood cuts (<20 acres). A single access road to Glass Mountain traverses through the association on the northern extremity of Lyons Peak. Fire control has reduced loss from lightning fires to insignificant amounts. Approximately 6 acres has been visibly modified by a past fire but the disturbed area is currently densely stocked with a combination of mature residuals and saplings. These plant associations contain a total of 1,832 acres of "overstocked" stands. The SC1 association includes 1,034 acres, the SC2 association includes 164 acres, and the SC3 association includes 634 acres, of mid-mature trees that would benefit from commercial thinning.

Table 3.8: Watershed Plant Associations

Association			1 (LRMP WHR 1)		2 (LRMP WHR 2)		3P (LRMP WHR 3a)		3G (LRMP WHR3b/c)		4G (LRMP WHR4b/c)		Non-Stocked < 10% Canopy Cover[a]				Non-Productive[b]
													X≤40% Shrub		X>40% Shrub (CM, CX, ST)		
Code	Total Acres	% of Watershed	Acres	% of Assoc.	Acres	% of Assoc.	Acres	% of Assoc.	Acres	% of Assoc.	Acres	% of Assoc.	Acres	% of Assoc.	Acres	% of Assoc.	Acres
Hemlock Series:																	
SC1[f]	2471	3.1	0	0	0	0	120	4.9	1279	51.8	1071	43.3	0	0	0[f]	0	0
SC2	331	0.4	0	0	0	0	16	5.0	223	67.0	92	28.0	0	0	0	0	0
SC3[f]	1571	1.9	0	0	0	0	246	15.7	1196	76.1	129	8.2	0	0	0	0	0
Total	4373	5.4	0	—	0	—	382	—	2698	—	1292	—	0	—	0	—	0
Red Fir Series:																	
RF1[f]	5304	6.5	6	0.1	150	2.8	802	15.1	2765	52.2	1529	28.8	19	0.4	CM=33	0.6	0
RF2	3412	4.2	0	0	181	5.3	264	7.7	1880	55.1	657	19.3	21	0.6	CX=409	12	0
RF3[f]	5383	6.6	0	0	17	0.3	2241	41.6	2170	40.3	849	15.8	59	1.1	CM=37	0.7	10
Total	14099	17.3	6	—	348	—	3307	—	6815	—	3035	—	99	—	479	—	10
Lodgepole Pine Series:																	
LP1[f]	4471	5.5	8	0.2	0	0	2184	48.9	2259	50.5	NC	NC	0	0	0	0	20
LP2	96	0.1	NA	NA	NA	NA	18	18.8	78	81.2	NC	NC	0	0	0	0	0
LP3	2616	3.2	NA	NA	150	5.7	1447	55.3	931	35.6	NC	NC	0	0	0	0	88
Total	7183	8.8	8	—	150	—	3649	—	3268	—	0	—	0	—	0	—	108
Eastside Mixed Conifer Series:																	
EM1[f]	6193	7.6	170	2.7	982	15.9	237	3.8	4347	70.2	249	4.0	92	1.5	CX=80	1.3	36
EM3	2907	3.6	0	0	24	0.8	167	5.8	1716	59.0	996	34.3	0	0	0	0	4
EM4[f]	4975	6.1	98	2.0	907	18.2	2264	45.5	826	16.6	29	0.6	789	15.9	ST=62	1.2	0
EM5[f]	1605	2.0	0	0	390	24.3	674	42.0	129	8.0	22	1.4	271	16.9	0	0	119
Total	15680	19.3	268	—	2303	—	3342	—	7018	—	1296	—	1152	—	142	—	159
Ponderosa Pine Series:																	
PP1[f]	4364	5.4	0	0	1530	35.1	1491	34.2	265	6.1	8	0.2	53	1.2	ST=015	23.3	2
PP2[f]	2523	3.1	0	0	763	30.3	336	13.3	1352	53.6	21	0.8	11	0.5	39	1.5	1
PP3	4646	5.7	33	0.7	1104	23.8	459	9.9	2575	55.4	324	7.0	24	0.5	CX=115	2.5	12
PP4[f]	6405	7.9	0	0	1619	25.3	1749	27.3	2581	40.3	28	0.4	420	6.6	0	0	8
Total	17938	22.1	33	—	5016	—	4035	—	6773	—	381	—	508	—	169	—	23
White Fir/Chinquapin Association:																	
WF1	6775	8.3	58	0.9	1376	20.3	175	2.6	3666	54.1	435	6.4	17	0.2	CX=1048	15.5	0
Juniper-Ponderosa/Bitterbrush Association:																	
PJ1	951	1.2	197	20.7	0	0	NC	NC	NC	NC	NC	NC	0	0	ST=754	79.3	0
Shrub Associations - Climax																	
MM[f]	396	0.5															
CM	70	0.1															
CX	77	0.1															
Total	543	0.7															
Herbaceous Associations - Climax:																	
DM	113	0.1															
WM[f]	69	0.1															
PF	153	0.2															
RS[c]	14	0.02															
Total	349	0.32															
Non-vegetated Landscape Features:																	
Talus	150	0.2															
Lava[f]	12721	15.7															
Water[d, f]	432	0.5															
Total	13303	16.4															
TOTAL[e]	**81236**	—															

Source: Modoc National Forest Remote Sensing Lab (1993), Ecological Unit Inventory (1996).

LRMP WHR — Land and Resource Management Plan California Wildlife Habitat Relationship (see Appendix C — Seral Stage Crosswalk for additional explanation); NC — Not Capable

a Land capable of producing representative timber stands that is currently occupied by <10% cc of is classified "Non-Stocked". Non-Stocked lands with <40% cc shrub cover are designated by the symbol X. Non-Stocked lands with occupied by >40% shrub cover are designated by the symbol of the shrub association they characterize: CM=montane mixed shrub; CX=montane chaparral; ST=bitterbrush and associated shrubs.

b Land incapable of producing a vegetative cover is classified "Non-Productive". Such barren areas result from either natural causes or development for acquisition of specific resources.

c Rush-sedge Association located along the northwest and west shores of Medicine Lake.

d Water includes both lakes and ephemeral ponds.

e The gross area of the Watershed (including private lands) is approximately 85,196 acres.

f In the Watershed, 3,960 acres are in private ownership and have been excluded from the total acreage amounts given for certain associations. In addition, small patches of shrubs or dry meadows (DM) which are included within conifer associations, but have no potential for producing commercial timber, have been correlated to the appropriate climax shrub or herbaceous associations, and acreage has been excluded from the conifer associations in which they are resident. Tabulated below are the acreage amounts for associations occurring on private land and the small patches of land which are included within conifer associations, but have no potential for producing commercial timber.

	Private Land acres	Inclusions Correlated to Non-Conifer Associations: CM acres	CX acres	PT acres	DM acres
SC1	5	12			
SC3		8			
RF1		34			23
RF3		9			
LP1	128	13			
EM1				44	
EM4	1033		14		
EM5	397				

	Private Land acres	Inclusions Correlated to Non-Conifer Associations: CM acres	CX acres	PT acres	DM acres
PP1	1012		50		
PP2	310		13		
PP4	694				
MM	83				
WM	27				
Lava	231				
Water	41				

Table 3.8 displays the current status of the Hemlock Series relative to the composition, proportion, and acreage of the component seral stages. Only slightly over four acres of this series occurs on private land.

Currently all three hemlock associations are dominated by relatively even-aged mid- to late-successional stands with only a few small scattered patches of poles and saplings found in the entire ecosystem. The actual acreage of seral stage 2 is higher than indicated in RSL mapping, particularly in the SC3 association. The 3G and 4G seral stages are well distributed and have good connectivity throughout the entire hemlock series. See Appendix F for a more complete representation of seral stage arrangement within the SC series.

Modoc National Forest standards and guidelines for minimum maintenance of WHR seral stages probably apply to SC1 and SC3. It is obvious that Modoc Land and Resource Management Plan WHR (LRMP WHR) stages 1, 2, and 4a are missing. Some "old growth" stands may occur in the 4G category.

High Montane Zone:
Red Fir Series:

Red Fir/Ross's Sedge Association (RF1): This association occurs on mountain side slopes, benches and some ridges above the central basin floor. From Medicine Mountain it extends several miles south down the west side of the Watershed. The total area of occupancy is approximately 5,304 acres. Most commonly it occurs on slopes ranging from 0% to 30%, but it is also found on steeper slopes (30 to 50%). Elevations generally exceed 6,500 feet and aspects within the Watershed are predominantly southerly. Annual precipitation ranges from 35-45 inches. Soils are very gravelly, deep loamy coarse sands to sandy loams with moderate AWC and productivity (Forest Survey Site Class 5). Limiting factors for timber management include a 10-24 inch pumice overburden and 30-60% coarse fragments over 3/4-inch in the top 20 inches of soil.

Currently, late-successional stands account for approximately 28.8% of this association. Undisturbed late-successional stands are characterized by a relatively pure red fir component, canopy cover exceeding 70% (commonly >80%), and a mean dbh between 24 and 36 inches, though they usually contain a significant portion of size class 6 trees (>36 inch dbh). This association is commonly visualized as being even aged. However, undisturbed late-successional stands are actually two layered consisting of an overstory of large and very large trees and a lower interwoven canopy layer made up of poles and small matures. The understory rarely contains shrubs, and consists of a forb-grass layer that typically provides <2% cover. The understory also usually contains a 3-5% cover of shade tolerant red fir seedlings and saplings. Wood debris covers an average of 20% of the surface on representative plots.

Timber harvests of various types and intensities have occurred within 92% of the area occupied by the RF1 association. Most of the association has been included within the area of 2-4 different sales, yet the overall impacts of harvesting upon stocking have been only moderate. Approximately 2/3 of the total volume harvested from the RF1 association was derived from salvage logging in the 1960s and early 1970s. This method of logging intensified for several years (1963-1965) following the Columbus Day Storm of 1962 in which a large number of true fir, particularly red fir, were subjected to wind throw. Logging in this association in the late 1970s was limited to a single commercial thinning sale and some initial overstory removal. Through the 1980s the intensity of logging picked up again, employing a variety of silvicultural systems and cutting methods. These included overstory removal, sanitation cutting, commercial thinning, shelterwood, limited clear cuts, and some continued salvage along roads. Shelterwood cutting was included in more sales than any other method during the 1980s, and probably accounted for a significant portion of the volume removed during that era. Units cut by this method are currently marginally stocked (10-20% canopy cover), and approximately 20 acres are identified as unstocked. There appear to be additional units with less than 10% canopy cover that were not identified as such in RSL mapping. Some areas where heavy logging has occurred are currently stocked primarily with seral stage 2 stands. It appears that the actual acreage of early seral stands is underestimated in RSL date and mapping. The overall moderation of harvesting is attested to by the current stocking. Over 80% of the association is characterized by mid seral and

late seral stands with greater than 40% stocking. Relatively large stands of late-successional forest, constituting approximately 29% of the association, are well distributed throughout the area of occupancy. This plant association contains a total of 1,780 acres of "overstocked" stands. This includes 14 acres of poles that would benefit from precommercial thinning, and 1,766 acres of mid-mature trees that would benefit from commercial thinning.

Lightning fires within the past 50 years have modified limited additional acreage. Approximately 33 acres of burned patches are currently occupied by montane mixed shrub while the remainder appears to be adequately stocked with young regeneration or partially stocked with residuals (10-39% canopy cover).

Mixed results have been experienced in artificial regeneration. Patches resulting from heavy selective logging on the west side of the Watershed, near Little Mount Hoffman are well stocked with saplings, where as in other clear-cut and shelterwood areas seedling survival is low. Problems encountered in planting red fir on local volcanic soils include mortality from frost heave, gophers, and summer dessication. Some of these problems are more pronounced in surface soils of high pumice content.

No serious disease or insect problems have been detected in the RF1 stands of the Watershed. Dwarf mistletoe, and consequential mortality of weakened trees inflicted by insects has been a widespread problem in red fir stands of the Pacific region. However, it does not seem to be threatening the local population of this species. There appears to be one small infestation in a stand immediately adjacent to the Glass Mountain Lava Flow in Section 10, T43N, R4E.

The primary results of various disturbances, both natural and man-made, are reflected in the present distribution of seral stages within the RF1 ecosystem. Table 3.8 displays information on the current composition, proportion, and acreage of component seral stages.

Mid- and late-successional stands are well represented in the RF1 association. The mid seral stands have almost continuous connectivity and form the matrix for most of the area occupied by the association. The late-successional stands are also well distributed but tend to be concentrated in groups with gaps of less than ½-mile between groups. Early-successional stands are very limited in acreage and confined to a couple of isolated groups in the southern end of the association. However, there is considerable additional regeneration in the understory of 3P stands.

The Modoc National Forest LRMP standards and guidelines designate a minimum of 5% of capable land (or 2-1/2%) for each of 9 LRMP WHR seral stages. The Modoc National Forest LRMP standards and guidelines designate a minimum of 5% of each seral stage for eastside pine, mixed conifer, white fir, red fir, and lodgepole pine on lands capable of growing >20 cubic feet per acre per year. LRMP standards and guidelines designate maintaining a minimum of 5% in seral stages 1, 2, 3a, 4a-older (4b and 4c that are 140-180 years old) for each conifer and hardwood vegetation type on lands growing <20 cubic feet per acre per year. A minimum of 2-½% of 4b and 4c over 190 years old is required for each conifer and hardwood vegetation type on lands growing >20 cubic feet per acre per year. Requirements for high and low productivity lands are not interchangeable (LRMP 1991). This standard is attained within the RF1 association for 3P, 3G, 4P and 4G. It is not achieved for seral stages 1 and 2 or any of the three categories of "old growth" unless some of the stands classified as 3G actually have old growth characteristics.

The NFMP ROD minimum of 15% late-successional stands is met in this particular association, but for the Watershed as a whole only slightly more than 10% of this stage presently exists. Therefore, current silvicultural practices include thinning of some 1,200 acres of overstocked mid seral red fir stands to hasten development of additional late-successional stands.

There appear to be minor mapping deficiencies in the coverage of certain parts of the RF1 ecosystem. A network of small meadows on the SE flank of Medicine Mountain (Sections 23 and 26, T43N, R3E) do not appear to have been identified on either the EUI association or the RSL cover map. There also appear to be more seral stage 2 stands than indicated.

Red Fir-Lodgepole/Western Needle Grass Association (RF3): This association, for the most part, occurs within the Medicine Lake Basin at elevations between 6,200 and 7,000 feet. The total area occupied is approximately 5,383 acres. Approximately 3/4 of the association inhabits the basin floor and immediately adjacent or included toe slopes. The slope gradient is gentle, predominantly <5% and aspect is variable. The other quarter of the association is established on the south aspect of some surrounding mountains on slopes ranging to 45%. Populations of this phase occur on a western appendage of Mt. Hoffman, immediately north of the Medicine Lake Glass Flow, on mid- to upper-slopes of Red Shale Butte, and in other small outlying areas. The differences in microclimate and soils between these two phases result in some variation in species composition. Annual precipitation for the entire area ranges from 40-45 inches. The dominant soils are moderately deep to deep, loamy coarse sands with moderate AWC and productivity (Forest Survey Site Class 5). Limiting factors for timber production include a 2-15 inch pumice overburden and 30-60% coarse fragments greater than 3/4-inch in the top 20 inches of soil.

Undisturbed late-successional stands located on the basin floor typically have an overstory consisting of just red fir and lodgepole pine. On average the red fir occupy approximately 15% more of the site than the lodgepole pine. The red fir dominants, growing 55-75 feet in height form an upper canopy layer and the smaller mature lodgepoles secondary layer some 10-30 feet in height. The normal range of this layer is 10-20 feet, but in rare instances the layer can range up to 30 feet. The stands commonly contain a variety of size classes and the lodgepole component is largely represented by pole size trees (<11 inch dbh). Medium sized (>24 inch) lodgepole rarely are present in stands where as the red fir component commonly includes size class 5 and a few trees in size class 6. Canopy cover in undisturbed stands ranges from 50-70%. Shrubs are a rarity in the understory though pinemat manzanita and rabbit golden weed occasionally occur, especially in openings. A sparse grass-forb cover of <2% is most typical. Seedlings and saplings of both conifer species are usually present in the understory.

The stands representing the steeper-higher phase of the RF3 associations are characterized by a similar range of tree height, size distribution and canopy cover but vary in species composition. Western white pine usually is included as a co-dominant, and the understory commonly contains regeneration of all three species. Shrubs, though sparsely distributed, are more common in the understory, and in addition to pinemat manzanita may include chinquapin, greenleaf manzanita and other species. The grass-forb component is still sparse but includes a richer variety of forbs. Woody debris covers an average of approximately 10% of the surface of relatively undisturbed sites.

The RF3 association is the most poorly stocked of the Red Fir Series. Over 40% of this association is currently characterized by a sparse to open canopy cover of mid seral stands. Most of these occur in the northern 2/3 of the association and have <20% canopy cover. This poor stocking cannot be attributed to management impacts alone. Timber sale records indicate that an average of approximately 2.2 million board feet per acre were harvested from a portion of the association that contains the majority of the poorly stocked stands. The removal of this volume would not in itself account for the current poor stocking of overstory trees. Thus, it is thought that there must be some soil and microclimate limitations placed upon productivity. Since soils do not differ markedly from those supporting adjacent relatively dense stands of red fir, the microclimate of the central basin floor may be the principle limiting factor.

Timber sales of various types and intensities have occurred within the entire area occupied by this association, potentially removing over 15 million board feet. Salvage logging occurred in the early to mid-1960s following the Columbus Day Storm of 1962 that resulted in a high volume of windfalls in red fir. Most of the logging since that time occurred within the 1980s. Overstory removal and shelterwood logging accounted for most of the volume removed from this association during that era. There has been only two clear-cuts, totaling approximately 60 acres, and some limited sanitation logging and commercial thinning. Since 1989 no significant harvesting has occurred. Most of the volume removed from the RF3 association has been red fir, thus the proportion of lodgepole pine has increased in residual stands. In general,

natural regeneration is adequate to restock these stands but, because of the open and disturbed nature of the sites, the reproduction is predominantly lodgepole pine. Unless silvicultural treatments to prevent it are employed, this species will monopolize these sites for a considerable time in the future.

Attempts to plant clear-cut areas with red fir seedlings have failed and it appears that lodgepole pine will eventually dominate these areas as well. The problems encountered in planting red fir are identified under the RF1 association. These problems are even more pronounced in the RF3 ecosystem because soils on the basin floor tend to have deeper pumice layers and be more droughty. Also, the microclimate is influenced to a greater degree by cold air drainage thus increasing the potential for frost heave.

Lightning fires have resulted in only minor disturbances within this association. Approximately 37 acres previously burned are currently occupied by montane mixed brush. Currently no significant disease or insect problems have been detected.

Table 3.8 displays the current status of the RF3 association relative to the composition, proportion, and acreage amounts of the component seral stages.

Approximately 96 acres of the association is non-stocked, and 40% of this area is occupied by a dense cover of shrubs. Another 10 acres has been rendered non-productive through development.

Mid seral stands dominate this association with a disproportionately moderate amount of late-successional stands and practically no stands classified as early-successional in RSL mapping. This is somewhat misleading because most of the area classified as seral stage 3P is only sparsely stocked with overstory trees (10% to 24%) and may have considerable understory regeneration, particularly lodgepole pine. Relative to the stocking of size class 3 overstory trees, the association is very unbalanced. Sparse to open stands occupy over 80% of the north-central half of the association, while stands with moderate to dense canopy cover dominate the other half in south-central and western units. The latter areas also include a much larger proportion and consolidated arrangement of the limited late-successional stands. The later are most concentrated in Sections 35 and 36, T44N, R3E. This plant association contains a total of 840 acres of "overstocked" stands. This includes 840 acres of mid-mature trees that would benefit from commercial thinning. See Appendix F for average stand size and more details on seral stage arrangement.

Modoc National Forest LRMP standards for minimum proportions of seral stages are satisfied for LRMP WHR seral stages 3a, 3b/c, and 4b/c only. Late-successional stands occupy almost 15% of the ecosystem.

Lodgepole Pine Series:

Lodgepole/Western Needlegrass Association (LP1): This association occurs primarily on gentle slopes (<5%) of the central Medicine Lake Basin floor at elevations between 6,700 and 6,800 feet. The total area of occupancy is approximately 4,471 acres. The dominant soil occurring on lodgepole sites is Kinzel. This soil is characterized by pumice overburdens of 2-12 inches, strong to moderately acid surface horizons, and low AWC. It is rated as a Forest Survey Site Class 6 (low) for timber production. The microclimate in this basin area is influenced by cold air drainage. The annual precipitation ranges from 35-45 inches.

The LP1 stands are monotypic, rarely containing over 2-3% of conifer species other than lodgepole pine. Undisturbed stands of this association are typically moderately dense (50-60% crown cover) and the dominant overstory layer is approximately 50 feet tall. The canopy is actually made up of both pole and small mature trees, the former providing an average of 1/3 more cover than the latter. Thus a majority of the stands have a mean dbh of <11 inches (size class 2). Rarely do stands exceed a mean dbh of 16 inches. Limited to its normal habitat within the Watershed, the LP1 association is not capable of producing late-successional forest stands.

Understory surface cover is sparse, typically consisting of <2% grasses and forbs and <1% subshrubs (most commonly rabbitbrush-goldenweed). This community of subshrubs and herbaceous species may increase to 10-20% cover in disturbed openings. A 3-5% cover of

seedlings and saplings is also normally found in the understory. Accumulations of woody debris are well distributed over much of the surface of both disturbed and undisturbed stands at light to moderate amounts.

Some firewood is harvested from this association but, to date, less than 75 acres has been intensively logged. This includes roughly 50 acres of overstory removal and a single 7.5-acre clear-cut.

There is little evidence of impacts resulting from fires in recent history. Some disturbance has occurred from other management activities. A total of 12.5 acres has been taken out of production for gravel pits and geothermal exploration sites, and an undetermined additional acreage is being utilized for roads and recreational sites in the vicinity of Medicine Lake. Forest Service Roads 43N21 and 43N25 also pass through this association.

Regeneration of disturbed sites to lodgepole pine has occurred quite readily despite the harsh environment, but a single attempt to convert a lodgepole site to red fir resulted in 100% mortality. The Kinzel soil is rated slightly lower for seedling survival (moderate) than the dominant soils of adjacent RF3 and RF1 stands. No serious insect or disease problems are currently recognized in this association.

Table 3.8 displays the current status of the LP1 association relative to the composition, proportion, and average size of the component seral stages (128 acres of private land have been excluded from the acreage amounts in this table).

This entire association is dominated by mid seral size trees (stands of small mature and pole size trees) with practically no early or late seral stands as indicated in RSL mapping. 4G stands occurring along the association boundary and in limited inclusions are actually components of other types. The size class 3 stands are about equally divided between open and moderately dense stands, and these two components are unevenly intermingled to produce an unbalanced mosaic pattern on the landscape. On the basin floor, where the greater part of this association occurs, the denser stands dominate a central portion around Medicine Lake. The open stands are more concentrated in the east and west portions. Though no size class 2 polygons are recognized in RSL mapping, a relatively large proportion of this association probably should be classified as seral stage 2. In a majority of EUI survey plots recorded from this association, the mean dbh was under 11 inches. This discrepancy in classification needs to be corrected if the true seral stage distribution within the LP1 association is to be represented for assessment purposes. Currently certain wildlife interpretations that are influenced by tree size could be erroneous, as could also predictions of fire wood volume.

Lodgepole/Pinemat Manzanita Association (LP2): This association is confined to just two relatively small areas on the southern edge of the Medicine Lake Basin. One near the intersection of Primary Forest Roads 49 and 97, and the other a mile east at the head of the Paynes Springs drainage. The total area occupied is 96 acres and the mean elevation is approximately 6,650 feet. The annual precipitation ranges from 35-45 inches. This habitat is located immediately above a basalt cinder contact zone on the terminal portion of a lava flow. The topography is irregular and undulating with slopes varying from 0-35 degrees. The surface cover includes 10-25% rock cover and shallow layers of fine pumice still persist in portions of the area.

Unlike the monotypic LP1 association, 25-33% of this community is represented by a secondary conifer species, red fir. The overstory conifer composition is the reverse of the RF3 association in respect to the proportion of lodgepole to red fir in the mix. It is also less productive than the latter association because the soils are shallower and less productive. The Forest Survey Site Class for timber production is 6 (low). Undisturbed stands of LP2 typically have a maximum of 50-60% canopy cover and the dominant upper layer (red fir in size class 4 and 5) is 40 to 60 feet in height. Mature lodgepole pine (size class 3) average 40 to 45 feet tall. Stands are frequently all aged and include good understory reproduction of both species. The surface layer consists of 5-20% shrub cover, depending on the openness and rockiness of the site. Pinemat manzanita is the primary species. A sparse but relatively rich forb-grass layer is also present and 5-15% woody debris.

No substantial disturbance has occurred in this association though an access road to Bullseye

and Blanche Lakes runs through the western unit. Light individual selection of red fir from among the dominant lodgepole has occurred in some stands. The variation in cover that does occur in stands results primarily from microsite differences.

Table 3.8 displays the current composition, proportions, and acreage of the component seral stages of the LP2 associations.

This small association is entirely characterized by size class 3 stands which are predominantly moderately dense, uniform, and continuous across the largest unit of the association. In the second unit there is a relatively even mix of open and closed stands reflecting differences in soil depth and rock content.

A late-successional stand of red fir occurs as an inclusion within the LP2 association, located in the inner gorge of Paynes Creek. This 4G stand of red fir is atypical of the surrounding association relative to both species composition and productivity. Typical habitat of the LP2 association is incapable of producing late-successional forest stands. Consequently, for silvicultural analysis, this 12.4 acre stand is accounted to the RF1 association rather than LP2. For wildlife analysis it should be recognized that a 12.4 acre late-successional stands does occur within the LP2 association.

Modoc National Forest LRMP standards for minimum proportions of seral stages are satisfied for LRMP WHR seral stages 3a and 3b/c only for the LP2 association.

Lodgepole-Western White Pine/Creambush Association (LP3): This association occupies approximately 2,616 acres within the Watershed. It is located in the center of the Watershed between Mt. Hoffman and Glass Mountain, extending a couple of miles north from the latter to the base of Indian Butte. Elevations range between 6,400 and 7,400 feet, but are predominantly above 7,000 feet. The annual precipitation ranges from 40-45 inches.

Several phases of the LP3 association occur in the Highland area reflecting basic differences in the rooting medium and/or microsite. The majority of the association occurs upon a veneer of shallow soils which blanket the weathered surfaces of western and northwestern portions of the Glass Mountain Lava Flow. Flow surfaces are flat to gently sloping and characterized by 35-85% rock. Tree cover averages between 10-25% and is made up of slow growing lodgepole pine and western white pine. Stand dominants average approximately 18 inches in diameter but have stunted height growth, generally limited to 50 feet for western white pine, and 30 feet for lodgepole pine. The understory surface layer consists of a scattered to sparse cover of cream bush (*Holodiscus microphyllus var. glabrescens*) and forbs, most notably *Penstemon davidsonii*. Sites occupied by this open phase of the LP3 association probably produce less than 20 cubic feet per acre per year of wood (Forest Service Site Survey Class 7).

A second phase of this association occurs on the east side of Mt. Hoffman in an area contiguous with the preceding. The slopes are slightly steeper and the soil of moderate depth and more productive (Forest Survey Site Class 6), though still limited by pumice overburdens and low AWC. An overstory of small mature and pole size trees provide from 20-50% canopy closure over a dense understory of saplings and shrubs. The total cover exceeds 70% canopy closure. This stand structure may have resulted from fire, though there is no record of fires occurring within this area.

Between Glass Mountain and Indian Butte, a third phase of the association occurs upon steeper side slopes (20-50%) in highly dissected terrain. This area has a general northeast aspect. The soils and pumice overburdens are similar to the preceding phase. Undisturbed stands in this area are typically all-aged and have an overstory canopy cover of 30-40%. These stands commonly contain additional conifer species as secondary or minor components including red fir, ponderosa pine (possibly Washoe) and mountain hemlock. Western white pine dominants may grow to 55 feet and a few attain diameters exceeding 40 inches dbh. However, the mean dbh of these stands is still considerably less than 24 inches. Greenleaf manzanita and chinquapin are associated with cream bush in the open understory. On the southern end of this area the slopes ascend Glass Mountain and steepen to greater than 50%. Stands become more open and composed of predominantly pole size trees. For further details on the arrangement of seral stages within the PP4 association, see Appendix F.

Management impacts upon this association have been confined to some mining for pumice and small and isolated geothermal exploration surface disturbance. As a result approximately 25 acres of land has been rendered bare and unproductive. An additional 60 plus acres of naturally barren areas of rock outcrop and/or pumice also occur. There has been no logging. A couple of small roads provide access to mine sites and test well pads.

Table 3.8 displays the current status of the LP3 association relative to the composition, proportion, and average size of the component seral stages.

Approximately 88 acres of unproductive bare sites are included in this association.

Sixty-nine acres of 4G stands included within the boundaries of this association were correlated to the RF3 association and are not included in the total acreage of LP3. Additional narrow stringers and fragments of adjacent conifer associations, including the EM3, SC3, and SC1 associations, extend into the LP3 stands to a minor degree marking unique micro sites. These small atypical inclusions have not been differentiated for purposes of ecosystem analysis. A significant portion of the 3G stands mapped in the west half of Section 32, T44N, R4E, would be better typed as 3S/2G. When these areas reach a mid seral stage the canopy cover will probably not exceed 40%. This association, excluding minor inclusions of other associations, is considered incapable of producing late-successional stands (4G). With the exception of LRMP WHR seral stage 1 and 4b/c, all the LRMP WHR stages potentially occurring in this association are currently present at the required 5% minimum standard.

Eastside Mixed Conifer Series:

Washoe-Red Fir-Western White/Greenleaf Manzanita Association (EM3): This association occupies 2,907 acres in the Watershed. It occurs on volcanic mountain side slopes on the northern rim of the Medicine Lake Basin. Stands are located on both the north and south flanks of Mt. Hoffman, and a smaller unit occurs on the east side of Lyons Peak. The south facing slopes are relatively steep (30-55%) and linear, while on north aspects the slopes are predominantly moderately sloping (10-30%) and undulating. The soils are moderately deep, strongly to moderately acidic, have a moderate AWC, and are Forest Survey Site Class 5 (medium productivity). A thin pumice overburden is present on most sites.

Sites occupied by this association are relatively undisturbed and are for the most part characterized by dense (60-80% crown cover) all-aged stands of mixed conifers. Red fir and Washoe pine (Further study is necessary to confirm the identity of this species which is similar in some respects to ponderosa pine.) are the most common stand dominants in late-successional stands, growing to a height of 80-105 feet and eventually attaining a dbh exceeding 36 inches. Western white pine consistently occurs in stands as either a co-dominant or secondary species and is commonly shorter in stature. Lodgepole pine is a conspicuous component of the intermediate layer, and white fir may occur in transitional stands. An adequate stocking of seedlings and saplings of all resident species usually occurs in the understory with shade tolerant red fir being more abundant. The ground cover is characteristically sparse and divided between herbs and shrubs. The most characteristic of the herbaceous species are *Penstemon gracilentis* and Ross's sedge. The most commonly occurring shrub species are greenleaf manzanita, chinquapin, and pinemat manzanita. Shrub cover increases in openings and the potential for competition with regeneration is greater in this association than in other high montane types.

Most of this association has remained relatively free of impacts from other management activities or natural disturbances in recent years. However, roughly 450 acres along the northern border (in the south half of Section 19, and surrounding the intersection of Sections 20, 21, 28, and 29, T44N, R3E) has been harvested by overstory removal. This occurred in the late 1970s or early 1980s as part of the Cougar Sale. A high density of skid trails and surface disturbance resulted from logging, and currently the cutover area is a mosaic of seral stage 2 and small 3P stands, the former being predominant. For the most part, regeneration following logging has been good and understories are well stocked with saplings. It is possible that the understory also includes concentrations of shrubs.

No significant fires have occurred in this association recently, though some two-layered stands identified as seral stage 3P have undoubtedly resulted from historical burns. The understory layer is composed of a dense cover of size 2 and 3 regeneration. The location of a single small burn (8-10 acres) on the western fringe of the association (Section 26, T44N, R3E) currently has almost a 100% canopy of poles and needs thinning.

No significant disease or insect problems have been noted in this association in recent years, and no additional human impacts or developments have occurred.

Table 3.8 displays the current composition, extent, and proportion of the component seral stages in the EM3 association.

Stands of seral stage 3G form an almost continuous matrix throughout most of this association with only minor gaps. Within this matrix the seral stage 4G stands are well distributed with gaps between stands generally limited to less than 1/4-mile. These late-successional stands actually dominate the unit of the EM3 association occurring on the southern flank of Mt. Hoffman. Stands of seral stage 3P occur in only a few isolated localities, separated from each other by more than a mile. Seral stage 2 stands occur in only a couple of locations within the entire association. See Table 3.8 for more details on the arrangement of seral stage stands and average stand sizes within the EM3 association.

Though only a small acreage of seral stage 2 was identified in RSL mapping, such stands constitute a significant portion of the approximately 450 acres of this association in which overstory removal has occurred. A good stocking of saplings also occur in the understory of 3P stands in these same disturbed areas. The typing on the RSL maps, for the most part, is incorrect for the stands in which overstory removal occurred. In fact it is possible that approximately 200 acres of seral stage 3P and 2 stands are still identified as 4G on the RSL map (S1/2 of Section 19, T44N, R4E). This potential error has not been accounted for Table 3.8.

According to the existing RSL data, the Modoc LRMP standards for minimum proportions of various seral stages are satisfied for LRMP WHR seral stages 3a, 3b/c, and 4b/c in the EM3 association. The proportion of late-successional stands is well above the ROD minimum of 15% in this particular association.

Northern Transition Group:
Ponderosa Pine Series:

Ponderosa-Lodgepole/Bitterbrush Association (PP4): This association occurs in the northern third of the Watershed at elevations between 5,600 and 6,400 feet, in a climatic zone receiving 25-40 inches of annual precipitation. It occupies 6,405 acres in a band approximately 2 miles wide that spans most of the breadth of the Watershed. This area is dominated by gently sloping (2-20%) volcanic mountain sideslopes with scattered inclusions of contrasting small buttes and craters. The Ponderosa-Lodgepole/Bitterbrush Association occupies the dominant moderate slopes; the steeper conical inclusions being characterized by PP2 and PP1 associations. The dominant soils supporting the PP4 association are deep, very gravelly loamy coarse sands, with a moderate to high AWC, and have a moderate to high AWC. The primary limitation for timber management is due to a 10-20 inch pumice overburden.

Intense logging has occurred within this association leaving few undisturbed late-successional stands remaining. Undisturbed 3G stands are typically an all-aged mix of ponderosa pine and lodgepole pine, though white fir may sometimes occur as a secondary stand component. Ponderosa pine dominates the 60-90 foot overstory layer and lodgepole the 40-50 foot intermediate layer, consisting predominantly of pole sized trees. Canopy cover in relatively undisturbed stands ranges from 60-70%, lodgepole usually supplying a greater proportion of this cover than ponderosa. Seedlings and saplings of both major species consistently occur in the understory, though lodgepole regeneration is usually more abundant and more aggressive in colonizing disturbed openings. As a result of the selective logging of mature ponderosa pine, many stands currently have a higher ratio of lodgepole pine than they formerly had. However, it is still quite common to find stands with less than 40% crown cover that have a good mix of both species in various age classes.

Typical ground cover in undisturbed stands consists of a less than 5% combined cover of shrubs and forbs. The most characteristic shrubs are bitterbrush and greenleaf manzanita, both becoming more prominent as the stands are opened up. Some disturbed areas may require vegetative management to reduce shrub competition with regeneration.

The entire PP4 association has been logged at various intensities, much of it rather heavily. Disturbance from logging is particularly apparent in the eastern third of the association where most of the stands are either poorly stocked or occupied by early-successional stages. The majority of the 6% of non-stocked land also is located in this eastern sector.

Logging within this association began with the railroad logging that took place in the 1930s through the early 1950s. This initial logging was concentrated along the northern third of the association and on the east side. Subsequent logging by overstory removal took place between 1974 and 1984 (Cougar Sale) and extended over most of the association. Some of this was also very intense, resulting in a high density of roads and skid trails, and additional acreage of poorly stocked mid seral stands (3P), and early seral stands. Logging in the PP4 association has also included a 168 acre clear cut and a second block of 273 acres to which a very heavy selective cut was applied.

Fire has also contributed to the heavy disturbance in the eastern sector of the association. Approximately 500 acres of PP4 stands in Sections 10, 14, and 15, T44N, R4E were affected by a burn in 1930. The current stocking and seral stage distribution within the perimeter of that burn is very similar to that in the balance of the heavily disturbed eastern sector. However, the northern portion, in Section 10, has not been impacted by logging since the burn, and appears to have a good stocking of healthy regeneration despite moderate brush cover.

No significant disease or insect problems are currently recognized in this association.

Development, in the form of small gravel pits and pumice mines, has put approximately 12 acres out of timber production. This plant association contains a total of 1,605 acres of "overstocked" stands. This includes 75 acres of poles that would benefit from precommercial thinning, and 1,530 acres of mid-mature trees that would benefit from commercial thinning.

Table 3.8 displays the current composition, extent, and proportions of the component seral stages in the PP4 association.

Disturbance has resulted in an unbalanced arrangement of seral stages within this association. According to RSL data, seral stage 3P and 2 stands are distributed throughout the association but are heavily weighted to the eastern third, where only a few 3G fragments occur. In the western two-thirds of the area occupied by this association, 3G stands form a relatively unbroken matrix, enclosing irregularly but widely distributed stage 3P and 2 stands. However, the latter are concentrated primarily in the northern half of the unit and the former in the southern half. Only a few small isolated polygons of late-successional (4G) stands occur and no stage one. For further details on the arrangement of seral stages within the PP4 association see Table 3.8.

The RSL mapping needs some revision. Some changes in classification and acreage amounts were made to account for relatively recent disturbances that have occurred (EUI present condition), but the following additional deficiencies were noted, though not quantified: (a) some areas mapped as 3G appear to be instead 3S or 2G; (b) some 3P areas appear to have less than 10% stocking of overstory but are adequately stocked with younger size class trees, and probably should be classified as seral stage 2; and (c) some non-stocked areas appear to have an adequate stocking of size 1 or 2 regeneration.

Eastside Mixed Conifer Series:

Lodgepole-Ponderosa-Sugar Pine/Jewel Flower Association (EM5): This association which occupies approximately 1,605 acres in the Watershed is located on an old lava flow at the east and northeast base of Glass Mountain just outside the Medicine Lake Basin. Elevations range from 5,000 to 6,200 feet and annual precipitation is between 25 and 40 inches. The topography of the two geographic units in which this association occurs is different, even though

they are separated by only a half-mile of recent lava flow. The larger northern unit is characterized by undulating, highly dissected lava flow with relatively gentle convex slopes. The southern unit consists of a relatively flat elevated bench and a moderately steep slightly irregular side slope below and above it. Overall slopes in the association usually range between 15 and 40%, and the general orientation ranges from northeast to southeast. The soils supporting the EM5 association are Stonewell Family with 40-60 inches of pumice and a gravelly surface. These soils are deep and have a moderate to high AWC, but a low timber productivity (Forest Survey Site Class 6-7). Thus some inclusions are incapable of producing late-successional forests. The chance of seedling survival is rated as low to moderate.

The EM5 association is a pine-dominated conifer mix of 3-5 species. Lodgepole pine, ponderosa pine, and sugar pine are the most characteristic, while white fir frequently occurs as a secondary component and western white pine occurs in certain localities. Lodgepole pine accounts for a slightly greater proportion of the total cover than either of the other two prominent pine species, but is usually limited to pole and small mature-size trees and an intermediate canopy layer ranging in height from 25-40 feet. Ponderosa and sugar pine usually constitute the dominant upper layer which varies with site quality from 70-90 feet. These two species, as well as white fir, may attain diameters exceeding 36 inches on the better sites of the association. It is difficult to identify a characteristic canopy cover for undisturbed mid- or late-successional stands because only a few fragments of such stands currently remain. Most remnant stands have less than 40% canopy closure, and the majority have less than 20% canopy closure. Natural regeneration appears to be rather good on disturbed sites, though some areas have been monopolized by shrubs. The most common lower layer species are greenleaf manzanita and bitterbrush. In a small sampling of EUI plots averaging 30% overstory canopy closure, the shrub cover averaged approximately 8%, and forb cover remained quite constant at 1-2%. Consistently included in the herbaceous layer are *Streptanthus tortuosa, Penstemon davidsonii,* and *Eriogonum nudum.*

The EM5 association has been impacted heavily by management activities including timber harvesting and pumice mining. The latter has included approximately 164 acres that have been taken out of production. Heavy selective logging of ponderosa and sugar pine occurred in portions of both the northern and southern units of this association as part of the private railroad logging of the 1930s through 1950s. Section 36, T44N, R4E, which remains in private ownership, still contains a large acreage of unstocked land. In 1949 and 1950, the North Lavas sale included some moderate selective logging within approximately 46 acres of Section 1, T43N, R4E. Additional intensive harvesting occurred between 1974 and 1984 when over 75% of the northern unit was logged by overstory removal. The cumulative impacts of harvesting within the later area have resulted in an extensive unstocked component. Also, as a result of the selective logging of commercial pine species, the proportion of lodgepole pine has increased in residual stands.

Table 3.8 displays the current composition, extent, and proportion of the component seral stages on land managed by the Modoc National Forest (excluding 379 acres of private land).

The largest geographic unit occupied by this association is blanketed by open small mature, non-stocked and early seral stands. RSL mapping indicates that the non-stocked areas are largely concentrated in the eastern half of the area, while 3P stands dominate the western half and a band of seral stage 2 stands essentially divide the two. In reality, over two thirds of the stands classified as 3P have only a sparse overstory of less than 20% canopy closure and most of the balance are under 30% canopy closure. Thus the entire geographic unit is really not that different, but is one continuous area marked by disturbance. Considerable sapling regeneration occurs in the understory of the open stands and in many of the polygons classified as non-stocked, thus size class 2 trees are really the predominant feature over the landscape. However, some of the non-stocked area is now occupied principally by brush. Only a few isolated 3G stands remain, and the size of this remnant is actually considerably smaller than indicated by RSL mapping.

The majority of the southern geographic unit is private land (all of Section 36, T44N, R4E). The fraction of Forest land occurs in the western and southern portions. Approximately half of that segment is barren as a result of pumice mining

and inclusions of talus and deep pumice overburden. The remaining half is a mosaic of early-, mid-, and late-successional stages with moderate to open stocking.

Northern Transition Group:
Red Fir Series:

Red Fir-White Fir/Wintergreen Association (RF2): This association which occupies 3,412 acres in the Watershed, occurs in the southern 1/3 of the Watershed at elevations primarily between 6,000 and 6,600 feet. Annual precipitation ranges from 30-40 inches. The largest unit of this association consists of a band roughly one mile wide and four miles long extending diagonally southwest to northeast from Yellowjacket Butte to just south of Forest Service Road 97, east of Undertaker's Camp. RF2 stands in this unit occupy smooth side slopes of rolling to hilly topography in a landscape dominated by small buttes and cinder cones. Slopes range from 10-55%, the majority being under 30%. The resident soils, formed from basalt or cinders, have a moderately high water holding capacity and productivity (Forest Survey Site Class 5). Other units of this association occur on the convex upper slopes and summit of Black Mountain, and along the western boundary of the Watershed immediately northeast of Six Shooter Butte. Slopes in the latter area are mostly less than 20% and the soils have a slightly higher productivity (Forest Survey Site Class 4).

The RF2 association is basically a two species mix of red fir and white fir, with only occasional minor inclusions of other conifers. In undisturbed late-successional stands these co-dominants occur in approximately a 60% red fir to 40% white fir ratio on the average. Such undisturbed stands are dense in respect to both basal area, stocking and canopy cover (75-90%). Almost all mid- and late-successional stands sampled in the EUI survey were all-aged. This should be expected since both fir species are shade tolerant. White fir tends to be predominant in small size classes and thus in stands harvested by overstory removal the proportion of white fir is likely to increase.

In the lower layer of the understory of undisturbed stands, forbs are more common than shrubs, though neither group generally exceed 1-2%. Characteristic forbs include: wintergreen (*Pyrola picta*), prince's pine (*Chimaphila umbellata*), coyote mint (*Monadella adoratissima*), and spotted coral root (*Corallorhiza maculata*). Typical understory shrubs include: Sierra gooseberry (*Ribes roezlii*), snowberry (*Symphoricarpos mollis*), and chinquapin (*Chrysolepsis sempervirens*). Greenleaf manzanita is common in disturbed areas. When stands are disturbed by logging, forbs and graminoids generally become established in openings more rapidly than shrubs. However, following fires, dense montane chaparral thickets colonize the burned sites over time. However, not as quickly as in lower elevation mixed conifer and east side pine associations.

Timber sales of one type or another have at one time or another included all of the area of the RF2 association within the Watershed. A majority of the area has actually been included within several different sales. However, the intensity of logging has varied considerably between sales and sites, and consequently the evidence of disturbance ranges from slight to heavy. Approximately 75% of the stands still evidence >40% canopy cover.

The most intense logging has occurred in the eastern unit of this association located on the upper slopes of Black Mountain. Logging in this unit includes 154 acres of continuous shelterwood, accounting for over a third of the entire unit. Most of this cutover area is currently stocked with a sparse cover of mid-mature trees, but portions are unstocked as a result of blowdown and subsequent salvage logging. Fir seedlings have been planted in the understory. In such regeneration cuttings subsequent regrowth is expected to be relatively even aged. Another third of this eastern unit is currently occupied by montane chaparral resulting from an old burn. About half of the remaining third consists of mid seral stands that have been partially opened by commercial thinning and salvage logging. The balance of the area is occupied by dense mid and late seral stands.

Logging within the central unit of the association occurred periodically from 1951 through 1989 and included salvage of windfalls, shelterwood cuts, sanitation logging, and overstory removal. For the most part the impacts have been moderate and stands are well stocked. The most apparent modification by logging occurs in Sections 31 and 32, T43N, R4E, near Shotgun Peak, where there is a concentration of small unstocked patches.

A relatively small volume has been harvested from the western unit and for the most part the area is characterized by well stocked stands. The most intense logging occurred in the early to mid-1960s when salvage of wind throws occurred following the Columbus Day storm of 1962. Later logging within the unit included some moderate shelterwood, sanitation, and overstory removal. Concentration of open early and mid or mid seral stands occur in a couple of locations adjacent to Primary Forest Road 49 through Section 35, T43N, R3E.

Fires of the past century have also caused some major modification of vegetation in this association. Currently, 409 acres of previously burned areas on Black Mountain, and a large butte in Section 20, T43N, R4E, southeast of Undertaker's Camp, are occupied by relatively dense stands of montane mixed chaparral. Included in this total is 125 acres of failed plantations on Black Mountain that is now occupied by brush.

Other natural disturbances to stands in recent years have been quite limited. Though both red fir and white fir are susceptible to windthrow and breakage, such losses in the RF2 association have been small.

As a consequence of recent drought years, very limited white fir mortality was experienced from fir engraver beetle attacks. Because annual precipitation normally averages 30-40 inches, there is only a medium risk of high white fir mortality in this association. A much lower risk than in white fir-mixed conifer associations occurring at lower elevations within the Watershed. Densely stocked stands subject to moisture stress are at the greatest risk, and thinning in such stands can reduce mortality. However, the primary purpose of thinning in the RF2 association is to promote sustained growth, allowing mid seral stands to move more rapidly to a late-successional condition. Considerable opportunity occurs in this association for commercial thinning, for there are currently approximately 1,628 acres of mid seral stands with >60% stocking. An additional 20 acres of densely stocked stage 2 stands occur. Areas with densely stocked stands of small mature trees and/or poles occur in T43N, R4E in the center and S1/2 of Section 29, the NE1/4 of Section 29, NW1/4 of Section 28, the middle of Section 21 and the SW1/4 of Section 25. There is also some opportunity for commercial thinning in the W1/2 of Section 35 and SW1/4 Section 26, T43N, R3E. This plant association contains a total of 1,648 acres of "overstocked" stands. This includes 20 acres of poles that would benefit from precommercial thinning, and 1,628 acres of mid-mature trees that would benefit from commercial thinning.

Table 3.8 displays the current status of the RF2 association relative to the composition, proportion, and acreage of the component seral stages.

Mid to late seral stage stands dominate this association with 3G stands forming an almost continuous matrix. Late-successional stands are found throughout the association but tend to occur in local concentrations rather than being evenly distributed. The greatest density of 4G stands occur at either end of the central unit. Sparsely stocked 3P stands are primarily isolated at east and west extremes of the association, on Black Mountain and along the western boundary of the Watershed. When these areas successfully regenerate, this will represent the major distribution pattern of the early seral stands which currently occur primarily in fragmented and scattered groups. The largest concentrations of seral stage 2 stands identified in RSL mapping are currently either 3P or CX stands.

The minimum standard of 5% for LRMP WHR seral stages is met in the RF2 association for seral stages 2, 3a, 3b/c, and 4b/c. Also in this particular association the late-successional stands exceed the minimum occupancy of 15% prescribed in the ROD.

White Fir Series:

White Fir/Chinquapin Association (WF1): This association which occupies 6,775 acres in the Watershed, occurs as a broken chain across the middle of the southern half of the Watershed on various aspects and at elevations between 5,600 and 6,800 feet. The annual precipitation in this zone is 30-40 inches. The largest concentration of WF1 forest occurs on the east side of the Watershed, surrounding and extending northward a couple of miles from Black Mountain. The stands of the WF1 association occur predominantly on 20-40 degree side slopes of

buttes and cinder cones, though a significant part of the association also occupies toe slopes of the cones and buttes and cinder cones, and intervening old lava flows on more gentle slope gradients (5-20%). The resident soils are formed on basalt and cinders and are slightly acid, gravelly sandy loams. They have a moderate AWC and for timber productivity are rated as Forest Survey Site Class 4 or 5. The chance of planted seedling survival is considered moderate. The most limiting factor for timber management practices (planting, etc.) on mid- to upper-slopes is the slope gradient. In portions of the low gradient areas the most limiting factor is a 6-20 inch pumice overburden.

