Topsy/Pokegama

Landscape Analysis

User's Guide

The Topsy/Pokegama Landscape Analysis document you hold in your hands was designed with the iterative nature of watershed analysis in mind. This document is not a "final" product in the sense that is has been completed. As new information is collected, discovered, or generated, that information will need to be added to this analysis. Therefore, in designing this document we have attempted to design a document that will be relatively easy to update.

There will be one "official" binder containing the master copy of this document. This master copy will reside at the Klamath Falls Resource Area BLM office. Other copies will be available, but may not contain the newest information.

One of the important features that you should note in this document is the date on the bottom of each page. The date has been provided on each page so that minor changes can be incorporated into the "official" documents without having to reprint every page each time there is a revision/change. A single or a few pages can be reprinted showing the new information. The dates on the new pages will also let the reviewer(s) know that new information has been incorporated. In addition, the dates should also help reviewers with older versions compare their version of the document with the newer version to see where and what changes have been made.

When something within the landscape has changed, you should note that change in the margin of the master copy in the binder. Occasionally this binder will be reviewed and the new information incorporated as appropriate. For example, if a timber sale occurs within the landscape area, a note in the margin describing when, where, how, why, etc. will help the reviewer(s) know what has changed since the last update. It should also help the reviewer(s) determine when a major review of the analysis is needed.

Suggestions on the format, appearance, and usability of this document would be appreciated. Such suggestions/comments should be inserted into the back of the "official" binder for later review and action. Enjoy and thank you for your interest.

Table of Contents

Chapter 1

Introduction to the Topsy/Pokegama Landscape Area

Purpose and Need for the Analysis

In April 1994, the Record of Decision for the Northwest Forest Plan was released. That document includes Standards and Guidelines for the management of late-successional and old-growth forest related species within the range of the northern spotted owl. Included in the Standards and Guidelines is a list of objectives known as the "Aquatic Conservation Strategy". This strategy provides direction for the restoration of riparian/wetland habitats, and has four primary components, as follows:

1. It establishes Riparian Reserves on public lands along streams and on unstable and potentially unstable areas where special standards and guidelines direct land use.

2. It also establishes a system of Key Watersheds throughout the range of the northern spotted owl that are crucial to at risk fish species and stocks that provide high water quality.

3. It requires that Watershed Analysis be completed to provide the basis for monitoring and restoration programs and the foundation from which Riparian Reserves can be delineated.

4. A comprehensive, long-term program of Watershed Restoration to restore watershed health and aquatic ecosystems is the final component of the strategy.

This document, the Topsy/Pokegama Landscape Analysis, has been prepared to partially meet requirements under the Northwest Forest Plan's Aquatic Conservation Strategy. It was prepared by an interagency (BLM and USFWS), interdisciplinary team.

Background

The Topsy/Pokegama Landscape Analysis presents an ecosystem analysis at a scale slightly different than the traditional fifth field watershed. It does, however, still fit in the 20 to 200 mile scale described in the *Federal Guide for Watershed Analysis* (version 2.2). The boundaries of this analysis have been modified from the fifth field watershed boundaries to include some lands outside the watershed boundary and exclude some of those lands within the boundary.

The upper Klamath River runs through this fifth field watershed. It was decided early that this Topsy/Pokegama effort would not be able to cover many of the issues concerning the Klamath River itself since those issues need to be examined at a larger scale. This includes such issues as river flows and water quality and quantity in the Klamath River. These issues will have to be covered as part of larger efforts such as the Klamath River basin/province assesment.

With these considerations in mind the Topsy/Pokegama team looked at the fifth field watershed and decided to make some modifications to the analysis area boundary. On the north end of the fifth field watershed there is a sixth field subwatershed that is islolated from the rest of the larger watershed by the Klamath River. All of the land within this subwatershed is privately owned and so the subwatershed was dropped from the analysis. The Klamath River was seen as a logical boundary considering the issues to be covered in this analysis. Similarly, on the southwest end of the fifth field watershed, subwatersheds that flow directly into the Klamath River were seen as being effectively isolated from the larger analysis area. Therefore these subwatersheds were dropped from consideration, mainly along the subwatershed boundaries. Finally, to the west and southwest side of the Topsy/Pokegama fifth field watershed portions of two subwatersheds of the Butte Valley fifth field watershed were added to our analysis area. These additions were made to include lands that were similar in character and contiguous with the Topsy/Pokegama fifth field watershed, but very different from the highly modified farm lands into which they flow and adjoin. The boundary lines were drawn along the Klamath River, artificial hydrologic features (drainage canals) that flow into the Klamath River, subwatershed boundaries, and other topographic breaks.

The analysis describes the current understanding of the processes and interactions of concern occurring within the Topsy/Pokegama landscape. The analysis looked at the entire area regardless of ownership so that a more complete understanding of the landscape could be achieved. It is intended to guide management on the federal lands within the landscape. It is also meant to help us understand how past land use activities interact with the physical and biological environments in the landscape. This analysis provides a logical way to learn more about how ecological systems function within the landscape. This information is essential to protect beneficial uses and to protect and sustain the natural systems that society depends upon. The analysis provide a vehicle to efficiently identify and balance multiple concerns. The analysis provides a summary of trends for resources where restoration actions are needed.

Existing information was used for this analysis. Some information team members wanted and/or needed was not available to assist in describing conditions, predicting trends, or evaluating relationships. There is a section that outlines data needs that would improve this analysis and could aid in future evaluations of activities. The analysis focused on specific issues, values, and uses identified within the landscape that are essential for making sound management decisions. The historic, current, and desired conditions of the landscape are described, as are the processes and activities affecting the resources in the landscape.

This is the first iteration of this analysis. New versions of the document will be produced over time as new information is gathered, generated, or discovered. It is not expected that new iterations will be produced and distributed on specific time schedules.

Landscape Boundaries

The Topsy-Pokegama Landscape Analysis (TPLA) area is approximately 171,390 acres in size and is located entirely in the Klamath River Basin (see Maps 1 and 2). The analysis area boundary on the northeast follows the Klamath River from the point where U.S. Highway 97 crosses the river to the confluence of the Klamath River and Spencer Creek. From the confluence, the boundary of the analysis area extends northwest, following a ridge line that parallels Spencer Creek on the southwest, reaching the northernmost extent of the analysis area approximately 1.5 miles north of Buck Mountain. The boundary for the analysis area then continues southwest to near Grizzly Mountain and approximately 1/2 mile from the Jackson County line. From there, it roughly parallels the Jackson County line to Copco Reservoir in California, the southwestern corner of the analysis area. The southern boundary of the analysis area extends from the south side of Copco Reservoir easterly along the Klamath River to Shovel Creek. It then follows the watershed ridge north of Shovel and Panther Creeks, continuing along the northern boundary of agricultural lands in California to the southeastern corner of the analysis area near the town of Dorris on U.S Highway 97. The eastern boundary then extends north roughly along Highway 97 to the Klamath River.

Land Ownerships

The landscape analysis area is a diverse checkerboard of private, state, and federal ownerships (Refer to Table 1 for an overview). Of the approximately 171,389 acres that comprise the landscape analysis area, the majority of lands are owned by Weyerhaeuser Corporation (with approximately 68,425 acres or 40 percent of the total landbase) followed by public lands administered by the BLM-Klamath Falls Resource Area (approximately 30,457 acres or 18 percent). Other ownerships include private lands belonging to Pacific Power and Light (PPL) company with approximately 7,514 acres or 4 percent; federal lands of the Bear Valley National Wildlife Refuge with approximately 4,200 acres or 2.5 percent; state forest lands administered by the Oregon Department of Forestry (ODF) with approximately 4,065 acres or 2.4 percent; public lands administered by the BLM in California with approximately 3,262 acres or 2 percent; and public lands of the Klamath National Forest in California with approximately 1,830 acres or 1 percent.

Table 1. Acres for TPLA area.

Acres based on GIS polygons.	Acres	Percent
Total Acres in TPLA area.	171,389	
Total Acres covered by WODDB* (68%)	116,020	
Total Acres in Long Prairie Watershed	25,716	15
Total Acres in Hayden Creek Watershed	17,802	10
Total Acres in Edge Creek Watershed	4,831	3
Total Acres of Riparian Reserves	3,466	2
Total Acres for Oregon BLM lands**	30,457	18
Estimated acres obtained from ownership maps.		
Weyerhaeuser Corporation lands	68,425	40
Pacific Power and Light (PPL) lands	7,514	4
Acres supplied by agencies.		
Bear Valley National Wildlife Refuge	4,200	2.5
Oregon Department of Forestry	4,065	2.4
California BLM-administered lands	3,262	2
Klamath National Forest lands	1,830	1
Summary for Ownerships		
Federal Lands	39,749	23
State Lands	4,065	2.4
Private Lands (Weyerhaeuser and PPL lands)	75,939	44
Other Private Lands	51,636	30
Roads (for Oregon BLM-administered lands)		**Miles**

Total miles of road		185.4
Average miles of road per section		3.9
* WODDB = Western Oregon Digital Database ** BLM-KFRA-administered lands		

The percent equivalent for federal, state, and private lands in the analysis area breaks down roughly as follows: federal lands (23 percent), state lands (2.4 percent), private lands (only Weyerhaeuser and PPL lands) (44 percent), and all other private lands (30 percent). The last ownership component (other private lands) consists of a diversity of privately owned agricultural, forest, and range lands.

Physiography

The eastern portion of the Topsy/Pokegama Landscape Analysis (TPLA) area lies within the northwestern corner of the Basin and Range physiographic Province. This province is characterized by a series of long and narrow, north-south trending, fault-block mountains and valleys. In this area, the uplands are volcanic in origin and the valleys filled with volcanic-derived sediments. The Klamath Basin is the westernmost basin in the Basin and Range province.

To the west of the Klamath Basin lies the Cascade Range physiographic province. This province is divided into two subprovinces: the High Cascades and the Western Cascades. The High Cascades, located along the crest of the Cascade Mountain range, are characterized by a chain of relatively young, high-elevation volcanoes. The lower-elevation western Cascades province consists of older, more deeply-eroded volcanic rocks. Interstate 5 closely follows the boundary between the Cascade Range province and the Klamath Mountains province from about the Klamath River crossing in northern California north to the Oregon border.

The landscape analysis area is largely a low- to mid-elevation plateau that lies between the crest and the eastern toeslope of the Cascade Mountains. The central interior of the plateau is deeply incised by the approximately 800 foot deep (244 meters) Klamath River Canyon.

Biodiversity

The lanscape anlaysis area is biogeographically unique in the Cascades Range physiographic province. Low-elevation and aquatic-habitat conectivity corridors exist between east and west slopes of the Cascade range. These corridors, although fragemnted to a degree by human activities sunch as dams and logging, serve as a genetic link between plant and animal populations that occur both east and west of the Cascade range. In addition, there are unique spring habitats containing endemic species (species whose entire range is confined to a specific locality). In both cases, the landscape analysis area contains an important genetic legacy that contributes to the adaptiveness and resiliency of species and populations.

Environment

Except for the Klamath River Canyon, the landscape analysis area is for the most part a mid- to high-elevation plateau [ranging from approximately 1,100 to 1,600 meters (3,608 to 5,249 feet) in elevation] of generally flat topography with Buck, Chase, and Hamaker Mountains the highest points at 1,904 meters (6,247 feet), 1,935 meters (6,348 feet), and 1,829 meters (6,001 feet) respectively. The area can be characterized as semi-arid with mean annual precipitation ranging from 630 to 890 millimeters (25 to 35 inches) west of the Klamath River Canyon and around 380 millimeters (10 inches) on the east side of the river canyon. Although no temperature and precipitation records exist for the landscape area, forest types and plant communities would indicate that the landscape area receives less precipitation than adjacent Spencer and Jenny Creeks, higher-elevation watersheds to the north. Climatic conditions and topoedaphic factors appear to have led to the creation of forest stands that are generally more open in structure than mixed conifer and higher-elevation forests to the north in adjacent watersheds. Plant communities include mixed conifer forest [predominantly ponderosa pine (*Pinus ponderosa*), Douglas-fir (*Pseudotsuga menziesii*), and white fir (*Abies concolor*)]; ponderosa pine plantations (many on Weyerhaeuser lands); pine/juniper forest; pine/oak forest; oak forest; and oak shrub. Ponderosa pine and Douglas-fir are the dominant tree species. Soil organic horizons are generally much less developed compared to those in mixed conifer forests in watersheds to the north, and the probable greater frequency of low-intensity fires in this semi-arid area, before the institution of fire exclusion, may have been a factor in leading to less comparable amounts of coarse woody debris on the forest floor. As a result of local climatic conditions, topoedaphic factors, and past disturbance, the area is generally less productive than adjacent watersheds to the north. Except for the Klamath River, the analysis area is a dry physiographic region that contains few streams, riparian areas, or wetlands. Major streams in the area include Spencer, Long Prairie, Tom, Edge, and Hayden Creeks.

Soils

The dominant soil series in the TPLA area are Pinehurst, Greystoke, Pokegema and Woodcock. The Pinehurst series consists of very deep, well drained loam soils on plateaus and hillslopes. These soils formed in colluvium derived dominantly from andesite. Slopes are 1 to 35 percent. The Greystoke and Pokegema series consist of deep, well drained soils on plateaus and hillslopes. These soils formed in colluvium and residuum derived dominantly from andesite. Slopes are 1 to 75 percent in the Greystoke stony loams and 1 to 35 percent in the Pokegema loams. The Woodcock series consists of very deep, well drained soils on plateaus and hillslopes. These soils formed in colluvium derived dominantly from andesite. Slopes are 1 to 55 percent in this stony loam.

Riparian Vegetation

The many benefits of riparian areas are well-stated in the following definition of Proper Functioning Condition (BLM Technical Reference 1993): "Riparian-wetland areas are functioning properly when adequate vegetation, landform, or large woody debris is present to dissipate stream energy associated with high waterflows, thereby reducing erosion and improving water quality; filter sediment, capture bedload, and aid floodplain development; improve flood-water retention and ground-water recharge; develop root masses that stabilize streambanks against cutting action; develop diverse ponding and channel characteristics to provide the habitat and water depth, duration and temperature necessary for fish production, waterfowl breeding, and other uses; and support greater biodiversity."

Riparian communities function as crucial breeding and feeding habitat for wildlife. Some of the attributes which make riparian areas so valuable are the presence of diverse and highly productive vegetation, the positive edge effects of streams, the high availability of terrestrial and aquatic insects, and the presence of water.

Livestock Grazing

Livestock grazing has likely occurred in the landscape analysis area since the late 1880s. Grazing levels have probably varied with the amount of logging activity which opened up areas and increased the production of herbaceous vegetation. Livestock grazing still occurs throughout the watershed at levels that are lower than those in recent decades.

Properly managed grazing on public lands contributes to the economic viability and stability of local communities in the West, including the Klamath Basin. It also supports a lifestyle that many people feel is important to support and maintain. Livestock grazing on public lands additionally contributes to the national production of meat.

Properly managed grazing can benefit the land in various ways including the following: reduction of fine fuel loads and accompanying fire hazards; positive manipulation of some types of wildlife habitat; and the construction and maintenence of watering facilities that are used by both livestock and wildlife.

Grazing animals can be used as a tool to manipulate vegetative conditions towards or away from specific vegetative community structures, commensurate with potential. Grazing can also be a tool to maintain plant succession at certain stages and to maintain biological diversity.

Wild Horses

Through Congressional action, the American people have prescribed that wild horses (and burros) are a resource worth protecting and preserving when found on publicly administered lands. These same laws allow for the use of privately owned lands within a Herd Management Area (HMA) for the maintenance of wild horses with the consent of the land owners. This is the case with the Pokegama HMA, where approximately 80 percent of the HMA is private land, largely owned by the Weyerhaeuser Company.

The existence of the Pokegama herd is relatively unknown even among the local populace. It is known, however, to a few people who do enjoy being able to observe the activities of these high-quality (by typical wild-horse standards) wild horses.

The herd is also controversial in that it is believed by some to be competitive with livestock, elk, and deer, and also may be contributing to riparian related resource problems. Most HMAs on BLM-administered lands, including those in eastern Oregon, are difficult to access; however, the Pokegama HMA is located in an area that offers relatively easy access to those who wish to observe wild horses. Conversely, since the area is forested, the odds of viewing a group of horses on any given visit is fairly low, unless one is familier with the area and the herd distribution characteristics.

Water Use

Water use in the landscape analysis area consists of the following: hydroelectric power generation, irrigation, stock watering, road watering, and fire suppression. Several in-channel and off-channel reservoirs, spring developments and guzzlers have been constructed on or near federal lands.

The primary beneficial uses for water resources that are related to land management activities on BLM-administered lands are rearing and spawning habitat for salmonids, domestic water supply, fishing, resident fish and aquatic life, and recreation (see Table 2 in the analysis chapter). All these uses require high water quality and sufficient water quantity. The Klamath River Basin Compact (Oregon Revised Statutes 542.610 to 542.630), an interstate compact between Oregon and California, identifies beneficial uses for the waters of the Klamath River Basin, including domestic, irrigation, recreation, fish and wildlife, industrial, and hydroelectric power purposes, along with other uses recognized by each state involved.

Recreation

The landscape analysis are is used extensively and during all seasons of the year for a wide variety of recreation activities. Many of the recreational opportunities found in the analysis area are within a one to two hour drive of Klamath Falls and the cities of the Rogue River valley, making the area popular with the residents of those cities. Recreational users residing in other areas of Oregon as well as outside of the state are also drawn to the area to use the recreational resources found there.

The major recreation activities ocurring in the analysis area include stream and lake fishing, sightseeing, off-highway veicle driving, camping, hunting, whitewater boating, and target shooting. There are a number of developed recreation sites managed by different agencies and land owners which provide facilities to pursue these and other activites. Most of the other well known outdoor, natural setting-based recreation activities, such as mountain biking or edible plant gathering, undoubtedly occur in the area also.

The value of the recreational resources found in the analysis area is recognized in the following land management designations. The BLM-administered lands within the Klamath River Canyon are a designated scenic waterway in the state of Oregon, a Special Recreation Management Area (SRMA), and a scenic component of the federal Wild and Scenic Rivers program. The Hamaker mountain area was identified as a potential SRMA in the 1995 BLM Resource Management Plan. The scenic quality of the viewshed in the Klamath River Canyon is designated as BLM visual resources management (VRM) class II which maintains the existing character of the landscape in a mostly undisturbed appearing state (see Map 3).

Human Values

Traditional cultural values are often central to the way a group or community defines itself, and maintaining such values is often vital to maintaining the group's sense of identity and self-respect. It is vital to evaluate properties thought to have traditional cultural significance from the standpoint of those who ascribe such significance to them. The landscape analysis area is exceptionally rich in both prehistoric and historic resources which are regarded by Native and Euroamericans as basic to their cultural heritage. In addition, the analysis area offers a rich blend of employment and recreation to modern Americans who work and play there.

Chapter 2

Core Topics, Issues, and Key Questions

In version 2.2 of the *Ecosystem Analysis at the Watershed Scale, Federal Guide for Watershed Analysis* core topics are given to serve as a framework for focusing the basic analysis process used by many federal agencies. In addition to the core topics listed in the federal guide, the Topsy/Pokegama Landscape Analysis team developed numerous other issues and key questions that could have been addressed as part of this analysis process. However, due to various constraints the list was pared down to the most critical items needing analysis at this stage of the process. This also helped to focus the analysis on the Topsy/Pogemama landscape. The following list includes those issues and key questions addressed in this stage of the analysis:

Issue: Forest succession, composition, structure, and function have been altered in the landscape analysis area.

Key Question: What changes have occurred in the forested landscape as a result of selective (highgrade) logging, fire exclusion, and livestock grazing?

Issue: Ecosystem structure and function (forest health) have been altered by human-introduced disturbance in the landscape area.

Key Questions: Are there forest stands in the landscape area that are at moderate to high risk of disease outbreak, insect attack, and catastrophic disturbance? Are there significant disease or insect problems in the landscape area?

Issue: Soil and site productivity has been altered in the TPLA area.

Key Questions:What are the dominant characteristics of soils in the TPLA area? Are there sensitive soils within the TPLA area that deserve special protection or mitigation consideration? What erosion processes are dominant within the TPLA area? Where have they occurred or are they likely to occur? Do compaction and loss of soil organic matter associated with logging activities affect soil productivity? Do potential reductions nitrogen fixation and in populations of mycorrhizal fungi occur with management activities? What is the nutrient status, especially for nitrogen (N), in forest soils in the TPLA area? What historic processes affected soil productivity in the TPLA area? What are the historic erosion processes within the TPLA area? Where have they occurred? What are the natural and human causes of changes between historical and current erosion processes and soil productivity in the TPLA area? What are the influences and relationships between erosion processes, soil productivity and other ecosystem processes?

Issue: Distribution and abundance of special-status plants have been altered in the landscape area by human-introduced disturbances.

Key Questions: What special-status plants occur in the landscape analysis area? Where are known populations of these plants located in the landscape analysis area? What are the habitat requirements for each species?

Issue: Alteration of the landscape area has resulted in the introduction of populations of noxious weeds and the displacement of native plant species.

Key Questions: What species of noxious weeds occur in the landscape analysis area? Where do known populations of these plants occur in the area? Are populations increasing in size and, if so, what is their estimated rate of expansion? To what extent are population sources displacing populations of native plant species?

Core Topic: Plant Associations - no issues

Issue: Critical use areas for terrestrial listed and non-listed wildlife have been altered.

Key Questions: How has habitat been changed by management practices? What have been the habitat changes? What are the species of concern, their life history characteristics, and how has habitat alterations affected these species?

Issue: Hydrology has been altered in the TPLA area.

Key Questions: What are the dominant hydrologic characteristics and other notable hydrologic features and processes in the TPLA area? What are the current conditions and trends of the dominant hydrologic characteristics and features prevalent in the TPLA area? What are the historical hydrologic characteristics and features in the TPLA area? What are the natural and human causes of change between historical and current hydrologic conditions? What are the influences and relationships between hydrologic processes and other ecosystem processes?

Issue: Stream channel condition has been altered in the TPLA area.

Key Questions: What are the basic morphological characteristics of stream valleys or segments and the general sediment transport and deposition processes in the TPLA area? What are the current conditions and trends of stream channel types and sediment transport and deposition processes prevalent in the TPLA area? What are the natural and human causes of change between historical and current channel conditions? What are the influences and relationships between channel conditions and other ecosystem processes in the TPLA area?

Issue: Vegetation communities in riparian-wetland areas have been altered in the TPLA area.

Key Questions:What is the array of plant communities and seral stages in riparian-wetland areas? What processes caused these patterns? What are the current conditions and trends of the prevalent plant communities and seral stages in the riparian-wetland areas? What is the historical array of plant communities and seral stages in riparian-wetland areas? What processes caused these patterns? What are the natural and human causes of change between historical and current vegetative conditions in riparian-wetland areas? What are the influences and relationships between vegetation and seral patterns and other ecosystem processes in the TPLA area?

Issue: Water quality has been altered in the TPLA area.

Key Questions: What beneficial uses dependent on aquatic resources occur in the TPLA area? Which water quality parameters are critical to these uses? What are the current conditions and trends of beneficial uses and associated water quality parameters? What were the historical water quality characteristics of the TPLA area? What are the natural and human causes of change between historical and current water quality conditions? What are the influences and relationships between water quality and other ecosystem processes in the TPLA area?

Issue: High road densities, grazing, hydrologic modifications, and intensively managed forests have impacted aquatic ecosystem function in the tributary watersheds.

Key Questions: What is the relative abundance and distribution of species of concern in the watersheds? Where are key aquatic habitats? What is the current habitat condition? What is the historic condition of species distributions and habitats? What are the causes for observed changes in distribution and habitat? Which are natural and which are human caused?

Issue: Concentrated recreational activity, grazing, exotic species, and hydrologic modifications have impacts to aquatic species in the Klamath River Canyon.

Key Questions: What is the relative abundance and distribution of species of concern in the Klamath River Canyon? Where are key aquatic habitats? What is the current habitat condition? What is the historic condition of species distributions and habitats? What are the causes for observed changes in distribution and habitat? Which are natural and which are human caused?

Issue: Livestock grazing has impacted other resources and activities within the TPLA watershed.

Key Questions: What are the historic and current livestock grazing uses within the TPLA area? What are the historic and current livestock forage use levels and patterns within the TPLA area? What monitoring of livestock use has been done on public lands within the watershed? What has the analysis of this monitoring data shown? What livestock management improvements have been installed in the TPLA area?

Issue: A formally established Wild Horse Herd Management Area (HMA) exists and the horse herd is creating impacts within the analysis area.

Key Questions: How much of an effect does the herd have on the vegetative communities and dependent wildlife species in the area? Is the current management level of 30 to 50 horses suitable for the HMA?

Issue: Land in the Topsy/Pokegama Landscape Analysis area was ceded to the United States by the Treaty of Klamath Lake, 1864. The Klamath Tribes have a hereditary interest in the TPLA area.

Key Questions: Do the Klamath Tribes have treaty rights within the TPLA area? What are the needs and interests of the Klamath Tribes in this analysis area?

Issue: The Shasta People were in residence in Klamath Canyon at the time of contact. The Shasta people have a hereditary interest in the TPLA area.

Key Questions: Do the Shasta people have treaty rights within the TPLA area? What are the needs and interests of the Shasta People within this landscape area?

Issue: Historic and prehistoric resources exist in the landscape.

Key Question: How has human activity impacted the landscape and what archaeological sites (historic and prehistoric) are present within the TPLA area?

Issue: American pioneer settler homesteads are located within the TPLA area.

Key Questions: What are the identifiable homesteads in the TPLA area? What are the identifiable Historic roads and trails in the TPLA area?

Issue: Recreation use is occurring in the TPLA area and may be affecting different resource values.

Key Questions: What are the historical patterns of recreation use in the TPLA area? Are the lands in the TPLA area currently being managed to serve the recreation needs of the public, and maintain ecosystem health? Does the road network in the TPLA area adequately serve the needs of the recreating public? What is the anticipated future demand for recreation development and opportunities in the TPLA area? Is there a need for more developed winter sports recreation opportunities in the TPLA area?

Issue: Biological diversity has been altered in the landscape area.

Key Questions: Has biological diversity of plant and animal species decreased or increased in the landscape analysis area? What changes in biological diversity have selective logging, fire exclusion, and livestock grazing brought about in the landscape area? Will activities such as commercial thinning and the introduction of prescribed fire increase or decrease biological diversity?

Issue: Landscape ecology has been altered in the landscape analysis area.

Key Questions: What functions do landscape features and patterns have? What is the present structure and composition of forests across the landscape analysis area? What sort of future forest matrix across the landscape analysis area do we wish to achieve? Are we creating a disproportionate amount of young forests that lack structural and compositional complexity? Are we providing for late-successional and old-growth forests and the unique assemblage of plant and animal species that such forests support? Are we creating a landscape diversity of forest structures to absorb future destructive disturbances, to maintain minimal habitat requirements and migration pathways for species, and to maintain viable population "sources" for recolonization of depleted areas? In short, will we create a functional or dysfunctional landscape with future proposed management activities?

Core Topic: Forest Stucture, Composition, and Function

Issue: Forest succession, composition, structure, and function have been altered in the landscape analysis area.

Key Question: What changes have occurred in the forested landscape as a result of selective (highgrade) logging, fire exclusion, and livestock grazing?

Overview

Selective logging, fire exclusion, and livestock grazing associated with Euro-American settlement of the inland west have resulted in profound changes in forest succession, composition, structure, and function across the landscape (DellaSala et al. 1995, Covington et al. 1993, Oliver et al. 1993, Oliver et al. 1994). Together these factors have brought about a shift in low- and mid-elevation forests from open, parklike stands dominated by ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) to denser replacement stands dominated by grand fir (*Abies grandis* (Dougl.) Forbes) and white fir (*Abies concolor* [Gord. & Glend.]). Historically, forest composition was much different within the landscape analysis area based on extensive forest surveys conducted at the turn of the century (Leiberg 1899). Leiberg (1899) reported that forests on the west side of the Cascade Range were dense with luxuriant undergrowth whereas forests on the east side were open with no underbrush. Ponderosa pine reportedly constituted six-sevenths of all the conifer species east of the Cascade Range (Leiberg 1899). Fire was reported as having "ravaged" the region leaving no forested township either on the west or east side of the Cascade Range untouched (Leiberg 1899). Although broad in delineating forest types, a map produced in the 1960s of potential natural vegetation for the contiguous United States describes a large part of the landscape analysis area as a ponderosa pine-dominated forest ecosystem (Kuchler 1964).

The shift in forest composition from past to present conditions is reflected in stand inventory data gathered and analyzed from the BLM-Klamath Falls Resource Area (MICROSTORMS database, 1996). Below are tables adapted from Leiberg (1899) displaying changes in past and present forest composition by township in the landscape analysis area. Percent of dominant overstory conifer species displayed for contemporary forests includes only federal lands administered by the BLM-Klamath Falls Resource Area. Stand inventory data for other ownerships in the analysis area were not available in time for inclusion in this document. Because Weyerhaeuser lands comprise a significant porportion of lands within the analysis area and for the most part contain stands dominated by ponderosa pine, the percent of ponderosa pine displayed in the table for contemporary forests would probably increase substantially (perhaps as much as 10 percent with a concomitant decrease in the proportion of other species). An inventory of Weyerhaeuser lands, the other major ownership in the landscape area, was not available for inclusion in this analysis. Leiberg's use of the common name, red fir, refers to Douglas-fir (*Pseudotsuga menziesii*) forests at the turn of the century of which Shasta red fir (*Abies magnifica var. shastensis lemmon*) was a component. The red fir category for contemporary forests distinguishes between the Douglas-fir (PSME) and Shasta red fir (ABMA) components. Four-letter codes, conventional in plant association use, refer to tree species: PSME (*Pseudotsuga menziesii*, Douglas-fir), PIPO (*Ponderosa pine*, Ponderosa pine), ABMA (*Abies magnifica*, Shasta red fir), ABCO (*Abies concolor*, white fir), CADE (*Calocedrus decurrens*, incense cedar), PICO (*Pinus contorta,* lodgepole pine) and QUGA (*Quercus garryana*, Oregon white oak). See Tables 3 through 11 for more specific information.

Table 3. T. 39 S., R. 6 E. (Spencer Creek)		
Species	Past (circa. 1900)	BLM-KFRA- Administered Lands (1996)
ponderosa pine (*Pinus ponderosa*)	31	12
sugar pine (*Pinus lambertiana*)	7	trace
red fir (*Pseudotsuga menziesii*)	50	27 PSME 35 ABMA Total = 62
white fir (*Abies concolor*)	10	26
incense cedar (*Calocedrus decurrens*)	1	trace
lodgepole pine (*Pinus contorta*)	1	trace

Table 4. T. 40 S., R. 5 E. (Long Prairie Creek and Tom Creek)		
Species	Past (circa. 1900)	BLM-KFRA- Administered Lands (1996)
ponderosa pine	50	11
sugar pine	15	trace
red fir	30	73 PSME 0 ABMA Total = 73
white fir	4.5	16
incense cedar	0.5	trace

Table 5. T. 40 S., R. 6 E. (Hayden Creek)		
Species	Past (circa. 1900)	BLM-KFRA- Administered Lands (1996)
ponderosa pine	60	46
sugar pine	15	trace
red fir	22	35
incense cedar and white fir	3	2 CADE 14 ABCO Total = 16
Oregon white oak	---	3

Table 6. T. 40 S., R. 7 E. (Grenada Area [west of Hamaker Mountain])		
Species	Past (circa. 1900)	BLM-KFRA- Administered Lands (1996)
ponderosa pine	40	34
sugar pine	5	trace
red fir	55	40 PSME 0.3 ABMA Total = 40.3
incense cedar	scattered	trace
white fir	---	24

Table 7. T. 40 S., R. 4 E. (north of Copco Reservoir)		
Species	Past (circa. 1900)	BLM-KFRA- Administered Lands
ponderosa pine	50	52
sugar pine	5	trace
red fir	30	trace
incense cedar	2	trace
white fir/western juniper	1	trace
oak	12	48

Table 8. T. 41 S., R. 5 E. (south of Long Prairie and Tom Creeks)		
Species	Past (circa. 1900)	BLM-KFRA- Administered Lands (1996)
ponderosa pine	50	74
sugar pine	10	trace
red fir	36	15 PSME 0 ABMA Total = 15
white fir and incense cedar	4	trace
western juniper	---	10

Table 9. T. 41 S., R. 6 E. (south of Hayden Creek/lower Klamath River Canyon)		
Species	Past (circa. 1900)	BLM-KFRA- Administered Lands (1996)
ponderosa pine	45	76
red fir	55	6 PSME 0 ABMA Total = 6
Oregon white oak	---	5
non-forest	---	7

Table 10. T. 41 S., R. 7 E. (south of Grenada area and Hamaker Mountain)		
Species	Past (circa. 1900)	BLM-KFRA- Administered Lands (1996)
ponderosa pine	75	87
red fir	25	12 PSME 0 ABMA Total = 12

Table 11. Present (1996) and past (circa. 1900) forest composition within townships in the landscape. Percent cover of major tree species is shown for each township for which data were available.		
	T. 39 S., R. 6 E. 1900 1996 PIPO 31 12 PILA 7 trace PSME 50 27 PSME 35 ABMA ABCO 10 26 CADE 1 trace PICO 1 trace	*T. 39 S., R. 7 E.* 1900 PIPO 73 PILA 3 PSME 13 ABCO 7 CADE 0.2 JUOC 3.8
T. 40 S., R. 5 E. 1900 1996 PIPO 50 11 PILA 15 trace PSME 30 73 PSME 0 ABMA ABCO 4.5 16 CADE 0.5 trace	*T. 40 S., R. 6 E.* 1900 1996 PIPO 60 46 PILA 15 trace PSME 22 35 CADE 1.5 2 ABCO 1.5 14 QUGA--- 3	*T. 40 S., R. 7 E.* 1900 1996 PIPO 40 34 PILA 5 trace PSME 55 40 PSME 0.3 ABMA CADE scattered trace ABCO--- 24

T. 41 S., R. 5 E.		*T. 41 S., R. 6. E.*		*T. 41 S., R. 7 E.*	
1900	1996	1900	1996	1900	1996
PIPO 50	74	PIPO 45	82	PIPO 75	87
PILA 10	trace	PSME 55	6 PSME	PSME 25	12 PSME
PSME 36	15 PSME		0 ABMA		0 ABMA
	0 ABMA	QUGA---	5		
ABCO 2	trace	non-forest---	7		
CADE 2	trace				
JUOC---	10				

Legend for Tables 3 - 11
PIPO = *Pinus ponderosa* (ponderosa pine)
PSME* = *Pseudotsuga menziesii* (Douglas-fir)
CADE = *Calocedrus decurrens* (incense cedar)
JUOC = *Juniperus occidentalis* (western juniper)
PILA = *Pinus lambertiana* (sugar pine)
ABCO = *Abies concolor* (white fir)
PICO = *Pinus contorta* (lodgepole pine)
QUGA = *Quercus garryana* (Oregon white oak)
---- no records for the species
* Note: Leiberg included Shasta red fir in the Douglas-fir component.

Past Conditions

The forest surveys conducted by Leiberg (1899) reveal that ponderosa pine and Douglas-fir were the dominant tree species at the turn of the century in the townships comprising the Topsy-Pokegama landscape analysis area. Ponderosa pine *(Pinus ponderosa)* ranged from 30 to 60 percent of all tree species and Douglas-fir (*Pseudotsuga menziesii*) 22 to 55 percent of all tree species. In several townships, Douglas-fir exceeded ponderosa pine as the dominant tree species (T. 39 S., R. 6 E.; T. 40 S., R. 7 E.; and T. 41 S., R. 6 E.). Sugar pine (*Pinus lambertiana* Douglas) comprised 5 to 20 percent of the forest composition. The white fir (*Abies concolor*) component, on the other hand, appears to have been minor, ranging from only 0 to 10 percent.

Present Conditions

Stand inventory data from the MICROSTORMS database indicate changes in forest composition that have occurred since Leiberg's surveys at the turn of the century and point to future trends in forest composition and structure. The ponderosa pine component has decreased substantially in the townships containing Spencer Creek, Long Prairie Creek, Tom Creek, Hayden Creek, and Grenada areas. Table 12 displays the percent change in the ponderosa pine and white fir components in those townships.

Table 12. Percent Change in the Ponderosa Pine and White Fir Components.				
Townships	Change in Ponderosa Pine Composition	Percent Change	Change in White Fir Composition	Percent Change
T.39S., R.6E. (Spencer Creek)	31 to 12	-61	10 to 26	+160
T.40S., R.5E. (Long Prairie and Tom Creeks)	50 to 11	-78	4.5 to 16	+256
T.40S., R.6E. (Hayden Creek)	60 to 46	-23	3 to 14	+367
T.40S.,R.7E. (Grenada)	40 to 34	-15	No Record	------

Selective logging and white pine blister rust have reduced sugar pine composition from a historic range of 3 to 15 percent of forest composition in the landscape area to that of a remnant species with a distribution of only a few individuals per acre. The Douglas-fir component shows substantial increases in some townships and yet substantial decreases in others.

Dense understories of white fir and Douglas-fir have replaced stands formerly characterized by more open-canopied structures which maintained a sizable ponderosa pine component in forest stands. The higher stem density of contemporary forests have led to conditions that significantly reduce ponderosa pine regeneration for future forests. Not all areas in the landscape analysis area, however, are overstocked with dense understories of white fir. Some forested landscapes such as in the Grenada area remain fairly open with small islands of moderately dense, young white fir and Douglas-fir stands scattered in a larger matrix of relatively open forest.

Effects of Introduced-Human Disturbances (Selective Harvest, Fire Exclusion, and Livestock Grazing)

A complex of disturbances introduced with Euroamerican settlement, beginning around the 1840s, accounts for the ecological changes that have occurred in eastside forests in Oregon and Washington (Covington and Moore 1994, Oliver et al. 1993, Belsky and Blumenthal 1995). Selective harvest, fire exclusion, and livestock grazing have contributed in creating forest stands that are out of balance within the historic range of variability (HRV) and are, therefore, more susceptible to high-severity disturbances such as catastrophic, stand-replacement wildfire and virulent outbreaks of disease and insect attack that threaten ecosystem integrity or robustness (Morgan et al. 1993). Selective harvest of the healthiest, largest, and most valuable trees, which were for the most part ponderosa pine, resulted in a disporportionately high residual component of other tree species in the forest overstory. On the forest floor, Douglas-fir, grand fir, and white fir seedlings out-competed ponderosa pine seedlings for freed growing space, water, and nutrients, reducing recruitment of ponderosa pine. Beginning around 1920 and continuing to the present, active fire suppression measures aided by construction of an extensive road network across the federal forest landscape and the effectiveness of modern fire-fighting technology have resulted in disruption of the natural fire regime of frequent, low-intensity fires which historically burned the less fire-tolerant white fir component and reduced the accumulation of fuels on the forest floor. Mature ponderosa pine were able to survive these periodic, low-intensity fires because of thicker bark. With fire exclusion, as forest stands grew denser, they became shadier, encouraging establishment of shade-tolerant species such as Douglas-fir, grand fir, and white fir. A shift in forest composition resulted from dominance by shade-intolerant ponderosa pine to dominance by more shade-tolerant species such as Douglas-fir and true firs. Grazing livestock introduced by settlers reduced the amount and vigor of the grass and herbaceous cover on the forest floor. This resulted in an increase in tree seedling density and a reduction in fine fuels that carry frequent, low-intensity ground fires. Both conditions allowed for more tree seedlings to become established (Miller 1988, Karl and Doescher 1993).

Fire Ecology (The Effects of Fire Exclusion)

Overview

Disruption of the natural fire regime has effected a change in vegetation and landscape pattern for the entire region of eastern Oregon including the landscape analysis area. Fire is the chief natural disturbance and an integral natural process in eastside forest ecosystems affecting succession (for example, whether pondersoa pine-dominated forests persist over time or are replaced by fir species); overstory and understory composition of forest stands; structure (for example, diameter- and age-class distributions, canopy layer diversity, and amounts and distribution of standing and down dead wood); and function (for example, decomposition of organic materials, nutrient cycling, forest hydrology, and species interactions).

Cimate (temperature and moisture conditions) strongly affect decomposition rates in terrestrial ecosystems; hence, in eastside forests decomposition is, generally, much slower compared to that on the west side of the Cascade Range due to cold winters and dry summers. Compared to westside forests, fire is a principal agent of decomposition in eastside forests, reducing fuel accumulations resulting from decaying and dead woody debris on the forest floor. Natural fire regimes follow a temperature and moisture gradient with the length of fire-return intervals increasing with elevation or latitude. Both Native American and lightning ignitions were important sources of fire in both ponderosa pine and mixed conifer forests; yet despite many narratives in the ethnographic literature recounting the use of fire by Native Americans it is not clear whether these ignitions augmented or substituted for lightning ignitions (Agee 1993). As fire-return intervals lengthen in Oregon forests on the eastern flank of the Cascade Range, whether dictated by cooler climatic conditions or as a result of fire exclusion, there is a tendency to have higher proportions of white fir in the overstory (Agee 1993).

Natural mean fire-return intervals (that is, average time periods between wildfires derived from fire history studies) are different for different forest types. Reconstruction of presettlement fire histories from fire scars in Crater Lake National Park indicate that the natural mean fire-return interval in mid-elevation (roughly 1300 to 1600 m or 4,265 to 5,249 feet) white fir ecosystems ranges from 9 to 42 years (McNeil and Zobel 1980). For a low-elevation *Abies concolor/Ceanothus velutinus* community near Bend, OR, a 9 to 25 year fire-return interval was determined (Bork 1985). Ponderosa pine forests have a shorter mean fire-return interval compared to white fir or mixed conifer forests. A fire-return interval of 11 to 16 years was calculated for a ponderosa pine forest on the Warm Springs Indian Reservation in eastern Oregon (Weaver 1959). Another fire study at Warm Springs produced a mean fire-return interval of 3 to 36 years (Soeriaatmadja 1966).

Summary

Overall, the natural mean fire-return interval for eastside forests is roughly 10 to 20 years as contrasted with 350 to 500 years for westside forests (Agee, J.K., 1995, University of Washington, personal communication). The difference in the fire regime between eastside and westside forests is primarily a function of climate. Mean fire-return intervals in ponderosa pine forests are 8 to 15 years (Hopkins 1995, pers. comm.). Mean fire-return intervals in white fir forests are longer, ranging from 20 to 40 years (Hopkins 1995, pers. comm.). The fire regime in eastside forests is characterized by frequent, low-intensity surface fires that thin out the understory but do not greatly affect the overstory component in contrast to a regime of infrequent but high-intensity, stand-replacement fires in westside forests. Presently, low- and mid-elevation forests on the eastern side of the Cascade Range in Oregon have higher proportions of white fir as a result of human-introduced disturbance and disruption of the natural fire regime.

Such periodic, low-intensity fires apparently consumed much of the coarse woody debris (CWD) in ponderosa pine forests, leaving the forest floor relatively free of large amounts of CWD (Leiberg 1899, Agee 1993, Covington et al. 1993). Leiberg (1899) describes the forest stands that he surveyed at the turn of the century as parklike with little undergrowth or down logs. But it is important to remember that wildfire, especially of low-intensity, does not burn uniformly across landscapes. Because such fires burn patchily across the land, post-fire landscapes resemble a complex, shifting mosaic of burned and unburned areas. Therefore, it is reasonable to assume that CWD survived in certain areas following wildfire for periods of time to play an important structural and functional role in eastside forests as centers for wildlife habitat, microbial and arthropod activity, and water storage benefiting trees during periods of summer drought. CWD is an important biological legacy in both eastside and westside forests that persists in post-fire landscapes and aids in the ecological recovery or resilience of post-fire ecosystems (Franklin 1990). Mycorrhizal activity, which is critical to forest health and productivity, is concentrated above or within the soil surface in soil organic horizons, logs, and other woody debris reserves (Harvey et al. 1988). See section in document on soil organic matter for an overview of the beneficial roles of mycorrhizal fungi in terrestrial ecosystems.

Livestock Grazing

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

Livestock have altered the species composition of plant communities, ecosystem structure, and ecosystem functioning. Species composition of plant communities are affected in essentially two ways: (1) active selection by herbivores for or against a specific plant taxon, and (2) differential vulnerability of plant taxa to grazing (Fleischner 1994). Because livestock prefer native grasses to exotics, native grasses have been replaced by exotic graminoids and weedy species which are more successful in colonizing areas that have been grazed or disturbed in some other way. Heavy grazing of native grasses has also allowed a greater number of tree seedlings to establish resulting in denser understories of trees which have replaced grass communities on the forest floor. All of these effects have produced changes in ground-level, understory, and overstory species composition within the forest.

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

Throughout the inland west, livestock grazing has altered nutrient cycling process, an essential ecosystem function (Fleischner 1994). Microbiotic (or cryptobiotic crusts) in arid and semi-arid ecosystems in the inland west have been greatly reduced by or lost to livestock grazing. The major share of nitrogen fixation in desert ecosytems occurs in these fragile, thin crusts that consist of cyanobacteria, soil lichens, and mosses. Although most of the research on cryptobiotic crusts has occurred in arid and semi-arid ecosystems outside of Oregon such as the Great Basin region in Utah (Harper and Pendleton 1993, Belnap 1993, Belnap and Gardner 1993), it is possible that cryptobiotic crusts occur in less disturbed areas in eastern Oregon and were more common prior to the introduction of livestock (Rosentreter, R., 1995, personal communication). Because of past disturbances, it is probably unlikely that cryptobiotic crusts occur in the landscape analysis area. However, nutrient cycling processes in general can be altered by removal of ground-layer vegetation, soil compaction and erosion, and disturbance to the soil organic layer from livestock grazing.

The extent of past and current livestock grazing in the landscape analysis area is best addressed in the section dealing with cows and grazing allotments. A discussion in that section of present grazing regulations, numbers of animals, and allotments will furnish information on past and present grazing management practices in the landscape area.

Core Topic: Ecosystem Structure and Function

Issue: Ecosystem structure and function (forest health) have been altered by human-introduced disturbance in the landscape area.

Key Questions: Are there forest stands in the landscape area that are at moderate to high risk of disease outbreak, insect attack, and catastrophic disturbance? Are there significant disease or insect problems in the landscape area?

Introduction

A field inventory of tree disease and insect attack has not been conducted in the landscape analysis area. However, an aerial survey by plane is conducted annually for eastside federal forests to locate disease and insect epicenters. Little information at present exists on the distribution, extent, intensity, or frequency of these disturbance agents. Nor have any disease or insect epicenters been located and mapped in the landscape area unlike in the upper Spencer Creek watershed area where locations of known laminated root rot (*Phellinus weirii*) centers and fir engraver (*Scolytus ventralis*) attacks have been determined. However, the landscape area would be susceptible to the same diseases and insects that are common in other eastside forests and so a general discussion of these disturbance agents and their ecology is germane.

Increased occurrence of disease and insect outbreak is dependent to a large degree on the density of forest stands. As tree density in a forest stand increases, so does intertree competition for resources (Oliver and Larson 1990). Trees compete among one another for limited resources (light, water, nutrients, and growing space) in a forest stand. Those individuals that are less successful in competing for such resources may become suppressed and overtopped by other trees. A tree unable to secure the resources that it needs for its growth and maintenance becomes weakened and, in the process, becomes more susceptible to disease and/or insect attack. Schmid and Mata (1992) found that a growing stock level, a measure roughly equivalent to basal area, of 120 square feet per acre may be the critical threshold in Rocky Mountain ponderosa pine forests at which point density-dependent mortality caused by bark beetles and disease begins to occur. (The higher the growing stock level or basal area figure, the denser or greater number of stems within the forest stand). At times, during insect epidemics or virulent disease outbreaks even otherwise healthy individuals in a forest stand can be attacked and killed. The critical threshold for ponderosa pine forests in other regions of the western United States may be different due to climate, topography, soils, and other factors. But, in general, it appears that the critical threshold for density-dependent mortality in ponderosa pine forests in eastern Oregon lies in the range of 110 to 130 square feet of basal area per acre (Cochran 1992, Goheen 1992). White fir stands can be maintained at higher stocking levels than ponderosa pine, but white fir is more susceptible to root diseases and insect problems during periods of summer drought than is ponderosa pine.

Climatic conditions (temperature and moisture) can add to the physiological stress placed on trees and can predispose suppressed, weakened, or less hardy trees to disease and insect attack. The classic example in eastside forests is white fir (*Abies concolor*) which is less drought-tolerant than ponderosa pine. Summer drought conditions generally tend to place a greater stress on white fir than ponderosa pine, making the fir species more susceptible to disease and/or insect attack. Ponderosa pine is a more drought-tolerant and fire-adapted species.

Diseases

Diseases such as dwarf mistletoe (*Arceuthobium* spp.), Armillaria root and butt disease (*Armillaria* spp.), annosus root and butt disease (*Heterobasidion annosum*), laminated root and butt disease (*Phellinus weirii*), Indian paint fungus (*Echinodontium tinctorium*), red ring rot (*Phellinus pini*) and brown cubical butt rot (*Phaeolus schweinitzii*) are common and widespread throughout Pacific Northwest (PNW) forests. Their distribution in the landscape analysis area is unknown, but all are probably present. Although these diseases do cause significant timber losses, they are native to PNW forests and serve important ecological roles such as creating canopy gaps for the potential recruitment of other plant species within the stand. Canopy gaps increase biological diversity, provide for wildlife habitat, and alter forest succession and composition. Through the process of tree death, limited resources such as growing space, light, water, and nutrients are made available to neighboring live trees.

Dwarf mistletoe (*Arceuthobium* spp.) is caused by a parasitic plant that attacks PNW conifers. Mistletoe infection has been observed in western juniper in the Hayden Creek sub-area and in Douglas-fir and ponderosa pine in the Grenada sub-area. Dwarf mistletoe most likely occurs throughout the landscape analysis area. Mistletoe pockets of mid- to high-severity that occur within the landscape area will need to be located in the future for evaluation. Mistletoe brooms create microhabitat preferred by nesting northern spotted owls; at the same time, however, the disease is highly infectious in stands, deforms trees inducing bole and branch cankers that result in timber volume loss, and can kill trees.

The fungi responsible for diseases such as Armillaria root rot (*Armillaria* sp.) and annosus root and butt disease (*Heterobasidion annosum*) are facultative parasites, meaning that they can exist in either a parasitic or saprophytic state. These fungi are capable of either attacking a tree or surviving as a saprophyte deriving their energy and carbohydrate needs from decaying or dead organic material in the soil. Under the right conditions, these diseases can become more virulent and infect an entire stand rather than selected individuals within the stand. On the Klamath Ranger District on the Winema National Forest, north of the landscape analysis area, sizable areas of forest have been infected with Armillaria root rot.

Two strains of annosum root disease occur: the P-group and the S-group (Hessburg et al. 1994). The S-group affects primarily true firs, hemlocks, and spruce whereas the P-group primarily affects ponderosa pine. Centers of P- and S-group annosum root disease were relatively uncommon in presettlement Douglas-fir/white fir forests on the eastside, and the distribution of the P-group in ponderosa pine forests was scattered (Hessburg et al. 1994). Regular underburning associated with the natural fire regime reduced stocking levels in stands, and natural intertree spread of the pathogen was restricted by low tree density (Hessburg et al. 1994). Annosum root disease will probably increase in incidence since stands with multiple entries experience the highest frequency of mortality caused by this disease (Schmitt et al. 1984, 1991; Filip et al. 1992). The distribution and severity of the P-group annosum root disease have increased as a result of current management practices. Marginally commercial ponderosa pine sites have been selectively logged, leaving abundant stumps infected by airborne annosum spores. The result has been an increase in inoculum and in intertree spread of the disease (Hessburg et al. 1994).

The ecologies of Armillaria root disease and laminated root and butt disease were probably very similar in turn-of-the-century forests dominated by the Douglas-fir and grand (white) fir series (Hessburg et al. 1994). The maintenance of seral species within forests that resulted from frequent low-severity fires probably made large centers of root disease-caused mortality uncommon. The pathogens functioned more as secondary, opportunistic root pathogens that attacked low-vigor, overmature, weakened, or injured trees (Filip and Goheen 1982, Goheen and Filip 1980).

Laminated root and butt disease (*Phellinus weirii*) is the most damaging disease of Douglas-fir in PNW forests. Several large infection centers (25 to 30 acres in size) have been located in the upper Spencer Creek watershed, north of the landscape analysis area, infecting a mixed-conifer stand of white fir, Douglas-fir, and even usually resistant pine. The disease in these stands appears to be fairly virulent since even resistant tree species such as ponderosa and sugar pine were found infected with the disease. *P. weirii* spreads across live roots and root grafts rather than by airborne spores. It rarely produces sporocarps (fruiting bodies) such as *Armillaria* spp. or *Heterobasidion annosum*. The pathogen can be harbored in the roots of resistant trees, but it travels slower along the roots of resistant trees than non-resistant trees (Goheen 1996, pers. comm.). The pathogen can only colonize live roots; it cannot colonize or spread along dead roots. Hence, a web of dead roots in the soil created by harvesting trees in a 50 foot buffer zone around a *P. weirii* infection center can theoretically create an effective barrier against the outward spread of the pathogen (Goheen 1996, pers. comm.). *P. weirii* forms pseudo-sclerotia (hardened nodules in the soil that are the resting, dormant state of the fungus), allowing it to survive for greater than 50 years in dead roots and stumps. This biological mechanism enables it to continually infect non-resistant trees growing on the site for decades.

Indian paint fungus (*Echinodontium tinctorium*) infects true firs, but rarely Douglas-fir. This disease is fairly common in eastside mixed conifer stands. The distinctive woody, perennial fruiting bodies of this fungus has been seen in stands in the Spencer Creek watershed. The likelihood that Indian paint fungus occurs in the analysis area is almost certain.

Brown cubical butt rot (*Phaeolus schweinitzii*) infects Douglas-fir, pines, true firs, and incense cedar. It is most common on Douglas-fir along the Pacific Coast, but it does occur occasionally in inland Douglas-fir, especially in older trees. Rot is usaully confined to the root system and lower 2.5 to 3.0 m (8 to 10 feet) of the tree bole. The disease makes its entry through basal fire scars and through roots. There is a good likelihood that brown cubical disease occurs in the analysis area.

Red ring rot (*Phellinus pini*) can infect Douglas-fir, pines, true firs, and rarely incense cedar. It is fairly common in western hemlock/Douglas-fir forests on the westside of the Cascade Range. Its occurrence in eastside forests is probable but less so than the major diseases such as *Armillaria* spp., *Heterobasiodion annosum, Phellinus weirii*, and *Echinodontium tinctorium*. It forms a characteristic perennial, woody, bracket-like fruiting body on the boles of trees usually beneath branch insertions. Red ring disease most likely occurs in the analysis area.

White pine blister rust (*Cronartium ribicola*) infects western white pine (*Pinus monticola*) and sugar pine (*Pinus lambertiana*) and has greatly reduced the distribution of these pine species in eastside forests. Its introduction to North America from Europe has resulted in one of the most serious disease outbreaks on conifers. To effectively control white pine blister rust requires eliminating its alternate host, *Ribes* spp., a near to impossible task. This disease has infected western white and sugar pine in forest stands north of Highway 66 and is probably present in the landscape analysis area as well.

Insects

Bark beetles, which are highly opportunistic and able to exploit host trees in a weakened condition, are the insects of primary concern in eastside forests (Eglitis 1995). Because they generally attack trees growing in dense stands, bark beetles are often considered thinning agents. Specific bark beetles of probable importance in the landscape analysis area include the mountain pine beetle (*Dendroctonus ponderosae*), western pine beetle (*D. brevicomis*), and fir engraver (*Scolytus ventralis*). Other bark beetles which could be of significance under certain conditions include the red turpentine beetle (*D. valens*), Douglas-fir beetle (*D. pseudotsugae*), and pine engraver (*Ips pini*).

Fir engraver attack of white fir is fairly common in mixed conifer stands in the Spencer Creek watershed, north of the landscape analysis area. The likelihood is high that the fir engraver is active to some degree or another in stand aggregations of white fir within the landscape analysis area.

Table 13 displays relevant life-history characteristics of the above insects.

Table 13. Life History Characteristics.

BEETLES	HOSTS	COMMENTS	ATTACK PREFERENCES	ATTACK LOCATION	ANNUAL GENERATIONS
western pine beetle (*Dendroctonus brevicomis*)	ponderosa pine and Coulter pine	Breeding location in overmature trees, windfalls, root-rotted trees, or in trees weakened by drought, stand stagnation, or fires. Mazelike gallery pattern.	Trees under 15 cm (6 in) in diameter are seldom attacked	Initial attacks made about mid-bole; subsequent attacks fill in above and below.	1-2 in northern part of range; 2 1/2 to 4 in southern part of range
mountain pine beetle (*Dendroctonus ponderosae*)	lodgepole, sugar, western white, ponderosa, and whitebark pine	Ranks first in destructiveness among the bark beetles of the West. Long vertical egg galleries. Sometimes slightly sinuous. Decidedly winding in sugar pine. At bottom of galleries is a short crook or bend, 25 or 50 mm in length.	Infests entire stands in mature lodgepole pine forests; group killings in mature and in young, overstocked forests of ponderosa, sugar, and western white pine	Heaviest among main trucnk of tree from within about a meter of the ground up to the middle branches, but may extend from root collar to top of tree and into the larger limbs	1 generally. However, in portions of CA, 2 and a partial 3rd may develop. In coldest portions of range, 1 generation may require 2 years.
fir engraver (*Scolytus ventralis*)	true firs including white fir	Periodic epidemics or outbreaks occur during and following periods of drought. Trees infected with *Heterobasidion annosum* are especially subject to attack. Egg galleries cut transversely across the grain of the wood while larval galleries are vertical. Soil compaction should be avoided around firs.	From pole-size to full maturity	On the bole from the base to the top. Trees may be killed outright, top-killed, or may survive repeated attacks.	1 generally. In colder portions may require 2 years to complete the life cycle.

red turpentine beetle (*Dendroctonus valens*)	ponderosa, lodgepole, Jeffrey, sugar, western white, and Monterey pine	Beetle is ordinarily not aggressive and does not become epidemic. It sometimes kills trees but more often weakens them.	Injured, weakened, or dying trees, and freshly cut logs and stumps	Lowermost portion of bole and the root collar.	1 in 2 years in coldest portion of range; 2 to 3 in warmest part of range.
Douglas-fir beetle (*Dendroctonus pseudotsugae*)	Douglas-fir and western larch	Most important bark beetle enemy of Douglas-fir. Beetles work in pairs when constructing egg galleries. Galleries are perpendicular to bole, usually straight or slightly sinuous, ranging from 12 cm to 90 cm in length.	Felled, injured, or diseased trees. At times, becomes epidemic and kills healthy trees.	Bole and base of tree.	1 per year
pine engraver (*Ips pini*)	ponderosa, Jeffrey, and lodgepole pine	One of the most common bark beetles in N. America and at times a serious pest. 3 or 4 egg galleries fork from a central nuptial chamber and run more or less longitudinally with the grain of the wood for 13 to 25 cm (5 to 10 in). 1 to 7 feamales to each male. Timely slash disposal and thinning of desne mature stands are best control measures.	Windfalls, feshly cut logs, pieces of slash greater than 5 cm (2 in) in diameter, and in the tops and limbs of trees killed by *Dendroctonus* beetles. When suitable host material is plentiful, they can develop in large numbers and become aggressive in their attacks on healthy living trees. Most frequent damage is in killing of replacement trees from 5 to 20 cm (2 to 8 in) in diameter and the top-killing of older trees.		1 to 5

Management Implications

Multi-layered mixed conifer stands are now prevalent in eastside forests where multi-cohort, parklike ponderosa pine stands once dominated (Hessburg et al. 1994) or where ponderosa pine comprised a much larger component in turn-of-the-century forests. The landscape analysis area is composed of eastside forest types that include mixed conifer stands, pine/oak/juniper stands, and juniper woodlands. The ponderosa pine component in the landscape analysis area has diminished significantly from turn-of-the-century forests as a result of selective logging, livestock grazing, and fire exclusion (Leiberg 1899). With the exclusion of fire, Douglas-fir and white fir understories have developed throughout eastside forests (Hessburg et al. 1994) and in the landscape analysis area. Many in the scientific community recommend reversing the shift toward late-successional stands of shade-tolerant species that has occurred in the Douglas-fir and grand (white) fir series by restoring a seral-dominated forest matrix (Hessburg et al. 1994, Oliver et al. 1993).

Associated with root rot diseases are bark beetles, so the higher incidence of root disease infection centers will in all likelihood result in increased bark beetle populations and tree mortality. It is, however, equally important to note that although insects and pathogens cause substantial economic losses in eastside forests, they also play important ecological roles by creating nesting and roosting habitat for owls, wildlife habitat for other birds and mammals, and canopy gaps that promote biological diversity within forest stands. They are also important to forest succession and nutrient cycling. A balance that maintains these natural processes and functions within matrix stands while at the same time providing for healthy forest stands that produce wood products for our generation and successive generations is the challenge presented to today's resource managers.

Disease and Insect Risk Assessment

Disease and insect attack occur to some degree within any forest. They are natural disturbance and mortality agents within forest ecosystems, so their elimination should neither be a management consideration nor an objective. When their occurrence causes high timber losses in a forest stand, however, managers may consider the need to intervene with measures to control the extent of their destructive influence. Group killings of trees within stands by beetles generally indicate damaged, weakened, or diseased trees as a result of high tree density, disease, drought, or management activities (for example, basal scarring of trees or soil compaction from previous logging entry). At present, scientific research suggests that many contemporary eastside forests are out of balance ecologically compared to pre-settlement or even turn-of-the-century forests: that is, they are more prone to catastrophic disturbance and less able to retard the spread of catastrophic disturbance (Hessburg et al. 1994, Perry 1994). Higher tree densities; replacement understories of Douglas-fir and white fir; and the loss of the ponderosa, sugar, and western white pine component in eastside forests have created conditions predisposing eastside forests to increased risk of catastrophic wildfire, virulent disease centers, and insect outbreaks.

The likelihood of disease and insect attack generally increases as stand density increases in eastside forests. Fire-history reconstructions of eastside forests suggest that many pre-settlement forests at low- and mid-elevation were dominated by ponderosa pine (Agee 1993). Livestock grazing, selective logging, and fire exclusion have resulted in a shift from open, park-like stands of ponderosa pine to denser, replacement forests of Douglas-fir and white fir in forests on the eastern flank of the Cascade Range. The landscape analysis area south of Highway 66 is for the most part a low- to mid-elevation, xeric environment of flat topography that according to historic records contained less white fir and more pine at the turn of the century compared to contemporary forests (Leiberg 1899). Ponderosa pine was recorded as the dominant species in the landscape analysis area in the Prairie Creek, Tom Creek, and Hayden Creek sub-areas (Leiberg 1899). However, it should also be noted that in the Spencer Creek sub-area, north of Highway 66, and in the Grenada sub-area, south of Highway 66, Douglas-fir was reported as the dominant tree species, comprising 50 percent and 55 percent respectively of all species present compared to 31 percent and 40 percent respectively for ponderosa pine (Leiberg 1899). Although second to Douglas-fir, ponderosa pine was reported to comprise a sizable proportion of total tree species in both sub-areas. White fir was reportedly only a minor component (much less than 10 percent) in these turn-of-the-century forests.

From these historical records and contemporary inventories emerges a story that is consistent with that for forests elsewhere on the eastside of the Cascade Range (Hessburg et al. 1994). Relatively open, single-canopy stands with a large ponderosa pine component have been replaced by extensive blocks of dense, multiple-strata forests with large increases in the Douglas-fir and white fir components. However, according to Leiberg's account, Douglas-fir comprised a significant proportion of the forest composition in three townships within the landscape analysis area at the turn of the century, suggesting that stand density was probably historically higher in these areas compared to those areas dominated by ponderosa pine. But since ponderosa pine was also present in large numbers in the townships, one can reasonably speculate that shade-intolerant ponderosa pine may have established first on these sites following periodic wildfire events with Douglas-fir colonizing as ingrowth beneath the ponderosa pine. Alternatively, it is possible that ponderosa pine could have established along with Douglas-fir if the shifting landscape mosaic resulting from low- to mid-frequency wildfire created sufficiently large gaps for pondersoa pine to become established. Leiberg (1899) reported that all townships in the area had been "ravaged" by fire, attesting to the ecological role of fire in shaping forest succession and composition.

The forests in the Spencer Creek and Grenada sub-areas where Douglas-fir historically dominated probably do not require thinning to as low a basal area as those sub-areas where ponderosa pine reportedly dominated since these forests were probably historically denser given the Douglas-fir fir component. However, if managers were to decide in favor of trying to recruit ponderosa pine in these sub-areas, basal areas of contemporary forests would need to be reduced to a range at which ponderosa pine could re-establish.

The white fir component generally has increased in low- to mid-elevation forest stands in the landscape analysis area because of selective logging, fire exclusion, and livestock grazing. Disease and insect attack of white fire will occur and likely increase as stands get denser and stress from competition for limited resources and the overall xeric environmental conditions in the area exact their effect on this less drought-tolerant tree species.

Assessment of Forest Health Treatments

The concept of "forest health" is useful in the effort to assess whether all the complex structural and functional components that make up a healthy forest ecosystem are being maintained given human-introduced disturbance. At the same time, however, the term has become highly politicized, inviting numerous interpretations depending on the definer's viewpoint or bias. Economic considerations have led to definitions of forest health that focus on the timber production capability of matrix forest stands. A broader definition of forest health is needed that addresses all the biotic and abiotic components that comprise a forest ecosystem, from belowground processes that occur in the forest soil to interactions of plant and animal species in the forest canopy. The reason for this need is that long-term site productivity to which timber production is inextricably linked depends on maintenance of the complex of components that creates a healthy forest ecosystem. A forest ecosystem is more than a stand of trees. DellaSala et al. (1995) provide one of the better definitions for what it means to assess forest health treatments such as thinning-from-below and prescribed underburns and, in so doing, offer a good conceptual basis for what forest health is all about:

Forest health treatments can be evaluated based on whether they contribute positively to maintenance or restoration of (1) viable populations of native species across their geographic range; (2) critical ecosystem processes such as nutrient cycling, natural disturbance regimes (wildfire, disease, and insects), and species interactions; and (3) ecosystem integrity or robustness (i.e., retention of biological diversity and dynamic properties that allow ecosystems to persist in the face of natural and human disturbances whether short- or long-term in effect (DellaSala et al. 1995).

Attempts to re-establish ponderosa pine-dominated ecosystems on a landscape level within their historic geographical range in eastside forests can be consistent with the above criteria. However, natural resource managers who decide to implement forest health treatments to restore ponderosa pine ecosystems need to consider all components that comprise a forest ecosystem. Impacts associated with forest health treatments may occur that violate the above criteria. For example, in the landscape analysis area the maintenance of critical processes associated with soil organic reserves such as nutrient cyling may be threatened by salvage and thinning operations. And this in turn may affect the third criterion listed above of ecosystem integrity or robustness.

A case in point is one of the sub-areas within the landscape analysis area. The Grenada sub-area can be characterized as a mosaic of open forest and small clumps or clusters of less disturbed, denser stands distributed across it. Much of the open forest bears the marks of previous human-introduced disturbances--skid roads associated with past intensive logging of the area and livestock grazing. The clumps or clusters of denser, replacement forest stands within the open forest appear to have experienced less ground disturbance. On a landscape scale, the less disturbed areas are embedded in a much larger disturbed matrix. The forest soils in the larger disturbed matrix generally reveal little in the way of development of an organic horizon. Many of these open stands were previously disturbed by skid road entry and are still in the process of recovering. By contrast, a healthy soil organic horizon has developed beneath the forest floor within clumped stands where past disturbance from skid road entry is less evident or did not occur.

Compaction and/or reduction of the soil organic horizon underlying the forest floor beneath the forest clumps could have long-term consequences for site productivity. Maintenance of the soil organic horizon and other organic residues is critical for retention of water, nutrients, and minerals; sustaining populations of beneficial mycorrhizal fungi on which conifer species depend for water and nutrient uptake; maintenance of a decomposer community (arthropods and microbes) for cycling nutrients; and maintenance of the biological pathway by which the majority of nitrogen is supplied to the ecosystem for plant and animal nutrition. Short- and long-term site productivity of a forest ecosystem depends on these critical belowground processes associated with soil organic matter. An example illustrating the close interrelationship between soils, plants, and animals is the food web that supports the northern spotted owl, for its primary diet is the northern flying squirrel which in turn depends on the belowground fruiting bodies (truffles) of mycorrhizal fungi for its staple food.

Soil properties in contemporary forest stands in the Grenada sub-area may have been altered by human-introduced disturbance. The natural fire regime of frequent, low-intensity surface fires would have consumed portions of the soil organic horizon along with woody debris on the forest floor, but these fires were of low intensity and would have burned patchily across the landscape leaving a mosaic of burned and unburned areas. Unburned areas would act as refugia for plant and animal species and provide for biological legacies (that is, structural and biological components) such as standing dead trees, down logs, and associated decomposer communities. Refugia and biological legacies are important to ecosystem resilience (that is, rate of recovery) following disturbance and to ecosystem integrity (Franklin 1990). The clumps of less disturbed forest stands in the Grenada sub-area could act as refugia for soils having a relatively well-developed organic horizon. Physical alteration of soils associated with frequent, low-intensity fires would have been far less than that associated with human-introduced disturbances because intensive logging, road networks, and livestock grazing were not part of presettlement forests or the natural disturbance regime. The soil organic matter properties in the Grenada sub-area may be out of equilibrium because of previous logging and grazing disturbance and therefore may be susceptible to threshold degradation that affects ecosystem health in the sub-area. We can only speculate on how thick soil organic horizons were in pre-settlement forests. Frequent, low-intensity fires may have maintained thin organic horizons. Local climatic conditions and topoedaphic factors also may have played a major role in creating the open structure of forest stands in the area and the amount of soil organic matter in forest soils. However, it is clear that previous harvest entries in the area have compacted soils (especially in areas where skid trails occur), a human-introduced disturbance from which soils are still recovering.

Core Topic: Soils

Issue: Soil and site productivity has been altered in the TPLA area.

Key Questions:What are the dominant characteristics of soils in the TPLA area? Are there sensitive soils within the TPLA area that deserve special protection or mitigation consideration?

Introduction

Both soil and non-soil factors influence soil productivity. Non-soil factors, such as geology, are not influenced by land management activities. Soil factors that can be modified by management activities include: structure; density; organic matter content and distribution; the amount, distribution, and continuity of soil pore space; soil moisture and temperature; the effective soil volume for root development and water, heat, and gas storage; nutrient content; and microbial activity. Determining the sensitivity of soils to management activities is an important first step in preventing or minimizing soil-related adverse effects and reductions in soil productivity.

The physical soil properties (factors) affecting site productivity include bulk density, organic matter content, porosity, and texture. The disturbances that impact soil factors include compaction, surface mixing and disruption (known as displacement), fire (primarily through loss of soil cover and consumption of organic matter), and soil erosion (Childs et al. 1989). Information about these soil factors was gathered to decide which soil factors determine the susceptibility of a soil to losses in productivity resulting from the disturbances associated with the two dominant land management activities in the watershed, timber harvest and road construction. A discussion of these soil factors and the effects of these disturbances on them is given below.

Soil Factors and the Effects of Disturbance

Bulk density (the mass of dry soil per unit volume) is related to porosity (the volume of pores per volume of soil). Soil porosity, which is a function of pore size and distribution, influences soil-water relationships, aeration, and mechanical resistance to root penetration (Childs et al. 1989). Organic matter within the soil is an important source of nutrients for vegetation. Soil microbial populations slowly decompose the organic matter, releasing nutrients. Soil organisms also affect productivity by providing protection against pathogens, maintaining soil structure, and buffering against moisture stress (Amaranthus et al. 1989). Organic matter acts as a mulch to retain soil moisture and is key to maintaining good soil structure. The mulching effect of organic matter also reduces surface erosion by lessening the effect of raindrops, which tend to dislodge soil particles (Amaranthus et al. 1989). Soil texture (the relative proportions of sand, silt, and clay) determines certain soil characteristics such as soil structure. Management activities have no effect on texture, but they can affect the structure. Structure, in turn, influences soil characteristics such as water availability and movement, heat transfer, aeration, bulk density, and porosity (Childs et al. 1989).

Soil compaction is the process whereby soil pore space is reduced and bulk density is increased through physical pressure and vibration of the soil surface. Compaction results in reduced water infiltration and gaseous and nutrient exchange rates thus potentially reducing plant growth (Childs et al. 1989, USDA 1989b). Physical resistance to root growth can occur with high bulk densities. Compaction can also cause short-term decreases in soil microbial populations (Childs et al. 1989).

Soil displacement is a process in which a portion or all of the surface soil is moved by mechanical action. This may affect plant growth (depending on the extent to which the soil has been moved or churned) through the removal of nutrients and soil organisms and by reducing available water and rooting depth (Childs et al. 1989). Displacement can result in the alteration or destruction of surface structure by reducing the amount of pore space and connectivity and the aggregation of individual soil particles into a larger group. If displacement occurs when the soil is wet, "puddling" may result, which can create a soil surface that is hard and sealed against water and gaseous exchanges.

Fire directly affects soil by consuming organic matter, altering nutrients, creating water-repellent conditions, decreasing infiltration rates, and removing soil surface cover (Hungerford et al. 1990, DeBano 1990, and Childs et al. 1989). Although fire generally causes short-term effects, it can create a harsh environment for reforestation. Where soils are shallow and have low natural fertility or are susceptible to erosion, fire can have a more significant effect on productivity.

Surface soil erosion (which includes sheet, rill and gully erosion, and dry raveling) is the detachment and downslope movement of individual soil particles or aggregates, It is caused by the energy of rainfall and running water acting on bare soils, or by surface disturbance on steep slopes. Removal of soil cover can greatly increase the potential for surface soil erosion (Baker and Jemison 1991).

Soil Types and Characteristics

Description of Forest Stands and Soils. Much of the landscape analysis area can be characterized as a mosaic of relatively open forest stands (basal areas of 40 to 120 square feet per acre) in which are embedded forest clumps containing greater tree density (basal areas ranging from 150 to as much as 400 square feet per acre). Past disturbances which include livestock grazing, logging, and disruption of the natural fire cycle have all had a hand in creating the present landscape mosaic. A number of different soil series occur across the mosaic, all of which have undergone some alteration from either natural or human-induced disturbance. Field inspection generally reveals a pattern of differentiation between more and less disturbed soils resulting from physical alteration associated with logging and livestock grazing activities. Soils in open areas across the landscape have been physically disturbed by logging and livestock grazing; on the other hand, soils in forest clumps have experienced less physical disturbance.

Forest clumps can be thought of as islands of trees, small in size and containing relatively high densities of small-diameter trees ranging from 12 to 35 cm dbh (diameter at breast height). The matrix of open forest stands, on the other hand, within which these clumps are embedded, are characterized by lower tree densities with fewer but larger-diameter trees. Basal areas of 120 to 150 square feet per acre have been cited as the critical threshold in ponderosa pine forests at which tree mortality induced by stand density and mountain pine beetle attack begins to occur (Larsson et al. 1983, Schmid and Mata 1992).

Across the landscape, the open forest stands generally are marked by past logging activities with the presence of skid roads and planted seedlings while the islands of dense forest stands embedded within the open landscape area appear to have either escaped or experienced less disturbance in the form of skid road entry. Within these skid road-free areas, the forest floor beneath the dense clumps or clusters of trees is made up of an O horizon (broken down into Oi, Oe, and Oa layers) that is readily discernible. The O horizon ranges from 2.5 to 7.5 cm in thickness, containing litter, twigs, and humus. Associated with the O horizon are fungal mycelia and the fine roots of trees. Underlying the O horizon is a mineral A horizon of less or approximately equal thickness that is lighter in color and of finer texture. Below the A horizon is a reddish-brown colored B horizon consisting of loam to clay loam with greater bulk density than the A horizon. Disturbed soils (where skid trails from previous entries have been made), on the other hand, show a marked reduction in soil organic matter. Disturbed soils generally fall into two basic categories: (1) they either have a very thin Oi horizon (only 0.5 to 2.0 cm in thickness and usually characterized by only conifer needles) and lack an apparent Oe (fermentation) and Oa (humus) layer. Or (2) they lack an O horizon altogether with bare mineral soil exposed at the surface. An A horizon is minimal or apparently lacking in these disturbed soils with the reddish-brown, loamy, high-bulk density B horizon reaching to the surface.

Soil Types. Using the Jackson County Soil Survey (USDA 1993), a soil map was created for the TPLA area. It was not included in this document due to its complexity, although copies are available from the Geographical Information System upon request. A list of soils and the acreage of each was derived (see Appendix 1).

To determine whether impacts to soil productivity have occurred, soils in the watershed were evaluated to determine whether they were susceptible to disturbance. If a soil is susceptible to a particular disturbance and that disturbance is known to have occurred on that particular soil, then it is probable that productivity has been adversely impacted to some degree. Soil porosity, the organic capital in surface litter, and the surface soil horizons were among the factors analyzed to establish each soil types' susceptibility to compaction, surface erosion, and nutrient loss. Soil susceptibility was determined using the Soil Quality Module in the Deschutes National Forest *Watershed Evaluation and Analysis for Viable Ecosystems*--WEAVE (USDA 1994b), and Appendix E of the *Watershed Analysis Report for the Threemile, Sevenmile and Dry Creek Watersheds* (USDA 1995b), which contains an updated version of the Soil Quality Module. The ratings for each soil type and the methods for deriving these ratings are contained in Appendix 1. Acres in the watershed of each susceptibility rating for compaction, erosion and nutrient loss are listed in Table 14. Maps 3 and 4 display the overall soil susceptibility ratings for compaction and surface erosion, respectively, in the TPLA area.

Table 14. Acres of Susceptibility Ratings for Compaction, Surface Erosion and Nutrient Loss*

Compaction Susceptibility			Surface Erosion Susceptibility			Nutrient Loss Susceptibility		
L	M	H	L	M	H	L	M	H
0	50,815	69,943	9,927	110,693	138	0	119,591	1,167

*Approximately 32 percent of the TPLA area does not have available GIS soil map coverage. Therefore, the acres shown are not for the entire TPLA area.

An intensive inventory known as the Timber Productivity Capability Classification system has been completed for BLM-administered lands in the TPLA area. This inventory identifies fragile sites where the timber growing potential could be reduced by management activities due to inherent soil properties and landform characteristics. Sites are designated as fragile, non-suitable woodlands if they are judged to be biologically and/or environmentally incapable of supporting a sustained yield of timber. They are removed from the commercial forest land base and are managed for their non-timber resources. Sites are classified as fragile suitable restricted woodland if they are fully capable of being managed for timber production without site deterioration or off site impacts when Best Management Practices are used to avoid and mitigate potential impacts from management activities. There are 48 acres of fragile nonsuitable woodland and no acres of fragile suitable restricted woodland in the TPLA area (see Map A in the analysis files).

It must be noted that the susceptibility rating is used to assess the risk that impacts to soil productivity will occur as a result of management activities in the watershed. Whether or not the adverse impact actually occurred is dependent on whether protective measures such as Best Management Practices were prescribed and followed. Furthermore, the inherent productivity of the soil will determine the net effect of management activities on a particular soil type.

Key Questions: What erosion processes are dominant within the TPLA area? Where have they occurred or are they likely to occur?

Landslide/Debris Flow Potential

Numerous landslides have occurred in the Klamath River Canyon. The locations of these landslides were mapped by the City of Klamath Falls in 1989; they generally begin to appear in T. 41S R. 6E Section 3 and are present downstream until Copco Reservoir. Four types of mass movement/landslide features have been identified: translational-type landslides; landslide remnants and debris; secondary landslides; and talus (City of Klamath Falls 1989). The translational-type landslides consist of intact or near-intact basalt masses on tuff. The slope surface is at the base of the basalt or near the top of the underlying tuff. Very slow creep-type movement may be possible, especially near the canyon rim (City of Klamath Falls 1989). These slides occur where tuff underlying the more resistant basalt has been exposed by downcutting of the river and oversteepening of slopes in the tuff has occurred (City of Klamath Falls 1986). The landslide remnants and debris are typically weathered remains of older translational landslides. They are typically composed of broken basalt blocks ranging in size from fine gravel to large boulders in a silt or sandy silt matrix. They may be the source of very localized debris and/or block toppling if undercut. These features are considered stable and not capable of renewed mass movement. Secondary landslides typically originated in material previously disturbed by other translational-type landslides. Talus deposits are composed of rock rubble from basalt blocks. The voids around the larger rock pieces remain open where finer colluvium is not intermixed (City of Klamath Falls 1986).

Sheet and Rill Erosion Potential

Map 4 shows that the majority of the TPLA area is rated as having a moderate susceptibility to productivity losses from surface erosion. The soil factors contributing to a rating of moderate are surface soil structure, the percentage of coarse fragments, infiltration rates and permeability. To prevent surface erosion, the BLM implements Best Management Practices and project design features that conserve soil surface cover. Considering the gentle slopes and stable soil conditions in most of the TPLA area, there is a low probability that surface erosion from timber harvest activities has reduced soil productivity levels-with the exception of roads. Erosion from roads is addressed in the Hydrology Issue. Gully erosion and stream bank erosion are discussed in the Channel Condition Issue.

Key Question: Do compaction and loss of soil organic matter associated with logging activities affect soil productivity?

Compaction

The types of land management activities determined to have the most potential for impacting soils in the TPLA area are road building and timber harvest. These activities are addressed in this analysis. Although adverse impacts to soils have occurred from recreation activities and livestock grazing, the effect of these activities do not have the cumulative extent and impact in this watershed as do road building and timber harvesting. Recreation and livestock grazing can have severe local impacts, particularly if the impact occurs in a riparian or wetland area; however, these impacts are best analyzed at the site-specific planning level.

No attempt was made to quantify the acreage in the TPLA area impacted by the various land management activities. Almost all of the forested land in the watershed has been entered at least once for timber harvest. The type of harvest, design of the skid trail and road system, the soil conditions present during harvest, and the type of site preparation have varied. Records describing the types of management activities over time exist for federal land. Such records for private lands are not readily accessible. The extent to which soil productivity has been affected in the watershed by management activities has not been quantified, due to the lack of research on the subject conducted in the area, the lack of on-the-ground surveys with which to quantify the extent of impacted soils, and time constraints. This analysis discusses the likelihood of whether or not impacts have occurred, based on the type of activities commonly implemented and on the characteristics of the soils upon which they are implemented. Quantification of effects is expected to occur at the site-specific planning level.