This association is represented by monotypic stands of white fir. In the well stocked mid seral stands, which currently characterize over half of the association, ponderosa pine occurs as a secondary species, but provides an average of only 5% of the canopy cover. Undisturbed mid seral stands are typically very dense (greater than 75% crown cover) and all-aged, with the dominant layer at 70-100 feet in height. A 3-5% cover of white fir seedlings and saplings is consistently included in the understory. Competing shrub and herbaceous ground cover is quite sparse, typically consisting of less than 2% total cover. Species of forbs are the most common component and include: coyote mint, false spikenard (*Smilacina racemosa*), wintergreen, and milk kelloggia (*Kelloggia galioides*). Characteristic understory shrubs are chinquapin and snowberry (*Symphoricarpos mollis*). Greenleaf manzanita, snowbrush and bittercherry colonize disturbed openings and these species may persist for some time in the understory of young stands.

In areas that are transitional to red fir associations, red fir replaces ponderosa pine, in similar proportions, as the secondary species. Occasional large and very large ponderosa and/or sugar pine are scattered throughout the mid seral white fir stands, relics of the mixed conifer stands which preceded the current climax fir forest on these sites. Based on the stature of these old growth specimens, it appears that the WF1 habitat is favorable for production of these pine species.

Late-successional forest accounts for slightly more than 6% of the association and occurs as scattered individual and groups of stands throughout about two thirds of the areas occupied by the association. These stands are typically slightly more open (65-75% crown cover) and have a higher density of shrubs, forbs, and graminoids (10-29% total cover). They are typically pure white fir.

Fires have caused the most pronounced changes in stand composition and stocking within the WF1 association during the past century. Most of the non-stocked areas within the WF1 association resulted from fires that occurred more than fifty years ago. Currently over a thousand acres of these burned over areas are occupied by montane mixed chaparral (CX). Most of this acreage is located on Black Mountain where a fire occurred on the east side in 1919, and subsequent burns have included the south and west sides. The area currently occupied by CX on the west side includes a few failed plantations that have reverted to brush. Other areas now occupied with fire shrub include the south sides of Shotgun Peak and an adjacent butte, and an approximately 100-acre patch located in the SW1/4 of Section 11 and adjacent NW1/4 of Section 14, T43N, R4E.

A total of 694 acres of the area currently occupied by montane chaparral was mistyped as stocked with timber primarily seral stage 2, in RSL mapping. A significant acreage of the CX stands may indeed include suppressed white fir seedlings. In certain areas a sparse distribution of saplings and young poles have overtopped the shrub canopy, but chaparral still very much dominate these areas.

Blowdown, resulting from the 1962 Columbus Day storm also caused widespread, but not devastating mortality in this association. Salvage logging following this storm occurred in all of the WF1 units in the western half of the Watershed, and the windthrows accounted for a good part of the total volume removed from those western units. Salvage logging of windthrows also occurred on the north side of Black Mountain in 1971 and 1972.

In addition to salvage sales, harvesting of various types has occurred within the WF1 association, beginning around 1950. In the decade of the 1950s, three sales occurred on the east side of the association; north, west, and south of Black Mountain. These occurred on only a total of 700

acres of WF1 land and were concentrated primarily in other associations. Logging in the 1970s and 1980s was much more extensive and included shelterwood and sanitation cutting, as well as overstory removal. Certain areas logged by the latter method (Highhole Sale) appear to be modified the most. Included in this category is the east half of Section 28, T43N, T4E. This area currently includes a concentration of seral stage 2 and 3P stands. Logging in the far western unit of the association has also produced a grouping of poorly stocked stands. However, for the most part, stands within cut units are still characterized by overstories with greater than 40% canopy closure. Only 175 acres of open mid seral stands are currently identified on RSL maps, and the majority of such stands resulted from fires not logging. Herbaceous cover, and to a lesser degree the shrub layer, has increased moderately in disturbed understories, but in most cases a satisfactory stocking of natural regeneration is becoming established. Only 17 acres of clear cutting has occurred, and this area is currently unstocked.

The WF1 association currently contains a total of 3,430 acres of overstocked stands (i.e., stands in which stocking presently does or will eventually exceed site capability over time). These stands with >60% stocking include 174 acres of poles and 3,264 acres of mid-mature trees. At the same time, the association currently includes only 435 acres (6.4%) of late-successional forest. Thus, both the opportunity and the necessity exist for the accelerated development of additional late seral forest through thinning. The opportunity for commercial thinning is greater in this association than any other in the Watershed. At the same time there is a need for thinning from below to reduce dense understory trees that may be the major contributors to overstocking problems. To accomplish the latter purpose, the Medicine Lake Highland Biomass Sales have recently been initiated in the Watershed. Approximately 1,100 acres of these thinning sales will be conducted within the WF1 association.

Densely stocked stands occur in T43N, R4E in the SW1/4 of Section 11, the W1/2 of Section 14, a large part of Section 22, the W1/2 of Section 23, the SW1/4 of Section 24, the W1/2 of Section 25, the north ½ of Section 26 , the NE1/4 of Section 27, and the southwest 1/4 of Section 32; in T42N, R4E in the NW1/4 of Section 1, and the E1/2 of Section 11; and in T43N, R3E in the N1/2 of Section 36. The last area will probably be included in the Highhole Unit 8 sale. This plant association contains a total of 3,438 acres of "overstocked" stands. This includes 174 acres of poles that would benefit from precommercial thinning, and 3,264 acres of mid-mature trees that would benefit from commercial thinning.

The incidence of fir engraver mortality in this association appears to have been low in the recent drought years, when white fir trees in lower elevations, mixed conifer and eastside pine stands were experiencing considerable mortality. This result occurred despite the fact that the WF1 association is rated as having a medium risk of engraver beetle mortality; an assessment based on the average annual precipitation of 30-40 inches within the WF1 habitat. Evidently the microclimate afforded by a higher moisture regime and elevation provides a safeguard against epidemic attacks of the fir engraver beetle. The reduction of biomass in dense stands to promote growth, would also further reduce the risk of insect mortality within the association. (See EM1 association).

Table 3.8 displays the current status of the WF1 association relative to the composition, proportion and acreage of the component seral stages.

Mid seral stage stands dominate the undisturbed and moderately disturbed portions of the WF1 association, occurring as an almost continuous matrix over a majority of the total area. Contrasting large local concentrations of non-stocked and early seral stage stands occur in areas that have been subjected to heavy disturbance, as identified in the preceding portions of this description. Fragmented late-successional stands occur on approximately 1/3 of the association, primarily concentrated in several sections northwest of Black Mountain.

The seral stage 1 and 2 stands in the Black Mountain area, for the most part, identify ponderosa pine plantations, and therefore would seem to represent a conversion of approximately 1,400 acres from the WF1 association to the eastside pine series. However, considerable natural regeneration of fir is occurring within these plantations as well, and this species is a better survivalist in areas with heavy brush competition.

The minimum standard of 5% for LRMP WHR seral stages is met in this association for seral stages 2, 3b/c, and 4b/c. In this particular association, the area occupied by late-successional stands falls far short of the minimum 15% prescribed in the ROD.

Mid-Montane Zone
Eastside Mixed Conifer:

Ponderosa-White Fir-Incense Cedar/Squaw Carpet Association (EM1): This association constitutes approximately 7.6% of the Watershed (6,193 acres). Two approximately equal sized units of this association are located at the extreme southern end of the Watershed, both east and west of the Burnt Lava Flow Virgin Area. Small inclusions also occur within the latter area on isolated craters. Elevations range between 4,500 and 5,800 feet and the annual precipitation ranges between 20 and 40 inches being least in the extreme southeast portions. Orientation is southeasterly but stands occur on a variety of aspects due to topographical variation. The association occurs on two distinct landforms. The western unit, and the southeastern half of the eastern unit occur on a gently sloping (1-20%) complex of smooth basalt plateaus and broken and undulating lava flows. The remaining half of the eastern unit occurs on mid- to lower-slopes and toe slopes of cinder cones, on gradients between 20 and 55% (lower on toe slopes). The soils on the sides of cones are moderately deep to deep, slightly acid, sandy loams: with a moderate AWC, and a Forest Survey Site Class of 5-6. Soils on flats differ between east and west, but in general are deeper than those described above, finer textured, have a moderate to high AWC, and a higher timber productivity 3-4. The seedling survival rating varies from moderate to low on cone side slopes, to high on the gentler terrain where there are no significant natural restrictions on planting and other timber management activities.

This association is characterized by multi-species, all-aged conifer stands in which white fir and ponderosa pine are consistently co-dominants. Incense cedar and sugar pine are the other two regular components, but their prominence in individual stands varies from co-dominance to minor. In sample EUI plots, the relative proportions of these four species was: 44% white fir, 30% ponderosa pine, 13% incense cedar, and 13% sugar pine. The two latter species tend to be considerably more prominent on moderately steep slopes than on flatter terrain.

Regeneration of all four species commonly occurs in the understory, but shade tolerant white fir are most prevalent and ponderosa pine the least. Thus in stands harvested utilizing light selective cuts, the proportion of white fir would be expected to increase.

Understory ground cover consists of both a shrub and herbaceous layer in approximately equal proportions. Total ground cover in mid- to late-successional stands with greater than 40% canopy cover ranges from 5-20% and increases as the stand is opened up. The most characteristic understory shrub species include: squaw carpet, snowberry, and chinquapin. The most characteristic herbaceous species include the forbs: coyote mint, milk kelloggia, and woollyweed (*Hieracium scouleri*): and graminoids: western needlegrass, California brome (*Bromus carinatus*) blue wildrye (*Eymus glaucus*), squirrel tail (*Elymus elymoides*), and Ross's sedge. Grasses are more common in this association than any of those in higher elevation zones.

Most of the EM1 Association has been impacted to some degree by logging. Harvesting first focused on the west side where roughly 10,000 million board feet of windfalls were salvaged following blowdown during the Columbus Day storm of 1962. Approximately 84% of the salvage volume removed was white fir, the remainder being mostly ponderosa pine. During the early to mid-1980s, the northern half of the western unit was included in two sales which employed shelterwood and sanitation logging. Volume removed in these sales was considerably less than the earlier salvage sales.

Harvesting began within the eastern unit in 1958 when a corridor on the east side of Border Mountain was included in the Border Mountain Sale. Probably less than 1,000 million board feet was removed with the ratio of pine to fir being approximately 2.5:1. In the late 1980s logging intensified in this unit.

Harvesting in the vicinity of Border Mountain and Buck Butte has included the following: (a) approximately 20 acres of clear-cuts that are currently stocked with seedlings; (b) 475 acres of

heavy selective cutting, of which approximately two thirds is currently stocked with open to sparse stands of seral stage 2 remnants (primarily poles), and most of the remaining one-third (openings) with seedlings; and (c) 200+ acres of older cut blocks (regeneration and heavy selective) along the southern boundary of the Watershed. Currently, these older harvest units are densely stocked with a sequence of seral stage 2 stands, ranging from saplings to large poles.

In general it appears that regeneration of harvest units, both natural and artificial (planting) has been quite successful. Suppression of seedlings by competing vegetation does not seem to be a major problem in the EM1 association.

Most of the planting has been to ponderosa pine. Also, the intensity of logging has resulted in open stands where pine regeneration, especially ponderosa, would be favored over white fir and incense cedar. Therefore second growth in clear-cut and heavy selectively logged areas is expected to be predominantly ponderosa pine or at least to have a higher proportion of this species than in current mid and late seral stands. It is also expected to be more even aged. On the other hand, light selective logging has probably resulted in an increase in white fir in many stands, and promoted in all-aged stands.

Natural regeneration after fires has not been as successful. Approximately 80 acres of such burned over areas are currently occupied by dense montane mixed chaparral. These patches are located in Sections 6, 11, and 13, T42N, R4E.

There has been a significant amount of fir engraver beetle induced mortality in white fir, experienced as a consequence of the recent drought years, particularly on the east side. The risk of white fir mortality attributed to engraver beetle attack is "moderate" in the western unit where annual precipitation ranges between 30 and 40 inches, and "high" in the eastern unit where much of the area receives less than 30 inches of precipitation. Reduction of biomass through harvesting has decreased moisture stress and risk of mortality in much of the association. However, according to RSL data there are still considerable stands within this associatation with canopy cover exceeding 60% (i.e., "stands at risk"). These include 243 acres of late seral stage stands, 2,589 acres of mid-seral stands, and 100 acres of early seral stands. The later two stages would also benefit from accelerated growth and thus be the best candidates for commercial and non-commercial thinning respectively. Stands on the east side of the association, in a zone of low precipitation (high risk) would have the highest priority for thinning. Even white fir in stands with between 40 and 60% canopy cover will experience sufficient moisture stress to have a moderate risk of mortality. Table 3.9, though not intended as a standard for rating risk, illustrates the general relationship between climate and stand density relative to risk of white fir mortality from engraver beetle attack.

A transmission line through Section 13, T42N, R4E accounts for 36 acres of non-stocked land that is out of production. A pipeline along the southeastern boundary includes 44 acres of this association which is currently occupied by bitterbrush. This acreage has been correlated to the mountain mahogany-bitterbrush association (MM).

This plant association contains a total of 41 acres of "overstocked" stands. This includes 41 acres of mid-mature trees that would benefit from commercial thinning.

Table 3.8 displays the current status of the EM1 association relative to the composition, proportion, and acreage of the component seral stages.

Arrangement of seral stages differ between the east and west units and thus are described separately. In the west unit, fragmented stands of 2, 3P, and 4G seral stages are distributed over a matrix of almost continuous, well stocked, mid-seral stands (3G). The distribution pattern is uneven with a good portion of the 3P and 2 stands concentrated in the center of the unit. The late seral stands are all small in size, and though well distributed, constitute a disproportionally small component of the association.

Table 3.9: Risk of Engraver Beetle Mortality

Zones of Risk PPT	Stands At Risk			
	L=<40%CC	M=40-59%	H=60-79%	X=>80%CC
L = 40+"	LL (L)	LM (L)	LH (L)	LX (M)
M = 30-40"	ML (L)	MM (M)	MH (M)	MX (H)
H = 25-30"	HL (M)	HM (H)	HH (H)	HX (E)
X = <25"	XL (H)	XM (E)	XH (E)	XX (E)
Risk: (L) = low, (M) = medium, (H) = high, (E) = extreme				

The east unit is made up predominantly of seral stage 2 and 3G stands. Mid-seral forest dominates two large areas north and south of a central belt composed of fairly large blocks of seral stage 2. Another similar belt of seral stage 2 stands is located at the southern extremity of the unit. A small seral stage 1 component, for the most part, is scattered within the units of stage 2, though seedlings also characterize three small central clear-cuts. Seral stage 4G stands range in size from large to small, but make up a relatively small proportion of the association. They occur in a couple of localized groups that are separated from each other by more than a mile. It is possible that the 4G component has been underestimated in RSL mapping. For example, a good portion of the stands in Section 12, east of Border Mountain, appear, in aerial photos, to be late-successional, some bordering on old growth. A single EUI plot in that area confirmed the presence of at least one stand with old growth characteristics. The stands in question were all classified as 3G (mid-successional) by the RSL.

The minimum standard of 5% for LRMP WHR seral stages is met in this association for seral stage 2 and 3c only. In this particular association, the area occupied by late-successional stands falls short (by 11%) of the minimum proportion of 15% prescribed as a standard in the ROD.

Ponderosa - White Fir - Sugar/Bitterbrush (EM4): This association constitutes approximately 6.1% of the Watershed (4,975 acres). The main body of this association parallels the eastern boundary of the Watershed from Forest Service Road 97 southeast of Glass Mountain to almost the northern border of the Watershed at elevations between 4,800-6,000 feet. Annual precipitation is between 25 and 45 inches and both the topography and soils are variable. For much of its extent the association occurs on gentle to moderately sloping (5-30%) old lava flows with slightly convex undulating and highly dissected surfaces. The soils on this topography are deep and have a moderate to high AWC, but relatively low productivity (Forest Survey Site Class 6). On the southern end of the association (Sections 11 and 12, T43N, R4E) the volcanic side slopes are smoother, somewhat steeper and the soils more productive (Forest Survey Site Class 4). Small acreage amounts of this association also occur on Cougar and Buck Buttes on slopes to 50% and soils of intermediate productivity (Forest Survey Site Classes 5 and 6).

This association typically consists of all-aged stands and a mix of four conifer species. The order of abundance of these conifers in most stands is: (a) ponderosa pine, (b) white fir, (c) sugar pine, and (d) incense cedar. On the sides of buttes the abundance of the latter two species is reversed. Ponderosa pine consistently dominates the upper canopy layer though it may share this position with lesser numbers of white fir and/or sugar pine. Both the height of the dominant layer and canopy cover vary considerably, reflecting the differences in site potential. In relatively undisturbed late-successional stands the dominant layer height may range from 60-105 feet and the canopy cover from 50-70%.

Most of the area occupied by this association has been impacted by logging and includes few

stands that currently exceed 40% canopy closure. For the most part these open stands still exhibit a good mix of species and age classes including seedlings and saplings. However, pine regeneration is probably favored.

Typical ground cover in relatively undisturbed stands consists of a sparse (2-3%) cover of forbs and graminoids and a 5-15% cover of shrubs. The herbaceous component contains a relatively large variety of species which vary considerably with soil conditions and canopy closure. The ROD survey and manage species sugar stick (*Allotropa virgata*) is found on some sites. The most characteristic shrub species are bitterbrush and greenleaf manzanita. As the stand is opened the shrub cover increases, becoming quite conspicuous on severely disturbed sites.

Disturbance from logging has occurred throughout this association. The initial cutting in the north and central portions of the association was part of the railroad logging of the 1930's and 1940's by the Weed division of the Long Bell Lumber Company. Concurrent with this logging in the northern extremity of the association was a 1930 fire affecting approximately 720 acres in Sections 3, 9 and 10, T44N, R4E. Currently that area is primarily occupied by expansive and fairly uniform stands of small mature trees with a canopy cover of 20-40%. Also occurring in the northern section of the association are moderately large concentrations of size class 2 trees. In the 1970s and 1980s, the central portion of the association was logged again, this time by overstory removal. This portion of the association currently appears as a mosaic of small patches of timber with intervening similar sized open areas. The distribution pattern is quite regular across the landscape but the intervening openings, for the most part, are not regenerating well and are covered with various densities of shrubs. There are also large non-stocked areas.

Timber harvest in the association first occurred in 1949 and 1950 (North Lava Sale), and covered about half of this southern end. It was probably selective and currently that area appears to be well stocked with mid seral stands. The Eagle Sale of 1975-1980 occurred in the balance of the southern section and removed a large volume from 660 acres, utilizing predominantly shelterwood cutting. The area was highly disturbed, but currently has a very heterogenous cover of residuals and regeneration at various stages. In general both planting and natural regeneration appears to have been quite successful in this large harvest unit. However, there are occasional pockets of dense shrubs.

Impacts to this association other than logging and fire are quite limited. A transmission line passes through an isolated unit of the association at Buck Butte (Section 23, T42N, R4E) accounting for an additional 15 acres of non-stocked land.

Some pest losses to white fir have occurred in this association as a consequence of attacks by the fir engraver (*Scolytus ventralis*) with its associated brown staining fungus *Trechosporium symbioticum*. These attacks followed a weakening of trees in the recent drought years and the local population of fir engraver is still considered to be quite high. White fir mortality as a result of engraver attacks is strongly influenced by mean annual precipitation. A large percentage of the EM4 association occurs in a climatic zone where the probable annual precipitation is between 25-30 inches. White fir growing within this range are considered to have a high risk of mortality. One way of reducing risk is to alleviate moisture stress through thinning. The current open condition of most of the stands in this association would tend to reduce risk to the component white fir trees. However there are still a number of "stands at risk" with greater than 60% crown cover (see EM1). These include 338 acres of mid seral stands that would be candidates for commercial thinning, and 22 acres of late seral stands. Currently, two biomass sales have been initiated within the Watershed in which thinning will be done from below. Approximately 146 acres of this thinning will occur within the EM1 association (Buckboard Unit 126, a portion of Unit 125, and Highhole Unit 3). Table 3.8 displays the current status of the EM4 association relative to the composition, proportions, and acreage of the component seral stages (1,033 acres of private land are excluded from the acreage amounts in this table).

Early seral (stage 2) and open mid-seral (3P) stands dominate this association and are fairly well distributed and mixed throughout. Well stocked mid-seral stands (3G) for the most part are concentrated at the southern end as are also the few polygons of seedlings (stage 1). Non-stocked areas account for an abnormally

large proportion of this association and are concentrated in the south central portion.

The minimum standard proportions for LRMP WHR seral stages established in the Modoc National Forest LRMP are met for seral stages 2, 3a, and 3b/c only. The stocking of late-successional stands in this particular association falls far short of the minimum ROD standard of 15%.

Ponderosa Pine Series:

Ponderosa/Bitterbrush (PP1): This association, which constitutes approximately 4,376 acres of the Watershed, occurs along its northern perimeter and extends in an arc, mostly outside the Watershed, around to its most easterly appendage. This perimeter marks a topographical transition zone from gently sloping, highly dissected, irregularly undulating toe slopes of lava flows, to flatter and somewhat smoother basalt plateaus. Most of the PP1 association occurs on either of these two landscapes at elevations ranging between 4,400 and 5,400 feet. Less than 5% of the PP1 association occurs in scattered isolated populations on south facing side slopes of cinder cones, at elevations that extend to 6,200 feet (6,900 feet at a single site). With the exception of the latter higher elevation sites, the annual precipitation received in the habitat of this association ranges from 16-25 inches. Within the Watershed, only the Juniper-Ponderosa/Bitterbrush and the Mountain Mahogany-Bitterbrush Associations occur in drier climatic zones. The dominant soils on the slopes of the lava flows and plateaus are deep to moderately deep sandy loams, with a medium to high AWC and generally low productivity - primarily Forest Survey Site Class 6, with inclusions of Site Classes 5 and 7 (non-commercial). One major limiting factor effecting timber management on these soils is the deep (10-20 inches) pumice overburden which, in minor areas, may extend as deep as 60 inches. The climate is also limiting. The hot, dry summers result in a high evapo-transpiration rate, and the precipitation is only marginal to moderate.

This association is a ponderosa pine monotype, though other conifers, such as western juniper, incense cedar and white fir, occasionally occur in stands, particularly in those bordering mixed conifer associations. Stands are typically even-aged, although two-layered stands, as well as some with even-aged groups representing different size classes, may also occur.

Only a few acres of late-successional stands currently remain in this type and few stands are at their potential stocking. In fact it is difficult to estimate what the typical basal area and canopy cover of undisturbed mid to non-late-successional stands would be. Potential stocking varies considerably due to differences in soils, microsites, and precipitation, but on sites of average productivity a canopy cover between 40 and 60% could probably be expected. Potential height of dominants would also vary with microsite conditions. In a sampling of EUI plots, estimated potential height ranged from 50-95 feet. Diameter growth on good sites may exceed 40 inches, while some included sites may be incapable of producing late-successional forest.

Regeneration is commonly sparse, while understory shrub and herbaceous cover, under relatively open canopies (30-40%), averaged approximately 25% in representative plots. The shrub layer is most prominent, averaging 20% as compared with 5% for the graminoids and forbs. The most characteristic shrub species is bitterbrush. Frequent associates include: wax current (*Ribes cerceum),* mountain mahogany , rabbitbrush (*Chrysothamnus mauseosus and C. viscidiflorus*), and Utah serviceberry (*Symphoricarpos utahensis).* Typical understory grasses include squirreltail, western needlegrass, and Idaho fescue. The species composition of the forb component is quite variable. Among those commonly reoccurring in the understory are naked buckwheat (*Eriogonium nudum*), Columbia puccoon (*Lithospermum ruderales),* mules ears (*Wyethia mollis), (Clarkia rhomodiea),* and common yarrow (*Achillea milefolium).*

The PP1 association has been heavily logged, beginning with the railroad logging of the 1930s and 1940s by the Long-Bell Lumber Co. The early intensive logging in this association occurred not only on the 1,012 acres of private land still included within the Watershed boundary, but on considerable additional land which has since been acquired by the Federal Government and is being managed by the Modoc National Forest. Current stocking, through much of the association, is sparse and patchy, interrupted occasionally by large stands providing more

uniform, but still fairly open stocking. Though fragmented patches of medium large trees are still widely distributed, most of the stands of mature trees have a mean dbh <24 inches and a canopy cover <30%. Size class 2 stands are slightly more abundant than size class 3 stands, constituting approximately 39% of the association. These commonly have <20% crown cover. More recent logging has generally consisted of overstory removal and has contributed to the predominance of smaller size class trees. Approximately 870 acres of the PP1 association was included within the Cupboard Timber Sale, logged between 1977 and 1980, utilizing an overstory removal prescription. In addition to the sparse to open stocked stands, approximately 24% of unstocked land occurs. Most of this area is currently occupied by a 30-50% cover of bitterbrush and associated shrubs and herbs. Natural regeneration is slow and spotty and the brush seems to be claiming many sites.

Fire has contributed to the disturbance which has historically occurred within this association. An old burn incorporated approximately 607 acres in portions of Sections 12 and 13, T44N, R4E, and Sections 7 and 18, T44N, R5E. Most of this area, with the exception of minor residual islands of timber, remains unstocked.

Ponderosa pine are vulnerable to attacks from the western pine beetle, particularly when weakened by drought, stagnation or fires. Recent mortality has been low, limited primarily to overstocked stands of trees.

A few acres of the association are utilized for gravel pits.

Table 3.8 displays the current composition, extent, and proportion of the component seral stages on land managed by the Modoc National Forest (excluding 1,012 acres of private land).

This association, for the most part, is divided into three basic elements: (1) non-stocked land consisting primarily of sub climax stands of bitterbrush, (2) Sparse to open seral stage 2 stands, and (3) seral stage 3P stands. All three of these elements are distributed throughout the area occupied by the association, though somewhat disproportionally. Seral stage 2 stands occur almost continuously with only minor gaps, except in the southeastern unit where just scattered fragments occur. Seral stage 3P stands are concentrated in the southeastern unit but have fairly good continuity in other areas as well. Seral stage 3G stands occur in only two widely separated localities and for the most part are concentrated in a single central area.

The minimum standard proportions for LRMP WHR seral stages established in the Modoc National Forest LRMP are met for LRMP WHR seral stages 2, 3a, and 3b/c. The acreage of late-successional forest is negligible. Almost a quarter of the association is unstocked.

Ponderosa - White Fir/Bitterbrush (PP2): The PP2 association is located in the northwest corner of the Watershed. The principal geographic unit of the association occurs primarily west of Forest Road 49 on northerly oriented toe slopes of undulating basalt lava flows. Elevation range from 5200 to 6200 feet and slopes from 5-30%. Average annual precipitation ranges between 20 and 30 inches. Small isolated units also occur on the northern aspects of scattered cinder cones that are included within the Ponderosa Lodgepole/Bitterbrush association (PP4). The latter phase extends a couple miles further east, ranging to an elevation of 6500 feet on slopes of 20-50%. Precipitation rates are slightly higher in these areas.

Soils are deep to moderately deep, very gravelly to extremely gravelly loamy sands and sandy loams, with a moderate AWC. Productivity is predominantly Forest Survey Site Class 5 and the survival rating for planted seedlings is moderate. The principal limiting factors for timber management are an 8-20 inch pumice overburden and 30-60% course fragments in the upper 20 inches of the profile.

This association is characterized by all aged stands of the co-dominants ponderosa pine and white fir. The proportions of the two species varied somewhat on the EUI plots sampled, but averaged 57% white fur to 43% ponderosa pine. The stands surveyed had all been subjected to some degree of overstory removal, and ponderosa pine was commonly the preferred species harvested. Thus the original proportion of the pine component in the majority of the PP2 association stands was probably significantly greater than the current stocking.

Currently, relatively undisturbed late-successional stands are limited to a total area of less than 15 acres. These fragments are characterized by a canopy closure of 60 to 100%. Since overstory removal has occurred throughout the association, few trees currently exhibit their potential height. On EUI sample plots, the potential dominant layer height was estimated to range from 70 to 90 feet Snags were noted at greater than 40 inches dbh.

Regeneration of both species consistently occurs in the understory including both seedlings and saplings. In stands with greater than 40% canopy closure, shade tolerant while fir regeneration is about double that of pine. This ratio is also reflected among pole size trees. In stands with less than 40% crown closure, shade intolerant ponderosa regeneration is favored, and commonly more numerous than that of fir.

The lower layer of shrubs and forbs occupies less than 5% of the understory in well stocked stands exceeding 70% canopy cover, but averages approximately 30% in stands of approximately 40% canopy cover. This layer is made up predominantly of shrub species which readily invade and colonize openings. The most characteristic of these are bitterbrush and greenleaf manzanita. Snowbrush rabbit brush goldenweed, bush chinquapin, and bitter cherry are also quite common. Components of the herbaceous layer include the graminoids, Ross's sedge, squirreltail, and Wheeler's bluegrass (*Poa wheeleri)*, and the forbs, slender penstemon, Holboell's rockcress (*Arabis holboellii)*, seabland penstemon (*Penstemon deustus*), fireweed, and naked buckwheat. The last four species are primarily characteristic of disturbed openings.

Timber harvesting has occurred throughout this association, beginning with the Long-Bell logging in the 1930s through 1950s. This early logging was most concentrated in the proximity of the railroad line, and thus the northeastern portion of the association was heavily impacted. Currently, this area remains the most poorly stocked, even though portions of this sector have been excluded from more recent timber sales. Logging in the late 1970s and 1980s (portions of the Cougar and Cupboard Sales) continued and extended the earlier pattern of overstory removal, but was less intensive. Consequently over two-thirds of the remnant stands are still stocked with greater than 40% canopy cover, though larger trees have been removed and there is a high density of skid trails remaining. Only 52 acres are currently unstocked, of which 41 acres are occupied by greater than 40% cover of bitterbrush and associated shrubs.

The best stocking occurs in the southwestern half of the major geographic unit, and on the side slopes of various cinder cones. According to RSL data, there are currently 295 acres of seral stage 2, and 607 acres of seral stage 3, that have greater than 60% canopy closure on the side slopes of various cinder cones. In these stands, stocking exceeds the long term capacity of the site, and both growth and health could be improved by precommercial and commercial thinning, respectively. Aerial photo study of the association seemed to reveal contrary to RSL mapping, that the area of overstocked seral stage 2 stands actually equals or exceeds that of seral stage 3 stands, though this has not yet been confirmed on the ground.

An additional benefit of thinning in the PP2 association would be the reduction of risk of mortality in white fir as a consequence of engraver beetle attack. The risk of such mortality is high to extreme in this association because precipitation is limited to 20-30 inches annually. To a lesser degree this risk extends, to an additional 750 acres of seral stage 3 and 21 acres of seral stage 4 that have stocking exceeding 40% canopy cover (see EM1 for explanation).

No significant wild fires have occurred in this association within the past 100 years. Disturbance other than logging and associated road building has been insignificant, though the degree of white fir mortality resulting from engraver beetle attack in the recent drought years is unknown. Any such natural thinning of white fir would tend to balance the stands by compensating for the removal of greater amounts of ponderosa pine through harvesting.

Table 3.8 displays the current status of the PP2 association relative to the composition, proportion, and acreage of the component seral stages on land managed by the Modoc National Forest (excluding 310 acres of private land within the Watershed).

The minimum standard of 5% of capable habitat for LRMP WHR seral stages is met in this association for seral stages 2 and 3b/c only. The

acreage of late-successional forest is negligible, and only slightly over 1% of the habitat is non-stocked.

According to RSL data, the PP2 association is composed of roughly one-third size class 2, and two-thirds size class 3 stands. In actuality, the distribution of these two size classes may be more even. With the exception of certain isolated cinder cones, the various sized stands occupied by the two predominant seral stages are well distributed throughout the association habitat and intermixed. By contrast, late-successional stands occupy less than 1% of the habitat and occur in small, scattered and isolated stands. In addition to the disproportionate amount of larger size classes and seedlings, the principal imbalance in the arrangement of the stands within the association concerns density of stocking. The northeast half of the primary geographic unit contains many open or sparsely stocked stands, while the southwest half of this unit, as well as most of the isolated cinder cones, is occupied predominantly by stands with 50-90% canopy closure.

Ponderosa Pine-White Fir/Snowberry Association (PP3): The PP3 association is located in an arc surrounding Black Mountain on all but the northwest side. On the west side, the habitat extends to the edge of the Burnt Lava Flow Area, on the north it fingers to the base of the Glass Mountain Lava Flow, and on the eastside it characterizes a 5½ mile strip along the Watershed boundary. Within the Watershed, the PP3 association is located entirely on Modoc National Forest land.

This association occurs, for the most part, at elevations between 5200 and 5800 feet, on gentle, smooth to slightly undulating volcanic toe slopes with gradients predominantly less than 10%. There are minor inclusions of small cinder cones and ridges with slopes to 30%. Soils vary somewhat with geographic location and slope, but in general are deep, gravelly sandy loams, with a moderate AWC. Timber productivity is predominantly Forest Survey Site Class 4 (medium high), and the planted seedling survival rating is moderate. A pumice overburden occurs only on the northeast side. Included within the southwest section of the PP3 association are several parallel ribbons of lava rock approximately 1 mile in length which terminate in the Burnt Lava Flow Area. The annual precipitation ranges from 25-40 inches, being lowest along the eastern boundary.

Typically the PP3 association is characterized by relatively dense (greater than 70% canopy cover), all aged stands in which ponderosa pine and white fir occur as co-dominants. Sugar pine may be present, but only as a minor stand component (1-3%). In a small sampling of relatively undisturbed old growth stands, the proportion of the two codominants was roughly 60% white fir to 40% ponderosa pine. However, currently the proportion of the ponderosa pine component in most mid- and late-successional stands is considerably smaller. As a consequence of selective logging of the largest ponderosa pine, the average proportion of this species found in limited EUI sampling of late-successional stands with greater than 60% canopy cover was approximately 25%. The proportion of ponderosa pine occurring in seedling, sapling, and pole size classes was even smaller. In stands where single tree selection was practiced, frequently only small volumes were removed, leaving stands relatively dense and thus favoring shade tolerant white fir regeneration.

The lower understory layer which occurred on the above referenced late-successional plots averaged 2.6% shrubs, 2.6% graminoids, and 3.4% forbs. The most characteristic shrub species included: trailing snowberry (*symphoricarpos mollis*), *Ribes* spp. and bush chinquapin. Graminoids included : *Careh* spp. (including *C. rossii*), and western needle grass. The most consistent forbs included: coyote mint, milk kelloggia, slender penstemon, white-veined wintergreen, and spotted coralroot.

As already mentioned, selective cutting of ponderosa pine has been applied rather liberally in this association. This practice may have begun with the North Lavas Sale of 1949 and 1950. Most of this type of logging, though changing stand composition, left residual stands that were relatively well stocked. However, more intensive cutting has also occurred in the PP3 association. Shelterwood logging in the Eagle Sale (1975-1980) resulted in a rather extensive swath of open stocked stands in Sections 13 and 14, T43N,R4E. Small non-stocked patches still occur in the area, but for the most part there is currently a good understory stocking of saplings. In the vicinity of the eastern boundary, between Black Mountain

and Border Mountain, there is another concentration of open stands resulting from overstory removal, and a series of small clear cut patches. Logged areas have been successfully regenerated. The area was first logged in the Border Mountain Sale of 1958, but the most intensive logging has occurred more recently in the Buckborde Timber Sale of 1990, which was a overstory removal and sanitation.

In the Buckborde area, the SE1/4 of Section 3 T42N, R4E, there are a series of small to moderate sized harvest units in which conspicuous corridors and patches have been selectively cut, resulting in a mosaic of small clusters of trees and contrasting openings. The current composition and stocking of this area is not identified on RSL maps which indicated only 3G and 4G stands. This discrepancy has been accounted for in Table 3.8.

An additional unit in which overstory removal has occurred (Highhole Sale) is located in the W1/2 of Section 34 T43N, R4E. This unit is approximately 100 acres in size and current stocking of size class 2 and 3 residuals is roughly 25% crown cover. The RSL mapping incorrectly indicates 3G stocking for this area. This discrepancy has been accounted for in Table 3.8.

The largest single area of vegetation disturbance and modification in the PP3 association occurred as a consequence of fire rather than logging. A large wildfire in 1919 engulfed much of the northeast and east sides of Black Mountain, including 738 acres within the PP3 association. A large portion of this same area was again burned in 1945. Subsequently this burn was colonized by montane mixed chaparral. the brush, for the most part, was cleared in stages, and the area is currently planted to ponderosa pine. Most of the plantations occurring within the PP3 association are currently well stocked with sapling size trees, though vegetative management to control brush is needed in certain blocks. Approximately 115 acres of this area is still unstocked and dominated by brush.

It is evident that invasion of burns by brush occurs quite readily in this association, but the same rapidity of colonization by shrub species does not seem to occur in areas disturbed by logging. In fact shrub invasion into openings created by logging seems to proceed at a slower rate than observed in most other mid montane conifer associations of the Watershed. Internal stand openings resulting from logging remain relatively clear of brush for an extended period of time. Another example of encroachment of shrubs into areas following fire is noted on a smaller scale in the north half of Section 11, T43N, R4E, immediately adjacent to the Glass Mountain Lava Flow Area. This area, though never logged, appears to have been thinned by fire to an approximately 40% canopy cover. Greenleaf manzanita now blankets the understory, but is not similarly prominent in the understory of adjacent logged stands. Despite the various disturbances, almost 60% of the entire PP3 association is currently composed of stands with greater than 60% canopy closure. This proportion includes 322 acres of late-successional stands, 2,254 acres of mid seral stands, and 176 acres of early seral stands. Stands of the latter two stages would be considered "overstocked", (i.e., in a condition where the biomass will exceed site capability over time). Thus within the PP3 association there are 2,430 candidate acres for commercial or precommercial thinning. Such thinning would not only improve growth and accelerate development of additional late-successional stands, but reduce the risk of white fir mortality as a consequence of fir engraver beetle attack. The white firs in this association have a medium to high risk of such mortality, depending on whether annual precipitation is over or under 30 inches. Risk could be reduced by thinning of late-successional stands as well, if necessary. However, given the current ratio of white fir to pine, loss of a reasonable amount of salvageable white fir might even be considered desirable. Thinning from the ground-up in stands with dense white fir under stories would probably be most advantageous. Such thinning is the objective of the Buckborde Biomass Sale currently being initiated in this association. (Units 124, 125, 133, and 135) as part of the Medicine Lake Highlands Biomass Sales.

Table 3.8 displays the current status of the PP3 association relative to the composition, proportion and acreage of the component seral stages. Approximately 636 acres of the total 1,104 acres ascribed to seral stage 2 is currently occupied by plantations of relatively pure ponderosa pine; a temporary modification of the typical PP3 association.

Though five different seral stages are present within this association, they occur quite disproportionally. Mid seral stands dominate most of the association, and for the most part occur in stands with greater than 40% canopy cover. These 3G stands form almost a continuous matrix, enclosing other stages, except for approximately 2 miles along the eastern border that is fully occupied by stage 2 plantations. The latter area, on the northeast flank of Black Mountain, and a couple of smaller concentrations, account for most of the seral stage 2 stands. Likewise, most 3P stands are concentrated in a single approximately 600 acre area about a mile north of Black Mountain. Late-successional stands (4G) also are localized, for the most part occurring in several small groupings quite remote from one another. Stage one stands are represented by only 33 acres and occur in only two widely separated areas. Thus the seral stages within the PP3 association are poorly integrated.

The minimum standard of capable land for LRMP WHR seral stages is met in this association for seral stages 2, 3a, 3b/c, and 4b/c. The ROD standard of 15% for late-successional forest falls short by 8%.

Ponderosa Pine - Western Juniper/Bitterbrush Association (PJ1): The PJ1 association constitutes approximately 1.2% of the Medicine Lake Watershed (951 acres). This habitat is located along the extreme northeastern boundary of the Watershed at elevations between 4300 and 4600 feet. It occurs on two related landscapes: (1) approximately two-thirds of the association occupies flat volcanic plateaus with slopes of 0-5%; (2) the other third is located on undulating toe slopes of old lava flow with gradients of 5-15%. Annual precipitation ranges from 14-16 inches. Soils are dominantly shallow (less than 20 inches), very cobbly loam or loam, with low AWC. These soils are classified as Forest Survey Site Class 7 (non-commercial), yielding less than 20 cubic feet/acre/year of wood; thus definitely incapable of producing late-successional stands.

Typically, this association consists of sparse (10-20% canopy cover) stands of western juniper and ponderosa pine with a shrub understory cover averaging approximately 25%, and a herbaceous layer providing an average cover of about 8%. Currently almost 80% of the association has less than 10% canopy cover of conifers, and is more representative of a bitterbrush association.

The ratio of juniper to pine is roughly 3 to 1, the former being rather evenly distributed throughout the habitat, and the latter occurring primarily as scattered individuals or in occasional small concentrated groupings, representing "flower pot" inclusions of better soils. Individual mature pine and juniper trees reach girths that may exceed 24 inches dbh, but the poles are quite tapered and height growth is usually less than 50 feet for pine and less than 35 feet for juniper.

The shrub layer is dominated by bitterbrush and sage. Rabbit brush (*Chrysothamnus nauseosus* and *C. viscidiflorus*) and curlleaf mountain mahogany are regular secondary components, the later sometimes forming dense concentrations on rocky inclusions. The woody perennial, granite gillia (*leptodaclyon pungens*), is also a common component. In some stands, a conspicuous portion of the bitterbrush, as well as a lesser amount of mountain mahogany, is decadent or dead.

The herbaceous layer is composed predominantly of grasses (5-10% cover). Common species include needle grass (*Achnasterum thurberiana*), Idaho fescue, blue bunch wheatgrass (*Psuedoroegneria spicata*), cheat grass, and squirreltail.

Human impacts have been low in this association. Being non-commercial, it is not utilized for timber production, and currently there are no active range allotments within the Watershed. No fires have been recorded as occurring within this association in the past 50 years, and there is no record of accelerated mortality as a consequence of disease or insect attacks. However, natural disturbance has undoubtably historically occurred as evidenced by the current poor stocking of conifers and the relatively small proportion of medium to large sized trees.

Table 3.8 displays the current status of the PJ1 association relative to the composition, proportions, and acreage amounts of the component seral stages. Currently the association consists of a non-stocked matrix of bitterbrush and associated shrubs, within which occur sparse stands of seral stage 2 juniper and pine, averaging about 25 acres in size. Most of the

latter are concentrated in a central area that covers roughly half of the total habitat. All of the PJ1 association that occurs within the Watershed is located on Modoc National Forest land.

Key Question (2)

What is the current status of Northern Spotted Owl nesting, roosting, and foraging habitat?
(a) What is the extent of habitat?
(b) Where is it located?
(c) Is current seral stage distribution appropriate to sustain nesting, roosting, and foraging habitat?

Response

Northern spotted owl habitat is primarily located in the 3G and larger stands located within the southern two-thirds of the Watershed, with the notable exceptions of the lava flows, and scattered amounts in the northern third of the Watershed. Nesting habitat generally is considered to be 4G type. Presently within the Watershed there is approximately 6,500 acres of suitable nesting habitat, which is also suitable for foraging and roosting. This habitat is found within the hemlock, mixed conifer, ponderosa pine, white fir and red fir associations. Foraging and roosting habitat is interspersed with the nesting habitat and is composed of 3G, 3P, 4G and 4P within the hemlock, mixed conifer, ponderosa pine, red fir and white fir habitat associations. Presently there is approximately 37,000 acres of suitable habitat within the Watershed. NSO are rarely found within the lodgepole pine associations although it is possible that they may forage within this association.

SURVEY AND MANAGED SPECIES

Key Questions

What is the status of known information of survey management?

Summary Response

The NFMP provides a management strategy to protect the northern spotted owl and other old growth related species on federal land managed by the Forest Service and Bureau of Land Management. This strategy includes standards and guidelines for habitat management designed to benefit a wide range of animal, plant, and fungal species that are associated with late-successional forest in the Pacific Northwest (USDA Forest Service and USDI Bureau of Land Management 1994). The "survey and manage" standards and guidelines have four components. Component 1 standards and guidelines entail management of known sites occupied by designated late-successional species. Component 2 standards and guidelines include surveys for such species prior to ground-disturbing activities. Component 3 standards and guidelines include conducting extensive surveys, Component 4 standards and guidelines include carrying out general regional surveys. A list of species to be protected through the "survey and manage" standards and guidelines has been published in the Record of Decision for the Northwest Forest Plan (USDA Forest Service and USDI Bureau of Land Management 1994).

Background Information

Lichens and Bryophtes

A habitat assessment for "survey and manage" lichens and bryophytes was conducted in September 1997 by Leitner and Leitner (1997). The assessment determined that there is no suitable habitat within the Watershed.

Fungi

A habitat assessment for "survey and manage" fungi was conducted in October 1997 (Leitner and Leitner 1997). The area is a favorable environment for an abundant and diverse community of fungi. The greatest diversity occurs in undisturbed red fir forest. The least diversity occurs in lodgepole pine forests. Four (4) species of "survey and manage" fungi were located within the area: *Cantharellus subalbidus, Gomphus kauffmanii, Sarcodom fuscoindicum*, and *Sarcodom Inbricatum*. All four species are classified as "Component, 3" meaning no specific field survey are required prior to ground disturbance activities.

The four species observed and recorded in the Leitner and Leitner report do no represent the only fungi that occur in the Medicine Lake Highlands. It is difficult to precisely document all fungi species that occur in the area due to

species only appearing under specific environmental conditions and during different times of the year. Table 3.10 contains a list of "survey and manage" fungi species that are likely to occur in the Watershed.

Vascular Plants

One "survey and manage" plant species was found within the Highlands. This species is sugar stick (*Allotropa virgata*). Sugar stick is typically found in shady, mature stands of forest with much humus and downed wood. It is typically found as single individuals or very small colonies, widely spaced in mature forest. It is found in red fir, lodgepole pine, mixed conifer and subalpine forest. Thirty nine locations of sugar stick were mapped by Leitner and Leitner (1997).

In December of 1998, management recommendations for Sugarstick were approved by the Forest Service. According to these recommendations, the viability of *Allatropa Virgata* is considered to be secure within the core part of its range, including Modoc National Forest. Therefore, no special protection or management applies to this species within the Medicine Lake Highlands (Lippert 1998).

Wildlife Species

The NWFP ROD provides a management strategy to protect the northern spotted owl and other old-growth related species on federal land managed by the Forest Service and Bureau of Land Management. This strategy includes standards and guidelines for habitat management designed to benefit a wide range of animals. A list of species to be protected through the "survey and manage" standards and guidelines was evaluated by Leitner and Leitner (1997) to determine if any of the "survey and manage" animal species are likely to occur in the Medicine Lake Highlands. Several amphibian species and one mammal species are included in this list, but it has been determined that none of them occur in the Medicine Lake Highlands (Leitner and Leitner 1997). Similarly, none of the listed "survey and manage" mollusks or arthropods are believed to occur in the Watershed.

Table 3.10: Survey and Manage Fungi Species that May Exist in the Watershed

Species	Survey Strategies			
	1	2	3	4
False Truffles				
Nivatogastrium nubigenum	X		X	
Thaxterogaster pingue			X	
Chanterelles				
Cantharellus cibarius			X	X
Cantharellus subalbidus			X	X
Cantharellus tubaeformis			X	X
Chanterelles - Gomphus				
Gomphus bonarii			X	
Gomphus clavatus			X	
Gomphus floccosus			X	
Gomphus kauffmanii			X	
Rare Coral Fungi				
Ramaria cyaneigranosa	X		X	
Tooth Fungi				
Hydnum rapandum			X	
Sarcodon fuscoindicum			X	
Sarcodon imbracatus			X	
Rare Resupinates and Polypores				
Cudonia monticola			X	
Gyromitra esculenta			X	X
Gyromitra montana			X	X
Sarcosoma mexicana			X	
Sarcosphaera eximia			X	
Rare Cup Fungi				
Pithya Vulgaris	X		X	
Club Coral Fungi				
Clavariadelphus truncatus			X	X
Jelly Mushroom				
Phlogoitis helvelloides			X	X

Source: Telephone Flat Geothermal Development Project Final Environmental Impact Statement and Environmental Impact Report, Technical Appendices Volume, Appendix B (1999); Northwest Forest Plan (1994).

HUMAN USES

Heritage Resources

Key Question

What heritage resources exist within the Watershed?

Summary Response:

Archaeological research has determined that Native Americans have used the Modoc Plateau for the last 10,000 years.

Within the Watershed, the area over which cultural resource inventories have been completed is limited as resource inventories are only conducted on a project-by-project basis.

Later historic use in the analysis area is associated with pumice and gravel mining, their associated businesses and limited amounts of logging.

Background Information:

Prehistoric and historic use of the area was more intense in some portions of the Watershed than in others and has resulted in areas with different levels of potential sensitivity with respect to heritage resources. The projected relative cultural resource sensitivity of different geographic areas within the Watershed is depicted on Figure 3.15.

Areas of high cultural sensitivity in the Watershed include the areas around the northern boundary of the analysis area, the Glass Mountain Geologic Area, the area surrounding Blanche and Bullseye Lakes, and the area surrounding Medicine Lake and extending to the Modoc National Forest boundary with the Klamath National Forest.

Medium cultural resource sensitivity is found south of Medicine Lake, on the flanks of the Burnt Lava Flow Geologic Area, and extending upwards for about two miles from the Burnt Lava Flow in the center of the Watershed.

Low cultural resource sensitivity accounts for the remainder of the analysis area. This is primarily in the eastern half of the Watershed, south of the Glass Mountain Geologic Area, and north of the Glass Mountain Geologic Area up to the high sensitivity area located near the northern boundary of the Watershed.

Native American groups including the Pit River Tribe, Modoc Indians of the Klamath Tribes, and the Shasta Tribe recognize the Medicine Lake Highlands as a place of spiritual power and have historically used, and continue to use, the area for hunting, plant-gathering (food and medicinal), physical healing, prayer, spirit quests, and other traditional purposes. Native American burial places and cremation areas, as well as historic battlegrounds, are located within the Watershed area and vicinity.

Non-timber Commodities

Key Question

What non-timber commodities are utilized in the Watershed?

Summary Response:

Non-timber commodities such as miscellaneous forest products, mineral resources, geothermal resources, and water resources occur in, and have been extracted from, the Watershed. Miscellaneous forest products developed include firewood and wild mushroom harvesting. Pumice mines are located in the northern half of the Watershed. Geothermal leases have been issued over much of the Watershed and some geothermal exploration activity has been conducted. Water uses include both non-consumptive (recreation at area lakes) and consumptive (domestic use from wells and springs) uses. Very limited domestic livestock grazing resources occur within the Watershed, but are not being utilized.

Background Information:

Miscellaneous Forest Products: In addition to a small amount of logging cuts, other forest products primarily come from the harvesting of firewood. The Forest sells woodcutting permits to the highest bidders on sales of more than 25 cords. For sales of 10 to 25 cords, the Forest average for commercial sales of similar species is charged. Personal woodcutting permits are available for a fee, and are sold in 2 to 10 cord lots. Free-use permits are offered to encourage woodcutters to use downed culls and limbs.

During 1998, personal woodcutting permits were sold for a total of 177 cords of lodgepole pine firewood within the Watershed. Weekly mushroom picking permits are also available for a fee. Based on random picker contacts in the field, it is estimated that 70 pounds of mushrooms are harvested for each weekly permit sold. It is estimated that 541 permits were issued for the Watershed during the 1998 picking season, equaling 37,870 pounds of harvested mushrooms (B. Reed, Modoc National Forest, personal communication, 20 April 1999).

Mining: The Watershed is primarily composed of volcanic material which generally has low potential for most mineral occurrences, except for mineral materials used in construction trades. Mineral material mining activities within the Watershed have generally involved extraction of materials such as cinders, aggregate, and decorative rock. Mining activities located on Forest lands are subject to Special Use Authorizations from the Forest. There are several private in-holdings in the Watershed, either adjacent to or near the Glass Mountain Lava Flow, that are managed for pumice mining or have been previously mined (BLM *et al.* 1998). Only one of these enterprises is currently active. In this area the pumice resources range in thickness from a few feet to more than 60 feet. In this same general area, there is also one active mining claim extracting pumice on Forest lands that removes approximately 150,000 cubic yards of pumice per year (see Figure 3.16).

Geothermal Resources: The potential for geothermal resources within the Watershed has been recognized since the mid-1960s. The Glass Mountain KGRA (i.e., an area designated by the U.S. Geological Survey [USGS] as having potential for beneficial exploitation of the geothermal resource suspected to exist in the area), was created in the early 1970s and twice expanded in the late 1970s and early 1980s. It currently overlays approximately 69,300 acres, or nearly 82 percent, of the Watershed (the remainder of the 134,000 acre Glass Mountain KGRA overlays lands in the neighboring Klamath National Forest and Shasta-Trinity National Forest). The geothermal resource potential of the Glass Mountain KGRA has been estimated to be as high as 500 MW of electricity over a 30 year period (USFS and BLM 1984), although these initial electrical power estimates are considered to be over-estimates of the actual commercial geothermal resources, given economic constraints and available technology.

During the 1980s, the rights to explore, develop and utilize these potential geothermal resources, subject to specific conditions to protect other known Forest resources, were leased to private parties over approximately 55,000 acres of forest land within the Glass Mountain KGRA. Between 1981 and 1984, a total of 24 temperature gradient holes (used to measure the rate of temperature change with depth as a potential indicator of a geothermal heat source) were drilled by the geothermal lessees within the KGRA. Five deep geothermal resource exploration test wells were drilled in the 1980s east of Medicine Lake in the Medicine Lake basin portion of the Watershed (wells 17-6, 17A-6, 68-8, 31-17, and 87-13) [see Figure 3.17]. Exploration well 87-13 was deepened in 1991. Two plans for drilling additional deep geothermal resource test exploration wells have been submitted and approved since 1991, but no drilling activity under these approved plans has yet occurred.

In 1996 a plan for construction and operation of a 49.9 MW geothermal power plant project (the Fourmile Hill Geothermal Development Project) was submitted for geothermal leases located principally in Section 28, T44N, R3E, MDB&M, in the Klamath National Forest near the northwest boundary of the Watershed. Although the proposed Fourmile Hill Project geothermal wellfield and power plant facilities are proposed to be located outside of the Watershed, much of the proposed approximately 24-mile, 230-kV transmission line extending from the power plant eastward to the existing Bonneville Power Administration transmission line east of California Highway 139, and the fresh water well and pipeline from Arnica Sink to the power plant, would be built within the Watershed. The Final Environmental Impact Statement for the Fourmile Hill Project has been distributed, but neither the Record of Decision, nor the submitted plan, have been approved.

Plans for construction and operation of a 48 MW geothermal power plant project (the Telephone Flat Geothermal Development Project) proposed for portions of six geothermal leases located east of Medicine Lake in the Medicine Lake basin portion of the Watershed were submitted in

February 1997 and amended in May 1997. All of the Telephone Flat Project facilities, including the geothermal wellfield and power plant facilities and the proposed electrical transmission line interconnection route with the proposed Fourmile Hill Project 230-kV transmission line, would be built within the Watershed. The Final Environmental Impact Statement for the Telephone Flat Project has also been distributed, but neither the Record of Decision, nor the submitted plan, have been approved. The proposed geothermal development project facilities and associated proposed transmission lines within the Watershed are shown on Figure 3.18.

Water Uses: The use of water in the Watershed is managed through the Forest Service water rights program.

Surface stream resources are very limited. All streams, except a short segment of stream from Crystal Springs and about a 1½-mile stretch of Paynes Creek, are intermittent. Flows on intermittent streams are limited to after snowmelt or as intense storm runoff.

Permanent surface water features within the Watershed include five lakes (Medicine Lake, Little Medicine Lake, Bullseye Lake, Blanche Lake and an unnamed lake approximately 2.5 miles north of Medicine Lake); six springs (Paynes Springs I, II, and III; Schonchin Spring; Crystal Spring; and an unnamed spring); and Paynes Creek, a perennial stream resulting from Paynes Springs I and II, which flows for approximately 1.5 miles (2.5 km) and then disappears beneath the surface. There are also a number of small seasonal lakes and streams that occur annually, resulting from snow melt. Table 3.11 lists the permanent surface water features in Medicine Lake Basin, their elevations, and their uses. Due to the limited amount of surface water in the Watershed, there are no agricultural easements or special-use permits issued in the Watershed.

Grazing: Much of the Watershed is too rugged for domestic livestock. In addition, lack of understory, scarce flowing water, and porous soils substantially inhibit the growth of forage suitable for domestic grazing. Instead, the Watershed is an important provider of summer range for deer. A limited amount of area surrounding the Glass Mountain Lava Flow was recognized as suitable for rangeland in the preferred alternative of the LRMP. However, there are no grazing permits issued in the Watershed.

Table 3.11: Surface Water Features

Surface Water Feature	Elevation	Surface Water Uses[c]
Medicine Lake	6,676 ft (2,035 m)[a]	Domestic Use, Recreation, Fish Habitat
Little Medicine Lake	6,682 ft (2,037 m)[a]	Recreation, Fish Habitat
Bullseye Lake	6,742 ft (2,055 m)[a]	Recreation, Fish Habitat
Blanche Lake	6,735 ft (2,053 m)[a]	Recreation
Paynes Spring I	6,558 ft (1,999 m)[b]	Paynes Creek: Recreation, Fish Habitat
Paynes Spring II	6,471 ft (1,972 m)[b]	Paynes Creek: Recreation, Fish Habitat
Paynes Spring III	6,678 ft (2,035 m)[b]	Seep Only — No Identified Use
Schonchin Spring	6,820 ft (2,079 m)[b]	Domestic Use
Crystal Spring	6,860 ft (2,091 m)[b]	Crystal Spring Creek: Domestic Use, Recreation, Fish Habitat
Unnamed Spring (private)	6,700 ft (2,042 m)[b]	No Identified Use

Source: Telephone Flat Geothermal Development Final EIS/EIR (1999).

[a]USGS Topographic Map, 7.5 Minute series, Medicine Lake Quadrangle California, Siskiyou County, 1988 Provisional Edition
[b]Schneider and McFarland 1996
[c]USFS and BLM 1994

Recreation

Key Question

What are the primary recreational uses in the Watershed?

Summary Response:

The Modoc National Forest is notable for its remote location and uncongested recreation opportunities. Many visitors enjoy dispersed recreational activities. Winter recreational activities include snowmobiling and cross-country skiing. These activities are enhanced by the abundance of wildlife, variety of landscape settings, and uncrowded conditions. Table 3.12 summarizes the reported recreational uses that occurred within the Doublehead Ranger District during fiscal year 1997.

Table 3.12: Current Recreation Levels

Recreational Activity	Recreational Visitor Days (Thousands)
Camping, Picnicking and Swimming	133.6
Mechanized Travel and Viewing Scenery	67.2
Hiking, Horseback Riding, and Water Travel	5.6
Winter Sports	2.1
Hunting	12.6
Fishing	10.2
Miscellaneous Recreational Activities (Cabin use, nature study, hiking, horseback riding, general information)	29.3
Grand Total Recreational Visitor Days	260.6

Source: Doublehead Ranger District Office, Tulelake, California; December 17, 1997.

Background Information:

Within the Watershed, most developed recreational activities occur in the area immediately surrounding Medicine Lake. Recreation activities in the lake area include fishing, picnicking, boating, swimming, and hiking. The Blanche and Bullseye Lake areas are also actively used during hunting season.

The only developed recreation sites (i.e., campgrounds) within the Watershed are at Medicine Lake. There are four fee campgrounds located at Medicine Lake that offer approximately 75 individual sites (Medicine Lake Campground, A.H. Hogue, Hemlock, and Headquarters). Most sites can be used by either recreational vehicles or tent campers. There also is an undeveloped, designated overflow camping area located at Schonchin Springs, located just northwest of Medicine Lake. The operating season for these campgrounds is July through October. Although busy at certain times, these campgrounds are rarely full. Camping also occurs at undeveloped campsites located at Blanche and Bullseye Lakes, with greatest number during the Autumn hunting season.

Most dispersed recreation occurs from June through October and is primarily big-game hunting and recreational driving on the many primitive roads in the area. Camping, nature study, hiking, and off-highway vehicle are other typical dispersed recreation activities.

Smaller numbers of dispersed recreation occurs during late fall, winter, and early spring. These activities include snowmobiling, snowshoeing, and cross-country skiing.

Snowmobiling is the most intensive winter recreation activity and occurs in the Medicine Lake Highlands area as part of the Tri-Forest Snowmobile Trail area in the Klamath, Modoc, and Shasta-Trinity National Forests. This area includes a network of approximately 260 miles of signed, groomed snowmobile trails linking four snowmobile parks (USFS 1996).

Located directly north of the Watershed is the Lava Beds National Monument. Operated by the National Park Service, Lava Beds National Monument (LBNM) and the Medicine Lake area complement each other in attracting visitors. Bordering the northern edge of the analysis area, approximately ten miles north of Medicine Lake, the monument only has one campground which has 40 sites. The limited facilities and the non-forested landscape of the LBNM is a likely cause for attracting additional visitors to the Watershed.

Most of the area in Watershed has a Recreation Opportunity Spectrum (ROS) allocation of Roaded Natural. The ROS allocation for the Mt. Hoffman summit portion of the Mount Hoffman Roadless Area is Semi-Primitive Non-Motorized, and the Medicine Lake and Glass Mountain Lava Flows are managed as Semi-Primitive Wilderness (USFS, 1991a). The Medicine Lake and Glass Mountain Lava Flows are considered Semi-Primitive Wilderness as they do not meet the existing remoteness and size requirements for

wilderness consideration. However, they do meet the criteria for primitive classification when assessed for their social and managerial setting. Medicine Lake and Glass Mountain Glass Flows are also designated Geologic Special Interest Areas, with management direction to maintain these areas in their relatively undisturbed condition to provide educational, scientific and recreational opportunities. The ROS and developed recreation sites in the Watershed are shown on Figure 3.19.

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STEP 4 — REFERENCE CONDITIONS

INTRODUCTION

This step describes how ecological conditions have changed over time, resulting in current conditions as described in Step 3. A reference will be developed based upon historic conditions for comparison with current conditions. This is an attempt, using historical data, to determine how the ecosystem adapted/developed. The time period will vary by ecosystem features and data availability. Where actual data is lacking, descriptions of historical conditions will be constructed from a multitude of sources, inferences, and professional judgement.

This step begins with the historic overview that sets the framework for the step. Following the overview are answers to key questions by topics as presented in Step 2.

HISTORIC OVERVIEW

Prehistoric

Archaeological research has determined that Native Americans have used the Modoc Plateau for approximately the last 10,000 years with increased activity dating from 6,500 to 4,500 years ago. The analysis of both artifacts and other materials recovered from archaeological sites suggests that prehistoric land-use and settlement patterns appear to have changed over time. The Early Pattern [10,000-3,500 before present (BP)] is characterized by small groups of highly mobile gatherer-hunters foraging over large areas. This pattern shifts to a strategy characterized by the occupation of seasonal winter villages relying on stored resources during the Middle Period (3,500-2,000 BP) with relatively high residential mobility during the rest of the year. The Late Period strategy (2,500 BP to EuroAmerican contact) continues to focus on temporary settlements but sees the development of more complex and semi-sedentary settlements dependent on stored resources and the repeated use of the same winter areas and villages.

The Modoc Uplands subregion appears to have been important for hunting with only minor exploitation of seeds and plants by Native American groups. The analysis of site assemblage contents and artifact diversity across time suggests increased subsistence specialization from the Early to Late Periods. Quarry areas within the Medicine Lake Highland also appear to have been used differentially through time.

Early Period artifact assemblages (10,000-3,500 BP) include considerable hunting-related flaked stone tools (e.g., obsidian scrapers, core tools, bifaces in varying stages of reduction, simple flake tools, and moderate numbers of projectile points) and milling equipment in low but persistent quantities. Milling equipment becomes more scarce in Middle Period assemblages (3,500-2000 BP) which show a considerable increase in early stage bifaces (rough-outs) in the artifact assemblages. It is suggested that the increase indicates either the production of bifaces for trade with other groups or a need to reduce the number of trips to the Medicine Lake Highland quarries to procure obsidian. Bifaces from the Middle Period are present in archaeological sites in the surrounding areas of northern California and southern Oregon suggesting either trade or a wide-area subsistence settlement system. In contrast, Late Period assemblages (2,000-100 BP) consist primarily of hunting-related tools and provide little evidence of quarry exploitation or seed processing activities.

EuroAmerican Settlement

During the mid-nineteenth century, the Medicine Lake Highlands and vicinity was viewed as an obstacle to cross. The overland routes used by trappers, explorers, overland migrants, gold-seekers and teamsters typically avoided transiting the Medicine Lake Highlands (Wohlgemuth and Gilreath 1997 after Bunse 1996). The Modoc Indians were defensive of their homelands to EuroAmericans and frequently attacked overland parties. The hostilities deterred homesteading and settlement of the region into the 1870s.

Changes in the winter rainfall pattern also played an important part in opening the area to EuroAmerican settlement. Between 1855 and 1869 rainfall in northeastern California and

southeastern Oregon averaged above normal. Coincidentally, this wet cycle coincided with a 1863-1864 drought in the low-lying areas of California and Oregon and the Modoc region was viewed as desirable for settlement resulting in an influx of EuroAmerican settlers.

Relations between EuroAmerican settlers and the Modocs became more peaceful after 1857 and by 1864 the Modoc had been relocated on the Klamath Indian Reservation. The U.S. Army established Fort Bidwell in 1865 to guard the growing EuroAmerican population against Indian attack and to keep the peace among the settlers and various Native American groups. However, in 1865 a Modoc band under Keintepoos (aka Captain Jack) left the Klamath Reservation and the Modoc War of 1872-1873 resulted from the military's attempt to return them. The band held off various forces of the U.S. Army during the winter by hiding in the Lava Beds. After surrender, four band members, including Captain Jack were hanged at Fort Klamath in 1873, two were sentenced to life in prison, and the remaining 153 Modocs were transported to the Oklahoma Territory (Busby *et al.* 1990 after Pease 1965; Dicken and Dicken 1985; Martin 1987; Sutton 1987).

EuroAmerican settlement in the area was slow and infrequent after the end of conflicts. The low-density population was concentrated in areas with access to water, level land, pasturage, and soil adequate for farming. These areas were essentially claimed by 1880 (Busby *et al.* 1990 after Pease 1965; Gates 1983). One of the earliest homestead claims in the region was patented in the early 1890s near Dry Lake (located about 21 miles northeast of Medicine Lake). Modoc County was organized in 1874 from the eastern portion of Siskiyou County with the county seat at Alturas.

Railroad building and logging were the dominant activities in the analysis area from the turn of the century until World War II. By 1911, the Long Bell Railroad had been built from Weed to the logging town of Tennant and, after 1920, rail spurs were built further east from Tennant. By 1925, the company was ready to enter the Lava Beds-Medicine Lake Highlands, but went into default during the Great Depression. In January 1929, the Southern Pacific Railroad began construction of the Modoc Line, which connects Alturas to Klamath Falls, Oregon passing east of the Watershed just east of Tionesta. In 1932, the Great Northern and Western Pacific Railroads opened their track from Klamath Falls, Oregon to Keddie, California (located in Plumas County).

By 1911, the McCloud River Lumber Company and the Tionesta Lumber Company were the largest in the area, although the Weed Lumber Company was the most active. In the late 1920s, the Pickering/J.R. Shaw interest, which was based in Tionesta, and the Weed/Long Bell Lumber Company were logging cooperatively around Tionesta. Tionesta, developed as a temporary company lumber town, was the largest settlement in the Watershed vicinity. It was named in 1931 (Gudde 1969) and in the mid-1930s the Shaw Lumber Company of Klamath Falls built a large "export" mill at Tionesta. In 1940, Shaw purchased the Pickering lumber holdings of the Tionesta Company at the western edge of the Devils Garden. At this time, more than 700 loggers resided in the settlement which was the second largest town in Modoc County as a result of a logging boom and the presence of the only export mill in the upland area. After the Shaw Lumber Mill burned in 1946, it was not rebuilt, in part due to the depletion of the stands of Ponderosa pine in the area. As a result, Tionesta was essentially dismantled though the town still warranted a post office until November 1955 (Patera 1991). Sometime after 1945, it was moved from its location adjacent to the Western Pacific Railroad tracks to about 2/3-mile east. Present-day Tionesta memorializes the former logging boom town, but it now marks only a "wide spot" in the road composed of a small general store and a few residences.

Large scale commercial pumice mining was conducted in the Medicine Lake Highlands throughout the 1930s and 1940s. A pumice brick manufacturing plant operated in Tionesta and shipped via the Great Northern Railroad. The plant was relocated to its present State Highway 139 location upon the end of logging and the consequent demise of Tionesta in the mid-1940s.

At present, the Watershed and vicinity are dependent on government activities, ranching, mining, timber related industries and outdoor recreation.

UPSLOPE HYDROLOGIC PROCESSES

Key Questions

What were the historical (pre-EuroAmerican settlement) dominant hydrologic, both surface and subsurface, characteristics and processes within this Watershed and what disturbances have effected them?

Summary Response

Historic hydrologic processes were affected by volcanic activity within the area that (a) yielded the topography and geological features of the area, and (b) influenced the soil structures effecting vegetative communities.

Background Information

The Medicine Lake Highlands were formed by the Medicine Lake Volcano. This volcano is a shield volcano, 15 miles in diameter, located on the western margin of the Modoc Plateau, 33 miles east of Mt. Shasta, that rises almost 4,000 feet above the level of the surrounding Modoc Plateau. The highly faulted region around Medicine Lake Volcano is a transition zone between the Cascade volcanic arc and the Basin and Range province to the east. The volcano is located within an oblique right-slip, pull-apart graben connecting the Klamath graben with the Fall River graben. Tremendous volcanic activity has occurred here during the past several thousand years. Vast quantities of lava, mainly of basaltic nature, and associated pyroclastic materials flowed, or were deposited, over the landscape in almost continuous interbedded masses. The original peak of the volcano collapsed to form an elliptical caldera measuring about four by six miles. The caldera rim was subsequently surmounted and entirely obscured by a rampart of small secondary parasitic volcanoes including Glass Mountain, Mt. Hoffman, Medicine Mountain, Little Mt. Hoffman, Red Shale Butte and Lyons Peak. The parasitic volcanoes are also composed mainly of andesite flows. Some are apparently composite cones consisting of both flows and pyroclastics. In more recent time, eruptions from the floor of the caldera and from some of the secondary volcanoes have released an acidic suite of rocks including spectacular domes and flows of rhyolitic obsidian, rhyodacite, and dacite as well as a relatively thick extensive mantle of rhyolitic pumice. Basalts of the Modoc Basalt series have erupted on the flanks of the Medicine Lake Volcano in recent geologic time.

Medicine Lake Crater is a Hydrologic Sub-area of the Pit River Hydrologic Unit, which is part of the Central Valley Basin. The Medicine Lake Sub-area encompasses the Medicine Lake basin and the area to the south, including Medicine Lake, Little Medicine Lake and Arnica Sink. Within the Medicine Lake Crater Sub-area, surface drainage is generally to the south. Although most surface water in the Medicine Lake Basin flows toward the Lake, it infiltrates before reaching the lake, and surface water that does leave the basin flows to the south. In both the Medicine Lake Highlands and in the Modoc Plateau the occurrence of surface waters is sparse due to the highly permeable surface soils and rocks.

Due to the volcanic activity the Highlands are the dominant geological feature in the area. As a result, upslope hydrologic processes are localized events occurring within the Watershed.

RIPARIAN RESERVES

Key Questions

What are the historic and reference riparian conditions in the Watershed?

Summary Response

Riparian areas have not appreciably changed from the 1940s to the present. Air photos of the period indicate that those riparian areas currently present were present in the reference condition. There does not appear to be any significant change in the amounts of riparian habitats over the last 50 years.

Background Information

Aerial photos indicate that wet areas occurred seasonally at three locations in the Alcohol Crater areas (Sections 7 and 8 T43N, R4E). Actual riparian habitat in these areas was dependent on the amount of precipitation in a given year. In dry years the lack of water would not facilitate the development of vegetation that could warrant a

riparian habitat classification. In wet years, a type of riparian habitat may have developed in this area if water persisted for an extended period of time. Perennial wet areas with associated riparian habitat occurred near Medicine Lake, Little Medicine Lake, Schonchin Springs (Section 3 T43N, R3E), Crystal Springs and along the stream course between Crystal Springs and Medicine Lake (Section 10, T43N, R3E). In addition there were riparian areas along Paynes Creek (Sections 19, 30, and 31, T43N, R4E) and Paynes Springs (Section 19, T43N, R4E). Riparian areas were also found around Bullseye Lake and Blanche Lake (Section 24, T43N, R4E). There is no evidence of additional riparian areas in the reference condition of the Watershed. These reference conditions indicate that there has been no appreciable change in the riparian habitats over the past 50 years.

FIRE MANAGEMENT

Key Question (1)

What was the historic fire regime for each vegetation community?

Summary Response

Prior to settlement by EuroAmericans, historic fire regime can be generally described as having frequent fires. Lightning fires accounted for the majority of these fires, which would burn uninterrupted by humans. Following is a brief description of historic fire regimes by plant communities found in the Watershed. Plant associations are mapped on Figure 6.10 and reference vegetation conifer size and density is mapped on Figure 4.3.

Background Information

Eastside Ponderosa Pine:

Trees in this community occurred in relatively even age class where most are less than 30 inches dbh. Very little has been studied about fire history in the Eastside Ponderosa Pine type. The studies that have been done show a historical fire return interval of 8 to 16 years. It has been determined that fire is an important factor in maintaining this vegetation type. However, the biotic processes are slow and the system less resilient to fire (Chang 1996). Like the other Ponderosa Pine types the historical fire regime was probably frequent fires of low to moderate intensity.

Ponderosa Pine Mixed Conifer:

Trees in this community occurred in all class sizes, mostly in small even aged patches. Under stories consisted mostly of perennial grasses and forbs, with scattered pockets of shrubs. Low intensity, either creeping or fast moving ground fires maintained a mosaic of open understories and annual pine needle cast provided fuel for these fires. Openings in the overstory were also created following outbreaks of insect or disease or blowdown, followed by high intensity fire. This allowed for shrub and tree seedling regeneration. Fire returns were from 4 to 18 years.

White Fir Mixed Conifer:

This community was much smaller than it occurs today. Much of the area presently identified as this community was occupied by fire adapted conifer species. Under these conditions white fir was limited to cooler and moister, more fire safe sites. Fire occurrence was variable, with longer return intervals allowing for establishment and maintenance of the fire sensitive conifers. With a dense canopy, understory vegetation was limited. Openings created by insect and disease or blowdown followed by fire were soon occupied by dense regeneration or shrubs such as snow brush and manzanita. Fire returns were from 9 to 40 years.

Red Fir:

This community consisted of large patches of even-aged trees, many in larger size classes (greater than 24 inches dbh). Red fir dominated, with many of the same shrub species that currently exist. With fewer large scale disturbances, only a few large shrub dominated openings existed. Fire crept and smoldered through these stands throughout the summer, burning with higher intensity only during the hottest summer days in heavy fuels created by insects, disease, and blowdown. These areas were cleared by fire. Stand regeneration was perpetuated by seed rain. Fire returns were from 8 to 40 years.

Lodgepole Pine:

This community was commonly thought of as a closed-cone conifer requiring heat to open the cones and allowing the seeds to germinate. This is not the case in lodgepole pines of California (Skinner and Chang 1996). Lodgepole pines in the Watershed's higher elevations seem to be associated with any type of disturbance. The fire return interval range as determined by studies in the Caribou Wilderness was 28 to 41 years. Lodgepole pine historic fire regime is believed to be characterized by slow biomass accumulation, long periods of low fire danger, periodic droughts, and large fires. Periods of low intensity fires and periods of large stand replacement fires.

Shrub, Natural:

This community developed as a result of disturbances such as high intensity fires. On harsh sites and southwest aspects this community persisted as a fire climax community. On better sites, (i.e., north and east aspects), shade tolerant conifers grew through the shrubs and re-occupied the sites. Fire intervals ranged from 5 to 20 years.

Key Question (2)

> **What have the historical fire protection agencies been and where have their response areas been located within the Watershed?**

Response

The Watershed fire protection responsibility falls entirely under the protection of the USFS Modoc National Forest. Fire protection in the Watershed has always been their responsibility.

Key Question (3)

> **What have historic fire risks in the Medicine Lake homeowner and the proposed geothermal power plant interface areas been?**

Summary Response

The predominate risk of fires in the area come from lightning activity and recreational use in the summer. As human use increases in the Watershed, the need for fire prevention practices that will minimize the number of human caused fires must be implemented. The number of lightning caused fires will vary annually but will probably remain consistent with past patterns. The fire behavior experienced from these ignitions will also vary based on weather, available fuels and suppression resource availability.

Background Information

Without incorporating changes in the amount of ignitions, (which will be difficult to do primarily because most of the fires in the Watershed are lightning caused) or reducing the available fuels, the number of fires and their intensities will increase. Large catastrophic fires threaten to destroy valuable timber land, wildlife habitat, and recreation land base.

LATE-SUCCESSIONAL HABITAT

Key Question (1)

> **How much of the Watershed has historically been late-successional habitat, where was it located, and what was the block size?**

Summary Response

The total amount of late-successional habitat within the Watershed for the reference conditions was approximately 16,238 acres or 26% of the 60,847 acres area that was typed for reference conditions (see Figure 4.2).

Background Information

Little information is available describing the vegetative conditions within the Watershed prior to the turn of the century. Harvest records show that in the late 1920s limited areas within the Watershed were logged. Aerial photos taken in the 1940s show little indication of logging or road building activity in the Watershed. Aerial photos from 1944 and 1946 and soil survey information (Order 3 Modoc National Forest soil survey) indicate that between 40-50% of the capable sites in the Watershed were vegetated in open to dense LSH. These photos indicate that LSH's were comprised of 4G and 4P stand structure of the following plant associations:

Hemlock:

The hemlock associations were comprised of hemlock, hemlock-lodgepole and hemlock-red fir. Within the hemlock stands there were approximately 1,296 acres of 4G. The hemlock -lodgepole association was comprised of 129 acres of 4G and 438 acres of 4P for a total of 526 acres. The hemlock-red fir was comprised of 396 acres of 4G and 479 acres of 4P, for a total of 875 acres. The total amount of late-successional hemlock associations for the Watershed was 1,617 acres or 1.9% of the total Watershed.

The hemlock associations were established in approximately the same geographic locations as the current condition.

Lodgepole:

The lodgepole associations are comprised of pure stands of lodgepole, lodgepole-ponderosa pine-sugar pine and lodgepole-western white pine. As mentioned previously, lodgepole does not develop late-successional structural characteristics. While portions of these stands would have been comprised of older trees, they lack the structural attributes to be considered old growth habitat.

Ponderosa Pine:

The ponderosa pine associations were made up of ponderosa pine, ponderosa pine-lodgepole, and ponderosa pine-white pine. Of the pine stands, there were just 3 acres of 4G and 44 acres of 4P. Of the ponderosa pine-lodgepole there were 135 acres of 4G and 381 acres of 4P. Within the ponderosa pine-white pine stands there were 2,339 acres of 4G and 1,988 acres of 4P. The total amount of late-successional ponderosa pine habitats within the Watershed was 5,678 acres or 6.7% of the total Watershed.

Red fir:

The red fir stands were made up of red fir, red fir-lodgepole, red fir-white fir, and washoe red fir -western white pine associations. Within the red fir stands there were 1,435 acres of 4G and 1,002 acres of 4P. The red fir - lodgepole stands were comprised of 747 acres of 4G and 1548 acres of 4P. The red fir-white fir contained 892 acres of 4G and 514 acres of 4P. The washoe red fir-western white pine association contained 228 acres of 4G and 604 acres of 4P. The total amount of red fir LSH within the Watershed was 6,969 acres or 8% of the total Watershed.

White Fir:

Within the white fir association there were 243 acres of 4G and 854 acres of 4P for a total of 1097 acres or 1% of the Watershed.

Key Question (2)

> **Where was the historic connectivity and dispersal habitat across the Watershed and to adjacent watersheds?**

Summary Response

As described for Current Conditions, Key Question 2, foraging and dispersal habitats on the Modoc National Forest are defined as lands which have canopy closures of 40 percent or greater canopy closure and mean tree dbh between 11 and 24 inches. Nesting habitats are defined as having canopy closures of 40 percent or greater and mean tree dbh of greater than 24 inches (MNF 1998, p. 2). Both of these types of habitat are suitable for dispersal habitat. The structural components of the reference condition indicate that there was approximately 14,230 acres of habitat suitable for connectivity (7,784 acres of 3G and 6,446 acres of 4G). This figure is below the amount currently available (53,894 acres) due to the number of acres that were in an open stand condition (3P and 4P) in the reference condition. As with the current conditions, any stand with a canopy closure greater than 40% would have been suitable connective (dispersal) habitat.

Background Information

The majority of the connective habitat was within T43N, R3E and R4E, across the central portions of the Watershed. The notable exception is the lava flow within Sections 34, 35, and 36, T44N, R4E, and Sections 4, 5, 6, 7, 8, 9, 10, 15, 16, 17, 18, 20, 21, and 22, T42N, R4E. In addition, a fire scar in Sections 24, 25, 34,35, and 36, T43N R4E and Sections 1, 2, 3 11, and 12, T42N, R4E, would not be suitable as connective habitat. Lesser amounts of connectivity was found in the northwestern portions of the Watershed in T44N,

R3E and R4E, though this area appears more open in structure. The northeast portions of the Watershed was probably not suitable connective habitat due to the vegetative composition and open stand character of the area.

TERRESTRIAL WILDLIFE

Key Questions

For the species identified in this Watershed:

(a) What were the vegetative associations that constituted habitat for each specie?

(b) Where was the habitat in the watershed based on existing information?

(c) Based on available information, how much habitat was in the watershed?

Summary Response

Habitat needs for wildlife within the Watershed have not changed from the reference condition time frame of the 1940s to the present condition. While individual wildlife species may adapt to different habitat characteristics, habitat needs (that of food, shelter and cover) for individual species do not change through time. What does change through time is the amount and habitat available to be utilized by species within a given geographic area, in this case, the Watershed. A comparison of habitat change through time from the reference condition to the current condition is problematic for the Watershed in that the data for the reference condition is incomplete. The current condition for the Watershed shows approximately 80,000 acres of habitat inclusive of all geographic and vegetative features. For the reference condition, there is only data available for approximately 60,000 acres (see Table 4.3). This 60,000 acres of data is primarily representative of the southern two-thirds of the Watershed, with no data available for the northern one-third. In order to compare the change in habitat, only those areas where data is available for the reference and current condition can be compared. In Step 5, Table 5.1 compares the acreage amounts of the vegetative associations between the reference and comparable current condition. The vegetative association comprise the habitats for the wildlife species within the Watershed. For this assessment, those species considered in Step 3 will be analyzed here as to vegetative associations that comprise habitat.

The following description provides habitat requirements and amounts of habitat, if reasonably available, for each of the identified species.

Background Information

Bald Eagle (Haliaeetus leucocephalus)

Habitat: Eagles are primarily associated with the timber stands near Medicine Lake, their primary foraging area. Suitable nesting sites may be found in the 3G and 4G stands of all RF, PP, EM and SC1 associations within a 1.5 miles of Medicine Lake.

Amount of Habitat: Amount of Habitat: Actual suitable nesting habitat within 1.5 miles of Medicine Lake may be considered any large tree capable of supporting a nest structure, with sufficient canopy over the nest site. It is possible that such trees were fairly numerous in the 960 acres within the 1.5 mile radius of the Lake.

Northern Spotted Owl (Strix occidentalis caurina)

Habitat: NSO's were originally believed to be associated only with old growth habitats. More recent studies have shown that while these owls nest in structure with old growth structural characteristics, they may be found roosting, foraging and dispersing in a diversity of habitats. While nesting habitat is usually suitable foraging habitat, foraging habitat is not necessarily suitable for nesting. For this analysis, plant associations are broken down by function as follows: Suitable nesting habitat includes: 4G stands of PP1, PP2, PP3, EM1, EM3, RF1, RF2, RF3, and WF1. Dispersal and Foraging habitat includes: 3G, 3P, 4G, 4P stands of SC1, SC2, SC3, LP1, LP2, LP3, PP1, PP2, PP3, EM1, EM3, EM4, EM5, RF1, RF2, RF3, and WF1.

Amount of Habitat: Reference condition NSO nesting habitat may be considered the 4G stands of the above mentioned vegetative associations which were generally located in the southern two-thirds of the Watershed. These stands constituted approximately 6,403 acres of suitable nesting habitat. Roosting and foraging habitat was found

scattered throughout the Watershed and, as with the nesting habitat, generally more abundant in the southern two thirds of the Watershed, comprising approximately 16,000 acres.

Northern Goshawk (Accipiter gentilis)

Habitat: Goshawks nest are generally found in timberstands with more closed canopies, while foraging habitat may be found in more open forest habitats. Nesting habitats may be considered to be 3G and 4G stands of SC1, SC2, SC3, LP1, LP2, LP3, PP1, PP2, PP3, PP4, RF1, RF2, RF3, WF1, EM1, EM3, EM4, EM5 and WF1. Foraging habitats may be considered to be 3G, 3P, 4G and 4P stands of the above associations.

Amount of Habitat: Suitable goshawk nesting habitat for the reference condition was approximately 16,500 acres scattered across the Watershed in the 3G and 4G stands. Suitable roosting and foraging habitat contribute another 16,000 acres of habitat. Thus, within the Watershed there was approximately 33,000 acres of suitable goshawk habitat.

Pacific Fisher (Martes pennanti pacifica)

Habitat: Even though vegetative composition and structure are suitable for use by fishers, the Watershed is probably not suitable habitat for the fisher due to the high elevation with associated heavy winter snowfalls and lack of available water during summer months.

Amount of Habitat: The amount of suitable habitat for the pacific fisher in reference conditions is essentially the same as habitat in currents. Suitable habitat remained marginal due to high elevations in the Watershed and the occurrence of snow.

Mule Deer (Odocoileus hemionus)

Habitat: Deer utilize the Watershed primarily for summer range, with some possible fawning areas around succulent meadows in association with riparian areas. While the entire Watershed may be considered as suitable habitat, the best foraging habitat may be found in the northeastern portions of the area. Preferred foraging habitat may be considered to be the GL, ST, SX, WM, SG, NS, found within all plant communities as well as the PJ1 community.

Amount of Habitat: Suitable mule deer habitat may have been considered the entire Watershed, with the better foraging habitat comprising those early seral stage plant communities. This area would have totaled approximately 20,000 acres.

Sierran Red Fox (Vulpes vulpes necator)

Habitat: Red foxes may be associated with all forested habitats within the Medicine Lake Highlands.

Amount of Habitat: All vegetative areas within the watershed were suitable habitat for the red fox. This area would have totaled approximately 50,000 acres.

Osprey (Pandion haliaetus)

Habitat Requirements: Osprey nest in tree top nests in either live or dead trees or artificial structures such as power poles. Their nest are usually in association with a water body or stream. The only known occurrence of ospreys within the Highlands are in association with Medicine Lake. They will use any suitable tall structure for nesting within any timber association. All timber associations within one mile of Medicine Lake may be considered suitable nesting habitat. The Lake itself is the only suitable foraging habitat.

Amount of Habitat: The Medicine Lake area could have been utilized as foraging habitat for osprey. Suitable individual trees within ½-mile of the Lake would be expected to be used for nesting habitat.

American Marten (Martes americana)

Habitat: This species utilizes conifer habitats usually above 5,000 feet with structural components that includes overstory, log piles, downed logs and brush. Within the Watershed marten habitat may be considered the 3G, 3P, 4G and 4P stands of the SC, LP, PP, RF, EM and WF series above 5,000 feet in elevation.

Amount of Change: For the reference condition there was approximately 27,000 acres of suitable marten habitat available in those areas above 5,000 feet.

Wolverine (Gulo gulo)

Habitat: Wolverine are rare in California. From what is known, they primarily utilize the higher elevations of lodgepole pine and red fir in association with meadows. Within the Watershed wolverine habitat may primarily be all of the RF, WF, SC and LP associations above 5,500 feet.

Amount of Habitat: Wolverine habitat in the reference condition was approximately 61,000 acres scattered throughout the Watershed.

Great Gray Owl (Strix nebulosa)

Habitat: The Great Gray Owl forages in large perennial meadows in association with conifer forest at high elevation. This combination of habitat is lacking in the Watershed. For this reason, it is likely that Great Gray Owl's have neither historically, nor currently, utilized the Highlands.

Amount of Habitat: Little if any habitat for the great gray owl existed in the reference condition.

Bat Species:

It is probable that all the bat species considered in Step 3 were found within the Watershed. Some species utilize the lava caves and tubes for roosting while others utilize loose tree bark. All the species are believed to have foraged over the Watershed. Specific information on bat foraging habitat is limited.

Pallid bat (Antrozous pallidus)

Habitat: This species is found in grasslands, deserts, chaparral, woodlands and forests. All vegetative associations within the Watershed may be considered suitable.

Amount of Habitat: As specific information is lacking, it may be assumed the pallid bat foraged over the entire Watershed, some 80,000 acres.

Townsend's big-eared bat (Corynorhinus townsendii)

Habitat: This bat probably roosts in the lava tubes while foraging across most of the Watershed. As such, all vegetative associations may be considered habitat.

Amount of Habitat: As specific information is lacking, it may be assumed the Townsend's big-eared bat foraged over the entire Watershed, some 80,000 acres.

Long-eared myotis (Myotis evotis)

Habitat: This species forages within conifer associations and as such all conifer associations within the Watershed may be considered habitat.

Amount of Habitat: As specific information is lacking, it may be assumed the long-eared myotis foraged over the entire Watershed, some 80,000 acres.

Long-legged myotis (Myotis volans)

Habitat: This species forages in conifer woodlands. As such, all woodland habitats would be considered suitable habitats.

Summation of Change: As specific information is lacking, it may be assumed the long-legged myotis foraged over the entire Watershed, some 80,000 acres.

Fringed myotis (Myotis thysanodes)

Habitat: This species forages over more typically open canopy forest environments in association with forest edges and streams. Forest associations of 3P and 4P structure are most suitable.

Amount of Habitat: As specific information is lacking, it may be assumed the fringed myotis foraged over the entire Watershed, some 80,000 acres.

Silver-haired bat (Lasionycteris noctivagans)

Habitat: Maternity roosts are usually located in cavities in large trees or snags while exfoliating bark is used by smaller groups. Silver-haired bats apparently migrate to lower elevations or more southerly regions for the winter where they could hibernate in trees, snags, rock crevices, caves, mines and buildings. It is likely that the forested areas within the Watershed are suitable habitat for this species.

Amount of Habitat: As specific information is lacking, it may be assumed the silver-haired bat

foraged over the entire Watershed, some 80,000 acres.

ROADS

Key Questions

Why and how was the road system developed?

Response

Early roads provided access to timber, and limited areas used for mineral extraction. Between 1950 and 1970 a majority of road construction occurred. This construction was closely associated with providing access to timber harvest areas. The road system was primarily developed in association with resource development and extraction. It has not been until more recently that road development occurred for recreational access, in particular to the Medicine Lake area by way of Primary Forest Road 97 and Primary Forest Road 49.

SILVICULTURE

Key Question (1)

What were the characteristics of the Watershed prior to the introduction of intensified management activities, including harvesting, fire suppression, and silvicultural treatments? With respect to:

(a) Distribution of ecological associations;
(b) Species composition of associations;
(c) Percent distribution of seral stages within associations;
(d) Average stand size of each seral stage;
(e) Spatial arrangement of stands;
(f) Occurrence and location of stands where stocking exceeds the long term capacity of the site for sustained growth;
(g) Occurrence and location of stands at risk of catastrophic loss from insects, disease, or fire.

Summary Response

Reference condition information was in part developed from plant association typing interpreted from 1944-1946 aerial photographs (see Figure 4.1 and Table 2 in Appendix F). This information was used with other data to construct reference conditions for LSH (Figure 4.2) and land management plan units (Figure 4.3) that was used in the Step 5 interpretation of changes that have occurred.

Background Information

The most reliable data available for characterizing the composition, stocking, and distribution patterns of vegetation under pre-management conditions were aerial photographs of the Medicine Lake Highlands taken in 1944 and 1946. Thus, for the silvicultural assessment of reference conditions the mid 1940s was selected as the reference point. At that point in time, approximately 75% of the analysis area had not yet been manipulated or impacted by the management policies and practices which were instituted during the last 50 years. Therefore, vegetative composition and stocking patterns, in three-quarters of the analysis area, was for the most part sculptured by natural factors, including climate, topography and soil, as modified by periodic disturbances such as lightning fires.

The aerial photographs referenced above were studied and interpreted by silviculturalist Anne Mileck, of the Devils Garden-Doublehead Ranger District, to produce a vegetation map depicting stand structure and arrangement during that period (see Figure 4.1). This map differentiates between conifer, non-conifer, and non-productive stands. The structure of all timber stands is identified using USFS Region 5 standard codes for size (mean dbh) and crown closure classes. This same information is condensed on a second map (Figure 4.3) stratified according to seral stages utilized by the Land and Resource Management Plan of the Modoc National Forest.

Neither of the above referenced maps identify the species composition of stands, other than the lodgepole pine. Thus, for purposes of later comparing reference conditions and current conditions, the reference vegetation was divided graphically into EUI associations and miscellaneous landscape features identical with

those utilized for identifying current vegetation composition (see Figure 6.10). It has been determined that this ecological classification and mapping quite accurately depicts the potential natural vegetation of the analysis area, and thus the distribution of specific associations that could be expected under pre-management conditions.

The maps identifying the structure of the vegetation at the reference point was interfaced with the EUI map in order to formulate polygons from which appropriate data could be derived for answering most of the key questions in this document. This data is provided in the tables referenced below. Since no descriptive plot data of the stands or preceding the reference point were available, no narrative descriptions characterizing stands during the reference period are provided, and the answers to the key questions is presented only in tabular form. This information is considered adequate for comparing with current conditions, in Step 5, to determine and interpret changes that have occurred.

Responses to Silviculture Key Question (1) - Reference Conditions:

(a) The distribution of ecological associations is charted on Figure 3.12.
(b) The precise species composition and proportions cannot be determined from existing records of the era.
(c) The percent distribution of seral stages within associations is presented in Table 4.3.
(d) The average stand size of each seral stage for each association is given in Table 2 in Appendix F.
(e) The relative spatial arrangement of overstocked stands is identified in Table 2 in Appendix F.
(f) The distribution and acreage of overstocked stands is identified in Table 4.1.
(g) The distribution and acreage of stands at risk of fir engraver beetle mortality is also identified in Table 4.2.

Various degrees and intensities of timber harvesting had already occurred in the 25% of the Watershed prior to the reference point and therefore the 1946 stocking in the effected units was not representative of an unmanaged ecosystem. These previously disturbed areas are excluded from the map of reference conditions and no data has been tabulated for them. In addition, certain portions of the Watershed were inadequately covered on the photographs available for study and interpretation. This deficiency resulted in additional acres of some timber associations not being characterized. The omission of information on these areas from the reference map and database means that eight conifer associations were characterized using a partial sample, and two (PP2 and PJ1) not at all.

Data for the following associations accounts for only that proportion of the associations indicated: LP1 (77%); LP2 (77%); EM1 (73%); EM3 (71%); EM4 (34%); EM5 (55%); PP1 (2%); and PP3 (85%). Reference data for the EM5 association was derived from a land base that included approximately 230 acres of private land, and actually includes only a 40% sample of that portion of the association occupying land within the Watershed that is administered by the Modoc National Forest. The PP1 sample is definitely too small to consider representative, and data for the EM4 and EM5 associations is very likely skewed to some degree. Some inaccuracies will be introduced when comparing this data with current conditions to determine the changes that have occurred. The same may be true to a lesser extent with other partially represented associations.

Table 4.1 and Table 4.2 contain acreage amounts for plant associations that were either overstocked or at risk in the reference conditions.

Overstocked stands are stands in which stocking exceeded site capacity over time; leading to stagnation, reduced growth and vigor, and eventual mortality. Thinning of these stands is recommended to accelerate growth and hasten succession to advanced seral stages. Overstocked early seral stages would benefit from pre-commercial thinning. Overstocked mid seral stands are also candidates for commercial thinning.

Stands greater than 60% canopy cover are at the threshold of being overstocked. However for reference conditions it was not possible to distinguish stands between 60-69% canopy cover from those between 40-59% canopy cover.

Table 4.1: Distribution and Acreage of "Overstocked Stands" Under Reference Conditions

Association	Seral Stages with >70% Canopy Cover	
	Early (2G) (acres)	Mid (3G) (acres)
SC1	0	72
SC2	0	8
SC3	0	7
RF1	133	83
RF2	50	86
RF3	0	80
LP1	0	22
EM3	0	59
PP4	0	87
WF1	0	279

Source: Modoc National Forest Aerial Photographs (1944-1946) and Ecological Unit Inventory (1996).

Stands at risk are stands similar to overstocked stands, which were not only on the threshold of exceeding site capacity, but also occurred in climatic zones where they were at risk of mortality during periods when populations of fir engraver beetles were high (see Table 3.9).

Table 4.2: Distribution and Acreage of "Stands at Risk" Under Reference Conditions

Association	Seral Stages with >70% Canopy Cover		
	Early (2G) (acres)	Mid (3G) (acres)	Late (4G) (acres)
EM1	0	10	424
EM4	0	0	76
PP3	0	4	76

Source: Modoc National Forest Aerial Photographs (1944-1946) and Ecological Unit Inventory (1996).

Key Question (2)

What was the capacity of the Watershed Analysis Area for Northern Spotted Owl nesting, roosting, and foraging habitat under reference conditions?

(a) What was the extent of such habitat?
(b) Where was it located?
(c) Was the seral stage distribution appropriate to sustain nesting, roosting, and foraging habitat?

Response

NSO nesting habitat for the Reference condition may be considered the 4G stands of the PP1, PP2, PP3, EM1, EM3, RF1, RF2, RF3, and WF1. These stands constituted approximately 6,403 acres of suitable nesting habitat primarily located in the southern two thirds of the watershed.. Roosting and foraging habitat may be considered the 3G, 3P, 4G and 4P stands of SC1, SC2, SC3, LP1, LP2, LP3, PP1, PP2, PP3, EM1, EM3, EM4, EM5, RF1, RF2, RF3, and WF1. These vegetative association and stand structures were found scattered throughout the Watershed and, as with the nesting habitat, were generally more abundant in the southern two thirds of the Watershed. From existing data it appears that there may have been approximately 16,000 acres of suitable foraging and dispersal habitat.

SURVEY AND MANAGED SPECIES

Key Questions

What known information of survey management was historically used?

Response

Negligible information of survey management was historically used with respect to the species identified in Table C-3 of the NFMP ROD that are dependent on late-successional forest. However, it may be safely assumed that the habitat requirements for the "Survey and Manage" species in the Watershed have not changed since the reference conditions. As such, the changes that have occurred to the late-successional habitat in the Watershed are also a measure of both the availability and quality of the habitat of the "Survey and Manage" species discussed in Step 3 that are believed to occur in the Watershed (see discussion of late-successional habitat provided earlier in this section).

HUMAN USES

Heritage Resources

Key Questions

What prehistoric and historic resources exist within the Watershed?

Summary Response

Native Americans have been present in the Watershed and vicinity for the past 10,000 years. From this presence in the area over an extended period of time a variety of artifacts and historical uses of the land still exist. No significant Euroamerican presence existed in the Watershed area or vicinity until the mid-1800s.

Background Information

Cultural Resource reference conditions have been characterized in the introduction of this section, Step 4: Reference Conditions.

Prior to the 1860s, the Modoc Plateau and areas of the Medicine Lake Highlands including the Watershed were utilized by the Native American groups. The Medicine Lake Highlands, including the area of the Watershed were visited by members of the Modoc, Pit River, and Shasta Indians for plant, animal, and mineral resources and to undertake traditional and spiritual activities. Glass Mountain was a major source of obsidian used to fashion tools or to trade with other groups.