Appendix S and pages 4-11 through 4-16 in the Klamath Falls Resource Area Proposed Resource Management Plan and Final Environmental Impact Statement discuss the effects of compaction on soil productivity and the soil resource in general. That information is summarized in this analysis. Based on a review of these documents, some generalizations can be made regarding the level of impact to soil productivity various timber harvest practices (including road construction) could have. These impacts could be mitigated and/or reduced if Best Management Practices are prescribed and implemented for these activities. The level of impact would also vary depending on the condition of the soil before and during activity implementation. A summary of these activities and the generalized impact level each has on soil productivity is given in Appendix 1. This is a list of the activities that have or are likely to occur in the TPLA area.

Of the changes to productivity that could result from the activities listed in Appendix 1, tractor yarding and road building have likely caused some losses in productivity throughout the TPLA area. The road density in portions of the TPLA area is high (see the Hydrology core topic). Roads cause direct on-site impacts to soil productivity by creating a compacted surface and disturbed areas where the cut and fill has occurred. Tractor yarding has occurred in a large portion of the TPLA area and, in some instances, over the same area several times. Tractor yarding requires a network of skid trails that can cover a large portion of a harvest unit. Federal land administrators in the last 25 years or so have attempted to reduce the impact of tractor harvesting on soils through the prescriptions and implementation of Best Management Practices. However, it is likely that impacts to soil productivity have still occurred after the implementation of Best Management Practices due to the following factors: repeated entries into the same stand; the difficulty of restricting the extent of the skid trail network when selective harvest occurs or when a mechanical harvester is used; the difficulty in reducing existing compaction because of the high number of rocks in some of the soils; and the common use of rock rippers to reduce existing compaction instead of a winged subsoiler, which is more effective at breaking up compacted soil without churning it.

Growth losses from soil compaction of 4.8 percent have been factored into models of timber yields for BLM-administered lands. These models, used during the Klamath Falls Resource Management Plan and Environmental Impact Statement process, are discussed in the document entitled Managed Stand Yield Tables-Silvicultural Systems for the Retention of Biological Diversity, Klamath Sustained Yield Unit (Pierle and Lewis 1991). The impacts from tractor yarding were deemed significant enough to quantify a reduction in yields (4.8 percent). This figure was based on the assumption that an area occupied by skid trails and landings is normally 12 percent or less when designated skid trails are used, and that a growth loss of 5 percent can be anticipated if 12 percent of the harvested area is compacted. The average of the land base subject to tractor logging is 95 percent; thus the reduction is 4.8 percent instead of a full 5 percent. The 4.8 percent reduction does not take into account additional productivity losses from site preparation methods or for when more than 12 percent of a harvest area is impacted by skid trails and landings.

It is not known whether growth losses from compaction are accounted for on non-federally-administered lands. Also, it is not known what specific Best Management Practices or similar project design features are being implemented to reduce productivity losses by non-federal landowners in the TPLA area during timber harvest activities. However, the Oregon Forest Practices Act contains measures to be applied to non-federal lands for protection of soil productivity. It is assumed that most of the privately owned forest lands will continue to be managed for intensive timber harvest under the guidelines established in the Act.

Map 3 shows that the majority of the TPLA area is rated as having a high susceptibility to productivity losses from compaction. In addition, there is a significant amount of acreage that is rated as having a moderate risk of productivity losses from compaction. The soil factors contributing to the moderate and high ratings include surface texture, percentage of cobbles and stones, and soil structure.

Soil Organic Matter

The reduction of soil organic matter on the disturbed soils has important management implications. Productivity of western-montane forest soils is tightly bound to the organic matter component (Page-Dumroese et al. 1991). The western-montane area encompasses the area from the eastern slope of the Cascade mountain range in Washington and Oregon south to the Sierra crest in California and extends east to the Continental Divide in Montana and Wyoming. A primary portion of the nutrient capital, particularly nitrogen (N), in the forest ecosystem is contained in the O horizon and in woody residue (Page-Dumroese et al. 1991). Soil normally contains 80 to 90 percent of the total ecosystem N and even more of the phosphorus (Powers 1991). Lodgepole pine stands, in particular, are usually N-deficient so inputs from decaying wood and the forest floor can be very important for productivity (Cochran 1975, Cochran 1979, Page-Dumroese et al. 1992, Fahey et al. 1985). Other nutrients like calcium (Ca), magnesium (Mg), potassium (K), and phosphorus (P) are also abundant in organic horizons. Nutrient concentrations vary depending on overstory species and stand locations, but no matter where the forest stand the O horizons provide a large proportion of nutrients critical for seedling establishment and growth (Page-Dumroese et al. 1991).

Soil organic matter is critical to storage of nutrients and moisture, nutrient cycling, aeration, and arthropod and microbial activity (Harvey et al. 1988). Soil arthropods (oribatid mites, collembola, millipedes, centipedes) and microbes (fungi, bacteria, actinomycetes, cyanobacteria, and green algae) play a key role in decomposition and nutrient cycling. Fine roots and ectomycorrhizae are concentrated in the organic or shallow mineral horizon (Harvey et al. 1986, Vogt et al. 1980). The soil organic layer is biologically the most diverse part of the terrestrial ecosystem.

Postharvest natural and artificial regeneration success depends on soil organic matter content (Page-Dumroese et al. 1991). Soil organic matter affects cation exchange capacity, water-holding capacity, bulk density, nutrient budgets, and erosion potential in forest soils. Removal of organic horizons during harvesting and site preparation may seriously reduce overall site productivity, stability, and regeneration potential (Page-Dumroese et al. 1991).

Ponderosa pine is well-adapted to capture the productivity potential on infertile, skeletal soils in forest ecosystems characterized by frequent fires, slow decomposition rates, and extremely low organic matter accumulations (Daubenmire and Daubenmire 1968, Harvey et al. 1988). But Ponderosa pine seedlings are particularly sensitive to surface soil compaction (Helms and Hipkin 1986, Ross and Walstad 1986, Harvey et al. 1988). Investments made to reduce compaction and to conserve organic matter are likely to provide high returns in the form of retained or improved productivity potential for Ponderosa pine on most sites (Harvey et al. 1988). Our best concept of ecosystem productivity is based on the capacity of soil to support plant growth (Powers 1991). Organic matter retention on sites in the watershed analysis area is therefore imperative for future productivity and soil nutritional status must be of primary concern when management activities such as commercial thinning and underburning are proposed.

Key Question: Do potential reductions nitrogen fixation and in populations of mycorrhizal fungi occur with management activities?

Nitrogen (N) is the mineral element required in the greatest amounts by plants in virtually all ecosystems (Paul and Clark 1989) and is the most limiting nutrient in Pacific Northwest forest ecosystems (Johnson et al. 1989, Edmonds et al. 1989). Nitrogen for plant growth is either released and recycled from soil organic matter or it comes from precipitation, dry deposition, or fixation (Alexander 1974). In general, biological fixation is by far the most important source of N input into coniferous forests and is responsible for most of the external N input (Johnson et al. 1989, Chapin and Bledsoe 1992). Precipitation accounts for most of the remainder while the amount contributed by dry deposition is relatively minor (Chapin and Bledsoe 1992). Fixation of atmospheric N is a biological process mediated by two groups of bacteria: (1) symbiotic bacteria associated with certain vascular and non-vascular plants, and (2) asymbiotic (or free-living) bacteria that occur in the soil and with coarse woody debris. The amount of N added to forest soils by free-living microorganisms is small compared to symbiotic sources, but steady accretions in the rhizosphere from free-living bacteria can contribute significantly to the N budget in a forest ecosystem over the long term (Molina and Amaranthus 1991). The small contribution of N supplied by free living bacteria can be especially important in certain forest ecosystems having few to no N-fixing plants.

N-fixing vascular plants in eastside forests include *Ceanothus* spp., *Purshia tridentata* (bitterbrush), and *Cerocarpus* spp. (mountain mahogany), and *Lupinus* spp. N-fixing non-vascular plants in eastside forests include lichens in the genera *Peltigera, Collema*, and *Leptogium*. But a far greater diversity of N-fixing lichens occurs in westside forests and hence their contribution to the overall N budget there is more considerable. Certain N-fixing bacteria are also associated with mycorrhizal complexes in the forest soil (Amaranthus et al. 1989). Cyanobacteria (formerly designated as blue-green algae), which live at the soil surface and are phototrophic, also fix N. In the Arctic region, cyanobacteria are the primary source of fixed N (Chapin and Bledsoe 1992). In undisturbed open forest and range sites in the Great Basin area, cyanobacteria associated with cryptobiotic crusts at the soil surface play an important role in N fixation for these semi-arid and arid ecosystems.

Estimates of annual rates of N fixation by the various pathways listed above have been reported in ecosystem studies. Plant communities with significant components of either snowbrush (*Ceanothus velutinus* Dougl.), red alder (*Alnus rubra* Bong.), or other species supporting N-fixing symbionts can fix as much as 30 to 200 kilograms per hectare per year N (Newton et al. 1968, Tarrant and Trappe 1971, Zavitovski and Newton 1968). Atmospheric inputs (precipitation and dry deposition) of N in Washington are only about 1 kilograms per hectare per year (Gessel et al. 1972) and 1 to 5 kilograms per hectare per year in Oregon (Fredriksen 1975). By contrast, atmospheric N inputs varying from 20 to 25 and exceeding 50 kilograms per hectare per year have been reported from industrial sources in the eastern United States and Europe (Bormann et al. 1977, Van Breemen et al. 1982, Van Praag and Weissen 1986). In the Rocky Mountain region, the N content of precipitation is about 2 to 4 kilograms per hectare per year (Binkley 1991). Free-living bacteria probably add about 1 kilograms per hectare per year N in the Rocky Mountain region (Binkley 1991). Epiphytic canopy lichens (for example *Lobaria oregana*) in low-elevation old-growth forests on the west side of the Cascade Mountains are estimated to fix about 3 to 5 kilograms per hectare per year N (Franklin et al. 1981). Contributions of N to forest ecosystems from atmospheric input, free-living bacteria, and lichens, although much smaller than those made by symbiotic bacteria associated with vascular plants, may not be insignificant to the total N budget of a forest ecosystem over time.

Finally, some plant communities accumulate large amounts of soil nitrogen in the absence of known N-fixing plants (Perry 1994). Non-nodulated grasses and trees (particularly conifers) have been found to accrete from 50 to over 150 kilograms per hectare per year. In a controlled experiment, pitch pine and red pine accumulated an average of 139 to 168 kilograms per hectare per year (Bormann et al. 1993). Nor could this nitrogen accretion be explained by precipitation inputs. It remains a mystery as to how such significant N accretion is occurring, but "rhizocoenoses" (associative nitrogen-fixers) have been implicated as a possible pathway. These are N-fixing microorganisms that occur with roots, mycorrhizae, and mycorrhizal fruiting bodies (that is, mushrooms). Rhizospheres (soils in close proximity to roots) are favorable habitats for N-fixing microorganisms. The abundant labile carbon provided by root and mycorrhizal exudates support such microorganisms. However, if anything is clear it is that the various pathways by which N is added to terrestrial ecosystems are still incompletely understood.

Key Question: What is the nutrient status, especially for nitrogen (N), in forest soils in the TPLA area?

Overview. All but 1,167 acres in the TPLA area are rated as having a moderate susceptibility to nutrient loss (see Appendix 1 and Table14). The remaining 1,167 acres are rated as having a high susceptibility to nutrient loss. The soil factors contributing to the moderate and high ratings include litter thickness and soil structure.

Fire and Nitrogen Mineralization. Ponderosa pine ecosystems demonstrate low rates of nitrogen mineralization and nitrification in both laboratory and field studies (Powers 1980, Lodhi and Killingbeck 1980, Vitousek et al. 1982). Therefore, a concern is that the use of prescribed fire to reduce accumulated fuels and thereby the hazards of wildfire may reduce the easily decomposed fraction of the forest floor and leave the fraction more resistant to decomposition. This in turn would decrease the ability of the ecosystem to provide inorganic N via the process of N mineralization (White 1986).

However, an increase in site fertility appears to be achieved by low-intensity fire which may increase the ability of the ecosystem to supply inorganic N (and perhaps other nutrients) in the immediate future (White 1986). Following fire treatment, N mineralization and nitrification rates in the forest floor were found to increase and remain elevated for up to 10 months (White 1986). The flush of nutrient availability associated with fire has been documented by many other investigators. The conclusion drawn is that low mineralization rates in ponderosa pine ecosystems may be the result of fire restriction from the accumulation of volatile chemical inhibitors (tannins and polyphenols) in the soil (White 1986). Periodic low-intensity fires may consume or volatilize the allelochemical inhibitors, resulting in greatly increased rates of N mineralization.

Minimum post-treatment residue loadings of 24 to 36 metric tons of residual woody material per hectare (10 to 15 tons per acre) when available have been recommended for Rocky Mountain forests (Harvey et al. 1988). In Ponderosa pine forests on the eastern flank of the Cascade Mountains, fuel loads greater than 36 metric tons per hectare (15 tons per acre) are considered as predisposing a forest stand to greater risk of catastrophic fire (a high-intensity, stand replacement fire event) (J. Foran, BLM fuels specialist, personal communication).

Systematic surveys of fuel loads distributed across the landscape analysis area have not been conducted. However, preliminary surveys indicate higher than natural fuel loadings in forests where fire exclusion has led both to the development of dense understories of Douglas-fir and true firs and the accumulation of fuels (Foran 1995, pers. comm.). Because of these conditions, some forested areas within the landscape analysis area are at greater risk of catastrophic fire than others. At the same time, however, in other areas, especially in the matrix of open forest stands, the amount of coarse woody debris (CWD) may be less than 15 tons per acre and organic horizons in the soil profile are so thin that retention of what organic substrates are there may be important for maintenance of site productivity (that is, soil biota such as N-fixing bacteria and mycorrhizae, plant nutrition, and the food-energy web linking autotrophs and heterotrophs in the ecosystem). For example, the staple diet for the northern spotted owl is the northern flying squirrel whose main food source is truffles (the belowground fruiting bodies, or mushrooms, of mycorrhizal fungi). Mycorrhizal fungi, in turn, are critical to conifer nutrition and for conifer resistance against root disease pathogens.

By the simple "checkbook balancing" approach, "withdrawals" must not exceed "deposits" of soil organic materials if site productivity of forests is to be maintained (Amaranthus et al. 1989).

Higher Nitrogen Needs in Contemporary Eastside Forests. Nitrogen needs have probably increased in contemporary forests that have replaced historically ponderosa-pine dominated forests. Pine may require less N than fir to construct its leaves. Pre-settlement ponderosa-pine forests probably did not hold more than 30,000 square meters of projected leaf area per hectare [leaf area index (LAI) = 3.0]. Replacement forests of grand fir, Douglas-fir, and Engelmann spruce tend to double the LAI (LAI = 6.0) which increases the demand for N without providing an environment for plants such as *Ceanothus* inoculated with symbiotic N-fixing bacteria. A LAI of 6.0 only permits about 5 percent of full sunlight to penetrate to the understory (Waring 1996, pers. comm.). Therefore, the most significant pathway by which N is fixed in eastside forests may be greatly reduced with a decline in populations of vascular plants such as *Ceanothus* in the understory.

Fertilization. Nitrogen can be added to forest ecosystems by way of chemical fertilizers. Many studies have documented the positive effect on tree growth by fertilizers. Important to note, however, is that growth response to N fertilizers usually lasts only between 5 to 10 years depending on site and tree species, and then after this period of growth usually returns to control levels (Ballard 1979, Brix 1983, Davey 1968, Peterson 1982, Weetman et al. 1980, Vogt et al. 1989). Chemical fertilizers, therefore, usually do not raise the potential productivity of a site and so can be considered a crop treatment rather than a site treatment (Miller 1981). Fertilizers are used to achieve maximum productivities and reduce rotation lengths (Vogt et al. 1989). Nitrogen concentrations in the soil, litter, and plants returned to pre-fertilization levels 3 to 4 years after N was added in a lodgepole pine stand (Waring and Pitman 1985).

Key Questions: What historic processes affected soil productivity in the TPLA area? What are the historic erosion processes within the TPLA area? Where have they occurred?

Because the TPLA area is comprised of gentle slopes and generally stable soils, it is likely that little erosion and virtually no land sliding occurred in undisturbed areas outside of the Klamath River Canyon. Within the Klamath River Canyon, landsliding was likely a common occurrence. The City of Klamath Falls (1986) noted that "lacustrine deposits appear to have extensively filled in the canyon bottom in recent geologic time from below the existing J.C. Boyle powerhouse downstream to River Mile 214.3. The fine grain deposits are postulated to have formed when massive landslides blocked the valley creating a deep lake in which more than 200 feet of silt materials accumulated over a relatively short period of time. The landslides were subsequently breached and the river presently has eroded through more than 70 feet of lacustrine deposits in the vicinity of...River mile 217.7."

Outside of the Klamath River Canyon, wildfire was the primary agent of disturbance prior to Euroamerican settlement (see the Vegetation core topic). Fire has played an important role in the nutrient dynamics of soils in the TPLA area, particularly in the ponderosa pine vegetative zone. Wildfire, when it occurred, could have affected productivity in burned areas. Wildfire in the higher elevations was likely a more severe, stand-replacing event, while fire in the lower elevations was probably less severe, due to a more frequent return interval that kept fuel loadings lower (see the Vegetation core topic).

Fire affects soil productivity because organic matter located on or near the soil surface is burned. Some nutrients are volatilized and lost to the atmosphere, but some nutrients are made more available with fire. Fire acts as a rapid mineralizing agent that releases nutrients instantaneously compared to natural decomposition processes, which may take years or decades (DeBano 1990). Wildfire would have resulted in the loss of soil cover in burned areas, which would have made the soil more susceptible to surface erosion. However, due to gentle slopes and the buffering action of riparian areas and wetlands, any erosion that occurred is assumed to have caused insignificant off-site impacts.

The TPLA area has experienced grazing by cattle and horses for much of this century (see the Livestock Grazing core topic). The historic numbers of livestock are not well recorded. Livestock grazing was probably dependent on the existence of natural, non-forested openings and on openings in the forest canopy which had adequate forage production. Natural openings were likely more abundant in the lower elevations, where wildfire was more active. Thus, until openings were created by wildfire or human activities (timber harvest, creation of clearings through fire), much of the grazing was probably centered in the elevations where the least productive soils occur. The main impact from livestock grazing was probably loss of soil cover, although compaction and altered nutrient cycling likely occurred to a lesser extent. Because livestock numbers are currently at a 50 year low in the TPLA area, it is likely that the highest level of impact from livestock grazing has already occurred.

In the early part of this century, much of the TPLA area had already been entered for timber harvest, mostly in the lower elevations on private land. Harvest on all lands was mostly selective, with a system of roads and rail lines built to transport the logs. Limited harvest on Federal lands began in the 1940s, with activity peaking during the 1970s and 1980s. Within the last 40 years, various types of harvest have occurred, with varying intensities. Many areas have been entered two or more times, particularly in the ponderosa pine and mixed conifer vegetative zones (see the Vegetation core topic). Throughout the area, yarding has been mostly ground-based, with an extensive network of skid trails and roads. Site preparation methods have also varied. Tractor piling has been commonly used, with scarification, ripping, and broadcast burns also occurring. Activity during a wide variety of soil conditions occurred, and operating during wet soil conditions was probably a common practice.

To summarize, the condition of the various soil factors and, therefore, the productivity of soils in the TPLA area had already been adversely affected early in this century, particularly in the lower elevations. High levels of activity continue on private lands. Recovery of soil factors from adverse impacts has occurred to some extent through natural processes; however, many areas have been re-impacted several times in different ways. Thus, it is not likely that impacted areas have recovered to the extent that full site potential and soil productivity have been restored.

Key Questions: What are the natural and human causes of changes between historical and current erosion processes and soil productivity in the TPLA area? What are the influences and relationships between erosion processes, soil productivity and other ecosystem processes?

A preliminary survey of soils and plants reveals thin soil organic horizons and low numbers of populations of N-fixing plants in certain areas within the landscape analysis area. Because the nitrogen budget of a forest ecosystem is so closely tied to soil organic reserves and to N-fixing plants, there may be an inadequate source of N to maintain long-term site productivity in certain areas of the landscape analysis area if care is not taken to minimize further soil disturbance from timber harvest activities. An example is the Grenada sub-area, a matrix of relatively open forest in which are embedded denser pockets or islands of trees. Soil compaction and loss of soil organic horizons are evident throughout the open matrix, especially where skid roads occur. Conversely, soil organic horizons underneath the denser islands of trees are well developed, having experienced evidently less disturbance from previous logging entries. These islands can be thought of as refugia for soil organic reserves and for associated microorganisms such as bacteria and mycorrhizal fungi that supply nitrogen to the forest ecosystem, a nutrient which is critical for conifer nutrition. Frequent, low-intensity fires may consume a sizable portion of the soil organic horizon as they burn across the forest floor, and islands of trees such as those that currently exist in the Grenada sub-area may have been less prevalent in pre-settlement forests because of the natural fire regime. The opening of dense overstories can be beneficial since growing space is created for N-fixing plants such as *Ceanothus* spp. which require relatively high light levels. However, with the introduction of ground-based logging equipment, soils are subject to disturbances that do not occur under the natural fire regime. Soil compaction, loss of soil organic horizons, and loss of N-fixing microbes occur to a much greater degree with logging activities. Therefore, it is imperative to minimize soil disturbance as much as is feasibly possible when selectively thinning trees in the area. The best way to do this is to keep ground-based equipment on existing skid-roads and to limit as much as possible entry into denser islands of trees where soil organic horizons have developed. It is possible to successfully do the above given a conscientious effort by the timber sale operator and close supervision by the timber sale administrator.

Suppression of fire in the TPLA area has allowed for organic matter levels in the soil to increase in some areas, probably to levels higher than were present prior to fire suppression. However, in areas where scarification, tractor piling and burning, or prescribed burning have occurred, organic matter may have been reduced to levels at or below those present before fire suppression occurred. Reductions in organic matter from these activities would have to be assessed on a site-specific basis, due to the variability of site conditions prior to management and the management practices that have been implemented.

The implementation of a prescribed fire program on BLM-administered lands in the TPLA area could cause short-term decreases in soil productivity due to exposure of mineral soil and decreases in organic matter content.

However, fire was a natural disturbance agent and soils in the TPLA area evolved under the influence of fire to some extent. Best Management Practices will assist federal land administrators in maintaining soil productivity at current levels when implementing prescribed fire.

Because soils with a high compaction susceptibility rating occur in much of the TPLA area, it is likely that impacts from human activity (livestock grazing, road building, and timber harvest) have occurred. Because of the repeated number of entries into many stands, the high road density in areas, and the common use of tractor yarding during timber harvest, it is likely that soils in the TPLA area have had reductions in productivity from compaction. It is also probable that the level of productivity losses is higher on non-federal lands in the TPLA area because of the high susceptibility rating for most soils on these lands and the common implementation of Best Management Activities and other project design features on federal lands. However, adverse impacts have not been entirely avoided on BLM-administered lands and some reductions in productivity are likely in areas where more highly-impacting management practices have occurred.

Highly impacting activities such as road building, scarification and tractor piling, and burning may occur on non-federal lands and to some extent on federal lands, and can cause decreased soil productivity in areas. On federal lands, the number of acres in the TPLA area expected to be subjected to these activities in the future is expected to be low, and impacts should be mitigated by Best Management Practices.

The BLM employs Best Management Practices and project design features to reduce, avoid, or limit adverse impacts to soils and soil productivity from the implementation of timber harvest activities. With the continued application of these tools, overall impacts to soils and soil productivity (direct, indirect, and cumulative impacts) should remain at current levels for the short term (1 to 5 years) and will be reduced through natural recovery processes or standard operational practices (such as ripping of existing skid trails if they are not needed for the next harvest activity) in the long term (5 years or more). Also, because of the generally reduced harvest activities prescribed in the newest land use plans for the federal lands, less land may be impacted by timber harvest activities, particularly within Riparian Reserves. However, this effect could be counteracted by more acres being treated for forest health objectives (for example, there are many areas in the TPLA area where the understory needs to be thinned or treated with prescribed fire).

Impacts to soils and soil productivity on non-federal lands are expected to remain static or increase in the short term (1 to 5 years) as active forest health treatments and salvage programs are completed on these lands. In the long term (5 years or more), if harvest activity on non-federal land declines, then some recovery of soil productivity may occur through natural recovery processes.

Core Topic: Plant Species of Concern

Special Status Plant Species Including Threatened, Endangered, and Sensitive Plant Species

Issue: Distribution and abundance of special-status plants have been altered in the landscape area by human-introduced disturbances.

Historic Conditions

Little is known concerning the historic distribution of special status plant species within the landscape analysis area. Many special status species are naturally rare within the communities in which they occur, or are restricted to particular, uncommon habitats even if they are abundant within those habitats. Species are classified into one of the special status categories when human activities alter relative abundance and species composition of plant communities or further reduce the abundance of uncommon habitats.

Processes of Change

The primary changes in the landscape are the result of human activity, and include timber harvest, livestock grazing, road construction and water diversion for irrigation. Timber harvest can change the environmental conditions, such as relative humidity and exposure to sunlight, at a site that will affect the ability of individual species to survive or compete in the affected area. Livestock grazing can change relative abundance of species and species composition through selection of more palatable species for consumption, and trampling and compaction of soils. Road construction can contribute to fragmentation of habitat and decrease interior forest habitat through an increase in edge conditions throughout the landscape. Water diversion for irrigation can change the amount, geographic distribution and seasonal distribution of water thus changing habitat conditions in affected areas which results in changes in species composition and relative abundance.

Key Questions: What special-status plants occur in the landscape analysis area? Where are known populations of these plants located in the landscape analysis area? What are the habitat requirements for each species?

Current Conditions

Table 15 shows potential habitat and the likelihood of occurrence in the landscape area for BLM special status plant species documented or suspected in the Klamath Falls Resource Area. Botanical surveys conducted from 1989 to 1995 covered approximately 4,718 acres of BLM-administered lands in the landscape analysis area. Both Bellinger's meadowfoam (*Limnanthes floccosa* ssp. *bellingeriana*) and pygmy monkey flower (*Mimulus pygmaeus*) were found during these surveys. Additionally, amateur botanists have documented populations of red root yampah (*Perideridia erythorrhiza*) on private land, and BLM range survey crews in the mid-1980s reported approximate locations of Green's mariposa lily (*Calochortus greenei*) within the landscape area. The range of these species within the landscape area is not well known since known populations consist of incidental sitings and those found during surveys on BLM-administered lands which included only those areas that have been proposed for timber harvest or other management actions in the past.

Table 15. Bureau of Land Management Special Status Species For The Klamath Falls Resource Area.

Species	Status	Documented in Area?	Potential Habitat	Occurance in TPLA
Asarum wagneri	SC, BS	no	Fir, mixed conifer, LP forests, rocky sites	Possible, widespread in Spencer Creek area
Astragalus applegatei	FE, SE	no	Moist meadows	Possible, hist. site near Keno
Astragalus peckii	SoC, ST	no	LP/bitterbrush openings, sagebrush, pumice soils	Unlikely
Calochortus greenei	SoC, SC	no	Dry, brushy hillsides on clay soils	Probable, unconfirmed site in area
Calochortus longebarbatus var. longebarbatus	SoC, NHP1	no	Moist/dry meadows, edge of PP and/or LP woodlands	Unlikely, beyond documented range
Castilleja chlorotica	SoC, NHP1	no	Gravelly slopes/summits, PP/LP openings, 5,000' +	Unlikely, beyond documented range
Collomia mazama	SoC, NHP1	no	Mesic LP & fir forests partial canopies, mid. elevations	Unlikely, beyond documented range
Gentiana newberryi var. newberryi	NHP2, AS	no	Moist-wet meadows, mid-high elevations	Unlikely
Limnanthes floccosa ssp. bellingeriana	SoC, SC	yes	Spring wet depressions & flats with rocky, clay soils	Muddy Tom and Grenada timber sale areas
Mimulus pygmaeus	SoC	yes	Spring wet depressions & flats, intermittent stream beds	Muddy Tom timber sale area
Penstemon glaucinus	SoC, NHP1	no	LP/WF forests, high elevations	Unlikely, beyond documented range
Perideridia erythrorhiza	SoC, SC	yes	Spring moist meadows, edge of mixed conifer forest	Private lands
Rorippa columbiae	SoC, SC	no	Gravelly streambeds, lakeshores	Possible
Silene nuda ssp. insectivora	NHP4, TS	no	Spring moist meadows	Unlikely, beyond documented range
Thelypodium brachycarpum	NHP2, AS	no	Sagebrush openings, meadows in PP forests	Possible

Abbreviations:

FE: Listed as endangered by the USFWS under the Endangered Species Act.

SoC: Species of Concern. Includes all species formerly categorized as Federal candidate list 2 species (USFWS needs additional information before proposing as endangered or threatened). Also includes many of the species formerly categorized as Federal candidate list 1 species (USFWS has information to support proposing as endangered or threatened). The USFWS no longer intends to publish this list as a Notice of Review, and these species are no longer considered federal candidates for listing.

SE: State of Oregon endangered species.

SC: State of Oregon candidate species for endangered or threatened.

BS: U. S. Bureau of Land Management sensitive species in Oregon.

AS: U. S. Bureau of Land Management assessment species in Oregon.

TS: U. S. Bureau of Land Management tracking species in Oregon.

NHP1: Oregon Natural Heritage Program list 1. Taxa which are endangered or threatened with extinction or presumed to be extinct throughout their entire range.

NHP2: Oregon Natural Heritage Program list 2. Taxa which are threatened, endangered or possibly extirpated from Oregon, but are more common or stable elsewhere.

NHP3: Oregon Natural Heritage Program list 3. Taxa for which more information is needed before status can be determined, but which may be threatened or endangered in Oregon or throughout their range.

NHP4: Oregon Natural Heritage Program list 4. Taxa which are of concern, but are not currently threatened or endangered. Includes taxa which are very rare but currently secure, as well as taxa which are declining in numbers or habitat but are still too common to be proposed as threatened or endangered.

LP: Lodgepole pine

PP: Ponderosa pine

WF: White fir

Bellinger's meadowfoam

Bellinger's meadowfoam is an annual species that grows in moist meadows and vernally (seasonally) moist-wet sites, and in intermittent wet-dry stony flats. These areas fit the classification scheme for vernal pool habitat described by Holland (1976). All known sites occur in open coniferous and coniferous/oak woodlands dominated by ponderosa pine or foothill pine (in California). The elevation range of sites in Oregon vary from 1,800 to 4,200 feet, but in California sites range from 3,070 to 3,600 feet elevation with a single population at 950 feet. The range of the species covers parts of southwest and south central Oregon and north central California, and includes documented populations from Jackson and Klamath counties in Oregon and in Shasta County in California (Masinton 1995).

In the landscape analysis area, Bellinger's meadowfoam occurs in vernally wet meadows within ponderosa pine/oak woodlands. The landscape analysis area contains the largest number of populations of any management unit within the range of the species, however, these populations are at the extreme upper end of the elevational range. A draft conservation strategy called for more intensive inventory in order to better understand the environmental range of the species.

Pygmy monkeyflower

Pygmy monkey flower is a diminuative, annual species that tends to occur most prevalently in low meadows or herb-dominated openings along the edge of sagebrush swales or uplands. However, it can also be found scattered among the adjacent shrubs as well. Generally, known populations occur between 4,000 and 5,000 feet elevation. Surrounding vegetation may be dominated by juniper, pine or Douglas fir trees. In Oregon, pygmy monkey flower occurs from Lake County in the east to Jackson County in the west. Its range continues south in California through the Sierra Nevada to at least Plumas County, and possibly as far south as Nevada County (Meinke et al. 1994).

In the landscape analysis area, pygmy monkey flower occurs in vernally wet meadows within ponderosa pine/oak woodlands. The only two populations documented on BLM-administered lands occur adjacent to populations of Bellinger's meadowfoam. Surveys by Oregon Department of Agriculture personnel on the Fremont and Winema National Forests in 1993, following an unusually wet winter, found numerous large populations of this species.

Red root yampah

Red root yampah is a perennial species which is found in moist grasslands, valleys, and paturelands, often (but not always) in heavy, poorly drained soils. Sites occur within oak and/or pine woodlands at low to mid elevations (500 to 5,000 feet). The range of the species covers the southern Cascades of Oregon in Douglas, Klamath, Josephine and Jackson counties (Meinke 1981).

In the landscape area, red root yampah has been reported by amateur botanists in seasonally wet grasslands adjacent to streams on private lands. Botanical surveys on BLM-administered lands have not located any populations, but it would seem likely that populations of this species would be found as a result of more intensive inventories given its occurance on adjacent private lands.

Green's mariposa lily

Green's mariposa lily is a stout perennial which inhabits clay soil of chaparral areas, around dry thickets and on rocky slopes (Meinke 1981). Known populations range between 2,400 feet and 6,400 feet elevation, with the majority between 3,400 feet and 4,000 feet. The range of documented sites of the species covers parts of Jackson County, Oregon and Siskiyou County, California (Brock 1988).

In the landscape analysis area, a crew collecting range data using the Soil and Vegetation Inventory Method reported two populations of Green's mariposa lily. To date, BLM botanists have been unable to relocate these sites, but a more intensive botanical inventory effort would be likely to locate populations of this species.

Condition Trends

To the extent that human activities continue to affect species abundance, relative abundance of species, and the distribution of uncommon habitats, the abundance and distribution of special status plant species will likely continue to be reduced within the landscape area. This would probably result in contributing to an increased level of concern and/or to the need to list individual species. As a result, management activities will probably be constrained to conserve the species, and/or the species will eventually be extirpated.

Survey and Manage Species

Historic Conditions

Little is known concerning the historic distribution of survey and manage species within the landscape area. Survey and manage species are species that are primarily associated with many of the old growth conifer forest communities in the Pacific Northwest. This type of habitat was once more abundant than at the present time (see the Vegetation core topic). Therefore, it might be assumed that the survey and manage species were once more abundant and widespread within the landscape area.

Processes of Change

The primary cause of the decrease in old growth conifer forest in the landscape has been the harvest of timber. Timber harvest has removed the structural components that comprise old growth habitat of some forest communities within the landscape area, including large trees, down and dead woody material, standing dead snags, a multi-layered canopy, and a closed tree canopy. The disturbance to the substrate and alteration of environmental conditions also can affect species composition and relative abundance of species in the understory community, where most of the survey and manage species occur. These activities combined with fire suppression can alter fire return interval and fire intensity due to the accumulation of heavy fuel loads. Grazing by domestic and wild ungulates can also affect the understory community through selection of more palatable species for consumption, and trampling and compaction of soils.

Current Conditions

None of the survey and manage species of lichens, fungi, bryophytes, or vascular plants included in Table 3C of the Northwest Forest Plan are known to occur within the landscape area. Populations and/or potential habitat may be present for some of these species. Preliminary field surveys for cryptogams were conducted in the summer and fall of 1995. A list of taxa that were found in the field is included in Table 15.

Noxious Weeds

Issue: Alteration of the landscape area has resulted in the introduction of populations of noxious weeds and the displacement of native plant species.

Historic Conditions

All of the noxious weed species that occur within the landscape are exotic (introduced) to North America, mostly from Eurasia. Therefore, these species were not present before Euro-American settlement, and the effects they have on species composition and relative abundance of species within invaded communities, and on the ecosystem processes that support those communities were not present.

Processes of Change

Many of the noxious weed species are well adapted to the environmental conditions associated with disturbances that result from human activity. Some noxious weed species (knapweeds from the Middle East) are even thought to have evolved with human disturbances as a primary selection pressure. The primary disturbances in the landscape area associated with human activity include timber harvest, livestock grazing, road construction and water diversion for irrigation. Disturbances associated with these activities include alteration of the soil surface and profile, compaction of soils, changes in micro-habitat conditions, changes in fire frequency, and changes in hydrological regime. In addition to providing environmental conditions favorable for invasion by these species, human activities also provide dispersal mechanisms through machinery, equipment, livestock, and clothing and boots.

Key Questions: What species of noxious weeds occur in the landscape analysis area? Where do known populations of these plants occur in the area? Are populations increasing in size and, if so, what is their estimated rate of expansion?

Current Conditions

Five species of noxious weeds have been documented on BLM-administered lands within the landscape area. Weed populations seem to be primarily associated with physical disturbance. The Klamath Falls Resource Area Integrated Weed Control Plan and EA addresses management of noxious weeds on BLM-administered lands in this area.

Yellow starthistle (*Centaurea solstitialis*) is widespread and abundant within the landscape area. Large, dense populations occur at Wild Gal Spring, and at the Big Bend and near the powerhouse within the Klamath River Canyon. These large populations are treated primarily with several biological control organisms. Smaller patches and roadsides are treated mechanically and chemically under a contract with Klamath County.

Along a powerline right-of-way east of the Klamth River, a large population of diffuse knapweed (*Centaurea diffusa*) has become established and has been spreading along adjacent roads in recent years. St. Johnswort (*Hypericum perforatum*) and white top (*Cardaria draba*) are becoming established primarily along roadsides.

Tansy ragwort (*Senecio jacobaea*) has also become established near Parker Mountain within the landscape area.

Bull thistle (*Cirsium vulgare*) is present on disturbed sites throughout the landscape area. It is often a dominant species in clearcuts, on landings, and on ripped units, where it persists for approximately 5 to 10 years following disturbance.

Key Question: To what extent are population sources displacing populations of native plant species?

Condition Trends

Human activity that physically disturbs a site provides the site conditions where noxious weeds have a competitive advantage relative to native species. In addition, most noxious weed species have been introduced intentionally or unintentionally by Euro-Americans without the biological agents that may have reduced their ability to compete with other species in their areas of origin. Therefore, many of these species become established in areas disturbed by human activity, but then are able to persist on the site since the biological control agents that may have defined their successional role are absent. Invasion by noxious weeds and other exotic pest plants can reduce the diversity of plant communities and disrupt the ecological processes upon which these communities depend. These effects are expected to continue within the landscape area to the extent and intensity that management actions create disturbed areas.

Summary

Many of the plant species and communities of concern have been affected by human activities that change environmental conditions and introduce exotic pest plant species (noxious weeds). This results in changes in species composition and relative abundance of species within plant communities, and distribution of uncommon plant communities. Additionally, noxious weeds can affect the ecological processes that maintain native plant communities. Management actions are needed that are designed to reduce the level of disturbance usually associated with these activities, and designed to mitigate the impacts already present from past activities.

Core Topic: Plant Associations

Background

The plant association concept dates back to the 19th century and was formalized in the early 20th century by European biologists (Henderson et al. 1989). The concept was developed with the recognition that forests are more than just trees and that a diversity of ecosystems and plant communities exists across the landscape. The concept allows for thinking about forests as whole ecosystems rather than individual species or commodities (Henderson et al. 1989). In the United States, Daubenmire (1952, 1968) incorporated such ideas as "associations" and "site types" to describe northern Rocky Mountain forests in terms of their potential (climax) plant communities, the particular kind of vegetation that a given area of land is capable of supporting. He also described the land area where an association occurs as the "habitat type."

Plant association classifications are used to describe the diversity of plant communities and kinds of ecosystems that occur across the landscape based on potential natural communities (PNC) or stable community types (Hall et al. 1995). The PNC is defined as the "biotic community that one presumes would be established and maintained over time under present environmental conditions if all secondary successional sequences were completed without additional human-caused disturbance. Present environmental conditions include site characteristics, eroded or damaged soils, and existing climate. Grazing by native fauna and natural disturbances, such as drought, floods, wildfires, wind, insects, and disease, are inherent in the development of communities. However, PNCs are described without disturbance by natural elements, including fire. PNCs may include naturalized nonnative species. PNCs also have been called plant associations, habitat types, and range sites. They are used as a reference point and as an achievable end-point in secondary succession" (Hall et al. 1995). Plant associations offer valuable information on the composition, distribution, and environment of individual plant communities as well as their management opportunities for appropriate uses and values such as timber, water, wildlife, forage, and recreation. Today, classifications of plant associations and habitat types are available for many areas of federal forest lands in the western United States.

Plant Associations in the Landscape Analysis Area

The landscape analysis area falls in the category of federal forest lands for which systematic sampling of plant communitites has not been done; hence, the area lacks a plant association classification. Inventory, classification, and mapping of soils series have been conducted for the area, and stand inventory plots reflecting silvicultural and timber considerations are available. But no research has been done to describe plant associations or other ecosystem attributes and processes in the landscape area. To adequately inventory, describe, classify, and map plant associations across the landscape area, extensive and intensive field sampling is required, an effort not possible for the scope of analysis in this document because of a lack of field workers, time, and financial resources. However, a preliminary assessment of plant associations that probably occur in the analysis area can be done based on personal observations in the field, stand inventory data, plant association classifications for adjacent areas (Hopkins 1979a, Hopkins 1979b), an insect risk assessment for the adjacent Bear Valley National Wildlife Refuge (Eglitis 1995), and the Final Eligibility and Suitability Report for the Upper Klamath Wild and Scenic River Study (BLM 1990). A finer scale of resolution that would entail detailed description and classification of plant associations in the area remains for future work following systematic field sampling. Species discussed in the following plant community descriptions are representative only and not intended to be an all-inclusive list of plants that occur in the analysis area.

The plant community descriptions that follow are arranged according to five somewhat arbitrarily drawn sub-areas located within the landscape analysis area, moving across the landscape in a clockwise direction from north at Buck Mountain to southwest at Long Prairie Creek. The sub-area designations stem from preliminary surveys of vascular and non-vascular (lichens, bryophytes, and fungi) plant species conducted in the autumn of 1995. The five sub-areas are 1) Buck Mountain south to Highway 66, 2) Bear Valley National Wildlife Refuge, 3) Grenada, 4) Hayden and Long Prairie Creeks, and 5) the Klamath River Canyon.

Buck Mountain south to Highway 66

At the northern end of the landscape analysis area is township T39S, R06E, extending roughly from Buck Mountain south to Highway 66. This mid- to high-elevation sub-area (ranging from approximately 6,250 ft. elevation at Buck Mountain to 4,000 ft. at Highway 66) is dominated by mixed conifer forests. White fir (*Abies concolor*) and Douglas-fir (*Psuedotsuga menziesii*) dominate forest composition in these stands with remnant, large-diameter individuals of ponderosa pine, sugar pine, and incense cedar scattered in the overstory. Deciduous tree species such as willows (*Salix* spp.) and quaking aspen (*Populus tremuloides*) can be found within the sub-area as well. At higher elevations, as daily mean temperatures decrease and precipitation levels increase, the Shasta red fir (*Abies magnifica*) component increases in forest stands. Forests within the sub-area support a rich diversity of vascular plants in their understory. Common understory plants include golden chinquapin (*Castanopsis chrysophylla*), western serviceberry (*Amelanchier alnifolia*), snowbrush ceanothus (*Ceanothus velutinus*), squawcarpet (*Ceanothus prostratus*), boxwood (*Pachistima myrsinites*), thimbleberry (*Rubus parviflorus)*, red-osier dogwood (*Cornus sericea [stolonifera]*), snowberry (both *Symphoricarpos albus* and *S. mollis*), Douglas's spirea (*Spirea douglasii*), wax currant (*Ribes cereum*), Wood's rose (*Rosa woodsii*), bracken fern (*Pteridium aquilinum*), pipsissewa or prince's-pine (*Chimaphila umbellata*), and twinflower (*Linnaea borealis*).

Common foliose and fruticose lichens associated with the cool environment produced by the denser mixed-conifer forests in the sub-area include taxa such as *Letharia, Bryoria, Cetraria, Hypogymnia, Sphaerophorus, Parmeliopsis, Peltigera, Melanelia, Platismatia, Alectoria, Usnea, and Cladonia.* Common crustose lichens which adhere to rocks include taxa such as *Lecanora muralis, Umbilicaria hyperborea, Caloplaca holocarpa, Rhizoplaca melanophthalma*, and *Rhizocarpon geographicum*. Common bryophytes include saxicolous (rock-inhabiting) taxa such as *Grimmia* spp., *Lescuraea incurvata*, and *Dicranoweisia crispula*, and terricolous (ground-dwelling) taxa such as *Tortula ruralis, Encalypta rhaptocarpa*, and *Homalothecium nevadensis*. Common aquatic bryophytes and liverworts that occur in riparian areas remain to be identified.

Because a plant association guide does not exist for the landscape analysis area, the best that can be done at this point in time for classification purposes is to fit existing plant communities in the area into plant associations developed by Hopkins (1979a, 1979b) for the Winema and Fremont National Forests. Forests in the sub-area would fall largely into the Mixed Conifer, White Fir, and Shasta Red Fir-White Fir series described by Hopkins (1979a) for the Klamath Ranger District, Winema National Forest. All of these communities represent forests that lie at the wetter end of the scale for the described plant associations. They are individually:

Mixed Conifer/Snowbrush-Bearberry CW-C2-15
Mixed Conifer/Snowbrush-Squawcarpet/Strawberry CW-S1-16
White Fir/Snowberry/Strawberry CW-S3-12
White Fir/Chinquapin-Boxwood-Prince's Pine CW-H1-12
Shasta Red Fir-White Fir/Chinquapin-Prince's Pine/Long-Stolon Sedge CR-S3-11
Shasta Red Fir/Long-Stolon Sedge CR-G1-11

Where ponderosa, sugar, and western white pine were more prevalent at lower elevations within the sub-area in turn-of-the-century forests, selected plant associations from the Fremont National Forest (Hopkins 1979b) are applicable:

White Fir-Ponderosa Pine/Manzanita-Oregon Grape CW-S1-17
White Fir-Ponderosa Pine-Sugar Pine/Manzanita CW-C4-12
White Fir-Ponderosa Pine-Incense Cedar/Serviceberry CW-C1-11

These associations are confined to more xeric environments within the sub-area. With a natural fire regime or regular underburning allowed to occur, there may be portions of the sub-area that would support a Ponderosa Pine Series. Again, however, intensive and extensive field sampling is needed to describe and map locations of individual plant associations within the sub-area. At present, a plant association classification of finer-grained resolution is not possible until systematic field sampling is done.

Bear Valley National Wildlife Refuge

On the more xeric eastern edge of the landscape analysis area, the forests of the Bear Valley National Wildlife Refuge fall into two broad vegetative series (Eglitis 1995). Lower elevations are dominated by the Ponderosa Pine series which then quickly grades into the White Fir Series with a slight increase in elevation. The White Fir Series is the most prominent within the refuge and consists of plant associations which are considered at the drier end of the scale for this vegetative series (Eglitis 1995, based on communication with W.E. Hopkins).

Grenada

Moving west to the Grenada sub-area, a White Fir Series and, at higher elevations on Hamaker Mountain, Shasta Red Fir-White Fir Series appear to dominate. Preliminary field sampling in the autumn of 1995 within this sub-area suggested a White Fir-Ponderosa Pine/Manzanita-Oregon Grape plant association, CW-S1-17 (Hopkins 1979b), to be representative of many mid-elevation stands. On cooler aspects in this sub-area in both open and denser stands, a mixed-conifer forest of Douglas-fir and white fir dominates with some ponderosa pine. Occasionally, there are incense cedar, but they tend to be smaller trees in the understory. Sugar pine is also an occasional tree species. Small lodgepole pines can be found that appear to have been planted. In shallow drainages in the area, Douglas-fir and white fir dominate with or without ponderosa pine as a stand associate. The understory is dominated by Oregon grape (*Mahonia [Berberis] aquifolium*) and green-leaf manzanita (*Arctostaphylos patula*).

Foliose and fruticose lichen diversity is generally lower compared to mixed conifer stands north of Highway 66 because of more xeric environmental conditions and more open stands. The most common foliose and fruticose lichen taxa are *Letharia, Bryoria*, and *Hypogymnia*. Crustose lichens which adhere primarily to rocks and the soil become more dominant in this more xeric and open environment. Bryophytes become less common, confined to an even greater degree to cooler microclimates such as riparian areas, the perimeter of ground surrounding rocks, and shaded areas on the forest floor. The same crustose lichens and bryophytes listed above for the township north of Highway 66 occur in this sub-area. Historically, Douglas-fir dominated in this township/sub-area (Leiberg 1899), so in general the sub-area probably consists mainly of plant associations in the White Fir Series or Shasta Red Fir-White Fir Series. A Ponderosa Pine series could dominate on drier sites at lower elevations in the Grenada sub-area.

Hayden and Long Prairie Creeks

Farther to the west, the Hayden and Long Prairie Creeks sub-area generally appears to be an even more xeric environment than the Grenada sub-area with ponderosa pine and western juniper the dominant tree species. Oregon white oak (*Quercus garryana*), California black oak (*Quercus kelloggii*), Douglas-fir, white fir, and incense cedar also occur among the pine and juniper. Common understory shrubs include Oregon grape (*Mahonia [Berberis] aquifolium*), wooly mullein (*Verbascum thapsus*), wedgeleaf ceanothus (*Ceanothus cuneatus*), western serviceberry (*Amelanchier alnifolia*), and snowberry (both *Symphoricarpos albus* and *S. mollis*). Common grass/sedge/rush vegetation includes Lemon's needlegrass (*Stipa lemmonii*), Kentucky bluegrass (*Poa pratensis*), Baltic rush (*Juncus balticus*), and medusahead wildrye (*Taeniatherum caput-medusae).*

Lichen and bryophyte diversity is relatively limited, similar to the taxa listed above for the Grenada sub-area, as a function of the dry environmental conditions that prevail in the sub-area. Forest in this sub-area generally have a more open canopy than those in the Grenada sub-area. A Ponderosa Pine Series may be the appropriate plant classification for much of this sub-area; however, the distribution of California black oak within the conifer stands in the sub-area calls for a plant association in a ponderosa pine - California black oak/mixed shrub type that remains to be described and classified (Hopkins 1996, pers. comm.).

Klamath River Canyon

As a large riparian corridor that cuts across the Cascade region and through the landscape analysis area, the Klamath River Canyon supports its own unique and diverse plant communities that differ markedly from neighboring upland areas. The following description is largely excerpted from the Final Eligibility and Suitability Report for the Upper Klamath Wild and Scenic River Study (BLM 1990).

A mosaic of pine, oak, and mixed conifer communities dominate in the canyon. Ponderosa pine and Orgeon white oak are the dominant tree species throughout the canyon. A plant association series for ponderosa pine - Oregon white oak needs to be done for the Klamath River Canyon since one currently does not exist. The northern portion of the Klamath River Canyon is more moist and densely forested than the southern portion of the canyon where it widens out and the forest opens up and becomes drier as rim elevation of the canyon drops from 3,900 to 3,400 ft.. Major plant communities in the canyon include mixed conifer forest, pine/juniper, pine/oak forest, oak forest, and oak/shrub. Meadows and riparian areas occur within the canyon, but are small and limited to specific sites and conditions. Limited areas of oak grasslands occur on slopes and benches.

Mixed conifer forest is found on the rim, in the canyon bottom, and on north-facing slopes of the upper canyon. Dominant overstory species include ponderosa pine, Douglas-fir, and Oregon white oak. Incense cedar, California black oak, sugar pine, golden chinquapin, and white fire occur less frequently in these stands. Dominant shrub species include snowberry, western serviceberry, mountain mahogany (*Cerocarpus* spp.), deerbrush (*Ceanothus integerrimus*), and Oregon grape. Common forbs include wild strawberry (*Fragaria* spp.) and lupine (*Lupinus* spp.). Common grasses include western fescue (*Festuca occidentalis*), pine bluegrass (*Poa scabrella*), blue wildrye (*Elymus glaucus*), and medusahead wildrye (*Taeniatherum caput-medusae*).

The pine/juniper community is found on drier, more exposed slopes in the upper canyon. Dominant overstory species are ponderosa pine and western juniper. Oregon white oak is uncommon but does occur. Understory shrub species include deerbrush, rabbitbrush (*Chrysothamnus* spp.), mountain mahogany, and occassionally gooseberry (*Ribes* spp.). Common forbs are buckwheat (*Eriogonum* spp.), common buttercup (*Ranunculus occidentalis*), pussytoes (*Antennaria* spp.), Nuttall's gayophytum (*Gayophytum nuttallii*), and Puget balsamroot (*Balsamorhiza deltoidea*). Common grasses include cheatgrass (*Bromus tectorum*), hairy brome (*Bromus commutatus*), medusahead wildrye, needlegrass, and pine bluegrass.

The pine/oak forest is found primarily in the lower canyon. Dominant overstory species include ponderosa pine and Oregon white oak. Incense cedar, Douglas-fir, and California black oak occur on moister sites. The understory varies with drier environments composed of wedgeleaf ceanothus and bitterbrush (*Purshia tridentata*). In moister environments, deerbrush, poison oak (*Rhus diversiloba*), snowberry, western serviceberry, and rabbitbrush dominate.

The oak forest community occurs throughout the canyon on dry slopes and in the river bottom. The dominant tree species is Oregon white oak. Associate tree species are ponderosa pine, western juniper, and California black oak. The understory varies and includes mountain mahogany, snowberry, wedgeleaf ceanothus, bitterbrush, rabbitbrush, deerbrush, and western serviceberry. Common forbs and grasses include Puget balsamroot, Idaho fescue (*Festuca idahoensis*), bluebunch wheatgrass (*Agropyron spicatum*), cheatgrass, bottlebrush squirreltail (*Sitanion hystrix*), junegrass (*Koeleria cristata*), needlegrass, and medusahead wildrye.

The oak/shrub community is found throughout the canyon on slopes and benches. Oregon white oak is the dominant tree species and can occur in the form of a small, shrub-like tree. Associate tree species include ponderosa pine, western juniper, Douglas-fir, and sugar pine. Understory vegetation varies. Common shrubs include mountain mahogany, wedgeleaf ceanothus, manzanita (*Arctostaphylos* spp.), poison oak, deerbrush, snowberry, and rabbitbrush. Forbs and grasses are well developed in open areas and include Puget balsamroot, mountain dandelion (*Agnoseris* spp.), yarrow (*Achillea millefolium*), Solomon-plume (*Smilacina* sp.), large-flowered collomia (*Collomia grandiflora*), wooly sunflower (*Eriophyllum lanatum*), buckwheat (*Eriogonum* sp.), and tarweed (*Madia* spp.). Common grasses include cheatgrass, bluebunch wheatgrass, needlegrass, hairy brome, two-flowered fescue (*Festuca reflexa*), pine bluegrass, and bottlebrush squirreltail.

Small meadows occur in the canyon along the river bottom and on benches, supporting a diverse array of forbs and grasses. Riparian communities occur along the river, in drainages along the canyon, and on the edges of islands in the river, supporting trees, shrubs, forbs, and grasses. Overstory species include Oregon white oak, birch (*Betula* spp.), white alder (*Alnus rhombifolia*), and Oregon ash (*Fraxinus latifolia*). Common shrubs include blue elderberry (*Sambucus cerulea*), Lewis mockorange (*Philadelphus lewisii*), willow (*Salix* spp.), Douglas spiraea (*Spiraea douglasii*), western wild grape (*Vitus california*). Common forbs include watercress (*Rorippa nasturtium-aquaticum*), monkey-flower (*Mimulus* spp.), speedwell (*Veronica* spp.), cattail (*Typha latifolia*), and boreal bog-orchid (*Habenaria dilatata*). Reed canary grass, sedges, and rushes are also present. Quaking aspen (*Populus tremuloides*) can also be found in drainages along the canyon.

Future Needs

A real need exists for systematic field sampling in the landscape analysis area to produce a plant community association classification that discerns the continuum of diverse and unique plant communites that occur across the landscape and the relative abundance of species that falls within each plant association. The BLM-Klamath Falls Resource Area is dependent for the present on fitting plant communities that occur within the analysis area into plant associations developed for areas and regions outside the analysis area (Hopkins 1979a, Hopkins 1979b). The result can be an artificial or forced fit that does not reflect with accuracy or precision the plant communites in the analysis area. A plant association guide specific to the analysis area and other BLM-administered lands in the Klamath Basin is needed. Such an effort would require an investment of human and financial resources, but the information gathered would provide for better decision-making regarding management of natural resources (plants, wildlife, water, range, and timber) that occur on BLM-administered lands.

Core Topic: Wildlife

Issue: Critical use areas for terrestrial listed and non-listed wildlife have been altered.

Key Questions: How has habitat been changed by management practices? What have been the habitat changes?

Two principal vegetation communities (ponderosa pine and mixed conifer) and a range of seral stages occurs throughout the area, providing habitat for a variety of both specialist and generalist species. In general, the occurrence and persistence of species associated with old growth areas increases as patch size and connectivity of patches increases. These species are primarily associated with interior habitat of one seral or structural stage. Refer to the landscape ecology core topic and Appendix B for more information.

Timber Harvest. Historically, dominant tree species within the landscape area were ponderosa pine and Douglas fir, with scattered stands of white fir. However, past timber management practices have resulted in increased numbers and densities of white fir. Although forest openings are within the natural size and percentage range for disturbance in the area, they are the result of timber harvest instead of wildfire. Natural fires cause patchiness and diversity of habitat while recent logging has caused more uniformity. Differences between burned and logged stands may have an effect on wildlife using them.

Fires. Natural fire and/or fire suppression has shaped many of the vegetative communities in the landscape area. Historically, in ponderosa pine forests in this area fire returned in intervals of eight to ten years. Also, fires maintained large oaks which produced larger crops of mast. Fire suppression has caused oak to intrude into some areas resulting in smaller "stemy" trees, and has allowed vegetation on scrub rock flats to become decadent. Refer to the fire ecology section for more information.

Water. Historically natural water sources were scarce in the uplands, limiting the use of those areas by some wildlife species. Water sources (guzzlers) have been developed in the last few decades, primarily for the benefit of big game species. These have also expanded the area available to many non-game wildlife species. Other water sources developed for fire protection, road watering and grazing management are also being used by wildlife.

In a joint effort between BLM and Oregon Department of Fish and Wildlife, seven water developments have been installed on BLM land, enhancing habitat and expanding distribution of big game, wild turkey and many other non-game species (see Table 16). For additional information refer to the Livestock Grazing core topic.

Roads. In the landscape area on BLM administered lands only, there is an average of 3.9 miles of road per section. Within the entire landscape area the miles of roads per section is believed to be significantly higher. Roads affect wildlife and wildlife habitat by: 1) removing potential foraging and cover areas; 2) creating edges and linear openings allowing species normally associated with openings access to interior forest stands; and 3) causing direct loss and disturbance by providing easier and more widespread access to hunters, poachers, recreationists and others such as mushroom harvesters and firewood cutters.

Livestock Grazing. Historic grazing practices competed with wildlife for vegetation. With recent reductions in numbers of animal unit months and season-of-use, competition between wildlife and livestock has decreased. For more information refer to the Livestock Grazing core topic.

Table 16. Wildlife Water Developments in the Landscape Analysis Area			
Development	**Location**	**Year Developed**	**Comments**
Grizzly Butte guzzler	T. 41N, R. 6E, section 4	1972	fenced
Fox Lake cistern	T. 41N, R. 6E, section 6	1974	fenced
Parker Mountain guzzler	T. 40N, R. 5E, section 7	1989	fenced
Hayden Mountain	T. 40N, R. 6E section 16	1993	fenced 1994
Mud Springs Mountain	T. 40N, R. 5E section 34	1993	fenced 1994
Grenada (Chicken Hills) guzzler	T. 41N, R. 7E, section 5	1993	A livestock exclusion fence was built in 1994. Guzzler receiving high levels of wildlife use, especially elk.
North Chicken Hills	T. 40N, R. 7E section 20	1994	no fence (no grazing in vicinity)

Key Question: What are the species of concern, their life history characteristics, and how has habitat alterations affected these species?

Species that may have been present in the past, but were extirpated from this area, include grizzly bear, gray wolf, lynx, wolverine, fisher, bighorn sheep, and possibly California condor. Other species, like elk and bald eagle, were greatly reduced but have since increased in population numbers. There have been several new species introduced to this area since Euroamerican settlement, including starlings, house sparrows, Norway rats, house mice, elk, chukars and turkey.

Special Status Species and Species of Concern

The following species which occur in the landscape area, were selected for analysis because they are protected under the Endangered Species Act of 1973, as amended, require protection buffers under the Northwest Forest Plan (NFP), or have high social value such as deer and elk.

Bald Eagle

(Haliaeetus leucocephalus) Federal status: Threatened

Bald eagles within the inland Pacific Northwest are found in close association with lakes, reservoirs, rivers, or large streams providing abundant prey and suitable nesting and roosting habitat (Anthony et al. 1982; Lehman 1979). Nests are usually located in uneven-aged (multistoried) stands exhibiting old growth characteristics (Anthony et al. 1982), and generally the largest or codominant ponderosa pine, sugar pine and Douglas fir are the most frequently used nesting and roosting trees in these stands.

Bald eagles feed primarily on fish during the spring and summer but may shift to waterfowl and carrion in the winter. The biggest change in the prey base has been the loss of anadromous fish runs in portions of the Klamath River (Spencer Creek Watershed Analysis 1995).

Historic conditions in today's mixed conifer zones within the landscape area were likely suitable for bald eagles, especially areas in proximity to the Klamath River. The number of suitable nest and roost trees has declined due to timber harvest and fire management practices over the last 100 years. This has included selectively cutting large, dominate trees like ponderosa pine, effectively altering successional patterns (Emmingham et al. 1992). The encroachment of white fir has impacted eagle populations by: 1) providing poor nesting and roosting habitat due to the characteristic branching and crown structure of white fir; 2) precluding regeneration of preferred tree species in open canopy stands for nesting and roosting through fire suppression; and 3) reducing the amount of multi-story habitat upon which eagles depend. Eagles also vary in their tolerance of roads during nesting season.

The landscape area lies within the Klamath Basin Recovery Zone under the Pacific Bald Eagle Recovery Plan and the Klamath River has been identified as a "Key Area" for which target recovery territory goals have been set. Recovery Plan goals include evaluating and managing lands for existing and potential nesting and foraging habitat, and protecting roosts by maintaining their integrity and securing them through purchase or cooperative agreement. Within the landscape area, recovery goals have been exceeded, due to the establishment of the Bear Valley Wildlife Refuge in the late 1970s and the increased habitat protection effort from Weyerhaeuser and J.C. Boyle of Pacific Power and Light.

Historically there was a nest site at Dorris Hill, located in the extreme southeast portion of the landscape area. This nest has not been occupied since 1985. Today, there are five nest territories with 11 known nests in the landscape area. Since 1990, the Klamath Canyon nest has produced 12 young, the Chicken Hills nest - eight young, and the Chase Mountain nest - three young. Since 1992, Bear Valley nest has produced five young. In 1995, a new nest territory on Hamaker Mountain was discovered which produced one young. May 1996, a new nest was found on the southern boundary of the landscape area. Refer to Table 17 for additional information on nest sites.

Northern Spotted Owl

(Strix occidentalis caurina) Federal status: Threatened

Northern spotted owls (spotted owls) likely inhabited the shasta red fir/white fir plant community within the shasta red fir zone where the presence of large diameter ponderosa pine, sugar pine, and Douglas fir trees existed. Patches or stringers of mixed conifer provided canopy closure and the prey base necessary for their survival. Spotted owls may have also been present in those white fir zones in which periodic fires common in the landscape area did not reach.

Mature and old growth forests are preferred nesting and roosting habitats (Forsman 1980, Marcot and Gardetto 1980) although spotted owls are known to roost during the day in hardwood and second growth stands, in association with stands of old growth (BLM 1994a). Nesting and roosting habitats in the landscape area consist of mixed conifer dominated by Douglas fir with greater than 60 percent canopy closure.

Spotted owls seldom forage in clearcuts or second growth stands younger than 60 years, instead preferring old growth (Forsman et al. 1984, 1987; Solis 1983) which typically has an abundance of prey and habitat with structural features favorable for foraging (Carey et al. 1986a, Forsman et al. 1984, Raphael and Barrett 1984, and Raphael et al. 1986). This habitat must be capable of supporting small mammals such as the bushy-tailed woodrat, red tree vole, flying squirrel, snowshoe hare, deer mouse, western red-backed vole or other prey under closed canopied areas.

Past timber harvest within the mixed conifer zone caused removal of large diameter trees suitable for spotted owl nesting. Based on surveys conducted from 1990 through 1995, five of the six nest sites documented in the landscape area are still active; the sixth site is entirely on private lands along the extreme west boundary of the landscape area and nesting was last successful in 1992. All activity centers were located prior to January 1, 1994, and those on BLM-administered lands are protected by 100-acre no-cut buffers (Northwest Forest Plan 1994). The Dixie site, which is on private lands, has a 43-acre BLM buffer; the Hayden site, also on private lands, does not have a BLM buffer. Habitat surveys in three of the five active sites have documented mixed conifer/Douglas

Table 17. Bald Eagle Nest Sites Within the Landscape Area			
Nest site	**Land Status**	**Discovery**	**Year/young**
Klamath Canyon	private/BLM	1979	1990 /1 1991 /3 1992 /2 1993 /2 1994 /2 1995 /2
Chase Mountain	BLM	1979	1990 /uk 1991 /ud 1993 /1 1994 /f 1995 /2
Chicken Hills	FWS	1971	1990 /1 1991 /2 1992 /uk 1993 /1 1994 /2 1995 /2
Hamaker Mtn.	FWS	1995	1995 /1
Bear Valley	FWS	1992	1992 /1 1993 /1 1994 /1 1995 /2
(New active nest)		1996	(More information is needed)
(Isaacs 1995) uk- unknown ud- undetermined f- failed			

fir-dominant forests in the stem-exclusion stage of growth (20 to 60 years). A fourth site is in mixed conifer also in the stem-exclusion stage but in association with old growth, and the fifth site in a true fir mature or understory reinitiation stage of growth (60 to 150 years). Refer to Table 18 for information on nest sites.

In addition to the 100-acre buffers (Northwest Forest Plan 1994), protected habitat area buffers (PHABs) comprising suitable habitat, have been reserved in the vicinity of the activity centers. Portions of these buffers may be cut at the rate of five percent each decade provided old growth characteristics are maintained (habitat will continue to remain suitable for nesting, roosting and foraging).

The landscape area has and continues to provide connectivity (dispersal habitat) for spotted owls moving between late successional reserves (LSRs) located in northern California approximately five miles south of the landscape area, and those to the west and north approximately eight miles and ten miles respectively of the landscape area. Dispersal habitat for the landscape area is defined in terms of the 50-11-40 rule where 50 percent or each quarter township has trees greater than 11 inches diameter at breast height (dbh) and 40 percent canopy closure. Although the Northwest Forest Plan (1994) does not specifically require use of the 50-11-40 rule in maintaining connectivity between LSRs, this measurement, as described by Thomas et al. (1990) is useful in assessing dispersal and connectivity habitat in the matrix. The 50-11-40 rule is assessed for each quarter township within the landscape area.

In the landscape area three one-quarter townships on BLM do not meet dispersal habitat and probably never will. The average home range size for spotted owls in the Eastern Cascades Province is 1.2 mile radius activity center. The Service has endorsed recommendations to provide a minimum of 50 percent suitable habitat within a 0.7 mile radius (500 acres) and a minimum of 40percent suitable habitat within a 1.2 mile radius (1182 acres).

Table 18. Survey Information for Northern Spotted Owls

Nest Site	Land Status	Discovery	Year/young	Habitat	Habitat within 1.2 miles on BLM lands[1]
Dixie	private	1990	1990/ud 1991/2 1992/2 1993/nn 1994/nn 1995/2	mixed conifer 40-60% canopy Stem exclusion stage (20-60 yrs) elevation	280 acres suitable habitat 43 acre activity center 97 acre PHAB
Hayden Creek	private/BLM	1991	1991/2 1992/2 1993/2 1994/3 1995/2	mixed conifer 40-60% canopy Late stem exclusion stage elevation	60 acres suitable habitat 0 acre activity center
Long Prairie	BLM	1990	1990/nd 1991/1 1992/nn 1993/nd 1994/nr 1995/ud	mixed conifer >60% canopy Late stem exclusion stage elevation	237 acres suitable habitat 120 acre activity center 33 acre PHAB
Parker Mountain	private	1990	1990/nd 1991/ud 1992/2 1993/nn 1994/ud 1995/nr	No information	

Table 18. Survey Information for Northern Spotted Owls

Buck Mountain	BLM	1985	1990/fn 1991/nn 1992/nn 1993/nr 1994/nr 1995/ud	true fir >60% canopy mature understory reinitiation stage elevation	692 acres suitable habitat 116 acre activity center 176 acre PHAB
Topsy	private	1990	1990 1991/1 1992/2 1993/nn 1994/ud 1995/2	mixed conifer 40-60% canopy Stem exclusion to old growth elevation	539 acres 359 acre activity center 110 acre PHAB

Information from Beak Consultants survey & BLM nn = did not nest during the year
fn = failed nest nr = no response to survey
nd = no data available ud = reproductive status undetermined
[1] acres- suitable nesting, foraging and roosting habitat for northern spotted owl on BLM land
activity center - required 100 acre suitable nesting, foraging and roosting habitat buffer on BLM land (Northwest Forest Plan 1994)
PHAB - protected habitat area buffer where five percent excessive volume may be harvested every decade with the management goal to sustain old growth characteristics

Northern Goshawk

(*Accipiter gentilis*) - Federal status: none Other status: Oregon critical

Goshawk habitat has decreased slightly since the 1940s, primarily a result of logging which reduced the number of large, mature and old growth ponderosa pine stands (Klamath Ranger District 1996). Impacts from roads and off-highway vehicle management, and acres available for timber harvest could have also reduced suitable habitat. Roads and off-highway recreational vehicle use may have caused disturbance near nesting and foraging sites. Allocations that could have positive effects include riparian buffers to enhance habitat for the prey base, and high snag and old growth and mature retention levels which would provide nesting, foraging, and perch sites.

This species prefers mature (understory reinitiation stage) and old growth conifer forests (BLM 1994a) with a 40 to 60 percent canopy cover created by tall trees for nesting habitat. Today, suitable habitat may be found in the mixed conifer zone of the landscape area, where sufficiently large intact stands occur within one-half mile of a perennial water source (Hamilton 1996, pers. comm.). Most of the suitable habitat on BLM and Weyerhaeuser lands have been surveyed for goshawks, and two nest sites have been reported. The nests, both on Weyerhaeuser lands, are closely tied to spotted owl habitat.

Dixie. This site is in the southwest portion of the landscape area in close proximity to the Dixie and Hayden spotted owl nest sites. The nest was first located in June 1992 and nesting has been successful through 1995. In 1992, 1 young was produced; in 1993 - 2 fledged; in 1994 - 3 fledged; and in 1995 - 1 fledged.

Parker Mountain. This site is in the extreme western portion of the landscape area. Nested in 1992.

Bats, including Townsend's Big Eared Bat

(*Plecotus townsendii*) - Federal status: none Other status: Oregon Sensitive, California Threatened

Suitable habitat for many different bats exists within the landscape area, but only the following seven species and one subspecies have been documented.

Townsend's big-eared bat	*Plecotus townsendii*
Western Pacific big-eared bat	*P. townsendii townsendii*
Long-eared myotis	*Myotis evotis*
Long-legged myotis	*M. volans*
California myotis	*M. californicus*
Little brown myotis	*M. lucifugus*
Yuma myotis	*M. yumanensis*
Big brown myotis	*Eptesicus fuscus*

Of these species the long-eared myotis (*Myotis evotis*) and long-legged myotis (*Myotis volans*) are specifically targeted in the standards and guidelines of the Northwest Forest Plan (Cross 1995). The pallid bat (*Antrozous pallidus*), fringed myotis (*Myotis thysanodes*), hoary bat (*Lasiurus cinereus*), Keen's myotis (*Myotis keenii)* and silver-haired bat (*Lasionycteris noctivagans*) were also listed in the Northwest Forest Plan and may potentiallly occur in the landscape area.

Feeding activity over ponds and streams and in adjacent riparian habitat have been described for several species, including the California, long-eared, little brown, and silver-haired bats (Anthony and Kunz 1977; Bell 1980; Cross 1976; Kunz 1973; O'Farreil and Bradley 1970, cited in Thomas and West 1991). In Oregon, the feeding rates of *Myotis* spp. were found to be more than ten times higher over ponds and streams than in forests (Thomas and West 1991). According to Donna Howell (pers. comm 1995) all bats will take advantage of insect hatches associated with riparian, wetland, and aquatic habitats at some time during their life cycle.

Townsend's big-eared bats. Townsend's big-eared bats have been widely distributed in western North America and Oregon. Caves, wooden bridges and abandoned buildings are extremely important roost and hibernation sites for this species. Adequate numbers of large snags and green trees are also critical for use as maternity roosts, temporary night roosts, day roosts, and hibernacula (Barbour and Davis 1969, Kunz 1982, Rainey et al. 1992), which provide much needed thermal stability. Large snags and green trees should be well distributed throughout the landscape area because bats compete with primary excavators and other cavity-dependent species. Cave roosts and hibernacula sites are selected because temperature and humidity remains constant over time. Although this species does not migrate, they do move from one roost to another as temperature and weather conditions change. While some bats remain active year-round, those that hibernate do so in moderately large colonies. Females hibernate more continuously than do males. Males are generally solitary in spring and summer but do hibernate in colonies (OSIS 1994).

Nursery colonies are formed in spring and begin to disband in August. The maternity colony is made up of an adult female and her young which are born around the first of August. Mid- to late-July is the most appropriate time to determine if a site is used. Females who lose their young are the first to depart the site followed by lactating females. Young can fly when about three weeks old but are still dependent upon the mother and do not leave the maternity site with the adults until six weeks old (Pearson et al. 1952).

Townsend's big-eared bats emerge and forage only after dark. Flying insects, especially moths, compose the majority of their diet, along with some beetles and other soft bodied insects. Foraging densities are approximately 310 to 419 acres per bat (OSIS 1994).

The population of Townsend's big-eared bats wintering in western Oregon seems particularly depleted (Perkins 1987). A study was conducted within the landscape area where bats were netted at ponds which were developed to provide water for livestock and/or wildlife (Cross 1994). Currently, many of these ponds and springs in the landscape area are trampled by livestock. The changes in plant diversity and the increased sediment and nutrient loading at these sites could affect the insect prey base available to the bats. This in turn could have an affect on the population of bats in the area.

Townsend's big-eared bats are especially intolerant of disturbance of maternity colonies and hibernacula by humans. Entire colonies may move, which can cause increased mortality.

Inventories conducted in 1977 for Townsend's big-eared bat revealed no evidence of this species in Klamath County (Cross 1977). Then in 1988, a maternity colony was discovered in the Salt Caves in Klamath River Canyon. In the summer of 1989, Dr. Steve Cross initiated a monitoring study on this population to determine the species and numbers of bats in the cave as related to numbers at a control site. The results showed a decrease in the maternity colony population over the course of the study. The maternity colony has been subjected to heavy disturbance in the past from people accessing the caves during the breeding and rearing period from May through late August. Cross's studies also found a few bats use the caves as winter hibernaculum, and at least five other bat species use the caves (*Myotis* yumanensis, *M. californicus*, *M. lucifugus*, *Eptesicus fuscus*, *Plecotus townsendii*). Additional studies have shown small numbers of Townsend's big-eared bats use old buildings for roosting.

With a seasonal closure in place and rafting outfitters aware of the sensitivity of the bats, hopefully this will change the level of activity in the cave.

Resource allocations and management activities that could have negative effects by causing disturbance near the known sites include: off-highway vehicle management and mineral exploration and development. Riparian buffers and special habitat feature buffers could have positive effects by protecting the site from disturbance. Timber harvest, mineral exploration and development, or other actions around active sites could result in alterations of the air flow into the caves, and /or cause noise related disturbance that could reduce the suitability of a site either as a summer roost and nursery colony or for winter hibernation. In addition new road construction and increased water activities could increase the chances that human disturbance would also interfere with the bats' use of these sites (BLM 1994a).

Deer, black-tailed and mule

(*Odocoileus hemionus columbianus, O. hemionus heminous*) - Federal status: none Other status: none

Optimal habitat for black-tailed deer is a mix of forest openings and shrublands that provide both forage and forest cover for protection from adverse weather or disturbance (Witmer et al. 1985, in City of Klamath Falls 1986). Forage areas near cover are preferred because animals can quickly escape predators or harassment. Habitat requirements for deer differ seasonally, dictated by physiological changes and changes in forage quality and climatic conditions. Around November when winter weather conditions develop, deer move into their winter range (see Map 6). Migratory mule and black-tailed deer generally use higher elevation winter range when weather conditions are mild and low-elevation, south-facing slopes only during extended periods of severe weather (Loveless 1964; Wallmo and Gill 1971; Hanley 1984; Loft et al. 1984; Schoen and Kirchoff 1985, in City of Klamath Falls 1986). As weather conditions continue to change towards March, deer migrate to summer range. During summer, migratory populations occupy energy-rich, high-elevation sites, moving again to nutritionally poorer winter ranges as winter snow cover becomes excessive.

Cover is required by black-tailed deer to avoid disturbance or predation, and for protection from adverse weather. Hiding cover is represented by vegetation capable of obscuring 90 percent of a standing adult deer at 200 feet or less, making small trees up to six feet tall very important. Thermal cover is provided on winter range by evergreen trees and shrubs at least five feet tall with 70 percent or more crown cover; on spring, summer, and fall ranges, deciduous trees and shrubs also provide thermal cover (Thomas 1979; Witmer et al. 1985, in City of Klamath Falls 1986). Sufficient hiding cover is present in the mosaic of cover types found in the Klamath River Canyon. Optimal winter thermal cover may be limited to mixed conifer forest and pine/oak forests, although some pine/ juniper, oak shrub and steppe stands may provide marginal thermal cover. The pine/oak cover type has been used extensively by deer throughout the winter for both food and thermal cover. During severe winters deer tend to concentrate in oakscrub/ steppe elevations. As the weather changes deer tend to use oak shrub and meadow cover types where extensive greenup of vegetation has occurred. Also, scab-rock flats are very important in March-April when the new grasses and forbs are out. Bed sites have been identified under ponderosa pine, Douglas fir and juniper trees. Protection from adverse weather is also provided by topography. Areas near the Klamath River Canyon rim receiving extensive solar radiation and south-facing slopes offer thermal benefits to wintering deer populations (Loveless 1964; Hanley 1984, in City of Klamath Falls 1986).

Fawning areas for black-tailed deer typically have warm exposures, gentle slopes, low woody vegetation, dense ground cover two to three feet in height, and succulent forage and water within 600 feet. (Lemos and Hines 1974, Hines 1975, Black et al. 1976, in City of Klamath Falls 1986).

The diet of black-tailed deer on winter range is predominately browse, particularly when snow is present. When the weather is mild, a moderate amount of grasses and forbs is selected (Leach 1956; Crouch 1981; Hanley and McKendrick 1985, in City of Klamath Falls 1986). The most abundant food in the landscape area is wedgeleaf ceanothus (*Ceanothus cuneatus*) (BLM 1983; Opp 1984, pers. comm., in City of Klamath Falls 1986). Other shrubs and trees consumed in large amounts include deerbrush (*C. integerrimus*), glossy-leaf (*Ceanothus velutinus*), incense cedar (*Libocedrus decurrens)*, Douglas fir (*Pseudotsuga menziesii*) and western juniper *(Juniperus occidentalis*) (Opp 1984, pers. comm.; unpublished data from BLM Medford District Office, in City of Klamath Falls, Oregon 1986). Extensive browsing is also evident on bitterbrush (*Purshia tridentata*); mountain and birch-leaf mahogany (*Cercocarpus spp*). Acorns and foliage of Oregon white oak (*Quercus garreyana*) with lesser California black oak (*Quercus kelloggii)*, has been utilized extensively by deer.

Critical black-tailed deer winter habitat is often reported to be in poor range conditions, usually a result of past land-use practices (Wallmo and Gill 1971; Carpenter and Wallmo 1981, in City of Klamath Falls 1986). The changes in the distribution of forage and effective cover for big game is the result of timber harvest, fire suppression, high road density, and forage competition with livestock and wild horses. Shrub stands in the Klamath River Canyon have been heavily browsed, are decadent and show little sign of regeneration. Exotic weedy annuals have dominated the herbaceous understory, displacing native species. Plant communities within the Klamath River Canyon appeared to be in poor range condition which may explain why during the winter deer apparently preferred communities outside of the canyon when climatic conditions were mild enough to exploit them.

The high density of roads in the watershed is believed to be tied to deer losses resulting from poaching and harassment. Mountain lions and coyotes are also believed to be having an impact on the deer herd.

Black-tailed deer are the dominant sub-species between Medford and Klamath Falls, Oregon, although some hybridization with mule deer has occurred (Waterbury 1994, pers. comm.). The ODFW population trend estimates in the 1960s and early 1970s indicate that deer were more abundant in the past. The estimates in the late 1970s and early 1980s were lower. The winter snowfall of 1992/93 was hard on the deer population. It is estimated that forty percent of the deer population was lost to the severe winter. The management goal set by ODFW for the deer herd in the Keno Unit, which includes the landscape area, is 3,200 animals (Waterbury 1996, pers. comm.) and it is estimated that 2,500 deer currently use this area for their winter range.

In February 1991 the BLM, PP&L, ODFW and Weyerhaeuser developed the Pokegama cooperative habitat project. This project was designed to: 1) improve management of the Pokegama big game winter range; 2) improve winter range habitat effectiveness for elk, deer, wild turkey and other wildlife; and 3) reduce illegal take and harassment of wildlife on critical winter ranges, and protect other resources (reduce road damage, soil erosion, timber theft and vandalism). To meet these objectives (see Map 5) an annual seasonal motorized vehicle closure was implemented from November 20 through mid-April, which also significantly reduced deer poaching (Waterbury 1996, pers. comm.). The area remains open to foot and non-motorized traffic during the closure period.

Elk

(*Cervus elaphus*) - Federal status: none   Other status: none

Early conifer plantations are excellent forage areas for elk, as are wet meadows and vegetation associated with springs and seeps, especially during the spring and summer. As plantations age (5 to 20 years old), become overstocked and dense they provide excellent hiding cover for elk (Waterbury 1996, pers. comm.). During calving season (May to June) it is important that elk find gently sloping hiding cover adjacent to forage and away from roads, and in area with dead and down material. Johnson Prairie is a very important calving site is Grouse Butte (Waterbury 1996, pers. comm.). Elk winter in drainages at elevations between 3,500 and 4,500 feet. Elk are extremely sensitive to roads, and in areas where the road densities are 2.5 miles per square mile, habitat effectiveness drops to 50 percent (Waterbury 1996, pers. comm.).

Logging practices have created more forage for elk than probably existed in the past. Even though there appears to be a lack of cover in the clearcuts, elk seem to be utilizing this source of forage. Elk have successfully taken advantage of the existing cover patches in heavily roaded areas as evidenced by low to moderate hunting success (Waterbury 1994, pers. comm.). Due to the high density of roads in the landscape area, in the winter elk are known to use roads for travel, bedding, and foraging along in the closure area (Waterbury 1996, pers. comm.). It is not believed that poaching of elk is a significant cause of mortality especially with the winter road closure (Waterbury 1996, pers. comm.).