Artifacts exist in the Modoc Uplands ranging from hunting materials, such has flaked stone tools, to limited examples of milling equipment. This indicates the varied uses of the Medicine Lake Highlands obsidian and other hard rock sources.

Native Americans also utilized the Watershed by establishing various sacred sites in the area. These sacred sites were used for practices such as spirit or vision quests. An individual goes on a spirit or vision quest at a specific location in the forest for reasons such as puberty, birth or death of child, or other crises.

Non-Timber Commodities

Key Questions

What non-timber commodities were historically utilized in the Watershed?

Response

Prior to EuroAmerican settlement, commodities utilized in the Watershed included hunting and removal of minerals for subsistence use. The primary non-timber commodity first removed from the Watershed was pumice rock. Pumice rock was commercially mined from areas north of the Mt. Hoffman Roadless Area in the 1930s and 1940s.

Prior to the issuance of the first geothermal resource leases in 1982 there was no historic commercial interest in the geothermal resources of the Watershed.

Recreation

Key Questions

What have the primary recreational uses in the Watershed historically been?

Response

Historically, the Watershed was not a destination for recreational uses. Early EuroAmerican settlement and Native American use of the land was primarily for resource extraction. Recreational use of the land did not begin until the early to mid-1900s when the area was recognized for its dispersed recreation potential.

Table 4.3: Reference Condition Vegetation

Association		1 (LRMP WHR 1)		2 (LRMP WHR 2)		3P (LRMP WHR 3a)		3G (LRMP WHR3b/c)		4P (LRMP WHR 4a)		4G (LRMP WHR4b/c)	
Code	Total Acres	Acres	% of Assoc	Acres	% of Assoc.	Acres	% of Assoc.	Acres	% of Assoc.	Acres	% of Assoc.	Acres	% of Assoc.
SC1	2395	20	0.8	25	1.0	408	17	457	19	479	20	1006	42
SC2	331	2	0.6	4	1.2	73	22	36	11	6	2.0	210	63
SC3	1571	18	1.0	200	12.7	202	12.8	629	40.4	436	27.7	86	5.4
RF1	5304	265	5	583	11	642	12.1	1130	21.3	1273	24	1411	26.6
RF2	3412	707	20.7	203	5.9	237	6.9	575	16.8	575	16.8	1114	33
RF3	5301	200	3.8	389	7.3	1339	25.3	1019	19.2	1607	30.3	747	14.1
LP1	3453	59	1.7	262	7.6	262	7.6	2352	68.1	518	15	0	0
LP2	74	0	0	41.5	56	32.5	44	0	0	0	0	0	0
LP3	2616	0	0	471	18	1271	48.6	610	23.3	264	10.1	0	0
EM1[a]	5595	630	14	81	1.8	547	12.1	1185	26.3	1300	28.8	715	15.8
EM3	2071	56	3.0	14	0.6	430	18	729	35	604	29	238	11.5
EM4	1682	28	1.7	0	0	291	17.3	158	9.4	754	44.8	445	26.5
EM5	883	82	9.3	256	29	167	18.9	126	14.3	207	23.4	45	5.1
PP1[c]	99	15	15.1	0	0	16	16.2	0	0	65	65.7	3	3
PP2	0	0	0	0	0	0	0	0	0	0	0	0	0
PP3	3973	1138	28.6	138	3.5	139	3.5	635	16	1185	29.8	738	18.6
PP4	800	6	0.7	0	0	111	13.8	194	24.2	381	47.7	108	13.6
WF1	6572	3712	56.5	788	12	155	2.4	816	12.4	855	13.0	246	3.7
PJ1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Acres	46132	6938	—	3455.5	—	6322.5	—	10651	—	10509	—	7112	—
Talus	122												
Water	474												
Lava	12501												
Wet Meadow	96												
Rush Sedge	14												
Dry Meadow	108												
Flats	78												
Other	76												
Total Non-Conifer	13469												
No Data	1275												
Total	60876												

STEP 5 — INTERPRETATION

INTRODUCTION

This chapter begins with a brief outline of the planning direction as it applies to the Medicine Lake Highlands Watershed Area. Following the planning direction are answers to the Step 5 Key Questions and Issues as outlined in Step 2. Each Key question is followed by an interpretation of the changes that have occurred between reference and current conditions. After the interpretation of all the key questions for each resource area are the desired conditions for the Watershed.

Planning Direction

The planning direction for determining desired conditions is derived from all appropriate laws and administrative direction, including the Northwest Forest Plan, Record of Decision (ROD). The ROD provides standards and guidelines for management of habitat for late-successional and old growth forest related species within the range of the northern spotted owl. The ROD establishes a system of Late-Successional Reserves (LSRs) to provide habitat connectivity for late seral dependent wildlife species. The ROD also establishes the Aquatic Conservation Strategy (ACS) to restore and maintain the ecological health of watersheds and aquatic ecosystems. This strategy includes the establishment and management of Riparian Reserves and Key Watersheds, completion of Watershed Analysis, and watershed restoration.

The Forest Plan incorporates the ROD and ACS. It identifies Management Areas, Desired Conditions, and Standards and Guidelines for National Forest Lands. This analysis incorporates and relies on the Forest Plan. A comparison of existing conditions to reference conditions follows to provide a basis for desired conditions presented later in this step.

UPSLOPE HYDROLOGIC PROCESSES

Key Questions

Are there changes between the current and reference/historic dominant hydrologic, both surface and subsurface, characteristics and processes and what are their causes?

Interpretation

Changes to upslope hydrologic processes in the Watershed from reference conditions to current conditions have occurred primarily as a result of the construction of roads.

Roads impede natural hydrologic functions from occurring and promote soil erosion. Within the Watershed many roads have been constructed to accommodate timber sales. Following the completion of logging, many of these roads are no longer used, nor do they provide a benefit to the forest. Some of these roads can be considered nonessential and no longer need to remain open.

The nonconforming conditions of the Watershed for upslope hydrologic process are that existing roads not needed to meet management objectives contribute to soil erosion.

An additional nonconforming condition occurs with soil erosion due to disturbance from areas of human activity that have been abandoned without being restored to prevent soil erosion.

Desired Conditions

- Elimination of soil erosion from nonessential roads.
- Minimization of erosion from essential roads.
- Minimization of soil erosion resulting from areas of previous disturbance.

RIPARIAN RESERVES

Key Questions

What are the natural and human causes of change between the historical/reference and current riparian area conditions?

Interpretation

In the Watershed changes from reference conditions to current conditions have occurred to Riparian Reserves due to new plant species entering riparian areas and due to recreational use in riparian areas.

A nonconforming condition is that lodgepole pine growth has been encroaching upon Medicine Lake's Riparian Reserves. Excessive growth of this type of forest can lead to degradation and reduction of riparian habitat. However the encroachment of upland vegetation has not substantially degraded the existing Riparian Reserves around Medicine Lake.

Recreation use levels surrounding Riparian Reserves have greatly increased from reference conditions and has the potential for causing a nonconforming condition. However, recreational use has not substantially degraded the existing Riparian Reserves.

Desired Conditions

- Riparian areas are not inhibited or encroached upon by upland vegetation in a way that prevents attainment of Aquatic Conservation Strategy objectives.
- Riparian Reserves are not degraded by recreation activities in a way that prevents attainment of Aquatic Conservation Strategy objectives.

FIRE MANAGEMENT

Key Question (1)

What has changed and what have been the agents of change for fuel characteristics, fire hazard potential, and fire risks in the Watershed?

Interpretation

Nonconforming conditions in regards to fire management in the Watershed are that the MLSA and Matrix are currently dominated by moderate to high FBP putting late-successional and potentially late-successional stands at risk from stand replacing wildfire. The eastside pine stands and associated vegetation represent the highest FBP in the Watershed, and are at extreme risk of stand replacing fire. These stands are currently in early to mid seral stage.

Nonconforming conditions occur in specific areas where high Fuel Model levels exist such as the tree plantations at Black Mountain which are at high risk for stand replacing fire, which also pose a significant threat to activity centers in the MLSA.

The primary agent of change in the Watershed has been the increased accumulation of fuels as a result of fire suppression. Fire once played a major role in shaping the vegetation. Fire suppression has removed fire from the natural role it played in the ecosystem.

Extensive areas of vegetation that were represented by Fire Behavior Predictive Fuel Models 2, 8, and 9, are now represented by Fire Behavior Predictive Fuel Models 6, 10, and 11, respectively. Logging has changed the characteristics of the vegetation. These areas that once had vegetation with a fire regime of frequent, low intensity fires, are now at risk of having large stand forest type replacing fire occurrence. Fire behavior potential for most areas has increased from low to moderate, and from moderate to high. Fires that burn in the moderate to high hazard areas burn with higher intensity and have more severe effects on the soils and vegetation.

Opportunities exist to return fire potential of the ecosystem to its original condition. Low intensity, controlled fires can be used at periodic intervals to reduce fuel loading and vegetation arrangement that contribute to an area being classified with a high hazard rating. Changing Fire Behavior Predictive Fuel Models 5, 6, 10, and 11 to Fire Behavior Predictive Fuel Models 2, 8, and 9 will reduce fire hazard and the risk of stand replacing fires.

Key Question (2)

How have the fire protection agencies and their response areas within the Watershed changed?

Interpretation

The agency responsible for fire protection, the U.S. Forest Service and the response area have changed very little in recent history. A seasonal fire station located in the Watershed at Medicine Lake was closed by the U.S. Forest Service and moved to the Lava Beds National Monument. That station is co-managed by the National Park Service and the Double Head Ranger District of the Modoc National Forest. This station has primary initial attack responsibility for the Watershed. It is located in the Lava Beds National Monument area, just north of the Watershed boundary close to the northern high risk area.

Key Question (3)

How have current fire risks in the Medicine Lake homeowner and the proposed geothermal power plant interface areas changed?

Interpretation

In regards to human use in the Watershed and fire risk, concern over the semi-primitive non-motorized areas in the Watershed that are not managed for natural fire occurrence levels is a nonconforming condition.

The fire risk posed by the Medicine Lake home owners and the proposed geothermal power plant areas will change very little. Those risks posed can be mitigated by an increase in prevention and community awareness. Possible construction of power lines in the Watershed, if properly maintained to Forest Service standards, should do little to increase the fire risk.

Proper fuels treatment and fuels reduction techniques in the area of the improvements will go a long way toward mitigation of the losses from fires from the homeowners or the power plants.

Since incorporating changes in the amount of ignitions, will be difficult to do, primarily because most of the fires in the Watershed are lightning caused, mitigation of the hazards becomes very important. Such mitigation would include reducing the available fuels through mechanical treatments, protection of the forest from fires originating in developed areas by the construction of defensible fuel profiles zones (DFPZ), and the development of a prescribed fire program for the Watershed. Without proper mitigation of the hazardous fuel build up large catastrophic fires threaten to destroy valuable timber land, wildlife habitat, and recreation land base.

Key Question (4)

Are there high risk areas in or bordering high fire behavior potential areas and what are the management implications?

Interpretation

In the southern part of the Watershed, the highest fire risk lies inside the boundary of the MLSA and adjacent to the southern boundary of the MLSA. This high fire risk area is a very probable threat to the late-successional habitat in the area. The rest of the MLSA falls into the moderate fire risk category which still is a threat to the survival of the reserves. Wind driven fires from outside the MLSA and inside can be expected to burn into the MLSA. These fires can be expected to be high intensity fires as is pointed out in the Fire Management Plan for the MLSA. Much of the pine and white fir dominated forests have high amounts of ladder fuels that will allow fires to easily spread into the crowns of the trees causing crown fires which are difficult to suppress and will cause considerable damage.

In the northern part of the Watershed, the high and moderate fire risk areas encompass the ponderosa pine timber producing areas of the Watershed. This area of the Watershed has similar characteristics to the southern portion that will promote rapid fire growth and spread under high fire danger. The accumulation of fuels from timber harvest and dead stands of white fir add to the fuel accumulation which in turn adds to the fire hazard. These conditions contribute to the increase in the potential for large devastating wildfires.

Key Question (5)

What are the trends for fire risks and fire behavior potential?

Interpretation

See response to Key Question 1.

The predominate risk of fires in the area come from lightning activity and recreational use in the summer. As human activity increases in the Watershed, the need for fire prevention practices that will minimize the number of human caused fires must be implemented. The number of lightning caused fires will vary annually but will probably remain consistent with past patterns. The fire behavior experienced from these ignitions will also vary based on weather, available fuels and suppression resource availability.

Incorporating changes in the amount of ignitions will be difficult to do, primarily because most of the fires in the Watershed are lightning caused, and without reducing the available fuels, the number of fires and their intensities will increase. Large catastrophic fires threaten to destroy valuable timber land, wildlife habitat, and recreation land base.

The *Medicine Lake Highlands Managed Late-Successional Area Assessment* (MLSA) does not allow for fuels treatment inside the boundaries of the late-successional stands themselves (see Appendix G).

The goal of the Fire Management Plan is to protect existing late-successional areas and promote the attainment of late-successional areas. The achievement of these goals will require management activities within and adjacent to the MLSA that will change and/or maintain current fuel characteristics and arrangement to a desired or sustainable level over time. The guiding goals of the fire and fuels management strategy displayed in this plan are:

- *Protection of existing late-successional stands.*
- *Protection of stands developing to late-successional habitat.*

Protection of existing late-successional areas is to be accomplished by treating adjacent mid-seral stands silviculturally and with prescribed fire to reduce fire intensity characteristics in those adjoining stands; thereby reducing threat to the existing late-successional core areas.

Due to the rarity and high value of late-successional habitat in the MLSA, neither silvicultural treatments nor prescribed fire will be introduced into the existing late-successional stands. It is recognized however, that those stands will remain at moderate risk of high-intensity stand replacing fire from internal ignition.

Desired Conditions

- The MLSA and Matrix are characterized largely by low to moderate fire behavior potential (FBP), while maintaining an acceptable balance of down woody debris and snag components.
- The eastside pine stands north of road 44N01 are at low to moderate FBP, with late-successional stands represented at an appropriate level.
- FBP is low to moderate in tree plantations at Black Mountain.
- Semi-primitive non-motorized areas are managed to levels of natural fire regimes.

LATE-SUCCESSIONAL HABITAT

Key Question (1)

What has caused the amount of the Watershed that is late-successional habitat, its location, and its block size to change?

Interpretation

Nonconforming conditions in the Watershed are that only 17% percent of MLSA lands capable of producing LSH, and 10% of Matrix lands capable of producing LSH, are of this status. These patches of LSH are small in size and fragmented.

Other nonconforming conditions exist in regards to LSH and the risk of fire. Approximately 44 percent of the MLSA has a high fire behavior potential. There is approximately 750 acres within about 70 LSH stands that are either adjacent to stands that have high FBP ratings; or are LSH stands that have high FBP ratings. These stands are directly at risk to being lost during wildland fire events.

Additional nonconforming conditions are caused by fire risk occurs southwest of the MLSA and in the Matrix where there are LSH stands that are either adjacent to stands that have a FBP rating of high or are LSH stands that have high FBP ratings. These stands are directly at risk to being lost during wildland fire events.

Soil patterns, elevation, fire and precipitation are the dominant forces that have impacted the reference condition late-successional habitat locations.

Habitat typing of the available coverage of 1944-1946 photos indicates that 26 percent of the Watershed was in late-successional stage habitats. Individual stands appear larger than today, probably indicating that fire was the dominant landscape architect. Until the 1920's lightning caused fires burned unchecked in available fuels until weather conditions, natural barriers, or lack of fuels halted their spread. Historically east side mixed conifer stands tended to be more open than stands today, reflecting the frequency of low intensity fires. These fires favored species such as ponderosa pine, incense cedar, and sugar pine. White fir tended to be absent at the low to mid-elevation zones. In the upper elevation zones where fire tended to be less frequent, white fir was more common. The photos of the 1940s show numerous brush fields and even-aged conifer patches. Canopy closures on south and west facing slopes tended to be more open with less understory. There appears to be fewer snags and course woody debris which is probably resultant of the fires. Overall, the vegetation appears more heterogenous than is currently existent. The size and shape of current vegetation patterns have been determined in part by these fires.

Fire exclusion and human activities over the last 80 years have caused a change in the stand structure and species composition. Insect infestations, disease and windthrow have also contributed to the ongoing stand dynamics. The exclusion of fire has contributed to increased stand densities and biomass which has increased the fuel loading in most of the vegetative types within the Watershed.

Canopy closures on the south and west facing slopes tended to be more open with less understory and probably less snags and coarse woody debris. North and east slopes, which burned less frequently and intensely supported higher canopy closures and site biomass.

Timber management activities probably began in the 1920s with railroad logging east of Buck Butte, in the Longbell area. The 1940s photos indicate much of the Watershed still untouched by logging. The majority of the timber harvest in the area occurred between the 1950s and the 1970s. Much of this harvest was salvage following windstorms, the largest of which was the Columbus Day storm of 1962. Since 1990 only incidental windthrow or roadside salvage has been done.

Road construction was associated with timber harvest and primarily done between 1950 and 1970. The Matrix lands in the Watershed have an average road density of 2.9 miles per square mile. The construction of roads altered the vegetative patterns within the Watershed by removing vegetation and creating edge effects between the road corridor and surrounding vegetation.

Insects and disease have always existed in the Watershed but apparently have not created large scale disturbance patches or patterns. Older trees, as they aged and became less vigorous, would be most susceptible to insect attack. In the upper elevation zones harsh climatic factors tended to keep insect populations in check.

Key Question (2)

> **How has the location of the connectivity and dispersal habitat across the Watershed and to adjacent watersheds changed?**

Interpretation

With the increased fire suppression within the last 80 years there has been an increase in the amounts of 3G and 4G stand structure within the Watershed. This in turn has increased the amount of dispersal habitat and connectivity. The reference conditions indicates there were approximately 14,230 acres of habitat that was suitable for dispersal. Today, there are nearly 53,894 acres available, a 379% increase in the amount increase in the amount of dispersal habitat. The locations of the suitable habitat are primarily in those areas below 6,500 feet in elevation.

Desired Conditions

- Manage for a functional and sustainable MLSA by attaining a minimum of 40% of the MLSA in LSH seral stages. Average patch size is 100 acres or greater.
- The FBP ratings are moderate within; and adjacent to LSH stands.
- In the Matrix, a minimum of 15% is in LSH stage. Average patch size is in excess of 100 acres.
- The FBP ratings are moderate within; and adjacent to LSH stands in the Matrix.

TERRESTRIAL WILDLIFE

Key Questions

For the species identified in this Watershed:
(a) How has the habitat changed within the Watershed?
(b) How much has the amount of habitat in the Watershed changed?

Interpretation

Nonconforming conditions in the Watershed for Terrestrial Wildlife are primarily related to lands capable of producing LSH, which in turn, provide quality habitat for animals. In the MLSA, only 17% is currently in LSH status. Additionally, LSH patches are small in size and fragmented.

Additional nonconforming conditions are that in the Matrix there are areas that are deficient in dispersal habitat for LSH related terrestrial species. The Matrix also lacks an adequate amount of refuge for these species.

Currently in the Matrix, there appears to be a relatively good mix of early and mid seral stages to meet the requirements of terrestrial wildlife species.

Specific to each species, there has been change in the Watershed in regards to the amount of habitat available. Following is an account of the change that has occurred in the Watershed. For further explanation of the changes that have occurred in regards to plant associations that each specie utilizes as habitat the silviculture discussion of this section and Table 5.1 provide in-depth analysis of each plant association.

Bald Eagle (Haliaeetus leucocephalus)

Habitat Change: There has been no significant change in the amount of suitable nesting sites for bald eagles.

Northern Spotted Owl (Strix occidentalis caurina)

Habitat Change: Generally, nesting habitat has remained the same from the reference condition to present while the amount foraging and dispersal habitat has remained fairly constant. Significant changes have occurred in a shift of over 10,000 acres of 4P nesting transforming into other seral stages. See the response to Key Question 2 of the silviculture discussion of the section of the analysis for additional information on NSO nesting, roosting, and foraging habitat in the Watershed.

Northern Goshawk (Accipiter gentilis)

Habitat Change: Within the Watershed there has been an overall increase in available goshawk nesting habitat in the last 50 years. Although there has been a decrease of suitable 4G nesting habitat by 6,185 acres there has been an increase in the amount of suitable 3G habitat by 10,241 acres. This is a net overall increase in suitable habitat of 4,056 acres. This increase in total amount of suitable acres is not reflective of the quality of the habitat. In some cases the reduction in the 4G habitat may be assumed to be a reduction in the better quality nesting habitat due to the physical structure of the 4G stands. While goshawks are known to nest in both 3G

and 4G habitats on the Forest, preference by the bird for stand structure is unknown at this time. Therefore it is not possible to determine whether overall habitat suitability has increased or decreased over the past half century.

Pacific Fisher (Martes pennanti pacifica)

Habitat Change: No change has occurred in the amount of pacific fisher habitat available. Habitat available to the pacific fisher has therefore remained marginal due to higher elevations and the frequency of snowfall in the Watershed.

Mule Deer (Odocoileus hemionus)

Habitat Change: Within the Watershed, the general increase in the amount of 3G habitats, with its associated understory has been favorable for deer. Fires are generally favorable in terms of producing deer foraging habitat. The fire of the 1930s in the northern portions of the Watershed generally improved forage condition for deer as new growth after the burn is more palatable for deer. This improved condition begins to decline after 20 years and is essentially back to pre-burn value by 50 years, depending on the plant associations effected. The fires in the southern portion of the Watershed in the 1900s and 1940s had much the same effect. Due to the lack of reference condition information for the northern portion of the Watershed it is not possible to determine the change in mule deer foraging habitats of those areas. However, due to the soil types of the area, it is probable that much of the areas of suitable foraging habitat in the northern portions of the Watershed was suitable deer foraging habitat in the reference condition. Overall, mule deer habitat quality may be characterized as remaining constant across the Watershed.

Sierran Red Fox (Vulpes vulpes necator)

Habitat Change: There has been no change in amounts of habitat available to the sierran red fox. The quality of habitat has been reduced somewhat though, by the development of mines, housing, campgrounds and roads impacting their surrounding areas.

Osprey (Pandion haliaetus)

Habitat Change: There has been no change in suitable osprey habitat from reference conditions to current conditions.

American Marten (Martes americana)

Habitat Change: The most significant change with respect to marten habitat is the virtual elimination of the 4P stands. What were 4P habitats have shifted into the 3P, 3G and 4G habitat types resultant of logging and forest growth. This change has probably not had a significant impact into the quality of marten habitat on the Watershed scale, as resultant stands are suitable habitat. Marten evidence, in the form of tracks and scats have been found in every forested habitat currently available within the Watershed.

Wolverine (Gulo gulo)

Habitat Change: As with the marten, the reduction of the 4P habitat type is the most significant change. However, the wolverine is highly adaptable to habitat utilization and the shift in forest structure to the 3P, 3G and 4G may actually provide better foraging habitat for this species than the 4P.

Great Gray Owl (Strix nebulosa)

Habitat Change: There has been no change in the amount of suitable habitat available for great grey owls. Habitat still remains marginal due to the limited amount of meadows in the conifer forest dominated Watershed.

Bat Species:

Pallid bat (Antrozous pallidus)

Habitat Change: Minimally decreased due to development.

Townsend's big-eared bat (Corynorhinus townsendii)

Habitat Change: Minimally decreased due to development.

Long-eared myotis (Myotis evotis)

Habitat Change: Minimally decreased due to development.

Long-legged myotis (Myotis volans)

Habitat Change: Minimally decreased due to development.

Fringed myotis (Myotis thysanodes)

Habitat Change: Habitat reduced by increase in 3G stand structure and loss of 4P structure. In the current condition there is approximately 951 acres of the PJ1 habitat located in the northern portions of the Watershed. As no data was available for this area in the reference condition it is not possible to determine the change in habitat for this species. habitat this area.

Silver-haired bat (Lasionycteris noctivagans)

Habitat Change: As with any forest ecosystem the forest within the Watershed has changed over time as a result of natural and man caused events. It is anticipated that no overall change in the amount of suitable habitat for this species has occurred although the location of such habitat has changed with time.

Desired Conditions

- Manage for functional and sustainable LSH by attaining a minimum of 40% of the MLSA` in LSH seral stages. Average patch size is 100 acres or greater.
- On lands that are capable, attain a minimum of 35% of the Matrix in stands that have canopy closures of 40% or greater and mean tree Diameter at breast Height between 11 to 23.9 inches, and 15 %of the area in LSH habitat seral stages.
- On approximately 50% of the Matrix, continue to provide a mixture of early- and mid-successional habitats to sustain populations of dependent terrestrial wildlife species.

ROADS

Key Questions

How has the amount of roads changed and what have been the causes for exceeding density standards?

Interpretation

Nonconforming conditions for roads in the Watershed are that road density standards are exceeded. Average road density in the Watershed is 2.7 miles per square mile, exceeding the 2.5 miles per square mile guideline relative to wildlife disturbance. The MLSA has 3.3 miles per square mile. Individual roads in some areas are demonstrating erosion problems.

The amount of road in the Watershed has increased from virtually no roads to nearly 370 miles of roads. This build-up of roads has occurred primarily to provide access to the forest when timber removal techniques were not as concerned with the construction of additional roads and being below certain road density standards. As a consequence, areas where timber removal was highest, such as within the MLSA, current road density standards are exceeded.

The original road system was developed to provide access to the Watershed for extraction of resources and railroad construction. Roads were constructed in order to best serve loggers needs with haul roads. As a result, throughout the entire Modoc National Forest at least 50% of timber lands are within 1/2-mile of a road (Modoc National Forest, 1991a).

With the decline in timber harvest and other resource extractions, the primary use of roads has been by recreational visitors and for resource management. While there has been a reduction in timber traffic, the increase in recreational use can create public expectations for access to more areas than currently available. In turn, this conflicts with the direction for road management.

Increased management of roads, and declining timber sales will eventually cause the amount of timber haul roads to decrease; by classifying more roads as either Level 1 or 2 management. By doing this Level 1 roads will be able to

revegetate naturally and Level 2 roads will be restricted on their usage.

Desired Conditions

- Transportation system is adequate to meet all management needs but is designed and maintained to minimize erosion and does not unnecessarily provide opportunities for disturbance of wildlife species.

SILVICULTURE

Key Question (1)

How have timber harvest, fire exclusion, and other management activities changed the biological and physical elements of the landscape from the reference condition? With respect to:

(a) Percent distribution seral stages;
(b) Average stand size;
(c) Amount of Northern Spotted Owl nesting, roosting, and foraging habitat;
(d) Spatial arrangement of stands; and
(e) Species composition of stands.

Interpretation

With respect to Forest management objectives, nonconforming conditions in the Watershed include that there are currently no vegetation management projects planned. Also, that there is not a long-term sustainable balance of seral stages within the Watershed.

Other nonconforming conditions include that there are approximately 3,600 acres that are currently under stocked or non-stocked, and there are approximately 39,000 acres of small to mid-sized (seral stages 2 and 3) trees with reduced growth due to high stocking levels. Many of these stands currently lack diverse structural elements desirable in LSH.

Pre-management reference conditions of forested ecosystems were established on approximately 75% of the Watershed. A comparison of these with current conditions indicate that the Watershed has roughly 27 times fewer acres of early seral now than during the pre-management period, 1/3 the amount of late seral present than pre-management, and twice the acreage in mid-seral than pre-management. A comparison of stand density of mid and late seral stands in the reference conditions shows a ratio of about 1:2 to 1:3 of 3P:3G and about 1:1 to 2:1 of 4P:4G. Currently there is little to no 4P in any forested ecosystem in the Watershed, and the number of 3G stands has increased roughly seven fold relative to 3P.

The following interpretations are derived primarily from an analysis of the changes that have occurred in conifer stocking during the last 50 years. For the most part, these changes were determined by comparing the current structure (size and density) of conifer stands, as recorded on 1993 Remote Sensing Lab (RSL) maps, with baseline reference data formulated and mapped through interpretation of 1944-1946 aerial photographs. Comparison of these two data sets was made possible by establishing equivalent areas of plant composition. For both reference and current conditions, the timber and other plant association boundaries utilized were those identified on Ecological Unit Inventory (EUI) maps of the Medicine Lake Highlands, compiled in 1996. These EUI polygons represent the potential vegetation of the Watershed.

To characterize reference conditions, only those portions of the Watershed were interpreted and mapped that had not been manipulated by logging or other management activities prior to 1946. Thus for certain entire associations, and portions of additional associations, no baseline data was available for comparison with current stocking. Consequently, changes in stocking within those vegetation communities cannot be quantitatively expressed. The total area of reference vegetation directly compared with an equivalent area of current stocking represents approximately 75% of the Watershed.

Interpretation based on changes between reference and current conditions are limited to answering those key questions for which adequate data is available. Accurate estimates of overstocked stands under reference conditions cannot be made because the area of stands with a canopy cover between 60-69% cannot be determined from available data. Actual changes in species composition are unknown because no plot data was available for reference conditions.

Trends in species composition that may be identified are all based on limited observations made of current stands, or dependent on a knowledge of the relative shade tolerance of the conifer components.

Other sources of information used as a basis for interpretation included: timber sale and fire history maps and records, and personal communication from professionals familiar with the dynamics of the vegetation associations of the Medicine Lake Highlands. This information was supplemented by considerable study of recent aerial photos, and limited field sampling. Generally accepted facts regarding the requirements and responses of the various conifer types (series) also guided the interpretations made.

The landscape changes that have occurred within the Watershed vary in both substance and degree among the various vegetation associations. Therefore, for purposes of addressing and answering the key questions, each association will be independently interpreted in the same ecological sequence as they were described in preceding sections of this analysis. (This order varies somewhat from the organization by vegetation series in Table 3.8.)

Changes in percent distribution of seral stages is presented in Table 5.1. The table compares the coverage area where data is available for the reference conditions with the same area for current conditions.

Subalpine Zone:
Hemlock Series:

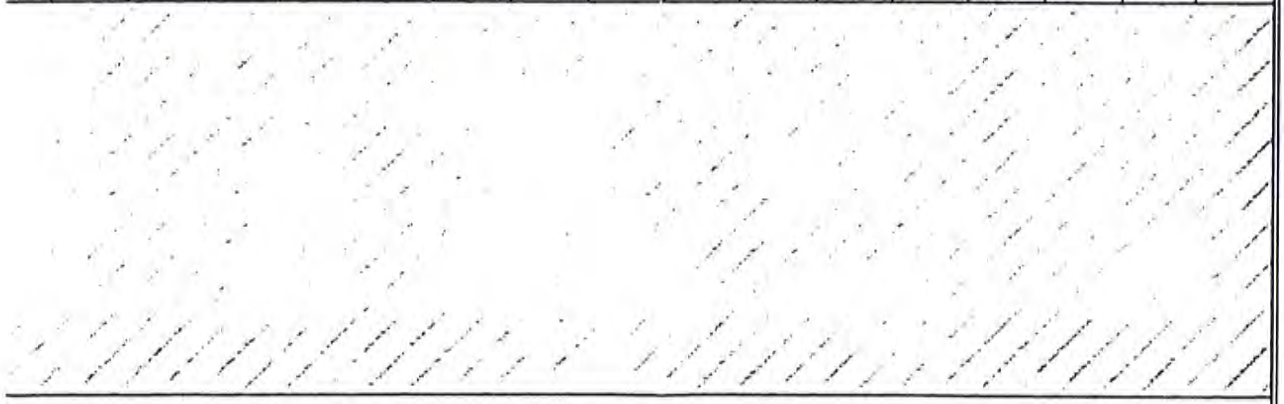
Hemlock-Red Fir/Ross's Sedge Association (SC1): Due primarily to fire exclusion, and confinement of harvesting and road building to a bare minimum, vegetative growth in this association has far exceeded losses. Consequently, basal area, mean dbh, and canopy closure have all increased. Though the acreage of late-successional stands has seemingly remained essentially the same (more old growth is probably currently included within this stage), well stocked mid seral stands have succeeded early seral stands and increased by 173% over reference conditions. Less than 50 acres of this increase came from even aged stands of young growth. The balance of the current mature stands developed from young understory of medium to large mature trees. Under reference conditions, there were 297 more acres of 3P stands, and 479 mores acres of 4P stands than currently exist.

The fact that no stands of SC1 are currently typed as seral stage 4P can partially be accounted for by the methodology used for interpreting satellite imagery. The remote sensing lab identifies and defines stands in terms of the size class providing the dominant cover. Thus, when a sparse canopy of medium to large trees is characterized by a dense understory of poles and saplings, the presence of the former may be masked, and will probably be unaccounted for in typing.

However, the fact remains that under reference conditions there were many acres of two storied SC1 stands characterized by a sparse to open canopy of mature trees and an understory of poles and younger regeneration. This structure resulted from prior disturbance, probably periodic fires that thinned the overstory and opened stands for development of understory regeneration. Thus prior to the current policy and program of fire suppression, there was a greater diversity of seral stages and a more even proportional distribution of WHR seral stages within the association.

The fire suppression management practiced over the past 50 years has yielded some definite benefits despite a reduction in diversity. The current heavy stocking of seral stage 3G stands represents a greater potential for significantly increasing late-successional stands even beyond the 43.3% proportion already present in this association; thus helping to attain Watershed goals for this important habitat resource. The late-successional stands thus developed have the potential to be large and have excellent continuity in several units within the central portion of the Watershed.

3G (LRMP WHR3b/c)					4P (LRMP WHR 4a)						4G (LRMP WHR4b/c)					
e is	Current Conditions		Change[a]		Reference Conditions		Current Conditions[b]		Change[a]		Reference Conditions		Current Conditions		Change[a]	
%	Ac.	%	Ac.	%	Ac.	%	Ac.	%	Ac.	%	Ac.	%	Ac.	%	Ac.	%
)	1247	52.1	790	173	479	20	0	0	-479	-100	1006	42	1037	43.3	31	3.08
	223	67.0	187	519.4	6	20	0	0	-6	-100	210	63	92	28.0	-118	-56.2
.4	1196	76.1	567	90.14	436	27.7	0	0	-436	-100	86	5.4	129	8.2	43	50
.3	2765	52.2	1635	144.7	1273	24	0	0	-1273	-100	1411	26.6	1529	28.8	118	8.3629
.8	1880	55.1	1305	227	575	16.8	0	0	-575	-100	1114	33	657	19.3	-457	-41.02
.2	2147	40.5	1128	110.7	1607	30.3	0	0	-1607	-100	747	14.1	839	15.8	92	12.316
.1	1692	49.0	-660	-28.1	518	15	0	0	-518	-100	0	0	0	0	0	NA
)	56	75.7	56	NA	0	0	0	0	0	NA	0	0	0	0	0	NA
.3	231	35.6	-379	-62.1	264	10.1	0	0	-264	-100	0	0	0	0	0	NA
.3	3370	74.8	2185	184.4	1300	28.8	0	0	-1300	-100	715	15.8	222	4.9	-493	-68.95
)	1194	57.5	465	63.79	604	29	0	0	-604	-100	238	11.5	688	33.1	450	189.08
.4	713	42.4	555	351.3	754	44.8	0	0	-754	-100	445	26.5	26	1.5	-419	-94.16
.7	60	6.8	-79	-56.8	232	26.3	0	0	-232	-100	46	5.2	22	2.5	-24	-52.17
)	14	14.3	14	NA	65	65.7	0	0	-65	-100	3	3	7	7.1	4	133.33
)	0	0	0	NA	0	0	0	0	0	NA	0	0	0	0	0	NA
)	2171	54.6	1536	241.9	1185	29.8	0	0	-1185	-100	738	18.6	279	7.0	-459	-62.2
.2	97	12.1	-97	-50	381	47.7	0	0	-381	-100	108	13.6	6	0.8	-102	-94.44
.4	3512	53.4	2696	330.4	855	13.0	0	0	-855	-100	246	3.7	400	6.1	154	62.602
)	0	0	0	NA	0	0	0	0	0	NA	0	0	0	0	0	NA
	22568	—	11904	—	10534	—	0	—	-10061	—	7113	—	5933	—	-1180	—



vas calculated as follows: ((Cur. Cond. - Ref. Cond.)/Ref. Cond.)x100.
contributed to the loss of 4P habitat.

Currently seral stage 3G stands are about the same average size as the those occurring under reference conditions (43 and 46 acres, respectively), but they are closer together and more integrated throughout the association. On the other hand, seral stage 4G stands are currently somewhat more fragmented than those occurring under reference conditions. (An average size of 38 acres as compared with 94 aces for reference conditions.) However, they are well distributed with relatively narrow separation (<1/4 mile). When the intervening mid seral stands, currently separating 4G units, also develop into late-successional forest, the combined stands could be quite extensive and have good connectivity.

As already identified under current conditions, there are abundant opportunities within the SC1 association for commercial thinning to stimulate growth and hasten development of additional late-successional stands. The 1,034 acres of resident mid seral stands with >60% canopy closure represent at least a 126% increase over reference conditions.

Data is unavailable for ascertaining any changes in species composition over the past 50 years. Since little harvesting has occurred, and losses from fire, disease and insects appears to have been insignificant, stand composition has probably remained rather stable. Some blowdown of red fir may have occurred during the Columbus Day storm of 1962, but within this association, such losses are unconfirmed, and it was not included within the sphere of any follow up salvage sales. It is possible that windfalls may account for the loss of some of the medium and large mature trees from the seral stage 3P and 4P stands which formerly constituted 37% of the SC1 association.

Mountain hemlock does have a greater shade tolerance than red fir, and thus as stand density has increased, hemlock regeneration has probably claimed a greater proportion of the understory. With the increased density of stocking has probably also come increased moisture stress and an increased risk of mortality from dwarf mistletoe; separate species of which are capable of seriously infecting both red fir and mountain hemlock. As a general rule, the conifer associations of the cool subalpine zone have been relatively free from serious insect attacks.

Hemlock/Pityopus Association (SC2): The SC2 association has experienced even less disturbance by management activities than the SC1 association, and fire losses have been insignificant due to prompt suppression of lightning ignited fires. Protection of late-successional stands which represent a good portion of this association, has been a high priority of fire management.

The expected consequences of such stability over 50 years of time would be substantial forest growth and development, and to some degree that has occurred. However, according to the data available for a comparative analysis of reference and current conditions, some apparent changes have occurred within this association that are difficult to interpret.

As could be expected, stands formerly typed as having sparse to open canopies of mature trees (3P and 4P) under reference conditions, have been reduced in acreage by 80% as they have filled in with small mature trees from developing understory layers. The result has been a five-fold (519%) increase in relatively dense mid seral stands (3G). However, contrary to what might have been expected, this increase has seemingly been offset by a 56% decrease in late seral stands, and a 32% decline in the proportion of these 4G stands that have >70% canopy closure. As a consequence of these changes the stocking of mid and later seral stages has essentially been reversed. Mid seral stands currently make up 75% of the association as compared with 33% under reference conditions, and late-successional stands presently account for 28% of the association as compared with an initial 63%.

The opening up (decline in density) of late-successional stands as they approach the old age stage is a natural phenomena, but it is difficult to explain the overall decline in late-successional stands from 210 acres to 92 acres, and the reduction in the average size of these 4G stands from 21 to 11 acres.

A couple of natural events did occur within the 50 year period which could possibly account for some losses of large dominant trees and the consequent reduction in mean dbh of portions of late seral stands. One such event was the 1962 Columbus Day storm, and the other was a sustained string of drought years. However,

Watershed records provide no evidence that either of these events resulted directly or indirectly in losses within this particular association.

A more likely explanation of at least some of the difference in late successional stocking between reference and current conditions may be error in RSL typing. Interpretation of vegetation for reference condition typing was based on a detailed study of relatively large scale aerial photography. On the other hand, typing of current vegetation depended on the processing of imagery from satellites. Such interpretation is based on the spectral characteristics (tone, texture, etc.) of the imagery, comparing pixels of stands with standardized "profiles" representing the various vegetation types and stand characteristics. Separate tree size profiles are generated for each different vegetation type; however, these types may be quite broad and general. For example, in the Medicine Lake Highlands the hemlock associations are included in the red fir type. Since mountain hemlock varies from red fir in the ratio of dbh to crown diameter and height, using a red fir profile for interpretation could underestimate the actual dbh of trees in relatively pure hemlock stands. Additional errors can be introduced by differences in illumination, shadowing, topography, etc.

If the current stocking in the SC2 association does indeed include 67%, 3G stage stands, then a relatively high priority in this association would be to manage stands in such a way as to promote the development of late-successional forest. As identified in Step 3, there are currently 164 acres of mid seral stands with canopy closure exceeding 60%. These stands represent a need and opportunity for pre-commercial thinning to sustain health and growth.

As indicated, the composition of seral stages has changed, their diversity has not. The association has remained essentially devoid of seral stages 1, 2 and 4P. The meager acreages of these stages present under reference conditions was insignificant. If LRMP standards for minimum proportions of all seral stages are to be achieved, some logging would be required.

The fragmentation, mixture, and pattern of distribution of stands is similar under both reference and current conditions, though the average stand size has decreased (See Appendix F). Species composition is believed to have remained stable; the association continues to be characterized by near monotypic stands of mountain hemlock.

Hemlock-Lodgepole/Ross's Sedge Association (SC3): Consistent with other sub-alpine conifer communities, the SC3 association has experienced little disturbance from either management activities or natural causes. Consequently growth and natural succession and maturity of conifers could be expected to have progressed relatively unimpeded over the past 50 years. The changes that have occurred in general provide evidence that such development has indeed taken place, but certain changes may appear somewhat out of sync.

As could be expected, 218 acres of early seral stands have been succeeded by mid seral stands. Both open (3P) and relatively dense (3G) stands of the latter have increased in acreage from their stocking under reference conditions; the 3G seral stage acreage almost doubling. The 3P stands occupy the shallower rocky soils of low productivity that characterize certain ridges and south aspects. The total increase of 567 acres in mid seral stands far exceeds the 218 acres of early seral stages that were replaced, therefore also accounting for a portion of the increase in acreage of the 3G seral stage are vegetative changes that have occurred in stands formerly typed as 4P. As the understory of these open canopied stands gradually developed into small mature trees, older trees were lost from the sparse overstory. Thus the stands became denser as the mean dbh became smaller. Some of the 436 acre differential of 4P stocking, between reference and current conditions, is also accounted for by deficiencies in RSL typing, as discussed in the interpretation of the SC2 association. The largest stand typed as 4P for reference conditions was typed as 3P for current conditions, probably underestimating dbh by using the wrong spectral profile for imagery interpretation.

As succession within the SC3 association progressed, some of the stands originally typed as 3G developed into late-successional forest, the latter stage increasing in acreage by 50%. However, the total acreage of late-successional (4G) stands still represent only 8.2% of the total

association, a considerably smaller portion than noted for the other two hemlock associations. This is to be expected because the SC3 association occupies poorer sites. Lodgepole pine, a species of limited size and longevity, is typically the predominant conifer in this association, thus development of late-successional stands is likewise limited. Perhaps 10% would be a reasonable goal to expect to achieve and maintain, though this estimate may be somewhat conservative. Currently there are 634 acres of 3G stands with >60% canopy cover which could be thinned to promote additional growth and development. If pre-commercial thinning focused on removing lodgepole pine and retaining mountain hemlock, the potential for development of additional late-successional stands would probably increase somewhat.

Under reference conditions, the SC3 association was represented by six different seral stages. Their arrangement, particularly those of seral stages 2, 3P, and 4P, suggested patterns etched upon the landscape by periodic fires. Stands of individual seral stages, for the most part, occurred in localized concentrations with relatively wide separations between stands. The predominant seral stage, 3G, represented 40% of the association and occurred in stands that averaged 90 acres in size.

Currently, the association is represented by only three seral stages, 3P, 3G, and 4G. The first two, though occupying somewhat more area than formerly, occur in similar arrangements as under reference conditions, and are represented by stands whose average size is almost identical in acreage as that of the stands which initially (1946) characterized these same seral stages. However, the predominant seral stage, again 3G, currently represents 76% of the association and occurs in stands now averaging 171 acres. These stands provide almost continuous connectivity throughout the association with only narrow gaps (<1/4 acre).

The current arrangement is the result of a policy and practice of suppression of lightning fires, and isolation of this association from management impacts. This has allowed for greater overall consolidation of stands while reducing diversity. Seral stages 1, 2, and 4P currently fall below the minimum 5% proportional standard targeted in the LRMP for all management areas. Discrete logging could be used to increase future diversity. Species composition in this association has probably been quite stable, though gradual proportional changes in the stocking of co-dominants has probably occurred, as influenced by stand structure. In dense stands, on the better sites, shade tolerant hemlock regeneration is probably prevalent, while under open canopies lodgepole pine seedlings and saplings would be favored. If fires continue to be excluded from this community, the stocking of mountain hemlock could be expected to gradually increase.

High Montane Zone:
Red Fir Series:

Red Fir/Ross's Sedge Association (RF1): During the past 50 years, the RF1 association has experienced a moderate amount of management activities, including road building and various forms and degrees of logging. It has also been subjected to impacts from natural causes. These activities and natural events are described in the Current Condition characterization of the RF1 association.

Despite the disturbance resulting from these impacts, the association has exhibited a net increase in overall density of stocking, basal area, and acreage of mid- and late-successional forest. This positive structural development has been due in part to management that has excluded fires. Also thinning of some mid seral stands has accelerated growth and probably contributed to the development of late-successional forest.

As young seral stages have been succeeded by mid seral stands, there has been a net reduction in seral stage 1 of 90%, and in seral stage 2 of 74%. Concurrently, the development of understory trees and loss of overmature trees from the canopy of 4P stands resulted in additional well stocked mid seral stands and brought about a 100% decrease in seral stage 4P acreage (see SC3 for explanation). Some of this apparent reduction may be attributed to differences between aerial photo interpretation (reference conditions) and remote imagery processing (see SC2 interpretations for explanation). As a consequence of succession, seral stage 3G stocking increased 145% and late-successional acreage by 8. As identified in Step 3, 1,766 acres, or 64% of the 3G stands, are "overstocked" (>60% canopy cover). Thus, there is considerable opportunity in this association for

increasing growth and accelerating the development of additional late-successional forest through commercial thinning.

The result of past management has been greater development and consolidation of stands within the RF1 association, but at the same time there has been a marked reduction in diversity of seral stages. Under reference conditions there was a good balance of six widely distributed seral stages, all of which were represented in proportions of the association that equaled or exceeded the 5% standard set forth in the LRMP. Currently, only the 3P, 3G, and 4G stages meet this standard, and the association is heavily weighted to stands of small mature trees. The stand of seral stage 3G, now constituting 52% of the association, have almost doubled in average stand size and also provide good connectivity throughout the association. Stands of seral stage 3P currently occur in a similar size, and are arranged in a similar distribution pattern as their reference counterparts (see Appendix F). Late-successional stands have actually become more fragmented, the average stand size shrinking from 64 to 21 acres, and separation between these units has increased slightly. Size and connectivity of late-successional stand could increase considerably as intervening mid seral stands mature. This would be of particular importance in the MLSA.

Artificial regeneration problems have been identified with red fir, particularly when this tolerant species has been planted in open plantations. Causes of the consistent failures that have subsequently followed include summer desiccation, winter frost heave, and pocket gopher mortality. The microclimate is altered quite drastically, and surface soils high in pumice and/or cinders are particularly susceptible to the rapid cooling which produces frost heave. Moderating the microclimate by utilizing shelterwood cuttings for protection have so far not been as successful in the Watershed as elsewhere. This has been due in part to blowdown of portions of the residual trees (Black Mountain). Vegetative competition in planted areas has been primarily herbaceous and in general not severe. Competition from shrubs is generally not a factor that has to be reckoned with in the high montane and sub-alpine zones of the Watershed.

Red Fir-Lodgepole/Western Needlegrass (RF3): Growth and impacts by management are both reflected in the changes that have occurred within the RF3 association during the past 50 years, and have, to a certain degree, off-set one another. Though this association is currently characterized by the most open stocking of any of the high elevation types capable of producing late-successional stands, the proportion of stands with <40% canopy closure was actually 32% greater in 1945. The poor stocking under both unmanaged and managed conditions may be attributed in part to natural site limitations, as pointed out for this association in the Step 3 discussion. However, periodic fires probably also influenced the density of stands prior to the institution of fire exclusion practices during the last half of the century. During the latter period, there has been a general increase in well stocked stands, as evidenced by a 114% net increase in seral stage 3G, and a 12% increase in stage 4G. In large part, the 3G increases resulted from the growth of understory trees in stands formerly typed as 4P, following overstory removal by logging or mortality from natural causes. Some of the increases in 3G stands also resulted from the succession of early seral stages, which were reduced by almost 500 acres. Logging also occurred in late-successional stands (4G), but reductions in acreage were more than compensated for by succession, resulting in the net increase of 12%. Removal of overstory trees from some of the original late-successional stands contributed to another 12% increase in seral stage 3P stands. A larger portion of the latter are presently characterized by a canopy closure of <20%, reflecting to some degree the relatively high intensity of the limited logging that did occur.

The proportional representation of seral stages is currently less broad and balanced than under reference conditions, with only three seral stages individually occupying 75% of the association, as compared with five stages for reference conditions. Those seral stages that are represented are slightly more integrated than they were formerly, but the association is heavily weighted to the middle stage. This again with <20% of late seral stages, and an insignificant amount of early seral stands reflects fire exclusion combined with harvesting that has consisted primarily of overstory removal.

The spacial arrangement of seral stage stands within the association boundaries have not changed much though their specific locations have shifted because of the dual processes of succession and disturbance. The average stand size and distribution patterns of mid and late seral stands are similar for both periods, except that the 3G stands are currently somewhat more fragmented, averaging only about half their former size. Connectivity has only slightly improved, there still being relatively wide gaps between stands of corresponding seral stages. For a more thorough examination of differences in seral stage arrangement and stand size compare Tables 1 and 2 of Appendix F.