Elk were first spotted about 20 years ago in the South Keno Management Unit east of the Cascades, which is a part of the landscape area. Today, the elk found in the landscape area are mostly Roosevelt elk, although some hybridization with Rocky Mountain elk may have occurred due to their introduction into Crater Lake National Park during the 1920s. Elk have probably moved into the area partially in response to favorable forage to cover ratios resulting from clearcut timber harvest prescriptions (Waterbury 1994, pers. comm.). A resident herd of about 450 elk has become established on the east side of the Cascades north of the Klamath River (Waterbury 1996, pers. comm.), and is referred to as the South Cascades Herd.

Federal and state agencies, conservation groups and private companies within the area are funding a Keno Unit Elk Telemetry study which began in 1994. To date, 20 elk have been fitted with radio collars. The objectives for this study are to determine year-round herd range and distribution and general use of habitat in the south Keno management unit. Data collected from the study has demonstrated interstate and inter-unit movement, has located summer ranges in Johnson Prairie, Long Prairie Creek, Mountain Lakes Wilderness and Aspen Lake, and has located winter ranges in Long Prairie Creek, Grenada Butte area, Jenny Creek and Emigrant Lake. Also, in February and March there is a large concentration in the Rosebud Mountain area. The Grizzly Mountain area has been determined to be an important summer thermal cover area (Waterbury 1996, pers. comm.).

The numbers of elk continues to expand and are expected to reach population goals for 700 animals by the year 2000. Once the herd reaches this number, intensive management is proposed by ODFW. Provided the number of elk does not exceed 700, it is believed there would be no direct conflicts for forage or cover between livestock, wild horses, deer, and in the overall health of riparian areas. There is potential for competition between deer and elk for fawning and calving habitat due to the limited number of mesic sites next to good cover. Elk are more adaptable and would probably out compete deer (Waterbury, pers. comm. 1994).

Protection Buffer Species

Great Gray Owl

(Strix nebulosa) - Federal status: none Other status: Protection Buffer species (NFP)

In south-central Oregon, great gray owls were located in old growth (45 sites) or mature (18 sites) stands characterized by areas of fairly dense forest in relatively large overstory trees with at least two canopy layers. Within the range of the northern Spotted Owl, the great gray owl is most common in lodgepole pine forests adjacent to meadows. Nest sites were located in lodgepole pine, lodgepole and ponderosa pine mix, or mixed conifer (Bryan and Forsman 1987) adjacent to meadows (Northwest Forest Plan, 1994). Ninety-five percent of 63 nest studied by Bryan and Forsman (1987) were in forests less than 0.3 kilometers from meadows with an average distance between the nest site and meadows of 275 meters and the maximum distance of 750 meters (Bryan and Forsman 1987). Great gray owls do not build their own nests, depending instead on cavities or nests built by hawks. Home ranges are very large, measured in miles, and juveniles travel many miles when they leave the nest. According to studies by Winter (1982), the home range size of great gray owls varies from 372 acres to 753 acres, and averages 593 acres.

Foraging occurs mainly in deep-soiled meadows or open forest stands, including partially-logged stands with canopy closures up to about 60 percent and heavy ground cover (average 88 percent) dominated by grasses (Bryan and Forsman 1987; Bull and Henjum 1990). Meadow size ranges from 15 acres to over 247 acres. All meadows were relatively wet during the early spring and many had grasses and herbaceous vegetation (Bryan and Forsman 1987). Optimum habitat is created by narrow or undulating meadows with maximum forest edge relative to the meadow (Winter 1982).

The diet of great gray owls consists pocket gophers, northern flying squirrels and red squirrels (Marshall 1992), but is dominated by voles (Hayward and Verner 1994). Microtine voles generally occupy moist grass/sedge openings and open herbaceous forests, whereas pocket gophers prefer drier meadows (Anderson 1987; Chase et al. 1982, cited in Hayward and Verner 1994). Food supply is believed to regulate the abundance of great gray owls across much of their range. When prey is scarce, many individuals abandon their breeding range. Winter (1982) maintains that the breeding success of the great gray owl is tied to the cycles of the vole prey base which forms a major part of their diet.

Historic logging in the landscape area has effectiely reduced the timbered acres adjacent to meadows to the point where very little suitable nesting and roosting habitat remains today. Great gray owls have not been located in the landscape area although some potential habitat exixts around Edge Creek, Hayden Creek, and Long Prairie meadows. Surveys will be conducted to determine the presence of great grey owls prior to implementing most land management activities.

White-headed woodpecker

(Picoides albolarvatus) - Federal status: none Other status: State Sensitive, Bureau Assessment species and Protection Buffer species

White-headed woodpeckers prefer open-canopied stands of mature and older ponderosa pine and, to a lesser degree, mixed ponderosa pine and Douglas fir (Weber and Cannings 1976; Cooper 1969; Burleigh 1972; Ligon 1973, cited in Blair 1993; Frederick and Moore 1991). Sugar pine, and red and white fir forests have been reported to provide secondary habitat (Scott et al. 1977, cited in Blair 1993). Home range sizes vary depending upon the quality and fragmentation of the preferred habitat, and range from an average of 261 acres in good habitat to 1,100 acres in fragmented habitat (Rita Dixon, pers. comm., cited in Blair 1993). Two radio-tagged birds had home ranges of 250 acres and 500 acres, respectively (Marshall 1992).

Snags near openings are preferred nesting sites, and 26 inches dbh are the average sized trees in Oregon (Dixon, pers comm. 1993 in Blair 1993), although trees with 18 inches dbh have also been selected (Marshall 1992). Reports on tree size for foraging indicate that pines (primarily ponderosa pine) greater than 20 inches dbh are used (Marshall 1992). Thes trees, which do not produce heavy seed crops until 60 to 100 years of age (Spencer Creek Pilot Watershed Analysis 1995c), provide up to 60 percent of the woodpeckers' annual diet. Most nesting and foraging occurs on the lower 15 feet of the trees. Milne and Hejl (1989) as cited in Blair (1993) reported local breeding territories in the Sierra Nevada to be about 24 acres in size.

It is assumed that the white-headed woodpecker was fairly common in the TPLA area because of the hitoric distribution of ponderosa pine. However, intense logging in the 1940s left the landscape area with fewer large ponderosa pine and douglas fir. Surveys have not been conducted in the area for the white-headed woodpecker, but there have been sightings.

Flammulated Owl

(Otus flammeolus) - Federal status: none Other status: Protection Buffer species

The flammulated owl occurs mostly in mid-elevation ponderosa pine and douglas fir forests, but they will also utilize very dry submontane interior Douglas fir stands that are more open due to selective logging (Hayward and Verner 1994). A significant selection for mostly open patches of old ponderosa pine/Douglas fir and avoidance of patches of both young conifer and mature aspen vegetation was shown by Linkhart 1984; Reynolds and Linkhart 1992, cited in Hayward and Verner 1994. This preference for ponderosa pine and/or Douglas fir has been linked to prey availability of lepidopteran species (moth and butterfly) associated with these forests (Reynolds and Linkhart 1992, cited in Hayward and Verner 1994).

Flammulated owls are secondary cavity-nesters and use cavities in snags and live trees. The preferred cavities for nesting in Oregon are those excavated by the pileated woodpecker (Bull et al. 1990, cited in Hayward and Verner 1994). In northeast Oregon, a study of habitat structure and nest-tree characteristics indicated habitat on ridges, upper slopes, south and east slopes was generally selected (Bull et al. 1990, cited in Hayward and Verner 1994). Two studies in Oregon indicated an average minimum nest tree diameter of 22 and 28 inches (Goggans 1986 and Bull et al. 1990, cited in Hayward and Verner 1994). In northeast Oregon, nest tree sizes were 12 to 23 inches dbh and 80 percent of the nests were located near a forest opening. The study area contained one breeding pair per 210 acres. Average home range size during the breeding season ranges from 39 acres during incubation to 9 acres during the fledgling period (Goggans 1986, cited in Hayward and Verner 1994).

Dense conifer stands are used for roosting by this species (Marshall, 1992). In contrast to foraging and nesting habitat, preferred roosting habitat appears to be dense vegetation. In one Oregon study, these owls roosted disproportionately in multilayered, mixed-conifer forest with a ponderosa pine component (Goggans 1986, cited in Hayward and Verner 1994). Pure ponderosa pine stands were avoided, although they strongly selected ponderosa pines for roost trees within mixed conifer stands. In Oregon, mean distances from roosts to nests ranged from 27 yards to less than 109 yards depending upon the stage of the nestlings.

Intense logging in the 1940s left the landscape area with fewer large ponderosa pine and douglas fir. Systematic surveys have not been conducted for the flammulated owl; however, during northern spotted owl surveys conducted by the USFWS, one flammulated owl was located in the landscape area.

Pygmy Nuthatch

(Sitta pygmaea) - Federal status: none Other status: State Sensitive, Bureau Assessment species, Protection Buffer species

Pygmy nuthatches use habitat very similar to those of white-headed woodpeckers, consisting of uneven-aged ponderosa pine forests with medium to large sized trees for nesting, roosting and foraging, although they will forage in younger trees (Marshall 1992). Nuthatches prefer large broken-topped snags with a minimum of 60 percent bark which are at least 24 inches dbh for nesting and feeding (Marshall 1992). Very limited information is available on preferred canopy closure levels, however, in a study of preferred habitats in Arizona, canopy closure was usually less than 50 percent (Cunningham et al. 1980, cited in Chapel et al. 1992).

They excavate their own cavities at least 20 feet above ground in trees usually exceeding 20 inches dbh. Flocks of 100 or more birds may roost together in a single, large cavity. These roosts may be important for winter survival. The breeding territories size are about 5 acres in size. Foraging can occur in young or old ponderosa pines (Marshall 1992)

Based on the habitat needs of the pygmy nuthatch, the characteristics of the historic ponderosa pine forests in the landscape area appear as though they would have met the needs of this species. But no surveys have been conducted in the past. No surveys have been conducted in the past.

Core Topic: Hydrology

Issue: Hydrology has been altered in the TPLA area.

Key Question: What are the dominant hydrologic characteristics and other notable hydrologic features and processes in the TPLA area?

Overview

The Topsy-Pokegama Landscape Analysis (TPLA) area is 171,390 acres in size and is entirely located in the Klamath River Basin. The source of the Klamath River is Upper Klamath Lake via the Link River and Lake Ewauna at the city of Klamath Falls. The river flows generally in a southwesterly direction for a distance of approximately 260 miles through northern California before discharging into the Pacific Ocean (FERC 1990). The portion of the Klamath River included in the analysis area (about 25 miles) lies between two existing hydroelectric projects: the J.C. Boyle Project at river mile 225 and the Copco Project at river mile 200. Hydroelectric peaking operations at J.C. Boyle result in a large diurnal fluctuation in streamflow through this section of river. Flow is further regulated by controlled storage in Upper Klamath Lake, where irrigation diversion and additional hydroelectric generation occurs (FERC 1990). The watershed area above the J.C. Boyle powerplant is approximately 4,080 square miles (USGS 1990).

For purposes of this landscape analysis, three subwatersheds within the TPLA area were selected to assess hydrologic condition. Excluding the Klamath River, these subwatersheds contain the primary streams in the TPLA area: Long Prairie Creek, Edge Creek and Hayden Creek. These streams are minor tributaries to the upper Klamath River. Rock Creek, another tributary, is not analyzed in this landscape analysis because of the limited BLM ownership in that drainage (approximately 640 acres). The following summarizes the information known about Rock Creek: "Since 1965, (the) water level in neighboring Meiss Lake has been controlled by pumping into the Klamath River via Rock Creek. Total annual quantities pumped from Meiss Lake have varied considerable and pumping typically occurs from January through April only...Augmentation of Rock Creek flows during Meiss Lake pumping operations has been estimated at between approximately 40 and 90 cfs (cubic feet per second)...(During water quality sampling in March of 1984 through July of 1985 near the mouth of Rock Creek) flows were estimated to range from a spring maximum of 75 cfs to a summer minimum of less than 5 cfs" (City of Klamath Falls 1986). Some time after 1986 (the date of the previously cited text), pumping of Meiss Lake via Rock Creek may have been discontinued (Regan-Vienop 1996, pers. comm.). The BLM-administered portion of Rock Creek has been noted to go completely dry during the summer low flow months.

In addition, the effect of management activities on the flow of the Klamath River is not discussed in this issue because its hydrology is completely controlled by upstream, non-BLM entities. However, basic information about the quantity and timing of flow in the Klamath River is provided to help assess other resources, primarily those of aquatic and recreation.

The watershed hierarchy for the Long Prairie, Hayden and Edge Creek subwatersheds is as follows:

Region:
- California
- Subregion: Klamath-Northern California Coastal
- River Basin: Klamath
- Subbasin: Upper Klamath
- Watershed: Copco

These subwatersheds are shown on Map 2 and described in Table 18.

Table 18. TPLA Subwatersheds

Subwatershed	Total Acres	Percent of TPLA Area	Acres BLM	Percent BLM
Long Prairie Creek	25,720	15	1,856	7
Edge Creek	4,830	3	548	11
Hayden Creek	17,800	10	4,183	24

Topography in the TPLA area consists mainly (96 percent) of gentle slopes (0 to 35 percent). Less than 1 percent of the area has slopes over 60 percent. The general aspect of the TPLA area is to the south. Table 19 summarizes the major topographic characteristics of the subwatersheds in the TPLA area.

Table 19. Major Topographic Characteristics

Subwatershed	Relief (Feet)	Elevation Range (feet)	Order	Drainage Slope (Percent)	Aspect
Long Prairie Creek	3,641	2,606-6,247	5	2	34% South 30% West
Edge Creek	1,466	2,640-4,106	3	3.5	65% South 24% East
Hayden Creek	2,399	2,750-5,149	5	3	48% South 25% West

Table 20 summarizes the major fluvial characteristics of each subwatershed, as calculated in GIS. Map 7 shows the distribution of streams in the TPLA area.

Table 20. Major Fluvial Characteristics

Subwatershed	Total Miles of Streams	Drainage Density (miles per square mile)	Miles Perennial*	Miles Intermittent*	Miles Ephemeral*
Long Prairie Creek	141.2	3.5	7.0	62.6	71.6
Edge Creek	12.6	1.7	0	8.3	4.3
Hayden Creek	84.2	3.0	3.2	39.8	41.2

*Estimated

The three tables given above provide insight into the relative influence of BLM lands on overall conditions in each subwatershed and on the scarcity of surface water resources in the TPLA area outside of the Klamath River canyon.

Water use in the TPLA area primarily consists of the following: hydroelectric power generation, irrigation, stock watering, road watering and fire suppression. Several in-channel and off-channel reservoirs, spring developments and guzzlers have been constructed on or near Federal lands. These water sources are shown on Map 8. The Pacific Power and Light Company (PP&L) is licensed to divert up to 2,500 cfs of Klamath River water for the operation of the J.C. Boyle hydroelectric project. In addition, PP&L has three other water right claims which were acquired with the purchase of land adjacent to the river. Two of the permits allow diversion from the Klamath River and one uses water from small tributaries of the Klamath; all three are for irrigation, stock and domestic use (USDI 1990). The irrigation diversions from the Klamath River near the Laubacher Ranch have been used for flood irrigation of meadow pastures adjacent to the river. Two small diversions from Hayden Creek near the Klamath River were noted in a 1979 Field Inspection Report by PP&L. The ditches were apparently used to flood irrigate meadows at the 41 Ranch. The Oregon State Department of Forestry has a permit to use up to 10,000 gallons of water per day from an unnamed tributary of the Klamath River, near the Topsy Road, for dust abatement. The Oregon Department of Parks and Recreation and the Oregon Department of Fish and Wildlife applied for an instream water right on the Klamath River in 1990. Based on the release regime from the J.C. Boyle Powerhouse, the application requests 1,500 cfs for recreation and 550 cfs (not additive) for fish population and habitat (USDI 1994).

Key Question: What are the current conditions and trends of the dominant hydrologic characteristics and features prevalent in the TPLA area?

Streamflow Characteristics

This section will characterize and assess the dominant hydrologic characteristics in the three TPLA area subwatersheds selected for analysis. Some flow information is provided for the Klamath River to characterize existing conditions. However, no assessment of management activities on the hydrologic characteristics of the river will be undertaken, because of the regulation of river flow by upstream, non-BLM entities.

Current and historic streamflow data for Hayden Creek, Long Prairie Creek and Edge Creek are lacking. During water quality sampling in Long Prairie Creek (near its confluence with the Klamath River) between March of 1984 and February of 1985, flows were estimated to range from a springtime maximum of 50 cfs to a summer minimum of less than 5 cfs (City of Klamath Falls 1986). Flow on BLM-administered segments of Hayden Creek and Long Prairie Creek during the low flow season is estimated to be less than 1 cfs. No other information on stream flow is available.

Bankfull flow is the size of a flood sufficiently common to govern the channel size, transports the largest total amount of sediment over a period of years, and is the most effective or dominant channel forming flow. Bankfull stage is the stage of incipient overflow. Discharges that exceed this stage must overtop the banks and spread out over the floodplain. This flow has a recurrence interval of 1.5 years in a large variety of rivers (Dunne and Leopold 1978), which is about the average of the range between 1.0 and 2.5 years reported in Leopold, 1994. The Spencer Creek Watershed Analysis used a recurrence interval of 2 years for bankfull flow; however, until better regional information becomes available, a 1.5 year interval will be assumed for the TPLA area.

When field information is lacking, bankfull discharge and bankfull channel dimensions can be estimated using relations developed for four regions in the United States (Dunne and Leopold 1978). These relations express bankfull width, depth, cross-sectional area and bankfull discharge as a function of drainage area. These averages are useful in estimating bankfull characteristics, but dimensions for a particular stream may vary (Dunne and Leopold 1978). The bankfull discharge and bankfull channel dimensions for Long Prairie Creek, Hayden Creek and Edge Creek were estimated using the relations developed for the Upper Salmon River drainage in Idaho. These relations were considered most likely to approximate geomorphological characteristics in the TPLA area.

The bankfull discharge estimates are listed in Table 21 below.

The mean annual flow is the constant discharge value that, if continued uniformly, would give the same volume of water as that observed in the period of record (usually the water year from October to September) (Dunne and Leopold 1978). In mountainous regions there is a large variation of annual precipitation with elevation and with exposure. Data show that there is a consistent relation between average discharge rates and bankfull discharge. In the mountainous area of western Wyoming where floods are derived from snowmelt, bankfull discharge is 5 to 10 times the mean annual flow for basins of all sizes (Dunne and Leopold 1978). Data from the California Coast Range found a range in mean annual discharge of 0.2 cfs to 3 cfs per square mile and the following relations: mean annual discharge is .0034 times bankfull discharge; the 5 year flood is 4.5 times bankfull discharge and the 2 year flood is 1.9 times bankfull discharge (Leopold 1994). To estimate mean annual discharge, mean annual discharge versus drainage area was plotted for gaged streams in the region. This plot can be used to estimate mean annual discharge for ungaged streams, such as Long Prairie Creek, Hayden Creek and Edge Creek (see Table 21).

Table 21. Discharge Estimates

Stream	Watershed Area (square miles)	Bankfull Discharge (cfs)*	Mean Annual Discharge (cfs)	Mean Annual Discharge (cfs) per square mile	Ratio of Bankfull to Mean Annual Discharge
Long Prairie Creek	40.2	358	60	1.5	6:1
Hayden Creek	27.8	279	47	1.7	6:1
Edge Creek	7.5	118	----**	---	---

*From Dunne and Leopold Upper Salmon River Relation **Drainage area does not fit onto the plot created.

Average monthly flows were graphed for three streams within 25 miles of the TPLA area. These are the gaging stations closest to the TPLA area for which annual monthly flow information was available and which have relatively unregulated or diverted flows. Hydrographs were sketched for these streams using mean monthly flow data, showing the range of monthly values to illustrate the range of flows by time period. Only one of the three streams, South Fork Little Butte Creek at Big Elk Ranger Station, yielded a hydrograph that may be representative of streams in the TPLA area. The hydrograph has a pronounced peak during the months of April through June, with a wide variation in monthly flow amounts. Precipitation in this watershed ranges from 18 to 30 inches and the elevation ranges from 4,660 feet to 7,300 feet. The basin is 17 square miles in size, with an average annual flow of about 18 cfs (about 1.1 cfs per square mile) and a mean base flow of 10 cfs. The general orientation of the watershed is to the west. Bankfull discharge is estimated to be 175 cfs (about 10 times mean annual flow), using the relations provided in Dunne and Leopold (1978). The soils in this watershed have a lower infiltration rate than soils in the TPLA area.

The Klamath River. The mean annual flow out of J.C. Boyle dam is 1,980 cfs. Monthly mean flows range from 653 cfs in July to 3,210 cfs in March. The average yield of the Klamath River Basin at this site is 1,397,000 acre-feet per year (USGS 1990). Typical daily average streamflow below the J.C. Boyle powerhouse ranges from a low of about 350 cfs in summer to a high of about 8,000 cfs in early spring. The minimum flow measured at the J.C. Boyle gaging station was 317 cfs in July of 1968 and the maximum was 11,000 cfs in March of 1972 (USGS 1990).

Peak flow

Peak flows refer to the instantaneous maximum discharge associated with individual storm or snowmelt events. In the TPLA area, peak flows are primarily generated by spring snowmelt. However, rain-on-snow events may be responsible for the largest runoff events. Management activities can increase the size of peak flows through a variety of mechanisms, including: road building, compaction, removal of the forest canopy, higher soil moisture levels due to the reduction of evapotranspiration, increased rate of snow melt, and a change in the timing of flows that results in a synchronization of previously unsynchronized flows. Any change in the size of peak flows is most likely due to a decline in magnitude as one moves downstream. Proportionally larger increases in the size of peak flows will occur downstream only if the timing of peak runoff in the managed basin is altered in such away that it becomes synchronized with peak runoff in other tributaries (EPA 1991). Because sediment transport rate is usually exponentially related to streamflow, increases in peak flows could create a situation where accelerated sediment from roads or harvest units is more efficiently transported downstream. In certain situations, the increases in peak flows from small watersheds may be additive in the higher order stream channels (King 1989).

The following discussions are not intended to quantify the magnitude of change in streamflow from management activities. Rather, it is a tool to translate past and present research into management considerations. Specifically, the analysis is designed to give a picture of the probable effects given the magnitude of disturbances within the watershed, and to give an understanding of how to view the watershed in terms of hydrologic function.

Peak Flow Calculations. The discharges useful for a flow frequency computation are momentary peaks or the highest discharge in each storm event. The highest flood peak in a given year is called the annual flood. The mean annual flood is the arithmetic mean of all the annual maximum discharges for a stream. The recurrence interval of the mean annual flood is 2.33 years (Dunne and Leopold 1978). A discharge of this magnitude is lightly larger than bankfull and flows over the floodplain (Leopold 1994). When the annual floods for a stream are tabulated for each year of record, arranged in order of magnitude, they provide the basis for a frequency curve of the annual flood series (Dunne and Leopold 1978).

Several theoretical probability distributions are commonly used for fitting the observed sample distributions of annual maximum floods. One of these is the Pearson Type III probability distribution, which was used to analyze the annual maximum flood record for Fall Creek. Fall Creek is the gaging station nearest to the TPLA area, excluding the Klamath River, with annual flood information available. The Klamath River gaging stations are not suitable for this analysis because of flow regulation. Floods of various recurrence intervals were calculated for Fall Creek using this distribution (see Table 22, Calculated Peak Flows for Fall Creek). These calculated floods are useful to compare the results of estimations using other techniques, as described below.

Multiple regression techniques are used to predict floods of various occurrence intervals from measures of controlling factors such as precipitation, drainage area and topography (Dunne and Leopold 1978). These regression equations are used to estimate the magnitude and frequency of floods at ungaged sites. The USGS has developed regional flood frequency curves for the upper Klamath River region (including the Goose Lake, Shasta River, upper McCloud River and upper Pit River basins) using drainage area and an index of the main channel slope to predict discharges of various recurrence intervals (USGS 1967). A more recent flood frequency analysis for eastern Oregon was published by the USGS in 1983. For the Eastern Cascades Region (which encompasses the TPLA area), main channel length and mean annual precipitation in the basin are used to predict discharge at various recurrence intervals. Both publications were used to calculate flood flows in the Long Prairie, Hayden and Edge Creek subwatersheds and in Fall Creek. However, the drainage area of Edge Creek is too small to use Upper Klamath River Regional Curve.

Because neither of these publications provide equations to predict all recurrence intervals, ratios between the annual flood and floods of other intervals (Lohrey 1982) were used to estimate bankfull discharge and other missing recurrence intervals. In addition, the data used in these flood frequency analyses are not available for the South Fork Little Butte Creek near Big Elk Ranger Station. Therefore, no calculations were performed for this drainage using the two publications. Instead, flood flows for this stream were estimated using relations provided in Dunne and Leopold (1978) and by a Pearson Type III probability distribution of annual maximum floods.

Tables 22 through 26 list the discharges for various recurrence intervals calculated for the three subwatersheds in the TPLA area, for Fall Creek, and for South Fork Little Butte Creek at Big Elk Ranger Station. Estimates of discharge derived from ratios in Lohrey (1982) are indicated in bold type.

Table 22. Calculated Peak Flow for Fall Creek

Recurrence Interval (years)	Discharge Estimated using E. Cascades Regional Curve*	Discharge Estimated using Upper Klamath River Regional Curve**	Discharge Estimated using Upper Salmon River Regional Relation***	Discharge Calculated from Log-Pearson Type III Probability Distribution
1.2		71		78
1.5 (Bankfull)	**62**	**101**	152	120
2	94	**151**		145
2.3 (Average Annual Flood)	**104**	168		165
5	166	276		272
10	225	367		380
25	295	574		547

*From USGS (1983). **From USGS (1967). ***From Dunne and Leopold (1978).

Table 23. Calculated Peak Flow for Long Prairie Creek

Recurrence Interval (years)	Discharge Estimated using E. Cascades Regional Curve*	Discharge Estimated using Upper Klamath River Regional Curve**	Discharge Estimated using Upper Salmon River Regional Relation***
1.2	---	110	
1.5 (Bankfull)	**151**	**150**	358
2	227	**225**	
2.3 (Average Annual Flood)	**252**	250	
5	376	370	

10	495	450	
25	625	650	
*From USGS (1983). **From USGS (1967). ***From Dunne and Leopold (1978).			

Table 24. Calculated Peak Flow for Hayden Creek

Recurrence Interval (years)	Discharge Estimated using E. Cascades Regional Curve*	Discharge Estimated using Upper Klamath River Regional Curve**	Discharge Estimated using Upper Salmon River Regional Relation***
1.2	---	110	
1.5 (Bankfull)	**67**	**162**	279
2	101	**243**	
2.3 (Average Annual Flood)	**112**	270	
5	184	450	
10	255	600	
25	340	950	

*From USGS (1983). **From USGS (1967). ***From Dunne and Leopold (1978).

Table 25. Calculated Peak Flow for Edge Creek

Recurrence Interval (years)	Discharge Estimated using E. Cascades Regional Curve*	Discharge Estimated using Upper Salmon River Regional Relation**
1.2	---	
1.5 (Bankfull)	**18**	118
2	27	
2.3 (Average Annual Flood)	**30**	
5	55	
10	80	
25	128	

*From USGS (1983). **From Dunne and Leopold (1978).

Table 26. Calculated Peak Flow for South Fork Little Butte Creek at Big Elk Ranger Station		
Recurrence Interval (years)	Discharge Estimated using Upper Salmon River Regional Relation*	Discharge Calculated from Log-Pearson Type III Probability Distribution**
1.2		70
1.5 (Bankfull)	175	79
2		95
2.3 (Average Annual Flood)		100
5		124
10		141
25		160
*From Dunne and Leopold (1978). From USGS (1993).		

It should be noted that the estimates listed above may or may not represent the actual peak flows. In addition, the calculated peak flows were derived from models and not from a rigorous statistical analysis such as Log Pearson Type III probability distribution (which would require about 10 years of annual peak flow information to compute).

From the information presented in the above tables, it appears that the relation for the Upper Salmon River given in Dunne and Leopold (1978) likely overestimates bankfull flow (recurrence interval of 1.5 years) for streams in the TPLA area. If further information is made available regarding the return interval for bankfull flow in this region, it may be found that a 2 year interval for bankfull flow (such as was used in the Spencer Creek Watershed Analysis) would be more appropriate. And, if bankfull flow recurrence interval is closer to the 2 year flood, then the higher flows provided the Upper Salmon River relation would be somewhat closer but still would overestimate bankfull discharge for this region. Also, it appears that the Eastern Cascades Regional Curve provided in USGS (1983) is more appropriate for the TPLA area than the Upper Klamath River Regional Curve. This assumption is based on the results for Hayden Creek, which are intuitively too large for that system. Conversely, the Upper Klamath River Regional Curve appears to apply to Fall Creek, based on the close agreement with the results of the Log-Pearson Type III probability distribution. Therefore, until better information becomes available, estimates of peak flows in the TPLA area will be based on the Eastern Cascades Regional Curve.

Roads. Roads are often a major impact on the hydrology of a watershed. Roads, when incised into the slope, may speed up the evacuation of snowmelt to stream channels. Spring snowmelt and runoff that would normally travel in a downhill direction, usually as shallow sub-surface flow, is intercepted by the compacted roads and their ditches and becomes surface flow (Johnson 1995). If the intercepted water is synchronized in time and place with normal peak flows from the rest of the watershed, the flood peak could be increased. However, the reverse might also occur. A number of factors probably govern the response of an individual watershed to road construction, including the number and location of roads and the type of storm event. Another hydrologic effect of subsurface flow interception results when road culverts are too far apart. Oftentimes, subsurface flows are intercepted from slopes and smaller drainages outside the confines of the watershed containing the culvert. These flows are commonly carried in a ditch along the inside of the road until they can be discharged into the nearest culvert. This situation can increase the drainage efficiency of a watershed and increase peak flows and channel erosion. This increased drainage efficiency reduces the amount of subsurface flow moving downslope to streams, thus potentially adversely affecting groundwater recharge and base flows (Megahan 1972).

Wemple (1994) assessed the hydrologic integration of forest roads with stream networks in two western Oregon basins. Nearly 60 percent of the road network in these basins drains to streams and gullies and is considered hydrologically integrated with the stream network, and roads may increase the drainage density by as much as 36 percent during high flow events (Wemple 1994). Assuming that a similar effect occurs in the TPLA area, drainage densities in each subwatershed and other road-related statistics were calculated by GIS (see Table 27). Based on these figures, a hypothetical percent increase in drainage efficiency was estimated, using the methodology in Wemple (1994). For comparison, the basins studied by Wemple have the following characteristics: an average of 3.7 stream crossings per mile of road; average drainage density of 4.8 miles per square mile; average road density of 3.1 miles per square mile; and 60 percent of the road network is hydrologically integrated.

Table 27. Road Density and Increased Drainage Efficiency by Subwatershed

Subwatershed	Drainage Density (miles per square mile)	Road Density (miles per square mile)	Number of Stream Crossings per mile of Road	Miles of Road within 100 feet of streams	Percent Increase in Drainage Efficiency
Long Prairie Creek	3.5	3.7	2.2	31.15	66
Hayden Creek	3.0	3.6	2.4	21.38	73
Edge Creek	1.7	2.5	0.6	0.69	88

Because of the number of stream crossings, it appears that the road system in these subwatersheds is hydrologically integrated with the stream network to a level somewhat less than that in Wemple's study. However, the percentage of total road miles in each subwatershed that are within 100 feet of streams is 21 percent in Long Prairie Creek, 21 percent in Hayden Creek and four percent in Edge Creek. Therefore, the majority of the road system in these subwatersheds is probably located in the midslope or ridgetop position. Roads in these positions may intercept subsurface flow and incoming precipitation or melting snow, and the magnitude of the resultant flow routing effect is estimated to be moderate or large (Wemple 1994).

Based on the hypothetical increased drainage efficiency due to roads, there is a moderate to high probability that peak flows in the TPLA area have been increased by synchronization of flow and increased drainage efficiency. Compaction of soil through harvest activities may be adding to these effects. Furthermore, road densities are likely underestimated, due to the quality of GIS data for private ownership and for California lands. However, the lack of actual peak flow measurements makes it difficult to determine the level of effect. Because roads can synchronize or desynchronize peak flows (based on their configuration and position in the landscape), more information is needed for analysis of peak flow changes from road construction (see Map 9 for more information).

Cumulative Effects Analysis

An attempt was made to draw conclusions from research data to determine possible cumulative effects in the TPLA area. This creates a level of uncertainty, as various geological/geographic characteristics differ. However, discussions with silviculturists and foresters should counterbalance this discrepancy, as site specific data regarding recovery rates were factored into the models developed in other regions.

Research Discussion. Forest vegetation removal increases water yield due to one or more of the following reasons: a reduction of transpiration; an increase in wind turbulence which results in redistribution of snow and greater local snow accumulations; a reduction of interception; and more efficient conversion of the snowpack to streamflow. Disregarding the aerodynamic effect on snow distribution, removal of all vegetation would result in a potential increase in water available for streamflow approximately equal to transpiration, assuming precipitation is not limiting (USDA date unk.). Removal of vegetation also makes more water available for streamflow by reducing interception losses. Dunne and Leopold (1978) reported that median canopy interception for coniferous forest in climates that produce precipitation in the form of rain and snow is 28 percent of gross precipitation. Interception is particularly effective when there is a drizzle or a low intensity storm event where there is a lack of "through fall" or "stem flow" which allows precipitation to enter the soil (BLM 1995).

The magnitude of increase in water yield is dependent upon:

1) Soil and rooting depth: greatest increases in water yield are obtained by removing deep-rooted vegetation from deep soils.

2) Precipitation input compared to energy supply: greatest increases in water yield are obtained from areas having great amounts of precipitation compared to evapotranspiration. Increases in water yield from north aspects are greater than those from south aspects.

3) Amount of vegetation removal: water yield increases are roughly proportional to the percentage of the drainage that is cut.

4) Type of vegetation removal: clearcutting produces maximum increases in yield, selective cutting produces the least increases. Size and geometry of clearcuts also affect amounts and timing of increases in yield.

5) Species differences: increases in water yield may differ between species because of differences in rooting characteristics, dormancy, plant size, radiation reflectance and interception.

6) Elevation and slope: an increase in elevation at a given latitude is associated with an increase in snow accumulation, a delay in snowmelt, and an increase in melt rate. On south aspects melt is delayed and rate of melt is increased with a **lower** slope angle On north aspects, melt is delayed and melt rate is increased with a **higher** slope angle. These differences with change in slope are also greater at the high elevations and are reduced as aspect shifts to east or west (USDA date unk.).

Increased water yields from clearcutting have been found to be proportional to the percent of the drainage cleared. Rothacher (1970) suggests that removing 20 percent or less of the forest cover would not produce a significant change in streamflow. Hibbert and Gottfried (1987) found that in mixed conifer forests in Arizona, winter peak flow increases were readily detectable only for treatments that affected vegetation on one-third or more of the watershed. The increases are primarily attributed to lower growing season evapotranspiration, which results in quicker soil recharge and more efficient moisture movement. Greater water yields are obtained from deep rather than shallow soils, and from high precipitation areas. The least increases in water yield result from partial cutting of trees. In "wet" years, when water is not limiting, partial cutting or any basal area removal could increase streamflow. In drought conditions, water savings may be used up by the residual vegetation and through evaporation (Baker 1988).

The logarithmic reduction of streamflow increases is closely associated with the rapidity of regrowth of vegetation. Studies have shown that increases in streamflow caused by deforestation decline exponentially with time and have a half life of about 2 to 7 years (Dunne and Leopold 1978). Increases in water yield from partial cutting diminish to pretreatment levels in usually less than 10 years, and may only take several years (USDA date unk.).

In the humid subalpine type with perennial flow conditions, treatment affects streamflow primarily on the rising side of the hydrograph. Streamflow increases occur earlier because melt of the snowpack may be advanced by up to several weeks in the clearcuts, and because soil moisture recharge requirements are smaller on the harvested areas making the "excess" water available sooner. In the subhumid ponderosa pine type, intermittent and ephemeral streamflow conditions introduce a greater potential for seasonal variation through greater sensitivity to precipitation amounts and differences in antecedent precipitation conditions. Even though annual precipitation totals may be similar, differences in precipitation distribution can produce significant differences in annual water yields. Water yield from the ponderosa pine type averages from 3 to 5 inches per year (Baker 1988).

Although the highest water yields usually occur in the spring, major flow events can occur anytime during the winter period in the ponderosa pine type, and rain-on-snow events are a more common occurrence than in the higher subalpine type. Streamflow is generally initiated earlier after harvesting because melt of the snowpack is advanced in clearcuts, and because soil moisture recharge requirements are smaller on harvested areas, making the "excess" water available sooner. However, differences in melting patterns between harvested and unharvested ponderosa pine may only be offset by a matter of days instead of weeks (Baker 1988).

Although the effect on snowpack accumulation and flow can be long-lasting in the subalpine type, the more arid condition of the ponderosa pine type may not be as conducive to producing long-lasting treatment effects unless sufficient water storage capacity below access of the vegetation is available. In arid situations, where water is limited, potential savings in water by partial cutting is often used by the residual trees. Harvesting influences in some ponderosa pine areas have been lost in the matter of a few years (Baker 1988).

Transient Snow Zone. Rain-on-snow research has shown that changes in both snow accumulation in the transient snow zone and rate of snowmelt during rainfall can combine to cause more water to enter soil in logged areas than in forests (Harr 1986). The Jenny Creek Watershed Analysis provides climatological information that can be applied to the TPLA area. An analysis of elevational temperature distribution and months during which a snow pack accumulates (based on normal temperatures) indicates that the transient snow zone for the Jenny Creek Watershed is located between elevations of 3,000 to 4,200 feet. Due to the proximity of Jenny Creek to the TPLA area, this elevation range is assumed to be valid. A rough visual estimate of the percentage of each watershed in the transient snow zone is as follows: Long Prairie Creek 30 percent; Hayden Creek 50 percent; and Edge Creek 95 percent.

Analysis Procedure. The calculated equivalent clearcut area (ECA) value represents the total acreage of forested land within a watershed considered to be in a clearcut condition in terms of hydrologic response. The equivalent clearcut area includes the area of clearcuts and roads plus an equivalent clearcut area for partial cuts, overstory removals, selective cuts, and commercial thinnings. Treatment factors are used to convert non-clearcut harvested areas to equivalent clearcut acres. "Recovered" in this analysis is considered to be "hydrologically recovered". Harvest units are considered to be hydrologically recovered when re-establishment of leaf area is sufficient to return transpiration rates to pre-harvest levels and canopy closure is sufficient to prevent excessive snow loading. Leaf area index is the ideal variable to quantify recovery; however, due to data limitations canopy closure is used as a surrogate (USDA 1994).

The Clearcut Equivalent equated to various percentages of crown closure resulting from partial cuts is outlined in Appendix 6 of the Spencer Creek Watershed Analysis. These relations were assumed to be also applicable to vegetation types in the TPLA area. Roads and areas of compaction were not incorporated in this recovery model as these conditions persist for long periods of time.

Crown (canopy) closure is usually determined through examination of aerial photos or satellite images and assigning values to harvest units. Due to the size of the TPLA area and because of data and time constraints, broad generalizations were made about the relation of canopy closure to stand attribute information contained in the MicroStorms database. This database only includes BLM-administered lands in Oregon. Canopy closure information was inferred from spotted owl habitat designations (habitat categories 1-4) contained in the database, and queries were made to determine the acres in each category for various vegetation types. Category 1 and 2 habitat was assumed to have canopy closure of greater than 60 percent; Category 3 habitat was assumed to have canopy closure levels between 40 and 60 percent; and Category 4 habitat was assumed to have canopy closure levels below 40 percent. The Clearcut Equivalent relations for canopy closure and vegetation type developed for the Spencer Creek Watershed Analysis were used (see Appendix 6 in the Spencer Creek Pilot Watershed Analysis). A GIS layer was created from the MicroStorms data to quantify current equivalent clearcut acres and to view their spatial arrangement.

A map that reflects vegetative stand conditions in 1900 (Leiberg) was used as a pre-management reference point. Because data prior to 1900 is not available for this watershed, 1900 will be considered "historic" condition in this analysis. It is recognized that harvest activity had occurred in the TPLA area by 1900, so comparisons to a "natural" (unaltered by Euroamerican activity) condition cannot be made using 1900 data only. Using Leiberg's map, a visual estimate was made of burned acres and deforested areas that are assumed to be old burns. These burned and deforested areas are considered "historical equivalent clearcut" acres. The total of these acres (between 9,000 and 10,000 acres) was pro-rated to BLM-administed lands, based on the percent of BLM administration in the TPLA area.

Table 28 summarizes the ECA acres present in 1900 and as of 1990 for BLM lands in the TPLA area.

Table 28. Equivalent Clearcut Acres on BLM-administered lands in the TPLA Area

Historic ECA*	Percent of BLM-administered lands	Current ECA*	Percent of BLM-administered lands
1,700 acres	6	0	0

*Percent of the **forested** acres on BLM-administered land in the TPLA area considered to be in ECA condition due to changes in canopy closure. Non-forested lands are not included in this calculation, although poor conditions on these lands can contribute to adverse cumulative effects. Does not include the ECA contributed by roads.

Widespread logging has occurred on non-BLM-administed lands, although many prescriptions were partial cuts which decreased canopy closure but did not create openings. Stands are either early- or mid-seral, are relatively open, and most are only 70 years old or younger. Therefore, according to this analysis, only non-BLM-administed lands and roads are currently contributing to ECA levels. Currently, there are at least 3,315 acres of ECA from roads in the TPLA area (only WODDB data was used, which covers 68 percent of the TPLA area). Studies in literature suggest that measurable change in magnitude of flows does not occur until approximately 20 to 30 percent of a watershed is clearcut. Historical ECA levels in the TPLA area are estimated to be between 9,000 and 10,000 acres. Therefore, non-BLM-administed lands would have to have between 4 and 5 percent of their total acreage in ECA to approximate historical levels of ECA and would have to have between 30,960 and 48,100 acres of ECA to reach the 20 to 30 percent "threshold" level of ECA. These levels equate to about 22 to 34 percent of non-BLM-administed lands in ECA. In addition, because much of the TPLA area lies in the transient snow zone, peak flows from rain-on-snow events would likely be increased by openings in the canopy. It is likely that the assumed historical level of ECA in the TPLA area has been exceeded, and it is possible that the 20 to 30 percent threshold has been exceeded because of harvest activities on non-BLM lands. It is unknown whether timber harvest on non-BLM-administed lands in the TPLA area has produced a measurable change in flows since 1900.

Changes in vegetation resulting from alteration of the fire regime were considered, but not quantified during the analysis. In the mid-elevation mixed conifer stands, succession in the absence of fire has likely caused higher stocking levels and increased canopy closure in some stands with a reduction in other stands due to harvesting. The change has likely increased transpiration rates in some stands. Therefore, the largest effect of vegetation on water quantity may be on the availability of water during late summer. This process may influence base flows if stocking levels have increased on a significant portion of the watershed area.

In the TPLA area, the road system is of most concern in altering the timing and magnitude of peak flow. While reduction of transpiration and interception is occurring, two characteristics mitigate this - infiltration rates of the soil and the increased white fir understory component of the vegetative community. The additional water availability does not appear to exceed the capacity of the soil profile to absorb it. The white fir invasion behaves as a compensation for the removal of the other conifer species, in terms of transpiration.

Overland Flow

The main factors contributing overland flow from snowmelt are: a deep snowpack; a snowmelt delayed because of elevation and aspect until the period of maximum incoming solar radiation (June) which melts the snow rapidly and releases a large quantity of snow water in a short period; rain on snow events; a moderately sloped terrain; and a completely saturated soil mantle or a high water table. Factors that reduce the likelihood of overland flow include the presence of very coarse and permeable soils and daily snowmelt rates that do not exceed the lateral transmission rate of the soil. Therefore, if the winter-spring water table is sufficiently high or soil permeability is reduced to the extent that the soil mantle cannot accommodate the daily snowmelt, then a significant portion of the daily snowmelt could enter the road drainage system as overland flow (Burroughs, Marsden and Haupt 1972).

Field experience indicates there is little overland flow occurring in compacted areas, except on native surface roads, on soil types which have a lower infiltration capacity, or in natural drainages. The lack of overland flow is assumed to be due to the high infiltration rates of most soils in the TPLA area. Roads and areas of compaction within 100 feet of the stream channel have the highest potential to generate overland flow that reaches stream channels. Although drainage density in the TPLA area is low, a significant number of roads cross streams or are within 100 feet of streams (see the Peak Flow section). Therefore, there is a moderate probability that overland flow is reaching stream channels and contributing to peak discharge.

Base flow

In most of the western U.S., the minimum streamflow is observed during the late summer and early autumn. This decline in discharge is due to a combination of low precipitation, reduced drainage from the soil and bedrock, and sustained high evapotranspiration (EPA 1991). Summer low flows are commonly referred to as base flow. Base flow is important for maintaining aquatic and riparian habitat and as a late-season water source for livestock and wildlife.

Map B in the Analysis Files shows the distribution of perennial, intermittent and ephemeral streams in the TPLA area. No attempt was made to determine the upstream limit of ephemerality nor the watershed area at the upstream limit of ephemerality due to a current lack of time and data. The upstream limit of perennial flow in Long Prairie Creek occurs in T. 41S R. 5E section 5. Water input from tributaries occurs only during spring runoff. Currently, baseflow for Long Prairie Creek is under 1 cfs. The spring in section 5 provides the only source of water during low flow periods. The upstream limit of perennial flow in Hayden Creek is assumed to be in the southern portion of section 36, T. 40S R. 5E. Baseflow for Hayden Creek is under 1 cfs, with the stream going almost dry during low flow months in drought years except for springs near its confluence with the

Klamath River. The source of water for Edge Creek is a perennial spring in T. 41S R. 5E section 3; however, the flow soon percolates into the stream bed to become subsurface flow.

The USGS publishes statistical summaries of stream flow data from stream gaging sites throughout Oregon. In their 1993 report, annual minimum (base) flow summaries are provided for gaging stations that had at least 10 years of record. Annual minimum flows of seven days in duration and a 5-year recurrence interval for gaging stations in the region were plotted against drainage area. From this plot, 5-year base flows were estimated for each subwatershed and the base flow per unit of watershed area was calculated (see Table 29). It should be noted that there was a lot of scatter in the plot, indicating that no good relationship exists between drainage area and base flows, probably because of irrigation withdrawals. The 5-year recurrence interval was selected because of its assumed representation of recent conditions in the TPLA area. The 7-day duration was selected because of its effect on aquatic organisms and water quality.

Table 29. Base Flows

Stream	Estimated Base Flow 7 day, 5-year	Calculated Base Flow* per square mile
Long Prairie Creek	1 cfs	<0.1 cfs
Hayden Creek	0.7 to 0.8 cfs	<0.1 cfs
Edge Creek	0.1-0.2 cfs	<0.1 cfs

*7 day, 5 year

Changes in vegetation structure and the resulting changes in transpiration rates are directly proportional to changes in soil moisture content, which are directly related to base flow conditions (USDA 1994). In lower elevation white fir-mixed conifer stands, succession in the absence of fire has caused a shift from ponderosa pine-dominated stands to white fir-dominated stands. This has resulted in higher stocking levels and increased canopy closure in some stands. For example, even though timber harvest has occurred on BLM-administered lands, canopy closure levels are currently such that no Equivalent Clearcut Acres are contributed from openings in the canopy. The increased canopy closure has also likely increased transpiration rates and may have slightly lowered base flow levels to some extent, due to increased use of late season soil moisture.

Regional groundwater recharge occurs within the volcanic rocks in the highlands surrounding the Klamath River Canyon. The lower canyon serves as a site of groundwater discharge (FERC 1990). Numerous springs and seeps were observed issuing from the steep slopes along the Klamath River during a 1984 survey by a consultant for the City of Klamath Falls. The majority of these springs discharged volumes less than 100 gallons per minute and from an elevation less than 150 feet above river stage. The water table in these areas intersects the ground surface just above the river level, and the discharge water either recharges the Klamath River alluvial and bank deposits or enters the river directly (City of Klamath Falls 1986). Other springs were observed at much higher elevations along the canyon walls in Sections 7 and 8 in T. 41S R 6E, approximately 300 to 400 feet above the Klamath River. These springs occur near the contact between the basalt and the underlying, less permeable tuff. Significant groundwater discharge on the order of 250 to 300 cfs to the river occurs in the Big Bend area (FERC 1990).

Carlston (1963) presented evidence that drainage density, surface-water runoff, and the movement of ground water are parts of a single hydrologic system controlled by the transmissibility of the bedrock and its overlying soil mantle. As the transmissibility of the bedrock and aquifer increases, ground-water discharge into streams increases and surface discharge and drainage density decrease. In addition, the greater the infiltration capacity of the soil, the less will be the amount of surface runoff. Megahan (1972) studied subsurface flow in shallow, permeable coarse textured soils overlying less permeable granitic bedrock. He found that water supplied by storms and melting of snow rapidly infiltrates the soil surface and continues to flow downward until it reaches the zone of reduced hydraulic conductivity at the bedrock surface. Continued inflow of water creates a saturated layer at the bedrock surface; this causes subsurface flow downhill along the bedrock surface.

A similar situation may exist in the TPLA area. It is speculated that the rapid infiltration rates of the soils in the TPLA area and the transmissibility of the bedrock beneath them allows water to percolate down to the next stratum, the tuff. Where the tuff layer intersects the ground surface, springs may appear. The high infiltration rates of the soils in the TPLA area limits annual water yields. With very little drainage development, it is probable that much of the TPLA area functions as a recharge zone for springs issuing into the Klamath River and emerging at the contact with the tuff layer. It is possible that the perennial water sources for Long Prairie, Edge and Hayden Creek are springs which issue at or near the contact with the tuff layer. A map of soil types in the TPLA area shows the presence of tuff-derived soils at several spring sites. Therefore, the upstream limit of perennial flow may be closely tied to the location of the tuff layer and its contact with the surface.

Many surface-water hydrologists believe that the base flow of many streams is largely derived from bank storage, rather than from discharge of ground water (Carlston 1963). Riparian areas and floodplains function to attenuate flood peaks and to store water to be released in the summer and fall months. This slow release of bank storage could have augmented base flows from springs. The extent of perennial flow could have been further upstream if significant amounts of bank storage occurred. Because Long Prairie Creek has the largest watershed area and the most extensive floodplain development, it is believed that this stream has the capability to augment base flows from springs with bank storage.

Key Question: What are the historical hydrologic characteristics and features in the TPLA area?

The following excerpts from Number 3 of *Klamath Echoes* (1966) discuss various water sources existing in the TPLA area around the early part of this century:

> "Their main logging camp and headquarters for logging operations the coming year will be located there, which is in section 4, township 48, range 5 east [the future Snow--Ed]. There is a fine spring of water located there." [This should be Township 41S].
>
> "There were three trestles built on the old logging railroad north of Snow, one rather high across Long Prairie Creek...Another, across a dry draw, a short distance southeast of the Long Prairie Creek trestle...A third was across a low swampy patch of ground approximately one mile north of the high trestle, or about half way between Horn's Camp and what later became old Pokegama". [The location of this swampy patch cannot be determined].
>
> "Long Prairie Creek used to be called Four Creek. It divided into four branches, where it emptied into the Klamath River".
>
> "The mill to be located at a favorable point in Section 16, Township 40, Range 5 east...[A dam on Long Prairie Creek, at this location, was partially constructed, but may have been washed out by high waters--Ed.]".
>
> "Finally on July 16th (1903)...we have this final bit of information, reprinted from the *Tidings*: 'Failure to secure a mill site where a sufficient amount of water to supply the boilers is insured has delayed the setting up of the big new sawmill near the terminus of the Klamath Lake Railroad at Pokegama by Potter and Son. The machinery has been on the ground for some time and a site was selected and excavations for a dam made and about eight feet of water turned in it but the supply failed with the coming on of dry

weather and made the selection of a new site necessary.' [The site finally chosen was in the extreme southwestern corner of section 28, possibly extending into the southeastern corner of section 2--Ed.]."

"...there was a little board school at the big spring, north of the last Pokegama...The railroad at Potter's Mill ran right alongside the mill. They could dump the logs into a pond on either side, or right onto the log deck in the mill...The horse pasture lay along Long Prairie Creek, from the mill to Old Pokegama."

The information contained in the *Klamath Echoes* raises some interesting points. No spring is now known to occur in Section 4, the site of Snow. No mention of Hayden Creek was found; its relative unimportance could be the lack of perennial flow. Settlements occurred along/near Edge Creek and Long Prairie Creek (Dixie, Horn's Camp, Old Pokegama, Potters Mill, New Pokegama, and Algoma Mill). Water would have been needed for up to several hundred people, for horses, cattle, and mill boilers at all of these settlements. Where did the water come from? The current flow in Edge Creek and Long Prairie Creek could not support this level of use during the low flow months. No mention is made of having to haul water from the Klamath River, and this activity would have been very difficult. Therefore, one may infer that either the flow in these streams was greater at the turn of the century than it is today or that all water was stored behind dams that caught the spring runoff.

Because there is no information to suggest that a significant shift in the regional groundwater level has occurred, a possible explanation for the more abundant water supply could be that precipitation was higher during that time. A reference in *Klamath Echoes* to five feet of snow at the site of Snow may be an indication of higher precipitation levels. In addition, it is likely that Long Prairie Creek was augmenting groundwater flows with bank storage. Historically, the meadows surrounding Long Prairie Creek would have functioned as a wetland system, attenuating flood peaks and storing water to be released in the summer and fall months. The gradual release of water from the system would have supplemented spring runoff.

It is estimated that approximately 9,000 to 10,000 acres in the TPLA area were in a burned condition (recent and older burns) during Leiberg's survey of 1899 (Leiberg 1900). Fire could have created adverse soil cover and hydrophobic soil conditions that would have affected infiltration rates and increased peak runoff amounts in affected areas. The adverse effects from fire would have recovered naturally.

Key QuestionS: What are the natural and human causes of change between historical and current hydrologic conditions? What are the influences and relationships between hydrologic processes and other ecosystem processes?

Base flows in the TPLA area have been reduced by drought and poor channel and riparian condition in certain areas. Reductions in evapotranspiration from vegetation removal have occurred but may be offset by the invasion of white fir and increased stand densities in portions of the TPLA area (especially on BLM-administered lands). There is a moderate to high probability that peak flows have been increased, primarily due to the road network. Reductions in canopy closure have likely occurred on non-BLM-administered lands in the transient snow zone, but the extent and effect of these openings is not known. The timing of peak flows may also be altered, in that the duration of high flows is probably shorter and, in south-facing portions of the TPLA area, earlier in the year due to more rapid snowmelt from openings in the forest canopy on non-BLM-administered lands.

Historically, the meadows surrounding Long Prairie Creek and Hayden Creek functioned as a wetland system, attenuating flood peaks and storing water to be released in the summer and fall months. The gradual release of water from these systems supplemented the spring runoff. With the decline in channel condition (see Channel Condition Issue), this function has been lost and reductions in riparian and floodplain function along these streams could influence base flow. As a result, base flows have likely decreased, or at least the number of low flow days has increased. It is difficult to quantify the magnitude of change, but it is fairly certain that water released from these riparian areas contributed to a higher base flow.

The increased drainage efficiency in the watershed allows for precipitation to quickly leave the watershed as surface flow rather than allowing it to percolate into the soil. In addition, poor channel and riparian conditions along various sections of streams in the TPLA area cause streams to act like canals (transporting water out of the watershed) instead of sponges (soaking up water and releasing it slowly). These effects serve to reduce base flows and exacerbate poor water quality conditions. Any increase in peak flows from reductions in canopy closure may mean increased water yield but, without a means to retain it in the watershed, the net effect is for these increased yields to leave the watershed in higher, shorter peak flow periods during snow melt. Thus, less water remains to contribute to base flow later in the season.

Current peak flow and base flow conditions are likely to continue into the future at or near current levels. Peak flows could be reduced and base flows increased over the long term if significant levels of road obliteration occur, particularly those roads that cross streams or are located mid-slope and have the potential to affect water movement to streams. As forest vegetation matures in the long term, use of water for transpiration will increase. However, on BLM-administered lands it is likely that stand densities will be managed to mimic historic conditions wherever possible, and that currently overstocked stands will be treated to reduce stand densities to sustainable levels. Stream channel and riparian conditions will remain static in the short term and will slowly improve over the long term. If a large wildfire or flood event occurs in the watershed, then peak flow and base flow levels would change in response to large scale removal of vegetation or greatly reduced stream channel and riparian area function.

Core Topic: Channel Condition

Issue: Stream channel condition has been altered in the TPLA area.

Key Question: What are the basic morphological characteristics of stream valleys or segments and the general sediment transport and deposition processes in the TPLA area?

This issue will examine the physical condition of stream channels in the TPLA area. Shading, riparian vegetation condition and aquatic habitat condition are addressed elsewhere in the analysis; therefore, they will not be directly addressed here.

Overview

Forest and range management can alter channel morphology by changing the quantity and timing of sediment, water and coarse woody debris (CWD) delivery to streams and the capability of the channel to transport and store sediment, water and large woody material (USDA 1994b). Potential channel adjustments to altered discharge and sediment load include changes in width, depth, velocity, slope, roughness, and sediment size (Montgomery and Buffington 1993). Increased sediment supply can induce channel widening and aggradation, decrease roughness through pool filling, and decrease bed sediment size. Increased discharge can cause channel widening, incision, and bed armoring (Montgomery and Buffington 1993).

The bank material of natural streams influences channel pattern and form and provides a boundary between aquatic and terrestrial realms. The resistance or erodibility of banks influences channel meandering, and bank erosion is one of the principal natural means of sediment supply to streams. Livestock grazing alongside streams can be one of the major impacts to banks and associated riparian vegetation. Other land uses which result in destabilization of stream channels include timber harvest and associated road building, which can increase sediment and water delivery to stream channels (USDA 1994b).

Changes in stream-side vegetation can have dramatic impacts on channel morphology and processes. Riparian vegetation contributes substantial cohesion to channel banks and influences the recruitment of CWD to channels. Changes in the age and species of wood entering the fluvial system can affect the magnitude and persistence of its morphologic influence. This morphologic influence is primarily associated with size and decay rate (Montgomery and Buffington 1993).

Channel response to changes in the supply of CWD depends on its role in sediment storage and pool formation. A decrease in the supply of CWD accelerates sediment transport and decreases sediment storage in small channels where woody debris provides significant sediment storage. Similarly, a decrease in the supply of CWD reduces in-channel roughness and may eliminate pools in channels where CWD controls in-channel flow variability (Montgomery and Buffington 1993). While pools tend to be stable channel features that persist through annual high flow events, their size and location may change if sediment loads increase due to road construction, timber harvest, or grazing activities. Excess aggradation caused by large amounts of sediment can smooth the channel by filling pools. Activities that increase the amount of sediment beyond a channels's transport capacity can cause aggradation and loss of depth, widening, and instability as the channel seeks a new equilibrium. Reduced frequency, depth and volume of pools; fewer and smaller size of in-channel wood debris; and a higher proportion of riffles and shallow pools are expected in intensively-managed watersheds (USDA 1994b).

Channel Classification

Channel classification is one mechanism for describing habitat conditions and stream channel response to disruptions. One method of classification is to use a combination of gradient and confinement to distinguish response potential. Gradient and confinement are general indicators of transport capacity and the balance between sediment supply and transportation capacity in a watershed (REO 1995).

Confinement is determined by comparing floodplain width to stream width at bankfull stage. Channel confinement is important for interpreting potential channel response. The geometry of the channel above the bankfull stage strongly controls the response of the channel bed to high-discharge flow. Unconfined channels may have extensive floodplains across which overbank flows spread. Lateral spreading of overbank flow from an unconfined channel across the floodplain effectively limits the depth of flow, and thus the basal shear stress, to about that associated with the bankfull flow depth, mitigating the effect of peak discharges of channel morphology. The geometry of a confined channel, however, translates discharge greater than bankfull into increased basal shear stress (Montgomery and Buffington 1993).

For the purposes of this analysis, three major natural fluvial processes will be used to discuss the function of confined and unconfined channels: erosion, transport and deposition. In general, "erosion" reaches are transport-limited, sediment storage sites subject to intermittent scour. "Transport" reaches are morphologically resilient, high-gradient, supply-limited channels that rapidly convey increased sediment inputs. "Depositional" reaches are low-gradient, transport-limited channels in which significant morphologic adjustment occurs in response to increased sediment supply (Montgomery and Buffington 1993). The higher gradient, confined reaches are primarily transportational and erosional and the lower gradient, unconfined reaches are primarily depositional.

Unconfined Reaches. Unconfined reaches regulate the transportation of water and sediments through the system. Viewed at a watershed scale the lower gradient reaches act as hydraulic controls, decreasing the rate of transport of water and sediment. During high flows, sinuosity, side channels and the floodplain increase channel roughness and slow water velocities. Organics and sediment, particularly fine sediment, are deposited as water flows out of the main channel and spreads out over the floodplain. This water, which is stored throughout the riparian zone, is slowly released during the low flow period. These low gradient, wide riparian areas in the system act to reduce the conveyance of water and sediments. The implications are a decrease in peak discharge, increase in late season water availability, and decrease in-channel sediment deposition (USDI 1995).

In general, channel substrate in unconfined reaches can be silts to gravel, depending on local velocities. Valley bottom/floodplain widths are relatively wide. Bed and bank material derive from fluvial processes and mainly consists of silts and sands. Gradients are low, decreasing stream power. Sediments transported through the confined reaches "fall out", building point bars, lateral bars, and an extensive floodplain. The combination of fine bank material and wide floodplains allows for channel adjustment. Tractive forces, produced by moving water, act on the stream banks and dominate the erosion process (USDI 1995).

Isolation of unconfined channels from their floodplain can entail dramatic consequences, as connections between a channel and its floodplain are an important geomorphic component of many biologic systems. Prevention of overbank flows by dikes, or other flood control measures, may trigger channel entrenchment. Flow diversions or regulation that prevent or decrease the frequency of floodplain inundation change both side channel and floodplain processes. Prevention of overbank flows stops sediment and nutrient delivery to floodplain soils (Montgomery and Buffington 1993).

The input of large woody debris into the unconfined channel system is dependent on stream processes working on the outer edges of the floodplain. On the outer edges large trees that fall onto the floodplain eventually reach the channel by either floods carrying them to the channel or the stream meanders to the large wood debris. The potential for large wood recruitment from these reaches is low compared to the confined channel segments (USDI 1995).

Unconfined alluvial channels with relatively uncohesive bank-forming materials are particularly susceptible to dramatic channel widening as a result of riparian vegetation disturbance. Unconfined reaches, due to their inherent adjustability, are more sensitive to changes in inputs. Changes in the sediment regime and disturbances to bank vegetation readily alter channel morphology. Width to depth ratios are probably more useful in assessing effects in unconfined channels than in confined channels because the stream bed and banks in confined channels are typically composed of larger sized, more resistant material, although bank erosion and channel widening has been observed in confined channels in response to increased sediment loads (USDA 1994b).

Confined Reaches. In the confined channel network, with low sinuosity and little floodplain development, the majority of energy dissipation is turbulence generated by large roughness materials in the stream bed. Substrate and large woody debris create turbulence which directs flow velocities, or kinetic energy, into the channel bottom or adjacent substrate. When the velocities are directed toward the channel bottom, the energy forms pools. Similarly, small pocket pools are formed when turbulence around large substrate removes the smaller material at the base. Spaced between these areas of high turbulence are stretches of less resistance, allowing for increased velocity. This sequencing of high velocities and pool formation creates the pool-riffle sequence (USDI 1995).

The riparian zones in these reaches function to provide large woody debris to the channel and canopy closure for shading. Due to the steepness of side slopes and presence of large conifers adjacent to the stream channel, these areas have the highest potential to deliver large woody debris into the stream channel (USDI 1995).

Lack of fluvial (produced from stream action) sediment deposits such as point bars, lateral bars, and mid-channel bars indicate these reaches are transportational. Corresponding to high gradients, these reaches have higher velocities and more turbulence than do the lower gradient segments. This allows for greater competence in transporting sediments. Consequently, bed and bank material derive from colluvial processes (derived from gravitational forces), rather than through deposition (USDI 1995).

Stratifications Used in the TPLA. The initial step to analyzing processes active in the channel is stratification of confined and unconfined segments exhibiting similar form and processes. Stream segments within the stratigraphic units have similarities in gradient, substrate, riparian width, width/depth ratios, and scour and fill processes. Additionally, channel responses to management activities are similar. The stratification used in this analysis is that of Rosgen (1994).

A correlation between the three natural fluvial processes and the Rosgen classification is shown in Table 30.

Table 30. Rosgen Stream Classification

Major Fluvial Process	Corresponding Rosgen Stream Type
Deposition	C, E, DA, F
Transport	B, G, F
Erosion	A, C
Source: (USDA 1995)	

The overlap of some of Rosgen's types is due to the nature of sediment carried, amount of flow, and geomorphic setting of stream channels.

"Confined" stream segments correlate with Rosgen's "entrenched" segments, "unconfined" stream segments correlate with Rosgen's "slightly entrenched" stream segments. Rosgen has added a third division, "moderately entrenched", which appears to be transitional between confined and unconfined.

Key Question: What are the current conditions and trends of stream channel types and sediment transport and deposition processes prevalent in the TPLA area?

Due to time and data constraints, only the BLM-administered portions of Long Prairie Creek and Hayden Creek are assessed. It is likely that the stream types and conditions described below are common throughout the TPLA area. Stream classifications were made using information gathered in a Level I inventory based on Rosgen (1994). These delineations provide a broad characterization of channel type that integrates the landform and fluvial features of valley morphology with channel relief, pattern, shape and dimension (Rosgen 1994). More detailed inventory of these streams is planned in Fiscal Year 1996, and stream classifications will be validated and further refined through field measurements during that time.

Long Prairie Creek. The entire BLM-administered reach of this stream can be classified as a F system according to Rosgen (1994). Type F streams are entrenched, meandering, gentle-gradient riffle/pool types with a high width to depth ratio (wide and shallow channels) with little to no developed floodplain. This channel type is laterally unstable with high stream bank erosion rates (Rosgen 1994). Fluvial processes involve both deposition and transport in this stream type. Channel substrate (as seen in photographs) is dominated by silt/clay, sand and gravel. Sensitivity to increases in streamflow magnitude and timing and/or sediment increases is very high to extreme in this channel type. Natural recovery potential is fair to poor, with better success occurring in segments dominated by silt/clay. Suspended and bedload sediment supply from channel derived sources is very high and stream bank erosion potential is very high. Vegetation has only a moderate influence on the stability of the width to depth ratio (Rosgen 1994).

In-channel coarse woody debris is scarce. Channel roughness has been reduced by the loss of large wood and reductions in woody vegetation and by the filling of pools with fine sediment. Historic logging activities (yarding, mill pond construction, railroad construction, and human settlement) in and adjacent to the stream likely initiated bank erosion. Furthermore, at least two dams were constructed on segments of Long Prairie Creek in the early part of this century, both of which failed. Because the failures were likely sudden in nature, it is possible that up to eight feet of stored water was abruptly released. The high energy of this flow likely scoured the stream channel and increased lateral instability and bank sloughing. These raw streambanks still persist and are very slow to heal. Roads are routing water directly to the stream channel, likely increasing peak flows. Livestock grazing and grazing by wild horses contributes to bank erosion and sedimentation. The combination of mechanical breakdown of banks from trampling and increased sedimentation results in the alteration of bed material composition and channel geometry. The input of sediment is fine materials; therefore, the channel is not aggrading, but a layer of sediment is evident throughout the area. Consequently, gravels are imbedded. Sedimentation is most profound during low flow periods. During the rise and peak of the hydrograph, sediments are lifted from the channel bed and become entrained. As the flow recedes, sediments are redeposited on the channel bottom.

Upstream conditions are adversely affecting this stream. In-channel water impoundments delay peak flow from reaching this section until they are filled. When peak flows recede, flows are limited to that in excess of available storage in the impoundments. Thus, the magnitude and duration of flows on the receding limb of the hydrograph have likely decreased. This effect, when combined with the loss of water storage in the large meadow systems associated with upstream sections of this stream and a possible watershed-wide increase in vegetation density over historic levels, may significantly reduce base flows and decrease the extent of perennial flow in this stream.

There are an estimated 335 road crossings and about 31 miles of road within 100 feet of streams in this subwatershed. The large number of crossings and length of road near streams increases the routing of water and sediment directly to stream channels. This increased routing may cause bank instability, which is compounded by the instability resulting from the roads and crossings themselves.

Hayden Creek. Two channel types occur in the BLM-administered reaches of this stream: G and B (Rosgen 1994). The section of G channel type is limited to about 1/8 mile in the upstream segment located in T. 41S R. 5E Section 1 which has been excluded from livestock grazing since 1985??????. This stream segment is in transition from a G system to an E system, which it probably was historically. Because recovery is still taking place, it is assumed that the channel forming processes associated with a G system are still dominant but are reduced in magnitude.

Type G streams are gullies that typically are step/pool channels. They have a low width to depth ratio similar to type E streams except they are well entrenched (have no floodplain), are steeper, and are less sinuous than type E streams. This channel type is vertically unstable with grade control problems and high bank erosion rates (Rosgen 1994). Fluvial processes in this type are mainly transportational, but depositional processes will slowly increase as the channel recovers to an E type. Channel substrate (as seen in photographs) is dominated by silt/clay, sand and gravel. Sensitivity to increases in streamflow magnitude and timing and/or sediment increases is very high to extreme in this channel type. Natural recovery potential is poor to very poor, with better success occurring in segments dominated by silt/clay. Suspended and bedload sediment supply from channel derived sources is high to very high and stream bank erosion potential is high to very high. Vegetation has a high level of influence on the stability of the width to depth ratio (Rosgen 1994).

The remainder of the BLM-administered reaches of Hayden Creek can be classified as a B system according to Rosgen (1994). Type B streams are riffle-dominated channels with occasional pools. They are moderately entrenched, of moderate gradient, with low sinuosity and are very stable (laterally and vertically). Fluvial processes in this type are mainly transportational. Channel substrate (as seen in photographs) is gravel and cobble. Sensitivity to increases in streamflow magnitude and timing and/or sediment increases is low to moderate in this channel type. Natural recovery potential is excellent. Suspended and bedload sediment supply from channel derived sources is low to moderate and stream bank erosion potential is low. Vegetation has a moderate level of influence on the stability of the width to depth ratio (Rosgen 1994).

In-channel large woody debris is scarce. Large woody debris likely played a role in the formation of pools in this channel, although the lack of it has not adversely affected channel stability. Sediment is transported through this section of stream, with little deposition occurring except in the G channel type. Impacts from roads, logging and grazing have been of lesser magnitude along this stream, with the reduction in shading and reductions in low flow being the two greatest impacts. Shading is addressed in the Riparian and Aquatic Habitat issues.

Upstream conditions are adversely affecting this stream. In-channel water impoundments delay peak flow from reaching this section until they are filled, similar to what is likely occurring on Long Prairie Creek. Furthermore, one of these reservoirs (Ward Reservoir) has failed in the past, releasing large amounts of sediment. During a recent field tour, concern was expressed that another failure is likely, due to the design of the spillway which results in erosion of the dam embankment. Gullying of upstream, low gradient sections of Hayden Creek has reduced the water storage capacity of this watershed; however, this storage, if restored, may not be enough to significantly increase base flows. The net effect of reduced flows from impoundment, when combined with the loss of water storage in the meadow systems associated with upstream sections of this stream and a possible watershed-wide increase in vegetation density over historic levels, could slightly reduce base flows and decrease the extent of perennial flow in this stream.

There are an estimated 242 road crossings and about 21 miles of road within 100 feet of streams in this subwatershed. The large number of crossings and length of road near streams increases the routing of water and sediment directly to stream channels. This increased routing may cause bank instability, which is compounded by the instability resulting from the roads and crossings themselves.

Upper Klamath River. Based on a cursory examination of aerial and ground photographs, the channel forming processes in this river can be generalized as B and C systems, according to the Rosgen Classification System (Rosgen 1994). The Rosgen B type is described under the Hayden Creek section. In the Rosgen C system, energy dissipation is from roughness, namely, sinuosity and bar development. Sinuosity occurs through erosion on the outside of the bends and depositing materials on the inside. Sinuosity increases channel length; channel gradient decreases proportionately. As the river meanders, bars alternately form, providing structure and slowing velocities. Pools are predominately scour holes on the outside of bends. Between bends, or cross over points, the channel is straight with little form roughness. Velocities increase forming riffles. Lateral scour holes, or undercut banks, are prevalent in these areas. This sequence of meander bends and cross over points define the pool-riffle sequence (USDI 1995).

The Klamath River is a very stable system, with a well-developed floodplain in the C type segments. Flow regulation has decreased the length and frequency of floodplain inundation, so the effect of peak flows is moderated. However, this moderating of peak flows also reduces the flushing of fine sediments from the system, and sedimentation effects are apparent in the section below the J.C. Boyle dam where flows can be greatly reduced. The cobble and boulder channel substrate is resistant to scouring, and provides the majority of channel roughness (except during periods where the river is accessing its floodplain). Channel complexity has likely been reduced, due to activities associated with log transport down the river (creation of dams to collect water and then abrupt release of the dammed water to "flush" logs downstream). Due to the size of the river, large woody debris acted more like sediment, being transported through the system rather than deposited and incorporated into the channel. Roads are having a minimal effect, except to floodplains in the sections of river near the Oregon-California border.

Intermittent and Ephemeral Channels. Many of these streams are likely of the Rosgen A or B stream type (see Hayden Creek section for a description of B type streams). A type streams are narrow, deep, confined and entrenched. The width of the channel and valley are similar. These channels are relatively straight and of high relief. They are generally stable cascading streams that occur on the steep slopes adjacent to the Klamath River. Vegetation plays a negligible influence in this type.

The majority of the channel network in the TPLA area, in terms of total stream miles, is first and second order streams. Stream density is low reflecting rapid infiltration rates of the soil. All but a very few stream segments are intermittent or ephemeral. These drainages connect with the main stream systems or the Klamath River only infrequently during runoff periods. Their function, as it relates to channel condition, is the storage of sediment and organic debris. Each channel is a catchment for the respective drainage area. Sediments and organic material migrate downslope and accumulate in the channel. During runoff events of sufficient magnitude (generally, a 5- to 10-year recurrence interval), the material is mobilized and delivered downstream. The products (sediment, woody debris, and organics) are important for bar/floodplain development, instream complexity, and food production (respectively) in the higher order stream systems.

Trends. In the B channel type, altered morphology and increased sedimentation will persist into the near term. The removal of wood from the channel has simplified channel form. And with the combination of harvest and road building, natural recruitment of wood to historic levels is not likely for more than 100 years. Routing of water and sediments from the road system will continue.

In the G and F channel types, the dominance of fine sediment on the channel bed and accelerated bank erosion will likely persist in the F channel type and decrease in the excluded portions of the G channel type. Improvement of channel substrate in the F and G channel types, from silt dominated to a historic mixture of silts to gravels, will require considerably more time considering the magnitude and spatial extent of the sediment input from roads and tributaries.

In-channel impoundments will continue to adversely affect low flows and, in the case of Ward Reservoir, may be a significant source of sediment if failure occurs.

Key Question: What were the historical morphological characteristics of stream valleys and general sediment transport and deposition processes in the TPLA area?

Direct information on historic stream channel characteristics in the TPLA area is lacking. Examination of aerial photographs taken in 1957 indicates that channel conditions existing today are similar to those existing in 1957. It is hypothesized that the majority of channel changes in Long Prairie Creek occurred around the turn of the century, when logging activity was centered along this drainage. It is not known when the changes to channel condition occurred in Hayden Creek. Inferences about historic channel processes can be inferred from the channel types assumed to be in existence prior to EuroAmerican activity in the TPLA area.

Historically, B-type channels provided high quantities of large woody debris, very stable banks, and high amounts of channel shading by conifers in higher elevations and by deciduous species at lower elevations. Historically, these processes form a pool-riffle system. Due to the high gradient the frequency of pool-riffle sequencing was approximately three to seven channel widths; increasing in frequency with higher gradient. Large wood was a factor in the number of pools. Water flowing over logs was directed to the channel bottom, scouring the substrate. Large wood also created dam pools upstream and slowed velocity allowing for the deposition of gravels.

The E channels and, to a lesser extent, the C channels of the Klamath River, had low width to depth ratios, stable banks, meandering and sinuous channel configuration, and a high amount of undercutting. Riparian vegetation consisted of sedges, rushes, willow, aspen and other riparian species. Stream shading was moderately high from willow and other deciduous species overhanging the stream. Water tables were generally higher in the riparian areas. This resulted in lower peak summer water temperatures and higher winter minimum temperatures. Conditions in A channels were likely similar to those existing today.

Key Questions: What are the natural and human causes of change between historical and current channel conditions? What are the influences and relationships between channel conditions and other ecosystem processes in the TPLA area?

Grazing has little affected stream bank erosion rates in the higher gradient B type reaches due to armoring or inaccessibility. Conversely, cattle and wild horses have detrimentally impacted many areas in the lower gradient segments (F channels) and in the G channel type portion of Hayden Creek. Armoring of banks from vegetation and root mass greatly limits the rate of erosion; grazing removes the armoring, initiating accelerated adjustment and associated sediment. Additionally, floodplain vegetation is reduced allowing for increased flow velocities during "out of bank" flow events; the process of deposition on the floodplain is reduced proportionally. Bank erosion from these reaches is a relatively high contribution to the total increase in the sediment budget.

Recent changes in livestock grazing management have removed livestock use from the upper portions of Long Prairie Creek, but increased grazing pressure may occur on the unexcluded lower portions. In addition, the presence of exclosures on Hayden Creek and Long Prairie Creek may not preclude use by wild horses, which can cause greater adverse effects than livestock because use is not restricted to a particular season.

Timber harvest and road building has reduced large wood recruitment potential and stream side shading in the F and B channel types. Assuming mid- to late-seral stages are the only source of large wood recruitment to the stream channel, this vegetation class has been reduced throughout the TPLA area (see Forest Composition, Structure and Function Issue). The proximity of roads adjacent to and paralleling stream channels prevents the upslope recruitment of large wood debris into the channel network. See Map 9 for road system information. Recruitment of large woody debris and shading will remain low for about 100 years in areas of confined reaches where trees were cut until trees grow to recruitment potential height. In unconfined reaches (E channel type), recruitment will be low, with willows functioning as the dominant pool forming material. Undercut banks and root wads from willows will be the important structural elements in these areas. Riparian vegetation is in a recovery phase due to recent changes in grazing management and the installation of an additional riparian exclosure on Hayden Creek.

There are a high number of road crossings and miles of road within 100 feet of stream channels in the TPLA (see the Hydrology core topic). In many areas, roads are routing water and sediment into stream channels. Roads are having adverse effects on channel condition and stability in many areas (particularly in the G and F channel types), with accelerated stream bank erosion and sedimentation occurring at many road crossings and where roads closely parallel streams. The sediment input from bank erosion is a moderate portion of the total increase in sediment budget in the G and F channel types. The increase in sedimentation is affecting aquatic habitat in the B type channel segments, but to a lesser extent because a large portion of the material is transported to the lower gradient reaches.

Core Topic: Riparian Vegetation

Issue: Vegetation communities in riparian-wetland areas have been altered in the TPLA area.

Key Questions:What is the array of plant communities and seral stages in riparian-wetland areas? What processes caused these patterns?

Lentic Riparian-Wetland Areas

Federal policy defines wetlands as areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and which, under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetland types include marshes, shallow swamps, lake shores, bogs, muskegs, wet meadows, estuaries, and riparian areas (USDI 1994b). Lentic riparian-wetland areas (hereafter referred to as "wetlands") are associated with still water systems. These wetlands occur in basins and lack a defined channel and floodplain. Included are perennial or intermittent bodies of water such as lakes, reservoirs, potholes, marshes, ponds, and stock ponds. Other examples include fens, bogs, wet meadows, and seeps not associated with a defined channel (Hinkley et al. 1995).

Information on wetlands in the TPLA is lacking. The primary source of information on these areas is the National Wetlands Inventory (NWI) conducted by the U.S. Fish and Wildlife Service. In many instances, wetlands were classified through aerial photo interpretation, rather than on-site examinations. The maps produced in the NWI were imported into the BLM GIS database to create a map of wetland areas (see Map C in the Analysis Files). A list of the wetlands occurring in the TPLA area and the acreage of each type is given in Table 31. There are a total of 1,850 acres of mapped lentic wetlands in the TPLA area. The NWI maps are not yet available for California; therefore, not all of the wetlands occurring in the TPLA area are included in the total.

The classification system used to describe the wetlands in the TPLA area was established by the U.S. Fish and Wildlife Service (USFWS) and was used in mapping wetland areas for their NWI. This classification system is described in *Classification of Wetlands and Deepwater Habitats of the United States* (USFWS 1979, Reprint 1992). This classification system uses modifiers to describe the plants, soil types, and frequency of flooding that define a particular wetland habitat.

The two lentic wetland types occurring in the TPLA area are lacustrine and palustrine. There are about 1,280 acres of palustrine wetlands and 570 acres of lacustrine wetlands. Lacustrine wetlands include permanently flooded lakes and reservoirs and intermittent lakes. These wetlands often have extensive areas of deep water, an active wave-formed or bedrock shoreline, and are greater than 20 acres in size. Trees, shrubs and emergent (see definition below) vegetation are lacking. The lacustrine wetlands in the TPLA area are all associated with J.C. Boyle Reservoir. Lacustrine systems are separated into two subsystems: limnetic and littoral. All deepwater habitats (habitats in which the low water level is greater than 6.6 feet in depth) within a lacustrine system are classified as limnetic. Many small lacustrine systems have no limnetic habitat. Littoral habitats generally extend from the shoreward boundary of the wetland/water body to a depth of 6.6 feet below low water (USFWS 1979, 1992).

Palustrine wetlands are vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and prairie. Also included are the small, shallow, permanent or intermittent water bodies often called ponds. Palustrine wetlands may be found shoreward of lakes, river channels or estuaries; on river floodplains; in isolated catchments; or on slopes. They may also occur as islands in lakes or rivers. Palustrine wetlands are characterized by the presence of vegetation (trees, shrubs and emergent vegetation) and they are usually less than 20 acres in size (USFWS 1979, 1992).

Lacustrine and palustrine wetland types can share certain vegetation, substrate or water regime characteristics. The classifications of vegetation and substrate characteristics of lentic wetlands in the TPLA are listed in Table 31 and are defined below (from USFWS 1972, 1992). In addition, special terms are used to describe human-made wetlands and natural wetlands that have been modified to some degree by the activities of humans or beaver.

Table 31. Lentic Riparian-Wetland Areas (Wetlands) in the TPLA Area

Lentic Riparian-Wetland Area (Wetland) Type	Acres
Palustrine Emergent, Seasonally Flooded	756
Lacustrine, Limnetic, Unconsolidated Bottom, Permanently Flooded, Diked/Impounded	421
Palustrine Emergent, Temporarily Flooded	364
Lacustrine, Littoral, Aquatic Bed, Permanently Flooded, Diked/Impounded	150
Palustrine, Emergent, Seasonally Flooded, Diked/Impounded	38
Palustrine, Emergent, Saturated	27
Palustrine, Emergent, Semipermanently Flooded	14
Palustrine, Emergent, Temporarily Flooded, Diked/Impounded	13
Palustrine, Aquatic Bed, Semipermanently Flooded, Diked/Impounded	10
Palustrine, Scrub-Shrub, Seasonally Flooded, Diked/Impounded	9
Palustrine, Emergent, Semipermanently Flooded, Diked/Impounded	9
Palustrine, Forested, Saturated	9
Palustrine, Unconsolidated Bottom, Semipermanently Flooded, Excavated	9
Palustrine, Unconsolidated Bottom, Semipermanently Flooded, Diked/Impounded	5
Palustrine, Forested, Temporarily Flooded	4
Palustrine, Forested, Seasonally Flooded	3
Palustrine, Scrub-Shrub, Temporarily Flooded	3
Palustrine, Aquatic Bed, Semipermanently Flooded	2
Palustrine, Emergent, Seasonally Flooded, Excavated	2
Palustrine, Unconsolidated Bottom, Permanently Flooded, Excavated	2

Emergent. This wetland type is characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants, and are commonly called marshes, meadows, fens, potholes, or sloughs.

Scrub-Shrub. These wetlands include areas dominated by woody vegetation less than 20 feet tall, including true shrubs, young trees, or trees or shrubs that are small or stunted because of environmental conditions.

Forested. This wetland class is characterized by woody vegetation that is 20 feet tall or taller. Vegetation is commonly an overstory of trees, an understory of young trees or shrubs, and a herbaceous layer.

Unconsolidated Bottom. All wetlands and deepwater habitats with at least 25 percent cover of particles smaller than stones, and a vegetative cover less than 30 percent. These wetlands are characterized by the lack of large stable surfaces for plant and animal attachment.

Aquatic Bed. Includes wetlands and deepwater habitats dominated by plants that grow principally on or below the surface of the water for most of the growing season in most years. The plants are either attached to the substrate or float freely in the water above the bottom or on the surface.

Permanently Flooded. Water covers the land surface throughout the year in all years. Vegetation is composed of obligate hydrophytes (those species found only in wetlands, such as cattails).

Semipermanently Flooded. Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land surface.

Seasonally Flooded. Surface water is present for extended periods especially early in the growing season, but is absent by the end of the season in most years. When surface water is absent, the water table is often near the land surface.

Saturated. The substrate is saturated to the surface for extended periods during the growing season, but surface water is seldom present.

Temporarily Flooded. Surface water is present for brief periods during the growing season, but the water table usually lies well below the soil surface for most of the season. Plant that grow both in uplands and wetlands can occur.

Excavated. The wetland lies within a basin or channel excavated by humans.

Diked. Wetlands that were created or modified by a human-made barrier or dike designed to obstruct the inflow of water.

Impounded. A wetland created or modified by a barrier or dam which purposefully or unintentionally obstructs the outflow of water. Both human-made dams and beaver dams are included in this category.

Because no inventory has been conducted on lentic wetlands in the TPLA area, only broad generalizations will be made on the likelihood that a particular vegetation type or plant species will occur. These generalizations were formed by grouping various wetland types used in the NWI (U.S. Army Corps of Engineers 1984). These groupings, which are based on familiar habitat types, have "indicator" plant species that typically or commonly occur in these wetland/habitat types. Table 32 lists the habitat type, the corresponding NWI wetland types, and the "indicator" plant species that occur in wetlands in the Pacific Northwest. Not all of the indicator species listed will occur in the TPLA area, and the indicator species listed represent only a small percentage of the plant species that occur in Pacific Northwest wetlands and in the TPLA area.

Using the habitat types in Table 32 below, in the TPLA area there are about 820 acres of lentic wetlands classified as shallow fresh water marsh; 380 as seasonally flooded basins or flats; 27 as wet meadow; 15 as swamp; 14 as deep fresh water marsh; and 9 as bog. Most of the 820 acres of shallow fresh water marsh and the 380 acres of the seasonally flooded basins or flats are associated with Lake Miller and the Klamath River in the northeast portion of the TPLA area. Both of these wetlands are located on non BLM-administered lands. It is estimated that up to five percent (about 90 to 100 acres) of the total acres of lentic wetlands in the TPLA area are located on BLM-administered land.

Table 32. National Wetlands Inventory Types		
Waterfowl Habitat Type	Corresponding NWI Wetland Types*	"Indicator" Plant Species (common name)
Seasonally flooded basins or flats	Emergent, Temporarily Flooded Forested, Temporarily Flooded	None listed. Plants that grow both in uplands and wetlands can occur.
Wet meadow	Emergent, Saturated	Spike rush, soft rush, skunk-cabbage, reed canarygrass, buttercup, curly dock
Shallow fresh-water marsh	Emergent, Semipermanently Flooded Emergent, Seasonally Flooded	American water plantain, lady fern, slough sedge, beggars-tick, spike rush, soft rush, reed canarygrass, common duckweed, fireweed, marsh willow-herb, touch-me-not, yellow iris, purple loosestrife, water parsley, reedgrass, smartweed, arrowhead (wapato), small-fruited bulrush, burreed, common cattail
Deep fresh-water marsh	Emergent, Permanently Flooded Emergent, Semipermanently Flooded Aquatic Bed Semipermanently Flooded Aquatic Bed Permanently Flooded Unconsolidated Bottom, Permanently Flooded	Yellow iris, common duckweed, Eurasian watermilfoil, spatterdock, white water lily, smartweed, hardstem bulrush
Swamp	Scrub-Shrub, Seasonally Flooded Scrub-Shrub, Temporarily Flooded Forested, Seasonally Flooded	Red alder, lady fern, slough sedge, red-osier dogwood, Oregon ash, skunk cabbage, Pacific ninebark, Sitka spruce, Western crabapple, willow, small-fruited bulrush, Douglas spiraea
Bog	Forested, Saturated	None listed.
*All are Palustrine wetland types. No "indicator" species for lacustrine wetlands is provided in U.S. Army Corps of Engineers (1984).		

Lotic Riparian-Wetland Areas

Lotic riparian areas are a category of riparian-wetland areas that are associated with running water habitat such as rivers, streams, and springs. An estimate of the total amount of lotic areas within the TPLA has not been attempted at this point. In the Hydrology section of this document , an estimate has been made of the stream miles within the three major subwatersheds of Long Prairie Creek, Hayden Creek, and Edge Creek. Within these three subwatersheds there are an estimated 10.2 miles of perennial, 110.7 miles of intermittent, and 117.1 miles of ephemeral stream channel. Riparian vegetation would typically be found along the perennial and long term intermittent streams due to the prescence of more permanent surface or subsurface water. The ephemeral channels normally do not exhibit typical riparian area vegetation due to the lack of permanent moisture.

The Northwest Forest Plan (NFP ROD) document contains the Aquatic Conservation Strategy. This was developed to restore and maintain the ecological health of watersheds and aquatic ecosystems contained within them on public lands. One componenet of this strategy is the inclusion of Riparian Reserves.

The Riparian Reserves include those portions of a watershed directly coupled to streams and rivers, that is, the portions of a watershed required for maintaining hydrologic, geomorphic, and ecologic processes that directly affect standing and flowing waterbodies such as lakes and ponds, wetlands, streams, stream processes, and fish habitats. Under the Aquatic Conservation Strategy, Riparian Reserves are used to maintain and restore riparian structures and functions of intermittent streams, confer benefits to riparian-dependent and associated species other than fish, enhance habitat conservation for organisms that are dependent on the transition zone between upslope and and riparian areas, improve travel and dispersal corridors for many terrestrial animals and plants, and provide for greater connectivity of the watershed (NFP ROD 1994).

The width of Riparian Reserves are based upon five categories of streams or waterbodies. The determination of the width of the Riparian Reserve for each of the five categories is described on pages C-30 and C-31 of the NFP ROD document. Within the TPLA area an estimate of the amount of Riparian Reserves on perennial and intermittent streams on BLM lands based upon using a 150 foot site potential tree is as follows:

Fish bearing streams -	896 acres
Permanently flowing nonfish-bearing streams -	78 acres
Seasonally flowing or intermittent streams -	2492 acres

Some of the most important biological and physical effects of riparian vegetation are: providing organic matter that can be used as food sources for aquatic organisms; supplying large woody debris that alters sediment storage, influences channel morphology, and enhances fish production; shading the stream and reducing temperature fluctuations; reducing bank erosion; and providing habitat and cover for both aquatic and terrestrial organisms (MacDonald 1991).

An inventory of the riparian ecosystems in the TPLA has not been completed. Plant lists have been developed for some areas during riparian surveys as discussed later. A description of the overstory vegetation communities within the TPLA area can be found in the Vegetation core topic. The riparian vegetation is influenced by the moisture regime of the particular stream and by the overstory community surrounding it. Typical riparian vegetation would include small tree/shrub species like willows, aspens, cottonwood, spirea, and Oregon ash. Grass/forb/shrub species would include sedges, rushes, and bluegrasses.

Key Question: What are the current conditions and trends of the prevalent plant communities and seral stages in the riparian-wetland areas?

Lentic Riparian-Wetland Areas

The BLM expresses the status of wetland areas in terms of functioning condition and ecological status. Functioning condition is an important measure of the health of wetland areas, and wetlands have the potential to function properly at all plant successional stages (USDI 1994). Evaluating functionality is based upon a wetland's capability and potential. Capability is the highest ecological status a wetland area can attain given political, social, or economical constraints. Potential is the highest ecological status an area can attain given **no** political, social, or economical constraints (USDI 1994b).

Lentic wetland areas are considered to be functioning properly when adequate vegetation, landform, or debris is present to:

-dissipate energies associated with wind action, wave action, and overland flow from adjacent sites, thereby reducing erosion and improving water quality;

-filter sediment and aid floodplain development;

-improve flood-water retention and ground-water recharge;

-develop root masses that stabilize islands and shoreline features against cutting action;

-restrict water percolation;

-develop diverse ponding characteristics to provide the habitat and water depth, duration, and temperature necessary for fish production, waterbird breeding, and other uses;

-and support greater biodiversity.

Analysis of a lentic wetland's health must consider vegetative characteristics and physical factors such as soils and hydrology. Changes in soil or hydrologic conditions can affect the functional capacity of a wetland, and the susceptibility of a system to changes in functional capacity is important for assessment of health. The BLM's Technical Reference 1737-11 *Riparian Area Management: Process for Assessing Proper Functioning Condition for Lentic Riparian Areas* (USDI 1994b) contains a process for assessing factors that affect the health of lentic wetlands. Three major components of health are assessed using this process:

Hydrology. The hydrology of a lentic wetland is perhaps its most important characteristic. Changes in hydrology may result not only in short term vegetative changes, but also in different climax communities. Examples of such changes include changes in the rate or timing of flow entering the wetland, water table changes, and artificial draw down of the water level in the wetland (Hinkley et al. 1995).

Vegetation. Because they are more visible than soil or hydrological characteristics, plants may provide early indications of wetland health as well as successional trend. These are reflected not only in the types of plants present, but also by the effectiveness of the vegetation in carrying out its wetland functions of stabilizing the soil and trapping sediments (Hinkley et al. 1995).

Soils and Erosion/Deposition. Exposed soil surface is important in evaluating the health of a wetland area because exposed soil is vulnerable to erosion; it may contribute to or reflect shoreline deterioration; the higher the percentage of exposed soil, the less vegetation is available for soil protection and sediment entrapment; and exposed soil provides opportunity for invasion by noxious weeds and undesirable species. Exposed soil surfaces resulting from human-caused activity include cattle wallows and trails; hiking and off-highway vehicle trails; roads; skid trails; and mining activities (Hinkley et al. 1995). Soil or an underlying geologic structure are often important to maintaining the hydrologic regime of a wetland by functioning as a restriction to water percolation (USDI 1994b).

Information from this Technical Reference can be used to infer likely influences on the health of wetlands in the TPLA area. The likely influences on the health of wetlands in the TPLA area, based on the three components outlined above, are presented in later in this analysis.

Lotic Riparian-Wetland Areas

Most of the perennial and long term intermittent streams in the TPLA area currently have willows (*salix sp.*) , sedges (*Carex sp.*), and rushes (*Juncus, Scirpus,* and *Eleocharis sp.*) as the major riparian vegetation types.

Also, Oregon ash (*Fraxanus oregana*), spirea (*Spirea douglasii*), and members of the *Rosaceae* family are frequently encountered. In areas where channel conditions have been degraded, more xerophyllic species have encroached into the riparian areas. Some of these species include Kentucky bluegrass (*Poa pratensis*), cheatgrass (*Bromus tectorum*), and Juniper (*Juniperus occidentalis*). A listing of the species found within the BLM portions of Long Prairie Creek and Hayden Creek can be found in Table 15. These inventories include the plant species that are typical of the riparian areas and adjacent uplands in the TPLA area.

Proper Functioning Condition surveys

Proper Functioning Condition surveys were completed for the BLM portions of Long Prairie Creek, Hayden Creek, and Edge Creek during 1994 and 1995. These surveys are designed to determine if the current vegetative, hydrologic, and erosion/deposition characteristics of riparian areas are in a condition to allow a stream or other type of wetland to function within it's capability and potential. Additional information on this process can be found in BLM Technical Reference 1737-9 *Riparian Area Management - Process for Assessing Proper Functioning Condition*. The results of these surveys are presented below.

Long Prairie Creek

The following surveys of Long Prairie Creek were completed on 7/26/94. See Map 10 for the location of the surveys.

This stream section was rated as Functional-At Risk with livestock grazing given as the great demon. Excessive cattle trampling damage has occurred on the streambanks with grazing occurring on the sedge and rush species occurring there. Riparian vegetation observed included willows, rushes, and sedges, but only in scattered patches. Also at this point, a stream crossing has washed out and is supplying high levels of fine sediments to the stream. Vehicles are still traversing the stream at this point and causing major streambank damage.

Riparian Photo Point LP-R-2

This section is inside of the lower end of the Dixie exclosure.

This stream section was rated as being in Proper Functioning Condition. Some raw banks were noted, but riparian vegetation was noted as increasing throughout this section. Water was present in the stream channel on the date of the survey, 7/26/94. Note: This section is located below the outflow of the Dixie spring, which has perennial flow.

Riparian Photo Points LP-R-3 & 4

This section is in the upper end of the Dixie Exclosure.

This section was rated as Nonfunctional. There was a lack of riparian vegetation present (sedges or rushes) with actively eroding banks. Some "unnatural looking" overflow channels were noted in this section. This section is upstream from the Dixie spring outflow. The channel was dry at the time of the survey, 7/26/94.

Riparian Photo Point LP-R-5

This section is upstream and outside of the Dixie exclosure.

This section was rated as Functional-At Risk. Areas of willows and other riparian vegetation were noted. Raw banks and mesic grasses were also present. There were also signs of hoof trampling on the streambanks attributed to cattle.

Hayden Creek

The following surveys were completed on Hayden Creek on 7/27/94. See Map 10 for locations of stream sections.

Riparian Photo Point H-R-1

This section of Hayden Creek was rated as Functional-At Risk with an upward trend. This section is within an exclosure that was built to exclude livestock. The stream has severely downcut at some point in time but is now starting to revegetate with willows, sedges, and rushes. Most of this vegetation is of a young age class. The large meadow area that the stream goes through has dried up due to the stream downcutting and the plant community is dominated by weedy species and exotics.

Riparian Photo Point H-R-2

This section was rated as Functional-At Risk with no apparent trend. Late season cattle grazing was identified as a risk. Many riparian plants were present but had been heavily grazed including the willows. Cattle and horse tracks were evident.

Riparian Photo Point H-R-3

This section was rated as being in Proper Functioning Condition. Numerous willows were noted with little impact from grazing in this stretch. This point compared similarly to Point H-R-2 but without as much grazing pressure. It was noted that a road crosses through the creek below this point, but not much impact was evident.

Riparian Photo Point H-R-4

This section was rated as being in Proper Functioning Condition. This section does not appear to have much water during a significant part of the year. This reason was given for the lack of riparian vegetation species. Plants that were present have low water demands. A road crosses through the creek upstream of the point and another follows along the channel.

Riparian Photo Points H-R-5,6, & 7

This section was rated as being in Proper Functioning Condition. It was also thought to be mainly intermittent with few riparian species present. There were a few willows and a small stand of young black cottonwoods was noted. Klamath Weed (*Hypericum perfoliatum*) was a dominant species along the channel.

Edge Creek

This survey of Edge Creek was completed on 5/26/95. See Map 10 for location of survey. This small section of Edge Creek that is on BLM-administered land was rated as being in Proper Functioning Condition. A high amount of fine sediments were noted in the stream bed. This portion of the creek flows through wide meadows that appear to be flooded during spring runoff. Evidence of hoof action from livestock and wildlife was noted. The meadows also have received heavy grazing pressure in the past as evidenced by the high percentage of annual weed and grass species.

Key Questions: What is the historical array of plant communities and seral stages in riparian-wetland areas? What processes caused these patterns?

Lentic Riparian-Wetland Areas

No information was found on the type, distribution or extent of wetlands historically occurring in the TPLA area. Also, the vegetation communities and seral stages that existed prior to EuroAmerican activity are unknown, although many of the plant species that historically occurred probably have persisted to some extent. Because of the high permeability of soils in most of the TPLA area, it is probable that the extent of wetlands was not significantly greater than currently in existence. An exception to this may be Lake Miller. It is not known whether Lake Miller was more extensive than it is today.

Some wetlands in the TPLA area would have existing in association with the Klamath River because of its hydrologic role as a groundwater discharge zone (see Hydrology Issue). Most of the wetlands in the TPLA area are assumed to have been formed though the accumulation of finer alluvial material in basins and valleys over time. This finer alluvial material reduced the loss of surface moisture from percolation into the soil and would have retained water near the soil surface. Some locally perched water tables could also have caused wetlands to form. These perched water tables could result from local irregularities in the underlying rock where percolation is restricted. Percolation may be restricted by a lack of fracturing in the bedrock or by the nature of the bedrock. For example, in the Hydrology Issue a relation between tuff-derived bedrock and springs or other surface expression of groundwater is theorized. Because a regional shift in groundwater is not known to have occurred, any change in a wetlands hydrology in the TPLA area from historic conditions would likely have been localized and probably human-caused.

Lotic Riparian-Wetland Areas

Historical data on riparian plant communities were not found for the TPLA area. The current communities were probably also present in the past, The percentage and levels of the different species within a community was likely different prior to the effects of disturbance factors such as timber harvest, beaver trapping, and livestock grazing. These disturbance factors resulted in erosion and downcutting in many of the stream systems which resulted in a lowering of the water table. This lowered water table reduced the amount of moisture present to support the riparian vegetation and allowed more xerophyllic species to encroach.

Key Questions: What are the natural and human causes of change between historical and current vegetative conditions in riparian-wetland areas? What are the influences and relationships between vegetation and seral patterns and other ecosystem processes in the TPLA area?

Lentic Riparian-Wetland Areas

Of the 1,850 acres of lentic wetlands in the TPLA area, about 670 have been modified or created by dikes, impoundment, or excavation. Therefore, it is uncertain whether there is currently more or fewer acres of wetlands than existed historically but it is likely that the total acreage has remained stable over time. Most of the excavated wetlands are water developments for livestock and other uses; these may be newly created wetlands or a development may have been built in an existing wetland (such as the digging of a pit in a shallow fresh water marsh to hold water later in the year). The lacustrine wetlands associated with J.C. Boyle Reservoir were created by impoundment of the Klamath River, although it is likely that riverine (lotic) or palustrine wetlands occurred in association with the river in that area historically. Because J.C. Boyle does not experience drastic fluctuations in water levels, these lacustrine wetlands probably have a stable hydrologic regime. Lake Miller may have been modified from its historic condition by agricultural or water control practices, but no modification is indicated by the NWI inventory (Lake Miller is not designated as excavated, diked or impounded).

The extensive road network in the TPLA area has likely altered the hydrologic regime of some wetlands in the TPLA area by filling of wetland areas to build a road bed, increasing the water supply to specific wetland areas by runoff from drainage facilities, or interception and redirection of water away from a wetland area by road drainage facilities. Roads are also a significant source of fine sediment, and it is probable that some filling of wetlands with road-derived sediment has occurred. Infrequently, water may be taken from a developed water source and used for fire suppression or road construction and maintenance. This dewatering would have short term effects on the hydrology of the wetland associated with the water source.

Other likely impacts to wetlands include trampling of shorelines and substrate by livestock, elk and wild horses and overgrazing of wetland vegetation by these herbivores. This may have altered vegetation composition or vigor from historic levels. Excessive inputs of nutrients from grazing animals has not been noted, and it is not likely because concentrated numbers of these animals around a single wetland for any length of time probably does not occur.

The current health and condition of lentic wetlands in the TPLA area will likely remain static or slightly improve over the short- and long-term. Improvements in condition may result from the recent changes in livestock grazing management and a potential reduction in wild horse herd numbers.

Lotic Riparian-Wetland Areas

The condition of the riparian areas in the TPLA area has been primarily influenced by two major factors, timber harvest and livestock grazing. Timber harvest activities including construction of roads, skid trails, and landings within riparian areas directly affect riparian vegetation through the uprooting, displacement, or destruction of the plant species. The disturbed areas also provide sites for the invasion of weedy and exotic plant species. The harvest of trees in the riparian area affects the plant communities by changing the amount of sunlight that reaches the plants in the lower canopies. This increase in solar radiation can result in a shift in the populations of species present or may allow for conditions that favor the introduction or elimination of certain species.

Unwise use by livestock is considered the most common cause of deteriorated riparian zones in western rangelands (Knopf and Cannon 1981). Improper grazing can reduce plant vigor and reduce or eliminate streamside vegetation. This in turn can change plant species composition, lower water tables, change the timing and amount of organic energy entering and leaving a stream, decrease canopy cover and change a stream from perennial to ephemeral flow. Improper livestock grazing can directly alter streamside vegetation by trampling, rubbing and grazing herbaceous plants and browsing on shrubs (Platts 1990). As noted in the Livestock Grazing section of this document, livestock have made moderate to heavy use of some of the riparian areas in the TPLA area. Wild horses, elk, and deer also use riparian vegetation as a major part of their diets.

Core Topic: Water Quality

Issue: Water quality has been altered in the TPLA area.

Key Questions: What beneficial uses dependent on aquatic resources occur in the TPLA area? Which water quality parameters are critical to these uses?

Beneficial Uses

Oregon. The State of Oregon has established beneficial uses for the Klamath Basin and water quality requirements that provide protection for those uses. Sediment, stream temperature, dissolved oxygen, and chemical composition are important indicators of the level of protection for beneficial uses within a watershed. These indicators are listed in the Oregon Administrative Rules (340-41) and are summarized in Table 33.

Table 33. Oregon's Instream Water Quality Standards (DEQ 1994)

Parameter with Numeric Standards*	Primary Beneficial Uses Protected**
Dissolved Oxygen	Fisheries and Aquatic Life
E. Coli Bacteria	Water-Contact Recreation
pH	Fisheries and Aquatic Life
Temperature	Fisheries and Aquatic Life
Turbidity	Fisheries and Aquatic Life
Chlorophyll a	Aesthetics and Fisheries

*Numeric standards are listed for the Klamath Basin in OAR 340-41-965.
**Additional beneficial uses protected by these standards include aesthetics, livestock watering, wildlife and irrigation water supply.

The primary beneficial uses for water resources that are related to land management activities on BLM-administered lands are rearing and spawning habitat for salmonids, domestic water supply, fishing, resident fish and aquatic life, and recreation (see Table 2). All these uses require high water quality and sufficient water quantity. The Klamath River Basin Compact (Oregon Revised Statutes 542.610 to 542.630), an interstate compact between Oregon and California, identifies beneficial uses for the waters of the Basin, including domestic, irrigation, recreation, fish and wildlife, industrial, and hydroelectric power purposes, along with other uses recognized by each state involved.

Table 2. Beneficial Uses of Waters in the Klamath Basin as Listed in Oregon DEQ's Basin Rules

Beneficial Uses	All Waters in the TPLA Area
Public Domestic Water Supply*	X
Private Domestic Water Supply*	X
Industrial Water Supply	X
Irrigation	X
Livestock Watering	X
Salmonid Fish Rearing**	X

Salmonid Fish Spawning**	X
Resident Fish and Aquatic Life	X
Wildlife and Hunting	X
Fishing	X
Boating	X
Water Contact Recreation	X
Aesthetic Quality	X
Hydroelectric Power	
Commercial Navigation and Transportation	

Source: Oregon Administrative Rules 340-41-962
*With adequate pre-treatment and natural quality to meet drinking water standards.
**Where natural conditions are suitable for salmonid fish use.

California. The Klamath Basin is part of California's North Coast Region, one of the planning units used by the State of California for control of water quality and protection of its waters. The *Water Quality Control Plan for the North Coast Region* (North Coast Regional Water Quality Control Board 1993) describes the water quality and quantity problems and the present and potential beneficial uses of the surface and ground waters within the Region. The plan also prescribes water quality objectives to protect the beneficial uses and describes the measures and policies which form the basis for the control of water quality. The beneficial uses identified for the Klamath Basin and its waters are listed in Table 34. Protection is afforded to present and potential beneficial uses, and the beneficial uses of any specifically identified water body generally apply to all its tributaries (North Coast Regional Water Quality Control Board 1993).

Table 34. Beneficial Uses of Waters in the Klamath Basin as Listed in the North Coast Water Quality Control Plan

Beneficial Uses	Klamath River and Tributaries	Copco Reservoir
Municipal and Domestic Supply	E	P
Agricultural Supply	E	P
Industrial Service Supply Not Dependent on Water Quality	E	P
Industrial Process Supply Dependent on Water Quality	E	P
Groundwater Recharge	E	
Freshwater Replenishment	E	E
Navigation		
Hydropower Generation	E	E
Water Contact Recreation	E	E
Non-Contact Water Recreation	E	E
Commercial and Sport Fishing	E	E
Aquaculture	E	E
Warm Freshwater Habitat	E	E

Cold Freshwater Habitat	E	E
Inland Saline Water Habitat		
Estuarine Habitat		
Marine Habitat		
Wildlife Habitat	E	E
Preservation of Areas of Special Biological Significance		
Rare, Threatened, or Endangered Species	E	E
Migration of Aquatic Organisms	E	E
Spawning, Reproduction, and/or Early Development of Fish	E	E
Shellfish Harvesting		
E=Existing beneficial use P=Potential beneficial use		

Water Quality Standards

Oregon

The numeric and narrative State of Oregon water quality standards that apply to waters and management activities in the TPLA are summarized below:

Antidegradation Policy. Requires that water quality in high quality waterbodies be maintained above standards unless no other reasonable alternative exists and the polluting activity is necessary and justifiable for economic or social benefit. However, even if these two criteria are satisfied and some water quality degradation is allowed, the antidegradation standard requires that water quality standards continue to be met and beneficial uses protected. High quality waters are those waters which meet or exceed those levels necessary to support the propagation of fish, shellfish, and wildlife and recreation in and out of the water, and other designated beneficial uses (Oregon Administrative Rules 340-41-006 [41]). The Antidegradation Policy also prohibits degradation of water quality in outstanding resource waters and waters failing to meet water quality standards. No waterbodies in the TPLA area have been nominated as outstanding resource waters (DEQ 1994).

Biological Criteria. Requires that water quality be sufficient to support aquatic species without detrimental changes in the resident biological communities (Oregon Administrative Rules 340-41-027).

Dissolved Oxygen. For waterbodies identified by the Department as providing salmonid spawning, during the periods from spawning until fry emergence from the gravels, the following criteria apply: The dissolved oxygen (DO) shall not be less than 11 milligrams per liter (mg/l). However, if the minimum intergravel dissolved oxygen, measured as a spatial median, is 8.0 mg/l or greater, then the DO criteria is 9.0 mg/l. Where conditions of barometric pressure, altitude, and temperature preclude attainment of the 11 mg/l or 9 mg/l criteria, dissolved oxygen levels shall not be less than 95 percent of saturation. The spatial median intergravel dissolved oxygen concentration shall not fall below 6.0 mg/l.

For waterbodies identified by the Department as providing cold-water aquatic life the dissolved oxygen shall not be less than 8.0 mg/l as an absolute minimum. Where conditions of barometric pressure, altitude, and temperature preclude attainment of the 8.0 mg/l, dissolved oxygen shall not be less than 90 percent of saturation.

For waterbodies identified by the Department as providing cool-water aquatic life the dissolved oxygen shall not be less than 6.5 mg/l as an absolute minimum.

For waterbodies identified by the Department as providing warm-water aquatic life the dissolved oxygen shall not be less than 5.5 mg/l as an absolute minimum.

Temperature.

The numeric criteria for all surface waters in the state is 64 degrees Fahrenheit (F), measured as the seven day moving average of the daily maximum temperatures. If there is insufficient data to establish a seven day average maximum temperatures, the numeric criteria shall be applied as an instantaneous maximum. Exceptions to this numeric criteria are as follows: waterbodies serving as habitat to Bull Trout should not exceed maximum temperatures higher than 50 degrees F; and waterbodies in which salmonid species spawn or rear should not exceed 55 degrees F during the spawning and rearing seasons.

Unless specifically allowed under a Department-approved surface water temperature management plan as required under OAR 340-41-026(3)(a)(D), no measurable surface water temperature increase resulting from anthropogenic activities is allowed: in a basin in which surface water temperatures exceed 64.0 degrees F; in waters and periods of the year determined by the Department to support native salmonid spawning, egg incubation, and fry emergence from the egg and from the gravels in a basin which exceeds 55.0 degrees F; in waters determined by the Department to support or to be necessary to maintain the viability of native Oregon Bull trout, when surface water temperatures exceed 50.0 degrees F; in waters determined by the Department to be ecologically significant cold-water refugia; in stream segments containing federally listed Threatened and Endangered species if the increase would impair the biological integrity of the Threatened and Endangered population; in Oregon waters when the dissolved oxygen (DO) levels are within 0.5 mg/L or 10 percent saturation of the water column or intergravel DO criterion for a given stream reach or subbasin; and in natural lakes.

Turbidity. No more than a ten percent cumulative increase in natural stream turbidities is allowed.

pH. pH values are not allowed outside the range of 6.5 to 9.0. Dams existing on January 1, 1996 which result in pHs that exceed the criteria shall not be considered in violation of the standard if the Department determines that all practicable measures have been taken to bring the pH in the impounded waters into compliance with the criteria.

Conductance. In the main stem Klamath River from Klamath Lake to the Oregon-California Border the specific conductance shall not exceed 400 micromhos at 77 degrees F when measured at the Oregon-California Border.

Bacteria. Organisms of the coliform group commonly associated with fecal sources shall not exceed a 30-day log mean of 126 E. coli organisms per 100 ml. No single sample shall exceed 406 E. coli organisms per 100 ml.

All the criteria listed above are detailed in full in Oregon Administrative Rules 340-41-965, versions dated September 1992 and November 1995 (Proposed). The November 1995 version was adopted by the Environmental Quality Commission at their January 1996 meeting (DEQ 1996, pers. comm.). Designations of water bodies as providing salmonid spawning or cold-, cool- or warm-water aquatic life have not yet been made; therefore, there is some uncertainty in what standards will be applied to which streams in the TPLA area. It is assumed that the upper Klamath River will be designated as providing salmonid spawning, due to the important fisheries it supports.

California

The numeric and narrative North Coast Region water quality standards that apply to waters and management activities in the TPLA are summarized below:

General Objective. Whenever the existing quality of water is better than the water quality objectives established...such existing quality shall be maintained unless otherwise provided...

Sediment. The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.

Turbidity. Turbidity shall not be increased more than 20 percent above naturally occurring background levels.

pH. The pH shall conform to those limits listed as follows:
for the Klamath River above Iron Gate Dam (including Iron Gate and Copco Reservoirs) and other streams, the maximum pH is 8.5 and the minimum pH is 7.0.

Dissolved Oxygen. Dissolved oxygen concentrations shall conform to those limits listed as follows:
for the Klamath River above Iron Gate Dam (including Iron Gate and Copco Reservoirs), the minimum dissolved oxygen level is 7.0 mg/l, and 50 percent or more of the monthly means must be greater than or equal to 10.0 mg/l. For other streams, the minimum dissolved oxygen level is 7.0 mg/l, and 50 percent or more of the monthly means must be greater than or equal to 9.0 mg/l.

Bacteria. The median fecal coliform concentration based on a minimum of not less than five samples for any 30-day period shall not exceed 50 per 100 ml, nor shall more than 10 percent of total samples during any 30-day period exceed 400 per 100 ml.

Specific Conductance. Specific conductance shall conform to those limits listed as follows: for the Klamath River above Iron Gate Dam (including Iron Gate and Copco Reservoirs), 90 percent or more of the values must be less than or equal to 425 micromhos at 77 degrees F and 50 percent of the values must be less than or equal to 275 micromhos. For other streams, 90 percent or more of the values must be less than or equal to 300 micromhos at 77 degrees F and 50 percent of the values must be less than or equal to 150 micromhos.

Temperature. The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses. At no time or place shall the temperature of any intrastate waters with the "cold freshwater habitat" designated beneficial use be increased by more than 5 degrees F above natural receiving water temperature. Elevated temperature waste discharges into interstate waters with the "cold freshwater habitat" designated beneficial use are prohibited. At no time or place shall the temperature of intrastate and interstate waters with the "warm freshwater habitat" designated beneficial use be increased more than 5 degrees F above natural receiving water temperature.

All the criteria listed above are detailed in full in the *Water Quality Control Plan for the North Coast Region* (North Coast Regional Water Quality Control Board 1993).

Key Question:What are the current conditions and trends of beneficial uses and associated water quality parameters?

Non-Point Source Pollution

In 1988 the Oregon Department of Environmental Quality (DEQ) conducted an extensive inventory of water quality problems in the state, *The 1988 Oregon Statewide Assessment of Nonpoint Sources of Water Pollution* (DEQ 1988). In this report, waterbodies are identified that have serious or moderate nonpoint source pollution problems, or problems have been reported without challenge. Pollution types are classified according to source of information (substantiated with data or reported observations) and pollution problems are rated as being severe or moderate. Two waterbodies in the TPLA area are listed in this report: the Klamath River and Long Prairie Creek The results of the 1988 Report are listed in Table 35.

Table 35. Results of the 1988 Oregon Statewide Assessment of Nonpoint Sources of Water Pollution				
Stream Segment Name	Pollution Type	Severity (Information Source)	Impacted Beneficial Uses	Probable Causes
Klamath River	Nutrients	Severe problem (observation)	Irrigation Cold Water Fisheries Water-Contact Recreation Aesthetics Navigation	*Surface erosion *Water withdrawal *Traffic *Reservoir storage and releases *Altered physical characteristics of stream *Bank filling *Dredging/Aggregate removal *Channelization/Wetland drainage *Irrigation return flows
	Pesticides	Severe problem (data)		
	Sedimentation	Moderate problem (data)		
	Insufficient Stream Structure	Severe problem (data)		
	Excessive Plant Growths	Severe problem (data)		
Long Prairie Creek	Sedimentation	Moderate problem (observation)	Cold Water Fisheries	*Surface erosion *Elimination of thermal cover to stream

Section 303 (d) of the Federal Clean Water Act requires the establishment of total maximum daily loads (TMDLs) for "water quality limited" stream segments. Streams, rivers and lakes that do not meet water quality standards and would not even after the best available technology is applied to wastewater discharges are referred to as "water quality limited" and states are required to establish a list of these waters (referred to as the 303(d) list). A TMDL is the total amount of a pollutant that can enter a waterbody without causing it to violate the water quality standard for that pollutant. The Oregon Department of Environmental Quality has identified the upper Klamath River upstream from the Keno Dam as being water quality limited for dissolved oxygen and pH. Therefore, DEQ is in the process of developing TMDLs for biochemical oxygen demand and total ammonia, which influence pH and dissolved oxygen levels and contribute to the cumulative effect of point and nonpoint pollution in the river. The DEQ has proposed that the upper Klamath River from the California Border to Keno Dam be designated as water quality limited for dissolved oxygen (levels are too low in the fall, winter and spring) and for temperature (levels are too high in the summer). Dissolved oxygen may be removed as a reason for listing this section of the river due to the adoption of new water quality standards. However, it is unknown at this time whether this parameter has indeed been dropped.

As part of its ambient monitoring program, DEQ has conducted sampling in the upper Klamath River at a site downstream of the J.C. Boyle powerhouse (around river mile 220). The results of this ambient monitoring indicate that the river "supports" the designated beneficial use of aquatic life for measured parameters (pH, chlorophyll a, fecal coliform and dissolved oxygen) except for temperature and dissolved oxygen for portions of the year, as discussed above (DEQ 1994). In addition to DEQ's ambient monitoring program, water quality information in the upper Klamath River was collected by the City of Klamath Falls in relation to its proposed Salt Caves hydroelectric project. Water quality problems in the upper Klamath River are generally attributed to both natural and human-caused conditions, and are worse in late summer and fall when basin inflows are low and agricultural diversions are high (USDI 1994). Some of the water quality problems are due to poor quality of irrigation return water from the Lost River Basin, the extensive marshes and shallow waters of Upper Klamath Lake, reservoirs created by dam construction, algae blooms, and, to a small extent, agricultural, sewage and industrial sources (BLM 1994). Detailed discussions of water quality in the upper Klamath River may be found in the *Final Eligibility and Suitability Report for the Upper Klamath River Wild and Scenic River Study* (USDI 1990), the *Final Environmental Impact Statement for the Proposed Salt Caves Hydroelectric Project* (FERC 1990), the City of Klamath Falls' *Application for License Salt Cave Hydroelectric Project* (City of Klamath Falls 1986) and DEQ's 305(b) reports (DEQ 1988, 1990, 1992 and 1994).

Summary of Water Quality by Parameter

Measurements of water quality in the TPLA (other than for the upper Klamath River) are minimal. Monitoring in Long Prairie and Rock Creek occurred from March of 1984 to February of 1985 and was conducted by the City of Klamath Falls. These monitoring sites were located at the confluence of these streams with the Klamath River. Twelve samples were collected in Long Prairie Creek and five in Rock Creek. Water quality measurements on BLM-managed segments of Long Prairie Creek and Hayden Creek consist of a single measurement from each stream taken in 1993 during collection of macroinvertebrate samples.

Because designations of water bodies as providing salmonid spawning or cold-, cool- or warm-water aquatic life have not yet been made for streams in the TPLA area, there is some uncertainty in what standards will be applied to which streams in the TPLA area. For the purposes of this analysis, it will be assumed that only the upper Klamath River would be designated as providing salmonid spawning habitat. Therefore, streams in the TPLA will be compared only to standards for cold-, cool- and warm-water habitats, if applicable.

Dissolved Oxygen. Dissolved oxygen (DO) refers to the amount of oxygen dissolved in water. The concentration is influenced by such factors as re-aeration from turbulence and photosynthesis, which add dissolved oxygen to a water column. DO is critical to the biological community in a stream and to the breakdown of organic material. Carbonaceous oxidation, benthic demands (respiration), algal and macrophyte respiration, and nitrogenous oxidation all diminish dissolved oxygen levels. In salmonid streams intergravel dissolved oxygen should be near saturation to ensure normal growth and survival of eggs and alevin. High dissolved oxygen levels in streams and intergravel areas also are needed to sustain the more sensitive macroinvertebrates. For slow moving streams with high populations of algae, large diurnal fluctuations in DO can occur as a result of algal photosynthesis and respiration. During the day, photosynthesis may be a source of oxygen. At night, photosynthesis ceases and oxygen is used for respiration (EPA 1991). Dissolved oxygen levels are often lowest just before dawn.

The values of dissolved oxygen measurements in Rock Creek, Long Prairie Creek and Hayden Creek are listed in Table 36.

Table 36. Measured Values of Dissolved Oxygen

Stream	Measured Values in mg/l			Applicable Water Quality Standards in mg/l			
				Oregon			California
	Actual*	Range**	Number of Samples Exceeding Standards	Cold-Water	Cool-Water	Warm-Water	
Long Prairie Creek	8.3	7.8-11.8	1	8.0	6.5	5.5	7.0
Rock Creek	--	8.0-10.8	0				
Hayden Creek	6.7	---	1				

*Actual measurements on BLM-managed segments from 1993
**Range of measurements at the confluence with the Klamath River in 1984-1985.

The lowest dissolved oxygen levels were measured during periods of low flow and higher temperatures, and all measurements were taken between 10:00 a.m. and 7:00 p.m., when photosynthetic activity is occurring. Because of the timing of these measurements, even lower levels of dissolved oxygen could be occurring just before photosynthetic activity begins. Based on the limited data available, it is likely that all three streams would not meet the Oregon cold-water dissolved oxygen standard during some portion of the low flow period, and it is possible (in the case of Hayden Creek, probable) that the Oregon cool-water temperature standard and the California standard could be exceeded in the early morning hours during the warmest months in all three streams. Planned monitoring of dissolved oxygen levels in BLM-managed sections of Hayden Creek and Long

Prairie Creek, with measurement occurring during the early morning hours, will provide better information about the status of this parameter.

Temperature. Reductions in shading cover along streams can increase incident solar radiation and peak summer stream temperatures (EPA 1991). Temperature increases are generally additive, so that an alternation of shaded and unshaded reaches usually is not effective in reducing or minimizing temperature increases. Removal of shading vegetation may also decrease the minimum nighttime temperature in winter by allowing more radiation heat loss. The largest changes in winter minima occur in small, shallow, slow-flowing streams that do not have significant groundwater inflow. In these streams, complete icing of the stream may be of concern. Another effect of increased stream temperatures is a reduction in the amount of dissolved oxygen.

The values of temperature measurements in Rock Creek, Long Prairie Creek and Hayden Creek are listed in Table 37.

Table 37. Measured Values of Temperature

	Measured Values in degrees F			Applicable Water Quality Standard	
				Oregon	California
Stream	Actual*	Range**	Number of times standard was exceeded		
Long Prairie Creek	62	40.8-59	0	64 degrees F	N/A
Rock Creek	---	44.8-70.9	1		
Hayden Creek	84	---	1		

*Actual measurements on BLM-administered segments in 1993.
**Range of measurements at the confluence with the Klamath River in 1984-1985.

With the lack of point source contributions (discharges from a single conveyance) to these streams, nonpoint sources (unconfined discharges from within a watershed) are probably responsible for exceedance of the state standards. Stream temperature increases in Hayden Creek and Long Prairie Creek have been caused by the following factors: changes in channel shape to one that is wider and shallower than what would occur if the streams were functioning properly; low flows due to drought and in-channel water impoundments; and removal of or reductions in shading vegetation in many reaches. Because the general orientation of the Long Prairie and Hayden Creek watersheds is to the south, reductions in shading allow for much larger increases in input of solar radiation than if the watersheds were oriented to the north or east. Shading is discussed in the Aquatic Habitat and Riparian Issues.

Turbidity. Turbidity refers to the amount of light that is scattered or absorbed by a fluid. Hence, turbidity is an optical property of the fluid, and increasing turbidity is visually described as an increase in cloudiness (EPA 1991). Turbidity is an important parameter for drinking water mainly for aesthetic reasons. Turbidity also has a direct detrimental effect on the recreational and aesthetic use of water. Most of the biological effects of turbidity are due to reduced light penetration in highly turbid waters. Reduced light penetration may impact primary productivity, with periphyton and attached algae being most affected. Turbidity in streams is usually due to the presence of suspended particles of silt and clay, but other materials such as fine organic matter can cause turbidity as well. In general, a management activity that generates large amounts of suspended sediment will more or less proportionally increase turbidity. However, watersheds where the primary sediment source is clay or silt may have consistently high turbidity levels but only moderate concentrations of suspended sediment (EPA 1991). Typically, there is a strong relationship between turbidity and discharge. This relationship will vary by site and by precipitation event.

Turbidity measurements provide an indication of the amount of suspended material in the water, but the precise relationship between turbidity and the mass of suspended material depends on the size and type of suspended particles. This relationship must be established for each stream or sampling location and over the full range of discharge. The relative ease of measuring turbidity means that it is commonly used for monitoring nonpoint sources of sediment. The variability in turbidity among sites and over time generally makes it quite difficult to determine a natural or background level for any specified level of discharge. The combined uncertainty due to natural variability and measurement error makes it difficult to detect increases in turbidity due to forest harvest and other management activities.

The values of temperature measurements in Rock Creek, Long Prairie Creek and Hayden Creek are listed in Table 38.

Table 38. Measured Values of Turbidity

Stream	Measured Values		Water Quality Standards	
	Actual*	Range**	Oregon	California
Long Prairie Creek	1 NTU***	2.0-27 FTU****	No more than a ten percent cumulative increase in natural stream turbidities	No increase of more than 20 percent above naturally occurring background levels
Rock Creek	---	3.2-18 FTU		
Hayden Creek	1 NTU	---		

*Actual measurements on BLM-administered segments in 1993.
**Range of measurements at the confluence with the Klamath River in 1984-1985.
***Nephelometric Turbidity Units
****Formazin Turbidity Units. Usually turbidity is expressed in Nephelometric or Jackson Turbidity Units.

Based on the limited data available, turbidity does not appear to be a concern. However, without extensive monitoring it will not be possible to determine whether management activities are causing the water quality standard for turbidity to be exceeded. The Jenny Creek Watershed Analysis (USDI 1995) recommended that two of the soil series occurring in the TPLA are (Medco and Skookum) be designated as TPCC Fragile soils. One of the reasons for this designation is the potential for these soils to contribute fine sediment to streams and cause increased turbidity.

Conductivity. Conductivity (or specific conductance) refers to the ability of a substance to conduct an electric current. The conductivity of water is a function of temperature and the concentration of dissolved ions. There is no State of Oregon water quality standard for conductivity applicable to waterbodies in the TPLA except for the upper Klamath River. The North Coast Regional standard for conductivity for streams other than the Klamath River is 300 micromhos and 50 percent of the values must be less than or equal to 150 micromhos. The range of conductivity for potable water is 30 to 1500 micromhos/cm; the conductivity of streams emanating from forested areas in the Pacific Northwest almost always falls at the low end of that range (EPA 1991). Measured conductivity levels in Long Prairie Creek range from a low of 79 micromhos to a high of 207 micromhos, in Rock Creek from a low of 137 micromhos to a high of 227 micromhos, and in Hayden Creek one measurement was recorded at 100 micromhos. All of these measurements are within the standards for the state in which it is located.

pH. pH is not considered to be sensitive to most forest management activities. However, the pH of a system should be monitored as an integral part of any water quality monitoring program because pH can vary diurnally in aquatic systems where there are sufficiently high rates of primary productivity (production of plant biomass). For example, maximum pH values usually occur in the afternoon when photosynthetic activity consumes carbon dioxide and dissolved oxygen concentrations are at a maximum. Minimum pH values are observed at night when carbon dioxide is being released by algal respiration (EPA 1991).

The values of temperature measurements in Rock Creek, Long Prairie Creek and Hayden Creek are listed in Table 39.

Table 39. Measured Values of pH				
Stream	Measured Values		Water Quality Standards	
	Actual*	Range**	Oregon	California
Long Prairie Creek	7.2	6.8-8.1	6.5-9.0	7.0-8.5
Rock Creek	---	7.6-8.3		
Hayden Creek	6.7	---		

*Actual measurements on BLM-administered segments in 1993.
**Range of measurements at the confluence with the Klamath River in 1984-1985.

The one measurement in Long Prairie Creek that exceeded the North Coast Regional standard was a field measurement. A lab analysis of the same sample yielded a pH value of 7.9. Further monitoring of pH in Hayden Creek should occur, as the one pH measurement was close to the Oregon standard.

Bacteria. Bacterial contamination is of concern in all waters that humans come into contact with, but has little effect on aquatic organisms. Bacterial contamination can result from dispersed and developed recreation, wild and domestic animal populations, and human settlements.

The only measurements of bacteria levels in streams in the TPLA was performed by the City of Klamath Falls in 1984-1985 in Rock Creek, Long Prairie Creek and the upper Klamath River. Because **total** coliform was the parameter measured, no comparison with Oregon or California water quality standards can be made (the Oregon standard is based on numbers of E. Coli bacteria and the California standard on fecal coliform). However, it was noted that "levels of total coliform bacteria were generally elevated at all sampling sites...highest levels were typically observed upstream of J.C. Boyle reservoir and in Rock Creek, where mean probable numbers of coliforms occasionally exceeded 24,000 per 100 milliliters" (City of Klamath Falls 1986). The very high levels of total coliform bacteria were sampled in Rock Creek in March of 1984, and it is likely that water from Meiss Lake was being discharged into the Klamath River via Rock Creek at that time of year. Because the BLM has limited ownership in this watershed, the ability to affect bacteria levels through its management activities is negligible.

Nutrients (Nitrogen and Phosphorus). Nitrogen is one of the most important nutrients in aquatic systems. Most of the effects of nitrogen result from stimulation of the growth of bacteria and algae (primary productivity) when increased levels of nitrogen are available. However, studies have shown that the growth of algae may not occur if light or other nutrients such as phosphorus are lacking (EPA 1991).

For many forest streams, a small or moderate increase in primary productivity could provide positive benefits to the aquatic community. However, if plant respiration begins to deplete dissolved oxygen levels, the net effect is negative. Logging, fire, fertilization and livestock grazing can substantially increase nitrogen levels in streams. Phosphorus is an essential nutrient for plant growth. In aquatic ecosystems, phosphorus is usually the limiting nutrient to algae growth. Forestry practices generally do not affect phosphorus levels, but human and livestock waste can contribute phosphorus to streams.

Although no national standards have been established, a nitrate concentration of less than 0.3 mg/L and a phosphorus concentration of less than 0.10 mg/L is recommended to help prevent eutrophication (EPA 1991).

No data exist for phosphorous levels in the TPLA, except for the upper Klamath River. Nitrate levels in Rock Creek and Long Prairie Creek were measured in 1984-1985 and range from 0.10 to 0.46 and 0.10 to 0.42, respectively. These levels are likely to be above historic levels, and may be elevated because of increased sedimentation and inputs from livestock and wild horses. The impacts of elevated nutrient levels, in addition to increased temperature, have probably led to an increase in primary productivity and a change in algal community structure in some sections of Long Prairie Creek and Rock Creek. Changes in algal community structure can influence important functional groups of grazing aquatic invertebrates (for example, scrapers).

Sediment. Suspended sediment is one component of the overall sediment budget. Changes in bedload generally have the greatest geomorphic impact, but these impacts may or may not be correlated with suspended sediment.

Turbidity is highly correlated with suspended sediment, but this relationship must be determined for each basin and usually each site (EPA 1991). Water quality standards are usually set in turbidity units rather than the concentration of suspended sediment. The primary problem with using suspended sediment as a monitoring tool is its inherent variability. Representative samples are difficult to obtain, and suspended sediment concentrations vary tremendously over time and space. It is often difficult to determine if there has been a significant increase in suspended sediment and whether an observed increase is due to management activities or natural causes. These problems are exacerbated as one moves farther downstream because the impact of individual management activities is diluted and the amount of suspended sediment from other sources becomes larger (EPA 1991).

The Soil topic discussion includes a map which shows the susceptibility of soils in the TPLA area to surface erosion. Susceptibility was rated as being high, moderate or low. Table 14 in the Soil core topic summarizes the acres rated as high or moderate by subwatershed. Based on this analysis, surface erosion is not likely to be a substantial source of sediment, particularly from BLM-administered lands outside of the Klamath River Canyon.

Stream bank instability is of concern along sections of Long Prairie Creek and Hayden Creek. Reaches of these streams with a high percentage of unstable banks are contributing sediment and causing adverse impacts to aquatic resources. In addition, sediment from the eroding embankment in Ward Reservoir is affecting Hayden Creek. The possibility exists that complete failure of the dam could occur, which would release significant amounts of sediment into the system.

Roads often account for a majority of sediment problems in a watershed and are often the links between sediment source areas (skid trails, landings, and cutslopes) and stream channels. The majority of the transportation system in the TPLA area has been completed, with most roads located on gentle slopes. The focus of this analysis is to identify roads producing a significant amount of sediment; primarily those roads that are in close proximity to and/or cross stream channels. The overall effect of the road system on sediment yield will be roughly analyzed by comparing the potential sediment delivery to streams from roads among the three subwatersheds.

Based on Rosgen (1991), a Road Impact Index was calculated for the Long Prairie, Edge Creek and Hayden Creek subwatersheds. The following assumptions were used in this methodology:

as road density increases the potential for more sediment yield increases due to the larger acreage of exposed surfaces including cut banks, fill slopes, ditch lines, and road surfaces;

on steep side slopes and/or wide roads, more road acreage can be expected;

as more streams are crossed, there is a very high probability that direct sediment introduction will occur during and for several years following road construction (this occurs from road surface/ditch line/fill slope erosion and runoff routed directly into the stream);

and the higher on the slope that the road is constructed from the stream network, the less probability that sediment delivery to the stream to occur (Rosgen 1991).

The Road Impact Index can be compared with research results in Rosgen (1991) to make a gross estimate of the average annual sediment yield produced from roads (assuming that all roads were built at about the same time). This level of sediment yield would occur for the first five years following construction; after that, sediment yields would decline as disturbed soil is stabilized by vegetation. It must be noted that this methodology is based on research from watersheds 600 acres in size or less, so the results may not be directly transferable to larger basins. The results of the Road Impact Index calculations are presented in Table 40.

Table 40. Road Impact Index and Calculated Sediment Yield from Roads		
Subwatershed	Road Impact Index	Calculated Sediment Yield*
Long Prairie Creek	9.78	1,596**
Hayden Creek	6.85	1,072**
Edge Creek	0.22	62

*Average yield in tons per year for the first five years following construction.
**The Road Impact Index for these subwatersheds is too high to use the relations in Rosgen (1991). These figures were derived by using the sediment yield calculated for Edge Creek and pro-rating it to the road mileage in the two larger subwatersheds. The actual sediment yield in Long Prairie Creek and Hayden Creek subwatersheds could have been higher, due to the higher road impact index and the higher percentage of roads within 100 feet of streams in these watersheds (see the Hydrology core topic).

None of the figures in this table can be taken at absolute value. The usefulness of these calculations lies in the differences in orders of magnitude between subwatersheds. Monitoring will be needed to test these conclusions. Although most of the roads in these subwatersheds are older than five years and current sediment yields are lower than those calculated, it is likely that sediment yields have been high in the Hayden Creek and Long Prairie Creek subwatersheds. It is also probable that sediment has and is likely still adversely affecting water quality.

Based on the previous discussion, roads in the TPLA area are a significant contributor to fine sediment input. The majority of soils throughout the TPLA area have a moderate susceptibility to surface erosion (see Soil Issue). Road building and harvest activity remove soil surface cover and cause soil disturbance. However, erosion from landings and skid trails has a low probability of reaching stream channels because a routing mechanism from the point of erosion to the stream is often not present. Hill slope roughness is usually sufficient to slow water velocities and cause "dropping out" of sediment from overland flow before it can enter streams. Sediment from roads, on the other hand, has a high potential to reach streams. The high number of road crossings and miles of road within 100 feet of streams (see Hydrology Issue) results in the delivery of water and sediment directly to stream channels. Overall, road crossings and road segments close to streams are having a moderate effect on the supply of sediment to streams in the TPLA area.

In summary, there are a variety of mechanisms for delivery of sediments to streams (surface erosions, stream bank erosion and roads). Overall, stream bank erosion has the greatest influence on sediment levels, followed closely by roads. Surface erosion constitutes a relatively small portion of the sediment budget. Sedimentation levels are elevated and are having an overall moderate impact on water quality in the TPLA area and its subwatersheds.

Macroinvertebrate Community Information

Macroinvertebrate surveys are an important tool in describing the condition and relative health of the aquatic ecosystem (USDA 1989). Interpretation of the health and integrity of the aquatic ecosystem is based on a number of aquatic macroinvertebrate indices and life history characteristics of individual taxa and physical habitat and water chemistry data (Vinson 1994). Information on macroinvertebrate communities is available for the upper Klamath River, Long Prairie Creek and Hayden Creek.

Klamath River. Aquatic macroinvertebrates in the TPLA reach consist primarily of caddisflies, small mayflies, dipteran larvae, aquatic worms and snails. High abundance immediately below the J.C. Boyle dam reflects the suspended load of organic materials from the reservoir. The basalt rubble and cobble substrate in this section of the Klamath River is ideal substrate for macroinvertebrates (FERC 1990). Limited sampling by the City of Klamath Falls in 1986 and 1990 indicates that the macroinvertebrate community in the reach between the J.C. Boyle Powerhouse and river mile 209 is limited in terms of abundance and community composition by variable flows (FERC 1990). Variable flows in tailwaters of hydropeaking projects generally have fewer taxa, lower diversity, and often higher density of chironomidae, oligochaete and amphipoda and lower densities of mayflies and stoneflies. The results of sampling in this reach indicate a predominance of variable flow-tolerant taxa

(FERC 1990). Although some taxa intolerant of sediment and organic enrichment and higher water temperatures are present, taxa tolerant to these pollutants are more abundant.

The total abundance (numbers per square meter) of macroinvertebrates in sections of the river is notable. According to Rick Hafele, manager of the Oregon DEQ Biomonitoring Section, "the Klamath River has excellent invertebrate populations...Both numbers and diversity of invertebrates appear high in the places I have collected...Caddisflies and Diptera appear to be the dominant taxa, but good populations of mayflies and stoneflies are also present...The number and diversity of invertebrates present in the Klamath indicates that there is an excellent food base available for fish." (Hafele 1989). These comments were based on impressions made from his collection of qualitative samples in this river (primarily the stretch below the J.C. Boyle Powerhouse) and other rivers in Oregon.

Long Prairie Creek and Hayden Creek. In 1993 a single macroinvertebrate sample was collected from BLM-administered sections of each stream during the low flow period. The location of the sample site (generally in the lower portion of each watershed) allows for broad generalizations to be made regarding the general health of the aquatic system in the watershed and the nonpoint pollution sources affecting water quality and aquatic habitat conditions at the sample site. Several specific metrics were used in the evaluation of the benthic invertebrate data. Each metric measures the presence or absence of groups of invertebrates known to have certain habitat requirements (both physical and chemical).

The total bioassessment scores for Long Prairie Creek and Hayden Creek (23 and 24 percent, respectively) are on the low end for western North American montane streams. The numbers for these streams are difficult to interpret for comparative purposes since little information was found for the Klamath Ecoregion. However, two other streams in the Klamath Falls Resource Area that have been sampled have total bioassessment scores exceeding 70 percent. Both of these streams are in the Klamath Ecoregion and could be used for comparison. The higher scores for these two systems indicate a higher biological integrity (based mainly on stability and diversity) because of lower land based impacts (USDI 1995).

Biotic indices make use of the indicator taxa concept. Taxa are assigned water quality tolerance values or quotients based on their tolerance to pollution. The most common biotic indices in use in the United States are the modified Hilsenhoff Biotic Index (MHBI) and the USFS Biotic Condition Index (BCI) (Vinson 1994). The MHBI has been used to detect nutrient enrichment, high sediment loads, low dissolved oxygen, and thermal impacts. It is best at detecting organic pollution (Vinson 1994). The MHBI for Long Prairie Creek and Hayden Creek indicates that moderate organic enrichment is occurring, which could relate to elevated levels of nutrients. The BCI is expressed as a percent of the predicted community tolerance quotient, which is based upon its potential as determined by natural physical and chemical characteristics (total alkalinity, sulfate, substrate size and stream gradient) (Mangum 1986, Vinson 1994). The BCI for Long Prairie Creek indicates poor water quality and stressed conditions and the BCI for Hayden Creek indicates good water quality.

Specific invertebrate functional groups were rare or lacking in these streams. One is the "scraper" functional group. This group is associated with the diatom (algal) films typically found in streams draining forested ecosystems. The scraper functional group is sensitive to fine sediments which foul rock surfaces during base flow conditions. Another factor that may inhibit this invertebrate group is filamentous algae replacing the diatom algal community on rock surfaces. Increased temperatures, sunlight, and nutrients favor filamentous algae over diatoms (USDI 1995). Only one scraper taxa was present in both streams, and this particular taxa is considered tolerant of moderate organic enrichment. Taxa from the shredder functional group were absent, which indicates a lack of coarse particular organic matter as a food base. Generally, unimpacted streams with relatively stable substrates and high biotic/habitat integrity will support many shredder taxa (Wisseman 1994).

The presence, absence or relative dominance of a particular taxon or group of taxa can provide information on the relative water quality at a site. Taxa are labeled as pollution intolerant if they are known to occur primarily in unpolluted waters. Pollution tolerant taxa are those known to be tolerant of fine sediment, high water temperatures, or high organic loads (Vinson 1994). Presence of intolerant taxa are considered a positive indicator of water quality. Positive invertebrate indicators for both streams are absent.

Negative indicators were present in both steams. These indicators include a high percentage of collector-gatherers and oligochaete worms. High numbers of collector-gatherers are generally indicative of stressed habitat conditions, and oligochaete worms can be highly tolerant of fine sediment (Vinson 1994). The percentage of collector-gatherers ranged from 34 to 61 percent of sample abundance, and the percentage of oligochaete worms ranged from 14 to 18 percent of sample abundance. Greater than 40 percent abundance of collector-gatherers and five percent abundance of oligochaete worms are considered negative indicators (Wisseman 1994). Other negative indicators include the presence of tolerant mayflies, dipterans and chironomidae midges; low numbers of Ephemeroptera, Plecoptera and Tricoptera taxa; and dominance by relatively few taxa. The community in Long Prairie Creek is dominated by a tolerant taxa (Baetidae), while the community in Hayden Creek is dominated by a taxon abundant in all lotic waters (Simuliidae). Excessively high numbers (greater than 40 percent total abundance) of this taxa may indicate nutrient enrichment (Vinson 1994). The total abundance of Simuliidae in Hayden Creek is about 56 percent.

Based on macroinvertebrate community indicators, impacts to water quality in Hayden Creek and Long Prairie Creek are apparent from high summer water temperatures, nutrient/organic enrichment and fine sediment. Overall water quality impacts appear to be greater in Long Prairie Creek than in Hayden Creek. These impacts negatively affect the biotic and habitat integrity of these streams and influence the distribution and abundance of macroinvertebrates and those aquatic species that are dependent on them as a food source.

Key Question: What were the historical water quality characteristics of the TPLA area?

Direct information on historic water quality conditions in the TPLA area is lacking. Some inferences about water quality can be made using available knowledge regarding historic channel condition and historic riparian vegetation.

Historic Temperature Regime. Assumed historic riparian and aquatic habitat conditions are discussed in the Riparian and Aquatic Issues of this document. Based on assumed channel conditions, it is probable that most sections of Long Prairie, Edge and Hayden creeks were shaded by trees, willows and other shrubs. This vegetation was likely dense, except in a few isolated areas where vegetation may have been affected by natural events such as insects, disease, fire, beaver activity or flood damage. This vegetation likely limited solar input to streams. However, some solar input would have occurred from direct, overhead sunlight and, because most sections of these streams have southerly aspects, from afternoon sun. Ambient air temperatures would also have influenced stream temperatures. In these streams, it cannot be known whether, for how long and when Oregon State or North Coast Regional Water Quality Standards were exceeded historically. However, it is possible that during drought conditions (low stream flow in summer) and with high ambient air temperatures these standards were exceeded for limited periods in certain years.

Historic Dissolved Oxygen. It is assumed that dissolved oxygen levels historically were within water quality standards.

Historic Sediment Regime. Except for immediately following disturbance events such as severe flooding and fire, sediment levels in the TPLA area are assumed to have been relatively low. This assumption is supported by the presence of stable soils and gentle slopes in the watershed, and the lack of a mass wasting mechanism active in other geomorphic terrains.

Historic Turbidity. Based on the sediment discussion above, it is assumed that turbidity levels were low in the TPLA area except immediately following disturbance events.

Historic pH, Conductivity and Levels of Bacteria and Nutrients. There is no evidence that pH levels in the TPLA area were not within standards historically. Conductivity was likely low, due to the probable low concentrations of dissolved solids in the water column. Because elevated levels of bacteria and nutrients are usually associated with livestock grazing and agricultural activity, it is not likely that these water quality parameters were elevated above standards historically. Some bacteria and nutrients could have entered streams from wildlife use, but wild animals probably did not concentrate in numbers that would produce levels of bacteria and nutrients similar to those resulting from human management activities. Nutrient levels in the upper Klamath River may have been somewhat elevated, due to the extensive wetlands in and around Upper Klamath Lake.

Key Questions: What are the natural and human causes of change between historical and current water quality conditions? What are the influences and relationships between water quality and other ecosystem processes in the TPLA area?

Sections of the upper Klamath River and its tributaries are currently not meeting water quality standards for temperature and dissolved oxygen. Temperature increases have been caused by the following factors: changes in channel shape to one that is wider and shallower than what historically occurred; reduced base flows due to drought and in-channel water impoundments; and removal of or reductions in shading vegetation along streams. Elevated nutrient levels occur in the TPLA because of sedimentation to streams and direct inputs from livestock and wildhorses. The elevated nutrient levels, in addition to increased water temperature, have probably led to an increase in primary productivity and a change in algal community structure. This, in turn, has likely caused reduce levels of dissolved oxygen. Macroinvertebrate populations throughout the TPLA area are dominated by species tolerant to fine sediment, higher temperatures and organic enrichment. Habitat degradation is also reflected through changes in channel and riparian conditions.

Roads in the TPLA area are a significant contributor of fine sediment to streams. The high number of road crossings and miles of road within 100 feet of streams results in the delivery of water and sediment directly to stream channels. Stream bank erosion is also contributing sediment and causing adverse impacts to aquatic resources, and Ward Reservoir is currently a chronic source of sediment to Hayden Creek due to erosion of its embankment.

Conductivity does not appear to be of concern in the TPLA area. Other water quality parameters (turbidity, pH and bacteria) need additional information to evaluate whether water quality standards are being met and beneficial uses are being fully supported. Preliminary indications suggest the pH and bacteria may, at times, be elevated above standards in some areas.

Core Topic: Aquatic Species and Habitats

Characterization of Aquatic Species and Habitats

The TPLA is biogeographically unique in the Cascades physiographic province. The aquatic species are representative of both east of the Cascade and west of the Cascade faunas. Thus, there exists important connectivity and dispersal corridors for species with populations distributed on both sides of the Cascade Mountain Range (Bury 1994:St John 1987)(for example, western pond turtle and rainbow trout). Several reptile and amphibian species found in the oak habitat of the Klamath River canyon are do not occur elsewhere east of the Cascade range (Holland 1993). There are also several aquatic animals that are endemic to the Klamath River in the area between Klamath Falls and Yreka (Frest and Johannes 1995). These endemic species are primarily aquatic molluscs that are confined to springs and spring influenced reaches of the Klamath River. The areas outside the Klamath River Canyon reflect more typical faunas of mid-elevational ecosystems of the Cascade Mountain Range. The important issues and natural processes that drive these two ecosystems are vastly different. For these reasons, it is useful to divide the discussion of these two systems between the Klamath River Canyon and the remaining tributary watersheds.

The quality of habitat for most aquatic species in the Klamath River canyon is primarily influenced by flows regimes and water quality. Upstream irrigation withdrawals, associated agricultural returns, and hydroelectric power projects are the dominant forces controlling flows and water quality. The influence that BLM is able to impose on these factors is minimal. However, information specific to aquatic species and habitat is abundant for the Klamath River, whereas, information is lacking for aquatic species and habitats in the tributary watersheds.

Biologically, streams in the tributary watersheds are characterized as having low habitat connectivity, low aquatic species diversity, and few high quality habitat species indicators. This is largely because the streams are disconnected from the Klamath River by steep canyon walls and intermittent or ephemeral connections to the Klamath River. Except for one fish species, other species that may have historical distribution in the tributaries have either been extirpated or were never able to colonize successfully.

To assess biological processes in the tributary watersheds some parallels can be drawn from similar habitat types in adjacent watersheds including Jenny Creek and its tributaries (King et al 1977; Medford BLM 1995). Since this analysis is primarily a tool for guiding BLM resource management decisions and coordinated management actions such as road management, discussions on species of concern are limited to the ability of BLM to impart management that will affect those species and their habitats.

In an attempt to simplify the analysis procedure and use the best available information, this analysis will focus on the physical and biological processes of three watersheds where we have some information concerning species distributions and where a thorough hydrology and stream channel assessment was completed.
This section will characterize the distribution and abundance of aquatic faunas and their habitat, describe the current habitat conditions, and then relate observed changes to an assumed historic condition. While this analysis focuses on the species that are important indicators of ecosystem health, others are included in discussions because of their state and federal status or their relevance to issues identified in the watershed analysis process.

Issue: High road densities, grazing, hydrologic modifications, and intensively managed forests have impacted aquatic ecosystem function in the tributary watersheds.

Key Question: What is the relative abundance and distribution of species of concern in the watersheds? Where are key aquatic habitats?

Tributary Watersheds

Distribution and Habitat. The three primary analysis streams in the analysis area (Hayden Creek, Long Prairie Creek, and Edge Creek) are intermittent or are perennial with intermittent segments. In addition, they are connected to the Klamath River by steep narrow draws within the Klamath River canyon. This lack of continuous connectivity and low relative water quantity limits the ability of these streams to provide habitat for a diverse fish assemblage. Low flows are conducive to high summer water temperature extremes which limit opportunities for colonization of salmonid fish and other cold water dependent invertebrates. Non-native fish have been introduced into some of the man-made ponds within the analysis area. A population of self-propagating black crappie are known to occur in the spring fed heli-pond adjacent to Long Prairie Creek. Other introduced game fishes in the sunfish family (bass, crappie, and sunfish) may occur in other ponds but they have not been surveyed for.

It should be noted that no stream surveys have been conducted in the three stream systems. Observations have been incidental and no attempt to quantify populations have been made. Only Long Prairie Creek is known to contain native fish. Speckled dace, a common minnow species in the chub family, is found in most perennial stream systems in the Klamath basin (Logan and Markle 1993). Speckled dace are tolerant of high water temperatures and low flow conditions (Moyle 1976).

Springs and seeps in the tributary watersheds may contain rare and endemic aquatic invertebrates. The incidence of these animals in the Klamath River below Boyle Dam and in the springs of the Jenny Creek watershed would indicate a high probability for occurrence (see Jenny Creek WA 1994; Issue II in this report). However, the springs in the analysis area are of relatively low volume. Low volume springs are more vulnerable to disturbance and have a greater likelihood of drying up during drought periods thus reducing their potential to maintain populations of aquatic snails over time. All known springs in the analysis area have had moderate to severe impacts from grazing and other disturbances. No surveys for rare and endemic molluscs have been conducted to date in the tributary watersheds. See Map 8 for spring and seep sites.

Amphibian species known to occur in the tributary watersheds area are those that are adapted to intermittent and ephemeral water sources. (interpreted from Nussbaum, Brodie and Storm 1983). They include the Pacific chorus frog, the long-toed salamander, and the Western toad. All three of these species are known to respond reproductively to favorable water years and can reach extremely high densities under ideal conditions (Hayes pers comm. 1995).

Other important riparian dependent vertebrates in the area include the Klamath garter snake, the common garter snake, the mountain kingsnake, and the Western pond turtle. All of these species use amphibians as an important food source. Hayden Creek and Long Prairie Creek probably provide habitat for the western pond turtle (Sokol 1996, pers. comm.). Potential dispersal, foraging, over-wintering, and nesting habitat could occur in these two watersheds. The Klamath River, however, is the primary habitat area for the western pond turtle in the analysis area.

Key Question: What is the current habitat condition?

Tributary Watersheds

The tributary watersheds are characterized by intermittent streams with perennial segments, and small spring feeds. The dominant management factors that have defined the current condition of these habitats are logging roads, impacts form cattle and horse grazing, and past and present impoundments with associated de-watering and flooding events (see channel and hydrology reports). The current aquatic fauna reflects a system limited by warm water and intermittent and ephemeral stream flows. Connectivity of these habitats to perennial systems is limited to species with terrestrial life stages and overland dispersal behaviors such as the amphibians and reptiles or species which can navigate the steep rocky canyon draws of the Klamath River canyon.

The riparian, channel condition, and water quality assessments provide a functional assessment of habitat condition for aquatic species. Water quality, channel processes, and riparian vegetation include attributes which can be used to indicate the suitability of habitat to meet the life history requirements of a given species or guild. While low base flow alone may limit the quantity and quality of aquatic habitat available, there are other indicators of lowered habitat quality that are noteworthy.

Channel Condition. The channel condition assessment (this report) used a Rosgen (1994) classification system. BLM stream segments were the focus because the information there was readily available. The analysis is likely readily transferable to non-BLM portion of the analysis since ownership patterns and management scenarios are somewhat similar. This classification system is useful for describing habitat potential because important stream processes including deposition, transport, and erosion can be accurately predicted.

Long Prairie Creek, a type F channel in the BLM reach, is characterized by an entrenched channel with no developed floodplain, high width/depth ratio, poor bank stability, lack of in-channel coarse roughness elements and little streamside vegetation (see channel condition assessment, this report). These attributes, translated into fish habitat parameters, include high incident solar radiation, high input of fine sediments from streambanks, low availability of refugial habitat (pools and overflow channels), reduced hiding cover, and poor quality substrate for insects and spawning habitat. Long Prairie Creek is the only tributary stream in the TPLA occupied by native fish.

Hayden Creek was classified as a type G channel (1/8 mile BLM) and a type B channel) The type G segment is also entrenched with a historic flood plain but no active floodplain presently. This stream segment presently has many of the same habitat characteristics as Long Prairie Creek except that there is some amount of streamside riparian vegetation recovery (willows, some from planting) occurring within the entrenched channel. Fish are not known to occupy this stream currently.

The Type B portion of this stream is characterized by stable banks, gravel and cobble substrate, scarce in-channel large woody debris and reduced streamside shading. Because of relatively high gradient and confinement, fine sediments are generally transported through these stream segments. Lack of streamside shading and loss of pool habitat due to reduced input of large woody debris contribute to downstream increases in water temperature. Low base flows probably preclude the colonization of fish into this stream.

Sediments. There is evidence that there are increased sediment inputs due to roads, bank erosion and impoundment failure. Furthermore, some stream segments that formerly contained areas of gravel and cobble have become imbedded with sediments. Fine sediments including silt and suspended flocculent fines are deleterious to all species with semipermeable membranes in either there egg stages or early larval life stages (Bjornn and Reiser 1991). Fine sediments can prevent the exchange of gases, thus suffocating eggs and larvae. Species which are visually oriented for foraging and predator avoidance suffer when sediments cause increases in turbidity.

Water Quality. From the limited macroinvertebrate data there are missing ecological functional groups (shredders and scrapers), negative species indicators, and low bioassessment scores (see water quality issue in this report). Although there are extremely limited samples to draw inferences regarding causes of poor water quality in these tributaries, there is evidence of problems with sediments, water temperature, and nutrient enrichment. This would suggest that current habitat conditions for native aquatic fauna is low.

Base flow (low summer flow) is an important factor in determining the magnitude of diurnal fluctuations in water temperature. Thus, reduced base flows due to soil compaction, increased drainage networks, and lowered water storage capacity in historic flood planes (see channel issue) can negatively affect species with cold water and high dissolved oxygen requirements. Low summer flows in the tributary watershed coupled with degraded channel morphology and lack of streamside shading contribute to summer temperature extremes deleterious to cold water species.

Human-made impoundments. Water diversions and stock ponds create habitat for some species adapted to still water. Long-toed salamanders, rough skinned newts, and western pond turtles all benefit from the availability of still-water habitats (Spencer Creek WA 1995). The extent that they remain wet through the summer and fall will determine which species benefit from these water sources. Western pond turtles are known to take advantage of ephemeral water sources for foraging and basking under certain circumstances (Holland, 1995).

Problems associated with man-made impoundments include impacts from concentrated livestock and wildlife use, colonization of non-native fish and amphibian species (possibly bullfrogs in the TPLA), and hydrologic impacts discussed in detail in the channel condition and hydrology sections of this report. The potential impacts due dam breakage of these impoundments to aquatic life is exacerbated by the presence of hydrologically sensitive channel types (types G and F (Rosgen 1994). There is a lack of refugial and floodplain habitat that would otherwise allow for temporary displacement of aquatic species during flood events. In addition, any associated decrease in base flow due to impoundments further limits these stream ability to support aquatic animals.

Spring habitat. Spring and seep habitats that provide a relatively constant supply of water at a constant year-round temperature are refugial and/or overwintering habitat for some amphibian species. In Hayden Creek and Edge Creek, spring feeds keep some stream segments running perennially. Most of the Spring areas in the analysis area are (or have been) in a degraded vegetative condition due to grazing. Many have been developed as stock watering areas and therefore have had water diverted from the natural condition. Species such as snails and some aquatic insects have low mobility and therefore have a high rate of endemism. This dependency on specific spring sites combined with their relative immobility makes them very vulnerable to disturbance.

Key Question: What is the historic condition of species distributions and habitats?

Tributary Watersheds

Species Distributions. Documentation of species occurrences of aquatic animals in the tributary watersheds are derived from incidental sightings only. No historic accounts of amphibian or fish species could be found. This is unfortunate in that it becomes difficult to establish a reference habitat condition without some species for which habitat condition can be assumed. It is likely that if base flows, channel condition, and riparian conditions have been seriously impacted, some species would have been eliminated from the system. Local extirpation of sparsely distributed species in marginal habitats is a probable scenario in these watersheds. The species that are of concern today did not receive attention historically, thus it is not surprising that there are no species accounts. Even under pristine conditions, these systems may or may not have supported high profile species such as salmon and trout. The lack of historic documentation may be indicative a system that historically did not have many species of interest. Therefore, a species assemblage consisting of species adapted to intermittent water sources may not be an unreasonable assumption of the historic condition.

If it is assumed that flows were, prior to European settlement, significantly higher than they are presently (see hydrology report for more information), then the assumed historic condition would be one capable of supporting resident rainbow trout and other cold water adapted species. In general, the system would have been able to support a more diverse and resilient aquatic community. The rationale for this is that other streams in nearby watersheds with similar elevations, gradients and drainage areas, are occupied by rainbow trout. Excepting possible base flow conditions, habitat conditions would have been favorable to salmonids. Large woody debris from deciduous and conifer species would have been in plentiful supply to provide for the formation of pools, habitat complexity, and a source of nutrients. Stream shading would have been relatively continuous, in the form of mature and old growth conifers in the confined, upper elevational areas or as riparian associated trees and shrubs in unconfined valley segments. This would have ensured that stream temperatures remained cool during the summer low flow periods. Channel process including floodplain development, overflow channels, and sediment transport and deposition would have functioned to provide refugial habitat, clean gravel sources, and healthy macroinvertebrate populations. Riparian vegetation would have functioned to provide bank stability, and a source of nutrient input.

If conversely, it is assumed that base flows have not changed significantly, then changes in species abundance and distribution would be more subtle and more difficult to detect. Based on the channel condition assessment, current road densities and the riparian condition assessment, it can be assumed that species sensitive to changes in habitat quality have been reduced in their abundance and distribution.

As surveys are conducted in these watersheds, some remnant or isolated populations of aquatic may be discovered. This species distribution information will assist in interpretations of historic habitat condition. For example, if an animal dependent on cold water (such as the Cascade frog) is found only in spring influenced stream reaches, and is disconnected from other neighboring populations, than this would be indicative of a reduction is suitable habitat and reduced connectivity of habitat. There is no survey or inventory data to make any historic habitat inferences based on species distributions.

Key Question: What are the causes for observed changes in distribution and habitat? Which are natural and which are human caused?

Tributary watersheds

The causes of changes in habitat condition are covered in the respective analysis of issues including grazing, hydrology, water quality, channel condition and riparian vegetation. The history of land use practices is described in the Cultural core topic. From this it is assumed that habitat quality has undergone an incremental and downward change over the last 120 years. The effects of grazing and streamside logging were first realized before the turn of the century as the railroads were built and cattle and sheep were herded through the area. It should be noted that severe overgrazing was known to occur in other areas of Klamath County during this era and some of the degraded channels observed today may be lingering effects from that period (Spencer Creek WA 1994). The effects of roads on the drainage network were probably a more recent impact to aquatic systems as the rate of road building and logging increased in the 1950s through the 1980s.

That there was a railroad network and a logging camp occupied by up to several hundered people, is evidence that a significant quantity of water was probably removed from the natural watercourses at times. The results of reduced or interrupted flows could have a dramatic and sudden impact to species that require continual flowing water. The result could have been local extirpation of species that were unable to adapt to sudden changes in water regimes.

Increases in sediment, water temperature, and reduced habitat complexity tend to be more chronic and changes in species abundance more subtle. Over time, species unable to adapt to reduced habitat quality could also become extirpated from the stream system.

If it is assumed that these systems had significantly greater perennial flows before human's activities, than we must also assume that these systems could have supported a diverse assemblage of aquatic animals, including some adapted to colder, flowing water. Although extensive survey information is lacking it appears that species adapted to these conditions can not be supported in the analysis area currently.

Too little information is available to make inferences regarding human caused changes versus natural changes. Natural disturbance regimes such as fire, drought, and floods likely played a large role in influencing changes to these stream systems during the last 120 years. These natural process are probably greatly obscured and observable changes are masked by the dramatic alterations caused by human's activities.

Issue: Concentrated recreational activity, grazing, exotic species, and hydrologic modifications have impacts to aquatic species in the Klamath River Canyon.

Key Questions: What is the relative abundance and distribution of species of concern in the Klamath River Canyon? Where are key aquatic habitats?

Fish

Middle Klamath Fish Assemblage. The Klamath River between Copco and Keno has a unique assemblage of fish species which includes representatives of Klamath lakes endemic species (Lost River and short-nose sucker), landlocked forms of coastal migratory fish (Pacific Lamprey and rainbow trout, and resident riverine fishes including the Klamath largescale sucker and the Pit-Klamath brook lamprey. Several of these are migratory and spawn in tributary watersheds or spring-influenced reaches of the Klamath River below J.C. Boyle dam.

Endangered Suckers. The Lost River sucker and shortnose sucker are two Federally listed endangered fish species documented to occur in the Klamath River including Copco and J.C. Boyle Reservoirs (Buettner and Scoppettone 1991). Suckers need flowing, well oxygenated water for spawning. Neither species is known to spawn in any of the tributary watersheds between Copco and Keno (Buettner unpbl report 1995). Potential spawning habitat occurs in the Keno reach of the Klamath River below Keno dam and in portions of the

Klamath River. Some researchers have speculated that the reservoirs of the upper Klamath River have allowed these suckers to expand their range because of the Lake-like habitat for rearing and adult feeding habitat created by the formation of these reservoirs. These habitats appear to have only a downstream connection. Few upstream migrating suckers have been documented to pass the Link River Dam (Olson pers comm). Thus, most suckers downstream of Upper Klamath Lake remain disconnected to their principal habitat (Upper Klamath Lake).