As changes in stand structure and arrangement have occurred, changes in stand composition have probably also occurred. However, no record of species composition under reference conditions is available to allow an accurate identification or verification of such changes. Under the relatively open canopies that have prevailed in both the unmanaged and managed states, lodge pole pine regeneration would be favored over red fir, and the proportion of the former might be expected to increase. However, lodgepole pine is very susceptible to mortality from fire injury, and could have been limited or thinned by periodic fires during the period preceding active fire exclusion. On the other hand, control of lodgepole expansion by this means is questionable, because its regeneration is actually proliferated when its cones are opened by the heat generated in burns. Rather than number or cover of lodgepole being limited by fire, it is more likely that its size and development was suppressed to maintain a predominance of smaller size classes (poles and saplings) in the mixed stands. As noted in Step 3, lodgepole pine does occur as predominantly pole size trees in the two layered stands of the current RF3 association.

A good portion of the RF3 stands in Section 8, T43N, R4E, west of Red Cinder Butte, were actually mapped as a lodgepole pine monotype under reference conditions. Though the current stands in this same area now include some red fir; lodgepole pine still provides the greater cover. Included in a 60 acre clear-cut that was sited prepared and planted to red fir, all of which died. The plantation subsequently was stocked with natural lodgepole vegetation. The soils of this area appear to be quite marginal for red fir, and other microsite conditions, such as cold air drainage, make the local habitat more favorable for lodgepole. To a lesser extent, this may be generally true of the entire portion of the RF3 association that occurs on relatively flat topography within the central caldera basin. Thus, to retain a desirable proportion of red fir in the mixed stands, it is probably necessary to maintain at least a moderate canopy cover, and to treat stands opened by logging, fire or other disturbance in a manner that would suppress residual and regenerating lodgepole pine.

The RF3 association currently includes 840 acres of mid seral stands with a stocking exceeding 60% canopy cover, (i.e., potentially overstocked stands). This figure represents a ten-fold increase over reference conditions (80 acres), and a significant opportunity for some commercial thinning. On the other hand, primarily as a result of logging, there is currently over 100 acres of non-stocked land; 59 acres supporting a sparse herbaceous and sub shrub cover, and 37 acres occupied by a denser cover of montane mixed shrub. It is very possible that the former area is adequately stocked with lodgepole seedling and saplings, but it is definitely void of red fir regeneration. At the reference point, no non-stocked areas were identified.

Overall, net gains in the RF3 association have been significantly greater than net losses, despite adverse years of storm and drought, moderate harvesting, and some geothermal exploration (drilling and testing of preliminary wells). As previously identified the gains have included a 12% increase in late-successional stands. This entire increase has occurred in the MLSA; while the acreage of seral stage 4G stands has actually declined slightly in the matrix area, it has approximately doubled in the MLSA. The latter area has been managed to maximize such late seral development, while there is no similar goal (standard) set forth for the Matrix area.

Lodgepole Pine Series:

Lodgepole/Western Needlegrass Association (LP1): The LP1 association essentially consists of monotypic stands of lodgepole pine throughout the central caldera habitat that is occupies. Lodgepole dominance and the species composition of other stand components has

remained relatively unchanged throughout the past 50 years. Structurally, there apparently have been some changes, as reflected in both the mean size of resident trees and the density of stocking.

Under reference conditions, the association was represented by a broader distribution of seral stages than it is currently. Seedlings, saplings, and/or poles characterized 10% of the stands; 75% of the habitat was occupied by mid seral stands; and 15% consisted of stands dominated by a sparse overstory of medium and large trees (4S). Some of the latter had understory layers and some occurred over relatively barren forest floors.

Currently the association is less balanced. Approximately 99% of the total habitat is characterized by mid seral stages 3P and 3G, each accounting for almost half of the association. The density of stocking has also decreased since 1945. At that time there was a total of 780 acres of mature stands with less than 40% canopy cover, whereas today there are 1,719 acres, a 220% increase in open or sparsely stocked stands. These open stands are mixed in a complex mosaic with well stocked stands, resulting in a more fragmented spacial arrangement of stands than occurred under reference conditions. The average size of undisturbed stands of seral stage 3G have been reduced from 261 acres to 158 acres while 3P stands have actually increased in average size from 33 to 289 acres, reflecting the expansion of disturbance among contiguous stands.

Among the factors probably accounting for the reduction in density of stocking, the removal of the largest overstory remnants (4S), and the current spacial arrangement of stands, are the following: (a) firewood cutting; (b) an extended 6-7 year drought during which weakened trees were subjected to attacks from insects and disease, including the mountain pine beetle and dwarf mistletoe; and (c) additional roading and development for recreational use. Actually the campground development that occurred in lodgepole stands surrounding Medicine Lake did not impact these stands severely, for they are still among the best stocked, and contain some of the largest trees, in the Watershed.

Fire has not played a part as a thinning agent in this association during the past 50 years. Though lodgepole pine quickly succumbs to fire because of its thin bark, lightning fires within this particular Highlands' habitat have been contained to only a few acres, as evidenced by the small size of the patches of young regrowth found in scattered locations in the LP1 association.

The net decrease in basal area has had no significant adverse effect upon the LP1 habitat. As noted in the current conditions discussion of the LP1 association, adequate seedlings and saplings for restocking are consistently found in the understory of LP1 stands. Since lodgepole is a very light demanding species, openings in stands should promote the growth of this understory regeneration. However, some soils and sites in this association are very marginal. These sites are characterized by a sparse stocking on both the reference and current vegetation maps, and will continue to be limited to such stocking.

As evidenced by the absence of late-successional stands under both reference and current conditions, the LP1 association is not capable of producing this quality of habitat. Individual trees are usually limited in longevity to an age of between 100 and 175 years, but if exempt from fires could probably persist longer. However, heredity and site limitations dictate that stands of LP1 association within the analysis area will not simultaneously reach a mean dbh exceeding 24 inches and a canopy closure >40%. In fact, as indicated in the current conditions discussion of the LP1 association, most stands in the Medicine Lake caldera basin have a mean dbh of <11 inches (pole size). The RSL mapping seems to have exaggerated the mean dbh of stands, particularly in the lodgepole pine associations. This discrepancy in classification needs to be corrected if it is determined that more accurate interpretations of stand dynamics are necessary for the lodgepole series.

Since the association is incapable of producing late-successional stands, and since lodgepole is not utilized locally for saw timber the thinning of overstocked stands is not usually a management consideration. However, there may be instances in which stands need to be manipulated to improve wildlife habitat diversity, or reduce insect or disease mortality.

Lodgepole/Pinemat Manzanita Association (LP2): The changes that have occurred within the small LP2 association during the past 50 years reflect a period of growth unimpeded by management activities or abnormal mortality from natural agents. No data is available for determining possible changes in species composition, but seral stage succession is documented, and appears to have progressed quite normally.

The western unit of the association, which is essentially a single stand of 41.5 acres, has been developed from seral stage 2S to 3G. In the eastern unit at the head of Paynes Springs and Creek, timber development in shallower soils has not been as pronounced. In the latter area, 32.5 acres of seral stage 3S has developed into a 3G stand of 14.5 acres, and a 3P stand of 18 acres. The more open stocking represents the site capacity of that portion of the unit that includes considerable rock outcrop and some steeper slopes.

The sparse stocking over the entire association at the reference point, probably represents its status following fires or other disturbance. During the past 50 years fire has been excluded and succession has progressed quite unimpeded. As stands have matured, their spacial arrangement has remained approximately the same, and the association still contains only two seral stages. Greater diversity is really not a concern in this association, for realistically it represents only two small southern appendages of the larger LP1 association to which it is attached.

The fact that unimpeded growth in this association has failed to produce any late-successional stands is a clue to the fact that this association does not have the capacity to produce this quality of habitat. The explanation of this limitation is the same as presented for the LP1 association. Currently included within the LP2 association is a single 4G stand, but it is an isolated fragment of a large adjacent unit of the RF1 association.

Silvicultural manipulation of stands might, possibly be needed if the integrity or health of the eastern unit is threatened. Stands in this area provide Watershed protection above and, to a certain degree, within the gorge that forms the head of Paynes Springs.

Lodgepole-Western White Pine/Creambush (LP3): The LP3 association contains several different phases, as explained in Step 3. The most unique but least productive phase occurs in very shallow soils formed from weathered lava on the western end of the Glass Mountain Lava Flow. This portion of the association lies within the Glass Mountain Geologic Area. It is characterized by over 1,000 acres of an open to sparse forest of stunted western white pine and lodgepole, complemented by an equally sparse, but rather unique, understory community of forbs. Because of the site limitations imposed upon growth in this area, there has been little change in stand composition, structure or arrangement since 1945. A single, continuous, open to sparsely stocked, mid seral stand, complexed with rockland, has characterized this area for probably the entire 20th century. Growth is very slow, mortality and replacement are approximately balanced, and the sparse stocking and limited stature of the trees represent site capacity. Depending on the accuracy of the RSL density mapping, average canopy cover may have actually dropped from above, to below 20% during the past 50 years.

There is a second area of very limited productivity on the north facing upper mid slopes of Glass Mountain. A stand of approximately 120 acres occurs in this area on steep slopes of pumice. The stunted trees are predominantly seral stage 2P. This area, like the preceding, has evidenced very little change between reference and current conditions. RSL mapping of current vegetation indicates that this stand is now 3P, but study of aerial photos clearly shows that the stand is still dominated by pole size trees, probably representing the limited capacity of the site.

The foregoing two habitats of the LP3 association have a distinctly different site capacity than the balance of the association, and for future silvicultural assessment should probably be considered as a separate management unit.

The principal changes in stocking have been confined to stands of slightly higher productivity which occupy roughly 50% of the association on the west and north extremities. Within this half, mid seral stands have expanded, seral stage 3P by 14% and seral stage 3G by 53%, as saplings and poles have developed into small mature timber. Accounting for such development were

68% of the stands classified as early seral under reference conditions, as well as 100% of the stands formerly characterized by a sparse canopy of medium and large mature trees. In the later stands, most of the larger trees died off as they were replaced by the developing understory. Seral stage 2 stands decreased by 321 acres as 3G stands increased by the same amount, and seral stage 4S were replaced by an equivalent acreage of 3P stands. Though the numbers seem to match up perfectly, actual changes, so noted on the maps, were more complex, with both 2 and 4S stands developing into both 3P and 3G stands.

These changes probably represent a rather normal pattern of growth and replacement slowly taking place on the marginal sites occupied by this association. It is improbable that the site occupied by this association is capable of producing stands of large mature trees exceeding 40% canopy cover. Some of the adjacent associations, such as EM3, do finger into the LP3 stands and account for some minor strips and small patches of large trees. Also there are some relatively large included islands of late-successional stands that are representative of the RF3 association, and separated into the latter community for this analysis.

For that half of the association in which structural changes have occurred, there has possibly also been some change in species composition. Most of the stands which were characterized by a sparse overstory of large trees at the reference point, were mapped as having lodgepole understories of various densities. The large dominant trees in the upper layer were probably western white pine and, as the stand was replaced from below, it is possible that lodgepole became a more prevalent stand component than previously. Likewise, the seral Stage 2 stands in this association at the reference point were typed as lodgepole pine. Whether or not western white pine is actually declining in the denser stands of this association cannot presently be confirmed, for there is no quality data on species composition for either reference or current conditions available. It is possible that in time, larger growing western white pine may again overtop the lodgepole and reappear as a sparse to open layer in the overstory.

Within the other half of the association, represented by the large open stand on the Glass Mountain Lava Flow, a good mix of lodgepole and western white pine seems to have been perpetuated.

The current distribution of seral stages is less diverse and well balanced than that which occurred under reference conditions. Formerly there were four seral stages with >5% representation whereas currently there are only two. Also, the stands of the stages represented are more isolated from one another, and the average size of stand is larger (3P from 159 to 289 acres; and 3G from 122 to 186 acres). This pattern has probably been influenced by fire exclusion. There has been no logging in this association and disturbance resulting from pumice mining occurred prior to the reference point.

Eastside Mixed Conifer Series:

Washoe-Red Fir-Western White/Greenleaf Manzanita (EM3): The area of the EM3 association evaluated for change represents 71% of its total habitat. The structural changes which took place in that portion, make it obvious that considerable growth has taken place since 1945. At the reference point, there were 867 more acres of mature timber stands characterized by open or sparse stocking, than are currently found within the association, and 450 fewer acres of late-successional stands. During the following 50 years, the acreage of 3P and 4P stands decreased by 61% and 100%, respectively, while 3G stands increased by 638% and 4G stands by 189%. The few stands of seedlings, saplings and poles noted at the reference point were all succeeded by small mature stands of varying densities.

This overall successional progress was made possible by sites with a medium high productivity, the exclusion of fire, and the virtual absence of management impacts within the reference area. Only on the very northeastern boundary of the association did any logging cross over into this area, and that impacted only about 24 acres, which are currently stocked with seral stage 2. Overstory removal, as part of the Cougar Sale, did occur on roughly 450 acres on the northern perimeter of the association, but that area is excluded from this analysis.

While there has been a large increase in well stocked stands, the diversity of seral stages represented by a minimum proportion of 5% of the association has been altered only slightly. Seral stage 4P acreage declined to zero. This leaves the association with slightly less diversity and less balance between seral stages 3 and 4.

The spacial arrangement has not been changed significantly nor has average stand size. The stands representing seral stage 3P, which also declined in acreage, currently have more limited distribution and connectivity patterns than formerly. On the other hand, these same characteristics have improved considerably for the 3G and 4G stands, consistent with their greater representation. Average stand size decreased by 63% for the 3P stage, and 19% for seral stage 4G, while increasing by 40% for seral stage 3G. The result was a slight increase in the overall average stand size. (see Tables 3.8 and 4.3, and Appendix F for actual acreages, and a more complete picture of stand arrangement under current and reference conditions).

Changes in overstory species composition could not be evaluated because relevant information on species resident at the reference point is not available. As the stands have increased in density, regeneration has probably shifted in favor of the shade tolerant red fir component. This was evidenced to some degree in the understory stockings recorded for EUI plots.

With growth and succession, has come a rather dramatic increase in stands whose current stockings exceeds the long term capacity of their sites. At the reference point there were only 59 acres of mid seral stands with 70% canopy cover. This figure compares with an estimated 329 acres (71% of association total) of this same component in current stocking. As already identified in Step 3, there is presently a total of 1,179 acres of mid seral stands with >60% canopy cover. Thus, this association provides abundant opportunity for commercial thinning to improve growth and health, and accelerate succession to the late seral stage. It should be pointed out that all of this association occurs within the Matrix Area, and thus the significant gains already registered in late-successional forest, as well as potential future gains, do not contribute directly to MLSA stocking.

Because of the multiple species and variety of age classes resident in typical EM3 stands, this association is probably best adapted to uneven aged management and selective cuttings. In general, open cut over areas would favor regeneration of pine (Washoe, western white, and lodgepole), whereas light cuttings would be most favorable to red fir regeneration. In heavier cutting, suppression of lodgepole, which is quite abundant in understory layers, might be required. Large openings may also be colonized by shrubs (principally greenleaf manzanita) which are more prominent and invasive in this community than in other high elevation associations.

Northern Transition Group:
Ponderosa Pine Series:

Ponderosa-Lodgepole/Bitterbrush Association (PP4): The PP4 association had an early history of logging and disturbance (see Step 3, PP4 discussion). Therefore only 11% of the total 7,098 acres of habitat it occupies was considered representative of pre-management conditions and included on the reference map. Since portions of this association have been much more heavily impacted than others, the changes that have occurred on the relatively small 800-acre parcel used as a sample of reference conditions would not be representative of the net changes that have occurred over the association as a whole during the past 50 years. However, because that area has been rather heavily impacted by logging since 1945, the changes that have occurred there do give some idea of the intensity of the impacts that have modified stocking within the association. After evaluating the changes that have occurred on that sample area, reference conditions will also be compared with the current stocking in the association as a whole. This will provide a more complete and balanced picture of the effect of management practices upon stocking, and help identify current needs.

The intensity of impacts will first be looked at by referencing the data on Table 5.1. There was an obvious reduction in basal area of stocking on the 800 acre reference area. Stands with a mean dbh >40 inches, which formerly occupied 489 acres, currently characterize only 6 acres, and well stocked mid seral stands were reduced by 50%. The size class 4 trees were harvested in overstory removal; the principal type cutting used in the association. There was also a heavy

removal of mid seral overstory trees, resulting in a 576-acre increase in sparse to open stands of pole and small mature size timber, most of which have <20% canopy cover. Even given a 15-20 year period of recovery since the last timber harvesting, 286 acres of these open stands still have a mean dbh <11 inches (seral stage 2). The changes that have occurred within the reference area are probably quite representative of the modifications of stocking that has occurred in at least half of the association, though impacts to certain more easterly stands have been more severe, leaving them currently unstocked.

If we accept the fact that the reference area was representative of vegetation patterns which typically occurred in the PP4 Association prior to its manipulation and protection by management, then the current stocking patterns, as identified in Table 3.8, would compare with the reference stocking in Table 5.1 as indicated in Table 5.2.

Table 5.2: Comparison of PP4 Stocking

Seral Stage	Reference Stocking (% of Assoc.)	Current Stocking (% of Assoc.)	Change (% of Assoc.)
1	(insignificant stocking, both currently and at reference point)		
2	0	25	+25
3P	13.8	28	+14.2
3G	24.2	40.6	+16.4
4P	47.7	0	-47.7
4G	13.6	0.4	-13.2
NS	0	6.1	+6.1
BA	0	0.1	+0.1
Source: Modoc National Forest Aerial Photographs (1944-1946), Remote Sensing Lab (1993), and Ecological Unit Inventory (1996).			

The net result of the above changes in stocking is that losses have exceed gains and late-successional habitat has been reduced to an insignificant amount. Therefore there is currently a need in this PP4 Association to reverse that trend. The increase in well stocked mid seral stands provides some evidence of recovery and gains in basal area in some portions of the association.

Simultaneous with changes in seral stage representation as noted only slight decreases in average stand size. The reference point sample is actually too small to ascertain average stand size or the spacial arrangement of stands under reference conditions nor is any data available to verify the former species composition.

Most of the poorly stocked and unstocked areas occurring within the PP4 association are concentrated in the eastern third, and to a lesser extent in a broad band across the northern third of the Watershed. Beginning in the early 1930s, these geographic areas were repeatedly logged and recovery seems to be slow in a number of disturbed areas. A reliable inventory of the current stocking of regeneration and brush is needed upon which to base a plan of recovery.

Should a program of planting be necessary, certain site limitations and problems will likely be encountered. In general, sites on the eastern and northern extremities of the association receive less precipitation annually (approximately 25%) than do areas located in the central and southerly portions of the Watershed. Moisture in these areas may limit seedling survival and growth, especially if there is competing vegetation. It is also recognized that the microclimate on open sites, particularly those with pumice and ash surface soils, may adversely effect pine regeneration in both the heat of summer (desiccation), and cold of winter (frost heave). Other site problems, such as a pocket gopher population, may also be serious.

Invasive shrubs, the most prominent being bitterbrush and greenleaf manzanita, have already colonized some of the disturbed understories and non-stocked areas, and will provide serious competition for moisture on these sites if not eradicated or the population reduced. In some cases, suppression of lodgepole pine may be necessary to establish desirable levels of ponderosa pine. Because the latter species has historically been selectively harvested from the mixed stands, the proportion of lodgepole pine has increased in the second growth. EUI plot data also indicates that lodgepole regeneration is commonly more plentiful than ponderosa pine, and seemingly more aggressive in colonizing disturbed openings.

As attested to by the stocking at the reference point, the PP4 association is capable of producing late-successional stands. Yet under reference condition 4G stands accounted for only 13.8% of the association as compared with a 47.7% stocking of 4P stands. Fires may account for most of this open stocking of medium and larger trees, but it is possible that to some degree this stocking may reflect site limitations for timber production. When establishing desired conditions for this association, the proportional goal for late-successional forest should probably be somewhat conservative if it is to be realistic.

Eastside Mixed Conifer Series:

Lodgepole - Ponderosa-Sugar/Jewel Flower (EM5): The EM5 association is among the most heavily impacted of the conifer associations occurring within the Watershed. It currently contains over 24% of non-forested land, the same proportion as the PP1 association, and is exceeded only by the non-commercial PJ1 association. In a large portion of the EM5 association, much of this disturbance occurred prior to the reference date, and thus these areas could not be considered in a sample of pre-management conditions (reference conditions). Consequently the reference area selected represents only 55% of the total portion of the association managed by the Modoc National Forest and previously described in Step 3.

The reference sample actually contains 279 acres of private land, reducing the sample of Forest land to 607 acres. This area constitutes 38% of the association. The inclusion of private land does somewhat distort the picture of changes that have occurred on land managed by the Modoc National Forest, because a very large portion of this private land was heavily impacted by logging and is currently non-stocked. The proportion of such non-stocked land currently occurring on the association as a whole is 16.9%. The proportion currently occurring within the reference area is 19.9%. The reference area also includes a larger proportion of bare land than occurs within the association as a whole; 10.6% as compared with 7.4%. This discrepancy occurs because a 94-acre pumice mine, developed since the reference date, occurs within the sample area. As a result of the foregoing abnormalities, the changes that occur among seral stages will also be slightly skewed. However, it was found that the relative proportions of these seral stages currently represented in the sample area are very similar to those in the association as a whole. Because of this similarity, the changes occurring between reference and current conditions should be a reasonable picture of changes that have occurred over time throughout the association.

In this association, the picture is not a pretty one, for it is a picture of decline. As in other associations, the changes reflect both growth and disturbance, but in this association the latter has prevailed as utilization of timber has far exceeded its renewal.

Both selective harvesting and overstory removal have occurred in this association, the latter being the prevalent type used in portions of the association north of the Glass Mountain Lava Flow. Throughout the area, well stocked stands of mature trees were harvested, resulting in a net reduction of 52% in both 3G and 4G stands. Large and medium size trees were completely removed from the 4P stands, which formerly accounted for 23% of the reference area but do not exist today. The current stocking in these cut over areas consists of open and sparse stands of young mature trees, and equally open stands of saplings and poles. North of the Glass Mountain Lava Flow, most of the stands have canopy closures of <20%, and on the private land in Section 36, there are 176 acres of non-stocked land.

Natural regeneration appears to be moderately good in many of the disturbed understories, but some areas have been monopolized by shrubs.

Some growth and recovery is evident. Most of the current stockings of 3G actually developed from the lower layers of cut over stands and are not a carry over of the reference condition stands of similar size and density. Some also developed from the original stocking of seedlings, saplings and poles resident in the area at the reference point. All these were succeeded by mid seral stands, and the entire current inventory of saplings and poles represent cut over areas. Growth and recovery has been slow, for the soils supporting this association are rated as low to non-commercial relative to timber productivity. This may account for the fact that even prior to disturbance most stands were quite open. Much of the association is probably incapable of

producing late-successional stands. All of this association occurs well outside the MLSA. Some in the Matrix Area where such production is not a priority of management, and the majority is even outside the area subject to the standards and guidelines of the Northwest Forest Plan.

There is some evidence that at least in some portions of this association the species composition may be changing. The map of reference conditions identifies one 4P stand with overstory ponderosa pine as having an understory stocking of predominantly lodgepole pine. It also types all 256 acres of the seral stage 2 stands as lodgepole pine. The latter areas may very well have resulted from fires, which frequently promote this species, but it appears that, even at the reference point, lodgepole regeneration was dominant in portions of the association.

The logging that has occurred has probably served to increase the proportion of lodgepole in mixed stands. In typical mature stands of this association, ponderosa and sugar pine constitute the dominant upper layer, while lodgepole accounts for a slightly greater proportion of the total cover, but it is usually limited to pole and small mature sized trees in an intermediate layer. In overstory removal, the ponderosa and sugar pine dominants were harvested, leaving the stands occupied predominantly by the lodgepole. If the more valuable pine species are to be retained as co-dominants, it may be necessary in future logging to thin lodgepole simultaneously. Ordinarily thinning would not be practiced in this association where canopy closure probably never reaches 60%.

As stocking has declined in this association, so has diversity. Under reference conditions six different seral stages were represented in proportions exceeding the minimum standard of 5% of capable land. Currently this minimum is met by only three seral stages and late seral stage occupancy is particularly low.

Disturbance has also tended to fragment stands, so that the current average size of all comparable seral stages is smaller by the following factors: seral stage 2 by 0.38; 3P by 0.75; 3G by 0.40; and 4G by 0.15. The reference area sample is really too small to clearly distinguish significant differences relative to spacial arrangement. It appears that under reference conditions, stands of individual seral stage were distributed more widely in the association.

Northern Transition Group:
Red Fir Series:

Red Fir-White Fir/Wintergreen Association (RF2): During the past 50 years, various types and intensities of timber harvesting has occurred within the RF2 association, as described in Step 3 (see Step 3, RF2 discussion). Coupled with this removal of timber has been good growth and successional development, reflecting the moderately high productivity of the resident sites. The net result has been a significant increase in the average density of stocking, offset, to some degree, by a significant decrease in the acreage of late-successional stands and the population of medium to large trees.

On the growth side of the coin, stands of mature trees with <40% canopy cover (3P and 4P) decreased by 548 acre while stands of small immature trees with >40% stockings increased by 848 acres. The latter development included the succession of all the stands identified as seral stage 2 at the reference point, as well as the development of the lower layers in a large portion of the 4G and 4P stands in which upper layer trees were harvested.

The decline in late seral stands and older trees represents the disturbance side of the coin. The representation of 4P stands declined to zero and there was also a 41% reduction in seral stage 4G. Several types of cuttings applied in this association focused on the older and larger trees, including salvage of windfalls, sanitation cuts, and overstory removal. The most intense logging of late-successional stands occurred on the eastern upper slopes of Black Mountain where a shelterwood cut was made on a very large 4G stand. Currently this area is occupied by a sparse overstory of small mature trees that have been under planted. For the most part, the seral stage 3P and 2 stands, in the current stocking, represent areas where intense logging, such as on Black Mountain, have occurred. The original stocking of these two seral stages developed into predominantly 3G stands.

The changes that have occurred in seral stage 1 stands are a different story. At the reference point,

most of the stands of seedlings were concentrated in Section 35, T43N, R4E, near the top of Black Mountain, and on a large butte in the south half of Section 20, T43N, R4E, and the north half of Section 29, T43N, R4E. Currently most of this area is occupied by dense stands of montane chaparral, mapped as "fire shrub" in the Ecological Unit Inventory. This Montane Chaparral (CX) association initially invaded these sites following lightning fires that probably occurred very early in the 20th Century. Currently these shrub stands are probably adequately stocked with suppressed fir seedlings, saplings, and scattered poles, but the brush is still the dominating feature. The sites where shrubs have become successfully established within this association all have a fire history. It appears the temperatures generated by the fires accelerates the germination of woody plant seeds, while possibly damaging or suppressing the germination of herbaceous species. Sites opened and disturbed by the logging seem to be more readily colonized by herbaceous vegetation with shrubs becoming established rather slowly.

Overall, the management of the RF2 association has resulted in timber removed by logging being more than offset by growth, resulting in a net increase in the total basal area of timber. However, the resulting representation of seral stages is not as complete or balanced as at the reference point. Formerly 6 seral stages represented the RF2 association in proportions exceeding the minimum 5%, whereas currently this minimum is satisfied for seral stages 2, 3P, 3G, and 4G.

As changes in seral stage representation and stocking have occurred, some changes in the spatial arrangement and average size of stands also took place. Seral stage 2 and 3P are currently more fragmented and localized than formerly. In both stages the average stand size has decreased to about half of what it was at the reference point. The 3G stands, which replaced 4G stands as the most prevalent stage in the association (40%), also now occur as larger units. These mid seral stands increased in size by 300% (58 to 157 acres) while late seral stage stands were reduced to less than 1/5 their former size (124 to 23 acres). The arrangement of the 3G stands is such that they have excellent connectivity throughout the occupied habitat, which was not achieved by any of the seral stages under reference conditions. This continuity will be particularly advantages when these stands develop into late-successional forest.

Approximately 87% of these 3G stands currently have a stocking density >60% canopy cover. These 1,628 acres of overstocked stands represent a huge increase, for in 1945 there were only 86 acres of 3G stands with >75% canopy closure.

Data on species composition during reference conditions is unavailable, and therefore changes cannot be determined. Currently RF2 stands are typically a 60:40 mixture of red fir-white fir, with regeneration of the later species being more abundant in the understory.

Based on the foregoing facts and the interpretations, the following needs and opportunities were identified:

- Cultivation of a larger proportion of late-successional stands.
- Commercial thinning in overstocked stands to improve general forest health and growth, and help achieve #1.
- Management to achieve a greater balance of seral stages, and to achieve a minimum proportional representation of all stages.
- Release of suppressed regeneration in areas currently dominated by brush; and type conversion of such chaparral stands that are currently unstocked.
- Continue exclusion of fire to conserve the gains made and to prevent the colonization of additional areas by shrubs.

White Fir Series:

White Fir/Chinquapin (WF1): The WF1 association is unique in that it contains both the largest acreage of overstocked mid seral stands, and the largest acreage of non-stocked capable land of any of the associations resident in the Watershed. This current stocking is indicative of both the medium to high growth potential of the sites occupied by this white fir community and the historical disturbance that has occurred within it.

This interpretive review of changes will focus first on the non-stocked component. Most of the 1,065 acres of land which is classified as non-stocked for the purpose of this document, is currently

occupied by dense stands of montane mixed chaparral (CX), as characterized in Step 1 of this analysis. This shrub association first colonized these sites following a series of intense fires that engulfed several thousand acres on Black Mountain and other areas, as identified in the Step 3 discussion of the WF1 association. These burns occurred prior to 1945, thus the current unstocked areas are products of the distant past and not representative of the WF1 association dynamics of the past 50 years. However, the responses of these sites to management, during this latter period, does provide some insight into the problems encountered in managing this association and some direction for present and future management priorities.

During the reference period, brush was initially cleared from most of the burned areas and a sequence of plantations were planted to ponderosa pine. Based on 1944-1946 aerial photos, 3,712 acres of this former burn were characterized and mapped as seral stage 1 for reference conditions. These plantations represented 56.5% of the entire association. In 1993 the RSL interpreted and mapped 1,976 acres of these plantations as seral stage 2, and an additional 868 acres as mid seral stages of various densities. Approximately 378 acres had again been encroached upon by shrubs and were considered non-stocked.

When this previously disturbed area was studied on 1994 aerial photos, it was determined that an additional 670 acres had reverted to relatively dense chaparral and that the inventory of plantations clearly occupied by seral stage 2 sands was closer to 1,376 acres. This is the current stocking reported in Table 3.8. It is acknowledged that a large proportion of the total chaparral inventory of 1,048 acres is probably adequately stocked with suppressed seedlings and saplings of shade tolerant white fir. However, for all practical purposes the shrubs still dominate these sites, and succession will be a very long process if the regeneration is not released from this competition. Some of the surviving plantations are also experiencing serious competition from shrubs. Brush is prominent enough in the area that the EUI inventory of the Highlands in 1995-1996, characterized most of the area representing the original burns as a fire shrub association.

Similar to the RF2 association, colonization by shrubs of disturbed openings resulting from logging does not seem to occur as rapidly as it may following fires.

While the foregoing changes were occurring in previously disturbed areas, the following net changes were taking place in the balance of the association. Under reference conditions only 43.5% of the total habitat had supported stands of mature trees. The overall stocking in this portion was approximately evenly divided between stands with greater than and less than 40% canopy closure, and 279 acres of mid seral stands exceeding 70% canopy closure. During the past 50 year period, the total area occupied by mature stands has increased to 62% of the association, the 18.5% increase representing recovery of disturbed areas. During the same period, the growth of understory layers filled in many of the holes, so that 96% of the mature stands now exceed 40% canopy closure. In fact most of the latter (3,264 acres) actually exceed 60% canopy closure. This large inventory of overstocked stands represents an increase of over 1,000% from the reference point. It also represents an increase in areas needing thinning to sustain growth and forest health, and opportunity for a small amount of commercial thinning.

All of this growth has proceeded despite considerable logging within the association. The types and intensities of cuts, and sale locations, are described in Step 3. One consequence of this logging was a 64% reduction in stands characterized by a mean dbh exceeding 24 inches. This logging of the large overstory trees primarily affected open and sparse stands. All of the former 4P stands were replaced by 3G and 3P stands, predominantly the former. However, the inventory of late-successional forest actually increased by 63%.

Modification of seral stage composition and representation within the WF1 association has resulted in 3, rather than 4, seral stages occurring in a >5% proportion. Seral stage 1 has been reduced to a single plantation in a clear cut, and seral stage 4P is no longer represented. Comparing the spacial arrangement and average stand size of the remaining stages, the only significant changes that have occurred are in respect to the 3G stage, now constituting over

half of the association. The average stand size in this stage has increased form 28 to 244 acres, and their current arrangement results in excellent connectivity throughout the association. Under reference conditions, the stands of all the individual seral stages were widely separated from one another (for a closer examination of changes in arrangement compare Table 3.8 and Table 4.3).

The foregoing gains and modifications within the WF1 association were achieved during a period in which fire was essentially excluded. Mortality from disease and insects was also quite insignificant. White fir losses resulting from fir engraver attacks have occurred primarily outside this association in lower elevation mixed conifer and eastside pine communities.

In summary, the current stocking in the WF1 association represents gains in total acreage of commercial stands, total basal area, and late-successional forest. It appears that this association is positioned to make even more gains if managed correctly. Significant contribution to such gains could be made through release of suppressed young stock in plantations and chaparral stands. Twenty eight percent of the original area disturbed by burns over 50 years ago are still dominated by shrubs, and in much of the balance of this area recovery has been slow. Thinning in the large overstocked inventory is another way in which health and growth could be significantly increased, and late-successional development could be accelerated. There is excellent opportunity within the WF1 association for increasing both the proportion and the connectivity of large successional habitat within the MLSA.

Mid Montane Zone:

Eastside Mixed Conifer:

Ponderosa - White Fir-Incense Cedar /Squaw Carpet Association (EM1): Changes between reference and current conditions within the EM1 association were assessed on 4,513 acres, approximately 73% of the total habitat occupied. The unsampled portion of 1,712 acres is located in the southeastern corner of the Watershed. This area includes a significant acreage of intensive logging, some of which occurred prior to the reference point but most of which has occurred since. Thus the impacts of the past 50 years may be somewhat greater than determined in the sampled area.

Within the 73% of the association where a comparison was made between 1945 and 1995 stocking, it was evident that both successive development and considerable disturbance have occurred. Growth through the years was best evidenced by a significant increase in the density of stocking. While the total acreage of mature timber remained almost constant, there was an approximately 1,900-acre reduction in open and sparsely stocked stands and a corresponding increase in well stocked stands (40% canopy cover), primarily mid seral (3G). An approximate estimate of the current stocking of mid seral stands >75% canopy cover within the 4,513-acre reference area is 1,889 acres. There is an additional 227 acres of late seral stands with >75% canopy cover. In 1945 the stands exceeding this same density of stocking consisted of 10 acres of mid seral and 424 acres of late seral. The combined total of such overstocked stands has currently increased by 488%. In the EM1 association these overstocked stands have not only reached their capacity for long term production but are also in high risk of mortality from fir engraver beetle attacks (see Step 3, EM1 association, for a discussion of this topic and table for rating risk of engraver beet mortality). "Over stocked" or "stands at risk" also include stands with between 60-69% canopy cover. Though this figure cannot be differentiated for reference conditions, 863 acres of 3G and 16 acres of 4G stands in this category are presently resident. Add to these stands 100 acres of densely stocked pole size stands needing precommercial thinning, and the grand total of stands at risk in the EM1 association is currently 3,095 acres.

The evidence of disturbance, as a result of logging, is just as apparent as that of growth in this association. The timing, location, intensity, and type of cuts made in harvesting portions of this association are all given in Step 3. As a consequence of timber harvest, stands with a mean dbh exceeding 24 inches were, in large part, reduced to lesser size classes, but only temporarily to more open densities. The representation in the association of 4P stands dropped 100%, from 1,300 acres to zero, and 4G stands were reduced by 69%. Much of the logging in these stands of medium and large trees

consisted of salvage and sanitation cuttings. Today stands thus treated have been restocked from below and constitute a significant portion of the 3G stands. Similar cuts were also made in stands that represented the reference point stocking of 3G stands, and most of these have also recycled back to their original status.

Limited areas of 4G, 4P, and 3G stands were more severely impacted by shelterwood or regeneration cuts. These kinds of cuts account for the current 503-acre stocking of seral stage 2 stands and approximately 60 acres of seedlings (the original stocking of seral stage 1 and 2 stands had since been succeeded, and most joined the crowd in the 3G seral stage). The more severe types of cuts also accounted for a 113-acre increase in non-stocked land.

Some of the losses and reduction in stocking can also be attributed to fir engraver beetle mortality. Losses during the recent drought years when beetle populations reached epidemic proportions were fairly heavy in this association. An accounting of number of trees or volume of timber lost or salvaged was not available. Losses were heaviest on the eastern unit of this association where precipitation rates fall below 30 inches and risk of mortality is "high". On the western side precipitation ranges between 30 and 40 inches and risk is "moderate".

As the composition and proportions of seral stages have been altered by growth and disturbance, the association has become more homogeneous. Under reference conditions, the association contained an integrated mixture of seral stages in relatively balanced proportions. Five of six stages represented exceeded the minimum proportional occupancy of 5% of the association. Currently only two seral stages, 2 and 3G exceed that minimum.

Because of the homogeneity of the association the spacial arrangement and average size of stands has also changed. A single seral stage, 3G, now occupies 75% of the association and is presented by stands which average 283 acres larger than this stage under reference conditions. These large stands provide continuity throughout the habitat occupied by the association. Previously, even the stands of the most representative seral stages, which included 3G, were separated by at least ¼ to ½ mile. The stands of the remainder of the seral stages are actually more fragmented and considerably smaller under current conditions than they were previously, but these differences are more or less overshadowed by the dominant pattern provided by seral stage 3G.

Since there is no record of the species composition of association stands at the reference point, changes in the dominance and mix of the conifer components cannot be assessed. Regeneration of both co-dominant species and secondary species commonly occur in the understory, but in dense stands white fir seedlings and saplings are most common and ponderosa the least. The proportions are probably reversed in large openings. In stands which are harvested by light selective cutting the proportion of white fir would be expected to increase, whereas pine regeneration would be encouraged by cuts which provided lighted openings.

The following changes have occurred within the EM1 association which reflect the management policies and practices employed in the past, and provide some insight into management priorities of the future.

- A net overall gain in basal area; growth more than offsetting losses (sustained yield).
- A net increase in dense mid seral stands of large size and good connectivity, but requiring silvicultural treatments to: (1) reduce risk, (2) sustain growth, (3) accelerate the development of late-successional forest, and (4) provide a quality product while protecting stand health during commercial thinning.
- A net decrease in late-successional habitat within the MLSA where standards and guidelines are designed to increase such habitat.
- A reduction in seral stage diversity and balance, with most stages falling below the LRMP min proportional standard of 5% of capable land.
- An increase in non-stocked land, bringing the current total for entire association to 172 acre, 80 acres of which will require a type conversion from montane mixed chaparral (CX).

Ponderosa - White Fir - Sugar/Bitterbrush Association (EM4): The EM4 association has been highly impacted by timber harvesting of

various types, intensities, and frequencies as described in Step 3. This timber harvest began in the northern portion of the association and by 1945 almost two-thirds of the association had already been impacted to some degree. Thus the area sampled for comparing reference conditions with current stocking represented just 34% of the total habitat occurring on land administered by the Modoc National Forest. An additional 1,033 acres of private land is also excluded from this assessment. Comparing current conditions in the 1,682-acre reference sample with current conditions in the association as a whole, some discrepancies are apparent. The relative acreage of young seral stages including both seedlings and saplings, is very similar, as is also the very small residue of 4P and 4G stands. The difference is in the stocking density of mid seral stages, which is essentially reversed. The association as a whole is currently characterized by only 16.6% 3G stands and 45.5% 3P stands, whereas the sample area contains 42.4% 3G stands and 21.2% 3P stands. Also the association as a whole has 38% more non-stocked land than the reference sample, further evidence of greater disturbance.

Because one of the chief purposes of this interpretive analysis is to determine the changes that have taken place in the Watershed under the management policies and practices of the most recent 50 year period, this analysis will focus on changes that have occurred in the reference area only. However, it should be borne in mind that the impacts that have occurred in the association as a whole are somewhat more severe, and the needs more urgent. Current conditions within the total association have already been described in Step 3 and summarized in Table 3.8.

Prior to disturbance, 98% of the association consisted of mature timber stands, roughly 33% of which had a canopy closure exceeding 40%. Stands with a mean dbh exceeding 24 inches were predominant; 4P and 4G stands accounting for 70% of the association stocking. As a consequence of timber harvesting, the total stocking of mature trees dropped to 65% of the association, and the 4P and 4G stands were reduced to just 6 acres (1.2% of the association).

However, growth and partial recovery were also evident, as a 65% proportion of the remaining mature stands exhibited canopy closures exceeding 40%. Additional evidence of growth is noted by the succession to mid seral stages of all the limited early seral stage stands that occupied the area at the reference point.

The types and intensities of logging were not uniformly applied across the area, and thus there are currently concentrations of seral stage stands which contrast with the stocking in other areas. In the western half of the reference area relatively moderate selective cuts were made in harvesting the larger trees. This logging occurred around 1950, and the area is now fully recovered and occupied by mid seral stands of denser stocking than occurred at the reference point. In fact, the total inventory of the entire association of stands >60% canopy closure occurs in this western area, adjacent to the Glass Mountain Lava Flow. Contrasted with this stocking are stands on the eastern half where logging occurred later and was more intense; employing predominantly shelterwood cuts but including some heavy selective cutting. The residual stands on this eastern side consist of a mosaic of 3P, 2 and 1 seral stages with inclusions of 208 acres of non-stocked land.

For the most part, non-stocked stands have been planted. On aerial photographs of the area, both planted and natural regeneration appear to have been quite successful, though there are also pockets of dense shrubs and some relatively barren openings. The portion of the EM4 association included within the reference area occurs on soils of superior productivity and AWC than those found on sites occupied by much of the balance of the association. Thus, in northern and central areas, regeneration has been slower and shrub competition more severe. Relatively extensive areas have remained with <10% canopy closure for a considerable time. Limited annual precipitation (25-30 inches), and harsh microclimates produced as a consequence of removing protective canopies, combine to make regeneration, by either natural or artificial means, difficult to achieve.

The changes in seral stage composition in the EM4 association have resulted in somewhat less diversity. Currently there are only 3 seral stages represented in proportions that exceed the minimum 5% of capable land, whereas formerly there were 4. Though early seral stages are currently better represented because of the

disturbance that has occurred, the association now contains only an insignificant amount of late seral stands. Spacial arrangement and average stand size has also been altered. Following logging, the stands became much more fragmented, though they continued to occur in rather localized groupings. Stands of all seral stages have been reduced to less than half their former size. The largest stands currently occur in the 3P stage and are an average of 79 acres. This size was exceeded by all seral stages except seedlings under reference conditions, and the 4P stands average 387 acres. Connectivity by these 4P stands was superior to that in current seral stages.

Though changes in species composition cannot be assessed, ponderosa pine regeneration has probably been favored under the open stand conditions resulting from logging. This advantage may be offset by the selective logging of pine that has historically occurred, resulting in a greater proportion of white fir in residual stands. This latter wold be more subject to windfall in open stands, and insect attacks have also thinned this species.

White fir losses to fir engraver beetle attacks accelerated in the recent drought years, and this association was among those hard hit. As previously mentioned, the EM4 association is located in a zone of relatively low precipitation rates where risk is high. Mortality is reduced in open stands of reduced moisture stress, and of which this association has plenty of such stands. Currently, there are only 338 acres of stands with >60% stocking in which risk could be reduced by thinning. The location of these was previously identified in this assessment. The northern 2/3 of the association contains only a few stands exceeding 40% canopy cover and none exceeding 50%.

As a result of management activities within the reference area, there has been a net decline in basal area stocking and a net increase in non-stocked areas and competition from shrubs. This same trend has been evidenced to an even greater degree throughout other portions of the EM4 association because this decline needs to be reversed, the following remedial steps and activities are suggested. Some or most of these may already be a part of current management.

- A recovery plan for the association.
- An inventory of non-stocked areas.
- Vegetative management of competing shrubs where necessary.
- Planting of areas with inadequate natural regeneration.
- A determination of the kinds and intensities of logging most compatible with assuring adequate and undelayed restocking of stands following harvests.
- Continued cessation of logging in this association until some of the losses have been recouped and healthy stands reestablished.

Note: This association is well outside the MLSA, or any corridor between such areas, thus production of late-successional forest is not necessarily a viable goal. Many sites are marginal for such production. Under reference conditions in the sample area, it was noted that the stands of medium and large trees were predominantly <40% canopy cover. This stocking may very well have resulted from fires, or the stands may have just been decadent and falling apart, but it is also possible that there were site limitations on production.

Ponderosa Pine Series:

Ponderosa/Bitterbrush (PP1): Two phases of the PP1 association occur, as identified in Step 3. Ninety-five percent of the association occurs on lava plateaus and toe slopes on the northern perimeter of the Watershed and has historically been heavily impacted by logging. This is discussed in some detail in Step 3. This main body of the association was already heavily impacted prior to the reference point, and therefore no part of it has been included in the reference area.

The second phase makes up approximately 5% of the association, and it is located on the south facing side slopes of scattered buttes (under cones). Elevation is 1000 feet higher, and the annual precipitation greater than the main body of the association, but the steep south aspects are hot and dry in the summer, and the soils somewhat rocky and of low productivity. The 90-acre sample of reference conditions, used to compare with current conditions, is located

entirely within this minority phase. It represents roughly a 45% sample of this small portion of the total PP1 association, and it consists of three small units located on widely separated buttes between 6,000 and 6,900 feet in elevation.

The two easterly of these units were included in the Cougar Timber Sale, and were harvested by overstory removal. This type of cutting accounts for the elimination of the former 4P component, which made up 65% of the area at the reference point. The residual understory layers in these cut over areas developed into the 3P stands which have replaced the former stands of larger trees. Small patches of seral stage 1 stands in these two units, also developed into principally 3P stands. A sparse to open stocking continues to characterize the stands on these two buttes as it did at the reference point. This open stocking probably reflects the productive capacity of these sites. The small acreages of late-successional stands recorded for these locations, for both reference and current conditions, actually are appendages of adjacent EM3 stands. The increase from 3 to 7 acres of the 4G stands resulted from development of some mid seral trees also included in this appendage. It is quite questionable that this phase of the PP1 association is capable of producing late-successional forest.

The remaining unit in the reference sample is located considerably west of the other two, in an area that has not been harvested or entered for other purposes. Thus changes which occurred on this site were not influenced by management, other than exclusion of fires. On this latter site it appears that a very sparse stand of medium and large trees has been replaced over time by understory layers. The current stocking density is quite variable, probably representative of a complex of soils that define the site. About half the mid seral stands are currently stocked at 40% canopy cover, and the balance range from 10 to 30%.

The limited size of the reference sample, and the even smaller area of the three units among which it is distributed, make an evaluation of changes in stand size and arrangement, or of diversity, impractical. On both disturbed and undisturbed sites there has been a replacement of the overstory canopy by understory layers, and stands, for the most part, have retained their open character.

For both recovery from overstory removal, and replacement of a decadent overstory by natural succession, there seems to have been adequate understory regeneration resident on the sites, and competition of shrubs was not a factor. These results may have been different if the logging had created extensive openings. This is one of the problems that has occurred in the main body of the association.

The preceding analysis does not necessarily apply to the balance of the PP1 association. For this 85%, little information is available for interpreting changes that may have occurred as a result of management policies and practices. However, it is obvious that drastic changes have occurred. The current condition of the PP1 association, some of the impacts that effected it through the years, and the potential and limitations of the site it occupies, are discussed in Step 3. The past century has been one of decline in this association. Though natural events, such as drought, have contributed to the reductions in stocking and health, the primary cause has been unwise harvesting. A good part of this occurred prior to the reference point as pointed out in Step 3.

As a result of harvesting exceeding growth, and sites being opened up to a degree that regeneration was adversely affected, almost a quarter of the association is currently unstocked (<10% canopy cover). Many of these sites are currently occupied by bitterbrush and other shrub and herbaceous species. Though this shrub cover is commonly limited to 30-50%, it offers serious competition for the limited available soil moisture. Annual precipitation throughout the PP1 habitat is marginal, ranging between 16 and 25 inches. This limitation, coupled with hot dry summers, makes successful planting difficult. Since soil productivity ranges from low to non-productive, a site-by analysis would probably be needed before areas with the greatest potential for sustaining growth could be identified. Some of the non-stocked areas may already have adequate seedlings and saplings.

A good portion of the association may be capable of producing late-successional forest, but records of pre-logging stocking are inadequate and

productivity cannot be verified. There are a few remnant late-successional stands with >40% canopy cover remaining, but many sites may be incapable of supporting mature trees at this density of stocking.

One favorable observation in this association is that 6% of the area is currently supporting stands of seral stage 3G. These stands may be evidence that a degree of recovery has occurred, and of potential future productivity. Most of these well stocked mid seral stands are concentrated in a central area of the association where the cutting may have been lighter.

Ponderosa - White Fir/Bitterbrush (PP2): Due to its occurrence in the northern third of the Watershed it is not possible to compare reference conditions and current conditions for the PP2 association due to reference data not existing for this area. Discussion of current composition for this association is available in Step 3.

Productivity of the PP2 association indicates that it is capable of producing 20 cubic feet per acre per year of wood. Additionally, the PP2 association is capable of producing late-successional forest. Stocking level in this association currently includes 50 acres of non-stocked land. There is a high to extreme risk of white fir mortality of engraver beetle attacks. Also, stands currently requiring thinning to sustain growth and decrease risk of insect and disease are 295 acres of seral stage 2 and 607 acres of seral stage 3. The Forest Survey Site Class of 5 for this association indicates a medium to high potential for growth.

There is a moderate rate of survival for planted seedlings in this association. Ponderosa pine seedling regeneration is favored in less than <40% canopy cover and white fir is favored in areas with greater than >40%.

Shrubs readily invade disturbed understories and opening in this association. Particularly greenleaf manzanita and bitterbrush. As a result, this area is susceptible to invasion following logging. There are 39 acres that currently require type conversion that can occur by removing brush in the association.