Introduced Species. Introduced fish species are largely confined to the Klamath River reservoirs (Boyle and Copco) although there is an assumed downstream connection between reservoirs as fish are flushed through the system during spill periods and through fish passage structures.

Invertebrates

Rare and endemic molluscs. Nine species of aquatic snails endemic to the "middle Klamath" River were identified in the Northwest Forest Plan, (1993) as needing consideration and site protection before planning ground disturbing activities. The middle Klamath for the purposes of this discussion is considered the area between Copco Reservoir and the Link River Dam (Frest and Johannes 1992). These freshwater snails occur in relatively undisturbed spring sites within lakes and rivers as well as upland spring sites. Several of these sites occur within the TPLA. These sites can be referenced in Frest and Johannes (1994;1995;1996). Only springs within the Klamath River Canyon have be surveyed thus far. The reach of the Klamath River between Boyle dam and the Boyle powerhouse which receives approximately 200 to 300 cfs of spring fed water is especially rich in mollusc fauna (Frest and Johannes 1992).

Sensitive insects. (Shue' caddisfly) **Waiting for reference article.** This caddisfly, a state sensitive species, is known to occur at a spring site on the east side of the Klamath River near the Big Bend area on BLM land. It is considered a species of concern because it is obligated to cold water springs and seeps which are sensitive to overgrazing and water developments including diversions and well development.

Reptiles and Amphibians

Western Pond Turtle (*Clemmys marmorata*). Western pond turtles are well distributed in the Klamath River Canyon where water velocity is minimal and adequate sites for basking foraging and refugial hiding habitat are available. Key areas include Boyle and Copco reservoirs, two slack water pools approximately 4 miles downstream from Boyle powerhouse, areas adjacent to the Frain Ranch, and several slack water areas below the California/Oregon boarder.

The western pond turtle has become a species of concern in recent years because of an apparent skewed age distribution in many populations. The evidence suggests poor recruitment of young turtles into the population. Suggested causes for population declines include loss of suitable riverine habitat and upland nesting habitat, and competition and predation from introduced exotic species including largemouth bass, painted turtles, bullfrogs, and nutria (Holland 1994). The upper Klamath River is an important biogeographic link for turtle populations in the Klamath-Trinity River basin in northern California and the Klamath region of southern Oregon. This population may use the Upper Klamath River as a connecting corridor between these larger populations (Bury 1995).

Key Question: What is the current habitat condition?

Riparian and channel habitat in the Klamath River Canyon are largely influenced by water controls (Hydroelectric projects and irrigation withdrawals. Water quality affecting aquatic animals is similarly affected by activities in the Upper Klamath Lake, Lake Ewana, and in Klamath Lake tributaries. Concentrated recreational use and livestock grazing are the greatest BLM imposed management impacts to the existing aquatic habitat. Additionally, exotic plant species including yellow star thistle, medusahead, elodea, and potomogetan have altered riparian and aquatic habitat. Off road vehicle use and past overgrazing has provided the disturbance mechanism that has allowed some of these species to become well established in some areas. See Riparian condition assessment and allotment evaluation for information of current riparian vegetative condition along the Klamath River. The following are descriptions of key aquatic habitat features of the Klamath River.

Copco and JC Boyle Reservoirs. Both of these reservoirs provide limited habitat for native fish species. Water quality in both systems becomes poor during the summer as turnover rates decline, primary productivity increases and decaying algal bloom consume oxygen and cause extreme peaks in pH levels (Hanel and Gerlach 1964; City of Klamath Falls 1986). Temperature and turbidity also reach levels considered detrimental to salmonids. The problem is most pronounced in Copco reservoir because it has lower turnover rates. Introduced exotic fish are dominant in these systems and may exert significant competitive and predatory impacts to native fish.

Cold Water Reach. The cold water reach is the area between Boyle Reservoir and Boyle Powerhouse (approximately 3 miles. This area has much of the flow diverted into a penstock at the dam and then is returned to the river at the powerhouse. Fish flow releases of approximately 100 cfs are comprised of fish ladder discharge, attraction water for the fish ladder entrance, and flows through the fish screen bypass. Combined discharge from springs in this reach have been estimated to average between 250 and 320 cfs (Hanel and Gerlach 1964). This combination results in summertime base flows that are relatively constant and of good water quality. It has been suggested that this area may provide the only "in river" spawning habitat for Klamath River rainbow trout above the stateline (Olson 1995, pers. comm.). The only other known spawning areas for Klamath River rainbow trout are Shovel Creek and Spencer Creek. Fish passage of adult rainbow trout over JC Boyle dam has declined in recent years by over 99 percent from levels one year after the dam was constructed in 1957 (ODFW 1990). That the Klamath River below Boyle Dam remains a productive trout fishery is indicative that the population has adapted to altered flow regimes and may be using the coldwater reach for spawning (Smith 1995, pers. comm.).

As stated previously, the high volume springs provide habitat for a rich endemic aquatic snail community. It is assumed that aquatic insects also fare very well in this reach compared to more water quality impaired reaches of the Klamath River.

Powerhouse to Frain Ranch. This reach was described in the channel condition assessment primarily as Rosgen type C. These areas are key foraging and rearing habitats for Klamath River rainbow trout. The nutrient rich waters in these areas is apparently responsible for the rapid growth rates and high productivity of this trout population. This reach (approximately 6 miles) is characterized by diurnal fluctuations in discharge from approximately 450 cfs to 1500 cfs. This change in discharge occurs rapidly (1000 cfs change in discharge in two to three hours) Aquatic species that persist here must adapt to this sudden change by moving and foraging accordingly.

Western Pond Turtle. While many of the same threats described in Holland (1994) exist in the TPLA analysis area, a recent single year population study in the area between Boyle Reservoir and the Frain Ranch (Bury 1995) indicated a healthy, albeit small population of western pond turtles. Bury attributed high growth rates to an abundant food source (molluscs, crayfish and other invertebrates) from the nutrient rich waters of the Klamath River. Additionally, he noted nesting and overwintering sites appeared to be in adequate supply. A skewed age distribution favoring older, sexually mature individuals was noted, indicating low recruitment rates. One significant threat not identified in the work of others (Holland 1994) is concentrated recreational activity in the area between Boyle powerhouse and the Frain ranch. Disturbance of basking turtles and shooting and harassment by uninformed recreationists was considered the single greatest threat to this population (Bury 1995).

Important behavioral aspects of western pond turtle ecology include thermoregulation (basking), foraging, nesting, overwintering, and dispersal. For a complete description of these behaviors see Holland (1994).

Habitat Requirements (terrestrial). Western pond turtles are tied to terrestrial habitats for oviposition (laying eggs), overwintering and overland dispersal. Typical overwintering sites are areas up to 500 meters from watercourses. Typically, turtles burrow into a thick layer of duff and may move several times during the course of a winter. Nests for oviposition are generally excavated in compact, dry soils with a high clay or silt fraction. Nest distance from a water course is has ranged from 3 meters to 400 meters. For a complete description of nest site characteristics, see Holland (1994).

Habitat requirements (aquatic). Western pond turtles are considered aquatic habitat generalists because they occur in a wide variety of both permanent and ephemeral habitats throughout its range. Functionally, western pond turtles use aquatic habitats as a foraging media, for basking sites, and as hiding refugia. Western pond turtles favor aquatic habitats which have emergent basking sites such as rocks, logs, or emergent vegetation. In riverine habitats, western pond turtles avoid areas of high flow or turbulence, areas laking nearby refugia and/or basking sites. In areas in the upper elevation range of the species such as the Klamath Basin, an abundant food source may be an important aquatic habitat characteristic. The nutrient rich waters from Klamath Lake appear to provide and abundance of clams, leaches, snails, insects for turtles (Bury unpbl. 1995)

Key Question: What is the historic condition of species distributions and habitats?

Extinct anadromous stocks. Several anadromous stock were eliminated with the construction of Copco dam in 1917 although dramatic declines were noted from other activities during the 10 years prior (Fortune and Gerlach 1966). It is documented that anadromous steelhead trout, Pacific lamprey, and Chinook salmon passed the Link River Falls near the City of Klamath Falls historically and that runs at least two species of anadromous salmonids occurred in Shovel Creek. One run occurred in the Spring and another in the Fall.

There is evidence that at least one species of amphibian, the foothill yellow-legged frog, has been extirpated from the area. The foot-hill yellow-legged frog occurs in rocky or gravelly streams in southwestern Oregon. Hayes (1995) reports that this frog was reported in the Keno area before the JC Boyle dam was built in 1958 but has not been recorded in the area since.

Western Pond Turtle. Suitable aquatic habitat for western pond turtles has probably increased over historic levels with the construction of Boyle and Copco reservoirs. Low summer flows due to water withdrawals and diurnal recharge of reservoirs has probably increased some foraging opportunities.

Key Questions: What are the causes for observed changes in distribution and habitat? Which are natural and which are human caused?

Introduced fish species. The negative effects from competition, introduction of diseases and parasites and predation on native fish and amphibians are all well documented in the literature (Moyle 1976, others). There is increasing evidence that fathead minnows are especially problematic for native catostomids (suckers) in the Klamath Basin because they are known to prey on larval fish and because they have become the dominant fish species in number and biomass in the Upper Klamath Lake during the summer months (Logan and Markle 1993). Many fish in the sunfish family including largemouth bass, pumkinseed, crappie, and yellow perch are detrimental because they are efficient predators of small fish and are territorial towards their own kind as well as towards other species. These species are tolerant of warm, slow moving water and may have a competitive advantage in the reservoirs over native riverine fish such as rainbow trout, largescale suckers, and small scale suckers.

Core Topic: Livestock Grazing

Issue: Livestock grazing has impacted other resources and activities within the TPLA watershed.

The following key questions under this issue will be addressed within the narrative that follows.

Key Questions: What are the historic and current livestock grazing uses within the TPLA area? What are the historic and current livestock forage use levels and patterns within the TPLA area? What monitoring of livestock use has been done on public lands within the watershed? What has the analysis of this monitoring data shown? What livestock management improvements have been installed in the TPLA area?

Introduction

There are 7 BLM grazing allotments within the boundaries of the TPLA area in Oregon: Chase Mountain (101), Edge Creek (102), Buck Mountain (103), Dixie (107), Dry Lake (140), and Chicken Hills (141), and Grubb Springs (147) (see Map 12). These allotments encompass both BLM and private land areas. The majority of the private land within these allotments is owned by Weyco and Pacificorp. Several smaller parcels owned by private individuals, state agencies, and companies are scattered throughout the allotments. In the California portion of the TPLA area there is one BLM grazing allotment, Laubacher (0155). This allotment consists only of the BLM-administered land with no private land included.

Early in 1982, the BLM implemented a new grazing management policy, known as selective management, to help assign management priorities among grazing allotments. Under selective management, all the grazing allotments within the KFRA were categorized into one of three groups to direct management efforts and funding to the areas of greatest need. The three categories are improve (I), maintain (M), and custodial (C). The category name refers to the management objective, so that the I category is to improve unsatisfactory conditions; the M category is to maintain satisfactory conditions; and the C category is to manage in a custodial manner the prevention of deterioration of current resource conditions. The primary criteria used in arriving at these categories were ecological condition, resource conflicts, economic feasibility of investments in range improvements, and the land ownership pattern (KFRA PRMP/FEIS, 1992). Of the five allotments within the TPLA area in Oregon, Edge Creek and Dixie are categorized as I allotments and the other three are C allotments. The Laubacher allotment in California is also considered a C allotment.

Livestock grazing leases for BLM-administered lands are connected to a private base property which supports the livestock operations of the lease holder. With Weyco being the major landowner in the watershed area, the Weyco grazing leases have been the major base property for the BLM grazing allotment leases. Pacificorp leases within the Klamath River canyon have also served as base property. With large tracts of unfenced private land adjoining public land within the allotments there is a need to coordinate the management of the livestock use. The state of Oregon defines most of the TPLA area as open range. This designation requires private landowners to build fences to keep unwanted livestock off of their property rather than requiring the owner of the livestock to fence their livestock in. On BLM-administered lands, unauthorized livestock are subject to unauthorized grazing use regulations. The BLM authorizes exchange-of-use agreements that permit the use of BLM-administered lands to the extent of the carrying capacity of the unfenced and intermingled private lands that are owned or controlled by the grazing lessee. Since the 1960s, increased coordination between the major landowners and the BLM has been pursued to establish grazing systems that benefit the resources of all landowners. The results of this cooperation will be discussed under each allotment.

Beginning in 1993, Weyco began decreasing the livestock numbers and seasons of use on their private land grazing leases. These changes have been made due to the adverse impact of season-long grazing to the meadows and riparian areas (Monfore, 1994a). In an effort to protect riparian and wetland areas from livestock use, Weyco required their current lessees to fence critical riparian and wetland areas with materials furnished by

Weyco. Several lessees decided not to comply with this requirement and chose to have their leases cancelled. From 1993 through 1994, several of the Weyco grazing leases were cancelled for this and other unspecified reasons (Monfore, 1994b). Some of these leases were also considered the base property for some of the BLM grazing leases in the TPLA area. Thus, the BLM grazing leases for Chase Mountain and Dry Lake were also cancelled. Weyco also cancelled their leases for lands within the Chicken Hills and Dixie allotments, but other private lands were also considered as base property so the BLM leases were continued with a decreased amount of exchange-of-use lands.

Chase Mountain allotment (#0101)

The Chase Mountain allotment is located to the south and east of the Klamath River, with the Chicken Hills and Grenada Butte area forming the southwest boundary and the section line between Ranges 7 and 8 East forming the east boundary. The allotment includes approximately 8,823 acres of BLM-administered land and approximately 19,680 acres of private land. Weyco land is the base property for the BLM grazing lease. The Weyco lease was cancelled in 1993 with the results that the BLM lease was also cancelled.

Prior to being cancelled the livestock lease on the allotment authorized cattle use of 194 AUMs on the BLM-administered lands and 239 AUMs of exchange-of-use for the Weyco lease. The annual season of use was from May 15 to August 13. This allowed for use by 145 cattle.

Edge Creek allotment (#0102)

The Edge Creek allotment includes approximately 38,260 acres of which approximately 8,860 are public land administered by the BLM. The remaining approximately 29,400 acres of private land are owned by Weyco (approximately 27,900 acres), Pacificorp (approximately 760 acres), and other landowners (total of approximately 740 acres). The grazing allotment extends from Highway 66 on the north, the Klamath River on the east and southeast, the California-Oregon border on the south, and the vicinity of Long Prairie Creek on the west. (see Map 12). The boundaries of the allotment are not all fenced. Topographic features like the Klamath River and the Klamath River canyon and non-natural features like Highway 66 help to define the allotment, but livestock movements are not totally restricted to the "designated" allotment. Practically speaking, the livestock will spend 90 percent of their use period within these boundaries with some drift into other allotments, mainly to the west into the Dixie allotment.

In 1966 the BLM, the Oregon State Game Commission (currently the Oregon Department of Fish and Wildlife), and the Weyco began work on seeding and fencing projects to benefit the deer herd in the Pokegama deer winter range. The fencing projects were designed to protect deer winter range from late season use by livestock. The fencing projects resulted in the creation of three separate pastures in the Edge Creek allotment . These pastures were designated the North, Ward, and Edge Creek pastures. (see Map 12) The North pasture is the largest of the three pastures (approximately 29,000 acres) and includes mainly Weyco lands with some BLM-administered land (approximately 4,000 acres) in the south end of the pasture. The Ward pasture (approximately 5,000 acres) is located along the north side of the Klamath River and includes BLM, Pacificorp, and smaller private lands within the Klamath River canyon and about 4 sections of BLM-administered land above the canyon. The Edge Creek pasture (approximately 3,500 acres) lies to the west of the Klamath River canyon and contains mainly Weyco and BLM-administered lands.

Buck Mountain Allotment (#103)

A small portion of the Buck Mountain allotment is located in the northern portion of the TPLA area. Highway 66 forms the south boundary of the allotment, Jenny Creek is the west boundary, and the east boundary is approximately one mile west of the Keno Road (see Map 12). The total allotment contains approximately 49,862 acres of which approximately 8,142 are BLM-administered lands. The portion that is within the TPLA area is approximately 14,000 acres of which approximately 1,900 acres are BLM-administered.

The majority of the land within this allotment is owned by Weyco and this property is considered the base property for the BLM lease. Weyco cancelled their grazing lease in 1994 due to riparian and wetland concerns. The BLM lease was subsequently cancelled in 1994 also. The BLM grazing lease had authorized grazing use from May 15 to October 1 for 204 AUMs on the BLM-administered lands and 948 AUMs of exchange of use grazing on the Weyco lease. The allotment was grazed by sheep up until 1989. From 1990 through 1994, grazing use was made by cattle.

This allotment is in the C category for management purposes and has had no monitoring studies established on it. No further analysis of this allotment will be done in this document.

Dixie Allotment (#107)

The Dixie allotment is located to the west of the Edge Creek allotment. The north boundary is Highway 66, the south boundary is the Oregon-California state line, and the west boundary is Jenny Creek. Some of the west side of the allotment lies outside of the TPLA area and is in the Jenny Creek watershed. For purposes of this analysis, the entire allotment will be included. (see Map 12)

The Dixie allotment includes approximately 5,547 acres of BLM-administered land and approximately 22,260 acres of private land. The BLM-administered lands are located in the southern part of the allotment along with the base property and other small private parcels. Weyco land makes up most of the northern 60 percent of the allotment. The base property for this lease is the Fall Creek Ranch, the livestock operation controlled by the lessee. The allotment was first licensed for grazing by the BLM in 1950. This was only for the BLM-administered lands in Jackson County. The BLM-administered lands in Klamath County were added in 1961.

There are currently 415 authorized AUMs for the allotment with a season of use from May 1 to September 15. This allows for use by 91 cattle units. The current BLM lease is for the period May 3, 1995 to February 28, 2005. Historically there has been an exchange-of-use agreement for leased Weyco lands that has been for up to 825 AUMs. The Weyco lease was cancelled in 1994. There currently is no exchange-of-use grazing on the allotment.

Dry Lake Allotment (#0140)

The Dry Lake allotment is located in the southeast corner of the TPLA area along the Oregon-California state line (see Map 12). The allotment consists of approximately 205 acres of BLM-administered land of which 145 acres are in Oregon and 80 acres are in California. A private land lease with Weyco was considered as the base property for this allotment. The amount of land in this lease has varied throughout the past as lands were added or subtracted for various reasons. Leases with other private landowners in the area have allowed for various levels of exchange-of-use grazing to take place. This allotment was first licensed for grazing in 1967. There was likely some grazing on the BLM-administered lands before this date from livestock drifting from adjoining private lands. The authorized grazing use has been for 10 AUMs on BLM-administered lands with up to 240 AUMs of exchange-of-use grazing for the private lands. The season of use on the BLM-administered lands was from May 1 through June 30 with 5 cattle. As mentioned in the introduction to this section, the Weyco and BLM leases were cancelled in 1994. Thus, no current authorized livestock grazing is occurring.

Chicken Hills Allotment (#0141)

The Chicken Hills allotment is located on the east side of the Klamath River with the California-Oregon border forming the south boundary. The Chicken Hills and Grenada Butte are the east boundary for the allotment (see Map 12). The allotment contains approximately 3,422 acres of BLM-administered land and approximately 5,340 acres of private land. The current base property for this allotment is a private lease with Bart Hadwick. The season of use for the allotment is from May 15 to September 15 with 82 AUMs of use on the BLM-administered lands. Former Exchange-of-Use grazing has been authorized for private leases with Weyco, Boise Cascade Corporation, Oregon Department of Forestry, and Hadwick. The current exchange-of-use agreements allow for an additional 383 AUMs. This allotment is considered a C category for management purposes. No current monitoring studies are taking place on this allotment and no further analysis will be done in this document.

Grubb Springs Allotment (#147)

The southwest corner of the Grubb Springs allotment is within the TPLA area. It is located to the east of the Buck Mountain allotment and lies to the north of Highway 66 (see Map 12). Approximately 11,000 of the total 38,144 acres lies within the TPLA area. Of this portion, approximately 900 acres are BLM-administered lands. The current BLM lease for the allotment authorizes use from May 1 to September 15 for 130 AUMs on the BLM portion and 499 AUMs on the Weyco base property. Grazing use was by sheep until the early 1970s. The allotment is currently grazed by cattle. This allotment is considered a C category for management purposes. No current monitoring studies are taking place on this allotment and no further analysis will be done in this document. .

Laubacher Allotment (#0155)

The Laubacher allotment is located south of the California-Oregon border on the east side of the Klamath River. It consists of 1,841 acres of public land with no private land exchange-of-use authorizations. The allotment is licensed for 92 AUMs with a season of use from April 15 to June 14. The allotment is within the Redding BLM district but the grazing use is administered by the KFRA. No monitoring data has been collected on this allotment and no further analysis will be done in this document.

Livestock Management Facilities in the TPLA Area

As livestock grazing systems developed in the TPLA area, management facilities were built for different purposes. Reservoirs were constructed in areas that had good forage but lacked water sources (see Table 41). Springs were also developed to provide storage for the water at these sources. Fences were built to control the movement of livestock. Some fences were designed to create separate pastures that could be used during different periods of the year. Others were designed to exclude livestock from areas with resource concerns like riparian and wetland sites, critical deer winter range, and constructed reservoirs and spring developments. The fences around the reservoirs and spring sites also included the placement of a trough outside of the fenced area to which water is piped for livestock use. Many of these developments are also beneficial to different wildlife species. The following table lists some of the known livestock related water developments in the TPLA area. These sites are also shown on Map 8. Fences that were built as allotment boundary or pasture fences are shown on Map 12.

Table 41. Water Developments

Facility	Location	Landowner	BLM Grazing Allotment	Purpose and Development
Fox Lake	T40S, R6E, Sec. 27 NWSW	BLM	Edge Creek	Livestock and wildlife water. Fenced with small livestock access.
Bear Reservoir	T40S, R6E, Sec. 33 SWNE	Weyco	Edge Creek	Livestock and wildlife water. Fenced with trough outside for livestock.
Griffith Reservoir	T41S, R6E, Sec. 6 SENE	J. Laubacher	Edge Creek	Livestock water
Ward Reservoir	T40S, R5E, Sec. 36 NWSW	Weyco	Edge Creek	Livestock and wildlife water. Dugout and diked reservoir on Hayden Creek.
Upper Potter Reservoir	T40S, R5E, Sec. 20 SESW	Weyco	Dixie	Livestock and wildlife water.

Tom Reservoir	T40S, R6E, Sec. 7 NWSW	Weyco	Edge Creek	Livestock and wildlife water. Dugout reservoir in channel of Tom Creek.
Potter Reservoir	T40S, R5E, Sec. 28 SWSW	Weyco	Edge Creek	Livestock and wildlife water. Adjacent to Long Prairie Creek.
?	T40S, R5E, Sec. 27 SWNW	Weyco	Edge Creek	Livestock and wildlife water.
?	T40S, R5E, Sec. 10 NENW	Weyco	Edge Creek	Livestock and wildlife water. On Long Prairie Creek.
?	T40S, R5E, Sec. 10 NWSW	Weyco	Edge Creek	Livestock and wildlife water.
Wild Gal Spring	T41S, R5E, Sec. 17 NWNW	BLM	Dixie	Livestock and wildlife water. Spring source developed and fenced.
Parker Reservoir	T39S, R5E, Sec. 34 SESE	Weyco	Buck Mountain	Livestock and wildlife water.
Dixie Spring	T41S, R5E, Sec. 5 NESW	BLM	Dixie	Livestock and wildlife water. Spring source developed and fenced. Outflow goes into Long Prairie Creek.
Grubb Spring Reservoir	T39S, R6E, Sec. 23 SWNE	Weyco	Grubb Spring	Livestock and wildlife water.

Resource Monitoring Data

Introduction

Monitoring means the orderly collection, analysis, and interpretation of resource data to evaluate progress in meeting management objectives. As discussed in the Introduction to the livestock section, allotments within the KFRA have been placed into one of three selective management categories to direct management effort and funding to areas with the greatest need. This categorization determines the priority of each allotment for resource monitoring. Following is a table showing the types of monitoring to be completed for each allotment category and the frequency of these studies. The table is followed by a description of each study type.

	Selective Management Category		
Monitoring Study	**Improve (I)**	**Maintain (M)**	**Custodial (C)**
Condition	15 years	15 years	15 years
Trend	5 years	10 years	10 years
Utilization	1-2 years	3-5 years	As needed
Actual Use	Annually	Annually	Annually where needed
Climate	Annually for crop year precipitation from NOAA weather stations		

Condition Studies - Condition is a generic term relating to the present status of a unit in terms of specific values or potentials. The two types of condition studies used on grazing allotments are Ecological Status and Range Condition. Ecological Status is use-independent and refers to the relationship of the present plant community on a unit of land to the plant community that would be the natural potential for that kind of land in the absence of abnormal disturbances.

Range Condition is the degree to which the present plant community resembles the plant community that best satisfies range management objectives. Because it is based on objectives developed in the land-use planning process, which included the resolution of multiple-use conflicts, Range Condition is the single most meaningful measure of multiple-use management on rangelands.

Trend Studies - In rangeland monitoring, trend is most frequently used to indicate whether management is resulting in resources changes that are either toward or away from an objective. The primary needs for trend determinations on rangelands are for trend of Ecological Status and trend of Range Condition. There are several different methods to monitor trend and these rely on the monitoring of some "indicator" such as change in cover, plant vigor, composition, or frequency or density of plants.

Utilization Studies - Utilization is the proportion or amount of the current year's production that is consumed or destroyed by animals. It may refer to a single plant species, a group of species, or to the vegetation as a whole. Utilization data are important in evaluating the effects of grazing and browsing by livestock, wildlife, and wild horses on specific areas of rangeland.

Actual Use Studies - Actual use data are important for evaluating causes of trend on specific areas of rangeland. Actual use data are obtained from the livestock operators annually and contain data on dates, number and classes of livestock turned out, moved, or gathered as well as death losses.

Climate Studies - Weather factors, particularly amount, distribution, and timing of precipitation in arid and semi-arid areas, have a dramatic effect on vegetation productivity and are considered when evaluating rangelands. Baseline data is obtained from NOAA weather stations and may be supplemented by BLM or other weather stations.

Other Studies: Cole Browse Studies - Cole Browse monitors the utilization of browse species by livestock and native ungulates (deer and elk). Readings are taken at selected sites in the fall and again in the spring.

Analysis of Data

Within the TPLA area, the Dixie and Edge Creek allotments are I category allotments and the others are all C category allotments. Monitoring studies have been implemented on the two I allotments and these data will be analyzed and interpreted in this document. The analysis will be based on guidance from BLM Technical Reference 4400-7, Rangeland Monitoring - Analysis, Interpretation, and Evaluation and will follow a format similar to that used in other allotment evaluations in the Lakeview District.

Dixie Allotment

Present Situation

BLM Lessee - Jerry Barry, Fall Creek Ranch

Grazing Preference (AUMs):

Active			415
Suspended		0	
Exchange of Use	0		
	Total		415

As stated under the General Allotment Descriptions above, the Dixie Allotment contains approximately 5,547 acres of BLM-administered lands and approximately 22,260 acres of private land. In 1994, Weyco cancelled their lease with the current BLM lessee. This cancellation nullified the exchange of use grazing which had been up to 678 AUMs in 1991 and was at 260 AUMs during 1993.

The following information is excerpted from the KFRA ARMP/ROD:

Other Forage Demands (AUMs):

Deer		928
Elk		100
Wild Horses		50
	Total	1,078

Season of Use - 5/1 - 9/15

Identified Resources Conflicts/Concerns

Under current management the range condition, level or pattern of utilization, and/or season-of-use may be unacceptable; or carrying capacity may be exceeded.

Critical deer winter range occurs in the allotment.

Riparian or aquatic habitat is in less than good habitat condition.

Water quality may not currently meet the Department of Environmental Quality water quality standards for beneficial use.

Allotment comprises a large portion of the Pokegama Herd Management Area.

Management Objectives

Maintain or improve rangeland condition and productivity through a change in grazing management practices, timing, and/or level of active use.

Management system should reflect the importance of deer winter range.

Improve and maintain riparian or aquatic habitat in good or better condition.

Maintain and improve water quality on public lands to meet or exceed standards for beneficial uses, as specifically established by the Department of Environmental Quality, where BLM authorized actions are having a negative effect on water quality.

Mange wild horse grazing levels on public lands to ensure a thriving ecological balance and prevent deterioration of the range.

Constraints

Officially listed threatened or endangered species and/or critical habitats occur within the allotment. Mitigate all management practices, as needed, to ensure full compliance with the recovery plan in effect for the species in question.

Critical deer winter range occurs in the allotment. Vegetation conversions must be coordinated to adequately address the needs of both big game and cattle. No more than 10 percent of current browse in deer winter range may be converted in any one year,

Allotment contains all or a portion of a wild horse herd management area. Management actions must be mitigated, as needed, to ensure the free-roaming nature of the herd.

Ensure that substantial vegetation conversions do not significantly reduce the variety of plant species or communities in abundance necessary for their continued existence and proper functioning.

The exchange of use figures listed within this allotment is dependent on the renewal of the private land grazing lease (Weyco).

The following area is excluded from general livestock grazing: Dixie Riparian Exclosure.

Grazing Systems

The livestock grazing system on the Dixie allotment has historically been continuous use during the spring and summer period of May through early October. The cattle would be turned out at the Fall Creek Ranch in the southwest corner of the allotment and gathered again at the end of the use period. The exchange of use grazing permitted by the Weyco lease comprised over 65 percent of the livestock numbers on the allotment. As discussed earlier, Weyco began decreasing the use on their leased lands in 1993 in an effort to protect riparian resources and water quality. This was done in part by shortening the season of use by one month from October 15 to September 15. The number of permitted livestock was also decreased from 134 pairs in 1991 to 57 in 1993. In 1994, Weyco required the lessee to construct approximately seven miles of riparian exclosure fencing prior to grazing their lands. The lessee chose not to comply with this requirement and the lease was cancelled.

In 1994 the BLM authorized grazing by 64 pairs from May 1 to October 1. During the grazing season Weyco hired someone to periodically ride their lands and push the lessees cattle back onto the BLM-administered lands. In the spring of 1995, Weyco built a drift fence on the east side of Grizzly Mountain in an effort to control the drift of livestock onto their lands and to keep livestock in the south end of the allotment where most of the BLM-administered land is located (Map 12). They also hired a rider to periodically check for livestock.

During 1995 the BLM issued a new 10 year lease authorizing grazing by 91 pairs of cattle from May 1 to September 15. This grazing preference is from the selected alternative in the KFRA ROD/RMP/RPS, June 1995.

Monitoring Studies - Analysis and Interpretation

Utilization:

Utilization study sites were established in the Dixie allotment in 1990. Five key areas were chosen that represent typical areas where livestock graze during the season of use on BLM-administered lands. Utilization points were set up in each of these key areas and have been read every year since establishment. The Key Forage Plant Method was used for these studies. This uses an ocular estimate of forage utilization within one of six utilization classes. These classes are: No Use (0 to 5 percent), Slight (6 to 20 percent), Light (21 to 40 percent), Moderate (41 to 60 percent), Heavy (61 to 80 percent), Severe (81 to 100 percent). These utilization classes are based on a full season of growth.

A table summarizing these readings is found in the wild horse section of this document. Map 10 shows the location of the utilization points.

The average utilization of all points falls within the Light to Moderate range of utilization. Heavy use was recorded for one or more years at Points 1, 2, 4 and 5. Points 1,2, and 3 are located within one mile of the Dixie Exclosure on Long Prairie Creek. Points 4 and 5 are within the Jenny Creek watershed in Jackson County (Medford district BLM).

In addition to the points, use pattern mapping has been done on the allotment during 1987, 1992-93, and 1995. Copies of these maps can be found in the Dixie Allotment Study file at the KFRA office. This mapping has shown slight to light use over the majority of the allotment with areas of moderate and heavy use in the riparian areas. The heavy use areas include Long Prairie Creek, Fall Creek, Upper Potter Reservoir, and Wild Gal Spring. A portion of the BLM-administered lands on Long Prairie Creek are protected from livestock grazing by the exclosure at Dixie Spring. But the areas of Long Prairie Creek above and below this exclosure have shown heavy use along with the areas on Weyco property. Wild Gal Spring also has an exclosure but there is a large unexcluded wet meadow area that receives heavy to severe use. The condition of the fence is poor and grazing within the exclosure has also occurred. The Dixie and Wild Gal Spring areas have also had historic and current use by wild horses as discussed in the Wild Horse section of this document.

Actual Use

Table 42 shows the actual use figures for the Dixie allotment from 1988 to 1995. These actual use figures were submitted by the permittee at the end of the grazing season. Some of the numbers submitted show only the permitted numbers on the BLM lease and don't include the exchange of use numbers. Also, during 1988 to 1993 the lessee also had authorization to graze on the adjoining Edge Creek allotment. There is no fencing between these allotments and the actual use numbers don't reflect the amount of grazing that could have occurred considering the drift between the two allotments.

Table 42. Actual Use Grazing Figures

YEAR	Season of Use	BLM Livestock #	BLM AUMS	Exchange of Use Livestock #	Exchange of Use AUMs
1995	5/01 - 9/15	90	411	none	
1994	5/01 - 10/01	67	342	none	
1993	5/01 - 9/15	71	324	57 *	260
1992	5/01 - 10/01	64	326	134 *	683
1991	5/01 - 10/01	64	326	134 *	683
1990	5/01 - 10/15	59 *	326	123 *	685
1989	5/01 - 10/15	59 *	326	123 *	685
1988	5/01 - 10/15	59	326	121	674

* - number is from grazing bill, no actual use reported

Climate

Precipitation data for the years 1990 to 1995 are shown in the Wild Horse core topic. An explanation on the use of this data in relation to the vegetation monitoring studies is also presented in this section.

Condition/Trend

No condition or trend studies have been established within the Dixie allotment.

Cole Browse

A modified Cole Browse method was used to monitor browse species utilization in the Edge Creek allotment. Fall measurements were done as per the Cole Browse method outlined in the BLM Technical Reference 4400-3, Rangeland Monitoring Utilization Studies. Spring measurements were similar to fall measurements with the exception of average leader length. Average leader length measured the previous fall was used to determine the use index assuming that there is no growth over the winter. The two browse species used in these studies were ceanothus (*ceanothus cuneatus*) and serviceberry (*amelanchier alnifolia*). The fall readings monitor use made by livestock and the spring readings monitor use made by wildlife over the winter and early spring. Table 43 summarizes the results of the studies.

Table 43. Cole Browse Studies - Dixie Allotment

Date	Study Number	Species Sampled	Ave. Leader Length	Use Index	Ave. Leader Use
5/10/95	107-2	*ceanothus cuneatus*	1.6"	1.01	63 percent
9/26/94	107-2	" "	1.6"	.16	10 percent
5/10/95	107-3	" "	1.6"	.16	9.7 percent
9/26/94	107-3	" "	1.6"	.10	6.0 percent

5/10/95	107-4	" "	1.7"	.20	11.6 percent
9/26/94	107-4	" "	1.7"	.22	13 percent
5/9/94	107-2	" "	2.8"	.92	33 percent
9/27/93	107-2	" "	2.8"	.14	5.0 percent
5/11/94	107-3	" "	absent	absent	23 percent
9/27/93	107-3	point not found------	-----------------	------------------	-----------------
5/11/94	107-4	*ceanothus cuneatus*	1.9"	.40	19 percent
9/27/93	107-4	" "	1.9"	.08	4.2 percent
5/24/93	107-2	" "	.67"	.30	45 percent
5/25/93	107-3	" "	.88"	.18	21 percent
5/25/93	107-4	" "	.70"	.18	25 percent
5/14/92	107-2	" "	1.14"	absent	absent
10/16/91	107-2	" "	2.4"	.20	8.5 percent
5/14/92	107-3	" "	1.19"	absent	absent
10/16/91	107-3	" "	2.5"	.16	6.5 percent
5/14/92	107-4	" "	1.4"	absent	absent
10/16/91	107-4	" "	2.3"	.25	11 percent

For all of the points sampled spring use was much greater than the fall use. The fall use levels were also fairly low. This indicates that livestock are making minimal use of the wildlife browse species sampled in this area.

Summary

Review of Objectives from the KFRA ARMP/ROD

- Maintain or improve rangeland condition and productivity through a change in grazing management practices, timing, and/or level of active use.

Changes have recently been made in the grazing on the Dixie allotment, mainly due to the cancellation of the private land lease by Weyco. Grazing use on BLM-administered lands is still authorized for the south end of the allotment. Due to these recent changes, monitoring studies will need to be modified to reflect the new management. Any additional changes in the grazing management will be based on monitoring data.

- Management system should reflect the importance of deer winter range.

Cole Browse studies have shown that livestock are not competing with deer and elk for browse species. These studies will continue. Coordination with the Pokegama working group on management of the deer winter range will continue.

- Improve and maintain riparian or aquatic habitat in good or better condition.

Utilization pattern mapping has shown areas of heavy use in riparian areas. This objective is currently not being met.

- Maintain and improve water quality on public lands to meet or exceed standards for beneficial uses, as specifically established by the Department of Environmental Quality, where BLM authorized actions are having a negative effect on water quality.

Grazing management changes will be made if water quality standard noncompliance is attributed to grazing activities. See water quality section of this document for more information on water quality.

- Manage wild horse grazing levels on public lands to ensure a thriving ecological balance and prevent deterioration of the range.

See wild horse section of this document for information on wild horses.

Interpretations

During 1995, full use was made by the authorized numbers of livestock and the forage utilization was higher than previous years, with heavy utilization (61 to 80 percent) along much of Long Prairie Creek, in the meadow areas around Dixie, and around Wild Gal Spring. The drift fence constructed by Weyco prior to the 1995 grazing season restricted the livestock movement out of this end of the allotment. These areas have also had documented use by the Pokegama wild horse herd. The amount of utilization made by the horses in the south end of the Dixie allotment is estimated to be 150 AUMs. A decision has been approved to remove a portion of the wild horse herd beginning in 1996. This removal should result in a reduction in the level of forage utilization in the Dixie allotment.

In addition to the removal of a portion of the wild horse herd, changes in the grazing system, authorized numbers, and/or season of use should be considered if the following objectives from the KFRA ARMP/ROD document are to be met: Maintain or improve rangeland condition and productivity through a change in grazing management practices, timing, and/or level of active use; Improve and maintain riparian or aquatic habitat in good or better condition. Changes in grazing use are normally based on three years of monitoring data. If monitoring in 1996 continues to show utilization levels that are higher than the guidelines for riparian areas and uplands, then sufficient data would exist to support a decision to make changes in the authorized grazing.

A reduction in livestock use would be based on the monitoring data with the goal of reducing the utilization to the standards given in Table D-7., *Utilization Standards in Riparian-Wetland Areas* and Table D-8., *Degree of Allowable Use* in the KFRA ARMP/ROD document. The standard for the upland areas in the Dixie allotment would be 50 percent utilization of perennial grasses. The standard for riparian areas would be based upon the Functional-At Risk status of Long Prairie Creek. This would allow for utilization of herbaceous riparian species at a 0-30 percent level. By calculating the AUMs of use made by livestock and horses and factoring in the utilization levels, a reduction in livestock AUMs can be calculated as follows, using the figures from the 1995 monitoring studies:

Livestock AUMs = 411
Wild horse AUMS = 150
Total AUMs = 561

Upland Areas

$$\frac{\text{561 AUMs}}{\text{70\% utilization}} = \frac{\text{X AUMs}}{\text{50\% utilization}}$$

Solving for X results in a level of 401 AUMs to reduce the utilization level from 70 percent, the midpoint of heavy use, to 50 percent which is the midpoint of the moderate utilization level and the standard for upland areas. Assuming the reduction in the horse herd would decrease that use by 75 AUMs, then the livestock use would need to be reduced to 326 AUMs.

Riparian Areas

$$\frac{\text{561 AUMs}}{\text{70\% utilization}} = \frac{\text{X AUMs}}{\text{30\% utilization}}$$

Solving for X results in a level of 240 AUMs to reduce the utilization level from 70 percent to 30 percent which is the standard for the riparian areas in this area. Assuming the reduction in the horse herd would decrease that use by 75 AUMs, then the livestock use would need to be reduced to 165 AUMs.

To achieve the utilization standards and meet the management objectives for this allotment, different combinations of management changes and livestock reductions could be implemented. To meet the 30 percent utilization standard for the riparian areas, a reduced level of AUMS along with a change in the season of use is recommended. The current season of use of 5/1 to 9/15 has resulted in overuse in the riparian areas. This is partly due to the drying and curing of the upland forage that takes place during the summer months which results in the livestock concentrating in the riparian areas where the vegetation remains in a more palatable condition for a longer period. Changing the end date from 9/15 to 8/15 would allow for use approximately 50 pair of cattle (177 AUMs) during this period assuming they would not be concentrating on the riparian areas with the earlier end date.

Another option would be to base the AUM levels on the upland standard of 50 percent and to fence off the riparian areas. To get to the 326 AUM level, the current 91 pairs could be grazed with a season of use from 5/1 to 8/15. Or the current season of use of 5/1 to 9/15 could be used with a reduction in livestock numbers to 71 pairs. The disadvantage to this approach would be that by fencing off the riparian areas on the BLM-administered lands then the cattle would likely concentrate more on the private land portions of Long Prairie Creek.

Monitoring of the use following the changes would then be done to determine if additional adjustments were necessary. A reevaluation of the allotment would be done at the end of three years.

In addition to the grazing system adjustments, the following items should be completed to provide additional resource protection:

> Reconstruct and expand the existing exclosure area around Wild Gal Spring. The current fence is in need of replacement due to age. An additional area of wetland and wet meadow should be included in the exclosure. This area has received heavy use in the past from livestock and wild horses.
>
> The spring development and exclosure in T40S, R5E, Section 31, SE1/4, SE1/4 should be rebuilt to exclude livestock.

Edge Creek Allotment

Present Situation

BLM Lessee - Robert and Pat Miller

Grazing Preference (AUMs):

Active	107	Ward Pasture
Inactive	100	Edge Creek and North Pastures
Suspended	0	
Exchange of Use	40	Ward Pasture
Total	247	

The North and Edge Creek pastures have Weyco property as the base property. Currently they are not leasing their lands for grazing. The past lease for their lands allowed for an Exchange of Use of up to 810 AUMs. The Exchange of Use for the Ward Pasture is for a lease with Pacificorp.

The following information is excerpted from the KFRA ARMP/ROD:

Other Forage Demands (AUMs):

Deer	1,681
Elk	100
Wild Horses	100
Total	1,881

Season of Use - 5/1 - 7/1 Ward Pasture

5/1 - 9/1 Edge Creek and North Pastures

Identified Resources Conflicts/Concerns

Under current management the range condition, level or pattern of utilization, and/or season-of-use may be unacceptable; or carrying capacity may be exceeded.

Large area that is not included in allotment but grazed in common with the Ward Pasture.

Critical deer winter range occurs in allotment.

Special status species and/or habitat exists within the allotment.

Riparian or aquatic habitat in less than good habitat condition.

Water quality may not currently meet the Department of Environmental Quality water quality standards for beneficial use.

River segment under study for inclusion in the National Wild and Scenic River System,

Potential Area of Critical Environmental Concern (ACEC) within this allotment.

Allotment makes up a large portion of the Pokegama Herd Management Area.

Potential for grazing/recreation conflicts within the allotment.

Management Objectives

Maintain or improve rangeland condition and productivity through a change in grazing management practices, timing and/or level of active use.

Include south and east side of Klamath River Canyon in Edge Creek allotment and Ward Pasture.

Management systems should reflect the importance of deer winter range.

Prevent significant risk to well being of special status species and/or habitat from BLM authorized actions.

Maintain and improve riparian or aquatic habitat in good or better habitat condition.

Maintain and improve water quality on public lands to meet or exceed standards for beneficial uses, as specifically established by the Department of Environmental Quality, where BLM authorized actions are having a negative effect on water quality.

Ensure livestock grazing management within the river corridor conforms with the river management plan if Congressional approval of river segment occurs.

If designated, grazing management will be consistent with the ACEC management plan.

Mange wild horse grazing levels on public lands to ensure a thriving ecological balance and prevent deterioration of the range.

Grazing management should consider recreation concerns.

Constraints

Officially listed threatened or endangered species and/or critical habitats occur within the allotment. Mitigate all management practices, as needed, to ensure full compliance with the recovery plan in effect for the species in question.

Critical deer winter range occurs in the allotment. Vegetation conversions must be coordinated to adequately address the needs of both big game and cattle. No more than 10 percent of current browse in deer winter range may be converted in any one year.

Allotment contains all or a portion of a wild horse herd management area. Management actions must be mitigated, as needed, to ensure the free-roaming nature of the herd.

Ensure that substantial vegetation conversions do not significantly reduce the variety of plant species or communities in abundance necessary for their continued existence and proper functioning.

The grazing lease for the BLM-administered lands (and the exchange of use) within the North and Edge Creek pastures is dependent on and tied to the intermingled private land grazing lease (Weyco).

The following areas are excluded from general livestock grazing: The upper and lower Hayden Creek Riparian Exclosures and Fox Lake.

Grazing Systems

A spring through fall grazing period has been used on this allotment since it was first licensed for use to Joe Laubacher in 1961 . In the fall of 1967, the division fence that is now the north border of the Ward Pasture was constructed to facilitate the management of the Pokegama Deer Winter Range . Also during that year a burn rehabilitation seeding was completed within the fenced area. No grazing was permitted inside this fenced area during 1968 and 1969, although some trespass cattle were observed. Beginning in 1970 the fenced area was grazed during April and May. During 1972, another fence was constructed to create the north boundary of the present Edge Creek pasture. The following rotation was established for the three areas of the allotment.

Odd Years

Pasture	**Spring**	**Summer**	**Fall**
Ward Pasture	<----------------------------	Defer------------------------	------------->Graze------->
Edge Creek Pasture	Graze--------------------->	Defer------------------------	----------------------------->
Unfenced Pasture	Defer--------->Graze------	------------------------------	----------------------------->

Even Years

Pasture	**Spring**	**Summer**	**Fall**
Ward Pasture	Graze--------------------->	Defer------------------------	----------------------------->
Edge Creek Pasture	<----------------------------	Defer------------------------	----------------------------->
Unfenced Pasture	Defer--------->Graze------	------------------------------	----------------------------->

This system had good intentions but was plagued by trespass cattle and fence repair problems. The trespass of cattle continued to be a problem through the 1980s and into the 1990s. The North pasture was leased to two different operators during this period. The Ward Pasture continued to be leased by Mr. Laubacher until 1994. As mentioned earlier, the lease with Weyco was cancelled in 1994. The North and Edge Creek pastures were not used in 1994 or 1995. The BLM lease for the Ward Pasture lands was tied to a base property lease with Pacificorp. This lease was held by Mr. Laubacher until 1995. Pacificorp has initiated a new lease for their property with Mr. Bob Miller. A private consultant working for Pacificorp developed a grazing plan that covers Pacificorp properties along the Klamath River in California and Oregon. This plan included the BLM lease in the Ward Pasture. The first year of implementation of this new grazing plan is 1996. The North and Edge Creek pastures are currently not leased and will be rested in 1996.

Monitoring Studies - Analysis and Interpretation

Utilization

Key area utilization points were established in the Edge Creek allotment in 1990. The Key Forage Plant study method described in the Dixie Allotment analysis was used. Six of these study points are within the Ward Pasture above the rim of the Klamath Canyon (see Map 12). These points have been read every year since establishment and this data is summarized in Wild Horse core topic. The average of all points for each of the six years sampled was within the Light (21 to 40 percent) range. Point #3 has shown use levels from Moderate (41 to 60 percent) to Severe (81 to 100 percent). This point is located within a quarter mile of Griffith Reservoir, the main water source in the Ward Pasture.

Another eight utilization points were established in 1992 and located within the Klamath River canyon (see Map 10). The 1992 readings were as follows:

Year	Pt. 1	Pt. 2	Pt. 3	Pt. 4	Pt. 5	Pt. 6	Pt. 7	Pt. 8	Ave.
1992	86 percent	88 percent	46 percent	64 percent	13 percent	30 percent	72 percent	74 percent	59 percent

The Klamath River canyon area has had chronic trespass and overuse problems. The canyon area was not formally identified as part of a grazing allotment until the late 1980s. At that time there were discussions on making the canyon a separate grazing allotment. It was decided to make it part of the Ward pasture in the Edge Creek allotment and use that season of use. Monitoring studies were established in 1992 to get data on the use in the area. Unfortunately, no readings have been taken since then. The monitoring in the canyon will be reinitiated in 1996 in conjunction with the new grazing plan being proposed by Pacificorp and the new lessee.

Use pattern mapping has also been completed for the Edge Creek allotment for the years 1984 to 1987 and 1992 to 1993. This mapping has shown most areas to have light use. The areas that have shown heavy to severe use are Griffith, Ward, and Bear Flat reservoirs, the Frain Ranch area, and portions of Hayden, Tom, Edge and Long Prairie Creeks, These use areas are all associated with water sources and riparian areas that support higher levels of green forage throughout the growing season. Some of these utilization patterns are a direct effect of unauthorized grazing use. This is discussed in the **Actual Use** section that follows. Copies of the use pattern maps are located in the Edge Creek Allotment Study file in the KFRA office.

During 1994 and 1995 no livestock use was authorized for the Edge Creek and North pastures. The Ward Pasture was licensed for use. Utilization points were read and a utilization narrative was written after surveys of the allotment were done by BLM range personnel. Field observations showed some incidental use by livestock in the North pasture. This was attributed to drift of livestock from the Dixie allotment. The Edge Creek pasture had little evidence of use. Utilization in the Ward Pasture was in the Light to Moderate range with heavier use around Griffith Reservoir. The Frain Ranch area along the Klamath River showed much less use than past years. This was attributed to the diligence of the lessee in removing livestock at the end of the use period.

Actual Use

Actual use figures have been submitted by the lessee at the end of each grazing season. These figures typically represent the livestock numbers and season of use permitted by the grazing lease. Unauthorized use in this allotment has been a common occurrence and these numbers and use periods are not reflected in the actual use reports submitted by the lessee. Thus, the analysis of the actual use data in conjunction with documentation of unauthorized use would be laborious and it would be difficult to obtain accurate results. The unauthorized use that has occurred on this allotment also makes it difficult to correctly analyze the monitoring data collected. Livestock use in the Ward pasture and the Klamath River canyon area after the authorized season of use has likely resulted in the heavy and severe use patterns shown during utilization mapping. These periods of unauthorized use occurred in late summer and early fall, which is the time that forage grasses produce seed and start to dry up and become less palatable to livestock. The livestock then spend most of their time in the riparian and wetland type areas where the vegetation remains green due to the presence of water and shade. These are the areas that have shown the patterns of overuse. The topography of this area and the intermingled land ownership pattern makes it difficult to fence to effectively control the movement of livestock. The new grazing program that is being proposed by Pacificorp for their properties, which includes the Ward Pasture and BLM properties along the Klamath River, will only be effective if livestock movements can be better controlled through fencing or herding.

Climate

Precipitation data for the years 1990-1995 are shown in the Wild Horse core topic. An explanation on the use of this data in relation to the vegetation monitoring studies is also presented in this section.

Condition/Trend

Two frequency trend studies have been established within the Edge Creek allotment. One is located within the Edge Creek pasture, in a meadow adjacent to Edge Creek. The initial reading was done in 1986 and reread again in 1995. However, the two readings can not be directly compared due to different sampling techniques that were used each year. One observation that can be made from the readings is that *Danthonia californica* has remained stable while the *Carex* and *Juncus* species have increased in abundance.

The second frequency plot is located within the Ward Pasture. The readings taken in 1986 and 1992 appear to be consistent in the data gathering methods used. This data was analyzed and presented in the Wild Horse section of this document and is reprinted here: The major changes of significance (at 95 percent confidence) are increases in the amount of Lemmon's needlegrass (*Stipa lemmonii*) (38 percent to 54 percent) and California oatgrass (39 percent to 67 percent). Perennial bluegrasses (*Poa pratensis, P. secunda*, and *P. bulbosa*) if considered as a group, as they are frequently hard to differentiate, did not change significantly (50 percent to 47 percent). In addition, Kellogg's rush (*Juncus kelloggii*) decreased (20 percent to 10 percent), Idaho fescue (*Festuca idahoensis*) stayed about the same (4 percent to 2 percent), serviceberry (*Amelanchier alnifolia*) stayed the same (7 percent to 10 percent) and annuals showed widely varying changes - annual bromes (*Bromus spp.*) and annual hairgrass (*Deschampsia danthoniodes*) decreased, while medusahead (*Taeneatherum asperum*) and annual fescue (*Festuca relexa* or *Vulpia myuros*) increased.

No formal condition studies have been completed on the Edge Creek allotment. The BLM's method for determining vegetation condition, the Ecological Site Inventory (ESI), has not been done in the resource area. General observations by resource specialists indicate that the removal of overstory trees has resulted in an increase in the understory vegetation of shrubs, grasses, forbs, and related species. Most of the naturally occurring open spaces in the TPLA area have been impacted by disturbance factors such as heavy livestock grazing and timber harvest activities. This has resulted in a decrease in the vigor and population of many native species and an increase in the population of exotic species. These exotic species are better able to compete under disturbance regimes and thus have severely impacted the vegetation community composition in many areas. Many of the exotic annual grass species including medusahead (*Taeneatherum asperum*) and cheatgrass (*Bromus tectorum*) can out compete the native perennial species. The ability to germinate and extend roots at relatively low soil temperatures gives cheatgrass a major advantage over the perennials..., it germinates and sets seed months earlier than native bunchgrasses (Miller et al. 1994). These exotic species are considered low quality forage species due to their short growing season, low amount of vegetative matter, and physical components such as awns that aggravate the mouths of grazing animals.

As mentioned in the Wild Horse section of this document, there was a Soil Vegetation Inventory Method (SVIM) survey performed in the TPLA area in 1981. This method is similar to the ESI method of condition inventory. However, the data records for this inventory are not complete and can not be used effectively. The survey covered only the BLM-administered lands in an area that is dominated by private lands.

Cole Browse

A modified Cole Browse method was used to monitor browse species utilization in the Edge Creek allotment. Fall measurements were done as per the Cole Browse method outlined in the BLM Technical Reference 4400-3, Rangeland Monitoring Utilization Studies. Spring measurements were similar to fall measurements with the exception of average leader length. Average leader length measured the previous fall was used to determine the use index assuming that there is no growth over the winter. The two browse species used in these studies were ceanothus (*ceanothus cuneatus*) and serviceberry (*amelanchier alnifolia*). The fall readings monitor use made by livestock and the spring readings monitor use made by wildlife over the winter and early spring. Table 44 summarizes the results of the studies.

Table 44. Cole Browse Studies - Edge Creek Allotment

Date	Study Number	Species Sampled	Ave. Leader Length	Use Index	Average Leader Use
5/12/95	102-1	ceanothus cuneatus	1.7"	.14	8.5 percent
9/27/94	102-1	ceanothus cuneatus	1.7"	.07	4.0 percent
5/12/95	102-2	ceanothus cuneatus	1.5"	.17	11.2 percent
9/27/94	102-2	ceanothus cuneatus	1.5"	.11	7.0 percent
5/12/95	102-3	amelanchier alnifolia	1.8"	.09	5.0 percent
9/27/94	102-3	amelanchier alnifolia	1.8"	.74	41.0 percent
5/12/95	102-4	ceanothus cuneatus	1.5"	.17	11.4 percent
9/27/94	102-4	ceanothus cuneatus	1.5"	.08	5.0 percent
5/4/94	102-1	ceanothus cuneatus	2.6"	.16	6.0 percent
9/13/93	102-1	ceanothus cuneatus	2.6"	.12	4.8 percent
5/4/94	102-2	ceanothus cuneatus	2.9"	.55	19 percent
9/13/93	102-2	ceanothus cuneatus	2.9"	.14	4.8 percent
5/4/94	102-3	amelanchier alnifolia	2.4"	.17	7.0 percent
9/13/93	102-3	amelanchier alnifolia	2.4"	.82	34.0 percent
5/9/94	102-4	ceanothus cuneatus	2.4"	.36	15.0 percent
9/13/93	102-4	ceanothus cuneatus	2.4"	.09	3.8 percent
5/17/93	102-1	ceanothus cuneatus	.62"	.30	49 percent
5/20/93	102-2	ceanothus cuneatus	.72"	.22	31 percent
5/20/93	102-3	amelanchier alnifolia	2.37"	.21	9.0 percent
5/19/93	102-4	ceanothus cuneatus	.76"	.16	21.0 percent
5/11/92	102-1	ceanothus cuneatus	1.25	data absent	data absent
9/30/91	102-1	ceanothus cuneatus	2.1"	.15	7.3 percent
5/11/92	102-2	ceanothus cuneatus	1.7"	data absent	data absent
9/30/91	102-2	ceanothus cuneatus	3.0"	.45	15 percent
4/30/92	102-3	amelanchier alnifolia	1.8"	data absent	data absent
10/1/91	102-3	amelanchier alnifolia	1.82"	.91	50.0 percent
4/30/92	102-4	ceanothus cuneatus	.90"	data absent	data absent
9/30/91	102-4	ceanothus cuneatus	2.32"	.14	6.0 percent

The fall use levels of the *ceanothus* are all low and this would indicate that livestock are not using this species. The use levels on the *amelanchier* are quite high compared to the *ceanothus*. This use could be contributed to livestock, horses, or deer. *Amelanchier* is not a very abundant species in this area but it is a favored browse species. The fall use levels in the studies were all in the 30 to 50 percent range. These studies were done during 1991, '93, and '94. Livestock were present in this pasture only during 1991 and 1993. No livestock were authorized in 1994. The heavy use levels may then be attributed to horse or deer in 1994 with a similar conclusion for the other years.

Summary

Review of Objectives from KFRA ARMP/ROD document

- Maintain or improve rangeland condition and productivity through a change in grazing management practices, timing and/or level of active use.

The recent changes in the private land leases (Weyco and Pacificorp) have resulted in changes in the grazing management in the Edge Creek allotment. The biggest change has been the suspension of private and BLM authorized livestock grazing on the Edge Creek and North pastures. This change will result in decreased forage utilization by livestock which should result in improved conditions in the short term. Any future renewal of Weyco leases would require consultation and coordination with them to insure that proposed grazing would continue to maintain or improve the upland and riparian conditions. The new grazing plan being implemented on Pacificorp properties in conjunction with the adjoining BLM-administered lands should result in improved conditions if control of livestock movements are achieved.

- Include south and east side of Klamath River Canyon in Edge Creek allotment and Ward Pasture.

These areas have been incorporated as part of the Ward pasture and follow the season of use and livestock numbers for that pasture.

- Management systems should reflect the importance of deer winter range.

Cole Browse studies have shown that livestock use on wildlife browse species has been minimal. The season of use for the Ward Pasture is designed to remove livestock from the Pokegama Deer Winter Range area in time to allow for sufficient regrowth of grass and forb species before late fall and before livestock begin utilizing browse species.

- Prevent significant risk to well being of special status species and/or habitat from BLM authorized actions.

Authorized actions on BLM-administered lands are reviewed by BLM biologists to determine if the action will cause significant risk to special status animal or plant species and their habitat.

- Maintain and improve riparian or aquatic habitat in good or better habitat condition.

Monitoring studies have shown that livestock grazing has been higher than desired to maintain good riparian and aquatic habitat. This objective is not currently being met. Management recommendations and proposed actions will address this objective.

- Maintain and improve water quality on public lands to meet or exceed standards for beneficial uses, as specifically established by the Department of Environmental Quality, where BLM authorized actions are having a negative effect on water quality.

Management changes would be made if water quality monitoring shows a direct effect from livestock grazing activities.

- Ensure livestock grazing management within the river corridor conforms with the river management plan if Congressional approval of river segment occurs.

Recommendations for grazing management in a river management plan would be followed if allowed by the regulations governing livestock grazing on BLM-administered lands.

- If designated, grazing management will be consistent with the ACEC management plan.

Recommendations for grazing management in an ACEC management plan would be followed if allowed by the regulations governing livestock grazing on BLM-administered lands.

- *Manage wild horse grazing levels on public lands to ensure a thriving ecological balance and prevent deterioration of the range.*

This objective is addressed by the Wild Horse section of this document.

- *Grazing management should consider recreation concerns.*

Livestock grazing management decisions and proposed actions are reviewed by BLM recreation specialists to determine if conflicts would result.

Interpretation

Edge Creek and North pastures

Recent changes in grazing management have been made, mainly due to the private land lease cancellations leading to no grazing use in the Edge Creek and North pastures. Weyco owns the lands which are currently considered the base property for these areas of the allotment. If Weyco decides to lease their lands for grazing again, the Exchange of Use grazing previously allowed for in the BLM lease should be reevaluated based upon the desired objectives for the allotment. The following items should be considered when formulating the objectives and the grazing system for these pastures:

Utilization pattern mapping has shown heavy use in riparian areas and meadows. Follow the guidelines for forage use from Table D-7., *Utilization Standards in Riparian-Wetland Areas* and Table D-8., *Degree of Allowable Use* in the KFRA ARMP/ROD document.

The allotment is within the Pokegama Deer Winter Range. Consider the recommendations of the Pokegama working group and resource area wildlife biologists.

Exclosure areas including Fox Lake, Bear Flat Reservoir, and Hayden Creek should be inspected and repaired as needed before turning out livestock. Exclosure areas on the Dixie allotment should also be inspected due to the lack of fencing between the allotments.

The pasture fences around Edge Creek and Ward pastures should be maintained prior to livestock turnout to control drift.

Ward Pasture

Pacificorp will implement a new grazing management system for their lands along the Klamath River in Oregon and California beginning in 1996. The Ward pasture has been included in this system due to the intermingled land ownership patterns in this area. The Ward pasture would have a season of use from 5/15 to 7/15 with 60 cows for a total of 120 AUMs. This is different than the KFRA ARMP/ROD document which has a use period from 5/1 to 7/1. This should not cause any resource problems as the AUMs are the same. Monitoring of the use in riparian areas would be needed to insure that guidelines for forage use levels would not be exceeded. The following items from the Pacificorp plan should also be implemented:

Rebuilding of the Hoover meadow fence. This will help control the drift of livestock onto BLM-administered lands outside of the authorized season of use.

Coordinating with the BLM on construction of the Rock Creek fence. This fence will control drift of livestock into the Frain Ranch area which has been an area of chronic unauthorized use.

In addition to the Pacificorp plan, the following items should be implemented in the Ward pasture to provide for additional resource protection:

Installation of several small sections of drift fence along the upper rim of the Klamath River canyon. This will help stop the drift of livestock from the upper Ward pasture into the canyon. This would allow for use of a rotation system between these two areas that would provide for periods of rest from livestock grazing.

Construction of a small reservoir in the east part of the upper Ward pasture. This would spread the livestock use to the east end of this pasture where there currently is no water source and very little utilization of a seeded wheatgrass area. This would help to decrease the use in the west end of this pasture which has shown levels of use higher than the accepted guidelines.

Core Topic: Wild Horses

Introduction

As stated in the preamble to the Wild Free-Roaming Horse and Burro Act of 1971, "...wild free-roaming horses and burros are living symbols of the historic and pioneer spirit of the West (and) they contribute to the diversity of life forms within the Nature and enrich the lives of the American People..." (U.S.Congress 1971). Through this Congressional action, the American people have determined that wild horses (and burros) are a resource worth protecting and preserving. Congress gave the responsibility for protection, management, and control of wild horses and burros to the Secretaries of Interior (BLM) and Agriculture (USFS) (BLM 1980b). Since the vast majority of wild horses (95 percent) are on public lands administered by the BLM, most of the management and actions dealing with horse have been by the BLM.

Much of the BLM's general management of wild horses since the 1971 Act has been highly controversial. Wild horses are often viewed with varying degrees of disdain by many public land users and range and wildlife managers who often see them as an unnecessary competitor for a seemingly ever shrinking vegetation resource. On the other side, wild horse advocates and horse protection interest groups believe the best use of public lands is for the production of aesthetically pleasing wild and free-roaming horses. Some of the more "radical" wild horse groups consider ranchers as "a criminal element" and the BLM as "the enemy" (Klinkenborg 1994). Most people truly acquainted with wild horse issues either love them or hate them - with few in the middle.

Controversy is also evident in regards to the existence and management of the Pokegama horse herd. Local sports groups, land owners, the Oregon and California state wildlife management agencies, grazing users, and other "publics" have expressed variable opinions on the Pokegama herd. As a case in point, during the drafting of the 1986 Herd Management Area Plan revision, a survey of the opinions of all of the land owners and responsible agencies involved in the Pokegama area was solicited by questionnaire. This survey found that, of the 25 responses returned, 12 percent were positive, 20 percent were neutral, and 68 percent were negative in regards to the existence of the Pokegama horse herd.

The BLM is required by law to manage "...at the minimum level necessary to attain the objectives identified in approved land use plans and herd management area plans." What management the KFRA has done or plans to do in the area is constrained by the fragmented land ownership patterns, limited budgets, and competing management priorities.

One general and over-riding wild horse issue was formulated.

Issue: A formally established Wild Horse Herd Management Area exists and the horse herd is creating impacts within the analysis area.

The two key questions under this issue will be addressed together in the narrative that follows. This is because the relationship between the two questions is such that addressing the first question naturally leads to a discourse on the second.

Key Questions: How much of an effect does the herd have on the vegetative communities and dependent wildlife species in the area? Is the current management level of 30 to 50 horses suitable for the Herd Management Area?

Assumptions/Analytical Process

A wild horse herd area is defined as an area used by wild horses or burros as habitat as of 1971 when the Act was passed. A herd management area (HMA) is a herd area where the land use planning process has determined that wild horses or burros will be managed (BLM 1990). As a practical matter, virtually all herd areas are managed as HMAs. This includes the Pokegama HMA. The appropriate number of horses for which to manage may be considered variable depending on habitat conditions and competing resource needs. However, the Pokegama herd area exists and will continue to exist under current law. Current BLM planning for the area - the June 1995 Klamath Falls Resource Area Resource Management Plan and Record of Decision - has acknowledged the decisions of the current laws and past plans (BLM 1980a), which have specified that the Pokegama herd area will be managed as an HMA.

Proper use of the public lands and protecting and maintaining viable, healthy herds of wild horses and burros are the primary wild horse management objectives for the BLM and KFRA. The 1971 Act requires that horses be managed as "components of the public lands" in numbers that "preserve and maintain a thriving natural ecological balance and multiple-use relationship in that area" (BLM 1990). Pertinent litigation in recent years has affirmed that the Appropriate Management Level (AML) for a horse herd must be at a level that "...will restore the range to a thriving natural ecological balance and prevent a deterioration of the range...". (IBLA 1989 to 1995). Numerous court decisions have required and affirmed that the BLM must predicate wild horse management levels - AMLs - on "...a reasoned analysis of monitoring data such as grazing utilization, trend in range condition, actual use, and other factors..." which demonstrate that changes in wild horse numbers are required. Normally AMLs based solely on planning generated numbers are not valid unless affirmed and supported by monitoring information. As one wild horse decision stated, "...an AML established purely for administrative reasons because it was the level of wild horse use at a particular point in time cannot be justified..." (IBLA 1989).

The discussion and assesment contained in this landscape analysis will be the "reasoned analysis" of the most recent monitoring data and other pertinent information with the intent of making management recommendations, if necessary, to ensure the horse herd is in balance with its habitat, while being in sufficient numbers to constitute a genetically viable herd. This examination will expand upon the brief analysis prepared in the "Lakeview District Wild Horse Gather" environmental assessment, EA #OR-010-95-10 (BLM 1995).

Analysis Discussion

Historic/Current Conditions

This section is broken into three portions - a discussion of the wild horse herd itself, the wild horses' habitat, and a short section that summarizes the pertinent objectives for the HMA.

Wild Horse Herd

The Pokegama wild horse HMA is located approximately 35 miles west of Klamath Falls, Oregon: south of highway 66 and generally north of the Klamath River. Local residents of the Pokegama area recall seeing bands of wild horses in the area since the early 1900s. The horse population is believed to have originated from one buckskin quarter horse stallion and approximately 7 buckskin mares that a rancher permitted to run loose on the range (Gottlieb 1993); a very common occurrence in the days prior to the 1934 Taylor Grazing Act. It was also a relatively common occurrence in many areas, up until the 1971 Act, for local ranchers to "manage" the wild horse herd in order to remove occasional horses for working ranch stock or for market (BLM 1980b).

The Pokegama herd has apparently always been relatively small and continues to use the same general historic area. When the BLM conducted its first survey (or census) of the area in 1972, 25 horses were counted (BLM 1986). Current (1996) estimates of the herd size are in the 60 to 75 head range. The average yearly increase in the horse herd over this period is 4 to 5 percent; extremely low by wild horse herd standards elsewhere, which generally average 22 percent (National Research Council 1980). It has been rumored and is entirely possible that young horses have been periodically - and illegally - removed from the herd over the last 25 years. This could help to explain the low increase in herd size (BLM 1986). The following is a list of wild horse counts made since the 1971 Act:

YEAR	NUMBER OF WILD HORSES
1972	25 horses
1973	25 horses
1977	30 horses
1978	35 horses (31 adults/4 foals)
1985	41 horses (36 adults/5 foals)
1992	55 horses (52 adults/3 foals)
1993	50 horses (47 adults/3 foals)
1994	50 horses (45 adults/5 foals)
1996	60-75 horses (estimate)

There is also a skewing of the herd composition towards more males and less females. As stated in Gottlieb's report (1993), "A sex ratio of more males and less fecund females acts to decrease the productivity of the herd and minimize the increase in population size. Annual growth rates of other wild horse herds range from 8 percent to 30 percent, with an average of 22 percent. The Pokegama herd experienced approximate annual increase rates of 6 percent from 1972 to 1978; 2.5 percent from 1978 to 1985; and 5 percent from 1985 to 1992. These figures revealed that the Pokegama herd has been increasing at a much slower rate than most other wild horse herds. The slower growth rate of this herd may be related to the higher number of male horses, but whether the slow increase led to higher numbers of males, or was caused by higher numbers of males, can only be determined by further study." (Note: This type of study is unlikely to occur for this herd.)

Following is the information available as to the ratio of studs to mares:

1978: 7 studs to 24 mares with 4 foals
1985: 16 studs to 20 mares with 5 foals
1992: 25 studs to 19 mares with 3 foals (some horses could not be ground classified as to sex, thus the different total from the previous page.)

The herd trend towards more studs and less mares is difficult to explain. The following discussion is excerpted from Gottlieb's 1993 report on the Pokegama herd, for which she did the field work, as a BLM volunteer from the Student Conservation Association during the summer of 1992. Specific literature references are omitted for brevity; a copy of Gottlieb's complete report is available at the Klamath Falls R.A. office.

> "Research indicated that many wild horse herds studied contained more adult females than males. The present study differed in that a higher number of adult males was observed; this occurrence was reported by two other researchers. Sex ratios at birth is reported to be nearly equal in many herds, therefore the cause of skewed sex ratios appears unrelated to sex ratios at birth. Asymmetries in sex ratios are often revealed to be caused by differential survival of the sexes, which is related to the reproductive cost incurred by each sex.
>
> "Berger studied highly aggressive and territorial bands of wild horses in Wyoming's Red Desert during drought conditions. Reproductive costs of males was highest in the spring due to the intense competition involved in acquiring and maintaining harems, and males defended these harems year round, leading to increased male mortality. Different herds in dissimilar habitats experience diverse demands, consequently other herds in less strenuous conditions may exhibit less aggressive behavior. Fighting was not observed among the Pokegama herd and the horses appeared to be relatively non-aggressive.
>
> "Environments with extreme ambient temperatures or drought conditions predispose females to higher mortality rates than males because lactation and gestation demand high amounts of energy. Energy demands on females are particularly high when females reproduce in consecutive years, incurring the costs of lactation and gestation simultaneously. A drought situation has existed in the Pokegama HMA for at least the past 5 years and may have influenced female mortality during that time, resulting in skewed sex ratios. Reproductive failure in a localized population was observed to cause a deficiency of foals and yearlings. Wolfe found that foals constituted 19% of the population, and a high proportion of foals was observed by (other researchers). The Pokegama herd exhibited only 5% foals and 9% yearlings, thus suggesting that this herd is not reproducing efficiently.
>
> "The Pokegama herd appeared healthy in 1992, therefore it is possible that their range supplied them with sufficient food and water even during a drought. (Researchers) noted that, when healthy, females

should produce a higher proportion of healthy male offspring that are good competitors and can pass on the most genes. If this has occurred among the Pokegama herd, this would explain the skewed sex rations and overall increase in total numbers."

The overall condition of the horses in the herd is still excellent. Individual adult horses appear to be larger than the typical wild horse (that is, over 1000 lbs. versus less than 1000 lbs. for the average wild horse elsewhere on BLM-administered lands). They also have good conformation, indicating that inbreeding is still not altering the "quality" of the horse herd (BLM 1978). Observations of the horses made during the past 3 or 4 years have indicated that the horses are still healthy, relatively docile (for wild horses) and appear to be consuming ample forage.

Wild Horse Habitat

The formally recognized external boundaries of the HMA are Copco Lake and the Klamath River on the south and east, Jenny Creek on the west and Highway 66 (Greensprings Highway) on the north. All of these external boundary features largely prevent wild horse ingress and egress from the HMA, with the exception of Highway 66 (which has an insufficient traffic load to constitute an impenetrable obstacle). The highway does not restrict movement, though up until recently, few horses had been observed north of this road (Gottlieb 1993). During the past several years at least one band of a dozen or so horses has been summering on areas north of the highway - outside the established herd area. 43 Code of Federal Regulations (CFR) 4710.4 requires that BLM "management of wild horses and burros be undertaken with the objective of limiting the animals' distribution to herd areas."

The entire Oregon portion of the herd area is contained within two grazing allotments - Dixie (#0107) and Edge Creek (#0102). See the grazing allotment map which shows the boundaries of these allotments. Also reference the "Livestock Grazing" issue of this landscape analysis for more information on domestic livestock grazing.

In 1978, a "Pokegama Herd Management Plan" (HMAP) was written and approved by the Medford BLM district. It established an Appropriate Management Level (AML) of 30 head with an allowable range of 25 to 50 head. A revision of this plan was drafted in 1986, but was apparently never signed and approved. Thus, the 1978 plan, despite its advanced age, is still the most current. According to the 1978 HMAP, the Pokegama HMA, including both California and Oregon, is 91 percent privately owned lands. The 1978 land ownership/administration pattern was broken down as follows: Private - 132,030 acres, BLM - 12,090 acres, USFS - 760 acres, and State (OR) - 80 acres: total - 144,960 acres. However, the 1986 plan revision significantly revamped the acreage amounts, coming up with a total of 80,885 acres within the HMA - 79 percent of which is privately owned. The 1986 figures appear more accurate and are as follows:

Ownership/Administration	**OR acres(%)**	**CAL acres(%)**	**Total acres(%)**
BLM - O&C	11,980		11,980
PD	3,795	710	4,505
	15,775(23%)	710 (5%)	16,485 (20%)
Other Public			
Klamath Co.	20		20
State (OR)	80		80
Klamath N.F.		740	740
	100 (1%)	740 (6%)	840 (1%)
Ownership/Administration	**OR acres(%)**	**CAL acres(%)**	**Total acres(%)**
Private			
WEYCO	48,187	825	49,012
Other	3,807	10,741	14,548
	51,994(77%)	11,566(89%)	63,560(79%)
Total	67,869	13,016	80,885

The major land owner within the HMA - Weyerhaeuser Company (WEYCO) - has generally allowed the presence of wild horses on their lands providing the horses are within the established AML and do not range outside of the HMA. Periodically since 1979, the BLM has received letters from WEYCO, the local office of the Oregon Department of Fish and Wildlife (ODFW), and other land owners requesting, encouraging and/or supporting the reduction of wild horse numbers down to the lower end of the management range. These requests, along with resource concerns that will be discussed later, prompted the completion of a environmental assessment (EA) in 1995, that analyzed the need for and allows the collection of horses within the Pokegama HMA down to the 30 head AML (BLM 1995b). A decision record was issued on the capture EA and became final without appeal. Due to other state priorities and severe budget constraints the horse capture that was planned for early 1996 was cancelled. In the near future, the Klamath Falls Resource Area will be actively competing with other districts for completion of the Pokegama wild horse reduction gather. This analysis compliments, supports, and expands upon the analysis made in the 1995 EA.

This HMA lies within the area encompassing the Pokegama Cooperative Habitat Improvement Project. The project cooperative group includes federal and state agencies, interested user groups, and land owners - including Weyerhaeuser. The purpose of the project group is to cooperatively address and find solutions for the resource problems in the area. The April 18, 1991 "Memorandum of Understanding", prepared and signed off by the major members of the group, has as an objective to "Maintain a wild horse population in the Pokegama Herd use area." It is important to keep the horse herd within the AML for resource related reasons and because of the KFRAs participation as part of the Pokegama group.

However, if Weyerhaeuser were to formally request the BLM to remove all wild horses from their lands, the BLM may be obligated to remove most if not all of the horses from the HMA, as per 43 Code of Federal Regulations 4720.2-1. This regulation states in part that "upon written request from the private landowner to...BLM, the authorized officer **shall** remove stray wild horses...from private lands as soon as practical..." (emphasis added). Since about 80 percent of the HMA is on private land (and it is estimated that the horses spend at least that proportion of time on the private lands), in order to ensure that the BLM fulfills its regulatory requirements would probably have to remove all the horses. The Pokegama group allows for a multi-resource approach as well as encourages a cooperative spirit towards accommodating the horses in an area of competing resource demands. Prompt action on limiting the herd numbers to the AML would assist greatly in maintaining this cooperation.

(Note: The Weyerhaeuser lands in the Pokegama area are reputed to be for sale at present. Even though the recent proposed sale (2/96) to Roseburg Lumber fell through, Weyerhaeuser reportedly has several other potential buyers still interested in the purchase of their land holdings in the area. Weyerhaeuser has publicly stated that they are more interested in western Oregon Douglas fir areas than east-of-the-Cascades pine dominated forests. The Pokegama area is an east-of-the-Cascades pine dominated forest habitat - see the vegetation analysis. A different owner of these properties may have a very different opinion about the presence of government "owned" wild horses being on their lands.)

* * *

Wild horse habitat is specifically made up of three major components: food, cover (or shelter), and water. The following section will address these components separately.

Food

Food directly relates to the vegetation since horses are herbivores. Horses are the most selective of grazers, primarily eating grasses and grass-like species and largely avoiding other plant classes. Horses do, however, have an ability to utilize coarse grass unsurpassed by any other kind of stock (Stoddard et.al. 1975). Both cattle and elk also have high dietary overlap with each other and with horses. The overlap is not often perceived as a problem where range conditions are good or the intensity of cattle and horse use is low. There may be problems, however, where forage availability is limited, as on winter ranges or on sites with cattle/horse/elk concentrations, such as riparian areas (Edge and Marcum 1990). Dietary overlap between deer and horses during any season is very low.

Between January of 1979 and February of 1981, the BLM contracted for the periodic microhistological analysis of fecal material collected from within the HMA (for horses) and in the general geographical area for deer, elk, and cattle (BLM 1982). This Pokegama herd specific information confirms that the horses diet is predominately made up of grasses with minor supplemental additions of forbs and trees on occasion. Highly preferential use of grasses is consistent throughout the year. The following chart summarizes this information.

	Winter	Spring	Summer	Fall
Grasses	88%	95.5%	95%	95.5%
Shrubs	0%	1%	0.4%	0%
Forbs	8%	1.8%	3%	2%
Trees	5%	2%	2%	2.5%

(Some columns do not total 100% due to rounding)

The complete file of microhistological analysis information is available and found within the wild horse files in the KFRA office. This information shows that needlegrasses (*Stipa spp.*), fescues (*Festuca spp.*), Bromegrasses (*Bromus spp.*) - both annual and perennial, bluegrasses (*Poa spp.*), muhly (Muhlenbergia spp.), oatgrass (*Danthonia spp.*), wildrye (*Elymus spp.*), medusahead wildrye (*Taeniatherum caput-medusae*), and rushes (both *Juncus* and *Eleocharis*) makeup the vast majority of the grass component of their diet. Medusahead is relatively abundant in the diet during the spring and early summer when it is most abundant and relatively palatable (for a largely unpalatable species). This is consistent with the observations that horses have the ability to utilize very coarse grass species. Also consistent with this is the fact that the horses consume the same high percentages of grass in the winter, when all grasses are at their most coarse and fibrous, as in the spring/summer when grasses are the most palatable.

Also of interest is the relative abundance of rushes (particularly *Eleocharis*), sedges, and other meadow/riparian species during the summer and fall. This is consistent with past and recent observations of the horses during that time of year making extensive use of meadow and riparian areas (Gottlieb1993). Due to the presence of the horses year-round in the Pokegama area, they are believed to have at least as much - and probably more - impact to meadow/riparian areas than do the current levels of cattle and elk grazing.

The minor though consistent grazing use of tree species by the horses is of some interest in the area since the WEYCO lands are managed primarily for timber production. The horses in the HMA have some taste for pine (*Pinus spp.*) throughout the year, but especially in the fall. However, the average pine component in their diet was only about 2 percent and never exceeded 6 percent during the study period. It is possible the horses were eating small, tender branches off young or seedling trees - perhaps in tree plantation areas. Other tree types occasionally sampled included Douglas fir (*Pseudostuga spp.*), oak (*Quercus spp.*), and juniper (*Juniperus spp.*).

Generally speaking, forage is not a limiting factor for the historic population levels of the Pokegama herd even though some areas are periodically overutilized (this is discussed later). Other information dealing with the vegetative component of the HMA is contained within the other sections of this landscape analysis.

Cover

During Gottlieb's survey of the Pokegama HMA during 1992, she found the horses had decided preferences for certain areas in the summer. The following is extracted from her report:

> "Utilization of shelter by wild horses was investigated by recording the habitat type that horses were observed in. Horses were found in meadows/open areas; in meadows under a lone tree; in the tree cover on the edge of meadows; and on a dirt road a quarter mile from a meadow. Horses were not located in thick tree cover, presumably due to diminished visibility inherent in that habitat type. Thirty-three percent of the sightings occurred in meadows/open areas, 11 percent were under lone trees in meadows, 50 percent were found in tree cover on the edge of meadows, and one sighting (6 percent) took place on a dirt road.
>
> "Concerning meadow use, 44 percent of the horses were sighted in meadows, 50 percent utilized the tree cover on the edge of meadows.... Wild horses showed a preference for meadow and open areas, remaining in or on the edge of this habitat type. Sixty-one percent of the horses sighted were under trees, suggesting that shade supplied by tree cover is important for shelter during hot, sunny summer days."

Wild horse winter use has been observed to follow a similar trend - that the horses gravitate towards more open (non or less tree covered) areas since these areas always have a more abundant grass component to the vegetation community. Also, the open areas receive more sunlight which melts the snow off much quicker than under the forest canopy, making the forage accessible. Due to the typically high winter snow accumulations present on the higher (central and northern) portions of the HMA, the horses concentrate in the south end of the area from December through March. These areas include around Wild Gal Spring, Grizzly Flat, Edge Creek, and east to Hayden Creek as well as south into the portion of the HMA that lies in California north of Copco Lake and the Klamath River. This winter area includes more non-meadow open areas - scabland flats and shrub dominated vegetation types - than the HMA lands to the north.

In summary, cover is not a limiting factor for the Pokegama herd.

Water

As with many wildlife species in relatively arid areas, the availability and location of water is critical to the survival and habitat utilization of the herd. The following information is from Gottlieb's (1993) report on the Pokegama herd:

> "Location of drinking water appeared to be an important factor in habitat selection of wild horses in the Pokegama herd. Eighty-seven percent of all sightings occurred within a half mile of a watersource, 70 percent were within a quarter mile, and 35 percent of the bands were observed at a water hole. Average distance to water was 0.28 miles.
>
> "Many researchers have found availability of water to be a major determinant in horse movements... Wild horses are found to concentrate near water sources during hot, dry summer months but wander farther during cooler weather...Horses were observed to remain within 3 to 7 miles of a water source during very hot weather...Ganskopp and Vavra found that a wild horse herd in eastern Oregon remained an average distance of 0.97 miles from water. In the (Pokegama HMA), it would be difficult for the horses to be further than 5 miles from any water source due to the size of the area, and the fact that it is bisected by a permanent creek and includes scattered springs...Remaining close to water sources during the dry summer would enable the wild horses to conserve energy because they would not have to travel far for water. Water is also an important factor for plants, therefore plant species edible to horses may be located near water..."

The primary water sources for the Pokegama herd are Wild Gal Spring, Edge Creek, Hayden Creek, Long Prairie Creek, and Jenny Creek as well as several dozen catchment ponds, reservoirs, and springs. Generally speaking, water is not a limiting habitat factor for the Pokegama HMA, although the majority of the water sources are on private lands.

HMA Related Objectives

The BLM regulations that pertain to the management of wild horses require that, "Management activities affecting wild horses and burros, including the establishment of herd management areas, shall be in accordance with approved land use plans..."(43 CFR 4710.1). Thus, the management of wild horses must be directly linked to the objectives and guidance found in approved land use plans (LUP). The applicable LUP for the KFRA is the Klamath Falls R.A. Record of Decision and Resource Management Plan and Rangeland Program Summary (BLM 1995a). Directly tiered to the LUPs are "activity plans" including allotment management plans (livestock grazing), habitat management plans (wildlife), and herd management area plans or HMAPs for wild horses. These plans include objectives that expand on, refine, quantify, and qualify the general objectives from the LUP. The following set of objectives will be the yardstick to measure the monitoring information against to determine if management of the Pokegama herd is appropriate, and if not, what management changes would be needed to meet, or move towards meeting, proper resource or animal management.

Excerpts from Pokegama Herd Management Plan - 1978

Animal

a. Manage wild horse in this herd unit to maintain a viable herd of approximately thirty healthy individuals.
b. Initiate a control program on an as needed basis to maintain horse numbers at a low point of 25 animals and a high point of approximately 50 animals. This is based on the current MFP Decision. However, as more accurate data is gathered these numbers may change.
c. Collect age and sex ratio data to determine population dynamics of this herd. This information is necessary to make a population and age structure analysis which will guide future management decisions.

d. Collect data on grazing and browse preference of the three major species in the HMA (deer, cattle, horses) by fecal analysis to determine what and how much competition exists.

e. Continue monitoring production and study plots to determine forage production, condition, and trend. This will determine the ideal number of horses that can use the HMA.

f. The herds are to be maintained in the present free-roaming status within the entire herd unit.

Habitat

a. Maintain or improve the current perennial grass and browse stands.

b. Continue to maintain the existing reservoirs and springs in the HMA which provide season long water for wild horses.

Management Plan for the Pokegama Wild Horse Herd - 1986 (draft)

(Note: The following objectives are not "binding" in that this management plan revision was never approved (signed). These objectives are listed since they show that the objectives from the 1978 plan have validity over time and, also, to help in the determination of what is important to the current management of horses in the Pokegama HMA.)

Animal

a. same as "1a" in 1978 plan.

b. same (virtually) as "1c" in 1978 plan.

c. same as "1f" in 1978 plan.

(1b,d, and e did not carry forward from 1978 plan.)

Habitat

a. Maintain or improve the current perennial grass and browse stands by burning and or seeding or fertilizing. This will be done in cooperation with the wildlife and range programs. (similar to "2a" in 1978 plan)

b. same as "2b" in 1978 plan.

c. Establish permanent salting areas with mineralized salt away from heavy use areas by 1988 growing season.

Excerpts from Klamath Falls RA Resource Management Plan/Record of Decision - 1995

Objectives (quoted from RMP/ROD)

> "Manage the Pokegama Wild Horse Herd in accordance with the Appropriate Management Level to ensure or enhance a thriving natural ecological balance between the wild horse population, wildlife, livestock, and the vegetation, and to protect the range from deterioration associated with overpopulation.
>
> Provide for wild horse grazing in an environmentally sensitive manner, consistent with other objectives and land use allocations. Wild horse grazing use will be consistent with the objectives found in Appendix H, General Allowable Use Guidelines, Livestock Grazing in Riparian-Wetland Areas, and Allotment Management Summaries, and in the Water and soils Section earlier in this chapter.
>
> Also, provide for range land improvement and management practices, that in whole or part are beneficial to wild horses, consistent with other objectives and land use allocations.

Land Use Allocations (quoted from RMP/ROD)

> The initial appropriate management level for the Pokegama herd management area, under this plan, will be 30 to 50 head. This number is based on the determination made when the Herd Management Area Plan was written in 1978 and current professional judgement of the grazing capacities of the herd management area.
>
> Within the Pokegama herd management area, 150 animal unit months of forage area allocated for wild horse use. The numbers of animal unit months allocated, by allotment, are found in Appendix H, Allotment Management Summaries. This animal unit months figure reflects the land distribution pattern within the herd management area where 20 percent of the lands are BLM-administered and 80 percent

are private. All wild horse use, within the resource area, is in the Dixie (0107) and Edge Creek (0102) Allotments."

Resource Monitoring Evaluation Summary

By necessity this analysis is tiered to the livestock grazing and vegetation related portions of this Landscape Analysis. Since management of the wild horses by the BLM entails both the animals themselves and their habitat, this analysis is divided similarly as the previous section - into a "Wild Horse Herd" (animals) and a "Wild Horse Habitat" (vegetation) section. Since both are interconnected and because the BLM has more monitoring information relative to the habitat than the animals themselves, the bulk of the information and analysis will be contained in the "Wild Horse Habitat" section. It is assumed that if the habitat is in good shape the animals that depend on that habitat, including wild horses, will be in good shape.

The following analysis, interpretation and evaluation section generally follows BLM Manual Handbook 4400-1, "Rangeland Monitoring and Evaluation" (BLM 1989). This process documents conclusions as to the progress of management actions in accomplishing specific resource objectives. These conclusions are used for formulating and implementing changes in management actions and/or for establishing new or revised objectives.

Following this guidance, the evaluation is accomplished by analyzing, interpreting, and evaluating the existing monitoring information. Although the structure of this analysis will not be compartmentalized into these three discrete sections, it is our intention to examine that information in this process. A brief description of the three "parts" of an evaluation are as follows (from the above referenced manual):

> Analysis of Monitoring Information: A detailed examination of the monitoring data or information, or a separation of any whole into component parts for the purpose of examining their essential features, nature, and function as they relate to the whole. Ultimately, the analysis should establish "cause and effect" relationships.
>
> Interpretation of Monitoring Information: Involves determining and explaining, as much as possible, the meaning of the data collected through monitoring, including interpreting individual data sets and examining their interrelationships.
>
> Evaluation of Monitoring Information: Evaluation is the examination and professional judgement concerning the worth, quality, significance, amount, degree, or condition of the natural resources based on interpretation of monitoring data. An evaluation provides a subjective assessment of all available information concerning a specific area and its management. The goal of the evaluation is to determine whether satisfactory progress is occurring toward meeting resource objectives, and if progress is not occurring, to identify the actions necessary to correct deficiencies.

Wild Horse Herd

The majority of the monitoring information dealing with the animals themselves is related to the census/herd count, growth rates, observed sex ratios, and microhistological information outlined earlier. There are two herd related "problems" that will be addressed briefly - the skewed sex ratio and the low apparent reproductive rate. Since the two are possibly related, they are addressed together.

As noted earlier the herd in recent years is about 60 percent studs and 40 percent mares, a ratio that may imply that there has been some selective survival advantage to males and disadvantage to females. As noted earlier, Gottlieb (1993) identified this skewing as a potential problem with the Pokegama herd. However, given the small size of the herd (probably less than 70 total animals) it may be likely that this skewing is a short term function of the low numbers, that is a few head more or less of males (or females) makes a large percentage difference in the sex ratio. During the late 70s to mid 80s, the ratio skewing was reversed with females being 55 to 77 percent of the herd composition. If the herd were to get up to the average size of wild horse herds on other public lands - approximately 240 head (BLM 1990) - it is believed that the sex ratio would be consistently closer to 50:50. (Note: There is no BLM intention to allow the herd to achieve this population size.)

The herd sex ratio skewing may also be a function of the inevitable inaccuracies of counting and "sexing" wild horses on the open range; a difficult proposition in the best of conditions and particularly difficult in forest dominated areas like the Pokegama HMA. However, field observations made during the past two years (1994-95) by BLM personnel have confirmed that studs still appear to be significantly more abundant than mares.

If indeed the high stud-to-mare ratio is acting as a depressant on herd growth rates, as Gottlieb (1993) suggests, this may not be undesirable. Given the situation outlined earlier regarding the amount of private lands in the HMA it may be beneficial to have slow (or no) growth.

Wild Horse Habitat

With the exception of the microhistological data summarized earlier, the bulk of the habitat/vegetation related monitoring information is comprised of the utilization and use pattern mapping, trend/condition studies, and other data that has been collected as part of the rangeland monitoring program. When this information was collected, it differentiated the responsible animal as much as possible. As a practical matter, and as explained earlier, the primary grazing animals in the area - cattle, horse, and elk - consume the same types of forage species and a conclusive allocation of the specific use can not usually be definitively and objectively made. When this is the case, the proportioning of use (and responsibility, when unacceptable resource impacts are occurring) will be allocated by a combination of actual use data (census for horses and certified actual use or licensed numbers for cattle) and specific field observations tempered by professional judgement.

The following summaries of the monitoring data are relevant to wild horse use. The complete information base for these summaries is located in the allotment specific monitoring files. An explanation of monitoring study methods and locations can be found in the KFRA "Coordinated Monitoring and Evaluation Plan for Grazing Allotments" (BLM 1994). All of this information is located in the KFRA office. Since the data was collected on an allotment specific basis, the information will be referred to by allotment - either the Dixie allotment (west side of the HMA) or Edge Creek allotment (east side). Dixie is loosely divided into a "north half" (virtually all WEYCO lands) and a "south half" (a mixture of BLM and private); the boundary being the Dixie fence, running roughly east/west in the south-center portion of the allotment. Edge Creek is divided into the "north" pasture (everything north of the Ward fence), the "Edge creek" pasture (west of the north/south portion of the Ward fence), and the "Ward" pasture (south and east of the Ward fence and north of the Klamath River Canyon). These pasture designations will be used as appropriate to describe areas. See Map 12.

Precipitation/Climate: The results of all vegetation related monitoring studies are affected by the climatic factors of a particular year; often significantly. Given similar grazing use, lower than "average" precipitation tends to produce higher utilization levels, larger zones of relatively higher utilization, less (or downward) changes in condition and trend, and more concentrated use in riparian/meadow zones; the opposite occurs with higher than "average" precipitation. All of this can, of course, be widely variable depending on the timing and intensity of precipitation, type of precipitation, and a myriad of other factors, too complex for this analysis. Nonetheless, it is useful information. Since most of the monitoring data that has been collected by the BLM has occurred in the last 6 years, only the period 1990 through 1995 will be discussed.

Research has indicated that the "precipitation crop year period" (September through June, inclusive) is the most representative period to use as a base for adjusting and/or predicting subsequent plant growth for the Intermountain Steppe region (Sneva and Britton 1983). Although the Pokegama is not considered "sagebrush steppe", its relative aridity, east of the Cascade mountains locality, and proximity immediately adjacent to the steppe region of eastern Oregon, give the crop year concept validity. Using the "yield index formula" from the above referenced publication and the crop year precipitation amounts, a yield index is arrived at which indicates how much below or above "average" the vegetative production is in a given year. For example, in 1990 the index is 1.17; which predicts vegetative production would be about 117 percent of normal. The yield index can be used to "adjust" observed utilization in order to compensate for deviations from average and allow for a relatively objective analysis of utilization data for a year or sequence of years as compared to long term trends.

The Klamath Falls, Oregon long term (30 year) average for the September through June crop year period is 11.40 inches. The average precipitation for the Pokegama area is significantly higher than for Klamath Falls. However, due to the close proximity of both areas, it is believed that the precipitation trends, though not in precise amounts, are typically the same and thus the yield index would be very similar. The following chart outlines the 1990 to 95 crop year precipitation period totals for each growth year:

Year(Crop Yr.)	Crop Year Precip.(1)	30-Year Average(1)	Yield Index
1990 (9/89-6/90)	12.96	11.40	1.17
1991 (9/90-6/91)	9.26	11.40	0.77
1992 (9/91-6/92)	6.00	11.40	0.42
1993 (9/92-6/93)	19.66*	11.40	1.89
1994 (9/93-6/94)	8.55	11.40	0.69
1995 (9/94-6/95)	19.92	11.40	1.92

(*Incomplete - one month missing. Total at least this much for Crop Year.)
(1) - in inches

The average precipitation for the 6 years monitored is 12.73 inches, which is 112 percent of the 30 year average. The yield index for the 6 year period would be 1.14 implying that the forage production was about 114 percent of average for the period. This is only slightly above the long term forage production "average" and implies that the average utilization levels calculated later are close to what would be expected in average years.

(NOTE: During personal communications with Sneva, Sneva (1990) noted that the index appears to progressively lose its yearly precision as precipitation deviates more than 25 to 30 percent either way from the 30 year average. Field observations made during this period seem to confirm this. During the crop year period 1990-1995, four out of six years deviated from the average by more than 30 percent. Forage conditions in 1995 showed as above "average", but not double the biomass the index predicted. Similarly, 1992 produced less forage than average, but appeared to produce above the 42 percent of "average" the yield index would indicate. Regardless, the crop year precipitation and related index still gives a valid representation of production that is useful in interpreting vegetative monitoring information. For this analysis, the six years are averaged together in order to give a better picture of the longer term trends in utilization.)

Actual Use: Site specific actual use for the wild horse herd is impossible to determine precisely. However, some general observations have been made that are helpful in understanding and interpreting the monitoring data. First is that the horses spend the entire year in the HMA vicinity. If we assume that there are 60 adult horses in the area - a realistic estimate - and that a horse consumes the equivalent of 1.25 AUMs (the universally accepted figure), then the horse herd is consuming about 900 AUMs of forage each year (75 AUMs per month). The horses also have been observed over the last 10 to15 years to concentrate their use in the southern third of the HMA, more than the northern two thirds. This is probably due to the more open nature of the southern portions of the HMA; a vegetation community feature preferred by horses. (Note: the southern third of the HMA is roughly defined as the area from Jenny Creek - just north of the California line - to Grizzly Flat and Dixie, east to Hayden creek, and Grizzly Butte, and from all of these areas south into California to the Klamath River and Copco Reservoir. The northern two thirds is everything north of there to Highway 66.)

From April through November the horses are more widely disseminated throughout the HMA and even beyond (the band north of Highway 66 noted earlier). However, at least one band of 9 horses and probably another 10 to 15 head apparently also spend the summer in the southern end of the HMA. From December through March, all of the horses are usually concentrated in the southern end of the HMA.

Given these trends, the horses are estimated to be meeting about half of their forage demands (i.e. 450 AUMs) in the southern third of the HMA. It is estimated that this southern use is apportioned as follows: 150 AUMs use from the south end of the Dixie allotment and 300 AUMs from the south portions of the Edge Creek allotment - primarily the Edge Creek and Ward pasture areas. The recent roaming of horses outside of the HMA may be circumstantial evidence that the horses are at numbers beyond their habitat capacity on the meadows in the southern third; especially if considered in conjunction with the summer use by cattle and the recent increases in elk numbers. See the Livestock Grazing analysis for information on the actual use made by cattle.

Utilization/Use Pattern Mapping: Key area utilization points were established on both allotments in 1990 - 5 points on Dixie and 6 on Edge Creek (all in Ward pasture). Most of these points have been read every year since establishment and the data are summarized in Tables 45 and 46.

Table 45. Dixie, Utilization Percent Point Data*							
						Averages	
Year	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	All pts.	KFRA pts.
1990	74	70	26	44	34	50	57
	80	42	74	40	50	57	65
1992	76	50	54	73	5	52	60
1993	44	43	9	16	8	24	32
1994	64	39	13	-	-	39	39
1995	70	63	40	-	-	58	58
Six year utilization averages -						47%	52%
"Adjusted" with six year average yield index (1.14)						54%	59%

*Points #1, #2, and #3 are all located within one mile of the Dixie site and the KFRA's portion of Long Praire Creek. #4 and #5 are located in the Medford BLM district's portion of Dixie.

Table 46. Edge Creek (Ward Pasture) - Utilization Percent Point Data*									
							Point Averages		
Year	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	All	Seeded	Native
1990	6	5	64	-	16	26	23	25	21
1991	5	8	76	60	20	70	40	30	50
1992	13	13	84	-	13	13	27	37	13
1993	27	23	54	15	28	33	30	35	25
1994	24	27	62	20	36	42	35	38	33
1995	20	23	45	13	19	19	23	29	17
Six year utilization averages							30%	32%	27%
"Adjusted" with six year average yield index (1.14)							34%	37%	30%

*Points #1, #2, and #3 are located within the seeded portions (east 1/2) of Ward and points #4, #5, and #6 are in the native range portions (west 1/2) of Ward.

In addition to the points, use pattern mapping has been done intermittently since 1984 (Edge Creek: 1984-87, 1992-3; Dixie: 1987, 1992-93, 1995). This use mapping shows that the vast majority of the HMA (more than 90 percent) is very lightly used by grazing animals. It also shows, however, that the riparian and meadow areas around several perennial water sources in the HMA has received excessive use in some years. This includes portions of Edge creek, the unenclosed portions of Long Prairie and Hayden Creeks, Wild Gal spring meadow, and Fall Creek drainage (Medford BLM). With some exceptions, virtually all of these areas are on private lands -primarily WEYCO. The exceptions and primary areas of concern on BLM administered lands are the Wild Gal spring meadow and the stretches of Long Prairie Creek immediately above (1/3 mile) and below (1/4 mile) the Dixie exclosure. This area is of higher concern recently, due to the construction (May 1995) of a drift fence on WEYCO lands, just north of the Dixie exclosure, which concentrates the cattle use in the south end of the Dixie allotment. In past years, the cattle drifted north during the summer, spreading their use over a much larger area.

Since the horses spend all year in these areas, they are believed to be the majority (but not all) of the over-utilization "problem".

The applicable riparian utilization objective from Appendix H of the KFRA ARMP/ROD is for a maximum of 30 percent use on herbaceous vegetation in riparian areas judged to be "functional - at risk" and without some type of intensive grazing management. This applies to both the BLM portions of Long Prairie Creek and Wild Gal Spring. Using a conservative wild horse population estimate (60 adults) and the average, yield index adjusted, utilization amount for the KFRA's portion of the south end of the Dixie allotment (59 percent) the following formula, from the KFRA ARMP/ROD and BLM Technical Reference 4400-7 (BLM 1985), may be used to determine a desired "stocking" rate.

$$\frac{\text{Actual Use (number of horses)*}}{\text{Adjusted Utilization (\%)}} = \frac{\text{Desired Use (number of horses)*}}{\text{Desired Utilization (\%)}}$$

Using the figures above, in the formula, gives the following result:

$$\frac{\text{60 adult horses*}}{\text{59\% actual utilization}} = \frac{\text{30 horses*}}{\text{30\% desired use}}$$

Thirty head of horses is the number appropriate in the area in order to meet the utilization objectives. (*Note: the total number of horses is used in the formula, instead of AUMs, because at times [winter] the entire herd is in the vicinity of the problem areas. In addition, there is no way to identify a particular band or group of horses as the responsible animals and just remove those horses. Thus, the entire herd must be assigned equal responsibility.)

Implicit with the wild horse calculations above is that some type of management changes in livestock use may also have to be implemented, since livestock are part of the problem in the Dixie area also. Similar calculations for livestock are found in that portion of this analysis.

Condition/Trend. Although limited, there is some condition and trend information in the HMA; all in the Edge Creek allotment.

Trend. Two frequency trend studies were established and read in 1986 and re-read in recent years within the Edge Creek allotment. One is within the Edge Creek pasture, in the meadow along Edge creek itself. Unfortunately, this study was read with different frame sizes during each reading (1986 and 1995) and thus can not be compared accurately. However, it does appear that California oatgrass (*Danthonia californica*) has remained stable, while the sedges (*Carex spp.*) and rushes (*Juncus spp.*) have become more abundant.

The other plot is in the Ward pasture appears to have been done relatively consistently between both readings - 1986 and 1992. The major changes of significance (at the 95 percent confidence level) are increases in the amount of Lemmon's needlegrass (*Stipa lemmonii*) (38 to 54 percent) and California oatgrass (39 to 67 percent). Perennial bluegrasses (*Poa pratensis, P. secunda*, and *P. bulbosa*) if considered as a group (they are frequently hard to differentiate) did not change significantly (50 to 47 percent). In addition, Kellogg's rush (*Juncus kelloggii*) decreased (20 to 10 percent), Idaho fescue (*Festuca idahoensis*) stayed about the same (4 to 2 percent), serviceberry (*Amelanchier alnifolia*) stayed the same (7 to 10 percent) and annuals showed widely varying changes - annual bromes (*Bromus spp.*) and annual hairgrass (*Deschampsia danthoniodes*) decreased, while medusahead and annual fescue (*Festuca relexa* or *Vulpia myuros*) increased.

Condition: Little in the way of formal condition studies has been done in the HMA. An Ecological Site Inventory (ESI), the BLM's method of determining current vegetation conditions, has not been done for the resource area. However, a couple general observations about conditions can be made. First is that the removal of overstory trees in the area, both on private and BLM administered lands, has dramatically changed the vegetation community composition. From the perspective of wild horse habitat, this has been generally good in that less tree canopy means increased herbaceous understory and more forage. The second point is that the more naturally open vegetation sites in the south end of the HMA are in an early ecological condition. This is likely due to heavy grazing pressure in decades past, possibly combined with timber harvest activities, which have enabled exotic annuals such as medusahead grass, several species of bromegrasses, and yellow starthistle to gain a seemingly irrevocable foothold. For more information on vegetation see that section of this landscape analysis.

One ESI based "condition" transect plot was measured in the seeded and far eastern portion of the Ward pasture in 1992 (the "Fox Lake Burn Reseeding"). Even though a poor growth year, this study showed production of the seeded wheatgrasses (*Agropyron pubescens* and/or *A. intermedium*) was over 850 pounds per acre and is still almost a pure monoculture even though the area was seeded 30 years ago. This would be considered "excellent forage condition" rangeland. Since the seeded areas are totally dominated by a species that is not native to the site, it can not be condition rated using the typical ESI site description information.

As an additional note, a SVIM (Soil-Vegetation Inventory Method) type range survey was performed in the analysis area in 1981 when it was under the administration of the BLM's Medford District. This information could be useful if the complete survey information can be found since it is very similar to the ESI. Unfortunately, most of the maps, all of the range site descriptions, and probably other information as well is missing. The information also covers only the BLM administered lands in the landscape area which is dominated by private lands. A quick review of the site write-up forms for the Edge Creek allotment confirms the general condition observations mentioned above.

Riparian Related Studies. Riparian information and studies are covered under that specific section in this analysis. The general effects on riparian areas by the wild horses were addressed previously.

Summary

This analysis has found that the primary Klamath Falls R.A. RMP/ROD objective to "...ensure a thriving natural ecological balance between the wild horse population, wildlife, livestock, and the vegetation, and to protect the range from deterioration associated with overpopulation" is not being met with horses at their current numbers. In particular, the wild horses are a major contributor to localized riparian/meadow over-utilization, most significantly on BLM administered lands along the unexclosed portions of Long Prairie creek and near Wild Gal Spring. Other creek drainages and open meadow areas on private lands in the HMA, also have been found to receive periodic overuse attributed to the horse herd. In order to meet this objective the wild horse herd needs to be kept near the lower end of the Appropriate Management Level (AML) - 30 head.

This analysis has also found that the "animal" and "habitat" objectives outlined in the Pokegama HMAP have been met with one exception - the herd numbers exceed the high end of the AML range. With the herd numbers gradually increasing, the potential for more problems also increases; especially if the horses commonly range outside of the established HMA. In addition, the private land dominated nature of the HMA requires the BLM to keep a check on horse numbers to prevent the herd from becoming intolerable to the private land owners. Returning the Pokegama herd's numbers to or near the lower end of the AML (30 to 50 head), and keeping it there, would likely resolve the wild horse related resource concerns and address the private land owner apprehensions, while still meeting the BLM's mandates regarding this herd.

Core Topic: Cultural Resources

Introduction

Both historic and prehistoric cultural resources abound within the Topsy/Pokegama Landscape Analysis (TPLA) area. The Klamath River Canyon from the John Boyle Power Plant to Copco Reservoir contains what is probably the highest density of cultural resources on the Klamath Falls Resource Area (KFRA). These resources range from prehistoric village sites to pioneer homesteads, historic roadways, town sites, railroad grades and historic log chutes including the Pokegama Log Chute. The towns of Dixie, Snow, Old Pokegama and New Pokegama, Horn's Camp, Potters Mill, Algoma Mill, the Kerwin Ranch, Frain Ranch, Truitt Ranch, Klamath Hot Springs, Topsy, the Agar-Klamath Road, the Pokegama-Klamath Falls Road, the Klamath-Lake Railroad, and the old Indian Trail are all located within this landscape. Logs from the Pokegama Plateau, sent down the Pokegama Chute and rafted down the Klamath River, fed the mills and box factory at Klamathon.

The first test of getting logs down the river was in November of 1888. About 135 logs were floated down the river to the site of Klamath City (later changed to Klamathon). This test paved the way for the Klamathon mill to be built assuring the supply of timber. Until the mill and town burned in 1903, a steady supply of timber was rafted down the Klamath River. Construction of the Klamath-Lake Railroad and the demise of Klamathon ended the heyday of log rafting on the river. See Appendix C for additional information.

The vast majority of these historic and prehistoric sites are located on private lands within the TPLA. Southern Oregon State College (SOSC) in cooperation with the Bureau of Land Management (BLM) has prepared a nomination of the lands within the Klamath River Canyon for an Archaeological District, to be placed on the National Register of Historic Places (NRHP) (see Map 13).

Human Impact on TPLA Area

The Prehistoric Period extends over the past 10,000 years, beginning with the Paleo-Indian people. There is sufficient evidence of these big game hunters in the area surrounding TPLA to confirm their presence in the Klamath Basin. The major archaeological site within TPLA, the Klamath River Canyon, is well documented by Mack (1991). Mack proposes a chronology (based upon radio carbon dating) of human occupation extending from 7646 BP (Before Present) plus or minus 400 years, until about 1800 AD. Mack proposes the lack of Euroamerican trade goods within the house pit villages indicates an end to this occupation at an early date after contact by Ogden.

Although Lewis and Clarks' arrival in 1805 established the historic period in the Northwest, the early historic period begins in the Klamath Basin around 1820 with the arrival of Ogden and his Fur Brigade. Other Hudson Bay Company Brigades followed Ogden until Fremont arrived and firmly established the claim of the United States to this portion of the Oregon Territory. This period of exploration ends with the settlement period beginning around 1860 with the arrival of early settlers such as O.T. Brown and Martin Frain. Within the TPLA area, the early historic period ends around 1880 with the advent of intensive logging activity. The 1864 Treaty of Klamath Lake ceded this area to the United States, and established the Klamath Indian Reservation. There may be some dispute between the Shasta Nation and The Klamath Tribes as to which group actually held territorial rights to the Klamath River Canyon. This is not the forum to address this subject.

The modern historic period begins around 1890 with the advent of intensive logging on the Pokegama Plateau, and continues until the present day. Modern land use in the TPLA area generally falls within three areas; Logging and forest products production, ranching, and recreation.

Issue: Land in the Topsy/Pokegama Landscape Analysis area was ceded to the United States by the Treaty of Klamath Lake, 1864. The Klamath Tribes have a hereditary interest in the TPLA area.

Key Question: Do the Klamath Tribes have treaty rights within the TPLA area?

The Klamath Tribes have no treaty rights within the TPLA area. The tribal members have the same rights as any other American citizen within the TPLA area.

Key Question: What are the needs and interests of the Klamath Tribes in this analysis area?

The BLM sent a written request to the Chairman of the Klamath Tribes inviting them to participate in the Topsy/Pokegama Landscape Analysis. To date, the Tribes have not responded other than a verbal statement that they are "interested" in these lands. Tribal staff members have been asked specifically how they would like to participate. There has been no reply either written or verbal. Based upon the Klamath Tribes' lack of response, it is assumed that they have no compelling interest in the area. There is very little archaeological evidence of any Klamath occupation. In fact, the very low number of Klamath artifacts may well indicate them to be trade goods, rather than the artifacts of resident people.

Issue: The Shasta People were in residence in Klamath Canyon at the time of contact. The Shasta people have a hereditary interest in the TPLA area.

Key Question: Do the Shasta people have treaty rights within the TPLA area?

The Shasta people have no treaty rights within the TPLA area. The tribal members have the same rights as any other American citizen within the TPLA area.

Key Question: What are the needs and interests of the Shasta People within this landscape area?

The Shasta people are vitally concerned with the area known as the Klamath River Canyon, which they occupied at time of contact with Euroamerican pioneers. In addition, the location the Shasta people call "The Beginning" is located within the Klamath River Canyon. This site is the place to which the Shasta trace their origin, and consider it as the place from which they emerged onto the earth. Other Shasta archaeological sites abound within the Klamath Canyon. In contrast there is a scarcity of artifact material that can be attributed to the Klamath Tribes who actually ceded the land to the United States. There does not appear to be a culture overlap, but rather a continuity of Shasta culture.

The archaeological resources of the Klamath River Canyon have been studied extensively beginning in the 1960s. In the BLM report: *Cultural Resource Series No. 8, Klamath River Canyon Prehistory and Ethnology*, Joanne Mack reports on Upper Klamath River Canyon Prehistory, with Dorthea Theodoratus et al., reporting on the Klamath River Canyon Ethnology. All of this information leads to the conclusion that the Klamath River Canyon was mainly the territory of the Shasta people.

For the management purposes of the BLM, this work has culminated in the award of a Challenge Cost Share Agreement with Southern Oregon State College (SOSC) for the preparation of a nomination to the National Register of Historic Places. The recommendation of SOSC is to nominate the Upper Klamath River Canyon as an Archaeological District. The first draft of the prehistoric sites portion has been completed, and the historic site portion of the draft nomination is in progress. Clearly, there are significant religious and traditional cultural properties within TPLA area.

Unfortunately, sites within the TPLA area, especially those in the Klamath River Canyon, have been looted. To a lesser extent, natural forces also impact the sites and damage them.

Issue: Historic and prehistoric resources exist in the landscape.

Key Question: How has human activity impacted the landscape and what archaeological sites (historic and prehistoric) are present within the TPLA area?

Prehistoric human activity was of low impact on the ecosystem, probably due to the low population numbers. This resulted in the low harvest of resources. At this time, the TPLA area appears to have been teaming with the resources exploited by aboriginal people. In contrast, the Euroamerican exploitation of the area was earmarked by the intense harvest of forest products. The forest product harvest was so intense as to make the impacts of mining and ranching on the landscape a relatively minor occurrence. These impacts are better discussed within the Ecology portion of this analysis.

From a social standpoint, all that remains are the artifacts of prehistoric and historic human occupations. The cultural sites of the Shasta people are protected under the laws of the United States and the State of Oregon; however, they are often impacted by artifact hunters who disregard the law. The town sites of Pokegama, Snow, Dixie, and New Pokegama have also returned to the earth where they now exist only in the archaeological and historical record. There are very few people still alive who worked and lived in these places.

Roads and Trails

Issue: American pioneer settler homesteads are located within the TPLA area.

Key Question: What are the identifiable homesteads in the TPLA area?

This question is partially answered in the historical and prehistoric literature. The historic homesteads are presently being studied by SOSC in their work on the National Register Archaeological District Nomination, and will be appended to this report at a later time.

Key Question: What are the identifiable Historic roads and trails in the TPLA area?

The TPLA area contains portions of The Applegate Trail, the Topsy Road, and the Linkville-Yreka Road. All of these were major conduits for trade and settlement of the area. There is a rich area of oral history pertaining to the Topsy Road; however, persistent research has failed to verify any of the stories regarding the person the road and grade was named after.

Issue: Historic and prehistoric resources exist in the landscape.

Key Question: How has human activity impacted the landscape and what archaeological sites (historic and prehistoric) are present within the TPLA area?

Prehistoric human activity was of low impact on the ecosystem, probably due to the low population numbers. This resulted in the low harvest of resources. At this time, the TPLA area appears to have been teaming with the resources exploited by aboriginal people. In contrast, the Euroamerican exploitation of the area was earmarked by the intense harvest of forest products. The forest product harvest was so intense as to make the impacts of mining and ranching on the landscape a relatively minor occurrence. These impacts are better discussed within the Ecology portion of this analysis.

From a social standpoint, all that remains are the artifacts of prehistoric and historic human occupations. The cultural sites of the Shasta people are protected under the laws of the United States and the State of Oregon; however, they are often impacted by artifact hunters who disregard the law. The town sites of Pokegama, Snow, Dixie, and New Pokegama have also returned to the earth where they now exist only in the archaeological and historical record. There are very few people still alive who worked and lived in these places.

Roads and Trails

Issue: American pioneer settler homesteads are located within the TPLA area.

Key Question: What are the identifiable homesteads in the TPLA area?

This question is partially answered in the historical and prehistoric literature. The historic homesteads are presently being studied by SOSC in their work on the National Register Archaeological District Nomination, and will be appended to this report at a later time.

Key Question: What are the identifiable Historic roads and trails in the TPLA area?

The TPLA area contains portions of The Applegate Trail, the Topsy Road, and the Linkville-Yreka Road. All of these were major conduits for trade and settlement of the area. There is a rich area of oral history pertaining to the Topsy Road; however, persistent research has failed to verify any of the stories regarding the person the road and grade was named after.

Four of these sites, Keno Dam,Pioneer Park, Copco Fishing Accesses 1-6, and Pioneer Park were developed by Pacific Power and Light(PP&L) as part of the Federal Energy Regulatory Commission(FERC) requirements for the upper Klamath Boyle hydro power project. A number of other recreation sites were developed starting in the 1960s and continuing to the present time, by the BLM and Klamath County.

In the early to mid 1970s people started using the Klamath river canyon for whitewater boating, on a stretch of the canyon that has come to be known as Hell's Corner gorge. Use of this resource was very light in the 1970s, mainly private, self-outfitted boaters from the local area, and probably numbered no more than 100 to 200 users per year. Use increased significantly in the early 1980s when the canyon and the quality of the whitewater it contained were discovered by the regional commercial whitewater outfitting industry. Another factor which contributed to the increased popularity of whitewater boating on the Upper Klamath was the improvement in whitewater boating gear, particularly the construction of rafts, in the early to mid 1980s. The development of stronger, stiffer raft fabrics and the invention of the self bailing raft, combined to make running difficult whitewater such as the Upper Klamath in the TPLA area both safer and easier. The construction of J.C. Boyle dam and powerhouse enhanced the potential for whitewater boating recreation on the Upper Klamath by providing road access to the river, and the reliable late summer dam release water flows previously mentioned. The Upper Klamath River has also been used for stream angling for Rainbow trout, semi-primitive and primitive dispersed camping, birding and other wildlife viewing, mountain biking and hiking, and sightseeing while driving primitive roads. These activities increased in popularity as road access improved and as the population in the surrounding towns and cities grew.

The large tract of land bordered by Highway 66 to the north, the Klamath river to the east and south, and by Copco road to the west, is primarily privately owned industrial timber land. The landowner does allow public access for recreation, with the main recreation opportunities being big game hunting for deer and elk, and dispersed primitive camping associated with hunting. This land has an extensive network of arterial gravel, logging, and skid roads with an average density of 3.25 miles of road per square mile of land, The roads in this area were developed during the late 1800s and through the 1900s as the area was settled and logged.

Winter sports recreation use has been observed on Hamaker mountain since the early 1980s. The summit area of Hamaker Mountain was originally developed as the Keno Air Force Base during the cold war years in the 1950s. This development provided the existing paved access road to the summit of Hamaker. The Federal Aviation Administration (FAA) took over some of the radar facilities on top of the mountain in the late 1970s and early 1980s when the Air Force base was closed. The FAA typically operates the Hamaker radar facility 365 days a year, 24 hours a day. Due to the need for continuous, uninterrupted access to these facilities on top of Hamaker mountain, the access road is kept open and plowed all winter by the FAA. This snow plowing of 8 miles of road up to an elevation of 6,500 feet above sea level, terrain suitable for skiing, and the close proximity to the Keno/Klamath Falls area, have combined to create a recreation opportunity for downhill shuttle skiing, cross country skiing, snowplay such as sledding and tubing, and to a lesser extent, snowmobiling.

Current Conditions

Dispersed Use Recreation

This refers to recreation activities that take place away from developed recreation sites in a natural setting. Hunting , fishing, driving, sightseeing, and biking are examples of this sort of recreation use. The TPLA area currently receives light dispersed use at most times of the year, exceptions being popular holiday weekends, opening weekends of hunting and fishing seasons, and areas of concentrated use such as boat launches.

A key question that pertains to dispersed recreation use is: "Does the road network in the TPLA area adequately serve the needs of the recreating public?" At this time the average road density of the entire TPLA area is 3.66 miles of open road per square mile, which provides vehicular access for recreational purposes into most areas of the LAU. A concern of some hunters is that as landowners and managing agencies close and remove roads, hunting opportunities with ready vehicle access are diminished. This is also a potential concern for land managers as road closures in one area may shift demand, use, and management problems such as vandalism, human caused wildfires, uncontrolled off road driving, and attendant resource impacts, to other areas nearby. Other recreational users prefer to see some road closure and eradication, preferring a non-motorized and more natural opportunity setting for their recreational pursuits.

The Topsy road is a gravel and native surface road which runs for approximately 18 miles between Highway 66 and the Oregon-California stateline, on the east side of the Klamath river. A number of sections of this road have places where rock fall, muddy soils and poor drainage, and poor road location, have caused deterioration of the road surface. Road maintenance appears to be occurring only on a limited basis, either where there is logging activity near Highway 66 or on the other end of the road by the ranches near Copco, CA. No specific managing agency has taken responsibility for maintenance of this historical roadway. The road is used by whitewater boaters, campers, anglers, and sightseers to access the canyon at the Frain ranch area. The BLM has received a number of comments from the public requesting better maintenance and improvements to this road. Use of this road when it is soft and muddy after considerable rain or during spring runoff, appears to be causing localized road damage in the form of rutting and widening and is frustrating for recreational users trying to access the area.

Uncontrolled vehicle use has caused an increase in the number of roads, erosion, and visual impact at the PP&L Frain ranch site. Because this is a relatively flat and open area and is isolated from law enforcement or park ranger personnel, vehicle use has spread out from the original roads. The BLM and various user and interest groups are currently consulting with PP&L to attempt to close extraneous roads to lessen impacts and damage, while maintaining adequate vehicle access for existing recreational use.

In response to the Key question "Are the lands in the TPLA area currently being managed to serve the recreation needs of the public and maintain ecosystem health?" an example of the ongoing management efforts to do so would be the "Pokegama Cooperative Habitat Project". This is a cooperative effort between various government agencies, landowners, and volunteer organizations to manage the Pokegama area by closing it to vehicle access seasonally with the objective of improving both resource conditions and recreational opportunities (hunting) at the same time. For more information on this project see the Terrestrial Wildlife section of this document. The designation of an eleven mile segment of the Klamath river as a Scenic river under the National Wild and Scenic Rivers Act recognizes recreation as an "outstandingly remarkable value" and directs management to preserve that value (BLM 1990). Management concerns associated with whitewater boating use in the Klamath River canyon are addressed separately.

Management concerns associated with dispersed recreation use of the TPLA area include:
-Uncontrolled use of off-highway vehicles
-Driving on unsurfaced, poorly drained roads when they are soft and wet causing road damage
-Illegal harvest of fish and game resources
-Degradation of the scenic/aesthetic, game resource, or other recreation resource values that originally motivated people to pursue a particular recreational activity in that area.
-Overcrowding at popular areas may be causing user conflicts.

In summary, the management concerns associated with dispersed recreation use of the TPLA area are somewhat lessened by the low overall use rates and the abundance of land suitable for dispersed recreation relative to the local population density. The large tracts of private land in the TPLA area ,and numerous government entities involved with management activities in the area, mandate the need for continued coordinated planning and management efforts.

Developed Site Recreational Use

There are a number of developed recreation sites within the TPLA area that provide users with facilities for camping, flatwater and whitewater boat launching, picnicking, target shooting, off-road vehicle and dirt bike riding and racing, model plane flying, and parking associated with these and other recreational activities. These facilities are managed by the BLM, PP&L, and Klamath County. Overall use rates of these facilities appears to be light to moderate for much of the season, high use rates appear to be limited to holiday weekends or other weekends when a special event is scheduled at or near the facility (Howison 1996).

In response to the key question "What is the anticipated future demand for recreation developments and opportunities in the LAU?", a study by the Pacific Northwest Regional Recreation Committee showed that sightseeing, picnicking, hiking, and walking, across the state of Oregon by Oregon residents, are projected to increase at rates ranging from 8.9 to 12.percent per year, and all outdoor recreation activities listed in the study "are projected to grow faster than the state population growth, 1.2 percent per year" (Oregon State Parks and Recreation Division 1988). While this indicates that the public will continue to seek the types of recreation experiences and developments found on the TPLA area and put more pressure on those resources, the current low overall use rates of existing facilities, estimated at 20 to 40 percent of capacity, indicates that there appears to be an adequate supply of general recreation facilities now and for the near future. The future demand and need for more recreation developments is likely to encounter shrinking park and recreation management budgets, especially in the federal government. A possible consequence to these shrinking budgets may be that future recreation development may be driven more by what users are willing to pay, for facilities as well as general recreational opportunities. Development of future facilities may increasingly occur as a side benefit or mitigation measure of other activities taking place in the area, such as commercial timber sales or forest health treatment activities. In the TPLA area there appears to be a need for increased recreation development associated with winter sports use of the Hamaker mountain area. This issue is discussed separately.

In response to the key question "Are the lands in the TPLA area currently being managed to serve the needs of the recreating public and maintain ecosystem health?", with regards to developed recreation sites, there are a number of observations to be made.

There are concerns associated with the use of campfires in the canyon causing an unacceptable increase in fire hazard. Commercial rafting outfitters have requested the construction of more designated firesafe campsites. These are campsites that have a constructed, concrete and metal firepit, and are signed as such by the Oregon Department of Forestry (ODF). The ODF is the agency responsible for fire suppression in the entire TPLA area and has expressed concern that an increase in the number of dispersed firesafe campsites in the canyon may contribute to fire hazard and increase the response time of firefighting units to wild fires in the area. However it can also be argued that creating and designating "firesafe" campsites, and limiting campfire building to these sites during periods of high fire hazard, may help to deter the number of human caused wild fires. A related management concern involves the permitted fire closures that are sometimes placed on the canyon by ODF when fire danger is extreme. Under this type of closure the canyon is closed to the public for general recreational use, however commercial rafting outfitters are still allowed access and to run their trips, because they are a commercial permitted operation. This situation has occurred in the past, and has proven to be very unpopular with private whitewater boaters and other non-commercial visitors to the canyon who are unaware of this situation before their arrival at the entrance to the canyon and then find out the area is closed to them but open to commercial groups. While this situation only occurs rarely, during periods of extreme fire hazard, it has the potential for negative public perceptions regarding the equity of the managing agency's policies.

A semi-developed recreation site that has a number of management concerns is the Stateline site in the Klamath River canyon. This area is on land managed by the Redding Resource Area BLM office. It is bounded by private land on the southwest side, and a good deal of recreational activity that takes place on the Stateline site spills over onto the adjoining private land. The site has received only minimal development to this point, that being primitive road construction and the construction of outhouses. Currently, the site is used as a take-out for the whitewater boating run through Hell's Corner, as a lunch site by whitewater boaters, and for general camping, fishing, and swimming. Recreation use levels at the site are estimated at 6,000 user days per year. The BLM has taken the temporary measure of having portable toilets installed at the site, seasonally from mid May until mid September. Uncontrolled use of the area has led to dusty/ muddy conditions caused by uncontrolled driving off the main roads, and occasional user conflicts due to the lack of signing, site design, or traffic control. Development of recreation facilities has been delayed by the intermingled land ownership on this site.

Most of the developed campgrounds in the TPLA area close for the season by late September as the weather turns cooler and use drops off. Because most big game hunting seasons occur in October and November, the concern has been raised that these campgrounds are not available for hunter use. In the case of the BLM Topsy campground, a lack of funding and personnel, and a need to maintain an adequate presence of park personnel to deter site vandalism, have caused the BLM to historically close the campground in mid- September.

Hamaker Mountain Winter Recreation Use

Winter recreation use of the summit area of Hamaker mountain consists primarily of downhill skiers and snowboarders from the Klamath Basin using a powerline corridor for their runs. Use of the saddle parking area consists of vehicles associated with the above mentioned summit area use, along with cross-country skiing and snowmobiling(Scott 1995). A number of local newspaper articles in the Klamath Falls *Herald and News* and the Oregon Institute of Technology (OIT) *The Edge* have described these winter sports recreation opportunities. Descriptions of the area and runs have been identified in the cross country skiing guide *Southern Oregon Cross*

Country Ski Trails(Lund 1987). Other areas along the Hamaker Mountain road are used by cross-country skiers, snowmobilers, sledders and tubers, but the areas of concentrated use are the saddle parking area and the summit.

For the downhill skiers and snowboarders using the summit powerline runs, a shuttle system is used where people in a group will take turns shuttling a vehicle up and down the mountain, while the rest of the group skis. This technique, provides a rare, if not unique in the region, opportunity for a low cost downhill skiing/snowboarding experience. The main attractions to the downhill runs on Hamaker Mountain are that it is very close to Klamath Falls (less than a 30 minute drive), and the minimal costs. This unique opportunity has attracted a fairly loyal following of winter recreation users, from the Klamath Falls area. A small but regular group of users has identified themselves as the "Radar Ski Patrol". While not actually performing the duties of a ski patrol, they have informally monitored visitors and helped skiers needing assistance. Other than the monitoring and informal surveys done by Peter Scott, a Student Conservation Association assistant who worked for BLM during the 1994-1995 winter, direct BLM management of winter recreation activities on Hamaker Mt. has been sporadic.

Since the BLM patrols have been sporadic, no facilities have been developed and no real management plan is in place yet, and use conflicts associated with winter recreation are occurring. Sledders, tubers and snowmobilers have on occasion used the main road for recreation. This creates a safety concern with traffic and snow plowing operations. People park on the main road at various locations due to inadequate parking facilities,which creates traffic safety hazards. Some informal reports of injuries arising from users of the downhill runs have been received. Vehicle accidents on the sharp hairpin curves of Hamaker Mountain road are frequent during icy conditions. The FAA has on several occasions requested that the BLM close the road during the winter months due to safety concerns and perceived conflicts with recreationists. The BLM has allowed the FAA to install a gate at the bottom of the Hamaker Mt. road which is locked during times of rotary snow blowing operations. This has been done to eliminate the potential for accidents with the snow blower. Signs have been installed warning visitors of the hazardous road conditions and to not park, sled or build fires in the road.

Snow base conditions on the powerline ski runs in most years (estimated at 7 out of 10 years) are adequate to cover up rocks, brush, small trees and stumps for a period from two to four months. As the snow is not mechanically groomed on the ski runs, winter recreationists are at the mercy of weather conditions to provide new snow to smooth the bumps and ice that typically develop with use. Conditions on the ski runs vary greatly, from fresh powder, to icy or crusty runs, to heavy or slushy snow. The main powerline run is very narrow and quite steep, with lots of short turns required to avoid obstacles. Consequently, the runs on Hamaker require advanced or expert skiing ability under most conditions.

The other primary recreation uses occurring on Hamaker Mountain during the non-winter season include mountain biking, sightseeing, hunting, and wildlife viewing. The Hamaker Mountain road has also received use as a regional sports car club hill climb.

The Klamath Falls Final Resource Management Plan (RMP) identified the Hamaker Mountain area as a potential Special Recreation Management Area (SRMA). A SRMA denotes an area requiring more substantial recreation investment and/or more intensive recreation management. Timber management and other activities are to be designed to enhance future trail and site development, with an emphasis on winter sports and mountain biking. The RMP states that the identification and resolution of specific recreation management issues and prioritization of projects such as developed parking areas and designated trails, would occur through the recreation site planning process. The RMP also states that a BLM patrol would be established to provide visitor assistance to winter sports recreational users on Hamaker Mountain .

Whitewater Boating Use of the Klamath River Canyon

Whitewater boating is a prominent and popular recreational use occurring in the TPLA area, particularly in the summer months. The river canyon reach from J.C Boyle dam to Copco reservoir was studied for recommendation to the federal Wild and Scenic rivers program and an 11 mile reach of the canyon, from just below Boyle powerhouse to the Oregon-California stateline, was designated as scenic in September, 1994. Recreation, and specifically whitewater boating, are recognized as outstandingly remarkable values in the Scenic designation. Over time, boating use patterns have changed and evolved, as have the flow management practices of PP&L as they involve boating use.

The 1990 Final Eligibility and Suitability Report for the Upper Klamath Wild and Scenic River Study stated that during typical summer operations one generator water releases were typically 12 hours in duration. Since that time PP&L has recognized the demand for recreational water releases and has modified their operations to where many summertime daily releases of one generator flow (1500 cfs) are only 3 to 4 hours duration, and in the case of extreme drought, may only be of one hour duration. The PP&L has also been able to reduce the number of days lost to recreational releases caused by the July maintenance period by making operational changes to the Boyle project, such that much of the routine annual maintenance work can be done and still allow for one generator to be operational, thereby producing both hydro power and a useable whitewater boating water release. This improvement in operations is relevant in that July, when maintenance activities typically occur, has boating use levels that are exceeded only by the month of August.

Currently the area receives whitewater boating use primarily between May and September, this time period coincides with the summer holiday period and drier, warmer weather in the canyon. Commercial use of the river has increased steadily in the past 10 years, increasing from 2,072 passenger user days in 1985 to 5,760 in 1995. BLM use figures show that private boating use, that is use by self outfitted parties with no trip member having a commercial interest in the trip, has stayed fairly constant since 1988 (618 user days in 1988 versus 602 in 1995). A use trend that has been noticed is that over the years, the majority of commercial river trips have shifted from two day trips with a night of camping on the river, to a single day trip that has no camping in the canyon associated with the trip. This has implications for management decisions associated with use of the river access points, and with the issue of future development of camping facilities.

The BLM records from the 1994 operating season were stored in a chronological spreadsheet format, which allowed some use patterns to be evaluated in more detail. This season had runnable flows, defined as 1400 cfs for at least one hour, every day between May 15th and October 15th. There was no interruption to the season in July by PP&L maintenance activities. 1994 was not a good water year for runoff for other free flowing whitewater rivers in the region due to low winter precipitation amounts. This may have caused an increase in overall use levels on the Upper Klamath that year as the scarcity of whitewater drove recreational boaters and outfitters to dam controlled rivers with dependable late season water, such as the upper Klamath.

Boating use was also analyzed by the day of the week. As has been the case historically, the river was used most heavily on weekend days, especially Saturdays (35 percent of overall use). What is notable is that the Upper Klamath is not exclusively a weekend use river. Weekday use of the river by commercial outfitters comprised nearly 40 percent of overall commercial use. It is suspected that comparing this distribution to data from 5 and 10 years ago may show a trend towards increasing weekday use of the river. Private boater numbers were analyzed by the day of the week also. The only finding that deviated from general field observations is that while private boaters only comprised 10 percent of the overall user numbers for the season taken as a whole, on Saturdays, Sundays, and Mondays private use was a larger percentage of overall use (13, 15, and 14 percent respectively). It may also be useful to compare this data from the 1994 season to other seasons to see if there is a trend to this pattern.

When boating use for 1994 was evaluated by the month of the year, the pattern fits very closely with field observations. July and August were the months with the heaviest overall use. When the data were further divided into commercial and private groups, the most striking change in the pattern is that in May of 1994, private use was nearly equal to commercial use, 74 private user days versus 103 commercial user days. It is reasonable to assume that the Upper Klamath was so popular with private boaters in May, 1994 due to the generally low runoff flows on other popular whitewater rivers in the region. May is typically a period when most of the comparable whitewater rivers in the region have sufficient flows for boating, however the winter/spring of 1994 saw low levels of precipitation, and consequently poor spring runoff in most of the region.

Management concerns associated with whitewater boating use within the TPLA area can be summarized as follows:

User conflicts are occurring on heavy use days, primarily mid summer weekends.

Records show that boating use is increasing, there is concern that the carrying capacity of this resource may be rapidly approaching its upper threshold.

Increasing use of this resource is putting pressure on recreation sites in the canyon, causing them to be unable to adequately accommodate use during heavy use periods.

Summary

Recreation use in the TPLA area is varied, occurring in a dispersed fashion over the entire landscape analysis area, intensively at developed sites and in seasonally popular areas, and on a year round basis. Management concerns are related to the management of people and resources to insure resource protection and minimize user conflicts or other degradations to the recreation resource. The need for more active recreation management practices, both at the field going and administrative level, will be challenged by the existing low rate of dollar return on recreational services and products, coupled with the forecast for shrinking budget dollars allocated to the management of recreation resources.

Core Topic: Biological Diversity

Issue: Biological diversity has been altered in the landscape area.

Overview

Complexity and diversity at the landscape and stand level are the key to maintaining richness of organisms, habitats, and ecosystem processes (in other words, biological diversity). Ecosystem complexity and diversity are defined by composition, structure, and function (Franklin 1992). Composition includes not only a diversity of vascular plants and animals but non-vascular plants such as lichens and mosses, invertebrates, and lower organisms such as soil microbes (fungi, bacteria, and actinomycetes). Lower organisms are especially important for providing critical ecosystem functions such as decomposition, nutrient cycling, and food webs which maintain the vitality of forests and streams. Structural attributes at the stand level include large, old trees; large snags or standing dead trees; and large down logs. Large trees function as primary producers. Canopies and boles provide habitat for epiphytic organisms (including nitrogen-fixing lichens), a diverse community of invertebrates, and habitat for birds and mammals. Snags offer habitat for cavity-nesting birds, other animals, and plants. Down logs are long-term sources of energy and nutrients to both terrestrial and stream ecosystems; habitat for animals and a diverse decomposer community; and structural components that greatly influence geofluvial and erosional processes in streams. Structure translates into niches so the more structurally complex a forest the greater is its potential to support a diversity of niches for organisms to occupy. At both the stand and landscape level, the structural complexity of individual plant communities and diversity in landscape patterns results in a complex of niches that enhance the diversity of animals and microbes (Perry 1994).

Species richness is related to forest successional or structural stages and correlates positively with structural complexity (See Figure 1). Although the graph displays species richness for mammals, it applies as well to many groups of organisms including plants, birds, fish, and invertebrates (Franklin 1992). Forests that have several canopy layers generally have more niches. Vertebrate and invertebrate species richness has been found to correlate positively with tree species richness and potential evapotranspiration (that is, the amount of solar energy or sunshine received) (Perry 1994). Canopy gaps created by the death of one to several trees in a forest stand function as successional islands within a matrix of closed forest and produce spatial heterogeneity at the stand level. Striking differences have been found in arthropod communities of young and old forests with herbivores such as aphids dominating in young forests but equal amounts of defoliators and predators constituting the arthropod biomass of old forests (Schowalter 1989). Amphibians use decaying logs on the forest floor for habitat. Riparian areas are long-recognized hot spots for biological diversity. Hence, the complexity of stand structures and their distribution across the landscape provide for the maintenance of biological diversity.

Finally, the landscape context influences the biological diversity of fauna within any given forest stand. An island of heterogeneous forest set within a sea of homogeneous forested landscape consisting of forest monocultures or structurally simple young stands may support only a relatively low diversity of animals. And an island of homogeneous forest set within a heterogeneous forested landscape may support a relatively high diversity of species because of its landscape context (Perry 1994). Within certain limits, disturbance can play an important role in enhancing diversity by creating niches; freeing up limited resources such as growing space, light, water, and nutrients; and creating structural diversity. The nature, extent, and intensity of a disturbance determines if it diversifies or homogenizes the forest landscape.

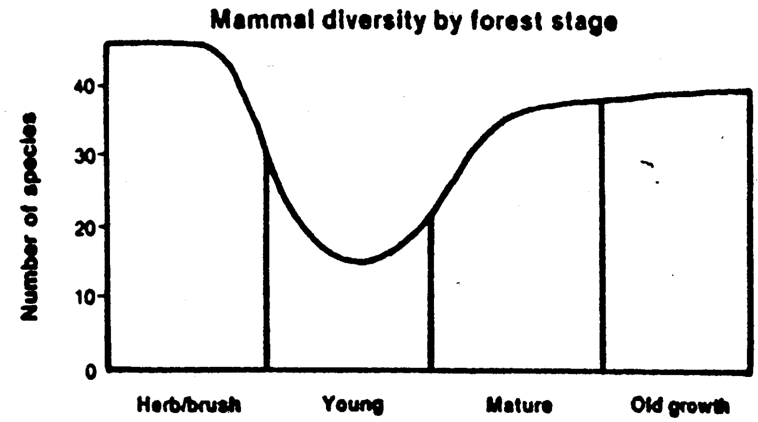


FIGURE 3.1. Number of species of mammals associated with different successional stages in Douglas-fir forests (data based on Harris 1984). Young forests are typically 20 to 80, mature 80 to 200, and old-growth 200 years old.

Figure 1. From Franklin 1992.

Key Question: Has biological diversity of plant and animal species decreased or increased in the landscape analysis area?

The animal side to this question is best addressed in the wildlife sections of the document where the status of particular animal species is reported. But it is reasonable to assume that conversion of late-successional and old-growth forests to young forests has resulted in a decrease in interior forest-dependent species across the landscape. Other species such as deer and elk have probably benefited from the increased forage opportunites created by young forests. Fire exclusion has greatly influenced forest composition and structure, and as a result the dense understories of white fir in mixed-conifer and ponderosa-pine forests have benefited the northern spotted owl and the goshawk at the same time that they have been less than beneficial to maintenance of the ponderosa pine component. The disturbance history for the area has brought about both decreases and increases in populations of plant species. Selective logging, fire exclusion, and livestock grazing all have had a hand in increasing white fir understories and decreasing ponderosa pine in the landscape area. Increases in populations of exotic weeds have probably occurred because of fragmentation of the forest landscape from logging disturbance and livestock grazing.

The question of whether biological diversity has increased or decreased in the landscape area can only be answered in general terms at this time for most species, addressing the habitat requirements of each repective species and how the distribution of stand structures across the landscape has changed over time and affected species numbers and distribution. For species that have been studied in some detail and for which survey data is available (such as the northern spotted owl), more specific conclusions can be drawn about the status of current individuals or populations.

Generally, however, species richness for animals has probably declined in the landscape area because of human-introduced disturbance and the imbalance of stand structures across the landscape. The disporportionate number of acres for stands in the stem exclusion stage would indicate a decrease in species richness because comparable to the other three structural stages stands in the stem exclusion stage support the lowest number of species (Harris 1984).

Key Question: What changes in biological diversity have selective logging, fire exclusion, and livestock grazing brought about in the landscape area?

This suite of human-induced disturbances has altered landscape ecology for the area and, therefore, this question can be approched from the perspective of landscape ecology. The current skewed distribution of stand structures across the landscape with a disporportionate number of stands in the stem exclusion stage compared to the number of old-growth stands indicates changes brought about by human-introduced disturbance in the area. Historically, even given the natural fire regime there was probably significantly more late-successional and old-growth forest in the landscape area. The natural fire regime consisting of frequent but low-intensity surface fires probably maintained more of an open forest structure within individual stands including old-growth stands (Leiberg 1899, Covington et al. 1993). Species richness for fauna and flora was probably greater across the landscape when more of the forest landscape was in late-successional and old-growth conditions.

Key Question: Will activities such as commercial thinning and the introduction of prescribed fire increase or decrease biological diversity?

Commercial thinning and prescribed fire are management tools for gradually returning current forests to more natural, pre-settlement conditions in terms of forest composition and structure. With sufficient consideration for minimizing soil disturbance and conserving soil organic matter reserves, the silvicultural practice of thinning from below can effectively reduce understories of white fir and overstocking conditions which would benefit stand health by reducing disease and insect outbreaks. However, white fir is extemely susceptible to soil disturbance so harvest entries in a forest stand can exacerbate the health of residual white fir individuals in the forest stand. The scientific consensus is that thinning from below is an ecologically sound method for treating densely stocked forest stands. In the short-term following thinning, species diversity may decline. Habitat for northern spotted owls and goshawks, for example, may be altered unfavorably as forest stands are opened up. The choice is a difficult one because at stake are species such as the northern spotted owl and the goshawk as well as the future of the forest stand. With dense understories of white fir and overstocked conditions, forest stands are at an increased risk of catastrophic disturbance such as stand-replacement wildfires and bark-beetle outbreaks that affect entire stands. Catastrophic disturbance may re-set the successional clock, returning the forest stand to the stand initation stage, which would neither benefit the northern spotted owl nor goshawks. On a landscape level, extensive catastrophic disturbances could be disastrous to interior forest-dependent species.

Less selective in thinning forest stands than commercial thinning, the introduction of prescribed fire will reduce stocking levels and aid in creating more open forest structure. Most importantly, fire will reduce fuel loads on the forest floor and the flammability of the forest stand. As with commercial thinning, the short-term effect may be a decline in species richness because of the creation of a more open forest structure that is altered unfavorably for interior forest-dependent species such as the northern spotted owl and the goshawk. However, fire is a principal agent of decomposition in dry eastside forest ecosystems and plays a pivotal role in nutrient cycling by releasing nutrients sequestered in woody debris for plant nutrition. Low-intensity fire can result in a flush or pulse of nutrients made available to plants and soil microbes (bacteria and fungi), which are vital to forest productivity. Low-intensity fire, therefore, may increase species diversity in plants and microbes, with their increase in turn benefiting animal diversity by way of the trophic levels and food webs interlinking all of these organisms. High-intensity fire, conversely, may consume soil organic matter, associated nutrients, and populations of beneficial soil microbes, reducing site productivity for decades.

If done properly to safeguard soil resources and a sufficient amount of desired forest structures such as snags and down logs, commercial thinning and prescribed fire may benefit species diversity in the long term although reducing it in the short term. Short-term depression of species diversity associated with commercial thinning and prescribed fire may be judicious considering potential risks to the long-term health of wildlife habitat within forest stands from catastrophic disturbance. The guide for assessing wise and proper use of these management tools must be seen not in what is removed but in what is left behind in treated forest stands since this will be the legacy carried forward in development of the future stand.

Core Topic: Landscape Ecology

Issue: Landscape ecology has been altered in the landscape analysis area.

Key Question: What functions do landscape features and patterns have?

Landscape ecology considers the question of landscape complexity and pattern over a large area of ten to thousands of square hectares. It offers the grand spatial and temporal overview of current conditions across the landscape. Patterns of landscape emerge from interactions among topoedaphic factors, disturbances, and relationships among species (Perry 1994). The distribution of vegetation types; successional stages; streams, rivers, lakes, associated riparian areas, and wetlands; protected reserves; and roads across the landscape influences the stability of ecosystems and the viability of populations of plants and animals in three general ways: (a) by affecting the rate at which potentially destructive agents such as fire, wind, insect outbreaks, and diseases can spread; (b) by providing minimal habitat requirements and pathways of migration; and (c) by providing population "source" areas from which individuals can disperse to recolonize depleted habitats (Perry 1994). How landscape pattern affects the spread of disturbances and the conservation of species is complex. In general, a heterogeneous landscape retards the spread of disturbance whereas a homogeneous landscape enhances the spread (Perry 1994). How heterogeneous or homogeneous a landscape is depends on the nature of the disturbance, the susceptibility of different community types and age classes to the disturbance and the *grain* of the landscape (that is, the distribution of patch sizes ranging in scale from single tree gaps in the canopy to 50 hectare clearcuts) (Perry 1994).

Landscape attributes such as gaps, patches, boundaries, and connectivity corridors influence the effects of a given disturbance. For example, sharp edges (boundaries) created when openings are made within previously intact forest enhance wind disturbance. Connected stands of forest across the landscape of the same species, age class, or stand structure can greatly enhance the disturbance effects of wildfire or insect outbreaks.

Natural resource managers face the daunting challenge of how to best structure a landscape to conserve species while at the same time reduce the potential for catastrophic disturbance events such as insect outbreaks, stand-replacement fires, and severe windthrow. The challenge comes into play when the best approach for minimizing the spread of disturbances (that is, relatively small-scale patchiness in different cover types) may conflict with the habitat needs of wildlife (Perry 1994).

In designing a forested landscape to reduce the catastrophic spread of disturbance, the following questions need to be asked:

1) What are the most threatening disturbances?
2) Which plant communities and age classes are susceptible, and which are not?
3) What is the natural (that is, unmanaged) *grain* of the landscape?
4) Does it retard or promote the spread of catastrophic disturbance?

As a general rule, the more uniform a forest stand or a landscape, the greater is the chance that some disturbance will spread catastrophically. Biological diversity, so often used as a measure of ecosystem health, refers as well to landscapes: diversity in plant and animal species, stand structures, and age-class distributions make for healthier landscapes by promoting the conservation of species and by reducing the risk of catastrophic disturbances. Uniformity and associated risk increase as follows (Perry 1994):

1) Landscapes dominated by a single tree species
2) Landscapes dominated by a single tree species with a relatively narrow age range
3) Landscapes dominated by a single tree species that is genetically uniform or that does not have adequate tree-based defenses against pests and pathogens

Conservation biology is inextricably linked to landscape ecology. The conservation of plant and animal species will depend in the long run not only on a system of nature reserves embedded within a matrix of intensively managed landscape, but on management of the matrix landscape itself. How well forest management techniques reconcile commodity production with preservation of biodiversity within the matrix will determine the success or failure of species conservation. Local ecosystems and landscapes must contain sufficient habitat to support not only a viable breeding population but a viable metapopulation that provides a large-enough gene pool to prevent genetic deterioration and a continuing source of immigrants both to colonize newly created habitats and to replace extinctions of local populations (Perry 1994, Wells and Richmond 1995). To do this requires that local habitats are sufficiently interconnected at the regional level so that individuals or reproductive propagules within the metapopulation can move between local populations.

Managing for a balance of habitats or stand structures distributed across the landscape may be the best approach for conserving biological diversity of native species and reducing the risk of catastrophic disturbance (Perry 1994, Oliver et al. 1994, Oliver and Larson 1990). At the same time, care must be taken not to create conditions that allow a disruptive species to invade and to exclude native species. The distribution of seral stages or stand structures across a landscape is one measure of landscape heterogeneity. *Seral stage* or status is not synonymous with *stand structure*. Seral stages refer to the various plant communities that together make up a *sere*, and a *sere* is the characteristic sequence of biotic communities that successively occupy and replace each other in a particular environment over time following disturbance of the original community or the formation of a new, previously uncolonized environment (Kimmins 1987). Stand structure is the physical and temporal distribution of trees within a stand. Distribution can be described by species; vertical and horizontal spatial patterns; the size of trees or tree parts (for example, diameter, crown volume, leaf area, stem cross-section); tree ages; or by a combination of the above (Oliver and Larson 1990). Early-, mid-, or late-seral stages have been used extensively to describe the condition and development of forest stands. Stand structure adds a finer scale of resolution to the description of forest stands by considering structural complexity and forest stand dynamics. The importance of forest structure to species conservation and to ecosystem function has been widely acknowledged by the scientific community.

Oliver and Larson (1990) describe four structural stages of forest development: 1) stand initiation, 2) stem exclusion, 3) understory reinitiation, and 4) old growth (See Figure 2). Stand initiation refers to a young stand of tree seedlings and saplings, shrubs, forbs, and grasses following a stand-replacement disturbance. As the stand grows, it reaches the stem exclusion stage characterized by high tree density with little vertical stratification in the stand. This stage is marked by intense competition for limited resources (light, water, and nutrients). Eventually, over time, individuals die and their deaths create canopy gaps in the stand for recruitment of other plant species in this freed growing space. The stand has now reached the understory reinitiation stage. Stem number decreases. As the stand breaks up, vertical stratification increases resulting in formation of a multi-layered canopy. Given enough time (+200 years) and barring major disturbances, the stand reaches an old-growth stage characterized by old, large-diameter, tall trees; a wide age-class distribution; a mutil-layered canopy; and an abundance of large snags and down logs.

Key Question: What is the present structure and composition of forests across the landscape analysis area?

A distribution of stand structures for BLM-KFRA-administered lands in the landscape analysis area, based on stand inventory data contained in the database MICROSTORMS, is shown in Table 45. This table displays the number of acres for each structural stage by township. The same information is graphically displayed in Figure 3. Additionally, Table 46 and Figure 4 display the distribution of stand structures within land use allocations for BLM-KFRA-administered lands in the landscape analysis area. Figure 5 displays the percentage of BLM-administered lands within each land use allocation.

Stand initiation stage. After a disturbance, new individuals and species continue to appear for several years.

Stem exclusion stage. After several years, new individuals do not appear and some of the existing ones die. The surviving ones grow larger and express differences in height and diameter; first one species and then another may appear to dominate the stand.

Understory reinitiation stage. Later, forest floor herbs and shrubs and advance regeneration again appear and survive in the understory, although they grow very little.

Old growth stage. Much later, overstory trees die in an irregular fashion, and some of the understory trees begin growing to the overstory.

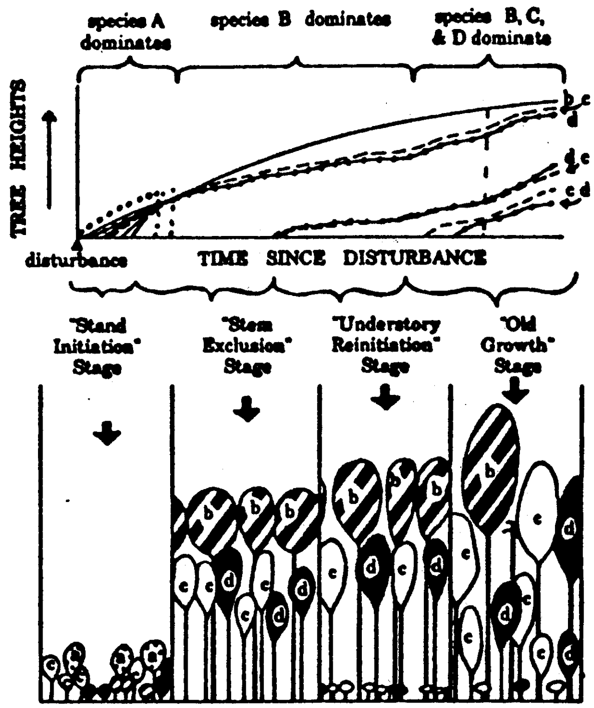


Figure 5.2 Schematic stages of stand development following major disturbances. All trees forming the forest start soon after the disturbance; however, the dominant tree type changes as stem number decreases and vertical stratification of species progresses. The height attained and the time lapsed during each stage vary with species, disturbance, and site. (Letters designate different species; *from Oliver, 1981,* Forest Ecology and Management *3.*)

Figure 2. From Oliver, C.D. and B.C. Larson 1990.

Table 45. Stand Structures for BLM-KFRA-Administered Lands

	EARLY (SI)	MID (SE)	LATE (SE)	UR-A	UR-B	UR-C	OG-A	OG-B	OG-C	NF& ROADS	SUMS
T39S-R6E	406.91	382.12	674.12	510.91		137.29				100.23	2211.58
T40S-R5E		202.04	1176.43	13.44		268.36			190.17	107.83	1958.27
T40S-R6E	997.41	119.31	2135.98	726.88	7.51	156.47	792.12		35.19	636.65	5607.52
T40S-R7E	896.58	1350.54	3748.5	906.18	143.23	225.56	609.98	191.85	63.65	466.56	8602.63
T41S-R4E	220.81		66.82	13.74			205.2		43.49	290.69	840.75
T41S-R5E		254.32	1513.39	142.22		682.02			35.19	846.2	3473.34
T41S-R6E	1246.1	0	1384.55	1980.92	26.69	216.27	19.27	0	0	344.87	5218.67
T41S-R7E	723.24	597.11	860.02	264.9	43.19	91.63	0	0	0	65.33	2645.42
											30558.2
Total Acres	4491.05	2905.44	11559.8	4559.19	220.62	1777.6	1626.57	191.85	367.69	2858.36	30558.2
Percent	0.14697	0.09508	0.37829	0.1492	0.00722	0.05817	0.05323	0.00628	0.01203	0.09354	1
Rounded Percent	14.69	9.5	37.82	14.91	0.72	5.81	5.32	0.62	1.2	9.35	

Decimal Equivalent

	EARLY (SI)	MID (SE)	LATE (SE)	UR-A	UR-B	UR-C	OG-A	OG-B	OG-C	NF& ROADS	SUMS
T39S-R6E	0.18399	0.17278	0.30481	0.23102		0.06208				0.04532	1
T40S-R5E		0.10317	0.6008	0.00686		0.13704			0.09711	0.05506	1
T40S-R6E	0.17787	0.02128	0.38091	0.12963	0.00134	0.02790	0.14126		0.00628	0.11354	1
T40S-R7E	0.10422	0.15699	0.43574	0.10534	0.01665	0.02622	0.07091	0.02230	0.00740	0.05423	1
T41S-R4E	0.26264		0.07948	0.01634			0.24407		0.05173	0.34575	1
T41S-R5E		0.07322	0.43572	0.04095		0.19636			0.01013	0.24363	1
T41S-R6E	0.23878		0.26531	0.37958	0.00511	0.04144	0.00369			0.06608	1
T41S-R7E	0.27340	0.22571	0.32510	0.10014	0.01633	0.03464				0.02470	1

Table 46. Distribution of Stand Structures Within Land Use Allocations for BLM-KFRA-administered Lands

	Acronym	Stand Initiation (0-10 yrs)	Stem Exclusion (20-40 yrs)	Late Stem Exclusion (50-90 yrs)	Understory Reinitiation (100-190 yrs)	Old Growth (200+ yrs)	Non-forest and Roads	Total Acres	Decimal Equivalent	Rounded Percent
1. District Designated Reserve*	DDR			368	125.33	149.25		642.58	0.0210284	2.1
2. General Forest Management Area	GFMA	1464.29	1746.84	5156.78	1929.91	735.15		11033	0.361053	36.1
3. Protected Habitat Buffer**	PHB			400.13	230.44	86.88		717.45	0.0234785	2.3
4. Klamath River ACEC***	KR ACEC	8.02	0.49	96.47	1158.25	356.73		1619.96	0.053013	5.3
5. Reserved Habitat Area	RHA			34.4				34.4	0.0011257 4	0.1
6. Visual Resource Management Area	VRM2	71.54	119.84	332.47	27.62	2		553.47	0.0181122	1.8
7. Riparian Reserve	RR	937.26	1038.27	3639.36	1071.6	535.85		7222.34	0.23635	23.6
8. Theatened & Endangered (Plants and Animals)	T&E			13.74	77.99			91.73	0.0030018 5	0.3
9. Timber Production Capability Classes & Non-Forest	TPCC & NF	2013.35		1517.95	1837.89	320.15	1985.42	7674.76	0.251156	25.1
10. Roads	Roads						968.12	968.12	0.0316816	3.1
TOTAL ACRES		4494.46	2905.44	11559.3	6459.03	2186.01	2953.54	30557.8		99.8

* DDR = Small late-successional forest reserve
** PHB = Forest reserve surrounding DDR
*** ACEC = Area of Critical Environmental Concern

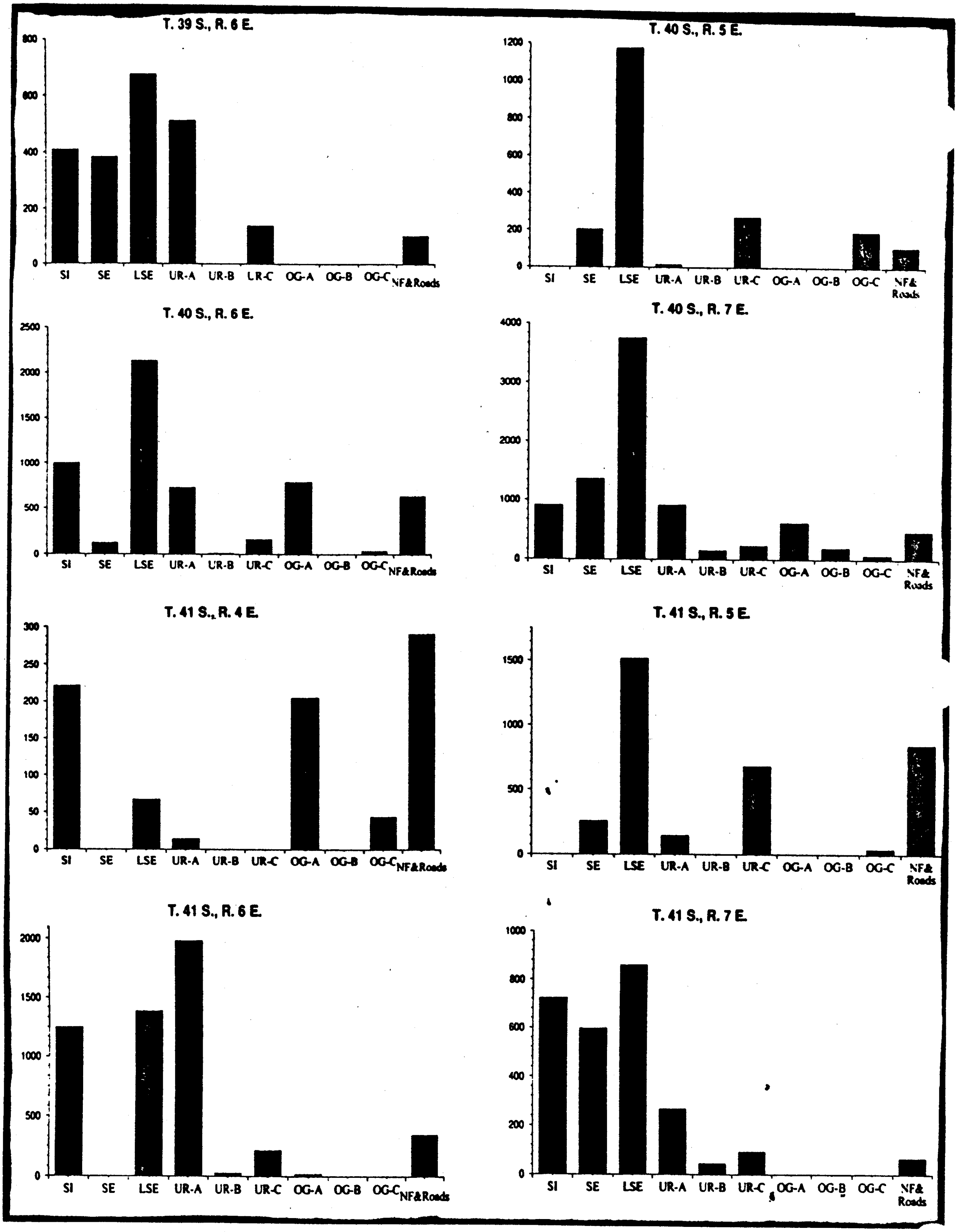


Figure 3. Stand Structure Acres for BLM-KFRA-Administered Lands by Township.

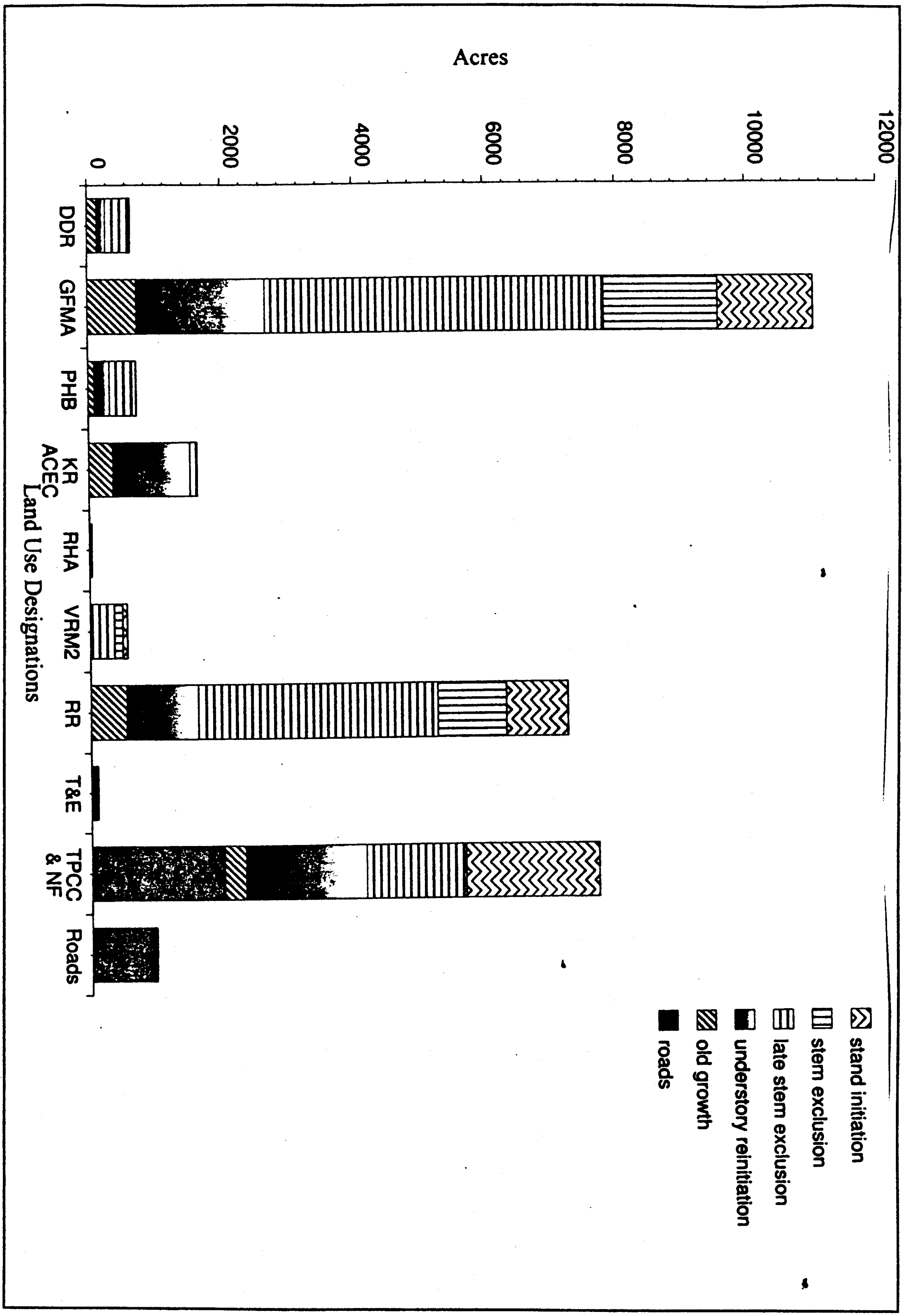


Figure 4. Land Use Allocations by Stand Structure for BLM-KFRA-Administered Lands.