The PP2 association has very poor seral stage diversity. The minimum proportional standard of 5% of capable habitat is met for seral stages 2 and 3G only. The greatest deficit in seral stage representation is in late seral stage development as seen by the lack of 4P and only 15 acres of 4G occurring in the association.

Ponderosa - White Fir/Snowberry (PP3): Changes between reference and current conditions within the PP3 association were assessed on 3,973 acres, representing approximately 85% of the total habitat occupied by this association. A 615-acre parcel located in Sections 23 and 24, T43N, R4E, north of Black Mountain was excluded from the sample because data for this area was not available. Judging from its current stocking, this unit is very similar to the remainder of the association relative to its seral stage composition and distribution. Therefore the changes reflected in the 85% sample should be representative of the entire association.

The structural changes that have occurred within the PP3 association represent both successional increases resulting from growth, and losses resulting primarily from utilization of saw timber. Fire has been excluded but losses of white fir to fir engraver beetle have been incurred. The risk of such mortality and the means to reduce it are discussed in Step 3. The magnitude of losses in this association are not on record. In the period between 1945 and 1995, there has been a 62% reduction in late-successional stands and a 151-acre increase in non-stocked land, the cycling and succession of seral stages has resulted in an overall gain in total basal area.

Growth within the association is evidenced primarily in an increased stocking density of mature timber. The total acreage of size Class 3 and 4 stands at the reference point was almost identical to the current stocking. However, the proportion of these islands with >40% canopy closure increased during the intervening period by 78%, while stands with <40% canopy closure decreased by the same increment. As a result of the magnitude of the changes in stand density, 60% of the entire PP3 association is currently stocked with stands that have a canopy closure in excess of 60%. The overstocked stands are broken down into their component seral stages in Step 3, and the need and benefits of thinning are discussed. Under reference conditions there were 80 acres of stands with a density of stocking exceeding 70% canopy closure. Currently there

are 2,206 acres of such stands. With these increases have come an increased risk of white fir mortality at epidemic proportions. Also there has resulted increased opportunity for commercial thinning to promote growth and accelerate development of late-successional forest. The latter objective is particularly important in the 2,732 acres of this association that lies within the MLSA.

Further evidence of growth is seen in the succession of seedlings which, at the reference point, were concentrated in plantations, most of them located on the northeast toe slopes of Black Mountain. These ponderosa pine plantations have developed into predominantly pole size stands, which account for much of the 659% increase in seral Stage 2 stands. However, some plantations in that area have failed and have been replanted, and others have been suppressed by brush. Consequently, a portion of the plantations are still at the sapling stage, and approximately 139 acres of the original planted area is currently non-stocked, most of it occupied by dense stands of montane chaparral.

Stand dynamics during the past half century not only reflect growth, but also the removal of timber. Under reference conditions 48.4% of the association consisted of stands with a mean dbh exceeding 24 inches. This component included 1,185 acres of 4P stands and 738 acres of 4G. Fifty years later there were essentially no sparse to open stands of size class 4 trees, and only 279 acres of late-successional stands, now representing 7% of the association.

These stands, as well as some originally typed as 3G, were modified by the various types and intensities of logging that occurred periodically over a span of 40 years. These timber harvests are identified and described in Step 3. Much of the cutting was light to moderate and the former size class 4 stands have been replaced over time, by dense mid seral stands (3G) which currently constitute approximately 55% of the association. Intense logging, utilizing shelterwood or patch cuttings, also occurred in some localities. This heavy cutting resulted in residual stands of sparse to open stocked size class 2 and 3. These 3P and 2 seral stage stands have also increased in the current inventory. (Most of the original stands of these stages at the reference point were succeeded by 3G stands).

Scattered non-stocked patches are also evident in some of the heavily logged areas, but for the most part, planting and natural regeneration has quite successfully become established in areas disturbed by logging. In older harvest areas good stockings of saplings were noted on aerial photographs. Invasion of shrubs into areas disturbed by logging has generally been relatively slow with only moderate amounts becoming established. This seems to contrast a rapid rate of colonization following fires. This apparent difference is discussed further in Step 3.

The combination of growth and disturbance has resulted in only a slight modification of seral stage diversity. One less stage (4P) is presently represented, but under both reference and current conditions the minimum standard proportion of 5% of capable land was satisfied for a total of four seral stages (identified in Steps 3 and 4). Predominance has shifted from late to mid seral stands.

The effect of growth and disturbance upon average stand size and spacial arrangement has been more pronounced. Stands of most seral stages became more fragmented, thus reducing their average size. The magnitude of the reduction in size varied among stages. Seral Stage 1 stands were only 0.02 their original size; seral Stage 2 only 0.60; 3P only 0.30, and 4G only 0.11. The single exception to this pattern of division was evidenced in seral Stage 3G, in which stand size actually increased from 79 to 368 acres. The only change in spacial arrangement of any consequence was that of the 3G stage. Because its current predominance in the association, and of its stands, continuity throughout the association is achieved, something no seral stage under reference conditions provided. Of some concern, of course, is the fragmentation of late seral stands that has occurred, as well as their decline in acreage, as mentioned previously. However, by careful management of the 3G stands it should be possible to reduce this deficit in a reasonable time, and to eventually produce an increased magnitude and more desirable arrangement of 4G stands than previously occurred.

No data on species composition at the reference point is available to compare with the proportions of white fir and ponderosa pine currently resident in PP3 stands. However, there is some evidence

that change has and may continue to occur in species composition. This evidence, and the possible reasons for such change taking place, are discussed in the description of this association in Step 3.

Ponderosa Pine - Western Juniper/Bitterbrush Association (PJ1): The PJ1 association occurs in the northeastern corner of the Watershed, occupying approximately 951 acres. Due to the location where this association occurs, it is not possible to make a direct comparison of reference and current conditions as reference conditions data does not exist for this area. In depth discussion of the association and its current composition is available in Step 3.

The PJ1 association is incapable of producing greater then 20 cubic feet per acre per year of wood. The Forest Survey Site Class of 7 for this association indicates a rating of noncommercial. Stocking of this association is typically sparse with a 10-20% canopy cover. In regards to understocking, currently 80% of the association has less than 10% canopy cover of conifers. The current ratio of juniper to pine is approximately 3:1. A conspicuous portion of the bitterbrush and a lesser amount mountain mahogany is either decadent or dead. Typical shrub understory averages approximately 25%, and the amount of brush needing type conversion is 754 acres.

Key Question (2)

How have changes in management practices caused forest health and sustainability to change from reference conditions?

(a) How has the amount of stands at risk of catastrophic loss from disease, insects, or fire changed; and where are they located changed?

(b) Has management caused stands where current stocking has reduced growth and vigor, compromising the Forest's ability to achieve both late seral habitat development or timber output expectations?

(c) How has current seral stage distribution appropriate to sustain nesting, roosting, and foraging habitat changed?

Interpretation

Through a lack of vegetation management projects the forest health is now in a present state that does not provide a long term sustainable balance of seral stages within the Watershed. Treatment of the forest will allow this to occur.

Evidence of the lack of sustainability in the Watershed's forest includes approximately 39,000 acres of small to mid-sized (seral stages 2 and 3) trees with reduced growth due to high stocking levels. Many of these stands currently lack diverse structural elements desirable in late-successional habitat. Other areas showing a lack of sustainability include 3,600 acres that are currently understocked or non-stocked.

The trend in the amount of 4G nesting habitat available to NSO from the reference condition to the present is possible to determine by a comparison of reference condition and current condition acreage amounts found on Table 5.1 Nesting habitat in the eastside mixed conifer associations has generally remained the same from the reference condition to the present, with an increase of only 380 acres. The same is true of the red fir associations, in which the 4G habitat has increased by just 180 acres. Similarly, the white fir 4G habitat has increase by 216 acres from the reference condition. Data is not available for the reference condition of the pine associations so no determination is possible. From what is known, it may generally be said that the amount of 4G nesting habitat within the Watershed has remained fairly constant over the last 50 years.

The most notable change in dispersal and foraging habitat is the nearly 100% reduction in the 4P habitat type in all associations across the entire Watershed. This change accounts for nearly 10,000 acres of habitat modification. For the most part this change has not impacted NSO dispersal and foraging habitat as most of those 4P acres have been modified to other habitat types. 3G habitat has increased from 9,663 acres in the reference condition to 21,031 acres for the current condition. The 3G habitat has increased in

every association except for the LP1, with the largest increased being 1,635 acres in the RF1 association. The amount of 3P habitat has also increase from 6,582 acres to 8,331 acres over the last 50 years. Combining the amount of 3G and 3P habitats yields an increase of 13,117 acres of habitat available from 1944 to present. This increase in habitat is balanced by the decrease in the amount of 4P habitat. With this balance and the 4G habitat remaining approximately the same, it appears that the overall trend in the amount of NSO habitat is remaining constant, but the associations where it is found changes. For a detail comparison of association changes see Table 5.1.

Desired Conditions

- Forested Matrix lands will be managed to produce commercial yields of timber while maintaining a balance of seral stages to meet wildlife habitat requirements on a sustained basis over time.
- Expand the acreage of LSH in the MLSA and Matrix to a minimum of 40% and 15%, respectively.
- Lands capable of supporting forested stands are forested.
- Forested ecosystems within the Watershed area are diverse, closely resembling the pattern and balance of age classes indicative of the reference conditions.

SURVEY AND MANAGED SPECIES

Key Questions

How has the status of known information of survey management changed?

Response

Known information of survey management has been gained as the necessity for project specific studies and funding for research of specific species has occurred.

Within the Watershed there are no Nonconforming Conditions for "survey and manage" species. Interpretation of protocol for bat species is anticipated from the REO in order to provide adequate planning direction.

Desired Conditions

- Liverwort (*Ptilidium californicum*) known sites are protected and managed per NFMP ROD direction.
- Compliance with REO interpretation of protocol for bat species.

HUMAN USES

Heritage Resources

Key Questions

What are the causes of change between historical heritage resources and heritage resources existing within the Watershed?

Interpretation

In regards to change, heritage resources have remained the same in the Watershed. Change that could possibly occur to existing heritage resources would be a result of the limited amount of development that occurs in the area. The Forest Service inventories, describes, and evaluates the prehistoric and historic cultural resources on the Forest. When development is proposed, it is required that the area be assessed for the presence of heritage resources.

A nonconforming condition in the Watershed is that some cultural resource sites have not been inventoried for the National Register of Historic Places and the National Historic Preservation Act.

Non-Timber Commodities

Key Question

What are the causes of change between historical and current utilization of non-timber commodities in the Watershed?

Interpretation

Traditional non-timber commodities such as mining and firewood collection have declined from historic levels. Other non-traditional uses such as mushroom collection have increased in presence in the Watershed. Utilization of non-timber

commodities in the Watershed has been dependent on market demand.

A decrease in the demand for pumice and extraction from more accessible sources has resulted in less demand for pumice. Much less pumice is mined from the two active sites, than was during the 1930s and 1940s. This market is also dependent on the desired participation of individuals in the area.

Cinder pits located in the northern part of the Watershed have also become non-active.

Firewood collection levels have declined as the availability of easy gathered firewood has gone down in association with reductions in timber sales.

Wild mushroom harvesting has increased as a non-timber market that did not exist previously. This is driven by foreign market demands.

Nonconforming conditions that exist with non-timber commodities are that current programs for fuelwood cutting are operating primarily in response to demand, instead of being designed to also accomplish other resource objectives.

The increased levels of harvesting other forest products, such as mushrooms, also creates a nonconforming condition. Currently, this type of harvesting is done according to demand, without placing any limits, nor analysis being made, on amounts being removed.

The Glass Mountain KGRA was formed by the U.S. Geological Survey in 1970 and encompassed a 15,371-acre area largely within the Watershed. The KGRA was expanded in 1974 and again in 1982 and 1983, and the KGRA now exists over a 134,254-acre area that encompasses almost all of the Watershed and extends into the neighboring Shasta-Trinity and Klamath National Forests and the Lava Beds National Monument. Geothermal leases were issued over a large portion of the Watershed and cover almost all of the surface area in the central portion of the Watershed in the Medicine Lake basin. Geothermal exploration activities were conducted in the 1980s and 1990s and one geothermal power plant project, the Telephone Flat Geothermal Development Project, has been proposed in the Watershed area and the wellfield and power plant site would be located approximately 1½ miles east of Medicine Lake. In addition, another geothermal development project, the Fourmile Hill Geothermal Development Project, has been proposed in the neighboring Klamath National Forest, one mile west of the Watershed and approximately 2½ miles northwest of Medicine Lake. The proposed 230-kV transmission line for that project would be constructed over an approximately 24-mile distance and would bisect the Watershed east-west through forested lands located north of Mt. Hoffman and Glass Mountain (see Figure 3.18).

No other geothermal development projects have been proposed in the Watershed, but future geothermal exploration and/or successful development of the proposed development projects could result in additional interest for expanded geothermal development in the Watershed and vicinity. Each proposed geothermal exploration or development project would be the subject of future National Environmental Policy Act and California Environmental Quality Act (NEPA/CEQA) analysis and would be evaluated for conflicts with other Forest resources and management direction. Geothermal development has the potential to create a nonconforming condition with respect to other Forest management goals; however, existing geothermal exploration activities have not resulted in a nonconforming condition.

Recreation

Key Question

> **What are the causes of change between historical and current primary recreational uses in the Watershed?**

Interpretation

Recreational uses in the Watershed have increased over historical levels. Most activities remain the same, such as camping, fishing and hunting. Development of campgrounds and other recreational facilities are the primary cause, as well as human preference changes for the outdoors.

A general reason for increased recreational use is that use patterns of outdoor recreation have

changed and individuals are more inclined to travel to wilderness destinations and places of interest.

Camping, fishing, and touring of the area have increased due to population increases and reputation of the quality of available recreation spreads. These activities will continue to be popular in the Watershed.

Winter recreation, primarily snowmobiling, has increased from past levels. This is due to the maintenance of snowmobile trails and parks in the wintertime. This use will continue to increase as long as snowmobile trails are maintained.

Overuse of areas as recreation sites is also cause of a nonconforming condition. As previously mentioned, demand is expected to increase in the future. Occasionally this demand exceeds capacity during peak periods.

In general this growing demand creates a nonconforming condition with regards to the fact that little is known about resource conflicts. Inadequate knowledge exists with regards to the quantity, quality and extent of resource damage of dispersed recreation use in the Watershed.

Desired Conditions

- Historic, cultural and archeological sites have been identified and assessed. Those eligible for listing on the National Register of Historic Places (NRHP) have been nominated and are being protected in conformance with the National Historic Preservation Act (NHPA).
- Access to and use of sites important to traditional Native American religious and cultural practices are protected consistent with American Indian Religious Freedom Act (AIRFA).
- Developed recreation facilities in the Medicine Lake area are developed and maintained to meet the present and future demand for high quality outdoor recreation that avoids resource damage.
- Dispersed recreation activities in undeveloped areas of the Watershed are taking place except where resource damage is occurring from the activity.
- Facilities and trails are protected within the Watershed to accommodate the demand for safe, non-damaging snowmobile use.
- Demand for fuelwood is being met by providing areas that enhance or do not conflict with other resource objectives.
- Mushroom collecting and other consumptive uses of other forest products are managed on a sustained yield basis with consideration given to other dependent resources.

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STEP 6 — RECOMMENDATIONS

This step synthesizes results of the ecosystem processes discussed in previous steps and generates management recommendations responsive to Issues and Key Questions. The goal of the recommendations is to identify changes in ecosystem conditions and function that require management action to achieve desired ecologic, economic, and social objectives.

Management recommendations are provided for each of the nine topical areas described in this analysis, and based on the analysis and conclusions reached in previous steps. Recommendations are displayed in narrative format by topical area as follows:

Table 6.1: Upslope Hydrologic Processes
Table 6.2: Riparian Reserves
Table 6.3: Fire Management
Table 6.4: Late-Successional Habitat
Table 6.5: Terrestrial Wildlife
Table 6.6: Roads
Table 6.7: Silviculture
Table 6.8: Survey and Managed Species
Table 6.9: Human Uses

Tables in this step provide general descriptions of the Desired Conditions, Nonconforming Conditions, Recommendations, and Priorities.

TABLE COLUMN DEFINITIONS

Desired Conditions: Desired Conditions are developed from Step 5 — Interpretation and represent a refinement of direction from the Forest Plan.

Nonconforming Conditions: These narratives are qualitative and quantitative determinations identified through the analysis process. Nonconforming Conditions are summary statements generated directly from integrating information on management practices and/or ecological processes from Steps 3, 4, and 5. The tabulated information represents observations of Existing Conditions that do not generally meet the Desired Conditions.

Recommendations: This is the identification of possible management actions, projects, and other activities that promote Desired Conditions. During the analysis process, comparisons were made between Existing Conditions and Reference Conditions to determine how closely a particular resource or ecological function was to achieving the Desired Condition. The analysis provided in Step 5 — Interpretation, identifies Existing Conditions that do not meet Desired Conditions. Recommendations were developed that improved ecosystem trends to move towards Desired Conditions. Recommendations may include risks or benefits to other resources, or options and alternatives to consider when achieving the Desired Condition. Recommendations can also include suggested monitoring and research activities.

Recommendations also include discussion of analysis limitations, confidence in the analysis, data gaps, and implications of these limitations for management. Cross-boundary issues are also identified and include suggested Recommendations for cooperative management remedies.

Priority: To assist with establishing work priorities for project development, a rating system is used. Each Recommendation is given a rating by the Interdisciplinary Team, based on their professional judgement. This is done by assigning a High (H), Medium (M), or Low (L) value relative to the other Recommendations resulting from the analysis.

A Recommendation is given a High priority if the need to complete the activity(ies) prescribed by the Recommendation is "as soon as practical" given available resources.

Recommendations given a Medium priority are the next tier of activities which should be scheduled to be undertaken as part of long term planning.

Recommendations given a Low priority are those activities with the least potential for substantively preventing attainment of the Desired Conditions and should be undertaken when resources are available.

LIST OF FIGURES

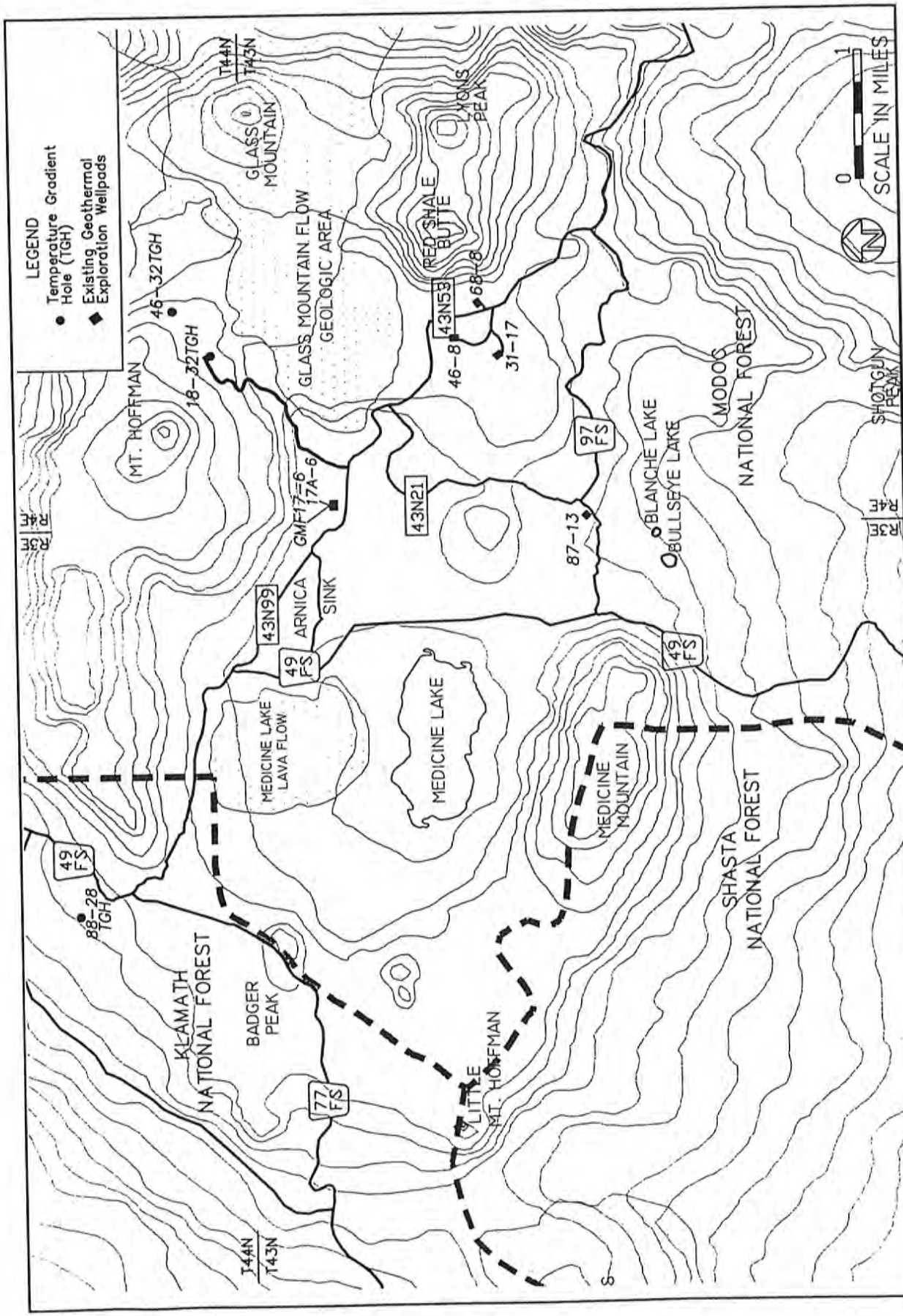

Figure 3.17:Existing Geothermal Exploration Facilities

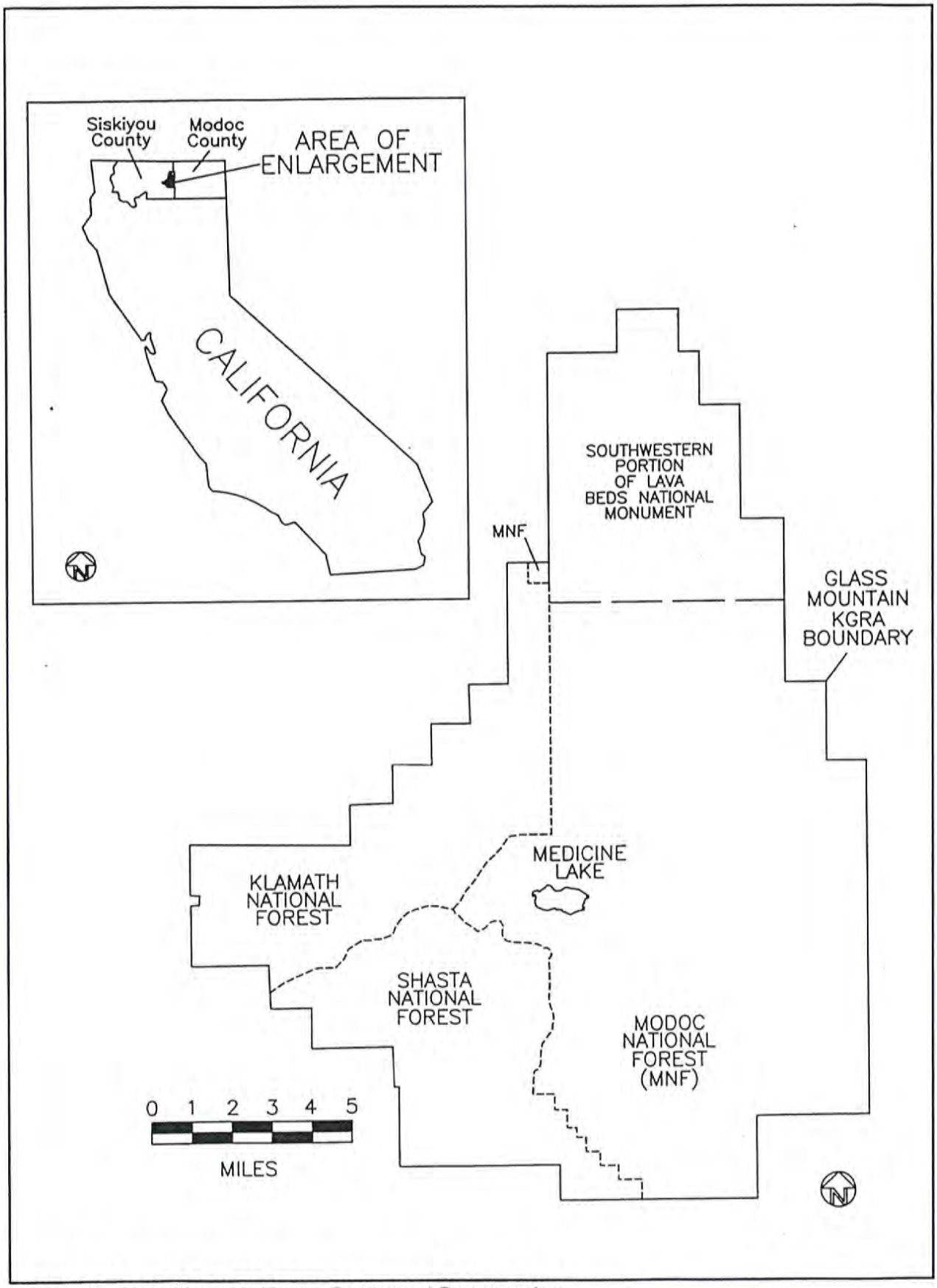

Figure 1.7: Glass Mountain Known Geothermal Resource Area

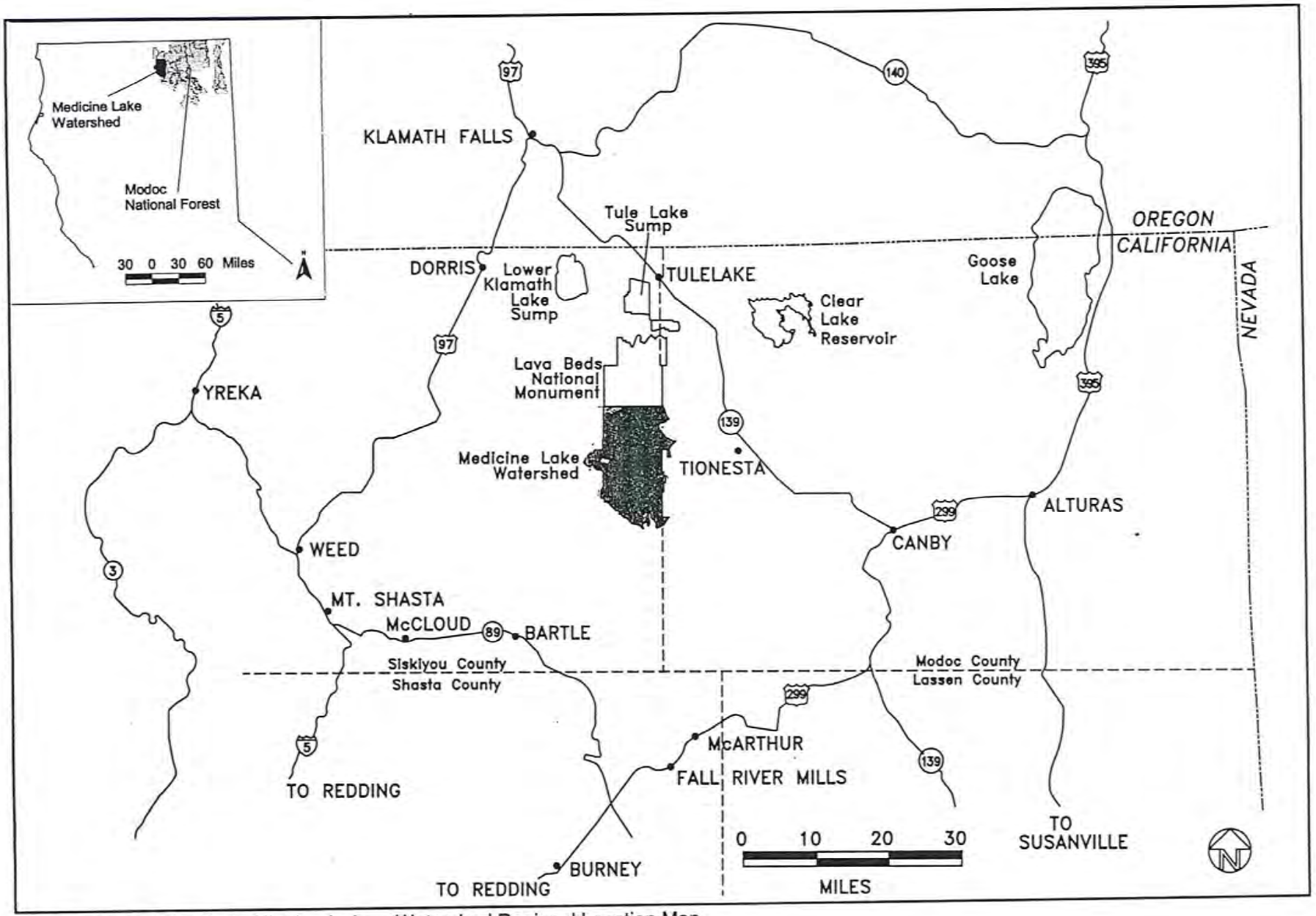

Figure 1.1: Medicine Lake Highlands Area Watershed Regional Location Map

Figure-1

Table 6.1: Upslope Hydrologic Processes — Recommendations

	Desired Conditions	Nonconforming Conditions	Recommendations	Priority
1	Elimination of soil erosion from nonessential roads.	Existing roads that are not needed to meet management objectives contribute to soil erosion.	• Identify nonessential roads. • Restore natural hydrologic function on nonessential roads.	H
2	Minimization of erosion from essential roads.	Existing roads contribute to soil erosion.	• Repair and prevent erosion problems on essential roads. • Identify erosion problems on essential roads. • Limit vehicle access on roads that are not necessary for public access.	H H H
3	Minimization of soil erosion resulting from areas of previous disturbance.	Surface disturbance from abandoned areas of human activity contributes to soil erosion.	• Identify the abandoned and unrestored areas of surface disturbance. • Initiate site restoration activities at abandoned sites. • Limit vehicle access to identified abandoned sites.	M M M

Table 6.2: Riparian Reserves — Recommendations

	Desired Conditions	Nonconforming Conditions	Recommendations	Priority
1	Riparian areas are not inhibited or encroached upon by upland vegetation in a way that prevents attainment of Aquatic Conservation Strategy objectives.	Lodgepole pines encroaching in Riparian Reserves in the Medicine Lake area.	• Employ silvicutural treatments of lodgepole pines effecting the Riparian Reserves. • Leave fallen material on site to provide additional woody debris.	M M
2	Riparian Reserves are not degraded by recreation activities in a way that prevents attainment of Aquatic Conservation Strategy objectives.	Some Riparian Reserves are currently being degraded by recreational uses and activities. In other Riparian Reserves, recreational uses pose the potential for degradation of Riparian Reserves.	• Monitor and possibly restrict recreation activities within Riparian Reserves. • Implement restoration if, or when, degradation is identified. • Initiate a program of public awareness to minimize activities that degrade riparian habitat.	H H H

Table 6.3: Fire Management — Recommendations

Desired Conditions	Nonconforming Conditions	Recommendations	Priority
1 The MLSA and Matrix are characterized largely by low to moderate fire behavior potential (FBP), while maintaining an acceptable balance of down woody debris and snag components.	The MLSA and Matrix is currently dominated by moderate to high FBP putting late-successional and potentially late-successional stands at risk from stand replacing wildfire.	• Reduce the FBP in the MLSA and Matrix to low and moderate, utilizing an active prescribed fire program focused southwest and southeast of NSO activity centers. • Thin stands prior to prescribed burns where needed.	H H
2 The eastside pine stands north of road 44N01 are at low to moderate FBP, with late-successional stands represented at an appropriate level.	The eastside pine stands and associated vegetation represent the highest FBP in the analysis area, and are at extreme risk of stand replacing fire. Stands are currently in early to mid seral.	• Thin stands to improve growth and reduce ladder fuels while maintaing remaining older tees. Reduce FBD by prescribed burning with low intensity fire. • Increase cooperative work with Lava Beds National Monument to reduce FBP along the shared boundary. • Acquire inheld private lands through land exchange to enhansilvicultural reduce FBP.	H H M
3 FBP is low to moderate in tree plantations at Black Mountain.	Tree plantations at Black Mountain are at high risk for stand replacing fire and pose a significant threat to activity centers in the MLSA.	• Thin plantation stands to improve growth and reduce risk of crown fire. Manage brush stands associated with the plantation to reduce FBP.	H
4 Semi-primitive non-motorized areas are managed to levels of natural fire regimes.	Semi-primitive non-motorized areas are not managed for natural fire occurrence levels and vegetation is at risk of type change.	• Use prescribed fire as a management tool to thin, reduce fuel loading, change understory vegetation (ladder fuels) and increase lower seral vegetation.	H

Table 6.4: Terrestrial Wildlife — Recommendations

	Desired Conditions	Nonconforming Conditions	Recommendations	Priority
1	Manage for functional and sustainable LSH by attaining a minimum of 40% of the MLSA* in LSH seral stages. Average patch size is 100 acres or greater.	Of lands capable of producing LSH in the MLSA, only 17% is currently in LSH status. Additionally, LSH patches are small in size and fragmented.	• Commercial thinning of treatments of mid-seral stage stands immediately adjacent to current LSH stands will result in an increase of total LSH and mean LSH patch size. Concentrate thinning treatments within 1.2 miles of the three NSO activity centers.	H
2	On lands that are capable, attain a minimum of 35% of the Matrix in stands that have canopy closures of 40% or greater and mean tree Diameter at breast Height between 11 to 23.9 inches, and 15 %of the area in LSH habitat seral stages.	In the Matrix there are areas that are deficient in dispersal habitat for LSH related terrestrial species. the Matrix also lacks an adequate amount of refuge for these species.	• Commercial thinning of treatments of mid-seral stage stands immediately adjacent to current LSH stands will result in an increase of total LSH and mean LSH patch size. Concentrate thinning treatments within 1.2 miles of the three NSO activity centers.	H
3	On approximately 50% of the Matrix, continue to provide a mixture of early and mid successional habitats to sustain populations of dependent terrestrial wildlife species.	Currently in the Matrix, there appears to be a relatively good mix of early and mid seral stages to meet the requirements of terrestrial wildlife species.	• Precommercial and commercial thinning of mid-seral stands.	M

Table 6.5: Late-Successional Habitat — Recommendations

	Desired Conditions	Nonconforming Conditions	Recommendations	Priority
1	Manage for a functional and sustainable MLSA by attaining a minimum of 40% of the MLSA in LSH seral stages. Average patch size is 100 acres or greater.	Of lands capable of producing LSH in the MLSA , only 17% is currently in LSH status. Additionally, LSH patches are small in size and fragmented.	• Commercial thinning of treatments of mid-seral stage stands immediately adjacent to current LSH stands will result in an increase of total LSH and mean LSH patch size. Concentrate thinning treatments within 1.2 miles of the three NSO activity centers.	H
2	The FBP ratings are moderate within; and adjacent to LSH stands.	Approximately 44 percent of the MLSA has a high fire behavior potential. There is approximately 750 acres within about 70 LSH stands that are either adjacent to stands that have high FBP ratings; or are LSH stands that have high FBP ratings. These stands are directly at risk to being lost during wildland fire events.	• Utilize prescribed burning and/or thinning treatments to reduce wildland fire hazards to LSH stands. Concentrate management treatments to within 1.2 miles of the three NSO activity centers.	H
3	In the Matrix, a minimum of 15% is in LSH stage. Average patch size is in excess of 100 acres.	Of lands capable of producing LSH in the Matrix 10% is currently in LSH status. Additionally, LSH patches are small in size and fragmented.	• Commercial thinning of treatments of mid-seral stage stands immediately adjacent to current LSH stands will result in an increase of total LSH and mean LSH patch size. Concentrate thinning treatments within 1.2 miles of the three NSO activity centers.	H
4	The FBP ratings are moderate within; and adjacent to LSH stands in the Matrix.	Southwest of the MLSA and in the Matrix there are LSH stands that are either adjacent to stands that have a FBP rating of high or are LSH stands that have high FBP ratings. These stands are directly at risk to being lost during wildland fire events.	• Utilize prescribed burning and/or silvicultural thinning treatments to reduce wildland fire hazards to LSH stands. Concentrate management treatments in LSH stands that have a FBP rating of high; or in stands that have FBP rating that are adjacent to a LSH stands.	M

Table 6.6: Roads — Recommendations

	Desired Conditions	Nonconforming Conditions	Recommendations	Priority
1	Transportation system is adequate to meet all management needs but is designed and maintained to minimize erosion and does not unnecessarily provide opportunities for disturbance of wildlife species.	Average road density in the Watershed is 2.7 miles per square mile, exceeding the 2.5 miles per square mile guideline relative to wildlife disturbance. The MLSA has 3.3 miles per square mile. Individual roads in some areas are demonstrating erosion problems.	• Inventory transportation system in the Watershed. • Decommission roads that are excess to management needs and that are considered non-essential. • Repair and maintain essential roads utilizing seasonal road closure to control or minimize erosion problems.	H H H

Table 6.7: Silviculture — Recommendations

Desired Conditions	Nonconforming Conditions	Recommendations	Priority
1 Forested Matrix lands will be managed to produce commercial yields of timber while maintaining a balance of seral stages to meet wildlife habitat requirements on a sustained basis over time.	There are currently no vegetation management projects planned. There is not a long term sustainable balance of seral stages within the Watershed.	• Within the Matrix, plan and implement vegetation treatments that generate commercial yields of timber and create a sustainable balance of seral stages and wildlife habitat over time.	M
2 Expand the acreage of LSH in the MLSA and Matrix to a minimum of 40% and 15%, respectively.	There are approximately 39,000 acres of small to mid-sized (seral stages 2 and 3) trees with reduced growth due to high stocking levels. Many of these stands currently lack diverse structural elements desirable in LSH.	• Accelerate growth and stand structural development processes through silvicultural manipulation in stands of small to mid-sized trees. First priority are stands adjacent to current LSH.	M
3 Lands capable of supporting forested stands are forested.	There are approximately 3600 acres that are currently under or non-stocked.	• Return lands to production begin with site specific evaluations and recommendations.	M
4 Forested ecosystems within the Watershed area are diverse, closely resembling the pattern and balance of age classes indicative of the reference conditions.	Pre-management reference conditions of forested ecosystems were established on approximately 75% of the Watershed. A comparison of these with current conditions indicate that the Watershed has roughly 27 times fewer acres of early seral now than pre-management period, 1/3 the amount of late seral present than pre-management, and twice the acreage in mid-seral than pre-management. A comparison of stand density of mid and late seral stands in the reference conditions shows a ratio of about 1:2 to 1:3 of 3P:3G and about 1:1 to 2:1 of 4P:4G. Currently there is little to no 4P in any forested ecosystem in the Watershed, and the number of 3G stands has increased roughly 7 fold relative to 3P.	• Plan and implement vegetation management projects that move the forested ecosystems toward pre-management seral stage balances, within the framework of the ROD, MLSA and LRMP directions. Vegetation management could consist of the following types of silvicultural treatments : (1) thinning to enhance long term health and growth and structural development, focusing initially on stands adjacent to late seral habitat; (2) site preparation and planting in stands currently understocked or non-stocked, and (3) small (approximately 5 acres) group selection harvest to increase ecological diversity by providing early-successional habitat, where deficient. • Reintroduce more fire sustainable fire resistant species.	M M

Table 6.8: Survey and Managed Species — Recommendations

	Desired Conditions	Nonconforming Conditions	Recommendations	Priority
1	Liverwort (*Ptilidium californicum*) known sites are protected and managed per ROD direction.	None.	• Manage known sites and survey prior to activities (1 and 2 strategies in ROD).	H
2	Compliance with REO interpretation of protocol for bat species.	Waiting for REO intepretation of protocol for bat species to determine nonconforming condition.	• Maintain compliance with REO protocol for bat species when interpretation is released.	M

Table 6.9: Human Uses — Recommendations

	Desired Conditions	Nonconforming Conditions	Recommendations	Priority
1	Historic, cultural and archeological sites have been identified and assessed. Those eligible for listing on the National Register of Historic Places (NRHP) have been nominated and are being protected in conformance with the National Historic Preservation Act (NHPA).	Sites have not been inventoried. Many inventoried sites have not been assessed for NRHP eligibility. Potential NRHP sites are not being conserved.	• Continue inventories in conjunction with project inventories. • Incorporate assessment into a portion of those sites identified through the project inventory process. • In addition to project inventories conduct systematic inventories and assessments for the entire Watershed over the next 20 years.	H M M
2	Access to and use of sites important to traditional Native American religious and cultural practices are protected consistent with American Indian Religious Freedom Act (AIRFA).	None at this time.	• Continue to consult with Native American Tribes and individual practitioners in determining locations of sites and types of activities that conflict with AIRFA for those sites.	H
3	Developed recreation facilities in the Medicine Lake area are developed and maintained to meet the present and future demand for high quality outdoor recreation that avoids resource damage.	Demand occasionally exceeds capacity during peak periods. Demand is expected to increase as population expands.	• Prepare a comprehensive development and maintenance plan for the Medicine Lake recreation area.	M
4	Dispersed recreation activities in undeveloped areas of the Watershed are taking place except where resource damage is occurring from the activity.	Little is known about quantity and quality of dispersed recreation use in the Watershed, nor the extent of resource damage that may be occurring.	• Develop an inventory of locations where resource damage is occurring. • Continue to inventory and monitor dispersed recreation activity.	M M
5	Facilities and trails are protected within the Watershed to accommodate the demand for safe, non-damaging snowmobile use.	Demand is growing and little is known about resource conflicts.	• Continue to monitor trends in use and any conflicts that may develop.	M
6	Demand for fuelwood is being met by providing areas that enhance or do not conflict with other resource objectives.	The fuelwood cutting program is now operating primarily in response to demand and not necessarily designed to accomplish other resource objectives.	• More closely integrate the fuelwood program with fire and fuels management, silviculture, sensitive plant management and wildlife management.	M
7	Mushroom collecting and other consumptive uses of other forest products are managed on a sustained yield basis with consideration given to other dependent resources.	Other forest products are currently being managed primarily to meet user demand.	• Analyze the impacts of forest products program on the sustainability of the products and on other resources.	M

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REFERENCES

Alexander, E.B., Sawyer, J.O., 1998. Ecological Subregions of California, R5-EM-TP-005-Net, Internet publication, USDA, Forest Service, Pacific South West Region, San Francisco, CA.

Barrett, R.H., H Salwasser. 1982. Adaptive management of timber and wildlife habitat using DYNAST and wildlife-habitat relationships models. Proc. W. Associated Fish Wildlife Agencies 62:182-198.

Barrows, C.W. 1980. *Feeding ecology of the spotted owl in California.* Journal of Raptor Research 14:73-78.

BLM. 1995. *Glass Mountain Unit Geothermal Exploration Project, Environmental Assessment/Initial Study.* (April 1995).

BLM, USFS, SCAPCD, and BPA. 1999. *Telephone Flat Geothermal Development Project Final Environmental Impact Statement/Environmental Impact Report.* (SCH #97052078) (DOI/FEIS-99-6) (USFS/MDF/FEIS-99-6) (DOE/EIS-0298). Environmental Management Associates, Inc. (February 1999).

BLM, USFS, SCAPCD, and BPA. 1998. *Fourmile Hill Geothermal Development Project Final Environmental Impact Statement/Environmental Impact Report.* SCH No. 96062042. MHA Environmental Consulting, Inc. (September 1998).

Brown, P.E. and E. D. Pierson. 1996. *Natural History and Management of Bats in California and Nevada.* Materials Prepared for Conference Sponsored by the Western Section of the Wildlife Society, November 13-15, 1996.

Bunse, M. 1996. *Cultural Setting: Historic Setting. In Biological and Cultural Resource Assessments for the Calpine Transmission Line Project.* Report submitted to Calpine Corporation, Santa Rosa, California (as cited in Wohlgemuth and Gilreath 1997).

Busby, C.I., J.C. Bard, R.J. Dezzani, K.M. Nissen, J.M. Findlay, R.M. Harmon and M.R. Fong. 1990. *Completion of Archaeological Compliance OTH-B Cultural Resources Program Modoc National Forest, California.* MS on file, ASR-05-09-421, California Archaeological Site Inventory, Chico.

California Department of Fish and Game. 1985. *McCloud Flats Deer herd Management Plan.* California Department of Fish and Game, Sacramento, CA.

California Division of Mines and Geology. 1966. *Geology of Northern California, Bulletin 190, 1966.*

California Natural Diversity Data Base (CNDDB). *1997 Printout for Medicine Lake and Eight Surrounding Quadrangles.* California Department of Fish and Game, Natural Heritage Division, Sacramento, CA. 33 pp.

Chang, C. 1996. *Ecosystem Responses to Fire and Variations in Fire Regimes. In Sierra Nevada Ecosystems Project: Final Report to Congress*, vol. II, chap. 39, Davis: University of California, Centers for Water and Wildland Resources.

Dicken, S.N. and E.F. Dicken. 1985. *The Legacy of Ancient Lake Modoc: A Historical Geography of the Klamath Lakes Basin.* Published by the authors, distributed by the University of Oregon Bookstore, Eugene, and Shaw Stationery Co., Klamath Falls.[1]

Donnelly-Nolan, J.M. 1990. *Geology of Medicine Lake Volcano, Northern California Cascade Range.* Geothermal Resources Council Transactions 14(Part II): 1395-1396.

Donnelly-Nolan, J.M. D.E. Champion, C.D. Miller, T.L. Grove, and D.A. Trimble. 1990. *Post-11,000-Year Volcanism at Medicine Lake Volcano, Cascade Range, Northern California.* Journal of Geophysical Research 95(No. B12): 19,693-19,704.

Forsman, E.D. E.C. Meslow, and H.M. Wight. 1984, *Distribution and Biology of the Spotted Owl in Oregon.* Wildlife Monographs 87:1-64.

Galea Wildlife Consulting. 1996. *Biological Survey Report, Mount Hoffman Assessment Area.* Prepared for Calpine Corporation, Santa Rosa, CA. 32 pp. + appendices.

Gates, G.R. 1983. *Cultural Resource Overview: Modoc National Forest.* MS on file, Modoc National Forest, Alturas.

Gudde, E.G. 1969. *California Place Names: The Origin and Etymology of Current Geographical Names* (Third edition revised and enlarged, Second printing).

Gutierrez, R.J. and Dames and Moore. 1993. *Biological Assessment, Northern Spotted Owl, Unocal Glass Mountain Geothermal Project.*

Hart, J.D. 1987. *A Companion to California* (New Edition, Revised, and Expanded). Oxford University Press, New York.

Jurek, R.M. Nonnative Red Foxes in California. Information Report of the California Department of Fish and Game. 1992.

Kerns, S.J. 1997. *Northern goshawk survey report for the Telephone Flat geothermal development project area.* Report to: Environmental Management Associates, Brea, CA. 4 pp. + figures.

Kerns, S.J. 1989. *Occurrence of spotted owls in managed timber stands on lands of the Pacific Lumber Company.* Report to: The Pacific Lumber Company, Scotia, CA. 28 pp. + figures.

Laudenslayer, Jr. W. F. (ed.) 1982. *Introduction and species - habitat relationships matrix. Volume 1. California wildlife/habitat relationships program: northeast interior zone.* U.S. Department of Agriculture, Forest Service, Pacific Southwest Region, San Francisco.

Leitner, P. and B. Leitner. 1997. *Biological Resources of the Telephone Flat Geothermal Project Study Area.* Report to: CalEnergy Exploration Company, Omaha, Nebraska. 54 pp.

Martin, L. 1987. The Modoc in Indian Territory. In *The Northwestern Tribes in Exile; Modoc, Nez Perce, and Palouse Removal to the Indian Territory.* Clifford E. Trafzer (ed.), pp. 15-26. Sierra Oaks Publishing Company, Sacramento.[2]

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[1]This reference is available for viewing at the Bancroft Library located at the University of California at Berkeley, Berkeley, California.

[2]This reference is available for viewing at the Bancroft Library located at the University of California at Berkeley, Berkeley, California.

Maser, C. And J.S. Gashwiler. 1978. Interrelationships of wildlife and western juniper in R.E. Martin, J.E. Dealy, and D.L. Caraher, eds. Proceedings of the western juniper ecology and management workshop. U.S. Department of Agriculture, Forest Service (Portland, OR), General Technical Representative Pacific Northwest

Mayer, K.E. and W.F. Laudenslayer, Jr. (eds.). 1988. *A Guide to Wildlife Habitats of California.* State of California, Resources Agency, Department of Fish and Game. 166 pp.

Modoc National Forest. 1998. *Medicine Lake Highlands Managed Late-Successional Area Assessment.* Department of Agriculture, United States Forest Service, Pacific Southwest Region (June 1998).

Patera, E.L. (ed.). 1991. *History of California Post Offices 1849-1990* (Second Edition). The Depot, n.p.

Pease, R.W. 1965. *Modoc County: A Geographic Time Continuum on the California Volcanic Tableland.* University of California Publications in Geography 17.

Reynolds, R.T., R.T. Graham, M.H. Reiseer, R.L. Bassett, P.L. Kennedy, D.A. Boyce, Jr., G. Goodwin, R. Smith, and E.L. Fisher. 1992. *Management Recommendations for the Northern Goshawk in the Southwestern United States.* General Technical Report RM-217. Fort Collins, CO. U.S. Department of Agriculture, Forest Service. Rocky Mountain Forest and Range Experiment Station. 90 pp.

Self, S. and S.J. Kerns. 1993. *Pine Marten Use of Managed Forest Landscape in Northern California.* Report to: Sierra Pacific Industries, Anderson, CA.

Skinner, C. N. and Chang, C. 1996. Fire Regimes, Past and Present,. In Sierra Nevada Ecosystems Project: Final Report to Congress, vol. II, chap. 38, Davis: University of California, Centers for Water and Wildland Resources.

Solis, D.M. 1983. *Summer habitat ecology of spotted owls in northwestern California.* Unpublished M.S. thesis, Humboldt State University, Arcata, CA.