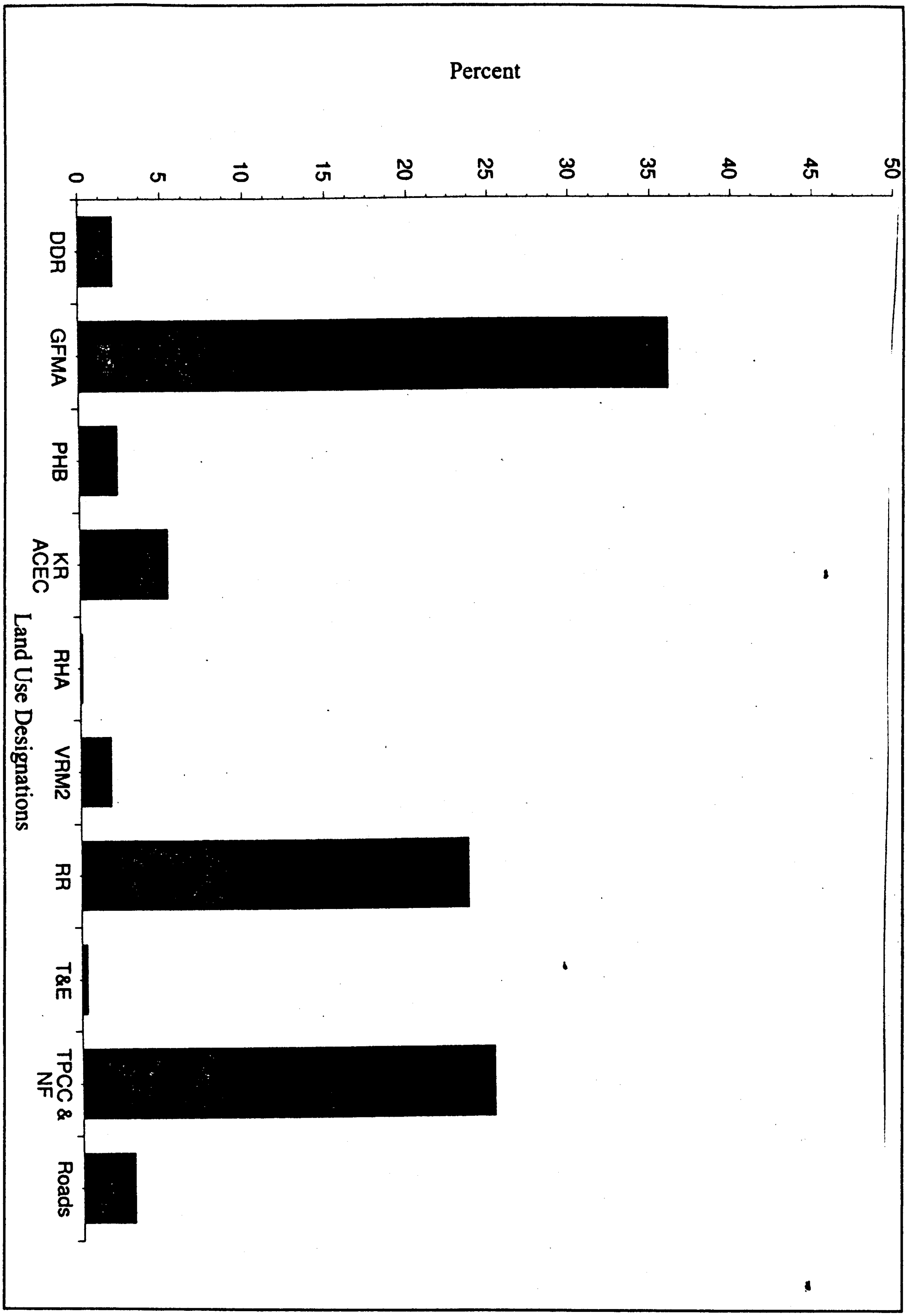


Figure 5. Percent of Land Use Allocations for BLM-KFRA-Administered Lands.

The categories in Table 45 and Figure 3 are as follows:
SI = stand initiation
SE = stem exclusion
LSE = late stem exclusion
UR-A = understory reinitiation with no significant understory
UR-B = understory reinitiation with understory of seedlings-saplings
UR-C = understory reinitiation with understory of saplings and pole-sized trees
OG-A = old growth with no significant understory
OG-B = old growth with understory of seedlings-saplings
OG-C = old growth with understory of saplings and pole-sized trees
NF and Roads = non-forested areas and roads

The stem exclusion stage was broken down into two categories: stem exclusion (9.5 percent) and late stem exclusion (37.8 percent). Late refers to those stands at the later end of the stem exclusion stage approaching understory reinitiation. Both the understory reinitiation and old growth stages were broken down into three respective categories: (A) no significant understory present; (B) understory of seedlings and saplings; and (C) understory of saplings and pole-sized trees. In other words, the category rankings indicate increasing structural complexity in the understory component.

Analysis of the distribution reveals approximately 14.7 percent of BLM-KFRA-administered lands in the landscape analysis area in the stand initiation stage, approximately 47 percent (nearly half of all forest stands) in the stem exclusion stage, approximately 21.5 percent in the understory reinitiation stage, and only approximately 7.1 percent in the old-growth stage. Non-forested areas and roads together comprise approximately 9.5 percent of BLM-KFRA-administered lands. Figure 3 displays the distribution of stand structure acres for BLM-KFRA-administered lands by township within the landscape analysis area. Map D in the analysis files is a GIS-generated map (Geographical Information System) which graphically displays the distribution of stand structures across the landscape analysis area.

Stands categorized as old growth include only stands with a birthdate greater than 200 years ago (in other words, such stands contain trees over 200 years in age). Selective harvest (thinning from below) to various degrees has occurred in many of these old-growth stands, but stands in all of the old-growth categories should meet criteria established for late-successional or old-forest habitat (See Record of Decision for Pacific Northwest Forest Plan, 1994). Some of the stands categorized as understory reinitiation (mature) contain late-successional habitat and may also be used by the northern spotted owl, goshawks, and other late-successional dependent species. Including stands classified as UR-C (the most structurally complex of the understory reinitiation stands) increases the amount of late-succesional forest from 7.1 to 12 percent. Including stands classified as UR-B only increases the amount of late-successional forest from 12 to 13 percent. Inclusion of stands classified as UR-A (no significant understory) would increase the amount of late-successional forest from 13 to 28 percent; however, further analysis is needed to determine if this category would qualify as late-successional forest habitat. In summary, the amount of old-growth forest on BLM-KFRA-administered lands in the landscape analysis area is about 7 percent. Late-successional forest habitat, including the 7 percent old growth, probably ranges from 12 to 28 percent depending on if the UR-B and UR-A categories qualify as late-successional forest habitat.

The structure and composition of late-successional and old-growth Douglas-fir/western hemlock forest ecosystems in western Oregon and Washington is given in the Record of Decision for the Pacific Northwest Forest Plan (1994). Four major structural attributes characterize these forests: (1) live old-growth trees, (2) standing dead trees (snags), (3) fallen trees or logs on the forest floor, and (4) logs in streams. Additional important elements include multiple canopy layers, smaller understory trees, canopy gaps, and patchy understory. Standards and guidelines for defining late-successional and old-growth forests vary among physiographic provinces. In the province that includes the landscape analysis area where forest types such as ponderosa pine are subject to frequent, low-intensity fire, late-successional and old-growth stages are characterized by relatively open understories and relatively few large fallen trees. Interim definitions have been developed for late-successional and old-growth forests for eastside forest types (USDA Forest Service, June 1993). However, to assess if forest stands categorized as UR-B and UR-A qualify as late-successional forest habitat requires further analysis which would include an inventory of large trees, snags, and downed logs in such stands.

Based on the above analysis, an imbalance of structural stages in the analysis area is apparent but not surprising. The distribution of forest structures is skewed toward forests in early and mid stages of development (that is, in the stand initiation and stem exclusion stages). This imbalance holds true for most forest regions in the Pacific

Northwest that have been intensively managed for timber production over the last 40 to 50 years. For example, by most estimates only 10 to 15 percent of old-growth forest remains in westside Washington and Oregon. Because Weyerhaeuser lands in the analysis area consist of stands in early to mid seral stages (stands under 70 years in age), their contribution would further increase the acres of stand structures in the stand initiation and stem exclusion stages, adding to the skewed distribution of early to mid forest structures dominating BLM-KFRA-administered lands in the analysis area.

The amount of old-growth forest in the landscape analysis area has been reduced to less than 15 percent (about 7 percent). Late-successional forest (that is, forest with old-growth characteristics) in the landscape analysis area ranges widely from 12 to 28 percent. A conservative estimate for the amount of late-successional forest in the landscape analysis area is probably about 13 to 15 percent. Until further analysis is conducted, however, forest stands categorized as UR-A cannot be included with confidence as late-successional forest habitat. A retention threshold of 15 percent late-successional forest has been established for fifth-field watersheds (20 to 200 square miles) (Klamath Falls Resource Area ROD and RMP 1995). This retention level requirement applies to all federal lands in a fifth-field watershed.

Table 47 and Figure 6 display the distribution of stand structure acres for state and other federal ownerships within the landscape analysis area. Because these ownerships comprise a relatively small proportion of land in the landscape analysis area (about 5.4 percent), they do not contribute to much change in the relative proportions of stand structures shown for BLM-KFRA-administered lands. Differences in distributions of stand structures for each respective agency can be seen in Table 47. With all three ownerships considered as a single landscape component, an imbalance of stand structures can be discerned as with BLM-KFRA-administered lands. Figure 6 reveals a skewed distribution with a disproportionate number of stands in early seral stages (that is, stand initiation and stem exclusion stages). Whereas the majority of BLM-KFRA-administered lands are in the stem exclusion stage, the majority of the lands for this ownership component fall in the stand initiation stage. There are more than twice as many acres in the stand initiation stage compared to the stem exclusion stage. Many of the stands categorized as stand initation (or early seral) stage include shrub-steppe lands of western juniper and grass. The vast majority of understory reinitiation stands for this ownership component are on state lands administered by the Oregon Department of Forestry (ODF). As with BLM-KFRA-administered lands, this land-scape component contains very little late-successional or old-growth forest relative to other stand structures. (Stand structure data for Pacific Power and Light company were not available in time for inclusion in this document.)

Table 47. Stand Structure Acres for other Ownerships in the TPLA Area

1. OREGON DEPARTMENT OF FORESTRY (ODF) LANDS (2.4 percent)			
Stand Structures	Acres		Percent
SI	751	0.184748	18.5
SE	1391	0.342189	34.2
UR	1593	0.391882	39.2
OG*	330	0.0811808	8.1
Total =	4065	1	,100
*Old Growth = marginal old-growth stands that may fit more appropriately in the UR stage			
2. BLM-CALIFORNIA LANDS (2 percent)			
Stand Structures	Acres		Percent
SI*	3047	0.93409	93
SE	0	0	0
UR	58	0.0177805	2

OG	157	0.04813	4.8
Total =	3262	1	99.8
*Stand Initiation = includes juniper woodlands and grass lands			
3. KIAMATH NATIONAL FOREST LANDS (1.0 percent)			
Stand Structures	Acres		Percent
SI	751	0.410383	41
SE*	1079	0.589617	59
UR	0	0	0
OG	0	0	0
Total =	1830	1	100
*Stem Exclusion = 624 of these acres (the largest component) are pinyon-juniper stands			
4. TOTALS FOR THE ABOVE THREE OWNERSHIPS (5.4 percent of landscape analysis area)			
Stand Structures	Acres		Percent
SI	4549	0.496778	50
SE	2470	0.269739	27
UR	1651	0.180299	18
OG	487	0.0531834	5
Totals =	9157	1	100

According to Leiberg (1899), ponderosa pine and Douglas-fir were the dominant tree species in forests in the analysis area at the turn of the century. The component of white fir was evidently small to neglible (0 to 10 percent). Since the turn of the century, the white fir component has increased, substantially in some areas. Table 48 displays the number of acres for dominant overstory and understory tree species on BLM-KFRA-administered lands in the analysis area. Figure 7 displays the proportion of acres for dominant overstory and understory tree species graphically. Maps E and F display the distribution of dominant overstory and understory species across the landscape. Based on stand inventory data in MICROSTORMS, the dominant overstory tree species is ponderosa pine (49 percent). Douglas-fir and white fir comprise 29.8 percent and 13 percent respectively. The dominant understory species is ponderosa pine (45.6 percent) with Douglas-fir and white fir 32.7 percent and 14 percent respectively. The white fir component has increased from a range of 0 to 10 percent to 13 to 14 percent.

The shift in forest composition at both the stand and landscape levels has resulted from human introduced disturbances: selective logging, fire exclusion, and livestock grazing. Contemporary forests are thought to have a greater risk of insect attack, disease outbreaks, and stand-replacing fires (Hessburg et al. 1994, Oliver et al. 1994). Competition for resources in these dense stands creates stresses which can predispose weakened trees to tree-killing Scolytid bark beetles and fungal pathogens, including Armillaria and annosum root diseases.

Figure 6. Stand Structure Acres for Oregon Department of Forestry, BLM-California-Administered, and Klamath National Forest Lands.

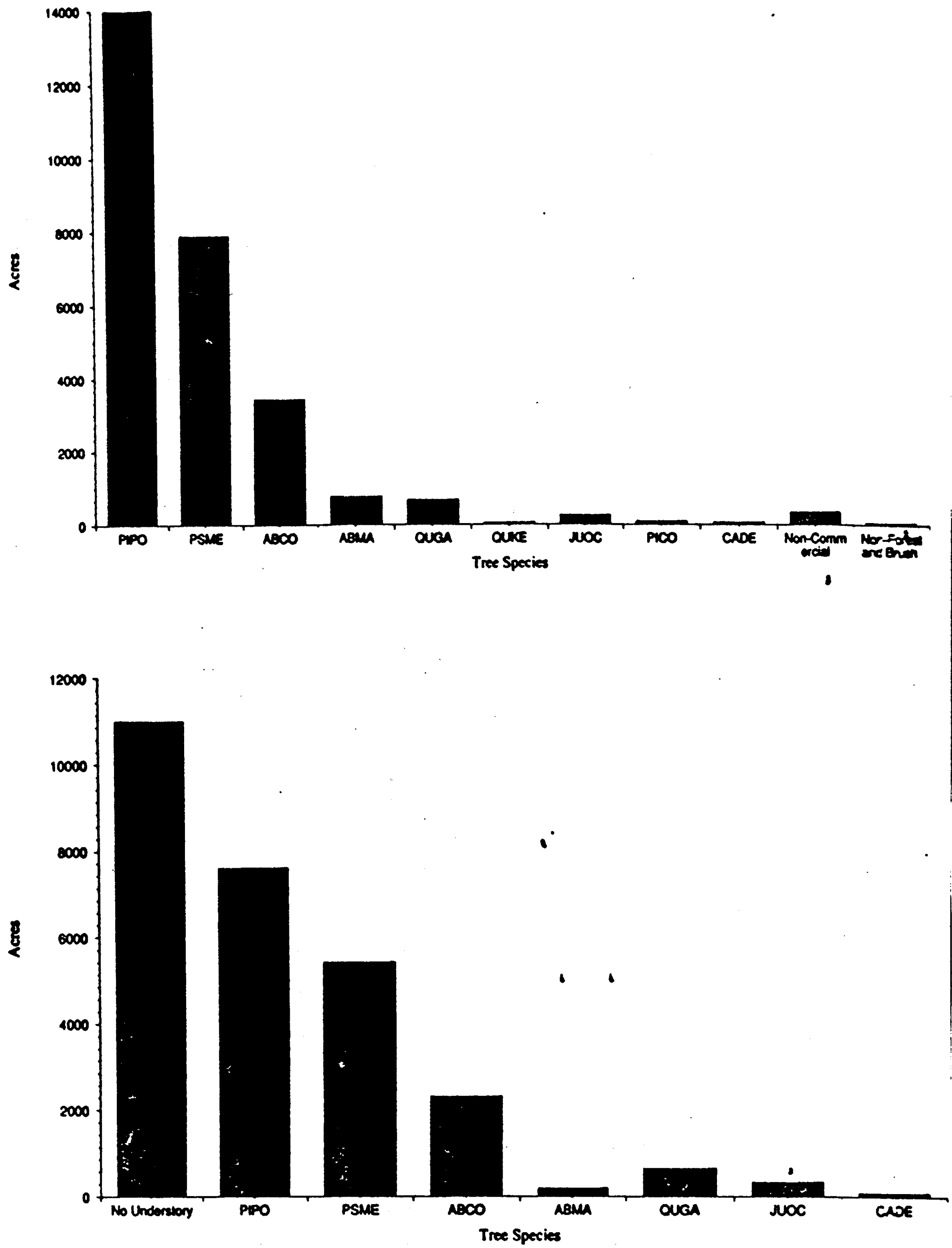


Figure 7. Dominant Overstory and Understory Species for BLM-KFRA-Administered Lands.

Key Questions: What sort of future forest matrix across the landscape analysis area do we wish to achieve? Are we creating a disproportionate amount of young forests that lack structural and compositional complexity? Are we providing for late-successional and old-growth forests and the unique assemblage of plant and animal species that such forests support? Are we creating a landscape diversity of forest structures to absorb future destructive disturbances, to maintain minimal habitat requirements and migration pathways for species, and to maintain viable population "sources" for recolonization of depleted areas? In short, will we create a functional or dysfunctional landscape with future proposed management activities?

At the landscape level, the strategy for protecting forests is to create (or to maintain) landscapes that buffer and absorb disturbances rather than magnify them (Perry 1994). Since homogeneity tends to magnify disturbances, heterogeneity is critical. The primary objectives of landscape silviculture are to create (or maintain) a proper mix of habitats and to buffer and absorb the energy of destructive forces (Perry 1994). Ecologically based management will focus on what it leaves behind rather than on what it takes. Biological legacies will be protected and habitat imbalances redressed by restoring forested landscapes to a higher proportion of old growth.

Based on distribution of stand structures, the greatest opportunity for selective timber harvest on BLM-KFRA-administered lands in the analysis area is in the stem exclusion stage which comprises nearly half (47 percent) of BLM-KFRA-administered lands. For reasons of forest health (to reduce the risk of catastrophic disturbance and to restore pre-settlement species composition to forest stands), it may be ecologically appropriate to harvest in understory reinitiation (mature) stands as well. Fir understories have increased in low- to mid-elevation eastside forests beneath what were historically open-structured, ponderosa pine-dominated forests (Hessburg et al. 1994). To restore ponderosa pine (a species declining in numbers) in these forests will require the creation of large-enough gaps in forest canopies using selective harvest of the understory fir (that is, thinning from below) and prescribed underburning. However, the process of introducing change in forest composition and structure (for example, the introduction of fire) must be gradual and will take time on the order of 100 years or more. Introduced changes in stand structure in mature stands that occur too quickly risk altering within-stand microclimate and other environmental conditions that may negatively affect wildlife species and favor the introduction of non-native (that is, exotic or alien) species that could eventually replace native species. In cases where virulent disease centers or insect outbreaks occur that cover large areas, introducing change in stand structure more quickly in order to retard spread of the disturbance may be appropriate. For example, destructive outbreaks of bark beetles (fir engraver, *Scolytus ventralis*, or mountain pine beetle, *Dendroctonus ponderosae*) may threaten large areas of forest, affecting healthy as well as weakened trees, because of overstocked stand conditions.

At the same time, however, care must be exercised to minimize disturbance to the soil resource caused by ground-based logging equipment if selective thinning of older forest stands is implemented. Previous entries have resulted in disturbance to soil organic horizons (compaction, displacement, and loss). Soil compaction can further aggravate already stressed or weakened trees, making them more susceptible to fungal pathogens and insect attack (Perry 1994). Deterioration of the soil organic resource also has long-term consequences that can result in reduction of site fertility. Mycorrhizal fungi and other soil biota that are critical to nutrient cycling and to food webs for mammals and birds are associated with soil organic reserves. Timber harvest activities introduce a complicating effect on soils that can differ markedly from the effects of periodic fires associated with the historical natural fire regime. Fire and thinning are not equal in their impacts to the soil resource.

Finally, because the majority of stands on Weyerhaeuser lands, which comprise a considerable proportion of the landscape area, fall into the categories of early- to mid-seral stage (probably the stem exclusion stage of forest development), the importance of late-successional forests on BLM-KFRA-administered lands increases. Late-successional forests can be viewed as population sources for interior forest-dependent species such as the

Table 48. Dominant Overstory and Understory Tree Species for BLM-[illegible]RA-Administered Lands

DOMINANT OVERSTORY SPECIES

SUMMARY

	PSME	PIPO	ABMA	ABCO	CADE	QUGA	PICO	JUOC	Non-Comm. Lands	Non-forest and Brush	QUKE	Total
T39S,R6E	563.19	256.59	744.67	546.6								2111.05
T40S,R5E	1353.75	208.16		288.33								1850.24
T40S,R6E	1705.71	2254.38		686.08	72.25	164.48						4882.9
T40S,R7E	3282.36	2784.65	24.61	1913.98			68.21		4.15	50.91		8128.87
T41S,R4E		285.56				264.41						549.97
T41S,R5E	387.37	1932.58						254.32			51.89	2626.16
T41S,R6E	295.64	3994.99				244.24			337.93			4872.8
T41S,R7E	301.48	2260.42					18.19					2580.09
Total Acres =	7889.5	13977.3	769.28	3434.99	72.25	673.13	86.4	254.32	342.08	50.91	51.89	27602.1

Table 48. Continued			
DOMINANT OVERSTORY SPECIES			
	Acres	Percent	Decimal Equivalent
PIPO	13977.3	51	0.506387
PSME	7889.5	29	0.28583
ABCO	3434.99	12	0.124447
ABMA	769.28	3	0.0278704
QUGA	673.13	2	0.0243869
QUKE	51.89		0.00187993
JUOC	254.32		0.0092138
PICO	86.4		0.0031302
CADE	72.25		0.00261756
Non-Commer cial	342.08	1	0.0123933
Non-Forest and Brush	50.91		0.00184443
Totals =	27602.1	98	1
DOMINANT UNDERSTORY SPECIES			
	Acres	Percent	Decimal Equivalent
No Understory	10997	40	0.398413
PIPO	7607.91	28	0.275628
PSME	5425.68	20	0.196568
ABCO	2315.99	8	0.0839064
ABMA	192.44		0.00697194
QUGA	640.1	2	0.0231903
JUOC	333.99	1	0.0121002
CADE	88.94		0.00322222
Totals =	27602.1	99	1

northern spotted owl and the goshawk. Maintenance of or an increase in these population sources will in all likelihood only occur on BLM-KFRA-administered lands. On a landscape level, BLM-KFRA-administered lands might be viewed as a population source and Weyerhaeuser lands as a questionable dispersal sink for such species. The importance of maintaining stand structures that qualify as late-successional forest habitat becomes apparent if populations of older-forest-dependent species are to be maintained.

Chapter 3

Management Recommendations

Table 49 presents a summary of the recommendations that are more fully set out at the end of this chapter. The management recommendations included in this chapter derive from the analysis contained in Chapter 2.

Recommendation Summary

Table 49. Summary of High Priority Restoration Opportunities

Generic Concern	Problem Statement	Management Recommendation	Some Benefits and Special Notes
Biological Diversity (Species and Habitat)	*Habitat for wildlife species have been altered by management practices.	* Maintain habitat and improve long range conditions to protect species of concern by increasing plant diversity, provide multistory timber stands, have adequate numbers of large snags, allow prescribed burns, decrease open road densities, and continue Pokegama road closure.	
	* The distribution of stand structures across the landscape has been altered with a current disproportionately high number of early-successional forest stands and a disproportionately low number of late-successional forest stands. * Biological diversity across the landscape has been altered because of human-introduced disturbance.	* Manage for a balance of stand structures (namely, more late-successional forest). * Link biodiversity concerns to landscape pattern and structures (e.g., source-sink areas, connectivity corridors).	* Provides a balanced distribution of stand structures, resulting in an increase in landscape heterogeneity, an enhancement of diversity of stand structures, and ensured maintenance of species dependent on late-successional forest habitat.

	*Habitat for aquatic species and communities has been altered by management activities	*Restore natural hydrologic function through protection of sensitive hydrologic sites and the placement of structures to accelerate aggredation and re-vegetation of degraded channels.	
	*Special status species are at risk from changes in habitat connectivity and potential future human impacts.	*Protect sites with known populations of rare or endemic species from harmful human impacts.	
Stream & Riparian	*Hydrology has been altered in the TPLA area through reductions in base flow from drought and poor channel and riparian condition in certain areas. Peak flows have likely been increased, primarily due to the road network. The timing of peak flows may be altered due to created openings in the forest canopy on non-BLM administered lands. Sediment from roads and stream bank erosion is adversely affecting water quality. Lowered base flows and poor channel and riparian condition in areas is contributing to higher water temperatures and lower dissolved oxygen levels in Hayden Creek and Long Prairie Creek.	*Plant conifers and/or willows and sedge/rush plugs in areas where streamside shading and large woody debris recruitment potential is low due to past management practices. *In cooperation with Weyerhaeuser, explore the possibility of removing Ward Reservoir and rehabilitating the affected section of Hayden Creek. *To improve channel condition and aquatic habitat, place in-stream structures in high resource value sections of Hayden Creek and Long Prairie Creek. *Implement livestock grazing management to reach desired utilization levels in Riparian-wetland areas.	*Improvement of water quality and aquatic habitat conditions. *Improvement and maintenance of riparian-wetland area condition and function. *Reductions in sediment input to streams from eroding stream banks and from roads. *Reduction in stream temperature and increases in dissolved oxygen levels. *Restoration of the hydrologic regime.

Forest Composition, Structure, and Function	* Forest composition, structure, and function have been altered across the landscape because of human-introduced disturbance.	* Restore composition, structure, and function of current forest stands to approximate more closely historic or pre-settlement conditions.	* Gradual restoration of the ponderosa pine component in forest stands * Reduction of white fir and Douglas-fir understories * Reduction of flammability of and fuel loads in forest stands, thereby decreasing the risk of high-intensity, stand-replacement wildfires * Reduction of disease and insect outbreaks induced by high tree densities
Roads	*Hydrology has been altered in the TPLA area through reductions in base flow from drought and poor channel and riparian condition in certain areas. Peak flows have likely been increased, primarily due to the road network.	*In high road impact areas and where the opportunity exists and Transportation Management Objectives allow, close, obliterate and/or stabilize selected roads and reseed or replant with native vegetation. Limit construction of new roads and obliterate or improve existing roads within Riparian Reserves. *Establish Transportation Management Objectives for roads in the TPLA area to reduce open and total road densities and to determine appropriate surfacing and maintenance for roads. *Continue the Pokegama Cooperative Road Closure.	

Soils	* Soils across the landscape have been altered because of human-introduced disturbance.	* Protect and conserve soil organic matter reserves (surface and subsurface components) in areas south of Highway 66 where soil organic matter development is minimal.	* Maintenance, conservation, and improvement of long-term site productivity * Restoration of organic reserves in areas still recovering from past timber harvest disturbance.
	*Soil and site productivity have been altered in the TPLA area due to losses of organic matter and displacement and compaction of the soil from management activities.	*If there are known areas where high compaction levels exist (particularly where the percent of detrimental soil conditions exceeds the recommended 20 percent areas extent), use a winged subsoiler or a self-drafting subsoiler to rip skid trails and landings that are not needed for future timber harvest activities or where management activities are not expected to occur for five to ten years or more. Ripping is not recommended for soils with rock contents of 35 percent or more. *Designate the following soil series in the TPLA area as TPCC Fragile Soils: Medco and Skookum. These soils would be classified as Fragile, Mass Movement and Fragile, Slope Gradient. *During site-specific planning and analysis and when practicable, conduct inventories to assess where detrimental soil conditions exist above levels allowable on BLM-administered lands.	*Provides consistency with the Jenny Creek Watershed Analysis recommendations.

Livestock & Wildhorses	*A formally established Wildhorse Herd Management Area (HMA) exists and the horse herd is creating impacts within the analysis area	*Remove sufficient wild horses from the HMA to get the numbers to as close to the 30 head minimum Allotment Management Level as possible. *Limit horses to established herd area.	*Reduces utilization and trampling of important meadow and riparian areas in Pokegama HMA. *Provides other benefits to riparian areas, riparian dependant species, and reduces conflicts with wildlife species.
	*Riparian and wetland areas within the TPLA have been negatively impacted by improper livestock management, timber harvest practices, and other uses.	*Change livestock grazing management to meet specified utilization levels for riparian areas. *During timber harvests follow established Best Management Practices.	*Reduce utilization and trampling of important meadow and riparian areas in the TPLA area.
Human	*A civil war era burial site, containing Shasta Nation Union Army Scouts, is located within the TPLA area on private land. The location is known to the BLM. The BLM has been told the Shasta Nation is concerned that if the burial site is known, vandals will attack it.	*The BLM contact the United States Army, and the War Memorial and Monuments Commission, and recommend they acquire the cemetery land and make it a Shasta National Cemetery.	* National Cemeteries supervised by full time care takers, usually veterans, could stop looters. (note: We would suggest this cemetery be supervised by veterans who are members of the Shasta Nation.)
	*Cattle and wildhorse grazing along the California State Line have adversely impacted cultural sites within the TPLA area, usually along streams and adjacent to springs.	*Develop plans to mitigate the damage done by animals in these areas, enlisting the cooperation of ranchers who hold grazing permits. Reduce the size of the wildhorse herd to lessen their impact on these sites. Institute fencing and trough projects to draw the animals away from the sensitive areas.	*Herd reduction will lessen the impact of the wildhorses on cultural resources. *Provides protection for other riparian and aquatic resources.

	*The Klamath River is subject to high and low water flows due to release of water from electricity generating facilities. This stream flow fluctuation causes bank erosion and subsequently adversely impacts cultural sites.	*Enlist the cooperation of PacifiCorp to notify the BLM when unusually large releases of water are to be made. PacifiCor and the BLM should cooperatively monitor river banks after unusually large releases to ensure that cultural sites are not damaged, and to stabilize any site damage that has occurred.	*Site stabilization along riverbanks benefits cultural resources. *Provides protection for other riparian and aquatic resources.
	*The Klamath River Canyon has an extremely high number of cultural sites. Many of these sites are regularly vandalized by looters.	*Increase law enforcement patrols of the Klamath River Canyon, and increase apprehension and prosecution of looters under the Archaeological Resources Protection Act.	*This action will help stabilize and protect cultural resources from further depredation.
	New uses and increasing recreation use levels have caused a number of management concerns.	Manage recreation resources to provide high quality recreation opportunities while minimizing impacts to other resources.	Improved recreation opportunities and developments for the recreating public. A potential for greater and improved visibility of BLM by the recreating public.

Management Recommendations

Forest Composition, Structure, and Function

Problem Statement

Forest composition, structure, and function have been altered across the landscape because of human-induced disturbance.

Restoration Opportunities

High Priority

Gradually restore composition, structure, and function of current forest stands to approximate more closely historic or pre-settlement conditions. Selective thinning of dense understories (i.e., thinning from below) and the introduction of prescribed underburns are appropriate tools that can be used to work toward this ecological goal. Restoring historic conditions will reduce risk of stand-replacement, catastrophic wildfire and the incidence and extent of disease and insect outbreaks.

Soils and Soil Productivity

Problem Statement

Soil and site productivity have been altered in the TPLA area due to losses of organic matter and displacement and compaction of the soil from management activities.

Restoration Opportunities

Moderate Priority

If there are known areas where high compaction levels exist (particularly where the percent of detrimental soil conditions exceeds the recommended 20 percent areal extent), use a winged subsoiler or a self-drafting subsoiler to rip skid trails and landings that are not needed for future timber harvest activities or where management activities are not expected to occur for five to ten years or more. Ripping would not be recommended for soils with rock contents of 35 percent or more.

Management Considerations

High Priority

Fully prescribe and implement all appropriate Best Management Practices on BLM-administered lands (See Appendix D in the Klamath Falls Resource Management Plan).

Require the use of a winged subsoiler or a self-drafting subsoiler, rather than a rock ripper, for site preparation.

Soil Resource Protection

Retain small woody (dead and down) material to sustain soil nutrients and a healthy forest ecosystem in areas that do not contain a sufficient supply of such material (p. D-11).

Timber Harvest

In previously unentered stands, use designated skid roads to limit soil compaction to 12 percent or less of the harvest area (p. D-23).

In previously entered stands, inventory existing soil compaction and design proposed management activities to mitigate or avoid reductions in soil productivity. Utilize existing skid roads (p. D-23).

Minimize the width of skid roads (p. D-23).

To minimize soil disturbance, restrict ground-based logging equipment such as rubber-tired skidders, tractors, and mechanical harvesters from entry into forest islands which contain a developed soil organic horizon. Forest islands are localized clumps or clusters of trees that are distinct from the more open forest matrix in which they are embedded.

To minimize soil disturbance, prohibit use of mechanical harvesters which need to visit each tree during the harvest operation.

Use appropriate seasonal restrictions that would result in no off-site damage from designated skid roads. Operation of both new and existing skid roads will minimize soil displacement and will occur when soil moisture content provides the most resistance to compaction (p. D-24).

Allow logging on snow whenever practicable when snow depths average 20 inches or greater and negligible ground surface exposure occurs during the operation. Logging on frozen ground may also be allowed when the ground is frozen to a depth of 6 inches (p. D-24).

Prescribed Fire

Evaluate the need for burning based on soils, plant community, hazard reduction objectives, site ecology, and site preparation criteria. Burn under conditions when a light to moderate-intensity burn can be achieved (p. D-30).

Moderate Priority

As recommended in the Jenny Creek Watershed Analysis, designate the following soil series in the TPLA area as TPCC Fragile Soils: Medco and Skookum. These soils would be classified as Fragile, Mass Movement and Fragile, Slope Gradient. These tuff-derived soils have a clayey subsoil and low strength when wet, while sediment derived from these soils is fine and stays suspended for extended periods of time. Infiltration and permeability is relatively low. These soils, when disturbed, are a significant source of fine sediment and turbidity to streams (USDI 1995). These two soil associations occur in the Klamath River Canyon and in the southwest corner of the TPLA area.

Information and Monitoring Needs

High Priority

Collect data on soil resources in the area before and after management activities. Measure depth of soil organic horizon and amounts of coarse woody debris. Inventory fungi, including mycorrhizal species, to develop baseline data on species diversity, distribution, and relative abundance. Collect data on the nitrogen status of soils in the area including information on the pathways by which nitrogen fixation is occurring.

Moderate Priority

During site-specific planning and analysis and when practicable, conduct inventories to assess where detrimental soil conditions exist (compaction, displacement, and loss of soil cover) above levels allowable on BLM-administered lands (20 percent of the total acreage in an activity area). Incorporate measures to reduce existing acreage or, at the least, not increase the acreage in the planning area where detrimental soil conditions exist. Monitor the effects of activities on the soil resource.

Encourage and support research to quantify the effects of compaction and soil organic matter losses on soil productivity for soils in this region.

ɜotany, Weeds, & Special Status Plant Species Including Threatened, Endangered, and Sensitive Plant Species

Problem Statement

Distribution and abundance of special status plants have been altered in the landscape area by human-introduced disturbances. Alteration of the landscape areas has also resulted in the introduction of populations of noxious eeds and the displacement of native plant species.

Restoration Opportunities

None identified.

Management Considerations

High/Moderate Priority

Noxious Weeds. Implementation of an integrated weed management plan is recommended for lands in the landscape area. Integrated weed management includes a combination of cultural, physical, biological and chemical control methods. Cultural methods include prevention of introduction of new weed species into an area that can be accomplished through appropriate cleaning of machinery and equipment prior to implementation of a project and the use of materials that are weed seed free, and choosing project design features that produce a minimum of disturbance to a site in order to limit the creation of environmental conditions favorable for weed invasion. Cultural methods also include competitive plantings on disturbed sites composed of native species derived from local genetic stock. Physical control can include manual and mechanical methods as well as prescribed fire. Classical biological control involves the introduction of species specific pests of the target weed in order to limit its ability to spread and compete with native vegetation. Chemical control includes the use of herbicides appropriate to the target species and the environmental conditions at the treatment site. More information on integrated weed management can be found in USDI Bureau of Land Management (1994).

Information and Monitoring Needs

High/Moderate Priority

Bellinger's meadowfoam. The draft conservation strategy for Bellinger's meadowfoam recommends systematic inventories for the species in order to better understand the species' distribution, abundance, population trends, existing and potential threats, and habitat requirements. This information would allow management decisions that would conserve the species and its habitat. Pilot monitoring of a population excluded from grazing and a population exposed to grazing would document if livestock grazing impacts the species.

Pygmy monkey flower. Meinke et al. (1994) stated that the Oregon Department of Agriculture would recommend to the U.S. Fish and Wildlife Service that pygmy monkey flower be removed from federal candidate status. Their recommendation was based on the abundance of the species that they found on the Winema and Fremont National Forests. However, they did recommend periodic, qualitative monitoring of large populations (more than 100,000 plants in 1993). They also recommended that major ground disturbing activities should avoid meadows or swales known to support those large populations.

Red root yampah. More complete inventories for the species are needed to further document its occurrance in the landscape area, particularly on public lands. If populations are located, the status and trend of the species can be determined.

Green's mariposa lily. More complete inventories for the species are needed to further document its occurrance in the landscape area, particularly on public lands. If populations are located, the status and trend of the species can be determined.

Survey and Manage Species. Under the Northwest Forest Plan we will be required to initiate extensive surveys for some of these species by 1996, and surveys for other of these species must be completed prior to ground-disturbing activities that will be implemented in FY 1999 or later. Therefore, it would be beneficial to begin inventories for these species as soon as possible in order to be able to assess their status and trend under current management.

Wildlife

Bald Eagles

Problem Statement

Bald Eagles are a threatened species and their habitat has been altered.

Restoration Opportunities

None identified.

Management Considerations

High Priority

Foraging needs should address maintaining waterfowl and fish habitat, and cooperating with landowners to maintain foraging areas. In addition, improve perch availability, continue information and education programs, and evaluate potential disturbance in foraging areas, in the Klamath River canyon by rafting, birders and photographers.

Moderate Priority

Coordinate with U.S. Fish and Wildlife Service on timber management in the bear valley refuge to maintain roosting habitat.

Information and Monitoring Needs

High Priority

Continue to monitor nest sites to determine success of birds.

Northern Spotted Owl

Problem Statement

Northern Spotted Owls are a threatened species and their habitat has been altered.

Restoration Opportunities

None identified

Management Considerations

High Priority

Manage district designated reserve area to maintain characteristics preferred by the northern spotted owl.

Continue and/or implement timber management practices that will maintain habitat and improve long range conditions such as plant species diversity and multistory timber stands.

Apply timber management practices that will provide connectivity habitat for northern spotted owls especially in

T39S R6E Section 15 and 21 T40S R6E Section 3, 11, and 13

Information and Monitoring Needs

High Priority

Continue to monitor nest sites to determine nest success and turnover recruitment at known sites.

Goshawk

Problem Statement

Goshawk habitat has been altered by managment practices.

Restoration Opportunities

None identified.

Management Considerations

High Priority

Retention and maintenance of continuous habitat with high canopy closure and mature to old-growth trees will have beneficial effects to goshawks.

Information and Monitoring Needs

High Priority

Continue to monitor known sites.

Bats

Problem Statement

Bat habitat has been altered by management practices. The maternity colony of Townsend's big eared bat at the Salt Caves have decreased in numbers.

Restoration Opportunities

Install upstream signs closing the river to stopping for a mile near the salt caves area.

Management Considerations

High Priority

Caves, wooden bridges, and abandoned buildings are extremely important roost and hibernation sites, and require additional protection to ensure their value as habitat is maintained.

Retain large snags for daily roosting habitat throughout TPLA.

Have cultural resource staff continue to look for bat habitat as they do cultural surveys.

Moderate Priority

Continue to maintain signs that are posted to protect the bats at the Salt Caves.

Information and Monitoring Needs

High Priority

Monitor the potential human disturbance to the Salt Caves on the weekends when there are a large number of rafters on the river to determine whether or not the closure has been effective.

Moderate Priority

Spot check water sources in the TPLA area for bat species and numbers.

Deer/Elk

Problem Statement

Deer/Elk habitat has been altered by management practices.

Restoration Opportunities

High Priority

Forage improvements on wedgeleaf ceanothus (*Ceanothus cuneatus*) by burning.

Use controlled burns in meadows and timber areas to improve habitat

Management Considerations

High Priority

The Klamath Falls Resource Management Plan recommends a maximum of 1.5 miles of roads per square mile to allow for more effective use of existing cover by big game.

Continue Pokegama road closure.

Moderate Priority

Reduce roads in the Grizzly Mountain, Mud Springs, and Johnson prairie areas.

Information and Monitoring Needs

None identified.

Protection Buffer Species (Great Gray Owl, White-headed Woodpecker, Flammulated Owl, and Pymgy Owl)

Problem Statement

Protection buffer species habitat has been altered by management practices.

Restoration Opportunities

High Priority

Improve meadow habitat by seeding native plants.

Management Considerations

High Priority

Manage for canopy closure exceeding 60 percent near meadows for great gray owls.

Survey and Manage Species. Under the Northwest Forest Plan we will be required to initiate extensive surveys for some of these species by 1996, and surveys for other of these species must be completed prior to ground-disturbing activities that will be implemented in FY 1999 or later. Therefore, it would be beneficial to begin inventories for these species as soon as possible in order to be able to assess their status and trend under current management.

Wildlife

Bald Eagles

Problem Statement

Bald Eagles are a threatened species and their habitat has been altered.

Restoration Opportunities

None identified.

Management Considerations

High Priority

Foraging needs should address maintaining waterfowl and fish habitat, and cooperating with landowners to maintain foraging areas. In addition, improve perch availability, continue information and education programs, and evaluate potential disturbance in foraging areas, in the Klamath River canyon by rafting, birders and photographers.

Moderate Priority

Coordinate with U.S. Fish and Wildlife Service on timber management in the bear valley refuge to maintain roosting habitat.

Information and Monitoring Needs

High Priority

Continue to monitor nest sites to determine success of birds.

Northern Spotted Owl

Problem Statement

Northern Spotted Owls are a threatened species and their habitat has been altered.

Restoration Opportunities

None identified

Management Considerations

High Priority

Manage district designated reserve area to maintain characteristics preferred by the northern spotted owl.

Continue and/or implement timber management practices that will maintain habitat and improve long range conditions such as plant species diversity and multistory timber stands.

Apply timber management practices that will provide connectivity habitat for northern spotted owls especially in

50. Selection of structures should be based on Rosgen stream class. Only structures that rate "Good" or "Excellent" in suitability to a particular stream type are listed (Rosgen and Fittante 1994). This list of structures may change when Rosgen stream classifications are refined by field measurements. These structures could function as large woody debris in instances and thus address the problem of low levels in certain areas.

Table 50. Suggested Structures for Improvement of Channel Condition and Aquatic Habitat

Stream	Rosgen Stream Class*	Suggested Structures**
Long Prairie Creek	F4-F6	bank placed boulder bank placed root wads vortex rock weir submerged shelter
Hayden Creek	G4-G6	bank placed boulder vortex rock weir bank placed root wads
	B3 and B4	low stage check dams medium stage check dams random boulder placement bank placed boulder single wing deflector double wing deflector channel constrictor bank cover submerged shelter vortex rock weir "W" shaped weir bank placed root wads rock or log spurs

*Subclasses are estimated.
**See Rosgen and Fittante (1994) for descriptions of these structures.

Management Considerations

High Priority

Implement livestock grazing management to reach desired utilization levels in riparian-wetland areas (see Livestock Grazing Issue and Wild Horse Issue for specifics).

Establish Transportation Management Objectives for roads in the TPLA area to reduce open and total road densities and to determine appropriate surfacing and maintenance for roads.

Fully prescribe and implement all appropriate Best Management Practices on BLM-administered lands (See Appendix D in the Klamath Falls Resource Management Plan).

Continue the Pokegama Cooperative Road Closure. This restricts wet-season use of unsurfaced roads.

Information and Monitoring Needs

High Priority

Conduct stream inventory surveys on Hayden Creek, Long Prairie Creek, Edge Creek, and important intermittent tributaries in the TPLA area. Refine Rosgen stream classifications for Hayden Creek and Long Prairie Creek by establishment of reference reaches and taking field measurements (channel cross section, Wolman pebble count, gradient, etc.).

Determine the classification of streams on BLM-administered lands (perennial, intermittent or ephemeral) and store this information in GIS.

Monitor water quality to determine whether water quality standards are being met and beneficial uses are being supported. Collect data on temperature and dissolved oxygen (particularly during the low flow season) using continuous recording devices and/or sampling during pre-dawn hours for dissolved oxygen. "Spot check" turbidity, pH, conductivity and nutrients (phosphorus and nitrogen).

Conduct additional macroinvertebrate sampling of Hayden Creek and Long Prairie Creek to establish baseline conditions. Three samples per year for three years at each sample site is recommended.

Determine road densities on BLM-administered land. Add areas of high road density to Map ___ which shows high road impact areas.

Classify ISAT data to determine current canopy closure levels for all ownerships. Determine assumed historic/sustainable canopy closures for all forest vegetation types. Recalculate ECA levels based on ISAT-based canopy closure data. Interpret current ECA levels in light of historic and sustainable canopy closures and current stream and watershed conditions.

Implement the recommendations for monitoring and information needs from the Livestock Grazing issue and the Wild Horse Issue.

Moderate Priority

Assess functioning condition of wetlands greater than one acre on BLM-administered land.

Collect peak flow measurements and determine bankfull channel dimensions for Hayden Creek and Long Prairie Creek. Use data from the Klamath Basin Adjudication Team to refine bankfull flow estimates for these streams.

Lotic Riparian Areas

Problem Statement

Riparian areas associated with streams have been negatively impacted by resource management activities within the TPLA area.

Restoration Opportunities

High Priority

The drainage crossing below the Dixie Exclosure has a high priority for repair. This is further addressed under the Road Rehabilitation portion of the section.

The restoration opportunities from the Hydrology, Stream Channel, Aquatic Resources, and Water Quality sections which address stream and riparian habitat should be implemented.

Management Considerations

High Priority

The Livestock Grazing and Wild Horse sections address reductions in wild horse and livestock numbers to benefit riparian vegetation and habitiat. These reductions should be implemented to improve the condition of the affected streams.

Information and Monitoring Needs

High Priority

Very little stream survey work, other than the PFC determinations, has been done on the perennial and intermittent streams in the TPLA area. In order to properly assess the riparian conditions and develop measurable and achievable objectives for these areas, a detailed survey needs to be completed. For 1996, plans are to begin a more intensive inventory of the streams within the KFRA. This will include some of the major streams in the TPLA area. If practical and economically feasible, these surveys should also look at conditions on private lands to correctly assess the problems and opportunities that exist on the entire watershed of a stream.

Complete the Proper Functioning Condition surveys on the perennial and intermittent streams in the TPLA area. This will provide a general inventory of the streams that will not be included in the more intensive inventory planned for 1996.

Moderate Priority

When the stream inventory and surveys are completed, measurable and achievable objectives should be developed for the riparian areas by an interdisciplinary group.

Aquatic Species and Habitats

Problem Statement

Aquatic species and habitats have been impacted by management activities in the landscape area.

Restoration Opportunities

High/Moderate Priority

Klamath River Canyon

Riparian protection. Construct enclosure fences around any spring sites that would otherwise be susceptible to overgrazing or ORV pressure. This is required under survey and manage guidelines for known sites of survey and manage species in management strategy category 2, including aquatic snails. There are three known survey and manage sites on Federal land present in the Klamath River Canyon.

Increase protection of riverbank areas that receive concentrated recreational boating and related foot and vehicle traffic. Provide bank erosion protection (logs or rocks and tree planting) to redirect traffic to areas with improved or low impact river access. Develop access points that have designated launch areas that include erosion protection such as surfaced (gravel or mulch) trails and launch points and designated parking areas.

Limit ORV activity in the Klamath River Canyon to protect sensitive soil sites, riparian areas, and known or potential western pond turtle nesting or overwintering sites. This will require the closure and obliteration of unnecessary roads, restrictive signing, and placement of structures to prevent or discourage off-road vehicle activity.

Improve a segment of Topsy road in section 9 (T41S, R6E) which enters a wet meadow. This road segment becomes nearly impassable during wet conditions and consequently alternative routes through an open meadow are taken. This causes soil compaction, soil erosion, and degraded riparian meadow conditions. Restoration would include adding fill to increase road grade and adding crushed rock surfacing material. Alternative routes could be blocked with rocks, logs, or ditches. Meadow areas impacted by off-road activity could be tilled with a winged subsoiler and possibly re-seeded with a native meadow mix.

Limit cattle grazing utilization to levels which encourage the reestablishment of native riparian and upland plant species over exotic or noxious weed species (see noxious weed recommendations).

Western pond turtles. Place large logs (hazard trees are a potential source) in slow water areas known to be important western pond turtle aquatic habitat (Bury, unpbl 1994). Logs could be anchored to shore where they would be partially submerged to provide basking and escape cover from boaters and predators. This includes two areas in the six mile reach below Boyle Dam (see map __) and potentially portions of Copco and Boyle reservoirs. Because of the upstream dams and past harvest activity, these areas may have less instream logs than were present historically.

Tributary watersheds

Aquatic species communities would achieve the greatest benefit from the reestablishment of perennial flow regimes where they have been lost due to channel degradation and associated loss of riparian area water storage capacity (see channel condition assessment). The re-inundation of the historic floodplain will also result in achieving the desired plant communities which provide the structure and energy resources for high quality aquatic habitat. This will naturally lead to cooler water temperatures as streamside shading increases and incident solar radiation is reduced due to increased summer flow and reduced channel width. Channel restoration can be achieved by reducing the impacts of grazing (horse, cattle and elk) and adding structures to capture sediment and reverse erosion processes. See the channel condition assessment and channel restoration opportunities for detailed information on possible structure options and appropriate structures for different channel types.

Management Considerations

High/Moderate Priority

Klamath River Canyon

Promote the Klamath River Canyon (reach from Boyle power house to caldera rapids) as a wildlife viewing area to commercial river outfitters, private boating associations, and private boaters. Provide interpretive information at launch sites and distribute information about wildlife and aquatic species concerns (bats, western pond turtles, rattle snakes, amphibians etc) at outfitter meetings or other appropriate forums. These efforts may help reduce disturbance levels and foster a greater appreciation and awareness of wildlife and aquatic species values (Bury unpbl 1994).

Tributary watersheds

See the recommendations in the Hydrology, Water Quality, Channel Condition, and Lentic Riparian section.

Information and Monitoring Needs

HighModerate Priority

Klamath River Canyon

Assist and support efforts to establish population reference reaches to monitor aquatic populations of special status species. Encourage and support repeating research and inventories that have been done in the past to monitor changes in distributions and habitat. These include repeating herpetological surveys as conducted by ODFW (St John 1987), turtle population studies (BLM, unpbl 1993; Bury 1994), and fish population studies, (Fortune et al 1966;Buchanan et al 1990;1991;Pacificorp 1992; Buettner and Scoppettone 1991).

Tributary watersheds

Conduct inventories in key habitat areas for special status invertebrates including survey and manage molluscs and sensitive, threatened or endangered insects.

Conduct comprehensive stream habitat surveys in streams that contain fish and other aquatic species of concern.

Livestock Grazing

Problem Statement

Livestock grazing on public lands within the TPLA area can be detrimental to some resources if not managed properly. Riparian and wetland areas within the Dixie and Edge Creek allotments have been negatively impacted by improper levels and timing of utilization of forage species and the physical impact of livestock on the vegetation and soils. Some upland areas have also been impacted by the improper utilization of forage species.

Restoration Opportunities

High Priority

Dixie Allotment

Reconstruct and expand the existing exclosure area around Wild Gal Spring. The current fence is in need of replacement due to age. An additional area of wetland and wet meadow should be included in the exclosure. This area has received heavy use in the past from livestock and wild horses.

The spring development and exclosure in T40S, R5E, Section 31, SE1/4, SE1/4 should be rebuilt to exclude livestock.

Edge Creek Allotment

Exclosure areas including Fox Lake, Bear Flat Reservoir, and Hayden Creek should be inspected and repaired as needed before turning out livestock.

The pasture fences around Edge Creek and Ward pastures should be maintained prior to livestock turnout to control drift.

The following items from the Pacificorp grazing plan should be implemented:

Rebuilding of the Hoover meadow fence. This will help control the drift of livestock onto BLM-administered lands outside of the authorized season of use.

Coordinating with the BLM on construction of the Rock Creek fence. This fence will control drift of livestock into the Frain Ranch area which has been an area of chronic unauthorized use.

Moderate Priority

In addition to the Pacificorp plan, the following items should be implemented in the Ward pasture to provide for additional resource protection:

Installation of several small sections of drift fence along the upper rim of the Klamath River canyon. This will help stop the drift of livestock from the upper Ward pasture into the canyon. This would allow for use of a rotation system between these two areas that would provide for periods of rest from livestock grazing.

Construction of a small reservoir in the east part of the upper Ward pasture. This would spread the livestock use to the east end of this pasture where there currently is no water source and very little utilization of a seeded wheatgrass area. This would help to decrease the use in the west end of this pasture which has shown levels of use higher than the accepted guidelines.

Management Considerations

High Priority

Dixie Allotment

A decision has been approved to remove a portion of the wild horse herd beginning in 1996. This removal should result in a reduction in the level of forage utilization in the Dixie allotment. In addition to the removal of a portion of the wild horse herd, changes in the livestock grazing system, authorized numbers, and/or season of use should be considered. Changes in grazing use are normally based on three years of monitoring data. If monitoring in 1996 continues to show utilization levels that are higher than the guidelines for riparian areas and uplands, then sufficient data would exist to support a decision to make changes in the authorized grazing.

To achieve the utilization standards and meet the management objectives for this allotment, different combinations of management changes and livestock reductions could be implemented. To meet the 30 percent utilization standard for the riparian areas, a reduced level of AUMS along with a change in the season of use is recommended. The current season of use of 5/1 to 9/15 has resulted in overuse in the riparian areas. This is partly due to the drying and curing of the upland forage that takes place during the summer months which results in the livestock concentrating in the riparian areas where the vegetation remains in a more palatable condition for a longer period. Changing the end date from 9/15 to 8/15 would allow for use by approximately 50 pair of cattle (177 AUMs) during this period assuming they would not be concentrating on the riparian areas with the earlier end date.

Another option would be to base the AUM levels on the upland standard of 50 percent and to fence off the riparian areas. To get to the 326 AUM level, the current 91 pairs could be grazed with a season of use from 5/1 to 8/15. Or the current season of use of 5/1 to 9/15 could be used with a reduction in livestock numbers to 71 pairs. The disadvantage to this approach would be that by fencing off the riparian areas on the BLM-administered lands then the cattle would likely concentrate more on the private land portions of Long Prairie Creek.

Monitoring of the use following the changes would then be done to determine if additional adjustments were necessary. A reevaluation of the allotment would be done at the end of three years.

Edge Creek Allotment

Edge Creek and North pastures

Recent changes in grazing management have been made, mainly due to the private land lease cancellations leading to no grazing use in the Edge Creek and North pastures. Weyco owns the lands which are currently considered the base property for these areas of the allotment. If Weyco decides to lease their lands for grazing again, the Exchange of Use grazing previously allowed for in the BLM lease should be reevaluated based upon the desired objectives for the allotment. The following items should be considered when formulating the objectives and the grazing system for these pastures:

> Utilization pattern mapping has shown heavy use in riparian areas and meadows. Follow the guidelines for forage use from **Table D-7., Utilization Standards in Riparian-Wetland Areas** and **Table D-8., Degree of Allowable Use** in the KFRA ARMP/ROD document.
>
> The allotment is within the Pokegama Deer Winter Range. Consider the recommendations of the Pokegama working group and resource area wildlife biologists.

Ward Pasture
Pacificorp will implement a new grazing management system for their lands along the Klamath River in Oregon and California beginning in 1996. The Ward pasture has been included in this system due to the intermingled land ownership patterns in this area. The Ward pasture would have a season of use from 5/15 to 7/15 with 60 cows for a total of 120 AUMs. This is different than the KFRA ARMP/ROD document which has a use period from 5/1 to 7/1. This should not cause any resource problems as the AUMs are the same. Monitoring of the use in riparian areas would be needed to insure that guidelines for forage use levels would not be exceeded.

Moderate Priority
Specific, measurable desired plant community objectives need to be developed for the Edge Creek and Dixie allotments. These objectives should be based upon Ecological Site Inventory data and developed by a team of resource specialists and others familiar with the allotment area and the needs of the dependent resources within the allotment. These objectives should include considerations for the multiple use nature of the allotment area and the intermingled private lands. The objectives should consider the different geographic areas including riparian and wetland sites, meadow habitats, forested areas, and rocky upland sites.

Information and Monitoring Needs
High Priority
Dixie Allotment
Additional riparian utilization points should be established along Long Prairie Creek, one above the Dixie exclosure and one below. There are currently riparian photo points at these locations which could also serve as utilization points. An additional point could also be placed on the private land portion of Long Prairie Creek, with permission, to provide a better picture of the riparian use in the allotment area. A point should also be established at Wild Gal Spring.

Annual utilization pattern mapping should continue on the allotment. When used in conjunction with utilization points, a good overall picture of the grazing use can be determined and potential problem areas can be detected.

Monitoring of livestock movement during the season of use through use supervision should also be continued. This is normally done by range personnel from the BLM. Other resource specialists that spend time in this area have also provided good information on livestock movements and this should be continued and encouraged.

A system to monitor wild horse use should be developed. The southern portion of the Dixie allotment has been a historic winter use area for the Pokegama herd.

Continue the Cole Browse studies for a few more years. At this point it is evident that livestock are not making significant use of the wildlife browse species. If the livestock grazing systems are adjusted as recommended, this minimal use should continue.

Edge Creek Allotment
The utilization monitoring points that have been established in the Ward pasture provide sufficient coverage to assess the annual livestock use. The eight points within the canyon portion of the pasture have only been read once, in 1992, and need to be read yearly along with the points in the upper pasture.

If the Edge Creek and North pastures are used again, utilization points need to be established to properly monitor the use there. These could be established in conjunction with the permission of the private landowners in these pastures. By putting some points on the private land, a better picture of the utilization on a watershed scale could be realized.

Utilization mapping should be continued on the allotment. This will be essential in determining whether the new

Pacificorp plan is providing adequate resource protection.

Monitoring of livestock movement during the season of use through use supervision should also be continued. This is normally done by range personnel from the BLM. Other resource specialists that spend time in this area have also provided good information on livestock movements and this should be continued and encouraged.

Moderate Priority

As mentioned earlier, objectives for the allotment areas should be based upon Ecological Site Inventory data. At this point, a formal ESI inventory will probably not be completed in the KFRA and the inventory has been done only on rangelands of the eastern Oregon type (not in coniferous forests). Some Ecological Site Inventory descriptions are available for land types in the KFRA. They do not match the landscape areas within the TPLA area precisely, but could be used with some professional judgement applied. Range Condition sites should be established at several sites within the Dixie and Edge Creek allotment. The current plant community data from these inventories could then be used to establish reasonable management objectives for the areas based upon the existing conditions and the use of professional judgement to help determine the ecological potentials. Selection of the sites for these studies should be done by an interdisciplinary team that is familiar with the landscape and the concepts of ecological site inventory. At a minimum, sites should be established in the vicinity of the Dixie exclosure, in the upper Ward pasture, the Klamath River canyon portion of the Ward pasture, the Edge Creek pasture, and the North pasture.

Wildhorses

Problem Statement

A formally established wildhorse herd management area exists and the horse herd is creating impacts within the landscape area.

Restoration Opportunities

High Priority

Remove sufficient wild horses from the HMA to get the numbers to as close to the 30 head minimum AML as possible. This action is being pursued and scheduled for completion within the next two years. This action is addressed and authorized by EA #OR-010-95-10 and the related Decision Record. Emphasis will be given to specifically removing those horses which have been drifting north of the formal HMA boundaries to remove that "racial memory" from the herd. Once achieved, the Pokegama herd will not need additional removals for many years, given the historically slow growth rates.

Moderate Priority

Maintain the existing BLM riparian protective fencing and pursue additional protective fencing as feasible. Most the important riparian areas on BLM lands are already fenced to preclude livestock and wild horse use. Maintenance of these existing fences is important and must be done in the spring of each year. Additional fencing around the currently unfenced BLM portions of Long Prairie creek, the meadow around Wild Gal spring, and possibly other areas, should be investigated.

Low Priority

No specific herd make-up or composition related management changes or alterations are proposed at this time. Since the herd, as is, is apparently happy and healthy, no animal related management recommendations are proposed at this time besides the removal of excess animals.

Prescribed burning will continue to be pursued within the HMA. There is currently a program to periodically burn decadent brush stands and excess fuel loads in the area for wildlife habitat and fire danger reduction purposes, respectively. The currently planned level of prescribed burning is sufficient to meet the wild horse HMAP objectives in that regard.

Management Considerations

The following are the "Management Actions/Directions" quoted from the Klamath Falls R.A. ROD/RMP/RPS (USDI-BLM, 1995a). These actions range from the general to specific and provide an overriding planning framework for the additional management recommendations that are outlined next (priorities added):

High Priority

The range land monitoring studies outlined in the Livestock Grazing section and explained in Appendix H, Range Land monitoring and Evaluation Section, will be used to collect information on the vegetation/riparian affects of grazing, including wild horses, and to determine if the objectives for wild horse management are being met or not.

Base future adjustments in the appropriate management level on an evaluation of range land monitoring data (this process is also summarized in Appendix H). If the evaluation(s) show that wild horse numbers are exceeding the forage carrying capacity within their range, are responsible for unacceptable damage to soils or riparian-wetland areas, or become a management problem to the private land owners in the area, initiate control measures to return the horse numbers to the appropriate management level determined through those evaluations.

Apply the management actions/direction in the Special Status and Supplemental Environmental Impact Statement Special Attention Species section."

Moderate Priority

Revise and update the 1978 Pokegama Herd Management Area Plan based on current information, conditions, and herd management area plan standards.

Make aerial reconnaissance flights and/or ground survey of the herd management area every two to three years to census the wild horse numbers.

Low Priority

Establish areas with mineral and salt licks away from streams, riparian-wetland areas, and wildlife guzzlers.

Information and Monitoring Needs

High Priority

Monitoring and future evaluations will be performed in accordance with the Klamath Falls Resource Area's Coordinated Monitoring and Evaluation Plan for Grazing Allotments, which also pertains to wild horse related vegetation monitoring. The wild horses will be periodically counted as noted in the Klamath Falls R.A. RMP/ROD "Management Actions/Directions" above.

Cultural Resources

Problem Statement

Cultural resources exist and are being impacted in the landscape area.

Restoration Opportunities

High Priority

Oral tradition of the Shasta Nation tells of a detachment of calvary scouts recruited by the Union Army during the War Between the States (Civil War). The Shasta Scout unit lost several men killed in combat with the Confederate Army. After these battles the detachment leader, a Shasta Tribe member named "Big Mike", would ceremonially cremate their dead. The cremains were placed in leather bags and sent to Jefferson Barracks, Missouri, where they were stored. After the war, Big Mike and his wife traveled to Jefferson Barracks to recover the cremains of his fallen warriors. The Army issued a pack horse to Big mike and he traveled back to the Shasta homeland to properly bury these men.

The burial site is located within the TPLA, on private land, and the location is known to the BLM.

The BLM contact the United States Army, and the War Memorial and Monuments Commission, and recommend they acquire the cemetery land and make it a Shasta National Cemetery. The men buried there are Veterans of the Civil War, killed in combat, and should be honored appropriately.

BLM has been told the Shasta Nation is concerned that if the burial site is known, vandals will attack it. BLM is under the impression that National Cemeteries are supervised by full time care takers, usually veterans. We would suggest this cemetery be supervised veterans who are members of the Shasta Nation.

Cemeteries are not normally eligible for listing on the NRHP.

Cattle and wild horse grazing along the California State Line have adversely impacted cultural sites within the TPLA, usually along streams and adjacent to springs.

Develop plans to mitigate the damage done by animals in these areas, enlisting the cooperation of ranchers who hold grazing permits. Reduce the size of the wild horse herd to lessen their impact on these sites. Institute fencing and trough projects to draw the animals away from the sensitive areas.

The Klamath River is subject to high and low water flows due to release of water from electricity generating facilities. This stream flow fluctuation causes bank erosion and subsequently adversely impacts cultural sites.

Enlist the cooperation of PacifiCor to notify BLM when unusually large releases of water are to be made. PacifiCor and BLM cooperatively monitor river banks after large releases to ensure that cultural sites are not damaged, and to stabilize any site damage that has occurred.

Management Considerations

High Priority

The Klamath River Canyon has an extremely high number of cultural sites. Many of these sites are regularly vandalized by looters.

Increase law enforcement patrols of the Klamath River Canyon, and increase apprehension and prosecution of looters under the Archaeological Resources Protection Act (ARPA).

Close roads that lead to or through, cultural sites where the road is not necessary to known transportation and project needs. This action will help stabilize and protect cultural resources from further depredation.

Information and Monitoring Needs

High Priority

Continue archaeological monitoring of cultural sites and continue survey to identify and evaluate previously unknown sites in accordance with the National Historic Preservation Act.

Recreation

Problem Statement

When andwhere use of a developed recreation site or popular area exceeds its capacity, the potential exists for user conflicts, poor quality of visitor experience, or resource degradation to occur. When dispersed recreation use of an area is light, management is faced with the difficult task of providing adequate visitor services and resource protection while minimizing the amount of disturbance and modification to the appearance of an area. As local populations increase, and interest in various recreation activities increases, there is a need for managing agencies to continue to provide diverse recreational opportunities while minimizing impacts to other resources.

Restoration Opportunities

None identified.

Management Considerations

High Priority

Continue to implement the road closure on the west side of the Klamath river between the Upper Klamath river campground and the Frain ranch area. Consider designating this route as a non-motorized use trail and lengthen it upstream to the BLM Spring Island raft launch site.

Pursue the acquisition of the private land which is part of the Stateline recreation area. Do the neccesary planning and NEPA clearances to provide minimum develpment of the site in order to safely and adequately accomodate existing levels of recreational use.

For winter sports use of Hamaker mountain area, consider the following actions;

Coordinate with the FAA, PP&L, and other inerested/affected parties to decide on a set of desired future conditions for winter recreation on Hamaker mountain.

Design and implement forest management activities to enhance winter sports recreation opportunities in this area. This could include thinning activities to improve downhill skiing, roads and skid trails to be designated for cross country skiing, and clearings for sledding and parking.

Provide improved parking, a portable toilet, and an area for picnicing and building campfires. All of these developments should occur at a level that will accomodate existing use levels and allow for some increase in use.

Develop some form of land management plan for the Klamath river canyon. Continue to coordinate with Oregon Parks and Recreation Department to determine management responsibilities and how to proceed with the planning process.

Assist and coordinate with PP&L in developing Copco Access #1 to improve river access for whitewater boating.

Moderate Priority

Do road maintenance and improvement to BLM administered portions of the Topsy road to the extent necessary to provide all season use, and prevent further widening of the road. Until appropriate use levels for this area are determined, the road standard should not be upgraded, that is it should be maintained as a high clearance vehicle, low maintenance road.

Further development of the Hamaker mountain area for winter sports use, developments may include a warming hut, groomed cross country ski trails, and ice skating facilities.

Information and Monitoring Needs

High Priority

Develop and implement a method to monitor winter sports use of the Hamaker mountain area. This could be accomplished with BLM/volunteer patrols, a visitor registration box, or by using a highway traffic counter.

Undertake a feasibility study to determine the desirable level of facility development on Hamaker.

Develop and implement a study to determine carrying capacity or "limits of accepatable change" for recreational use, particularly whitewater boating, of the Klamath river canyon.

Biological Diversity

Problem Statement

The distribution of stand structures across the landscape has been altered with a current disproportionately high number of early-successional forest stands and a disproportionately low number of late-successional forest stands.

Restoration Opportunities

High Priority

Manage for a balance of stand structures (specifically, more late-successional forest) across the landscape.

Target stem-exclusion stands over late-successional (i.e., understory-reinitiation and old-growth) stands for timber harvest activities.

Biological diversity across the landscape has been altered because of human-introduced disturbance.

Management Considerations

High Priority

Link biodiversity concerns to landscape pattern and structures (for example, source-sink areas and connectivity corridors). Maintain connections between population source areas (such as LSRs and DDRs) for genetic recombinations among breeding populations of species such as northern spotted owls and northern goshawks to occur. Maintain connectivity between source and sink areas for dispersal of juveniles and adults.

Information and Monitoring Needs

None identified.

Chapter 4

Preparer's List

Kristin Bail	BLM/Hydrologist
Dana Eckard	BLM/Range Conservationist
Andy Hamilton	BLM/Fisheries Biologist
David Lebo	USFS-BLM/Ecologist
Bill Lindsey	BLM/Range Conservatinist
Barb Masinton	USFWS/Biologist
Monica Miller	BLM/Wildlife Biologist
Jim Regan-Vienop	BLM/Writer-Editor
Grant Weidenbach	BLM/Recreation Specialist
Lou Whiteaker	BLM/Botanist
Bill Yehle	BLM/Archaeologist

Bibliography

Agee, J.K. 1993. Fire Ecology of Pacific Northwest Forests. Washington, D.C. Island Press.

Agee, J.K. 1996. University of Washington. Personal Communication with David Lebo.

Alexander, M. 1974. Introduction to Soil Microbiology. John Wiley: New York. pp. 467.

Amaranthus, M.P., D.S. Parrish, and D.A. Perry. 1989. Decaying Logs as Moisture Reservoirs After Drought and Wildfire. pp 191-194. In: Proceedings of Watershed '89: A Conference on the Stewardship of Soil, Air, and Water Resources. March 21-23. (ed.) Alexander, E.B. USDA Forest Service, Alaska Region, Juneau, AK.

Amaranthus, M.P., J.M. Trappe, and R.J. Molina. 1989. Long-Term Forest Productivity and the Living Soil. Maintaining the Long-Term Productivity of Pacific Northwest Forest Ecosystems. D.A. Perry et al., eds. Timber Press, Portland, Oregon.

Andreasen, J. K. 1975. Occurrence of the Fathead Minnow, *Pimephales promelas*, in Oregon. California Fish and Game 61: 155-156.

Anthony, R.G., R.L. Knight, G.T. Allen, B.R. McClelland, and J.I. Hodges. 1982. Habitat Use by Nesting and Roosting Bald Eagles in the Pacific Northwest. Trans. North Am. Wildl. and Nat. Resour. Conf. 47:332-342.

Baker, M.B. Jr. 1988. Selection of Silvicultural Systems for Water. Symposium Proceedings: Ponderosa Pine-The Species and Its Management; September 29-Octover 1, 1987; Spokane, Washington. Baumbartner and Lotan, eds.

Baker, M.B. Jr. and R.L. Jemison. 1991. Soil Loss-Key to Understanding Site Productivity. Agencies and Science Working for the Future. New Mexico Water Resources Research Institute.

Ballard, R. 1978. Effect of Slash and Soil Removal on the Productivity of Second-rotation Radiata Pine on a Pumice Soil. New Zealand Journal of Forestry Science 8:252-260.

Ballard, R. 1979. Use of Fertilizers to Maintain Productivity of Intensively Managed Forest Plantations. pp 321-342. In: Proceedings: Impact of Intense Harvesting on Forest Nutrient Cycling. 1979 August 13-16, Syracuse, New York. Syracuse, NY: State University of New York, College of Environmental Science and Forestry.

Barbour, R.W., W.H. Davis. 1969. Bats of America. Lexington, KY: University of Kentucky Press.

Barrows, C.W. 1981. Summer Roost Selection by Spotted Owls: An Adaptation to Heat Stress. Condor 83:302-309.

Beak Consultants Inc. 1996. 1995 Northern Spotted Owl Survey Report - Weyerhaeuser Company - Klamath Tree Farm. Beak Consultants Incorporated, Sacramento, CA. January 31, 1996. 48 pp.

Belnap, J. 1993. Recovery Rates of Cryptobiotic Crusts: Inoculant Use and Assessment Methods. Great Basin Naturalist 53(1):89-95.

Belnap, J. and J.S. Gardner. 1993. Soil Microstructure in Soils of the Colorado Plateau: The Role of the Cyanobacterium *Microcoleus vaginatus*. Great Basin Naturalist 53(1):40-47.

Belsky, A.J. and D.M. Blumenthal. 1995. Effects of Livestock Grazing on Upland Forests, Stand Dynamics, and Soils of the Interior West: Livestock and the "Forest Health" Crisis. Oregon Natural Resources Council report.

Beschta, R., R. E. Bilby, G. W. Brown, L. B. Holtby, and T. D. Hofstra. 1987. Stream Temperature and Aquatic Habitat: Fisheries and Forestry Interactions. pp 191-232. In: Streamside Management; Forestry and Fishery Interactions, E. O. Salo and T. W. Cundy eds. 1987. University of Washington, Institute of Forest Resources, Contribution No. 57. 467 pp.

Binckley, D. 1991. Connecting Soils with Forest Productivity. In: Proceedings--Management and Productivity of Western Montane Forest Soils. USDA Forest Service. Intermountain Research Station. General Technical Report INT-280.

Bjornn, T. C. and D. W. Reiser. 1991. Habitat Requirements of Salmonids in Streams. pp 83-138. In: Influences of Forest and Rangeland Management Salmonid Fishes and Their Habitats. W. R. Meehan editor. American Fisheries Society Special Publication 19, Methesda, MD 1991. 751 pp.

Blair, G.S. 1993. Species Conservation Plan for the White-headed Woodpecker (*Picoides albolarvatus*). (Final draft). USDA Forest Service and Idaho Dept. of Fish and Game.

BLM - See U.S. Department of the Interior, Bureau of Land Management.

Bork, J. 1985. Fire History in Three Vegetation Types on the East Side of the Oregon Cascades. Ph.D. dissertation, Oregon State University, Corvallis.

Bormann, F.H., G.E. Likens, and J.M. Melillo. 1977. Nitrogen Budget for an Aggrading Northern Hardwood Forest Ecosystem. Science (Washington, D.C.) 196:981-983.

Bormann, B.T., F.H. Bormann, W.B. Bowden et al. 1993. Rapid N2 Fixation in Pines, Alder, and Locust: Evidence from the Sandbox Ecosystem Study. Ecology 74:583-598.

Brix, R.D. 1993. The Role of Soil in Forest Productivity and Health. Proceedings of the 1993 Society of American Foresters National Convention, Indianapolis, IN, November 7-10, 1993.

Brock, Richard. 1988. *Calochortus greenei*: Habitat and Threat Analysis. Unpublished research report. 19 pp.

Bryan, T. and E.D. Forsman. 1987. Distribution, Abundance, and Habitat of Great Gray Owls in Southcentral Oregon. The Murrelet, 68:45-49.

Buchanan, D.V., A.R. Hemmingsen, D.L. Bottom, R.A. French. K.P. Currens. 1990. Annual Progress Report, Fish Research Project F-136-R. Oregon Department of Fish and Wildlife, Portland Oregon.

Buettner, M. E. and G. G. Scoppettone. 1991. Distribution and Information on the Taxonomic Status of the Shortnose Sucker (*Chasmistes brevirostris*) and Lost River Sucker (*Deltistes luxatus*) in the Klamath River Basin, California. Seattle National Fishery Research Center. Reno Substation, Reno Nevada.

Bull, E.L. and M.G. Henjum. 1990. Ecology of the Great Gray Owl. Gen. Tech. Rep. PNW-GTR-265. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 39 pp.

Bull, E.L., S.R. Peterson, and J.W. Thomas. 1986. Resource Partitioning Among Woodpeckers in Northeastern Oregon. USDA Forest Service Research Note. PNW-444.

Bureau of Land Management - See U.S. Department of the Interior, Bureau of Land Management.

Burroughs, E.R. Jr., M.A. Marsden, and H.F. Haupt. 1972. Volume of Snowmelt Intercepted by Logging Roads. Journal of the Irrigation and Drainage Division. Proceedings of the American Society of Civil Engineers. Vol. 98, No. IR1.

Bury, R. B. 1994. Draft Report: Status and Ecology of the Western Pond Turtle in the Upper Klamath River, Oregon. National Biological Service, USDI, Corvallis, OR.

Carey, A.B., L.L.C. Jones, B.L. Biswell, and J.A. Reid. 1986. The Ecology of Spotted Owls and Their Prey in the Coast Range. pp. 16-18. In: FY 1986 Annual Report, Forestry Science Lab, U.S. Forest Service, No. "4050 Research".

Carlston, C.W. 1963. Drainage Density and Streamflow. U.S. Geological Survey Professional Paper 422-C. Physiographic and Hydraulic Studies of Rivers. United States Government Printing Office, Washington.

Carothers, S.W., R.R. Johnson, and S.W. Aitchison. 1974. Population Structure and Social Organization of Southwestern

Riparian Birds. American Zoologist 14:97-108.

Chapel, M., A. Carlson, D. Craig, T. Flaherty, C. Marshall, M. Reynolds, D. Pratt, L. Pyshora, S. Tanguay, and W. Thompson. 1992. Recommendations for Managing Late-seral-stage Forest and Riparian Habitats on the Tahoe National Forest. U.S. Department of Agriculture, Forest Service, Tahoe National Forest. Unpublished Report. 31 pp.

Chapin, D.M. and C.S. Bledsoe. 1992. Nitrogen Fixation in Arctic Plant Communities. pp 300-319. In: Arctic Ecosystems in a Changing Climate. F. Stuart Chapin III et al. (eds.) Academic Press: San Diego.

Childs, S.W., S.P. Shade, D.W.R. Miles, E. Shepard, and H. A. Froehlich. 1989. Soil Physical Properties: Importance to Long-Term Forest Productivity. Maintaining the Long-Term Productivity of Pacific Northwest Forest Ecosystems. D.A. Perry et al., eds. Timber Press, Portland, Oregon.

City of Klamath Falls. 1986. Application for License, Salt Caves Hydroelectric Project. Submitted to the Federal Energy Regulatory Commission. Volume II, Exhibit E.

City of Klamath Falls. 1989. Application for License, Salt Caves Hydroelectric Project. Response to License Additional Information Requests Dated January 25, 1989. Submitted to the Federal Energy Regulatory Commission.

Cochran, P. 1979. Response of Thinned Ponderosa Pine to Fertilization. Res. Note PNW-339. Portland, OR: USDA Forest Service, Pacific Northwest Research Station, 8 p.

Cochran, P.H. 1992. Stocking Levels and Underlying Assumptions for Uneven-aged Ponderosa Pine Stands. USDA Forest Service, PNW, Research Note, PNW-RN-509.

Covington, W.W. and M.M. Moore. 1994. South Western Ponderosa Forest Structure. Journal of Forestry 92:39-47.

Covington, W.W., R.L. Everett, R.W. Steele, L.L. Irwin, T.A. Daer, and A.N.D. Auclair. 1993. In: Assessing Forest Ecosystem Health in the Inland West. R.N. Sampson and D.L. Adams (eds.). Proceedings of the American Forests Scientific Workshop, Nov. 15-19, 1993. Sun Valley, ID.

Cross, Stephen P. 1977. A Survey of Bat Populations and Their Habitat Preferences in Southern Oregon. Southern Oregon State College, Ashland, Oregon.

Cross, Stephen, and A.E. Kerwin. 1995. Survey of Bats and Their Habitats in the Winema National Forest and Lakview District BLM. Southern Oregon State College. 45pp.

Cross, S. P. and D. L. Waldien. 1994. Continued Study of Townsend's Big-eared Bats at Salt Caves and Klamath River Canyon, Klamath County, Oregon, 1993. Final Rep. Lakeview Dist. BLM. 23pp.

Daubenmire, R. 1952. Forest Vegetation of Northern Idaho and Adjacent Washington, and its Bearing on Concepts of Vegetation Classification. Ecol. Monog. 22:301-329.

Daubenmire, R. 1968. Plant Communities: A Textbook of Plant Synecology. Harper and Row: New York.

Daubenmire, R. and J.B. Daubenmire. 1968. Forest Vegetation of Eastern Washington and Northern Idaho. Washington Agricultural Experiment Station, Technical Bulletin 60, pp. 104.

Debano, L.F. 1991. The Effects of Fire on Soil Properties. Symposium Proceedings: Management and Productivity of Western Montane Forest Soils; April 10-12, 1990; Boise, Idaho. General Technical Report INT-280. USDA Forest Service Intermountain Research Station, Ogden, Utah.

DellaSala, D.A., D.M. Olson, S.E. Barth, S.L. Crane, and S.A. Primm. 1995. Forest Health: Moving Beyond Rhetoric to Restore Healthy Landscapes in the Inland Northwest. Wildlife Society Bulletin 23(3):346-356.

DEQ - See Oregon Department of Environmental Quality.

Dunne, J. 1989. Cryptogamic Soil Crusts in Arid Ecosystems. Rangelands 11(4):180-182.

Dunne, T. and L.B. Leopold. 1978. Water in Environmental Planning. W.H. Freeman and Company, New York.

Dunsmoor, L. 1993. Laboratory Studies of Fathead Minnow Predation on Catastomid Larvae. Natural Resources Department, The Klamath Tribes. Unpl. report, 15 pp.

Edge, W. Daniel and C. Les Marcum. 1990. Elk and Cattle on Public Lands: A New Look at An Old Conflict. Western Wildlands. 16(2):12-15.

Eglitis, A. 1995. Assessment of Insect Risk to Forest Stands in the Bear Valley National Wildlife Refuge. Internal Report available at BLM-Klamath Falls Resource Area Office.