Sutton, R.K. 1987. Captain Jack and His People: The Modocs Before Banishment. In *The Northwestern Tribes in Exile; Modoc, Nez Perce, and Palouse Removal to the Indian Territory.* Clifford E. Trafzer (ed.), pp. 1-14. Sierra Oaks Publishing Company, Sacramento.[3]

Swanson, F. J., Jones, J. A., Wallin, D.O., and Cissel, J.H. 1994. Natural variability - implications for ecosystem management. In Ecosystem Management: Principles and applications, edited by M.E. Jensen and P.S. Bourgeron, 80-94. Vol. 2 of Eastside forest ecosystem health assessment, General Technical Report PNW - GTR-318. Portland, OR: U. S. Forest Service, Pacific Northwest Research Station.

Theodoratus, D. and G. Emberson. 1996. *Ethnographic Report, Fourmile Hill Geothermal Project.* Report prepared for Bureau of Land Management and U.S. Forest Service, Alturas, California.

Thomas J.W. Tech. Edit. 1979. *Wildlife Habitats in Managed Forests.* U.S. Department of Agriculture Forest. Service Ag. Handbook No. 553.

Thomas, J.W., E.D. Forsman, J.B. Lint, E.C. Meslow, B.R. Noon, B.R., and J. Verner. 1990. *A conservation strategy for the northern spotted owl.* Interagency Scientific Committee to Address the Conservation of the Northern Spotted Owl, U.S. Department of Agriculture, Forest Service, and U.S. Department of the

[3]This reference is available for viewing at the Bancroft Library located at the University of California at Berkeley, Berkeley, California.

Interior, Bureau of Land Management, Fish and Wildlife Service, National Park Service. Portland, OR 427 pp.

USFS and Soil Conservation Service. 1983. *Soil Survey of Modoc National Forest Area, California.* In cooperation with the Regents of the University of California (Agricultural Experiment Substation).

USFS and BLM. 1994. *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl; Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl.* (aka Northwest Plan; aka formerly known as the President's Plan) (April 1994).

USFS. 1991. *Modoc National Forest Land and Resources Management Plan.* Modoc National Forest, Alturas, CA.

USFS. 1991a. *Modoc National Forest, Final Environmental Impact Statement.* Including Appendices Volume and Map Packet. Modoc National Forest, Alturas, CA.

Verner, J.E. and A.S. Boss tech. Coords. 1980. California Wildlife and Their Habitats: Western Sierra Nevada. U.S. Forest Service Gen. Tec. Report PSW-37.

Villegas, J. 1991. Northern Spotted Owl Survey Report to Modoc National Forest, Doublehead Ranger District. Modoc National Forest Wildlife Management files, Alturas CA.

Weatherspoon, C.P., Fire-silviculture relationships in Sierra forests, In Sierra Nevada Ecosystems Project: Final Report to Congress, vol. II, chap. 44, Davis: University of California, Centers for Water and Wildland Resources.

Whitaker, J.O., R. Elman, C. Nehring. 1988. The Audubon Society Field Guide to North American Mammals. Alfred A. Knopf, Inc. New York.

Wogen, N.S. and J. D. Lippert. 1998. "Management Recommendations for Candystick or Sugarstick (*Allottropa virgata*)". version 2.0.

Wohlgemuth, E. and A.J. Gilreath. 1997. *Cultural Resources Survey of the Telephone Flat Geothermal Project Area, Modoc National Forest.* MS on file, ASR 05-09-1084, California Archaeological Site Inventory, Chico.

Zeiner, D.C., W.F. Laudenslayer, K.E. Mayer, and M. White (eds.) 1990a. *California's wildlife. Vol II. Birds.* California Department of Fish and Game, Sacramento, CA. 732 pp.

Zeiner, D.C., W.F. Laudenslayer, K.E. Mayer, and M. White (eds.) 1990b. *California's wildlife. Vol II. Mammals.* California Department of Fish and Game, Sacramento, CA. 407 pp.

ACRONYMS

The following is a list of acronyms used throughout the Medicine Lake Highlands Area Watershed Analysis.

ALDS	Automatic Lightning Detection System
AWC	Available Water Capacity
BLM	Bureau of Land Management
BP	Before Present
CDFG	California Department of Fish and Game
EM1	Ponderosa-White Fir-Incense Cedar/Squaw Carpet Association
EM3	Washoe-Red Fir-Western White/Greenleaf Manzanita Association
EM4	Ponderosa - White Fir - Sugar/Bitterbrush Association
EM5	Lodgepole-Ponderosa-Sugar Pine/Jewel Flower Association
EUI	Ecological Unit Inventory
FBP	Fire Behavior Potential
GIS	Geographic Information Systems
KGRA	Known Geothermal Resource Area
LP1	Lodgepole/Western Needlegrass Association
LP2	Lodgepole/Pinemat Manzanita Association
LP3	Lodgepole-Western White Pine/Creambush Association
LRMP	Land and Resource Management Plan
LSH	Late-Successional Habitat
MLH	Medicine Lake Highlands
MLSA	Managed Late-Successional Area
NEPA	National Environmental Policy Act
NFMP ROD	Northwest Forest Management Plan Record of Decision
NSO	Northern Spotted Owl
PJ1	Ponderosa Pine - Western Juniper/Bitterbrush Association
PP1	Ponderosa/Bitterbrush Association
PP2	Ponderosa - White Fir/Bitterbrush Association
PP3	Ponderosa Pine-White Fir/Snowberry Association
PP4	Ponderosa-Lodgepole/ Bitterbrush Association
RF1	Red Fir/Ross's Sedge Association
RF2	Red Fir-White Fir/Wintergreen Association
RF3	Red Fir-Lodgepole/Western Needle Grass Association
ROD	Record of Decision
RSL	Remote Sensing Laboratory
SC1	Hemlock-Red Fir/Ross's Sedge Association
SC2	Hemlock/Pityopus Association
SC3	Hemlock-Lodgepole/Ross's Sedge Association
SIA	Special Interest Area
SNEP	Sierra Nevada Ecosytems Project
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
WF1	White Fir/Chinquapin Association
WHR	Wildlife Habitat Relationship

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Appendix A

Soils

The following information on soil families and associations applicable to the Medicine Lake Watershed Area is extracted from the Soil Survey of Modoc National Forest Area, California [USFS and Soil Conservation Service, in cooperation with the Regents of the University of California (Agricultural Experiment Substation), 1983)].

SOIL FAMILY ASSOCIATION (page 13)

Alcot-Sadie-Germany deep families

This unit consists of deep soils located essentially east and south of the Burnt Lava Flow Virgin Area on the western edge of the survey area. It is on basalt plateaus and lower sideslopes of cinder cones at elevations of 4,350 to 5,500 feet. Slopes range from 1 to 20 percent. Annual precipitation ranges from 20 to 30 inches, and the frost-free growing season is 10 to 110 days.

These soils support mixed conifer forest which consists of ponderosa pine, white fire, incense cedar, and sugar pine, with a forest survey site index of 3 to 4. Understory vegetation may consist of greenleaf manzanita, ceanothus, rabbitbrush, snowberry, bitterbursh, big sagebrush, arrowleaf balsamroot, and some perennial grasses and sedges.

This unit makes up about 0.7 percent of the survey area. It is about 30 percent Alcot, 30 percent Sadie, and 25 percent Germany soils. The remaining 15 percent of this unit is made up primarily of the Elmore and Lawyer families, Lithic Xerumbrepts and lava flow rock.

The Alcot soils are greater than 40 inches deep. They are somewhat excessively drained, and permeability is moderately rapid. They normally have a yellowish brown, gravelly sand loam surface over a very gravelly sandy loam substratum which normally grades to extremely gravelly loamy coarse sand with depth.

The Sadie soils are greater than 40 inches deep. They are well drained, and permeability is moderately rapid. They normally have a yellowish brown, gravelly sandy loam surface over a gravelly coarse sandy loam subsoil and substratum.

The Germany soils in this unit are greater than 40 inches deep. They are well drained, and permeability is moderately rapid. They normally have a dark yellowish brown, fine sandy loam surface soil over a cobbly fine sandy loam to very cobbly fine sandy loam subsoil and substratum.

Stonewell-Yallani families

This unit is composed of moderately deep and deep soils on volcanic mountain uplands of the south side of the Medicine Lake Highlands. Slopes range from 2 to 70 percent, and elevation ranges from 4,600 to 7,000 feet. Annual precipitation ranges from 25 to 45 inches, and the frost-free growing season is 60 to 90 days.

These soils support dense stands of white fir forest or mixed conifer forest of white fir, red fir, incense cedar, sugar pine, and ponderosa pine. Forest survey site class is 4 to 5. Understory vegetation is normally very sparse and may consist of greenleaf manzanita, snowbrush, squawcarpet, mint, currant, ceanothus, chinquapin, and few perennial grasses and sedges.

This unit makes up about 1.3 percent of the survey area. It is about 40 percent Stonewell and 35 percent

Yallani soils. The remaining 25 percent of this unit is composed primarily of the Sheld, Ahart, and Xynbar families and frigid, Lithic Xerorthents and rock outcrop.

The Stonewell soils are greater than 30 inches deep. They are well drained, and permeability is moderately rapid. They normally have a brown gravelly sandy loam surface over an extremely cobbly fine sandy loam or extremely cobby loam subsoil.

Stonewell-Yallani-Inville families, pumice overburden

This unit is composed of a deep soils with a recent pumice deposition of 6 inches to greater than 40 inches thick. It is on volcanic mountain uplands on the north and east side of the Medicine Lake Highlands. Slopes range from 2 to 40 percent, and elevation ranges from 5,300 to 6,500 feet. Annual precipitation ranges from 20 to 40 inches, and the frost-free growing season is 60 to 90 days.

These soils support open to semi-dense stands of white fir, or mixed conifer forests or white fir, ponderosa pine, incense cedar, and sugar pine or lodgepole pine forests. Forest survey site class fluctuates from 4, where the pumice deposit is thin, to 6 or 7, where the pumice deposit is deep. Understory vegetation may consist of greenleaf manzanita, rabbitbrush, ceanothus, bitterbrush, squawcarpet, and few perennial grasses and sedges.

This unit makes up about 1.2 percent of the survey area. It is about 40 percent Stonewell, 25 percent Yallani, and 15 percent Inville soils. The remaining 20 percent is made up mainly of frigid, Lithic Xerothents and rock outcrop.

The Stonewell soils are deep and contain a relatively recent pumice deposition of 6 inches to greater than 40 inches thick. The pumice deposit normally consists of a grayish brown, gravelly coarse loamy sand over a very pale brown, extremely gravelly coarse sand. The underlying soil, if present, is normally a very gravelly sandy loam, extremely gravelly loamy sand, or extremely coarse sand. They are somewhat excessively drained, and permeability is rapid in the pumice deposit and moderately rapid below.

The Yallani soils are deep and contain a relatively recent pumice deposition of 6 to 20 inches thick. The pumice deposit normally consists of grayish brown, gravelly coarse loamy sand over a very pale brown, extremely gravelly coarse sand. The underlying soil normally consists of an extremely cobbly fine sandy loam or extremely cobbly loam. It is well drained, and permeability is rapid in the pumice deposit and moderately rapid below.

The Inville soils are deep and contain a relatively recent pumice deposition 8 to 20 inches thick. The pumice deposit normally consists of a grayish brown, gravelly loamy sand or very gravelly loamy coarse sand over extremely gravelly coarse sand or gravelly loamy sand. The underlying soil normally consists of a very gravelly sandy loam to very gravelly loam. It is well drained, and permeability is rapid in the pumice deposit and moderate below.

Divers-Lapine-Kinzel families

This unit is composed of moderately deep and deep soils which may have a recent pumice deposition of up to 24 inches thick. It is in the Medicine Lake Caldera and volcanic mountain sideslopes of the Medicine Lake Highlands. Slopes range from 1 to 60 percent, and elevation ranges from 6,500 to 7,900. Annual precipitation is 35 to 45 inches, and the frost-free season is 40 to 70 days.

These soils support red fir forest or mixed conifer forest of lodgepole pine, western white pine, red fir, and mountain hemlock. Forest survey site class is 5 to 6. Understory vegetation may include penstemon, prostrate manzanita, mint, snowberry, and chinquapin, and is normally very sparse.

This unit makes up to 1.3 percent of the soil survey area. It is about 35 percent Divers, 30 percent Lapine,

and 15 percent Kinzel soils. The remaining 20 percent of this unit is made up primarily of the Wuksi family and rock outcrop.

The Divers soils are greater than 30 inches deep over basalt or cinders. They are somewhat excessively drained, and permeability is rapid. They normally have a grayish brown, very gravelly coarse sand surface over extremely gravelly coarse sand, extremely gravelly sandy loam, or extremely gravelly loamy coarse sand substratum.

The Kinzel soils are moderately deep over weakly cemented or compacted volcanic ash and cinders. They are well drained, and permeability is moderately rapid. They normally have a dark grayish brown, gravelly loamy sand surface over very cobbly sandy loam to extremely stony sandy loam subsoil.

Lava flow rock-Rock outcrop

This miscellaneous land type occurs throughout the survey area, with the main areas of concentration being in and around the Medicine Lake Highlands and on the east side of the Warner Mountain Range. It can be found on nearly level basalt plateaus to extremely steep mountain sideslopes.

This land type is used mainly for aesthetic values, recreation, some wildlife, and for watershed.

This unit makes up about 3.2 percent of the survey area. It is about 60 percent Lava flow rock and 15 percent Rock outcrop. The remaining 25 percent of this unit is composed primarily of the Bakeover and Cheadle families, frigid, Lithic Xerothents, Lithic Cryochrepts, and Rubble land.

Lava flow rock consists of relatively recent, hard vesicular basalt flow rock or obsidian flow rock.

Rock outcrop consists of basalt, andesite, or conglomerate tuff bedrock and may have minor accumulations of aeolian soil deposition in some fractures.

EROSION FACTOR (K) (page 22)

Soil Erodobility (K-factor). Indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on the soils surface texture and organic matter (up to 4 percent) and on soil permeability. The estimates are modified by the presence of rock fragments. Values of K in this survey range from 0.15 to 0.49. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

MAXIMUM EROSION HAZARD (page 22)

Erosion Hazard Maximum. This rating indicates the level of risk of soil loss by erosion and is based on the assumption that most or all of the vegetative surface cover has been removed due to management practices or to wildfire. The risk is low if the expected soil loss is small, moderate if standard and non-intensive measures are need to control erosion, and high or very high if excessive soil loss is expected without intensive and/or expensive measures to control erosion. The process used for evaluating the potential of a soil within a mapping unit for erosion includes such soil characteristics as texture, structure, permeability, and depth, at which permeability begins. The process also considers such others factors as slope and length of slope, distribution and form of precipitation, aspect and any remaining vegetative cover.

SOIL PERMEABILITY (page 22)

Soil profile permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement or water when the soil is saturated. They are based on soil characteristics observed

in the field, particularly structure, porosity, and texture. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability include: Very Slow, less than 0.06 inches; Slow, 0.06 to 0.2 inches; Moderately Slow, 0.2 to 6.0 inches; Moderate, 0.6 to 2.0 inches, Moderately Rapid, 2.0 to 6.0 inches; Rapid, 6.0 to 20 inches; and Very Rapid, greater than 20 inches.

DRAINAGE CLASS (page 22)

Soil Drainage Class. This interpretation is the natural drainage class assigned to that soil type. It refers to the frequency and duration of periods of saturation or partial saturation during which soil formation, as opposed to altered drainage, which is commonly the result of artificial damage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained - Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained - Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained - Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained - Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer, a high water table, additional water from seepage, or a combination of these.

Poorly drained - Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, or a combination of these.

Very poorly drained - Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded.

WATER RUNOFF POTENTIAL (page 33)

Water Runoff Potential. This rating indicates the relative velocity of surface water runoff over a soil type and its associated map unit under natural vegetative conditions. Factors considered in rating runoff were slope, average length of slope and hydrologic soil groups. Velocity of runoff directly affects surface soil erosion by water, and, therefore, becomes an important parameter for proper design of structures such as culverts, bridges, dams, spillways, and roads. The Water Runoff Potential also gives a good indication of the relative amount of soil water recharge a soil might receive for plant growth and soil development.

The five classes of water runoff and the definitions are:

Very Slow - Free water lies on the surface for long periods or enters immediately into the soil. Velocity is such that erosion by runoff would be minimal.

Slow - Free water covers the soil for significant periods or enters the soil rapidly; a large part of the water passes through the profile or evaporates into the air. The velocity is such that erosion by runoff would normally be only of slight concern.

Moderate - Surface water flows away at such a rate that a moderate proportion of the water enters the soil profile and free water lies on the surface for only short periods. With moderate runoff, the loss of water over the surface does not reduce seriously the supply available for plant growth. The velocity of the runoff is such that erosion by runoff could present a moderate to serious concern.

Rapid - A large proportion of the precipitation moves rapidly over the surface of the soil and a small part moves through the soil profile. Surface water runs off nearly as fast as it is added. The rapid velocity of the runoff would pose a serious concern to soil erosion by runoff.

Very Rapid - Most of the water moves very rapidly over the surface of the soil and only a very small part moves through the soil profile. The very rapid velocity of the runoff could result in very severe erosional problems.

WATERSHED SENSITIVITY (page 33)

Natural Watershed Sensitivity. This rating was developed as a method to help set watershed threshold levels for cumulative watershed impact analysis. It rates the potential of the map unit to contribute to water runoff and determines how rapidly it will respond with runoff from a given storm event or spring melt, and its sensitivity to erosion and slope stability. To determine natural watershed sensitivity rating by watershed, a proportionate rating is used based on area percentage of each soil map unit within the watershed. An overall watershed adjective rating of low, moderate, high or very high is only relative to the soils and watersheds in this survey area and is used as an indicator to help set the final cumulative watershed threshold level for a particular watershed.

The four natural watershed sensitivity ratings indicate the level of sensitivity by mapping unit and ultimately by whole watersheds when the above analysis is determined. The sensitivity is low if a large amount of disturbance can be tolerated before off-site degradation occurs, Moderate if a moderate amount of disturbance can be tolerated, and High or Very High if corresponding lower amounts of watershed disturbance can be tolerated before off-site watershed degradation is expected to occur.

HYDROLOGICAL SOIL GROUP (page 34)

Hydrologic Soil Groups. are used to estimate relative amounts of runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A - Soils have a high infiltration rate (potential for a low volume of runoff) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B - Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C - Soils having a slow infiltration rate when throughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D - Soils having a very slow infiltration rate (potential for a high volume of runoff) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

AVAILABLE WATER HOLDING CAPACITY (page 34)

Available Water Holding Capacity (AWC) Rating. This available water holding capacity rating refers to the quantity of water that the whole soil is capable of storing for use by plants. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, soil mineralogy, kind and volume of rock fragments, bulk density, and soil structure. Available water holding capacity is an important factor in determining the chance of conifer seedling survival and in the choice of plants to be seeded in range or wildlife vegetation manipulation projects or watershed stabilization or improvement work. Available water holding capacity is not an estimate of the quantity of water actually available to plants at any given time. The capacity for water storage is given as an adjective rating and includes the whole soil depth to 60 inches or to a root restricting contact if shallower. Total soil depth will always include a range in depth as shown under effective rooting depth in inches and type of underlying material. This range in depth will often result in a range in AWC adjective ratings such as a very low to low, or low to moderate, and so on. The adjective ratings represent the plant available water in inches of water for the whole soil depth and are as follows. Very low, 0.6 to 1.5 inches; Low, 1.5 to 3.5 inches; Moderate, 3.5 to 6.5 inches; and High 6.5 plus inches.

Appendix B

Fire and Fuels

The following is a description of the components and the process involved in determining fire behavior potential and risk for the Medicine Lake Watershed

FUEL MODEL DEFINITIONS

The prediction of fire behavior is valuable for assessing potential fire damage to resources. A quantitative basis for rating fire danger and predicting fire behavior became possible with the development of mathematical fire behavior fuel models. Fuels have been classified into four groups - grasses, brush, timber and slash. The differences in these groups are related to the fuel load and the distribution of the fuel among size classes. Size classes are: 0-¼" (1 hour fuels), ¼-1 " (10 hour fuels), 1-3" (100 hour fuels) and 3" and greater (1000 hour fuels).

Table 1: Description of Fuel Models Used in Fire Behavior as documented by Albini (1976)

FUEL MODEL Typical Fuel Complex	FUEL LOADING tons/acre				FUEL BED DEPTH feet
	1 Hr	10 Hr	100 Hr	Live	
GRASS AND GRASS-DOMINATED					
1-Short Grass (1 foot)	0.74	0.00	0.00	0.00	1.0
2-Timber (Grass and Understory)	2.00	1.00	0.50	0.50	1.0
3-Tall Grass (2.5 foot)	3.01	0.00	0.00	0.00	-
CHAPARRAL AND SHRUB FIELDS					
4-Chaparral (6 feet)	5.01	4.01	2.00	5.01	6.0
5-Brush (2 feet)	1.00	0.50	0.00	2.00	2.0
6-Dormant Shrub/Hardwood Slash	1.50	2.50	2.00	0.00	2.5
7-Southern Rough	1.13	1.78	1.50	0.37	2.5
TIMBER LITTER					
8-Closed Timber Litter	1.50	1.00	2.50	0.00	0.2
9-Hardwood Litter	2.92	0.41	0.15	0.00	0.2
10-Timber (Litter and Understory)	3.01	2.00	5.01	2.00	1.0
SLASH					
11-Light Logging Slash	1.50	4.51	5.51	0.00	1.0
12-Medium Logging Slash	4.01	14.03	16.53	0.00	2.3
13-Heavy Logging Slash	7.01	23.04	28.05	0.00	3.0

The criteria for choosing a fuel model (Anderson, 1982) includes the fact that the fire burns in the fuel stratum best conditioned to support the fire. Fuel models are simply tools to help the user realistically estimate fire behavior. Modifications to fuel models are possible by changes in the live/dead ratios, moisture contents, fuel loads, and drought influences. The 13 fire behavior predictive fuel models are used during the severe period of the fire season when wildfire pose greater control problems and impacts on land resources.

The following is a brief description of each of the 13 fire behavior fuel models.

GRASS GROUP

Fire Behavior Fuel Model 1 - Fire spread is governed by the very fine, porous, and continuous herbaceous fuels that have cured or are nearly cured. Fires are surface fires that move rapidly through the cured grass. Very little timber or shrub is present.

Fire Behavior Fuel Model 2 - Fire spread is primarily through cured or nearly cured grass where timber or shrubs cover ⅓ to ⅔ of the open area. These are surface fires that may increase in intensity as they hit pockets of other litter.

Fire Behavior Fuel Model Model 3 - Fires in this grass group display the highest rates of spread and fire intensity under the influence of wind. Approximately ⅓ or more of the stand is dead or nearly dead.

SHRUB GROUP

Fire Behavior Fuel Model 1 - Fire intensity and fast spreading fires involve the foliage and live and dead, fine woody continuous secondary overstory. Stands of nearly mature shrubs, six feet tall or more are typical candidates. Besides flammable foliage, dead woody material in the stands contributes significantly to the fire intensity. A deep litter layer may also hamper suppression efforts.

Fire Behavior Model 5 - Fire is generally carried by surface fuels that are made up of litter cast by the shrubs and grasses or forbs in the understory. Fires are generally not very intense because the fuels are light and shrubs are young with little dead material. Young green stands with little dead wood would qualify.

Fire Behavior Fuel Model 6 - Fires carry through the shrub layer where the foliage is more flammable than Fire Behavior Fuel Model 5, but requires moderate winds, greater than eight miles per hour.

Fire Behavior Fuel Model 7 - Fires burn through the surface and shrub strata with equal ease and can occur at higher dead fuel moisture because of the flammability of live foliage and other live material.

TIMBER GROUP

Fire Behavior Fuel Model 8 - Slow burning ground fuels with low flame lengths are generally the case, although the fire may encounter small "jackpots" of heavier concentrations of fuels that can flare up. Only under severe weather conditions do the fuels pose a threat. Closed canopy stands of short-needled conifers or hardwoods that have leafed-out, support fire in the compact litter layer. This layer is mostly twigs, needles, and leaves.

Fire Behavior Fuel Model 9 - Fires run through the surface faster than in Fire Behavior Fuelfuel model 8 and have a longer flame length. Both long-needle pine and hardwood stands are typical. Concentrations of dead, down woody material will cause possible torching, spotting, and crowning of trees.

Fire Behavior Fuel Model 10 - Fires burn in the surface and ground fuels with greater intensity than the other timber litter types. A result of over maturing and natural events creates a large load of heavy down, dead material on the forest floor. Crowning out, spotting and torching of individual trees is more likely to occur, leading to potential fire control difficulties.

LOGGING SLASH GROUP

Fire Behavior Fuel Model 11 - Fires are fairly active in the slash and herbaceous material intermixed with the slash. Fuel loads are light and often shaded. Light partial cuts or thinning operations in conifer or hardwood

stands are representative of this model classification. Clear-cut operations generally produce more slash than is typical of this fuel model.

Fire Behavior Fuel Model 12 - Rapidly spreading fire with high intensities capable of generating firebrands can occur. When fire starts it is generally sustained until a fuelbreak or change in conditions occur. Fuels generally total less than 35 tons per acre and are well distributed. Heavily thinned conifer stands, clearcuts, and medium to heavy partial cuts are of this model.

Fire Behavior Fuel Model 13 - Fire is generally carried by a continuous layer of slash. Large quantities of material 3 inches and greater is present. Fires spread quickly through the fine fuels and intensity builds up as the large fuels begin burning. Active flaming is present for a sustained period of time and firebrands may be generated. This contributes to spotting as weather conditions become more severe. Clearcuts are depicted where the slash load is dominated by the greater than 3 inch fuel size, but may also be represented by a "red slash" type where the needles are still attached because the of high intensity of the fuel type.

Fire Behavior Fuel Model 14 is virtually non-flammable due to wet conditions.

Fuel models identified and used in this analysis are in Table 2.

Table 2: Fire Behavior Fuel Model Acreage

Fuel Model	Acres	Percent
0	14375.4672	16.82660684
1	69.5969	0.081463764
2	194.5477	0.22771974
5	8544.0372	10.00086834
6	13756.5605	16.10217128
8	7626.4214	8.926791229
9	114.6268	0.134171646
10	35346.0737	41.37288043
11	5405.6221	6.327326726
Total	85432.9535	100

Source: Modoc National Forest Remote Sensing Lab (1993) Villegas and Sinclair.

FIRE BEHAVIOR POTENTIAL

To determine the Fire Behavior Potential Classes, each fuel model is run through the BEHAVE program. This program uses fuel model, slope, and weather parameters to predict fire behavior and resistance to control for fire suppression purposes. The 90th percentile weather from the most representative weather station was used to model late summer afternoons, typical of late July through early September.

Two slope classes are used 0-34%, and >35%. All fuel models were run through each of the two slope classes, to determine increases in fire behavior with increased steepness of terrain. As determined in the Medicine Lake Highlands Managed Late-Successional Area Assessment.

The output of this is a rating of Low, Moderate, or High Fire Behavior caused on flame lengths, which are good indicators of fire line intensity and resistance to control, and/or rate of spread (ROS), which is also a good indicator of resistance to control.

Fire behavior potential modeling is done in order to estimate the severity and resistance to control that can be expected, when a fire occurs during what is considered the worst case weather conditions. Late summer weather conditions are referred to as the 90th percentile weather data, which is a standard used when calculating fire behavior (90th percentile weather is defined as the severest 10 percent of the historical fire weather, i.e., hot, dry, windy conditions occurring on mid afternoons during the fire season). The modeling incorporates fuel conditions in calculating projections on flame lengths and rates of spread. A low rating indicates that fires can be attacked and controlled directly by ground crews building fireline and will be limited to burning in understory vegetation. A moderate rating indicates that hand built fires and that heavy equipment and retardant drops would be more effective. Areas rated as high represent the most hazardous conditions in which serious control problems would occur (i.e., torching, crowning, and spotting, control lines are established well in advance of flaming fronts with heavy equipment and backfiring may be necessary to widen control lines).

Using the CONTAIN model of BEHAVE, it was determined whether or not a fire with Low Flame Lengths could be contained by the initial attack forces. These runs indicated that given, typical response times, terrain, fuels, and available forces, a Low rating had to have a ROS >30 chains per hour (chs/hr), for containment to be accomplished during initial attack.

FIRE BEHAVIOR POTENTIAL CLASSES

Low - Flame lengths <4' and ROS <30chs/hr. Fires can generally be attacked at the head or flanks by firefighters using handtools. Handline should hold the fire.

Moderate - Flame lengths 4' - 8'
Fires are too intense for direct attack at the head of the fire by firefighters using handtools. Handline cannot be relied on to hold the fire. Equipment such as dozers, engines, water and/or retardant dropping aircraft can be effective.

High - Flame length >8'
Fires may present serious control problems, such as torching, crowning, and spotting. Control efforts at the head of the fire will be ineffective.

Table 3 contains the acreage amounts associated with each Fire Behavior Class in the Watershed:

Table 3: Fire Behavior Potential Acreage by Land Ownership

Fire Behavior Potential	Ownership		Entire Area
	Forest Service	Private	
Non-flammable	14050.7393	324.7279	14375.4672
Low	23936.4513	1031.4675	24967.9188
Moderate	20119.0977	762.4971	20881.5948
High	23364.4365	1843.5361	25207.9726
Totals	81470.7248	3962.2286	85432.9534

Source: Modoc National Forest Remote Sensing Lab (1993) Villegas and Sinclair

Table 4 through Table 7 provide additional information on how each Fuel Model group relates to specific habitat types, aspects, and Fire Behavior Potentials.

Table 4: Fire Behavior Potential (FBP) for WHR Habitat Types between elevations of 4300 and less than 6300 feet, and slopes between 0 and 35 percent. FBP is also based upon Aspect. Abbreviations used for Aspect: A = All, L = Level, N = North, E = East, S = South, and W = West (Exception: Level NOT included in all.) Abbreviations used for FBP: L = Low, M = Moderate, and H = High.

Fuel Model	Aspect	Fire Behavior	WHR Habitat Types
1	H		WTM
2	A	H	HRB SGB JUN3M JUN3P JUN3S EPN3P EPN3S EPN4P EPN4S
2	L	M	EPN4X
5	L	H	SMC2X SMC3D SMC3M SMC3P SMC3S SMC3X
5	N	M	SMC3M SMC3P SMC3S SMC3N WFR4P WFR4S WFR5P WFR5S RFR1N RFR2N RFR3M RFR3P RFR3S
5	E S W	H	SMC2X SMC3D SMC3M SMC3P SMC3S SMC3N SMC3X WFR4P WFR4S WFR5P WFR5S RFR1N RFR2N RFR3M RFR3P RFR3S
6	A	M	BBR MCP EPN1N SMC1N SMC2N WFR2N
6	L	M	EPN1X EPN2X SMC1X WFR2X RFR1X RFR2X
8	A	L	SMC2P SMC4S SMC5P SMC5S LPN1N LPN3P LPN3S LPN4P LPN4S SCN4D SCN4M SCN4P SNC4S SCN5D SCN5M
8	L	L	LPN1X
9	L	H	EPN3D
9	L	H	EPN3D
10	L	H	EPN4D SMC4D SMC4M SMC5M WFR3M WFR4D WFR4M WFR5D RFR4D RFR5D LPN3D LPN3M LPN4D
10	N	L	SMC4D SMC4M SMC5D SMC5M WFR3D WFR3M WFR4D WFR4M WFR5M RFR4D RFR4M RFR5D RFR5M LPN4D LPN4M LPN4N LPN3D LPN3M
10	E S W	H	SMC4D SMC4M SMC5D WFR3D WFR3M WFR4D WFR4M WFR5D RFR4D RFR4M RFR5D RFR5M LPN3D LPN3M LPN4D LPN4M LPN4N
11	A	L	RFR4P RFR4S RFR5M RFR5P RFR5S

Table 5: Fire Behavior Potential (FBP) for WHR Habitat Types between elevations of 4300 and less than 6300 feet, and slopes greater than 35 percent. FBP is also based upon Aspect. Abbreviations used for Aspect: A = All, L = Level, N = North, E = East, S = South, and W = West (Exception: Level NOT included in all.) Abbreviations used for FBP: L = Low, M = Moderate, and H = High.

Fuel Model	Aspect	Fire Behavior	WHR Habitat Types
1	A	M	WTM
2	A	M	HRB SGB JUN3M JUN3P JUN3S EPN3P EPN3S EPN4P EPN4S
2	L	H	EPN4X
5	L	H	SMC2X SMC3D SMC3M SMC3P SMC3S SMC3X
5	N	H	SMC3M SMC3N WFR4P WFR4S WFR5P WFR5S RFR1N RFR2N RFR3M RFR3P RFR3S
5	E S W	H	SMC3D SMC3M SMC3P SMC3S SMC3N WFR4P WFR4S WFR5P WFR5S RFR1N RFR2N RFR3M RFR3P RFR3S
6	A	H	BBR MCP EPN1N SMC1N SMC2N WFR2N
6	L	H	EPN1X EPN2X SMC1X WFR2X RFR1X RFR2X
8	A	M	SMC4P SMC4S SMC5P SMC5S LPN1N LPN3P LPN3S LPN4P LPN4S SCN4D SCN4M SCN4P SCN4S SCN5D SCN5M
8	L	M	LPN1X
9	A	H	EPN3M EPN4M
9	L	H	EPN3D
10	L	H	EPN4D SMC4D SMC4M SMC5M WFR3M WFR4D WFR4M WFR5D RFR4D RFR5D LPN3D LPN3M LPN4D
10	N	H	SMC4D SMC4M SMC5D SMC5M WFR3D WFR3M WFR4D WFR4M WFR5D WFR5M RFR4D RFR4M RFR5D RFR5M LPN3D LPN3M LPN4D LPN4M LPN4N
10	E S W	H	SMC4D SMC4M SMC5D WFR3D WFR3M WFR4D WFR4M WFR5D RFR4D RFR4M RFR5D RFR5M LPN3D LPN3M LPN4D LPN4M LPN4N
11	A	M	RFR4P RFR4S RFR5M RFR5P RFR5S

Table 6: Fire Behavior Potential (FBP) for WHR Habitat Types between elevations greater than 6300 feet, and slopes between 0 and 35 percent. FBP is also based upon Aspect. Abbreviations used for Aspect: A = All, L = Level, N = North, E = East, S = South, and W = West (Exception: Level NOT included in all.) Abbreviations used for FBP: L = Low, M = Moderate, and H = High.

Fuel Model	Aspect	Fire Behavior	WHR Habitat Types
1	A	M	WTM
2	A	M	HRB SGB JUN3M JUN3P JUN3S EPN3P EPN3S EPN4P EPN4S
2	L	M	EPN4X
5	A	M	SMC3D SMC3M SMC3P SMC3S SMC3N WFR4P WFR4S WFR5P WFR5S RFR1N RFR2N RFR3M RFR3P RFR3S
5	L	M	SMC2X SMC3D SMC3M SMC3P SMC3S SMC3X
6	A	M	BBR MCP EPN1N SMC1N SMC2N WFR2N
6	L	M	EPN1X EPN2X SMC1X WFR2X RFR1X RFR2X
8	A	L	SMC4P SMC4S SMC5P SMC5S LPN1N LPN3P LPN3S LPN4P LPN4S SCN4D SCN4M SCN4P SNC4S SCN5D SCN5M
8	L	L	LPN1X
9	L	H	EPN3D
10	L	M	EPN4D SMC4D SMC4M SMC5M WFR3M WFR4D WFR4M WFR5D RFR4D RFR5D LPN3D LPN3M LPN4D
10	N	L	SMC4D SMC4M SMC5D SMC5M WFR3D WFR3M WFR4D WFR4M WFR5D WFR5M RFR4D RFR4M RFR4S RFR5D RFR5M LPN3D LPN3M LPN4D LPN4M LPN4N
10	E S W	M	SMC4D SMC4M SMC5D SMC5M WFR3D WFR3M WFR4D WFR4M WFR5D WFR5M RFR4D RFR4M RFR4S RFR5D RFR5M LPN3D LPN3M LPN4D LPN4M LPN4N
11	A	L	RFR4P RFR4S RFR5M RFR5P RFR5S

Table 7: Fire Behavior Potential (FBP) for WHR Habitat Types between elevations greater than 6300 feet, and slopes greater than 35 percent. FBP is also based upon Aspect. Abbreviations used for Aspect: A = All, L = Level, N = North, E = East, S = South, and W = West (Exception: Level NOT included in all.) Abbreviations used for FBP: L = Low, M = Moderate, and H = High.

Fuel Model	Aspect	Fire Behavior	WHR Habitat Types
1	A	M	WTM
2	A	M	HRB SGB JUN3M JUN3P JUN3S EPN3P EPN3S EPN4P EPN4S
2	L	M	EPN4X
5	A	H	SMC3D SMC3M SMC3P SMC3S SMC3N WFR4P WFR4S WFR5P WFR5S RFR1N RFR2N RFR3M RFR3P RFR3S
5	L	H	SMC2X SMC3D SMC3M SMC3P SMC3S SMC3X
6	A	M	BBR MCP EPN1N SMC1N SMC2N WFR2N
6	L	M	EPN1X EPN2X SMC1X WFR2X RFR1X RFR2X
8	A	L	SMC4P SMC4S SMC5P SMC5S LPN1N LPN3P LPN3S LPN4P LPN4S SCN4D SCN4M SCN4P SCN4S SCN5D SCN5M
8	L	L	LPN1X
9	L	H	EPN3D
9	A	H	EPN3M EPN4M
10	L	M	EPN4D SMC4D SMC4M SMC5M WFR3M WFR4D WFR4M WFR5D RFR4D RFR5D LPN3D LPN3M LPN4D
10	N	L	SMC4D SMC4M SMC5D SMC5P WFR3D WFR3M WFR4D WFR4M WFR5D WFR5M RFR4D RFR4M RFR4S LPN3D LPN3M LPN4D LPN4M LPN4N
10	E S W	M	SMC4D SMC5D SMC5M WFR3D WFR3M WFR4D WFR4M WFR5D WFR5M RFR4D RFR4M RFR4S RFR5D RFR5M LPN3D LPN3M LPN4D LPN4M LPN4N
11	A	L	RFR4P RFR4S RFR5M RFR5P RFR5S

FIRE RISK

Historical records indicate lightning caused fires have been common in the watershed. Little precipitation (May to September) and high summer temperatures allow fuels to dry, which allows for ease and spread of wildfire ignitions.

There are numerous fire risks within the watershed. Summer residences, many dispersed campsites, recreational use, travel corridors, and powerlines, all contribute to the possibility of a wildfire occurrence from human causes.

The greatest risk of fire starts is from the occurrence of lightning. Thunderstorms are common throughout the summer months in and near the watershed. Lightning, erratic winds and usually precipitation accompany these storms, the latter which limits the actual number of ignitions.

The Modoc National Forest Automatic Lightning Detection System (ALDS) shows over a period from 1985 to 1996 there were at least 698 lightning strikes that could have started fires. This resulted in 344 fires occurring due to lightning (very few human caused fires are recorded). Using this fire history information and vegetation composition of the Watershed, one can determine the fire risk assessment. Table 7 provides acreage amounts and amounts of fires according to townships and ranges within the Medicine Lake Watershed.

It is important to realize that risk is not the probability of a fire occurring, but the probability of when a fire will occur. In this watershed, the fire will occur.

The historic disturbance regime for the watershed was dominated by fire. Natural fires were ignited by lightning and volcanic activity. Fires were also ignited by Native Americans. Native Americans ignited fires to enhance acorn production and facilitate gathering in the oak woodland communities, to improve bear grass quality for basket making in meadows and improve seed production of grasses, to improve travel, and to facilitate hunting. The vegetation in all the plant communities developed and adapted as a result of this disturbance regime.

Table 7: Analysis of Lightning Fires on the Klamath National Forest, Shasta-Trinity National Forests and the Modoc National Forest in the Medicine Lake Highlands; 1985-1996.

		R3E	R4E
T44N	Number of Fires	45	73
	National Forest Acres Burned	781	30
	Total Acres Burned	861	30
T43N	Number of Fires	29	22
	National Forest Acres Burned	89	50
	Total Acres Burned	89	50
T42N	Number of Fires	23	152
	National Forest Acres Burned	67	715
	Total Acres Burned	67	715

Source: Modoc National Forest, *Medicine Lake Highlands Managed Late Successional Area Assessment*, June 1998.

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Appendix C

Conifer Size and Canopy Closure Crosswalks

Table 1 crosswalks size and cover units provided with the Remote Sensing Laboratory Data to Modoc Land and Resource Management Plan Timber Size and Density Units (LRMP Timber Size and Density Units), USFS Region 5 (USFS R5)[1] codes and Modoc Land and Resource Management Plan Wildlife Habitat Relationships (LRMP WHR) codes. Figures 1.6, 3.7, 3.8, 3.9, 3.13, 4.2, 4.3 utilize the LRMP Timber Size and Density Unit classification of the Watershed.

Table 1: Seral Stage Crosswalk

Remote Sensing Lab Size/Cover Unit	LRMP Timber Size and Density Unit	USFS R5 Code	LRMP WHR Code	Size Description	Crown Cover Density Description
All 0's	1	0	1 (PL)	Plantations of Seedlings (<1" dbh)	
1 and 2's	2	1 and 2	2	Saplings and Poles (1-11" dbh)	
3S and 3P	3P	3S, 3P	3a	Small Tree (11-24"dbh)	<40%
3N and 3G	3G	3N, 3G	3b,c	Small Tree (11-24" dbh)	>40%
4S and 4P	4P	4S, 4P	4a	Med-Large Tree (>24" dbh)	<40%
4N and 4G	4G	4N, 4G	4b,c	Med-Large Tree (>24" dbh)	>40%

Table 2 crosswalks Conifer Crown Diameter to the to USFS Region 5 conifer size classes, and to the California Department of Fish and Game Wildlife Habitat Relationship System (CDFG WHR). It should be noted that the CDFG WHR codes are different from the LRMP WHR codes used in Table 1 of this Appendix.

Table 2: Conifer Size Classes

Conifer Crown Diameter	USFS Region 5	California Department of Fish and Game WHR System
N/A	0 Seedling (<1" dbh)	1 Seedling (< 1" dbh)
N/A	1 Sapling (1-4.9" dbh)	2 Sapling (1-6" dbh)
<12 feet	2 Pole	3 Pole
12-24 feet	3 Small	4 Small
25-40 feet	4 Medium	5 Medium/Large (>24" dbh)
>40 feet	5 Large	5 Medium/Large (>24" dbh)

[1]LRMP WHR should not be confused with CWHR (California Wildlife Hbaitat Relationships)

>1 Story	6 Two Storied	6 Multi-Layered (Size class 5 over a distinct layer of size 4 or 3, total tree canopy >60% crown closure)

Table 3 crosswalks Canopy Closure to the to USFS Region 5 conifer density classes, and to the California Department of Fish and Game Wildlife Habitat Relationship System (CDFG WHR System). It should be noted that the CDFG WHR codes are different from the LRMP WHR codes used in Table 1 of this Appendix.

Table 3: Conifer Density Classes/Canopy Closure

Canopy Closure	USFS Region 5	WHR System
0-9% Cover	0 (Non-stocked)	N/A
10-19% Cover	S (Sparse)	
10-24% Cover		S (Sparse)
20-39% Cover	P (Light)	
25-39% Cover		P (Open)
40-59% Cover		M (Moderate)
40-69% Cover	N (Medium)	
60-100% Cover		D (Dense)
70-100% Cover	G (Heavy)	

Appendix D

Road Functional Classifications and Maintenance Levels

The following *Road Functional Classifications* and *Road Maintenance Levels* applicable to the Medicine Lake Watershed Area are extracted from the Modoc National Forest Land and Resource Management Plan (LRMP), Appendix G.

Road Functional Classifications:

Forest Arterial Road: Provides service to large land areas and usually connects with public highways or other Forest arterial roads to form an integrated network of primary travel routes. The location and standard are often determined by mobility and efficiency needs rather than by specific resource management service needs. It is usually developed and operated for long-term land and resource management purposes and for constant service. These roads are usually paved, and often have safe travel speeds in excess of 25 miles per hour (mph). These roads have a Maintenance Level of 3, 4, or 5.

Forest Collector Road: Serves smaller land areas than a Forest arterial road, and is usually connected to a Forest arterial or public highway. Collects traffic from Forest local roads and terminal facilities. The location and standard are influenced by long-term multiple-resource service needs as well as by travel efficiency. May be operated for either constant or intermittent service, depending on land use and resource management objectives for the area served by the facility. The roads typically have an aggregate, aggregate and oil, or chip seal surface. Travels speeds are often 15 to 25 mph and the road is usually 5 to 15 miles in length. The road generally serves three or more local roads. These roads have a Maintenance Level of 2, 3, or 4.

Forest Local Road: Connects terminal facilities such as campgrounds and timber harvest areas with Forest collectors or Forest arterial roads, or public highways. The location and standard are usually controlled by a specific resource activity rather than travel efficiency. Forest local roads may be developed and operated for either long- or short-term service. The road may be closed until a future activity occurs or may be left open if on-going activities are necessary. The road is typically short in length (less than five miles), with a low travel speed (5-15 mph) and is typically unsurfaced except when necessary for resource protection (e.g., erosion), or in developed recreation sites which receive seasonally high use. These roads have Maintenance Levels of 1 through 5.

Road Maintenance Levels:

Level 1: Roads are closed to traffic. This level is basic custodial care as required to protect the road investments and to see that damage to adjacent land and resources is held to a minimum. Level 1 maintenance requires an annual inspection to determine what work, if any, is needed to maintain drainage and keep the road stable.

Level 2: Roads are open to limited traffic. This level is used on roads where Forest management activities require that the road be open for limited passage of high clearance vehicles. Traffic is minor, usually consisting of one or a combination of administrative use, permitted use, or specialized traffic. Level 2 requires the basic care of Level 1.

Level 3: Roads are open to traffic. This level is used on roads that are open for public traffic and generally applies when use does not exceed 15 vehicles per day average daily traffic (ADT). ADT should be sued as a guide in determining their maintenance level and not as the sole criterion. A road may receive only one or two vehicles a day for most of the year; however, during a brief period, such as hunting season, the road may receive 20 or 30 vehicles a day. Total traffic types and planned land use are important criteria for selecting maintenance level. The road is maintained for safe and moderately convenient travel suitable for passenger cars.

Level 4: Roads are open to traffic. This level generally applies when use of a road is between 15 ADT and 100 ADT. At this level, more consideration is given to the comfort of the user. These roads are frequently surfaced with aggregate material, but some routes are paved.

Level 5: Roads are open to traffic. This level is generally maintained for use of 100 ADT and greater. Roads in this category are generally paved surfaces. Safety and comfort are important considerations. Abrupt changes in maintenance will be posted to warn a traveler until these deficiencies are corrected.

Appendix E

Concordance of RSL, Reference Vegetation, and EUI Data

During preparation of this document it was determined that using two different data sets that mapped the Medicine Lake Highlands Area Watershed would provide the best stand structure and vegetative species composition information. Discovery of inaccurate vegetation typing in the Remote Sensing Laboratory (RSL) resulted in conifer stand size and canopy cover density only being used from this data. In place of the vegetation typing from the RSL, vegetation and plant association data from the Ecological Unit Inventory (EUI) and air photo interpretation has been used as a more accurate representation of vegetation in the Watershed. For reference conditions, stand size and canopy cover density from the Reference Vegetation data have been used in conjunction with the vegetation associations from air photo interpretation and the EUI data.

The following steps outline what was performed using geographic information systems (GIS), combined with aerial photographs and ground truthing, to determine acreage amounts for vegetation association stand sizes and canopy cover densities.

CURRENT CONDITIONS

Step 1: Characterization of Modoc Land Management Plan (LMP) Units from RSL Data

a) RSL data for conifer size and canopy cover density (crown cover density) was combined to produce Size/Cover Unit values (also known as strata).
b) Using the crosswalk contained in Appendix C of this document, Size/Cover Units were organized into the appropriate Modoc LMP Units (seral stages). See Figure 3.13, *Land Management Plan Units — Current Conditions.*

Step 2: Concordance of RSL Based Modoc LMP Units with EUI Data

a) Using GIS, data sets for the RSL based LMP Units and the EUI were stratified. This combination of data created new stand classifications that are grouped according to LMP Units and plant or vegetation associations.
b) As a result of combining two different data sets limited amounts of area did occur where impossible combinations of LMP Unit and plant association existed (i.e., 4G Water or Lava). This occurs because one data sets outline of major geographical features did not correspond precisely to another data sets major geographical features such as water, talus, or lava. Through a process of aerial photograph interpretation and ground truthing, the occurrence of these impossible combinations were distributed to the appropriate plant associations.
c) For each plant association and Modoc LMP Unit combination, the resulting acreage from parts (a) and (b) of this step were tabulated in Table 5.1, *Plant Association Comparison of Reference Conditions to Current Conditions.*

REFERENCE CONDITIONS

Step 1: Characterization of Modoc LMP Units from RefVeg Data

a) RefVeg data for conifer size and canopy cover density (crown cover density) was combined to produce Size/Cover Unit values (also known as strata).
b) Using the crosswalk contained in Appendix C of this document, Size/Cover Units were organized into the appropriate Modoc LMP Units (seral stages). See Figure 4.3, *Land Management Plan Units — Reference Conditions.*

Step 2: Concordance of RSL Based Modoc LMP Units with EUI Data

a) Using GIS, data sets for the RefVeg based LMP Units and the EUI were stratified. This combination of data created new stand classifications that are grouped according to LMP Units and plant or vegetation associations.
b) As a result of combining two different data sets limited amounts of area did occur where impossible combinations of LMP Unit and plant association existed (i.e., 4G Water or Lava). This occurs because one data sets outline of major geographical features did not correspond precisely to another data sets major geographical features such as water, talus, or lava. Through a process of aerial photograph interpretation and ground truthing, the occurrence of these impossible combinations were distributed to the appropriate plant associations.
c) For each plant association and Modoc LMP Unit combination, the resulting acreage from parts (a) and (b) of this step were tabulated in Table 5.1, *Plant Association Comparison of Reference Conditions to Current Conditions*.

Appendix F

Arrangement of Seral Stages within Associations

Table 1: Current Conditions

Conifers		Relative Distribution of Seral Stages		Distribution of Individual Seral Stages				
					Divisions			
Association	LMP UNIT	Proportions[1]	Integration[2]	Representation[3]	Fragmentation[4]	Average Stand Size[5] (acres)	Distribution[6]	Connectivity[7]
SC1	3P	VU	WM	S	N/A	15	L	WS
	3G	VU	WM	L	LS	43	W	CO
	4G	VU	WM	L	LS	38	W	NS
SC2	3P	VU	PM	A	UD	5	I	N/A
	3G	VU	PM	L	FS	19	W	NS
	4G	VU	PM	L	FS	11	W	NS
SC3	3P	VU	PM	A	FS	41	L	WS
	3G	VU	PM	L	FS	171	W	CO-NS
	4G	VU	PM	A	FS	13	L	M-WS
RF1	1	D	PM	S	N/A	6	I	N/A
	2	D	PM	S	N/A	12	I	MS
	3P	D	PM	A	LS	27	L	WS
	3G	D	PM	L	FS	120	W	CO-NS
	4G	D	PM	L	NS	21	WG	WS
RF2	2	D	PM	A	FS	12	L	WS
	3P	D	PM	A	FS	24	I	WS
	3G	D	PM	L	FS	157	W	CO
	4G	D	PM	A	LS	23	WG	M-WS
RF3	2	D	I	S	N/A	9	I	N/A
	3P	D	I	L	FS	149	L	CO
	3G	D	I	L	LS	56	L	WS
	4G	D	I	A	LS	34	W	MS-WS
			I					
LP1	2	U	PM	S	N/A	8	I	N/A
	3P	U	PM	L	FS	121	W	NS
	3G	U	PM	L	FS	158	W	CO
LP2	3P	VU	PM	A	UD	9	W	CO
	3G	VU	PM	L	UD	39	L	CO
LP3	2	VU	I	S	N/A	38	I	NS
	3P	VU	I	L	UD	289	L	CO
	3G	VU	I	L	UD	186	L	MS
EM1	1	D	PM	S	N/A	6	L	MS
	2	D	PM	A	NS	23	WG	NS
	3P	D	PM	S	N/A	15	L	MS
	3G	D	PM	L	FS	435	W	CO
	4G	D	PM	S	N/A	12	W	WS
EM3	2	VU	N/A	S	N/A	10	I	WS
	3P	VU	N/A	A	FS	28	L	WS
	3G	VU	N/A	L	FS	86	W	CO
	4G	VU	WM	L	FS	50	W	NS
EM4	1	D	PM	S	N/A	10	I	NS
	2	D	PM	A	NS	18	W	NS
	3P	D	PM	L	LS	79	W	NS
	3G	D	PM	A	FS	56	I	WS
	4G	D	PM	S	N/A	29	I	N/A
EM5	2	D	PM-I	L	LS	21	W	MS
	3P	D	PM-I	L	FS	62	L	CO
	3G	D	PM-I	A	FS	14	L	WS
	4G	D	PM-I	S	N/A	7	I	N/A

Appendix F
Arrangement of Seral Stages within Associations

Conifers		Relative Distribution of Seral Stages		Distribution of Individual Seral Stages				
					Divisions			
Association	LMP UNIT	Proportions[1]	Integration[2]	Representation[3]	Fragmentation[4]	Average Stand Size[5] (acres)	Distribution[6]	Connectivity[7]
PP1	2	U	WM	L	LS	57	W	CO-MS
	3P	U	WM	L	NS	41	W	CO-MS
	3G	U	WM	A	FS	28	I	N/A
	4G	U	WM	S	N/A	8	I	
PP2	2	D	WM	L	LS	30	W	NS
	3P	D	WM	A	FS	23	L	NS
	3G	D	WM	L	LS	64	W	CO-NS
	4G	D	WM	S	N/A	7	I	WS
PP3	1	D	PM	S	N/A	5	L	WS
	2	D	PM	L	LS	41	L	WS
	3P	D	PM	A	FS	42	L	WS
	3G	D	PM	L	FS	368	W	CO
	4G	D	PM	A	LS	15	WG	WS
PP4	2	D	I	L	NS	30	L	NS
	3P	D	I	L	LS	49	L	MS
	3G	D	I	L	FS	159	L	CO
	4G	D	I	S	N/A	14	I	WS
WF1	1	D	PM	S	N/A	58	I	N/A
	2	D	PM	L	FS	55	L	WS
	3P	D	PM	S	N/A	18	L	WS
	3G	D	PM	L	FS	244	W	CO
	4G	D	PM	A	LS	14	L	WS
PJ1	2	VU	N/A	L	FS	25	L	NS

RELATIONSHIPS OF STAGES:

1 Proportions
- B balanced
- D disproportionate
- U unbalanced
- VU very unbalanced

2 Integration: (of stages with greater than 5% presence)
- WM well mixed as a result of similar distribution patterns
- PM partially mixed as a result of dissimilar distribution patterns
- I isolated from on another into distinct localities

ARRANGEMENT OF INDIVIDUAL STAGES: within major units of an association

3 Representation
- S small (<5% of association)
- A adequate (5-19% of association)
- L large (>20% of association)

4 Fragmentation: of stages with >5% representation
- UD undivided (<5 polygons)
- FS few stands (5-20 polygons)
- LS limited stands (20-40 polygon)
- NS numerous stands (>40 polygons)

5 Average Stand Size (acres)

6 Distribution
- W widely distributed individual stands (polygons)
- WG widely distributed groups of stands (polygons)
- L localized stands concentrated in a few areas
- I isolated stands concentrated in a single or couple remote areas

7 Connectivity: between individual stands, groups, or concentrations and characterizing the general pattern (most stands) of each seral stage
- CO continuous (only minor or occasional gaps)
- NS narrow separation (<1/4 mile apart)
- MS moderate separation (1/4-1/2 mile apart)
- WS wide separation (>1/2 mile apart)

Note: The internal spacing of stands within groups or concentrations (distributions WG, L, and I) is most commonly <1/4 mile apart. The above ratings identify the relative distance between groups and not the internal spacing of their component stands.

Table 2: Reference Conditions

Conifers		Relative Distribution of Seral Stages		Distribution of Individual Seral Stages				
					Divisions			
Association	LMP UNIT	Proportions[1]	Integration[2]	Representation[3]	Fragmentation[4]	Average Stand Size[5] (acres)	Distribution[6]	Connectivity[7]
SC1	1	D	PM	S	N/A	7	I	M/A
	2	D	PM	S	N/A	6	I	N/A
	3P	B	PM	A	FS	37	W	WS
	3G	B	PM	A	FS	46	W	WS
	4P	D	PM	L	FS	53	L	WS
	4G	D	PM	L	FS	94	W	NS
SC2	1	D	WM	S	N/A	2	I	N/A
	2	D	WM	S	N/A	1.3	I	N/A
	3P	D	WM	L	FS	8	W	WS[8]
	3G	D	WM	A	UD	36	I	N/A
	4P	D	WM	S	N/A	3	I	N/A
	4G	D	WM	L	FS	21	W	WS[8]
SC3	1	D	PM	S	N/A	9	I	N/A
	2	D	PM	A	FS	40	L	WS
	3P	D	PM	A	FS	40	L	WS
	3G	D	PM	L	FS	90	L	M-WS
	4P	D	PM	L	FS	62	L	M-WS
	4G	D	PM	A	FS	14	I	WS
RF1	1	B	WM	A	FS	24	W	WS
	2	B	WM	A	FS	58	W	WS
	3P	B	WM	A	LS	31	WG	WS
	3G	B	WM	L	FS	66	W	WS
	4P	B	WM	L	FS	80	W	WS
	4G	B	WM	L	LS	64	W	MS
RF2	1	B	PM	L	FS	118	L	WS
	2	B	PM	A	FS	25	W	WS
	3P	B	PM	A	FS	47	L	WS
	3G	B	PM	A	FS	58	W	WS
	4P	B	PM	A	FS	58	W	WS
	4G	B	PM	L	FS	124	WG	WS
RF3	1	D	PM	S	N/A	20	I	WS
	2	D	PM	A	FS	63	L	WS
	3P	D	PM	L	FS	173	W	WS
	3G	D	PM	A	FS	100	L	WS
	4P	D	PM	L	FS	218	W	M-WS
	4G	D	PM	A	FS	29	W	WS
LP1	1	D	PM	S	N/A	59	I	N/A
	2	D	PM	A	UD	52	L	WS
	3P	D	PM	A	FS	33	L	WS
	3G	D	PM	L	FS	261	W	CO
	4P	D	PM	A	FS	86	I	W
LP2	3P	U	I	L	UD	42	I	N/A
	3G	U	I	L	UD	12	L	WS
LP3	2	D	PM	A	UD	118	L	WS
	3P	D	PM	L	FS	159	L	WS
	3G	D	PM	L	FS	122	W	CO
	4P	D	PM	A	FS	44	L	W
EM1	1	D	WM	A	FS	51	L	WS
	2	D	WM	S	UD	45	I	WS
	3P	D	WM	A	FS	30	L	WS
	3G	D	WM	L	FS	152	W	NS-MS
	4P	D	WM	L	FS	181	W	MS
	4G	D	WM	A	UD	77	L	WS
EM3	1	D	PM	S	UD	31	I	WS
	3P	D	PM	A	FS	75	L	CO
	3G	D	PM	L	FS	60	W	NS
	4P	D	PM	L	FS	86	L	WS
	4G	D	PM	A	UD	62	L	WS
EM4	1	D	PM	S	UD	67	I	N/A
	3P	D	PM	L	UD	168	L	NS
	3G	D	PM	A	UD	101	I	N/A
	4P	D	PM	L	UD	387	W	CO
	4G	D	PM	L	FS	81	L	NS

Appendix F
Arrangement of Seral Stages within Associations

Conifers		Relative Distribution of Seral Stages		Distribution of Individual Seral Stages				
					Divisions			
Association	LMP UNIT	Proportions[1]	Integration[2]	Representation[3]	Fragmentation[4]	Average Stand Size[5] (acres)	Distribution[6]	Connectivity[7]
EM5	1	B	WM	A	FS	23	L	WS
	2	B	WM	L	FS	55	W	NS
	3P	B	WM	A	FS	83	L	WS
	3G	B	WM	A	FS	35	W	WS
	4P	B	WM	L	FS	46	W	WS
	4G	B	WM	A	UD	46	I	N/A
PP1[9]								
PP3	1	D	PM	L	FS	227	L	WS
	2	D	PM	S	N/A	69	I	WS
	3P	D	PM	S	N/A	139	I	N/A
	3G	D	PM	A	FS	79	L	WS
	4P	D	PM	L	FS	131	W	WS
	4G	D	PM	A	FS	140	L	WS
PP4[10]	1				6			
	2				0			
	3P				55.5			
	3G				194			
	4P				191			
	4G				108			
WF1	1	D	PM	L	FS	376	W	MS-WS
	2	D	PM	A	FS	39	W	WS
	3P	D	PM	S	FS	55	L	WS
	3G	D	PM	A	LS	28	W	WS
	4P	D	PM	A	FS	39	L	WS
	4G	D	PM	S	FS	20	L	WS

RELATIONSHIPS OF STAGES:

1 Proportions
- B balanced
- D disproportionate
- U unbalanced
- VU very unbalanced

2 Integration: (of stages with greater than 5% presence)
- WM well mixed as a result of similar distribution patterns
- PM partially mixed as a result of dissimilar distribution patterns
- I isolated from on another into distinct localities

ARRANGEMENT OF INDIVIDUAL STAGES: within major units of an association

3 Representation
- S small (<5% of association)
- A adequate (5-19% of association)
- L large (>20% of association)

4 Fragmentation: of stages with >5% representation
- UD undivided (<5 polygons)
- FS few stands (5-20 polygons)
- LS limited stands (20-40 polygon)
- NS numerous stands (>40 polygons)

5 Average Stand Size (acres)

6 Distribution
- W widely distributed individual stands (polygons)
- WG widely distributed groups of stands (polygons)
- L localized stands concentrated in a few areas
- I isolated stands concentrated in a single or couple remote areas

7 Connectivity: between individual stands, groups, or concentrations and characterizing the general pattern (most stands) of each seral stage
- CO continuous (only minor or occasional gaps)
- NS narrow separation (<1/4 mile apart)
- MS moderate separation (1/4-1/2 mile apart)
- WS wide separation (>1/2 mile apart)

8 The SC2 3P and SC2 3G stands are actually continuous within each of 10 widely separated geographic units.

9 Too small a sample to be representative of the association.

10 Too small a sample to ve representative of the association arrangement.

Note: The internal spacing of stands within groups or concentrations (distributions WG, L, and I) is most commonly <1/4 mile apart. The above ratings identify the relative distance between groups and not the internal spacing of their component stands.

Appendix G

MLSA Fire Management Plan

The following *Fire Management Plan* is provided from the Medicine Lake Highlands Managed Late-Successional Area Assessment (June 1988) and is applicable to that portion of the Medicine Lake Watershed Area.

I. Goals

The Record of Decision (p. 3) for the Modoc National Forest Land and Resource Management Plan states:

> "A key to preserving national forests is the appropriate management of wildfire and fuels. The forest will manage fire at the most efficient level, balancing the costs of fire suppression, pre-suppression, fuels management and the potential values lost."

The Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl states:

> "Managed Late-Successional Areas are similar to Late-Successional Reserves but are identified for certain owl activity centers on the eastside where regular and frequent fire is a natural part of the ecosystem." (ROD, p. C-23).

The goal of the Fire Management Plan is to protect existing late-successional areas and promote the attainment of late-successional areas. The achievement of these goals will require management activities within and adjacent to the MLSA that will change and/or maintain current fuel characteristics and arrangement to a desired or sustainable level over time. **The guiding goals of the fire and fuels management strategy displayed in this plan are:**

- **Protection of existing late-successional stands.**
- **Protection of stands developing to late-successional habitat.**

Protection of existing late-successional areas is to be accomplished by treating adjacent mid-seral stands silviculturally and with prescribed fire to reduce fire intensity characteristics in those adjoining stands; thereby reducing threat to the existing late-successional core areas.

Due to the rarity and high value of late-successional habitat in the MLSA, neither silvicultural treatments nor prescribed fire will be introduced into the existing late-successional stands. It is recognized however, that those stands will remain at moderate risk of high-intensity stand replacing fire from internal ignition.

The mid-seral stands that are treated to create a low fire behavior condition will not receive future fuel hazard management and will be allowed to develop unencumbered toward late-successional habitat. Protection for these developing stands will be provided by "stepping out" to the next level of adjacent mid-seral stands and treating those to create a low-fire behavior condition.

We acknowledge that there will be a short-term delay in the progression of these mid-seral stands toward late-successional habitats as they are treated, particularly in valuable attributes such as CWD, however the initial protection provided existing late-successional stands should more than offset this delay.

It is also recognized that as the treated mid-seral stands progress to late-successional habitat the risk for severe fire will increase commensurately, thus placing the developing stands at moderate to high risk and diluting their effectiveness as "buffers" to the existing late-successional cores.

Safety is and will continue to be number one priority. All fire suppression actions will be tied directly to the Fire Orders and the Watch Out Situations. Safety is the highest priority.

II. Fire Regimes

Past management practices, fire suppression and logging, have altered the vegetation characteristics and potential for catastrophic wildfire. A catastrophic wildfire is a fire that is stand replacing and can result in damage to the soil resource. The fire regimes that existed in 1900 have been altered by increased fuel loading and a change in the structure and arrangement of live and dead vegetation. The Forest Service Manual (FSM) Chapter 5105 defines fuel as combustible wildland vegetative materials, living or dead. The purpose of the Fire Management Plan is to evaluate, plan, and treat the wildland fuels to control flammability and reduce resistance to controlling wildfires. The Fire Management Plan should contribute to the goal of managing late-successional stands.

Understanding natural fire regimes is important to managing and growing late-successional stands. The fire history portion of the Fire Management Plan discusses Mean Fire Return Intervals and the effect wildfire plays in shaping the vegetation in the MLSA landscape. Rodney W. Sabo describes natural fire regimes in his 1978 paper Natural Fire Regimes and Fire Management - Foundations for Direction. The following briefly describes four natural fire regimes that could apply to the MLSA:

A. Fire Regime Type One - Frequent fires of low to moderate intensity.

   Fires in this regime are frequent and of low to moderate intensity. The characteristics of this regime are frequent ignition sources, rapid fuel (biomass) accumulation, frequent dry weather, smaller fires, and plants are adapted to fire.

B. Fire Regime Type Two - Infrequent fires of high intensity.

   The characteristics of this regime are infrequent ignition, slow biomass accumulation, long periods of low fire danger, periodic drought, and larger fires.

C. Fire Regime Type Three - Frequent fires of high intensity.

   The characteristics of this regime are rapid biomass accumulation, frequent ignitions, heavy fine fuel loading, long periods of dry weather, and high live fuel component.

D. Fire Regime Type Four - Infrequent fires of low intensity.

   The characteristics of this regime are slow biomass accumulation, infrequent ignitions, short growing season, and long periods of low fire danger.

The MLSA contained two of the above fire regimes prior to active fire suppression. Some of the fire regimes as related to vegetation patterns that existed in the 1944 and 1946 aerial photos are:

A. Pine dominated mixed conifer stands - Fire Regime Type One.

B. Red Fir stands - Fire Regime Type Two.

C. Lodgepole Pine stands - Fire Regime Type Two.

D. Montane brushfields, white fir reproduction - Fire Regime Type Two.

The effects of interrupting Fire Regime Types One and Two are:

A. Fire Regime Type One - The characteristics of frequent less intense fires changes to infrequent, higher intensity fires. Fires will be crown fires rather than ground fires. Fires will be larger in size. Fire effects will be severe.

B. Fire Regime Type Two - The characteristics of infrequent fires becomes very infrequent with very high intensity. Vegetation becomes nutrient traps, with a net loss of nutrients in the type. After an initial high intensity fire, the cycle may be shortened. Fire effects will be severe.

Intensity - Fire intensity may be classified subjectively by using the appearance of the litter and soil after burning, and referred to in relation to soil as fire severity. In a light burn, litter and duff are scorched. In a moderate burn, litter and duff are charred, but do not visibly alter the soil. In a severe burn, organic matter is consumed and soil is visibly altered. Fires generally do not effect soil structure unless the organic matter has been removed and the exposed mineral soil is exposed to rain drop impact and surface baking.

III. Fire Behavior Analysis

Fire behavior modeling is done in order to estimate the severity and resistance to control that can be expected when a fire occurs during worst case fire weather conditions. Late summer weather conditions are referred to as Ninetieth Percentile weather data, which is a standard used when calculating fire behavior. Ninetieth Percentile weather is defined as the severest 10 percent of the historical fire weather (i.e. hot, dry, windy conditions occurring on mid-afternoons during the fire season). The modeling incorporates fuel condition, slope class, and Ninetieth Percentile weather conditions in calculating projections on flame lengths and rates of spread. A low rating indicates that fires can be attacked and controlled directly with handline and will be limited to burning in understory vegetation. A moderate rating indicates that handlines alone would not be sufficient in controlling fires and that heavy equipment would be more effective. Areas rated as high represent the most hazardous conditions in which serious control problems would occur (i.e. torching, crowning, and spotting). Control lines are established well in advance of flaming fronts with heavy equipment, and backfiring may be necessary to widen control lines.

Fuels have been classified into three groups: shrubs, timber, and slash. The differences in these groups are related to the fuel load and the distribution of the fuel among the size classes. Size classes are: zero to one-quarter inch, one-quarter to one inch, one to three inches, and three inches and greater. Fuel models are simply tools to help the user realistically estimate fire behavior.

Modifications to Fuel Models are possible through changes in the live to dead ratios, moisture contents, fuel loads, and drought influences. There are 13 Fire Behavior Predictive Fuel Models used to predict control problems and impacts on land resources. The Fire Behavior Predictive Fuel Models are described in Estimating Wildfire Behavior and Effects by Albini (1976). Seven of these Fire Behavior Predictive Fuels Models are used in this analysis.

Fire Behavior Predictive Fuel Models were identified by utilizing District Fire and Fuels Officers' knowledge, and data contained in Photo Series for Quantifying Forest Residues in the: Sierra Mixed Conifer Type and Sierra True Fir Type (1979) and Photo Series for Quantifying National Forest

Residues: Southern Cascades and Northern Sierra Nevada (1981). The following is a brief description of each of the seven Fire Behavior Predictive Fuel Models:

A. Grass Group

Fire Behavior Predictive Fuel Model 2 - This model is composed of grass and litter. Fire is generally carried primarily through fine herbaceous fuels, with curing or dead. These are surface fires where the herbaceous material, in addition to litter and dead-down stemwood from a timber overstory, contribute to the fire intensity.

B. Shrub Group

Fire Behavior Predictive Fuel Model 5 - This model is composed of brush (manzanita) two feet tall. Fire is generally carried by surface fuels that are made up of litter cast by the shrubs and grasses or forbs in the understory. Fires are generally not very intense because the fuels are light and shrubs are young with little dead material.

Fire Behavior Predictive Fuel Model 6 - This model is composed of dormant brush and pine plantations and young mixed conifer tree reproduction. Fires carry through the shrub layer where the foliage is more flammable than Fire Behavior Predictive Fuel Model 5, but requires moderate winds, greater than eight miles per hour.

C. Timber Group

Fire Behavior Predictive Fuel Model 8 - This model is composed of compact litter in closed, short-needle conifer stands. Slow burning ground fuels with low flame lengths are generally the case, although the fire may encounter small "jackpots" of heavier concentrations of fuels that can flare up. Only under severe weather conditions do these fuels pose a threat. Closed canopy stands of short-needled conifers support fire in the compact litter layer. This layer is mostly twigs, needles, and leaves.

Fire Behavior Predictive Fuel Model 9 - This model is composed of surface litter from long needle conifer stands. Surface fires spread through surface litter faster than Fire Behavior Predictive Fuel Model 8. Concentrations of dead-down woody material will contribute to possible torching out of trees, spotting and crowning.

Fire Behavior Predictive Fuel Model 10 - This model is composed of mid-seral and late-seral stands (greater than 12 inches DBH) with high loading of dead, down woody fuel, including shrub understory or conifer reproduction. Fires burn in the surface and ground fuels with greater intensity than the other timber litter types. A result of dense stands and natural events creates a large load of heavy dead and down material on the forest floor. Crowning-out, spotting, and torching of individual trees is more likely to occur, leading to potential fire control difficulties.

D. Logging Slash Group

Fire Behavior Predictive Fuel Model 11 - Light logging slash (under 40 tons per acre) from partial or clearcut red fir conifers. Most needles have fallen, and slash is somewhat compact. Fires are fairly active in the slash and herbaceous material intermixed with the slash. Fuel loads are light and often shaded. Clearcut operations generally produce more slash than is typical of this fuel model.

The Fire Behavior Predictive Fuel Models can further by defined by vegetation types. To assist understanding how the Fire Behavior Predictive Fuel Models interface with the existing vegetation, the following two tables define the Fire Behavior Predictive Fuel Models:

Fuel Models by R5 Veg Type, Species, Size Class and Stocking

R% Veg Type	Species	Size Class	Stocking	Fuel Model
EOX	PP	<1 DBH	N/D	6
FOX	MC	<1 DBH	N/D	6
F1X	MC	1-4.9 DBH	N/D	6
F2N	MC	5-11.9 DBH	40-69	5
F2X	MC	5-11.9 DBH	N/D	5
F3G	MC	12-23.9 DBH	70-100	10
F3N	MC	12-23.9 DBH	40-69	10
F3P	MC	12-23.9 DBH	20-39	8
F4G	MC	24-39.9 DBH	70-100	10
L3N	LP	12-23.9 DBH	40-69	10
R1X	RF	1-4.9 DBH	N/D	5
R3G	RF	12-23.9 DBH	70-100	10
R3N	RF	12-23.9 DBH	40-69	10
R3S	RF	12-23.9 DBH	10-19	10
R4N	RF	24-39.9 DBH	40-69	11
RNO	RF	non-stocked	0-9	
XNO		shrub		6
UBA		barren		
UGR		grass		2
UBB		bitterbrush		6

Fuel Models by Vegetation Type, Seral Stage and Density

Vegetation	Seral Stage	Density	Fuel Model
Mixed Conifer	Early	G, N	6
	Early	P, S	5
	Mid, Late	G, N	10
	Mid, Late	P, S	8
Lodgepole	Mid	N	10
Red Fir	Early	P, S	5
	Mid, Late	G, N	10
	Mid, Late	P, S	11
Montane Chapparal			6
Bitterbrush			6
Grass			2
Plantation, PP			6

Notes: Density is Regional standard described in Vegetation section of Analysis

Species composition, some species have low enough fuel moistures and structural characteristics to sustain burning, (i.e. true firs, bitterbrush).

Greater than 70 percent total crown cover must be present to support crown fire. Five foot to live crown from the ground.

Greater than four foot flame lengths, sufficient to carry flames into the fuel ladder and up into the crowns of trees.

Weather Data

Weather data was collected from the Round Mountain Fire Detection Lookout from 1977 to 1995. The data was collected during fire seasons which occurs from late spring until early fall. The Ninetieth Percentile weather data is based on the spread component and a NFDRS Fuel Model F. The Ninetieth Percentile data was obtained using the PC FIREFAMILY program. The following data is Ninetieth Percentile and is used in the BEHAVE program to determine hazard:

Ninetieth Percentile Weather Data

Data Class	Measurement
One Hour Fuel Moisture	3.3
10 Hour Fuel Moisture	4.3
100 Hour Fuel Moisture	5.2
Herbaceous Fuel Moisture	8.2
Woody Fuel Moisture	54.2
20 Foot Wind Speed	8.8
1000 Hour Fuel Moisture	7.1

This weather data was used for exposed and partially sheltered fuels for elevations between 4260 and 6260 feet. The fuel moistures were adjusted upward to three percent for fully sheltered fuels for the BEHAVE program runs. For vegetation greater than 6260 feet, the fuel moistures were adjusted upward to one percent for exposed and partially sheltered fuels and to four percent for fully sheltered fuels. Mid-flame windspeeds were determined by adjusting the 20 foot windspeed based on fuel exposure. Below are the mid-flame windspeeds used in BEHAVE program runs.

Fuel Exposure	Fuel Model	Mid-Flame Windspeed
Exposed	5, 6	4
Partially Sheltered	2, 8, 1	3
Fully Sheltered	10	2

Fire Behavior Potential

To determine fire behavior potential, each Fire Behavior Predictive Fuel Model is run through the BEHAVE program (Rothermel 1972). This program uses Fire Behavior Predictive Fuel Model, slope, and weather parameters to predict fire behavior and resistance to control for fire suppression purposes. The Ninetieth Percentile weather from the most representative weather station was used to model late summer afternoons, typical of late July through early September. All Fire Behavior Predictive Fuel Models were run through each of the two slope classes to determine increases in fire behavior with increased steepness of terrain.

The output of this is a rating of low, moderate or high fire behavior based on flame lengths, which are good indicators of fire line intensity and resistance to control and/or Rate Of Spread (ROS). ROS is also a good indicator of resistance to control. Using the CONTAIN model of BEHAVE it was determined whether or not a fire with low flame lengths could be contained by the initial attack forces. These runs indicated that given response times of initial attack forces, terrain, fuels and available forces a low fire behavior rating had to have a ROS less than 30 chains per hour for containment during initial attack to be accomplished.

A. Low Hazard Rating - Flame lengths less than four feet and ROS less than 30 chains per hour. Fires can generally be attacked at the head or flanks by firefighters using handtools. Handline should hold the fire.

B. Moderate Hazard Rating - Flame lengths of four to eight feet. Fires are too intense for direct attack at the head of the fire by firefighters using handtools. Handline cannot be relied on to hold the fire. Equipment such as dozers, engines, water and/or retardant dropping aircraft can be effective.

C. High Hazard Rating - Flame lengths of greater than eight feet. Fires may present serious control problems such as torching, crowning, and spotting. Control efforts at the head of the fire will be ineffective.

Fire Behavior Predictive Fuel Models are an excellent tool for modeling the fire behavior of ground fuels. They can be used to accurately predict a fire's horizontal spread. Vertical fuels and their role in fire behavior need to also be considered in determining effects on vegetation. It has been determined that no analysis of fuels can be considered complete without some assessment of the vertical fuel layer. This layer adds the fuel ladder, which increases the likelihood for stand replacement wildfires.

Characteristics that contribute to the vertical fuel layer were derived from the U.S.D.A. Fire Behavior Analyst Field Notebook. The characteristics are:

A. One Hundred percent live fuel moisture during August burning conditions.

B. Species composition, some species have low enough fuel moistures and structural characteristics to sustain burning (e.g. true firs, bitterbrush).

C. Greater than 70 percent total crown cover must be present to support crown fire. Five foot to live crown from the ground.

D. Greater than four foot flame lengths, sufficient to carry flames into the fuel ladder and up into the crowns of trees.

Fire behavior must be at a moderate rating for flame lengths to be carried into the overstory, flame lengths greater than four feet. The characteristics of Fire Behavior Predictive Fuel Model 10 with 70 percent closure were determined to fit the vertical fuel layer characteristics. In locations where Fire Behavior Predictive Fuel Model 10 is modeled as having moderate fire behavior potential, the moderate rating should be raised to high.

The following table displays the fire behavior potential of each Fire Behavior Predictive Fuel Model based on elevational criteria.

Elevations 4260 to 6260 Feet

Fuel Model	Aspect	0-35% Slope	>35% Slope
2	All	Moderate	High
5	N	Moderate	High
5	E, S, W	High	High
6	All	Moderate	High
8	All	Low	Moderate
10	N	Low	High
10	E, S, W	High	High
11	All	Low	Moderate

Elevations Greater than 6260 feet

Fuel Model	Aspect	0-35% Slope	>35% Slope
2	All	Moderate	High
5	N	Moderate	High
5	E, S, W	High	High
6	All	Moderate	High
8	All	Low	Moderate
10	N	Low	High
10	E, S, W	High	High
11	All	Low	Moderate

IV. Recommendations and Opportunities

Fire once played a major role in shaping the vegetation in the MLSA and adjoining areas. Fire suppression has removed fire from the natural role it once played in the ecosystem. Extensive areas of vegetation that once were represented by Fire Behavior Predictive Fuel Models 2, 8, and 9, are now represented by Fire Behavior Predictive Fuel Models 6, 10, and 11. Logging has changed the characteristics of the vegetation in and adjacent to the MLSA. These areas that once had vegetation with a fire regime of frequent, low intensity fires are now at risk of large stand replacing fires. Fire behavior potential for most areas of the MLSA has increased from low to moderate, to moderate to high. Fires that burn in the moderate to high hazard areas burn with higher intensity and have more severe effects on the soils and vegetation. Similar moderate to high hazard vegetation areas, that

are adjacent to the MLSA and are downslope and lie to the southwest and southeast of the MLSA also are in jeopardy of high intensity, stand replacing fires that may carry into the MLSA.

Numerous areas that exist within and adjacent to the MLSA pose opportunities to change the characteristics of the vegetation to promote the goals of the Fire Management Plan by promoting the conservation and management of late-successional stands. Opportunities exist to return fire to the ecosystem under controlled conditions. Low intensity, controlled fires can be used at periodic intervals to reduce fuel loading and vegetation arrangement that contribute to an area being classified with a high hazard rating. Changing Fire Behavior Predictive Fuel Models 5, 6, 10, and 11 to Fire Behavior Predictive Fuel Models 2, 8, and 9 will reduce fire hazard and the risk of stand replacing fires.

A. Recommendations Within the MLSA

1. Grass.

Fire Behavior Predictive Fuel Model 2 - Open grassy areas and continuous grass stands under trees have a moderate hazard rating in all areas except in lower elevations at slopes greater than 35 percent. As grass replaces it's biomass annually, treatment of adjacent forested and brush areas will be more effective than treating the grass type. Open grassy areas can be effectively utilized to fight wildfires due to ease of fireline construction.

2. Montane Chaparral, Bitterbrush and Ponderosa Pine Plantations.

Fire Behavior Predictive Fuel Model 6 - High hazard to rapidly spreading fires in this early-successional stage. Mechanical treatment and prescribed burning can reduce the hazard dramatically in this type.

3. Mixed Conifer.

Fire Behavior Predictive Fuel Models 5 and 6 - Early-seral stages are a high hazard to fires. Mechanical treatment of fuels with some use of low intensity prescribed fire can reduce the hazard of rapidly spreading fires that will burn into adjacent stands that are mid-seral to late-seral stage.

Fire Behavior Predictive Fuel Model 8 - Mid-seral to late-seral stage forests with low stocking rates are a moderate hazard now, but can be expected to become a high hazard as the vegetation develops. Mechanical treatments with use of low intensity prescribed fire can reduce hazard.

Fire Behavior Predictive Fuel Model 10 - Mid-seral to late-seral stage mixed conifer forests are dominated by high hazard to fires. These areas represent the majority of MLSA stands with potential for large stand replacing fires. Recommended treatments to reduce hazard are thinning and low intensity prescribed burning. Hand or machine piling of dead fuels may be used to accomplish hazard reduction.

4. Red Fir.

Fire Behavior Predictive Fuel Model 5 - Early-seral stage has high hazard to fire. Mechanical treatments can be used to reduce hazard.

Fire Behavior Predictive Fuel Model 10 - Mid-seral to late-seral stage forests have a moderate to high hazard to fire, depending on elevation and aspect. Thinning, mechanical treatments and low intensity prescribed burning can be used to reduce hazard. Stand replacing fires in this fuel type will be high intensity with severe effects on the soil and vegetation.

Fire Behavior Predictive Fuel Model 11 - Low hazard in mid-seral to late-seral stage forests. Prescribed burning can maintain low hazard in these stands.

5. Lodgepole Pine

Fire Behavior Predictive Fuel Model 10 - Mid-seral stage forests have low to moderate fire hazard. Logging and mechanical treatments will be the most useful tools to maintain low hazard rating.

B. Recommendations for Areas Adjacent to the MLSA

Most of the vegetated lower elevation areas that lie to the southwest and southeast of the MLSA have a high hazard rating. Nearly all of the vegetated areas are represented by Fire Behavior Predictive Fuel Models 6 and 10. Notable exceptions are areas in clearcuts. The low elevation forests are pine and white fir dominated. Ladder fuels exist in exceptional amounts. Some of the adjacent areas are eastside pine type associated with bitterbrush. Wind driven fires outside of the MLSA can be expected to burn into the MLSA. These will be high intensity fires with severe effects on the soils and vegetation. Fires burning upslope from the east can be expected to burn into the MLSA. These will also be high intensity fires. All fires burning in bitterbrush associations can be expected to have a high rate of spread with long distance spotting in front of the fire.

1. Fire Behavior Predictive Fuel Model 6 - Early-seral stage mixed conifer and pine stands, montane shrub and bitterbrush are high hazard areas. Mechanical treatment and prescribed burning can reduce hazard.

2. Fire Behavior Predictive Fuel Model 10 - Mid-seral to late-seral stage mixed conifer and pine stands are high hazard stands. Logging, thinning, low intensity prescribed burning and mechanical treatments can be used in combination to reduce hazard. Low intensity prescribed burning may be required to maintain a high frequency, low intensity fire regime in these areas.

C. Fuelbreaks

Fuelbreaks and hazard reduction corridors can be identified as areas where large fires can be stopped or slowed. Fuelbreaks and hazard reduction corridors can be established to protect existing and potential late-seral stage tree stands while fuel treatment projects are being planned and accomplished. Fuelbreaks and hazard reduction corridors can be established by prescribed burning, thinning or mechanical manipulation of vegetation. Fuel-break will be most useful in Fuel Models 6 and 10, either within or adjacent to the MLSA.

D. Guidelines for Fire Suppression Tactics

Fire suppression responses within the MLSA should be timely and appropriate for the situation and the resource. Minimum Impact Suppression Methods (MISM) may be considered in determining the appropriate response. Initial attack forces will be ordered by the Modoc Interagency Command Center (MICC) according the pre-planned initial attack level. Resource Advisors and Resource Specialists will be utilized for establishing the appropriate response.

Maps of Riparian Reserves are available to Resource Advisors and Resource Specialists.

E. Firelines

When establishing fireline, consider the following:

1. Minimize the cutting of green trees, burned trees and snags.

2. Use natural barriers such as ridges, meadows, rocky draws and outcrops.

3. Allow fires to burn to natural barriers.

4. Use existing roads and trails to burn-out or backfire against to stop fire spread. Use burning out as a fire suppression tool.

5. Use cold-trail, wet line, or a combination of these when appropriate.

6. When constructing fireline, use minimum width and depth to check fire spread. Minimize bucking and cutting of trees to establish fireline. Construct lines around coarse woody debris, when possible, without compromising fire containment or control.

7. Minimize use of dozers, consult with resource advisors prior to use of dozers. Dozers shall not be used within the immediate watershed of bat cave roosts that could effect water drainage patterns into and out of the cave systems.

8. Adjacent to fireline, limb only what is necessary to prevent fire spread.

9. Inside fireline, cut and limb only those fuels which would spread fire across the fireline if ignited.

10. Live trees will not be cut, unless they pose a safety hazard or they will cause fire spread across the fireline.

11. Consider allowing ignited trees or snags to burn out. Identify these hazard trees with flagging and/or a lookout. If they are causing safety and/or control problems, felling is appropriate.

12. Pre-line around snags and trees within the fire area near fireline if they are likely to increase fire spread.

13. On the burn-out side of the line, fall only those snags that would spread fire across the fireline if they should burn and fall over, or those that pose a high risk of spotting.

14. Do not fall snags on the unburned side of the constructed fireline, unless they are an obvious safety hazard to fire suppression crews or would become fire brand receptacles.

    Surviving trees that have defects caused by fire can provide valuable wildlife habitat. Consequently, trees that can be retained without jeopardizing crew safety should be retained.

    Maps of known northern spotted owl activity centers are available on the District and many are in the CAD in MICC.

F. Air Support

Firefighting air support may be used to suppress wildfires in the MLSA. This includes aerial observation, smoke jumpers, helicopters, airtankers, air attack supervisors's and lead planes. Air support use will be in accordance with the goals of the Fire Management Plan. Use of fire retardant shall not be used on or near bat cave roosts.

G. Mop-up

Ensure safety of crews at all times. Guidelines for mop-up of ground fuels include a minimum amount of spading of hot areas.

Restrict mop-up to hot areas. Mop-up a safe distance from line into the burn area. One Hundred percent mop-up may not be necessary or appropriate.

Hand feel charred logs near the fireline. Do minimal scraping and chopping to extinguish the fire.

Minimize bucking of logs to check for hot spots or extinguish fire. Roll logs when possible. Return logs to original position after checking or after ground is cool.

Consider allowing standing trees, snags, and logs to burn themselves out instead of falling or bucking when they do not pose a serious escape threat.

If burning trees or snags will spread fire brands and pose an escape threat, extinguish with water or dirt when possible and avoid felling.

H. Logistical Support Facilities

Logistical support facilities in the MLSA area includes incident bases, spike camps, helispots, helibases and staging areas. Establishing an incident base in the MLSA is not necessary. Incident bases needed for fire operations in the MLSA or other adjacent areas should be established at Long Bell Station. The Resource Advisor and Resource Specialist will be consulted prior to establishment of any other logistical or operational support facility within the MLSA.

I. Rehabilitation Guidelines

Rehabilitation of fire suppression activities will be important to achieving the goals of the Fire Management Plan. Rehabilitation will include fireline, vegetation modified for suppression (log, snags and trees), and logistical support facilities. Rehabilitation of the burned area needs to addressed as a separate project. Constructing fireline, transporting personnel and material, utilizing areas for support facilities, and other suppression activities will significantly impact sensitive resources, regardless of the mitigating measures taken. During rehabilitation efforts, a Resource Advisor with expertise on the MLSA will be available. Rehabilitation work should be done by initial attack personnel in order to maximize efficiency, reduce costs, and promptly begin returning the MLSA to a desired vegetation state. Rehabilitation efforts should include removing all flagging, garbage and equipment. Discourage the use of fireline as trails or roads by closing the lines with physical barriers. Obliterate any berms created during suppression efforts. Use standard guidelines for waterbars and soil protection measures.

J. Post-fire Evaluation

A post-fire evaluation of fire suppression strategies and tactics is important to assess if the action has met the goals of the Fire Management Plan. The evaluation should be conducted by Fire Management Specialists, Resource Advisors and Resource Specialists. Team members will evaluate this plan to ensure that the intent of the Standards and Guidelines in the LRMP have been met. The post-fire evaluation will consist of data collection, documentation, and making recommendations. The evaluation will occur prior to the departure of the overhead team. A copy of the evaluation will be placed in the final fire package and a copy made available to the Line Officer.

References

Albini, F.A. 1976. Estimating Wildfire Behavior and Effects. General Technical Report INT-30, U.S.D.A., U.S. Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah.

Brown, E.R. 1985. Management of Wildlife and Fish Habitats in Forest of Western Oregon and Washington. Part 1 - Chapter Narratives. 332 p.

Caster, G.P. Jr. 1981. Characteristics of Winter Roosts and Populations of Bald Eagles in the Klamath Basin. Masters Thesis, Oregon State University, Chervils, Oregon. 82 p.

Caster, G.P. Jr. & R.R. Anthony. 1983. Characteristics of Bald Eagle Communal Roosts in the Klamath Basin, Oregon and California. Journal of Wildlife Management 47(4):1072-1079.

Chen, J. 1991. Edge Effects: Microclimatic Pattern and Biological Responses in Old-Growth Douglas-fir Forests. Ph.D. Dissertation, University of Washington, Seattle, Washington. 174 p.

Chen, J., J.F. Franklin, and T.A. Spies. 1993. Contrasting Microclimates Among Clearcut, Edge and Interior of Old-Growth Forest. Agricultural and Forest Meteorology 63:219-237.

Fites, J., M. Chappel, B. Corbin, M. Newman, T. Ratcliff and D. Thomas. 1991. Preliminary Ecological Old-Growth Definitions for White Fir (SAFTYPE 211) in California. U.S.D.A., U.S. Forest Service, Pacific Southwest Region. 22 pp.

Fites, J., M. Chappel, B. Corbin, M. Newman, T. Ratcliff and D. Thomas. 1992. Preliminary Ecological Old-Growth Definitions for Mixed Conifer (SAFTYPE 243) in California. U.S.D.A., U.S. Forest Service, Pacific Southwest Region. 20 p.

Fowells, H. 1965. Silvics of Forest Trees of the United States. Agriculture Handbook No. 271. U.S.D.A., U.S. Forest Service, Washington, D.C. 762 p.

Freel, M. 1991. A Literature Review for Management of the Marten and Fisher on National Forest on National Forests in California. Unpublished report prepared for U.S.D.A., Forest Service, Pacific Southwest Region. 24 p.

Freeman, L.P. and T.V. Bacon. 1990. Style Guide. Revised Ed. Shirley Associates, Bountiful, Utah. 374 p.

Huff, M.H., D.A. Manuwal, and J.A. Putera. 1991. Winter Bird Communities in the Southern Washington Cascade Range. in Ruggiero, L.F., K.B. Aubry, A.B. Carey, and M.M. Huff., Tech. Coords. Wildlife and Vegetation of Unmanaged Douglas-fir Forests. General Technical Report PNW-GTR-285, U.S.D.A., U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon. p. 207-218.

Interagency Scientific Committee to Address the Conservation of the Northern Spotted Owl. 1990. A Conservation Strategy for the Northern Spotted Owl. U.S. Government, Portland, Oregon. 427 p.

Larson, K. 1997. Fire/Fuels Analysis of the Bench Timber Sale, Doublehead Ranger District, Modoc National Forest. ResearchPaper, Technical Fire Management 10, Washington Institute. 32 p.

Maxwell, W.G. and F.R. Ward. 1979. Photo Series for Quantifying Forest Residues in the: Sierra Mixed Conifer Type and Sierra True Fir Type. General Technical Report PNW-95, U.S.D.A., U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Mileck, A. 1997. Personal Communication at the Doublehead Ranger District, 1 July. District Silviculturist, Devil's Garden Ranger District, Modoc National Forest, 800 West 12th Street, Alturas, California, 96101.

Oberlag, D. 1996. Interim Snag and Coarse Woody Debris Standards and Guidelines for the Goosenest Ranger District, Klamath National Forest. Goosenest Ranger District, 37805 HWY 97, Macdoel, California, 96058.

Perry, C. and R. Overly. 1977. Impacts of Roads on Big Game Distribution in Portions of the Blue Mountains of Washington, 1972-1973. Wash. Game Dept. App. Res. Sect., Bull. 11, 39 p. Olympia, Washington.

Potter, D., M. Smith, T. Beck, B. Kermeen, W. Hance and S. Robertson. 1992a. Ecological Characteristics of Old Growth Lodgepole Pine in California. U.S.D.A., U.S. Forest Service, Pacific Southwest Region. 17 p.

Potter, D., M. Smith, T. Beck, B. Kermeen, W. Hance and S. Robertson. 1992b. Ecological Characteristics of Old Growth in California Mixed Subalpine Forest. U.S.D.A., U.S. Forest Service, Pacific Southwest Region. 31 p.

Potter, D., M. Smith, T. Beck, B. Kermeen, W. Hance and S. Robertson. 1992c. Ecological Characteristics of Old Growth Jeffery Pine in California. U.S.D.A., U.S. Forest Service, Pacific Southwest Region. 17 p.

Potter, D., M. Smith, T. Beck, B. Kermeen, W. Hance and S. Robertson. 1992d. Ecological Characteristics of Old Growth Red Fir in California. U.S.D.A., U.S. Forest Service, Pacific Southwest Region. 18 p.

Rapheal, M. and M. White. 1984. Use of Snags by Cavity Nesting Birds of the Sierra Nevada. Wildlife Monograph, Number 86, Wildlife Society, Bethesda, Maryland.

Sanders, C. 1996. Personal Communication at the Doublehead Ranger District, 20 November. Forestry Technician, Goosenest Ranger District, 37805 HWY 97, Macdoel, California, 96058.

Sinclear, D. 1996. Personal Communication, 26 March. District Fire Management Officer, Doublehead Ranger District, P.O. Box 369, Tulelake, California, 96134.

Smith, S. 1991. Revised Interim Old Growth Definitions for Interior Ponderosa Pine (SAF 237) in Northeast California. U.S.D.A., U.S. Forest Service, Pacific Southwest Region. 10 p.

Smith, S., W. Laudenslayer, J. Trask and M. Armijo. 1991. Interim Guidelines Old Growth Stands: Pacific Ponderosa Pine (SAF 245). U.S.D.A., U.S. Forest Service, Pacific Southwest Region. 6 p.

Thomas, J.W., M.G. Rapheal, R.G. Anthony, E.D. Forsman, A.G. Gunderson, R.S. Holthausen, B.G. Marcot, G.H., J.R. Sedell and D.M. Solis. 1993. Viability Assessments and Management Considerations for Species Associated with Late-Successional and Old-Growth Forest of the Pacific Northwest: The Report of the Scientific Analysis Team. U.S.D.A., U.S. Forest Service, Portland, Oregon. 523 p.

U.S. Bureau of Land Management. 1996. Electronic Format of Automatic Lightning Detection System (ALDS) Data for the Medicine Lake Highlands. U.S.D.I., U.S. Bureau of Land Management, National Interagency Fire Center, Boise, Idaho.

U.S. Department of the Interior. 1990. 1990 Status Review: Northern Spotted Owl: Strix occidentalis caurina. Report to the Fish and Wildlife Service, U.S. Fish and Wildlife Service, Portland, Oregon. 95 p.

U.S. Department of Interior and U.S. Department of Agriculture. 1981. Photo Series for Quantifying National Forest Residues: Southern Cascades and Northern Sierra Nevada. U.S.D.A., U.S. Forest Service.

U.S. Department of Interior and U.S. Department of Agriculture. 1995. Southwest Oregon Late-Successional Reserve Assessment. Medford BLM District and Siskiyou National Forest, Medford and Grants Pass, Oregon. 208 p.

U.S. Forest Service. 1991. Record of Decision for the Modoc National Forest Land and Resources Management Plan. U.S.D.A., U.S. Forest Service, Pacific Southwest Region. 17 p.

U.S. Forest Service. 1991. Modoc National Forest Land and Resources Management Plan. U.S.D.A., U.S. Forest Service, Pacific Southwest Region. 377 p.

U.S. Forest Service. 1992. Final Environmental Impact Statement on Management for the Northern Spotted Owl in the National Forests. U.S. Government Document, U.S. Forest Service, Region 6, Portland, Oregon. Vols. 1 and 2.

U.S. Forest Service. 1994. Record of Decision for the Final Supplemental Environmental Impact Statement on Management for the Northern Spotted Owl in the National Forests. U.S. Government Document, U.S. Forest Service, Region 6, Portland, Oregon.

U.S. Forest Service. 1994. Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species With the Range of the Northern Spotted Owl. U.S. Government Document, U.S. Forest Service, Region 6, Portland, Oregon. Vols. 1 and 2.

U.S. Government. 1990. Federal Register. Vol. 55, No. 192, p. 40412-40414.

U.S. Government. 1992. Federal Register. Vol. 57, No. 10, p. 1796-1838.

U.S. Government. 1993. Forest Ecosystem Management: An Ecological, Economic, and Social Assessment. Report of the Forest Ecosystem Management Assessment Team. U.S. Government Document, Interagency SEIS Team, Portland, Oregon. 1005 p.

Ure, D.C., and C. Maser. 1982. Mycophagy of Red-backed Voles in Oregon and Washington. Canadian Journal of Zoology 60:3307-3315.

Ward, A.L. 1976. Elk Behavior in Relation to Timber Harvest Operations and Traffic on Medicine Bow Range in South-Central Wyoming. in Proceedings of the Elk-Logging-Roads Symposium, Moscow, Idaho, Dec. 16-17, 1975. p. 32-43. Susan R. Hieb, ed. Univ. Idaho, Moscow, Idaho.

Woodbridge, B. 1997. Rules used to classify suitability of timber type polygons (KNF LRMP Veg Database) as nesting/roosting or foraging habitat for northern spotted owls. U.S. Forest Service, Klamath National Forest, Yreka, Ca.

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