Eldridge, D.J. 1993. Cryptogams, Vascualr Plants, and Soil Hydrological Relations: Some Preliminary Results From the Semiarid Woodlands of Eastern Australia. Great Basin Naturalist 53(1):48-58.

Elmore, W., B. L. Kovalchik, 1991. Effects of Cattle Grazing Systems on Willow-Dominated Plant Associations in Central Oregon. In: Symposium on Ecology and Management of Riparian Shrub Communities; May 29-31, 1991; Sun Valley, Idaho: pp. 111-119.

Emmingham, W.H., R. Holthausen, and M. Vomocil. 1992. Silvicultural Systems and Stand Management. pp 123-142. In: H.C. Black, Tech. Ed., Silvicultural Approaches to Animal Damage Management in Pacific Northwest Forests. USDA For. Serv. Gen. Tech. Rept. PNW-GTR-287. 422pp.

Everest, F. H., R. L. Beschta, J. Charles Scrivener, V. Koski, J. R. Sedell, and C. J. Cederholm. 1987. Fine Sediment and Salmonid Production: A paradox pp 98-142. In: Streamside Management; Forestry and Fishery Interactions, E. O. Salo and T. W. Cundy eds. 1987. University of Washington, Institute of Forest Resources, Contribution No. 57. 467 pp.

Fahey, T.J., J.B. Yavitt, J.A. Pearson, and D.H. Knight. 1985. The Nitrogen Cycle in Lodgepole Pine Forests, Southeastern Wyoming. Biogeochemistry 1:257-275.)

Fahey, T.J. 1983. Nutrient Dynamics of Aboveground Detritus in Lodgepole Pine (*Pinus contorta ssp. latifolia*) Ecosystems, Southeastern Wyoming. Ecological Monographs 53(1):51-72.)

Federal Energy Regulatory Commission. 1990. Final Environmental Impact Statement for the Proposed Salt Caves Hydroelectric Project, FERC 10199-0000. Washington D.C.

Fleischner, T.L. 1994. Ecological Costs of Livestock Grazing in Western North America. Conservation Biology 8(3):629-644.

Filip, G.M. and D.J. Goheen. 1982. Tree Mortality Caused by a Root Pathogen Complex on the Deschutes National Forest, Oregon. Plant Disease 66:240-243.

Filip, G.M., C.L. Schmitt, and K.P. Hosman. 1992. Effects of Harvesting Season and Stump Season on Incidence of Annosum Root Disease of True Fir. Western Journal of Applied Forestry 7:54-57.

Fortune, J.D., A.R. Gerlach, and C.J. Hanel. 1966. A Study to Determine the Feasibility of Establishing Salmon and Steelhead in the Upper Klamath Basin. Oregon State Game Commission and Pacific Power and Light Company, Portland, OR.

Forsman, E.D. 1980. Habitat Utilization by Spotted Owls in the West-central Cascades of Oregon. Ph. D. thesis. Oregon State University, Corvallis, OR.

Forsman, E.D., E.C. Meslow, and H.M. Wright. 1984. Distribution and Biology of the Spotted Owl in Oregon. Wildl. Monogr. 87.

Forsman, E.D., C.R. Bruce, M.A. Walter, and E.C. Meslow. 1987. A Current Assessment of the Spotted Owl Population in Oregon. The Murrelet.

Franklin, J.F. 1990. Biological Legacies: A Critical Concept from Mt. St. Helens. Transcripts 55th North American Wildlife and Natural Resources Conference. pp. 216-219.

Franklin, J.F. 1992. Scientific Basis for New Perspectives in Forests and Streams. In: Watershed Management: Balancing Sustainability and Environmental Change. R.J. Naiman (ed.). Springer-Verlag: New York, pp. 25-72.

Frederick, G.P. and T.L. Moore. 1991. Distribution and Habitat of White-headed Woodpeckers (*Picoides albolarvatus*). Boise, ID: Payette National Forest, Idaho Department of Fish and Game. 51pp.

Fredriksen, R.L. 1975. Nitrogen, Phosphorus, and Particulate Matter Budgets of Five Coniferous Forest Ecosystems in the Western Cascades Range, Oregon. Ph.D. thesis, Oregon State University, Corvallis. 127 p.

Frest, T. J. 1994. Mollusc Survey of the Upper Klamath Drainage. Progress Report 1994. Prepared for Oregon Natural Heritage Program. Deixis Consultants, 9 pp.

Frest, T.J. and E. J. Johannes. 1993. Mollusc Species of Special Concern Within the Range of the Northern Spotted Owl. Deixis Consultants 39 pp.

Frest, T.J. and E. J. Johannes. 1995. Mollusc Survey of the Klamath Drainage, Yearly Report. Deixis Consultants 78 pp.

Gessel, S.P., D.W. Cole, and E.C. Steinbrenner. 1973. Nitrogen Balances in Forest Ecosystems of the Pacific Northwest. Soil Biology and Biochemistry 5:19-34.

Gilbert, C. H. 1897. The Fishes of the Klamath Basin. Bull, of the U. S. Fish Comm. pp. 1-13.

Glinski, R.L. 1977. Regeneration and Distribution of Sycamores and Cottonwood Trees along Sonoita Creek, Santa Cruz County, Arizona. pp 166-174. In: R.R. Johnson and D.A. Jones, technical coordinators. Importance, Preservation, and Management of Riparian Habitat: A Symposium. General Technical Report RM-43. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Goheen, D.J. 1992. Forest Pest Management: Forest Insect and Disease Survey for the Klamath Falls Resource Area, Lakeview District, Bureau of Land Management. USDA Forest Service, Pacific Northwest Region.

Goheen, D.J. 1996. Personal Communication with David Lebo.

Goheen, D.J. and G.M. Filip. 1980. Root Pathogen Complexes in Pacific Northwest Forests. Plant Disease 64:793-794.

Gottlieb, Sari. 1993. Habitat Utilization and Population Characteristics of the Pokegama Wild Horse Herd. Unpublished manuscript submitted in fulfillment of requirements for B.S. degree at State University of New York, College at Purchase, May 1993.

Gregory, S. V., G. A. Lamberti, D. C. Erman, K. V. Koski, M. L. Murphy, and J. R. Sedell. 1987. Influence of Forest Practices on Aquatic Production. pp 233-256 In: Streamside Management; Forestry and Fishery Interactions, E. O. Salo and T. W. Cundy eds. 1987. University of Washington, Institute of Forest Resources, Contribution No. 57. 467 pp.

Hafele, R. Letter to BLM, Attn: Ron Hicks, dated May 5, 1989.

Hall, F.C., L. Bryant, R. Clausnitzer, K. Geier-Hayes, R. Keane, J. Kertis, A. Shlisky, and R. Steele. 1995. Definitions and Codes for Seral Status and Structure of Vegetation. USDA Forest Service, PNW-GTR-363.

Hamilton, A. 1996. Personal Communication with Monica Miller on April 23, 1996.

Hanel, J. and A. Gerlach. 1964. Klamath River Flow Study at J. C. Boyle Project. Pacific Power and Light Company, Portland, Oregon. Unpbl. report.

Harmon, M. E., J.F. Franklin, F.J. Swanson, P. Sollins, S.V. Gregory, J.D. Lattin, N.H. Anderson, S.P. and N.G. Cline, J.R. Sedell, G.W. Lienkaeinpu, K. Jr. Cromack, and K.W. Cummins. 1986. Ecology of Coarse Woody Debris in

Temperate Ecosystems. Advances in Ecological Research. 15: 133-302. New York, NY: Academic Press.

Harper, K.T. and R.L. Pendleton. 1993. Cyanobacteria and Cyanolichens: Can they Enhance Availability of Essential Minerals for Higher Plants? Great Basin Naturalist 53(1):59-72.

Harr, R.D. 1986. Myths and Misconceptions about Forest Hydrologic Systems and Cumulative Effects. Paper presented at the California Watershed Management Conference, November 18-20, 1986, Sacramento, California.

Harris, L.D. 1984. The Fragmented Forest: Island Biogeography Theory and the Preservation of Biotic Diversity. University of Chicago Press: Chicago, IL.

Harris, G.A. 1991. Grazing Lands of Washington State. Rangelands 13:222-227.

Harvey, A.E., M.F. Jurgensen, and R.T. Graham. 1988. The Role of Woody Residue in Soils of the Ponderosa Pine Forests. pp. 141-147. In Ponderosa Pine--The Species and its Management. (eds.) Baumgartner, D.M. and J.E. Lotan. Washington State University, Cooperative Extension, Pullman, WA.

Hayes, Marc. 1994. Personal communication with Andy Hamilton on 11/3/94.

Hayes, Marc. 1995. The Amphibian Fauna of the Spencer Creek System. Final Report to the Nature Conservancy for The Bureau of Land Management, Oregon Department of Fish and Wildlife, Pacificorp, Weyerhaeuser Company, and the Winema National Forest.

Hayward, G.D. and J. Verner, tech. editors. 1994. Flammulated, Boreal, and Great Gray Owls in the United States: A Technical Conservation Assessment. Gen. Tech. Rep. RM-253. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range and Experiment Station. 214 pp.

Helms, J.A., C. Hipken, and E.B. Alexander. 1986. Effects of Soil Compaction on Height Growth of a California Ponderosa Pine Plantation. Western Journal of Applied Forestry 1:104-108.

Henderson, J.A., D.H. Peter, R.D. Lesher, and D.C. Shaw. 1989. Forested Plant Associations of the Olympic National Forest. USDA Forest Service, PNW Region, R6 ECOL Technical Paper 001-88.

Hibbert, A.R. and G.J. Gottfried. 1987. Stormflow Responses to Forest Treatments on Two Arizona Mixed Conifer Watersheds. Management of Subalpine Forests: Building on 50 Years of Research. Proceedings of a Technical Conference, July 6-9, 1987, Silver Creek, Colorado. USDA Forest Service General Technical Report RM-149.

Hicks, B. J., J. D. Hall, P. A. Bisson, and J. R. Sedell. 1991. Responses of Salmonids to Habitat Changes. pp 483-517.

Hinkley, D., P. Hansen, S. Miles, and V. Ciliberti. 1995. Inventory Procedures for Determining Health and Functioning Condition of Riparian and Wetland Areas in Montana. Montana State Office, Bureau of Land Management.

Hobbs, R.J. and L.F. Huenneke. 1992. Disturbance, Diversity, and Invasion: Implications for Conservation. Conservation Biology 6(3):324-337.

Holland, D. 1993. Comment letter on Draft Klamath Falls RMP.

Holland, D. 1994. The Western Pond Turtle: Habitat and History. Final Report prepared for: Bonneville Power Administration, Portland, OR. 11 chapters plus appendices.

Hopkins, W.E. 1979a. Plant Associations of South Chiloquin and Klamath Ranger Districts, Winema National Forest. USDA Forest Service, PNW Region, R6-ECOL-79-005.

Hopkins, W.E. 1979b. Plant Associations of the Fremont National Forest. USDA Forest Service, PNW Region, R6-ECOL-79-004.

Hopkins, W.E. 1995. Area 4 Ecologist, Bend, OR, Personal Communication with David Lebo.

Hopkins, W.E., 1996, Personal Communication with David Lebo.

Howell, D. 1995. Personal Communication with Patty Buettner on February 21, 1995.

Howison, Russ. 1996. Personal Communication with Grant Weidenbach on February 28, 1996.

Hungerford, R.D., M.G. Harrington, W.H. Frandsen, K.C. Ryan, and G.J. Niehoff. 1990. Influence of Fire on Factors that Affect Site Productivity. Symposium Proceedings: Management and Productivity of Western Montane Forest Soils; April 10-12, 1990; Boise, Idaho. General Technical Report INT-280. USDA Forest Service Intermountain Research Station, Ogden, Utah.

Isaacs, F.B., and R.G. Anthony. 1995. Bald Eagle Nest Locations and History of Use in Oregon 1971 through 1995. Oreg. Coop. Wildl. Res. Unit, Oreg. State Univ., Corvallis. 25 pp.

Johnson, S.R. 1995. Factors Supporting Road Removal and/or Obliteration. USDA Forest Service, Kootenai National Forest. Memo to Fire Recovery Hydrologists from Kootenai Forest Hydrologist.

Johnson, D.J., H. Van Miegroet, and W.T. Swank. 1989. Markers of Air Pollution in Forests: Nutrient Cycling. In: Biologic Markers of Air-pollution Stress and Damage in Forests. National Academy Press: Washington, D.C., pp. 133-142.

Johnson, D.W. 1992. Nitrogen Retention in Forest Soils. Journal of Environmental Quality 21(1):1-12.

Jurgensen, M.F. and C.B. Davey. 1970. Nonsymbiotic Nitrogen-fixing Microorganisms in Acid Soils and the Rhizosphere. Soils Fert. 33(5):435-446.)

Karl, M.G. and P.S. Doescher. 1993. Regulating Competition on Conifer Plantations with Prescribed Cattle Grazing. Forest Science 39:405-418.

Kimmins, J.P. 1987. Forest Ecology. Macmillan: New York. 531 pp.

King, D., R. Browning, and M. Schuck. 1977. Selected Klamath Basin Tributary Drainages; Aquatic Habitat Inventory and Analysis. U. S. Department of Interior, BLM, Medford, Oregon. 46 pp plus appendices.

King, J.G. 1989. Streamflow Responses to Road Building and Harvesting: A Comparison With the Equivalent Clearcut Area Procedure. Research Paper INT-401. USDA Forest Service Intermountain Research Station, Ogden, Utah.

Klamath County Historical Society. 1966. Klamath Echoes, Number 3.

Klinkenborg, Verlyn. 1994. The Mustang Myth. Audubon Magazine, January-February 1994, pp. 34-43.

Kuchler, A.W. 1964. Potential Natural Vegetation of the Conterminous United States. New York: American Geographical Society.

Kunz, T., II. 1982. Roosting Ecology of Bats. pp 1-55. In: Ecology of Bats. Kunz, T.H., ed. New York, NY: Plenum Press.

Larsson, S., R. Oren, R.H. Waring, and J.W. Barrett. 1983. Attacks of Mountain Pine Beetle as Related to Tree Vigor of Ponderosa Pine. Forest Science 29(2):395-402.

Larsen, M.J., M.F. Jurgensen, and A.E. Harvey. 1978. N_2 Fixation Associated with Wood Decayed by Some Common Fungi in Western Montana. Canadian Journal of Forest Research 8:341-345.

Lehman, R.N. 1979. A Survey of Selected Habitat Features of 95 Bald Eagle Nests in California. Calif. Dept. of Fish and Game. Wildl. Manage. Branch Admin. Report. 79-1, Sacramento. 23pp.

Leiberg, J.B. 1899. Cascade Range Forest Reserve from Township 28 South to Township 37 South, Inclusive, Together with the Ashland Forest Reserve and Forest Regions from Township 28 South to Township 14 South, Inclusive, and from

Range 2 West to Range 14 East, Williamette Meridian, Inclusive. pp 209-498. In: Twenty-First Annual Report of the U.S. Geological Survey to the Secretary of the Interior 1899-1900. Walcott, C.D. (dir.). Washington: Government Printing Office.

Leopold, L.B. 1994. A View of the River. Harvard University Press, Cambridge, Massachusetts.

Lodhi, M.A.K. and K.T. Killingbeck. 1980. Alleopathic Inhibition of Nitrification and Nitrifying Bacteria in a Ponderosa Pine (*Pinus ponderosa Dougl.*) Community. American Journal of Botany 67:1423-1429.

Logan, D. and D. F. Markle. 1993. Fish Faunal Survey of Agency Lake and Northern Upper Klamath Lake, Oregon. In: Environmental Research in the Klamath Basin, Oregon, 1992 Annual Report, S. G. Campbell, ed. U. S. Department of the Interior, pp. 251-278.

Lohrey, M.H. 1982. Determining Design Discharge for Watersheds on the Fremont National Forest. Water Note Number 1. USDA Forest Service, Fremont National Forest.

Lund, John W. 1987. Southerm Oregon Cross Country Ski Trails. Smith-Bates Printing. 222 pp.

Madany, M.H. and N.E. West. 1983. Livestock Grazing-fire Regime Interactions Within Montane Forests of Zion National Park, Utah. Ecology 64(4):661-667.

Mangum, F. 1986. Macroinvertebrates. pp. 661-675. In: Inventory and Monitoring of Wildlife Habitat. Cooperrider et al., eds. USDI BLM, Service Center, Denver, Colorado.

Marcot, B.G. and J. Gardetto. 1987. Status of the Spotted Owl in Six Rivers National Forest, California. Western Birds 11 (2):79-87.

Marshall, D.B. 1992. Sensitive Vertebrates of Oregon. First edition. Portland, OR: Oregon Department of Fish and Wildlife.

Masinton, Barbara. 1995. Conservation Strategy and Management Plan for *Limnanthes floccosa* ssp. *bellingeriana*, Bellinger's meadowfoam (Draft). Unpublished document. 57 pp.

McNeil, R.C. and D.B. Zobel. 1980. Vegetation and Fire History of a Ponderosa Pine-White Fir Forest in Crater Lake National Park. Northwest Sci. 54:30-46.

Megahan, W.F. 1972. Subsurface Flow Interception by a Logging Road in Mountains of Central Idaho. Proceedings of a Symposium on "Watersheds in Transition", June 19-22, 1972. Csallany et al., eds. American Water Resources Association, Urbana, Illinois.

Meinke, Robert J. 1981. Threatened and Endangered Vascular Plants of Oregon: An illustrated Guide. U.S. Fish and Wildlife Service, Office of Endangered Species, Region 1, Portland, OR. 352 pp.

Meinke, Robert J., Steven Gisler, Matthew Carlson, Melissa Peterson, and Melissa Kirkland. 1994. Investigations into the Conservation Status of *Mimulus pygmaeus* and *Mimulus tricolor* (Scophulariaceae) on the Winema and Fremont Naional Forests. Unpublished report. 43 pp.

Methesda, MD 1991. Influences of Forest and Rangeland Management Salmonid Fishes and Their Habitats. W. R. Meehan editor. American Fisheries Society Special Publication 19, 751 pp.

Miller, D.L. 1988. The Influence of Competing Vegetation in Ponderosa Pine Forests. pp 115-120. In: Ponderosa Pine: the Species and its Management. D.M. Baumgartner and J. E. Lotan (eds.). Washington State Univ. Cooperative Extension, Pullman, WA.

Miller, H.G. 1981. Forest Fertilization: Some Guiding Concepts. Forestry 54:157-167.

Miller, R. F., T. J. Svejcar, N. E. West. 1994. Implications of Livestock Grazing in the Intermountain Sagebrush Region:

Plant Composition. pp. 101-146. In: Ecological Implications of Livestock Herbivory in the West. M. Vavra, W. A. Laycock, R. D. Pieper. (eds.). Society for Range Management, Denver, Colorado.

Molina, R. and M. Amaranthus. 1991. Rhizosphere Biology: Ecological Linkages Between Soil Processes, Plant Growth, and Community Dynamics. In: Proceedings--Management and Productivity of Western-Montane Forest Soils. USDA Forest Service, Intermountain Research Station, General Technical Report INT-280.

Monfore, J. 1994. Phone conversation with Bill Lindsey, 27 January 1994.

Monfore, J. 1994. Letter to Barron Bail, 22 December 1994.

Montgomery, D.R. and Buffington, J.M. 1993. Channel Classification, Prediction of Channel Response, and Assessment of Channel Condition. Timber Fish and Wildlife Report TFW-SH10-93-002. Seattle, Washington.

Morgan, Eric. 1996. Personal Communication with Grant Weidenbach, March 1996.

Morgan, P., G.H. Aplet, J.B. Haufler, H.C. Humphries, M.M. Moore, and W.D. Wilson. 1993. Historical Range of Variability: A Useful Tool for Evaluating Ecosystem Change. In: Assessing Forest Ecosystem Health in the Inland West. Sampson, R.N. and D.L. Adams (eds.). Proceedings of the American Forests Scientific Workshop, Nov. 15-19, 1993. Sun Valley, ID.

Moyle, P. B. 1976. Inland Fishes of California. University of California press. 405 pp.

Moyle, P.B. and R. A. Leidy. 1992. Loss of Biodiversity in Aquatic Ecosystems: Evidence from Fish Faunas. In: Conservation Biology: The Theory and Practice of Nature Conservation, Preservation, and Management, P. Fiedler and S. Jain eds. Chapman and Hall, New York. pp 127-169.

National Research Council. 1980. Wild and Free-Roaming Horses and Burros: Current Knowledge and Recommended Research. Phase I, Final Report. Frederic H. Wagner, Chairman of committee on Wild and Free-Roaming Horses and Burros. National Academy Press, Washington, D.C.

Newton, M., B.A. El Hassan, and J. Zavitkovski. 1968. Role of Red Alder in Western Oregon Forest Succession. pp. 73-84. In: Biology of Alder. (eds.) Trappe, J.M., J.F. Franklin, R.F. Tarrant, and G.H. Hansen. Pacific Northwest Forest and Range Experiment Station, Portland, OR.

North Coast Regional Water Quality Control Board. 1993. North Coast Region Water Quality Control Plan. Santa Rosa, California.

Nussbaum, R.A., E.D. Brodie, Jr., and R.M. Storm. 1983. Amphibians and Reptiles of the Pacific Northwest. University of Idaho Press, Moscow, Idaho.

Oliver, C.D. and B.C. Larson. 1990. Forest Stand Dynamics. McGraw-Hill: New York. 467 pp.

Oliver, C.D., D. Ferguson, A.E. Harvey, H. Malany, J.M. Mandzak, and R.W. Mutch. 1993. Managing Ecosystems for Forest Health: An Approach and the Effects on Uses and Values. In: Assessing Forest Ecosystem Health in the Inland West. Sampson, R.N. and D.L. Adams (eds.). Proceedings of the American Forests Scientific Workshop, Nov. 15-19, 1993. Sun Valley, ID.

Oliver, C.D., L.L. Irwin, and W.H. Knapp. 1994. Eastside Forest Management Practices: Historical Overview, Extent of Their Applications, and Their Effects on Sustainability of Ecosystems. USDA Forest Service, PNW-GTR-324.

Oregon Department of Environmental Quality. 1988. 1988 Oregon Statewide Assessment of Nonpoint Sources of Water Pollution. Planning and Monitoring Section, Water Quality Division, Oregon Department of Environmental Quality. Portland, Oregon.

Oregon Department of Environmental Quality. 1988, 1990, 1992, and 1994. Water Quality Status Assessment (305[b]) Reports. Oregon Department of Environmental Quality. Portland, Oregon.

Oregon Species Informational Systems. 1994.

Oregon State Parks and Recreation Division. 1988. Statewide Comprehensive Outdoor Recreation Plan. State of Oregon.

PacifiCorp Electric Operations, Environmental Services. 1992. 1990 Annual Report of Fish Trapping in the Klamath River Basin, Oregon.

Page-Dumroese, D., A. Harvey, M. Jurgensen, and R. Graham. 1991. Organic Matter Function in the Western-montane Forest Soil System. In: Proceedings--Management and Productivity of Western Montane Forest Soils. USDA Forest Service. Intermountain Research Station. General Technical Report INT-280.

Pearson, O.P., M.R. Koford, and A.K. Pearson. 1952. Reproduction of the Lump-nosed Bat (*Corynorhinus rafinesquii*) in California. J. Mammal. 33:273-320.

Perkins, J.M. and C. Levesque. 1987. Distribution, Status and Habitat Affinities of Townsend's Big-eared Bat (*Plecotus townsendii*) in Oregon. Oregon Dept. of Fish and Wildlife, Tech. Rep. No. 86-5-01. 49pp.

Perry, D.A. 1994. Forest Ecology. Johns Hopkins Press: Baltimore. 649 pp.

Peterson, C. 1982. Regional Growth and Response Analysis for Unthinned Douglas-fir. In: Regional Forest Nutrition Research Project Biennial Report 1980-1982. Contribution #46, Institute of Forest Resources, University of Washington, Seatlle, pp. 3-25.

Pieper, R.D. 1994. Ecological Implications of Livestock Grazing. pp 177-211. In: Ecological Implications of Livestock Herbivory in the West. (eds.) Vavra, M., W.A. Laycock, and R.D. Pieper. Society for Range Management: Denver, CO.

Platts, W. S. 1990. Fish, Wildlife and Livestock: Protection of Riparian Areas. Western Wildlands. Summer, 1990.

Powers, R.F. 1980. Mineralizable Soil Nitrogen as an Index of Nitrogen Availability to Forest Trees. Journal of the Soil Science Society of America 44:1314-1320.

Powers, R.F.. 1991. Are We Maintaining the Productivity of Forest Lands? Establishing Guidelines Through a Network of Long-term Studies. In: Proceedings--Management and Productivity of Western Montane Forest Soils. USDA Forest Service. Intermountain Research Station. General Technical Report INT-280.

Quinn, James W. 1983. Handbook to the Klamath River Canyon. Educational Adventures Inc., Medford, OR. 180 pp.

Rainey, W.E., E.D. Pierson, M. Colberg, J.H. Barclay. 1992. Bats in Hollow Redwoods: Seasonal Use and Role in Nutrient Transfer into Old-Growth Communities. Bat Reasearch News 33(4):71.

Raphael, M.G. and R.H. Barrett. 1984. Diversity and Abundance of Wildlife Late Successional Douglas Fir Forests. In: New Forests for a Changing World, Proceeding of 1983 Society of American Forestry National Convention, Portland, OR.

Raphael, M.G., C.A. Taylor, and R.H. Barrett. 1986. Smoked Aluminum Track Stations Recorded Flying Squirrel Occurrence. U.S. Forest Service, Research Note PSW-384. Pacific Southwest Forest and Range Experiment Station, Arcata, CA.

Reeves, G. H., F. H. Everest, and J. D. Hall. 1987. Interactions Between the Redside Shiner (*Richardsonius balteatus*) and the Steelhead Trout (*Salmo gairdneri*) in Western Oregon: The Influence of Water Temperature. Can J. Fish Aquatic Sci. 44: 1603-1613.

Regan-Vienop, J. 1996. Personal Communication with Kristin Bail.

Regional Ecosystem Office. 1995. Channel Condition Module in Section II, Review Draft of Ecosystem Analysis at the Watershed Scale: The Revised Federal Guide for Watershed Analysis, Version 2.1.

Rogers, R.W. and R.T. Lange. 1971. Lichen Populations on Arid Soil Crusts Around Sheep Watering Places in Southern Australia. Oikos 22:93-100.

Rothacher, J. 1970. Increases in Water Yield Following Clearcut Logging in the Pacific Northwest. Water Resources Research, Vol. 6, No. 2.

Rosentreter, R. 1995. BLM Botanist and Lichenolgist, Personal Communication with David Lebo.

Rosgen, D.L. 1991. An Empirical Prediction Methodology of Potential Sediment Yield from Forest Roads Utilizing a Road Impact Index. Unpublished.

Rosgen, D.L. 1994. A Classification of Natural Rivers. Catena, Vol. 22, No. 3.

Schmid, J.M. and S.A. Mata. 1992. Stand Density and Mountain Pine Beetle-caused Tree Mortality in Ponderosa Pine Stands. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Research Note RM-515.

Schmitt, C.L., E.M. Goheen, and S.J. Frankel. 1984. Effects of Management Activities and Dominant Species Type on Pest-caused Mortality Losses in True Fir on the Fremont and Ochoco National Forests. USDA Forest Service, Forest Pest Management. 34 pp.

Schmitt, C.L., D.J. Goheen, T.F. Gregg, and P.F. Hessburg. 1991. Effects of Management Activities and Dominant Species Type on Pest-caused Losses in True Fir and Associated Speces on the Wallowa-Whitman National Forest, Oregon. USDA Forest Service, PNW, BMPMZ-01-91. 78 pp.

Schowalter, T.D. 1989. Canopy Arthropod Community Structure and Herbivory in Old-Growth and Regenerating Forests in Western Oregon. Can. J. For. Res. 19:318-322.

Scott, Peter. 1995. Winter Development Report-Hamaker Mountain. US Department of the Interior-Bureau of Land Management, Klamath Falls Resource Area, unpublished report. 6 pp.

Sneva, Forest and C.M. Britton. 1983. Adjusting and Forecasting Herbage Yields in the Intermountain Big Sagebrush Region of the Steppe Province. Station Bulletin 659. Agricultural Experiment Station, Oregon State University, Corvallis, Oregon.

Sneva, Forest. 1990. Discussions between Mr. Sneva and Bill Lindsey (then on the BLM's Ely, NV range management staff).

Soeriaatmadja, R.E. 1966. Fire History of the Ponderosa Pine Forests of the Warm Springs Indian Reservation, Oregon. Ph.D. dissertation, Oregon State University, Corvallis.

Solis, D.M. 1983. Summer Habitat Ecology of Spotted Owls in Northwestern California. M.S. thesis. Humboldt State University, Arcata, CA.

Stoddard, Laurence A., Arthur D. Smith, and Thadis W. Box. 1975. Range Management. McGraw-Hill Book Co., New York, N.Y.

St John, Alan D. 1987. The Herpetology of the Oak Habitat of Southwestern Klamath County, Oregon. Oregon Department of Fish and Wildlife, Nongame Wildlife Program, Technical Report #87-3-01.

Swanson, R. N. 1991. Natural Processes. pp 139-179. In: Influences of Forest and Rangeland Management Salmonid Fishes and Their Habitats, W. R. Meehan ed. American Fisheries Society Special Publication 19, Methesda, MD 1991. 751 pp.
U.S. Army Corps of Engineers. 1984. Wetland Plants of the Pacific Northwest. Seattle District, US Army Corps of Engineers.

Tarrant, R.F. and J.M. Trappe. 1971. The Role of *Alnus* in Improving the Forest Environment. In: Biological Nitrogen Fixation in Natural and Agricultural Habitats. Edited by T.A. Lie and E.G. Mulder. Plant and Soil. Special Volume, pp.

335-348.

Thomas, J.W. (ed.). 1979. Wildlife Habitats in Managed Forests. The Blue Mountains of Oregon and Washington. Agriculture Handbook No. 553. U.S. Forest Service. 512pp

Thomas, D.W. and S.D. West. 1991. Forest Age Associations of Bats in the Southern Washington Cascade and Oregon Coast Ranges. In: Ruggiero, L.F., K.B. Aubry, A.B. Carey, M.H. Huff, eds. Wildlife and Vegetation of Unmanaged Douglas-fir Forests. Gen. Tech. Rep. PNW-GTR-285. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 295-303.

U.S. Department of Agriculture, Forest Service. Date Unknown. Forest Hydrology Part II: Hydrologic Effects of Vegetation Manipulation.

----- 1995. Region 2 Integrated Resource Inventory Training Guide.

----- 1995b. Watershed Analysis Report for the Threemile, Sevenmile, and Dry Creek Watersheds. Klamath Ranger District, Winema National Forest.

----- 1994. Watershed Analysis Report for the Rock, Cherry, and Nannie Creek Watershed Area. Klamath Ranger District, Winema National Forest.

----- 1994b. Watershed Evaluation and Analysis For Viable Ecosystems (WEAVE) Version 1.12. Deschutes National Forest.

----- 1989. Fisheries Habitat Surveys Handbook Chapter 5: Aquatic Macroinvertebrate Surveys. USFS Region 4 Forest Service Handbook 2609.23.

----- 1989b. Productivity and its Relation to Soil. Pacific Northwest Research Station General Technical Report GTR-222.

U.S. Department of Agriculture, Forest Service, U.S. Department of Interior, Bureau of Land Management. 1994. Final Supplemental Environmental Impact Statement on Management of Habitat for Late-successional and Old Growth Forest Related Species Within the Range of the Northern Spotted Owl. Portland, Oregon.

U.S. Department of Agriculture, Soil Conservation Service. 1993. Soil Survey of Jackson County Area, Oregon.

U.S. Congress. 1971. The Wild and Free-Roaming Horse and Burro Act of 1971. Public Law 92-195. 92nd Congress, S. 1116, December 15, 1971.

U.S. Department of the Interior - Bureau of Land Management. 1978. Pokegama Herd Management Plan for Wild Horses. Medford District BLM, Medford, OR.

----- 1980a. Jackson/Klamath Management Framework Plan. Medford District BLM, Medford, OR.

----- 1980b. Our Public Lands - Special Wild Horse Issue. Washington Office, Washington, D.C.

----- 1982. Microhistological Analyses of Cattle, Elk, Deer, and Wild Horses Fecal Material Collected Between 1 January 1979 and 21 February 1981. Unpublished report. Analysis of Fecal Materials Performed by Colorado State University, Fort Collins, CO.

----- 1985. Rangeland Monitoring - Analysis, Interpretation, and Evaluation. BLM Denver Service Center, Denver, CO.

----- 1986. Management Plan for the Pokegama Wild Horse Herd - unsigned draft document. Klamath Falls R.A., Medford District BLM, Medford, OR.

----- 1989. Rangeland Monitoring and Evaluation. BLM Manual Handbook 4400-1.

----- 1990a. Eighth Report to Congress 1990 - Administration of the Wild Free-Roaming Horse and Burro Act.

----- 1990b. Final Eligibility and Suitability Report for the Upper Klamath Wild and Scenic River Study. Klamath Falls Resource Area, Lakeview District.

----- 1993. Unpublished Data Located at the Klamath Falls Resource Area Office, Klamath Falls, OR.

----- 1994a. Final Klamath Falls Resource Area Resource Management Plan and Environmental Impact Statement. Klamath Falls Resource Area, Lakeview District.

----- 1994b. Riparian Area Management: Process for Assessing Proper Functioning Condition for Lentic Riparian-Wetland Areas. Technical Reference 1737-11. BLM Service Center, Denver, Colorado.

----- 1994c. Coordinated Monitoring and Evaluation Plan for Grazing Allotments. Klamath Falls R.A., Lakeview District, OR.

----- 1994d. Noxious Weed Strategy for Oregon/Washington. BLM/OR/WA/PT-94/36+4220.9. BLM Oregon State Office, Portland, OR. 37 pp.

----- 1995a. Klamath Falls Resource Area Record of Decision/Resource Management Plan and Rangeland Program Summary. Lakeview District, BLM.

----- 1995b. Lakeview District Wild Horse Gather - EA #OR-010-95-10. Lakeview District, BLM, Lakeview, OR.

----- 1995c. Spencer Creek Pilot Watershed Analysis. Klamath Falls Resource Area, Lakeview District and Klamath Ranger District, Winema National Forest.

U.S.Department of the Interior - Office of Hearing and Appeals, Interior Board of Land Appeals. Opinion by Administrative Law Judge. October 3, 1995. American Horse Protection, Inc., et.al. vs. BLM. IBLA #93-71 and #94-284.

----- November 2, 1994. Animal Protection Institute of America vs. BLM. IBLA #93-308 and #94-14.

----- March 5, 1992. Animal Protection Institute of America, et.al. vs. BLM. IBLA #92-39.

----- February 22, 1991. Animal Protection Institute of America, et.al. vs. BLM. IBLA #90-412, #90-413, and #90-414.

----- February 15, 1991. Animal Protection Institute of America vs. BLM. IBLA #89-206 and #90-243.

----- December 21, 1990. Animal Protection Institute of America vs. BLM. IBLA #90-419.

----- November 20, 1990. Animal Protection Institute of America vs. BLM. IBLA #90-115.

----- October 16, 1990. Animal Protection Institute of America vs. BLM. IBLA #89-285 and #89-286.

----- June 7, 1989. Animal Protection Institute of America vs. BLM. IBLA #88-591, #88-638, #88-648, and #88-679.

U.S. Environmental Protection Agency. 1991. Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska. EPA/910/9-91-001 by Macdonald, L.H., Smart, A.L. and Wissmar, R.C. Seattle, Washington.

U.S. Fish and Wildlife Service. 1979, Reprint 1992. Classification of Wetlands and Deepwater Habitats of the United States. FWS/OBS-79/31. Office of Biological Services, Washington D.C.

U.S. Fish and Wildlife Service. 1986. Pacific Bald Eagle Recovery Plan. U.S. Fish and Wildlife Service, Portland, OR. 160 pp.

U.S. Geological Survey. 1967. Magnitude and Frequency of Floods in the United States. Part 11. Pacific Slope Basins in California, Volume 2. Klamath and Smith River Basins and Central Valley Drainage from the East. Water-Supply Paper

1686 by Young, L.E. and Cruff, R.W. United States Government Printing Office, Washington.

----- 1983. Magnitude and Frequency of Floods in Eastern Oregon. Water Resources Investigations Report 82-4078 by Harris, D.D. and L.E. Hubbard. Portland, Oregon.

----- 1990. Statistical Summaries of Streamflow Data in Oregon: Volume 1--Monthly and Annual Streamflow, and Flow-Duration Values. Open-File Report 90-118 by Moffatt, R.L., R.E. Wellman, and J.M. Gordon. Portland, Oregon.

----- 1993a. Statistical Summaries of Streamflow Data in Oregon: Volume 2--Annual Low and High Flow, and Instantaneous Peak Flow. Open-File Report 93-63 by Wellman, R.E., J.M. Gordon, and R.L. Moffatt. Portland, Oregon.

----- 1993b. Water Resources Data-Oregon Water Year 1992. USGS Water Data Report OR-92-1. Portland, OR

Van Breeman, N., P.A. Burrough, E.J. Velthorst, H.F. van Dobben, Toke de Witt, T.B. Ridder, and H.F.R. Reijuders. 1982.
Soil Acidification From Atmospheric Ammonium Sulphate in Forest Canopy Throughfall. Nature (London) 299:548-550.

Vinson, M. 1994. Aquatic Benthic Macroinvertebrate Monitoring Report. Prepared for USDI BLM Klamath Falls Resource Area. Logan, Utah.

Vitousek, P. 1982. Nutrient Cycling and Nutrient Use Efficiency. American Naturalist 119:553-572.

Vitousek, P., J.R. Gosz, C.C. Grier, J.M. Melillo, and W.A. Reiners. 1982. A Comparative Analysis of Potential Nitrification and Nitrate Mobility in Forest Ecosystems. Ecological Monographs 52:155-177.

Vogt, K.A., R.L. Edmonds, C.C. Grier, and S.R. Piper. 1980. Seasonal changes in mycorrhizal and fibrous-textured root biomass in 23- and 180-year-old Pacific silver fir stands in western Washington. Canadian Journal of Forest Research 10:523-529.

Vogt, K.A., C.C. Grier, and D.J. Vogt. 1986. Production, turnover, and nutrient dynamics of above- and belowground detritus of world forests. Pp. 303-377 in Advances in Ecological Research. (ed.) D. Ford. Academic Press: London.

Vogt, K.A., E. Moore, S. Gower, et al. 1989. Productivity of upper slope forests in the Pacific Northwest. In Maintaining the long-term productivity of Pacific Northwest forest ecosystems. Edited by D.A. Perry, R. Meurisse, B. Thomas, et al. Timber Press: Portland, OR. pp. 137-163.

Vogt, K.A., D.A. Publicover, and D.J. Vogt. 1991. A critique of the role of ectomycorrhizas in forest ecology. Agriculture, Ecosystems and Environment 35:171-190.

Waring, R. 1995. Oregon State University. Personal Communication with David Lebo.

Waring, R.H. and G.B. Pitman. 1985. Modifying Lodgepole Pine Stands to Change Susceptibility to Mountain Pine Beetle Attack. Ecology 66:889-897.

Waterbury, B. 1994. Personal Communication with Patty Buettner on November 21, 1994.

Waterbury, B. 1996. Personal Communication with Monica Miller on April 4, 1996.

Wells, J.V. and M.E. Richmond. 1995. Populations, Metapopulations, and Species Populations: What Are They and Who Should Care? Wildlife Society Bulletin 23(3):458-462.

Wemple, B.C. 1994. Hydrologic Integration of Forest Roads with Stream Networks in Two Basins, Western Cascades, Oregon. Oregon State University Masters Thesis. Corvallis, Oregon.

White, C.S. 1986. Effects of Prescribed Fire on Rates of Decomposition and Nitrogen Mineralization in a Ponderosa Pine Ecosystem. Biology and Fertility of Soils 2:87-95.

Wisseman, R. 1994. Benthic Invertebrate Biomonitoring and Bioassessment Interpretive Manual.

Glossary

Many of the glossary entries below were taken directly from the Forest Ecosystem Management Assessment Team's (FEMAT) report. These entries are indicated with a FEMAT at the end of the entry.

50-11-40 Rule - One of the standards and guidelines of the Interagency Scientific Committee strategy designed to provide dispersal habitat for northern spotted owls on lands outside reserves. Calls for maintaining 50 percent of forested land within each quarter township (9 square miles) in forested condition with stands of trees averaging at least 11 inches diameter at breast height and with a stand canopy closure of at least 40 percent. FEMAT

Administratively Withdrawn Areas - Areas removed from the suitable timber base through agency direction and land management plans. FEMAT

Alevin - The larval form of salmon and trout.

Animal Unit Month (AUM) - The amount of forage necessary for the sustenance of one cow and calf, or the equivalent, for one month.

Annual plant - A plant that completes its life-cycle and dies in one year or less.

Biological Diversity - The variety of life forms and processes, including a complexity of species, communities, gene pools, and ecological functions. FEMAT

Biomass - The total quantity (at any given time) of living organisms of one or more species per unit of space (species biomass), or of all the species in a biotic community (community biomass). FEMAT

Candidate Species - Those plants and animals included in Federal Register "Notices of Review" that are being considered by the Fish and Wildlife Service for listing as threatened or endangered. Two categories that are of primary concern: Category 1 - Taxa for which there is substantial information to support proposing the species for listing as threatened or endangered. Listing proposals are either being prepared or have been delayed by higher priority listing work. Category 2 - Taxa information indicates that listing is possibly appropriate. Additional information is being collected. FEMAT

Canopy Closure - The degree to which the canopy (forest layers above one's head) blocks sunlight or obscures the sky. It can only be accurately determined from measurements taken under the canopy as openings in the branches and crowns must be accounted for. FEMAT

Carbonaceous Oxidation - See Oxidation.

Climax Community - see Potential Natural Community.

Commercial Thinning - The removal of generally merchantable trees from an even-aged stand, usually to encourage growth of the remaining trees. FEMAT

Congressionally Reserved Areas - Areas that require Congressional enactment for their establishment, such as National Parks, Wild and Scenic Rivers, National Recreation Areas, National Monuments, and Wilderness. FEMAT (These are also referred to as Congressional Reserves).

Cumulative Effects - Those effects on the environment that result from the incremental effect of the action when added to the past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time. FEMAT

Debitage - The refuse left after flaking stone tools.

Dendiform - Treelike in form or structure.

Desired Plant Community (DPC) - A plant community that contributes to meeting the management objectives for a given piece of land.

Disturbance - A force that causes significant change in structure and/or composition through natural events such as fire, flood, wind, or earthquake, mortality caused by insect or disease outbreaks, or by human-caused events, e.g., the harvest of forest products. FEMAT

Duff Layer - As specifically defined in the FEMAT Report, the layer of loosely compacted debris underlying the litter layer on the forest floor.

Early-Successional Forest - Forest seral stages younger than mature and old-growth age classes.

Eastside - Generally, east of the crest of the Cascade Range.

Ecological Condition (ecological status) - Status of the current plant community on a site compared to the potential natural or climax community.

Ecological Site (ecotype) - A locally adapted plant community that has a distinctive limit of tolerance to environmental factors and is distinctly different than other plant communities that may exist under other environmental parameters.

Effects - Effects, impacts, and consequences, as used in this analysis, are synonymous. Effects may be direct, indirect, or cumulative and may fall in one of these categories: aesthetic, historic, cultural, economic, social, health, or ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems).

Embedding - Degree to which large particles (such as boulders, rubble, and gravel) are surrounded or covered by fine sediment.

Endemic - A species that is unique to a specific locality. FEMAT

Ephemeral Streams - Streams that contain running water only sporadically, such as during and following storm events. FEMAT

Ethnic: Relating to large groups of people classed according to common traits, customs, and culture.

Even-Aged Management - A silvicultural system which creates forest stands that are primarily of a single age or limited range of ages. Creation of even-aged stands may be accomplished through a clearcut, seed tree, or shelterwood method.

Extirpation - The elimination of a species from a particular area. FEMAT

Exotic Plant - A plant species that is not native to the region in which it is found.

Forbs - Any herbaceous plant other than those in the Gramineae (grasses), Cyperaceae (sedges), and Juncacea (rushes) families.

Forest Land - Land that is now, or is capable of becoming, at least 10 percent stocked with forest trees and that has not been developed for nontimber use. FEMAT

Forest Types - A classification of forest land based on the tree species presently forming a plurality of basal area stocking or crown cover of live trees.

Forest Watershed - The forested drainage area contributing water, organic matter, dissolved nutrients, and sediments to a lake or stream. FEMAT

Fuelbreak - An area of land on which the native vegetation has been removed or modified so that fires burning into it can be controlled more readily. Some fuelbreaks contain firelines which can be quickly widened with hand tools or by burning.

Fuel Loading - The weight of fuel (such as leaves, branches, and other debris) present at a given site; usually expressed in tons per acre. This value generally refers to the fuel that would typically be available for consumption by fire. Fuel loading varies as a result of disturbance (including human activities), the magnitude of that disturbance, the successional stage of the vegetation, and other conditions of the site.

Fuel Profile - The amount and characteristics of live fuel and large woody debris in a given area. The amount is referred to as the fuel loading, while the characteristics include the horizontal and vertical arrangement and continuity of fuels that affect the spread and intensity of fire.

Green Tree Retention - A stand management practice in which live trees as well as snags and large down wood are left as biological legacies within harvest units to provide habitat components over the next management cycle. There are two levels:

> High level - A regeneration harvest designed to retain the highest level of trees possible while still providing enough disturbance to allow regeneration and growth of the naturally occurring mixture of tree species. Such harvest should allow for the regeneration of intolerant and tolerant species. Harvest design would also retain cover and structural features necessary to provide foraging and dispersal habitat for mature and old-growth dependant species.
>
> Low level - A regeneration harvest designed to retain only enough green trees and other structural components (snag, coarse woody debris, etc.) to result in the development of stands that meet old-growth definitions within 100 to 120 years after harvest entry, considering overstory mortality. FEMAT

Herbaceous Vegetation - grasses and forbs as a group; excludes shrubs and trees.

Heterogeneity - The condition or state of being different in kind or nature.

High Intensity Fire - A fire with the capability to be stand replacing or to cause excessive damage to late-successional forest characteristics.

High Severity Fire - A wildfire event with acute ecological impacts; usually, but not always of high intensity. FEMAT

Intermittent Stream - Any non-permanent flowing drainage feature having a definable channel and evidence of annual scour or deposition. This includes what are sometimes referred to as ephemeral streams if they meet these two criteria. FEMAT

Key Watershed - As defined by National Forest and Bureau of Land Management District fish biologists, a watershed containing (1) habitat for potentially threatened species or stocks of anadromous salmonids or other potentially threatened fish, or (2) greater than 6 square miles with high-quality water and fish habitat. FEMAT

Landscape - A heterogenous land area with interacting ecosystems that are repeated in similar form throughout. FEMAT

Large-Scale Fire - A very large-sized fire compared to the natural range of fire sizes of the fire regime in the geographic area considered. Fires that greatly exceed the typical fire size are often of high intensity and may cause profound fire effects.

Large Woody Debris (LWD) - Portion of a tree that has fallen or been cut and left in place.

Late-Successional Forests - Forest seral stages that include mature and old-growth age classes.

Late Successional Reserve - A forest in its mature and/or old-growth stages that has been reserved under each option in this report. FEMAT

Litter Layer - The loose, relatively undecomposed organic debris on the surface of the forest floor made up typically of leaves, bark, small branches, and other fallen material. FEMAT

Log Decomposition Class - Any of five stages of deterioration of logs in the forest. Stages range from essentially sound (class 1) to almost total decomposition (class 5). FEMAT

Long-Term Soil Productivity - The capability of soil to sustain inherent, natural growth potential of plants and plant communities over time.

Macrophyte - a macroscopic form of aquatic vegetation (such as vascular aquatic plants).

Managed Late-Successional Areas - Selected harvest areas and managed pair areas. FEMAT

Matrix - Federal lands outside of reserves, withdrawn areas, and Managed Late-Successional areas. FEMAT

Merchantable Trees, Stands, Timber - Trees or stands that people will buy for the wood they contain. FEMAT

Mesic - Pertaining to or adapted to an area that has a balanced supply of water; neither wet nor dry. FEMAT

Mitigation measures - Modifications of actions that (1) avoid impacts by not taking a certain action or parts of an action; (2) minimize impacts by limiting the degree or magnitude of the action and its implementation; (3) rectify impacts by repairing, rehabilitating, or restoring the affected environment; (4) reduce or eliminate impacts over time by preservation and maintenance operations during the life of the action; or (5) compensate for impacts by replacing or providing substitute resources or environments. FEMAT

Monitoring - A process of collecting information to evaluate if objective and anticipated or assumed results of a management plan are being realized or if implementation is proceeding as planned. FEMAT

Multistoried - Forest stands that contain trees of various heights and diameter classes and therefore support foliage at various heights in the vertical profile of the stand. FEMAT

Noncommercial Tree Species - Minor conifer and hardwood species whose yields are not reflected in the commercial conifer forest land allowable sale quantity. Some species may be managed and sold under a suitable woodland allowable sale quantity and, therefore, may be commercial as a woodland species. FEMAT

Native Plant - A plant species that is part of the original flora of the area in question.

Nitrogenous - See Oxidation.

Nonforest Land - Land developed for nontimber uses or land incapable of being ten percent stocked with forest trees. FEMAT

Noxious Species - A plant species that is undesirable because it conflicts, restricts, or otherwise causes problems under the management objectives.

O & C Lands - Public lands granted to the Oregon and California Railroad Company or the Coos Bay Wagon Road Company and subsequently revested to the United States, which are managed by the Bureau of Land Management under the authority of the O&C Lands Act.

Old-Growth Forest - A forest stand usually at least 180-220 years old with moderate to high canopy closure; a multilayered, multispecies canopy dominated by large overstory trees; high incidence of large trees, some with broken tops and other indications of old and decaying wood (decadence); numerous large snags; and heavy accumulations of wood, including large logs on the ground. FEMAT

Overstory - Trees that provide the uppermost layer of foliage in a forest with more than one roughly horizontal layer of foliage. FEMAT

Oxidation - combination of a substance with oxygen.

Partial Cutting - Removal of selected trees from a forest stand. FEMAT

Passerine Bird - A bird belonging to the order Passerifarmes which consists of perching birds known as the songbirds.

Patch - A small (20-60 acre) part of the forest. This term is often used to indicate a type of clearcutting (patch cuts) associated with the "staggered setting" approach to distributing harvest units across the landscape. FEMAT

Perennial Plant - A plant that has a life-cycle of 3 or more years.

Perennial Stream - A stream that typically has running water on a year-round basis. FEMAT

Periphyton - Sessile organisms that live attached to surfaces projecting from the bottom in a fresh water aquatic environment.

Plant Community - (also vegetation community) A group of one or more populations of plants in a common spatial arrangement.

Potential Natural Community (PNC) - The biotic community (living organisms) that would become established if all successional sequences were completed without interferences by man under the present environmental conditions. The term PNC is synonymous with climax community.

Precommercial Thinning - The practice of removing some of the trees less than merchantable size from a stand so that remaining trees will grow faster. FEMAT

Prescribed Fire - A fire burning within an approved, predefined, and planned prescription. The fire may result from either a planned or natural ignition. When a prescribed fire exceeds the prescription and/or planned perimeter, it may be declared a wildfire.

Proper Functioning Condition (PFC) - Riparian-wetland areas are functioning properly when adequate vegetation, landform, or large woody debris is present to dissipate stream energy associated with high waterflows, thereby reducing erosion and improving water quality; filter sediment, capture bedload, and aid floodplain development; improve flood-water retention and ground-water recharge; develop root masses that stabilize streambanks against cutting action; develop diverse ponding and channel characteristics to provide the habitat and water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and support greater biodiversity. The functioning condition of riparian-wetland areas is a result of interaction among geology, soil, water, and vegetation.

Quarter-Township - An area approximately 3 miles square containing nine sections of land. FEMAT

Range Condition - The current productivity of a particular rangeland relative to what that rangeland is naturally capable of producing.

Record of Decision - A document separate from but associated with an environmental impact statement that states the management decision, identifies all alternatives including both the environmentally preferable and selected alternatives, states whether all practicable means to avoid environmental harm from the selected alternative have been adopted, and if not, why not. FEMAT

Reforestation - The natural or artificial restocking of an area with forest trees; most commonly used in reference to artificial stocking. FEMAT

Resource Management Plan (RMP) - A land use plan prepared by an agency under current regulations in accordance with the Federal Land Policy and Management Act. FEMAT

Rhizomatous Grass - Grass with an underground stem, usually sending out roots and above-ground shoots from the nodes. These type grasses have good soil holding abilities and are typically more desired than non-rhizomatous grasses.

Riparian Area - As specifically defined in the FEMAT Report, a geographic area containing an aquatic ecosystem and adjacent upland areas that directly affect it. This includes floodplain, woodlands, and all areas within a horizontal distance of approximately 100 feet from the normal line of high water of a stream channel or from the shoreline of a standing body of water.

Riparian Reserves - Designated riparian areas found outside Late-Successional Reserves. FEMAT

Riparian Zone - As specifically defined in the FEMAT Report, those terrestrial areas where the vegetation complex and microclimate conditions are products of the combined presence and influence of perennial and/or intermittent water, associated high water tables, and soils that exhibit some wetness characteristics. Normally used to refer to the zone within which plants grow rooted in the water table of these rivers, streams, lakes, ponds, reservoirs, springs, marshes, seeps, bogs, and wet meadows.

Ripping - The process of breaking up or loosening compacted soil (e.g., skid trails or spur roads) to better assure penetration of roots of young tree seedlings. FEMAT

Rotation Grazing - System of pasture utilization using multiple pastures and generally having short periods of grazing use followed by periods of rest for herbage recovery during the same season.

Saprophyte - an organism using dead organic material as food.

Second Growth - Relatively young forests that have developed following a disturbance (e.g., wholesale cutting, serious fire, or insect attack) of the previous old-growth forest. FEMAT

Selection Cutting - a method of uneven-aged management involving the harvesting of single trees from stands (single-tree selection) or in groups (group selection) without harvesting the entire stand at any one time. FEMAT

Seral Stages - The series of relatively transitory planned communities that develop during ecological succession from bare ground to the climax stage. FEMAT

For the Spencer Creek Watershed Analysis, seral stages were divided into the five categories and are defined as follows:

> Non-forested - grass, snow, rock, agriculture;
>
> Early-seral - Brush, clearcuts, plantations, and forest stands which have undergone shelterwood or seedtree harvests; seedling and sapling canopy layer is about even or below the brush. The brush still dominates the vegetative canopy layer.
>
> Early-mid-seral - Forest stands dominated by pole (5 to 9 inches in diameter at breast height) sized trees; trees begin to dominate the vegetative canopy layer.
>
> Mid-seral - Forest stands dominated by small (9 to 21 inches in diameter at breast height) and some medium (21 to 32 inches in diameter at breast height) sized trees;
>
> Late-seral - Forest stands dominated by medium (21 to 32 inches in diameter at breast height) and large (greater than 32 inches in diameter at breast height) sized trees.

Shelterwood - A regeneration method under an even-aged silvicultural system. A portion of the mature stand is retained as a source of seed and/or protection during the period of regeneration. The mature stand is removed in two or more cuttings. FEMAT

Silvicultural Prescription - A professional plan for controlling the establishment,a composition, constitution and growth of forests. FEMAT

Snag - Any standing dead, partially dead, or defective (cull) tree at least 10 inches in diameter at breast height and at least 6 feet tall. A hard snag is composed primarily of sound wood, generally merchantable.

A soft snag is composed primarily of wood in advanced stages of decay and deterioration, generally not merchantable. FEMAT

Soil Productivity - Capacity or suitability of a soil, for establishment and growth of a specified crop or plant species, primarily through nutrient availability. FEMAT

Stand (Tree Stand) - An aggregation of trees occupying a specific area and sufficiently uniform in composition, age, arrangement, and condition so that it is distinguishable from the forest in adjoining areas. FEMAT

Stocked/Stocking - The degree an area of land is occupied by trees as measured by basal area or number of trees. FEMAT

Structural Diversity - The diversity of forest structure, both vertical and horizontal, that provides for a variety of forest habitats for plants and animals. The variety results from layering or tiering of the canopy and the die-back, death, and ultimate decay of trees. In aquatic habitats, the presence of a variety of structural features such as logs and boulders that create a variety of habitat. FEMAT

Subnivean - Situated or occurring under the snow.

Succession - A series of dynamic changes by which one group of organisms succeeds another through stages leading to potential natural community or climax. An example is the development of series of plant communities (called seral stages) following a major disturbance. FEMAT

Succession (plant) - The process of vegetative development whereby an area becomes successively occupied by different plant communities of higher ecological order. Secondary succession refers to this process after some disturbance occurs that moves a plant community to an earlier seral stage.

Sympatrically - Temporal and spatial overlap of the ranges of two or more species.

Timber Management - A general term for the directing, managing or controlling of forest crops and stands of trees.

Timber Production - The purposeful growing, tending, harvesting, and regeneration of regulated crops of trees to be cut into logs, bolts, or other round sections for industrial or consumer use other than for fuelwood. FEMAT

Tractive - the act of being pulled (by water).

Trend (aka "range condition trend") - The direction of change in range condition.

Type Converted - The change from one specific, definable plant community to another on the same ecological site.
Use Pattern Mapping - A process that entails traversing a grazing area (allotment or pasture) to obtain a general concept of the patterns of utilization. These patterns are recorded on suitable maps by 6 different zones - no use, slight, light, moderate, heavy, and severe use.

Utilization ("use" or "grazing use")- The proportion of current year's vegetative production that is consumed or destroyed by grazing animals. May refer either to a single species or to the vegetation as a whole.

Vagility - An organisms capability or tendency to become widely dispersed.

Watershed - The drainage basin contributing water, organic matter, dissolved nutrients, and sediments to a stream or lake. FEMAT

Watershed Analysis - A systematic procedure for characterizing watershed and ecological processes to meet specific management and social objectives. Watershed analysis provides a basis for ecosystem management planning that is applied to watersheds of approximately 20 to 200 square miles. FEMAT

Wet Meadows - Areas where grasses predominate. Normally waterlogged within a few inches of the ground surface for a significant period during the year.

Wetlands - Areas that are inundated by surface water or ground water with a frequency sufficient to support, and under normal circumstances do or would support, a prevalence of vegetative or aquatic life that require saturated or seasonally saturated soil conditions for growth and reproduction (Executive Order 11990). Wetlands generally include, but are not limited to, swamps, marshes, bogs, and similar area. FEMAT

Wilderness - Areas designated by congressional action under the 1964 Wilderness Act. Wilderness is defined as undeveloped federal land retaining its primeval character and influence without permanent improvements or human habitation. Wilderness areas are protected and managed to preserve their natural conditions, which generally appear to have been affected primarily by the forces of nature with the imprint of human activity substantially unnoticeable; have outstanding opportunities for solitude or for a primitive and confined type of recreation; include at least 5,000 acres or are of sufficient size to make practical their preservation, enjoyment, and use in unimpaired condition; and may contain features of scientific, education, scenic, or historical value as well as ecologic and geologic interest. FEMAT

Wildfire - Any wildland fire that does not meet management objectives, thus requiring a fire suppression response. Once declared a wildfire, the fire can no longer be declared a prescribed fire.

Windthrow - A tree or trees uprooted or felled by the wind. FEMAT

Woody Debris - See Large Woody Debris.

Underburning - Prescribed burning of the forest floor or understory for botanical or wildlife habitat objectives, hazard reduction, or silvicultural objectives. FEMAT

Understory - The trees and other woody species growing under the canopies of larger adjacent trees and other woody growth. FEMAT

Xeric - low or deficient in moisture.

Appendices

Appendix A

Table A-1. Soil Susceptibility Ratings

Soil Type	Acres	Compaction Susceptibility	Nutrient Loss Susceptibility	Erosion Susceptibility
13C	4086	H	M	M
13E	338	H	M	M
15C	1030	H	M	M
16A	643	H	M	M
24C	4518	H	M	M
24E	820	H	M	M
57E	920	M	M	L
57G	232	M	M	L
58E	313	M	M	L
58G	43	M	M	L
77F	456	M	M	M
77G	714	M	M	M
78F	914	M	M	M
79E	3027	M	M	L
80E	5334	M	M	L
96B	223	H	M	M
99A	534	H	M	M
107E	398	M	M	M
125F	138	H	H	H
129B	484	M	M	M
135E	700	H	M	M
136E	702	H	M	M
138C	636	H	M	M

Table A-1. Soil Susceptibility Ratings				
Soil Type	Acres	Compaction Susceptibility	Nutrient Loss Susceptibility	Erosion Susceptibility
142C	13	H	M	M
145C	18643	H	M	M
147C	35620	H	M	M
152B	1029	H	H	M
171E	541	M	M	M
172E	764	M	M	M
173D	2541	M	M	M
173F	1464	M	M	M
174G	5183	M	M	M
192A	270	H	M	M
202F	1344	M	M	M
203F	829	M	M	M
204E	12142	M	M	M
205E	13114	M	M	M
208C	58	M	M	L

Table A-2. Levels of Disturbance Resulting from Various Forest Management Activities (by disturbance type)				
Activity	Loss of Surface Cover	Compaction	Displacement	Overall Disturbance
Hand Felling	L	L	L	L
Mechanical Felling	L-M	M-H	L-M	M
Cable Yarding	L	L	L	L
Tractor Yarding	M	M	L-Slopes <30% M-Slopes 30-65% H-Slopes >65%	M
Scarification	H	M	H	H
Hand Pile	L	L	L	L
Excavator Pile	L	L-M	L	L

Machine Pile	H	M	H	H
Broadcast Burn	M	L	L	L
Ripping (rock ripper)	L	L	M	L
Ripping (winged ripper)	L	L	L	L
Road Construction	H	H	H	H

Appendix B
Priority Species Within the TPLA Area

Species	Federal Status	BLM Status	Other Status
Bat	None		
Bat, Townsend's big eared	None		State Sensitive
Deer, black-tailed	None		Social status
Deer, mule	None		Social status
Eagle, bald	Threatened		
Elk	None		Social status
Goshawk, Northern	None	Assessment	State Sensitive
Nuthatch, pygmy	None	Assessment	State Sensitive Protection Buffer
Owl, flammulated	None		Protection Buffer
Owl, great gray	None		Protection Buffer
Owl, Northern spotted	Threatened		
Woodpecker, white-headed	None	Assessment	State Sensitive Protection Buffer

List of the amphibians, reptiles, birds, and mammals documented or with the potential to occur within the Topsy/Pokegama Landscape Analysis, and their status.

Common Name	*Scientific Name*	*Status*
AMPHIBIANS		
Spotted Frog	*Rana pretiosa*	*PS,OU,3*
Ensatina	*Ensatina eschscholtzii*	
Cascades Frog	*Rana cascadai*	*PS,,OV,3*
Great Basin Spadefoot	*Scaphiopus intermontanus*	
Pacific Chorus Frog	*Hyla regilla*	
Foothill Yellow-legged Frog	*Rana boylii*	*OV,3*
Bull Frog	*Rana catesbeiana*	
Western toad	*Bufo boreas*	*OV,3*

Long-toed Salamander	Ambystoma macrodactylum	
Pacific Giant Salamander	Dicamptodon tenebrosus	
Rough-skinned Newt	Taricha granulosa	PS

REPTILES		
Western Pond Turtle	Clemmys marmorata	S,OC,2,M
Western Fence Lizard	Sceloporus occidentalis	
Western Skink	Eumeces skiltonianus	
Southern Alligator Lizard	Gerrhonotus multicarinatus	
Northern Alligator Lizard	Gerrhonotus coeruleus	
Short-horned lizard	Phrynosoma douglassi	
Rubber Boa	Charina bottae	
Western Yellow-bellied Racer	Coluber constrictor morman	
Sharptail snake	Contia tenuis	OV,4
Gopher Snake	Pituophis melanoleucus	
Klamath Garter Snake	Thamnophis elegans	
Common Garter Snake	Thamnophis sirtalis	
California Mountain Kingsnake	Lampropeltis zonata	
Ringneck snake	Diadophispuncattus	
Racer	Coluber constrictor	
Western Rattlesnake	Crotalis viridis	

MAMMALS

FURBEARERS		
Bobcat	Lynx rufus	
Wolverine	Gulo gulo	S,OT,2,M
Shorttail Weasel	Mustela erminea	
Fisher	Martes pennanti	PS,OC,2
American Marten	Martes americana	PS,OC,3,M,BSO

Ermine	Mustela erminea	
Long-tailed Weasel	Mustela frenata	
Mink	Mustela vison	
Red Fox	Vulpes vulpes	
Common Gray Fox	Urocyon cinereoargenteus	
Coyote	Canis latrans	
American Badger	Taxidea taxus	
Muskrat	Ondatra zibethica	
Northern River Otter	Lutra canadensis	
American beaver	Castor canadensis	
Ringtail	Bassariscus astutus	
Raccoon	Procyon lotor	

BATS		
Pacific Western Big-eared Bat	Plecotus townsendii townsendii	S,OC, M
Pallid Bat	Antrozous pallidus	OV,3
Big Brown Bat	Eptesicus fuscus	
Hoary Bat	Lasiurus cinereus	
Fringed Myotis	Myotis thysanodes	OV,1,
Silver-haired Bat	Lasionycteris noctivagans	
Little Brown Myotis	Myotis lucifugus	
Long-legged Myotis	Myotis volans	
Yuma Myotis	Myotis yumanensis	
Long-eared Myotis	Myotis evotis	
California Myotis	Myotis californicus	
Western Pipistrel	Pipistrellus hesperus	
Western small-footed Myotis	Myotis ciliolabrumaka leibii and subulatus	

BIG GAME		
Elk	Cervus elaphus	M
Black-tailed deer	Odocoileus hemionus	
Mountain Lion	Felis concolor	
Black Bear	Ursus americanus	

SMALL MAMMALS		
Bushy-tailed Woodrat	Neotoma cinera	
Dusky-footed Woodrat	Neotoma fuscipes	
Marsh Shrew	Sorex bendirii	
Water Shrew	Sorex palustris	
Vagrant Shrew	Sorex vagrans	
Trowbridge shrew	Sorex trowbridgii	
Dusky shrew	Sorex obscurus	
Shrew-mole	Neurotrichus gibbsii	
Mole	Scapanus latimous	
Western Red-backed Vole	Clethrionomys californicus	
Heather Vole	Phenacomys intermedius	
Long-tailed Vole	Microtus longicaudus	
Montane Vole	Microtis montanus	
Water Vole	Microtus richardson	
Western Harvest Mouse	Reithrodontomys Meqalotis	
Deer Mouse	Peromyscus maniculatus	
Western Jumping Mouse	Zapus princeps	
Pacific Jumping Mouse	Zapus trinotatus	
Yellow-pine chipmunk	Tamias amoenus	
Least Chipmunk	Tamias minimus	
Yellow-bellied marmot	Marmota flaviventris	

Western gray squirrel	Sciurus griseus	OU
Northern Flying Squirrel	Glaucomys sabrinus	
California Ground Squirrel	Spermophilus beecheyi	
Belding's Ground Squirrel	Spermophilus beldingi	
Golden-mantled Ground Squirrel	Spermophilus lateralis	
Douglas Squirrel	Tamiasciurus douglasii	
Botta's Pocket Gopher	Thomomys bottae	
Western Pocket Gopher	Thomomys mazama	
Common Porcupine	Erethizon dorsatum	
Striped Skunk	Mephitis mephitis	
Spotted Skunk	Spilogale putorius	
American Pika	Ochotona princeps	
Mountain Cottontail	Sylvilagus nuttallii	
Snowshoe Hare	Lepus americanus	
Black-tailed jack rabbit	Lepus californicus	

BIRDS OF PREY		
Golden Eagle	Aquila chrysaetos	P
Bald Eagle	Haliaeetus leucocephalus	FT,OT,1,P,M
Northern Harrier	Circus cyaneus	
Sharp-shinned Hawk	Accipiter striatus	
Cooper's Hawk	Accipiter cooperii	
Northern Goshawk	Accipiter gentilis	PS,OC,3,P,M
Swainson's Hawk	Buteo swainsoni	OV,3
Red-tailed Hawk	Buteo jamaicensis	
Rough-legged Hawk	Buteo lagopus	
Ferruginous Hawk	Buteo regalis	S,OC,3,M
Osprey	Pandion haliaetus	P

American Kestrel	Falco sparverius	
Merlin	Falco columbaris	2,BAO
Peregrine Falcon	Falco peregrinus	FE,OT,1,P,M
Prairie Falcon	Falco mexicanus	P
Flammulated Owl	Otus flammeolus	PS,OC,4,P,BSO
Western Screech Owl	Otus kennicottii	
Great Horned Owl	Bubo virginianus	
Northern Pygmy Owl	Glaucidium gnoma	OU,3
Northern Spotted Owl	Strix occidentalis caurina	FT,OT,1,P,M
Barred Owl	Strix varia	
Great Gray Owl	Strix nebulosa	PS,OV,4,P
Long-eared Owl	Asio otus	
Boreal Owl	Aegolius funereus	3
Northern Saw-whet Owl	Aegolius acadicus	
Barn Owl	Tyto albo	

UPLAND BIRDS		
Blue Grouse	Dendragapus obscurus	
Ruffed Grouse	Bonasa umbellus	
Wild Turkey	Meleagris gallopavo	
California Quail	Callipepla californica	
Mountain Quail	Oreortyx pictus	FC2,4
Mourning Dove	Zenaida macroura	

WOODPECKERS		
Red-naped Sapsucker	Sphyrapicus nuchalis	
Williamson's Sapsucker	Sphyrapicus thyroideus	OU,4,
Lewis' Woodpecker	Melanerpes lewis	OC,3,BSO

Acorn Woodpecker	Melanerpes formicivorus	OU,3
Red-breasted Sapsucker	Sphyrapicus ruber	
Downy Woodpecker	Picoides pubescens	
Hairy Woodpecker	Picoides villosus	
White-headed Woodpecker	Picoides albolarvatus	PS,OC,3,BSO
Three-toed Woodpecker	Picoides tridactylus	PS,OC,4,P,M,BSO
Black-backed Woodpecker	Picoides arcticus	PS,OC,4,BAO
Northern Flicker	Colaptes auratus	
Pileated Woodpecker	Dryocopus pileatus	PS,OC,4,P,M,BSO

WATER ASSOCIATED BIRDS		
American White Pelican	Pelecanus erythrorhynchos	S,OV,2,BAO
Double-crested cormorant	Phalacrocorax auritus	
Western least bittern	Ixobrychus exilis hesperis	FC2,OP/NR,2
American Bittern	Botaurus lentiginosus	
Great Blue Heron	Ardea herodias	
Great Egret	Casmerodius albus	OU,4
Snowy Egret	Egretta thula	OV,2
White-faced Ibis	Plegadis chihi	PS,OV,4
Black-crowned Night Heron	Nycticorax nycticorax	
Green-backed Heron	Butorides striatus	
Greater Sandhill Crane	Grus canadensis tabida	S,OV,4,S
Tundra Swan	Cygnus columbianus	
White-fronted Goose	Anser albitrons	
Snow Goose	Chen caerulescens	
Ross' Goose	Chen rossii	
Canada Goose	Branta canadensis	
Wood Duck	Aix sponsa	
Green-winged Teal	Anas crecca	

Mallard	Anas platyrhynchos	
Northern pintail	Anas acuta	
Blue-winged Teal	Anas discors	
Cinnamon Teal	Anas cyanoptera	
Northern Shoveler	Anas clypeata	
Gadwall	Anas strepera	
American Wigeon	Anas americana	
Redhead	Aythyra americana	
Ring-necked Duck	Aythyra collaris	4
Common Goldeneye	Bucephala clangula	
Barrow's Goldeneye	Bucephala islandica	OP/NR,4
Bufflehead	Bucephala albeola	OP/NR,2,BAO
Hooded Merganser	Lophodytes cucullatus	
Common Merganser	Mergus merganser	
Ruddy Duck	Oxyura jamaicensis	
Yellow Rail	Coturnicops noveboracensis	S,OC,2,M,BSO
Virginia Rail	Rallus limicola	
Sora	Porsana carolina	
American Coot	Fulica americana	
Killdeer	Charadrius vociferus	
Black-necked Stilt	Himantopus mexicanus	
American Avocet	Recurvirostra americana	
Marbled Godwit	Limosa fedoa	
Greater Yellowlegs	Tringa melanoleuca	2,BAO
Willet	Catoptrophorus semipalmatus	
Long-billed Curlew	Numenius americanus	S,FC3,4,M
Western Sandpiper	Calidris mauri	
Spotted Sandpiper	Actitis macularia	
Long-billed Dowitcher	Lomnodermuis scolopaceus	
Common Snipe	Galinago gallinago	

Wilson's Phalarope	Phalaropus tricolor	
Bonaparte's Gull	Larus philidelphia	
Ring-billed Gull	Larus californicus	
California Gull	Larus californicus	
Caspian Tern	Sterna caspia	
Forster's Tern	Sterna forsteri	3
Black Tern	Chlidonias nigar	PS,4

NEOTROPICAL MIGRANTS		
Common Nighthawk	Chordeiles minor	
Common Poorwill	Phalaenoptilus nuttallii	
Vaux's Swift	Aeronautes saxatalis	
Black-chinned Hummingbird	Archilochus alexandri	3
Anna's Hummingbird	Calypte anna	
Calliope Hummingbird	Stellula calliope	
Rufous Hummingbird	Selasphorus rufus	
Belted Kingfisher	Ceryle alcyon	
Western Kingbird	Tyrannus verticalis	
Olive-sided Flycatcher	Contopus borealis	
Western Wood-Peewee	Contopus sordidulus	
Willow Flycatcher	Empidonax traillii	
Hammond's Flycatcher	Empidonax hammondii	
Dusky Flycatcher	Empidonax oberholseri	
Gray Flycatcher	Empidonax wrightii	
Pacific-slope Flycatcher	Empidonax difficilis	
Cordilleran Flycatcher	Empidonax occidentalis	
Say's Phoebe	Sayornis saya	
Ash-throated Flycatcher	Myiarchus cinerascens	
Purple Martin	Progne subis	OC,3,BSO

Tree Swallow	Tachycineta bicolor	
Violet-green Swallow	Tachycineta thalassina	
N. Rough-winged Swallow	Stelgidopteryx serripennis	
Bank Swallow	Riparia riparia	OU,3
Cliff Swallow	Hirundo pyrrchonota	
Barn Swallow	Hirundo rustica	
House Wren	Troglodytes aedon	
Ruby-crowned Kinglet	Regulus calendula	
Blue-gray Gnatcatcher	Polioptila caerulea	
Mountain Bluebird	Sialia currucoides	
Swainson's Thrush	Catharus ustulatus	
Hermit Thrush	Catharus guttatus	
American Robin	Turdus migratorius	
American Pipit	Anthus rubescens	
Cedar Waxwing	Bombycilla cedrorum	
European Starling	Sturnus vulgaris	
Solitary Vireo	Vireo solitarius	
Warbling Vireo	Vireo gilvus	
Orange-crowned Warbler	Vermivora celata	
Nashville Warbler	Vermivora ruficapilla	
Yellow Warbler	Dendroica petechia	
Yellow-rumped Warbler	Dendroica coronata	
Black-throated Gray Warbler	Dendroica nigrescens	
Townsend's Warbler	Dendroica townsendii	
Hermit Warbler	Dendroica occidentalis	
MacGillivray's Warbler	Oporornis tolmiei	
Wilson's Warbler	Wilsonia pusilla	
Black-headed Grosbeak	Pheucticus lelanocephalus	
Lazuli Bunting	Passerina amoena	

Green-tailed Towhee	Pipilo chlorurus	
Chipping Sparrow	Spizella passerina	
Brewer's Sparrow	Spizella breweri	
Vesper Sparrow	Pooecetes gramineus	CU
Savannah Sparrow	Passerculus sandwichensis	
Lincoln's Sparrow	Melospiza lincolnii	
Fox Sparrow	Passerella iliaca	
White-crowned Sparrow	Zonotrichia leucophrys	
Yelow-headed Blackbird	Xanthocephalus xanthocephalus	
Brewer's Blackbird	Euphagus cyanocephalus	
Brown-headed Cowbird	Molothrus ater	
Northern Oriole	Icterus galbula	
Western Tanager	Piranga ludoviciana	
American Goldfinch	Carduelis tristis	
Cassin's Finch	Carpodacus cassinii	
Turkey Vulture	Cathartes aura	

OTHER BIRDS		
Wrentit	Chamaea fasciata	
Black-capped Chickadee	Parus atricapillus	
Mountain Chickadee	Parus gambeli	
Chestnut-backed Chickadee	Parus rufescens	
Plain Titmouse	Parus inornatus	
Bushtit	Psaltriparus minimus	
Red-breasted Nuthatch	Sitta canadensis	OV,4,
White-breasted Nuthatch	Sitta carolinersis	
Pygmy Nuthatch	Sitta pygmaea	OV,
Brown Creeper	Certhia americana	
Bewick's Wren	Thryomanes bewickii	

Winter Wren	*Troglodytes troglodytes*	
Golden-crowned Kinglet	*Regulus satrapa*	
Western Bluebird	*Sialia mexicana*	*OV,4*
Townsend's Solitaire	*Myadestes townsendi*	
Varied Thrush	*Ixoreus naevius*	
American Dipper	*Cinclus mexicanus*	
Rufous-sided Towhee	*Pipilo erythrophthalmus*	
Fox Sparrow	*Passerella iliaca*	
Song Sparrow	*Melospiza melodia*	
Golden-crowned Sparrow	*Zonotrichia atricapilla*	
Dark-eyed Junco	*Junco hyemalis*	
Western Meadowlark	*Sturnella neglecta*	
Red-winged Blackbird	*Agelaius phoeniceus*	
House Sparrow	*Passer domesticus*	
Pine Siskin	*Carduelis pinus*	
Lesser Goldfinch	*Carduelis psaltria*	
Red Crossbill	*Loxia curvirostra*	
Purple Finch	*Carpodacus cassinii*	
House Finch	*Carpodacus mexicanus*	
Evening Grosbeak	*Coccothraustes vespertinus*	
Gray Jay	*Perisoreus canadensis*	
Steller's Jay	*Cyanocitta stelleri*	
Scrub Jay	*Aphelocoma coerulescens*	
Clark's Nutcracker	*Nucifraga columbiana*	
Black-billed Magpie	*Pica pica*	
American Crow	*Corvus brachyrhynchos*	
Common Raven	*Corvus corax*	

Abbreviations used:
PS- May be listed in the near future as sensitive by region 6 of the U.S. Forest Service;
S- Listed as sensitive By Region 6 of the U.S. Forest Service
FE- Listed as endangered by U.S. Fish and Wildlife Service

FT- Listed as threatened by the U.S. Fish and Wildlife Service
OT- Oregon Threatened
OC- Oregon Critical
OV- Oregon Vulnerable
OU- Oregon Undetermined
OP/NR- Oregon peripheral species or naturally rare
1- Oregon Natural Heritage Program List 1
2- Oregon Natural Heritage Program List 2
3-Oregon Natural Heritage Program List 3
4- Oregon Natural Heritage Program List 4
P- Winema Forest Plan Protection Species
M- Winema National Forest Plan Monitor Species
BSO- BLM Sensitive in Oregon
BAO- BLM Assessment in Oregon

Klamath Falls, Oregon
May 20, 1996

I certify the following three documents are true copies of oral history interview original documents by L.Deich, Medford District Archaeologist. These interviews are dated November 9, 1976 and November 10, 1976.

William D. Yehle,
Archaeologist
Klamath Falls Resource Area

Interview with Devere Helfrich
Nov. 9 1976
Re: Topsy Road

I spent about 3 1/2 hours interviewing Mr. Helfrich and his wife Georgia at their home at 110 Georgia St. Klamath Falls Oregon. Mr. Helfrich a retired photogragher, has made a lifelong avocation of a study of the Oregon Trail and other pioneer routes. He has written and lectured extensively on this subject and is a generally recognized authority. His outlook is that of the professional, critical and objective.

The following general information was obtained. While there was and aboriginal trail in the vicinity of Topsy Road this was not an important route to the earliest Whites in the area. In the early 1850s the very little traffic that existed between the Klamath Basin and the Yreka area was mostly via a trail that led from Yreka to Little Shasta, thence Southeast around the foot of Sheep Rock, and then North East through grass Lake and Butte Valley, more or less following the route of the present US Hwy 97.

In the early 1860s this route was superseded by the more direct Ball Mtn. Road, Which went North from Grass Lake skirting the Eastern edge of Ball Mtn. and the Western Edge of Meiss Lake. This route was used by pack teams (not wheeled vehicles) and many of the supplies for the Modoc War came over it. An alternate route for pack trains was through the Ward Pokeama area from Killibrew to Keno. This Western route was the one used by George Nurse and Whittle.

The first wagon road connecting the Klamath Basin with Yreka was constructed along the Klamath River by Tichnor or Tickner in 1873 with the grade down the canyon being along the old Indian trail and about 200 yds above the present Topsy grade. This was apparently called the Yreka Linkville road and may have been financed by Klamath Co (Helfrich is not sure)(No mention of the road in Siskiyou County supervisors minutes at this time -L.D.)

The name "Topsy" was definitely in use by 1891, appearing in local newspaper account during that year. The origin of the name is uncertain. According to Helfrich, there was a local tale to the effect that there had been a Black washerwoman named Topsy employed at the station at the top of the grade (Elgin station) during the 80s. Topsy, in addition to clean shirts had supplied other services of a more intimate nature to the drivers of the many freight teams, who began to refer first to the Elgin station and subsequently to the road as "Topsy" As of this writing it has been impossible to confirm or deny this account from other sources.

The grade was rebuilt by Chase in the 1880s and again (in its present location) by Emmitt in 1889. While the Southern Oregon Wagon Road was an important route for travel and visiting since many of the early Klamath settlers came from the Ashland area the Topsy road was important because it was a year around route while the Southern Oregon Wagon Road was impassable due to snow during the Winter months.

While the topsy road remained important as an all weather link beetween the Klamath Basin and the outside world from 1875 until 1925 its peak use as a freight route was from 1887 to 1903. In the former year the rail lines reached as far a Montague. Klamath bound freight was off loaded here and subsequently Ager and taken to Klamath Falls by Wagon over the Topsy road. In 1903 a rail line was extended from Thrall through Pokegama to Keno thus eliminating the need for the long wagon trip up the klamath. Finally in 1909 the mainline reached Klamath Falls.

In 1906 the first automobile to reach the Klamath Basin was driven in from Montague over Topsy road by H.E. Peltz. This remained the preferred automobile road to the area until the Greensprings Hwy was gravelled in 1922. Thus a trip by auto from Portland to Klamath Falls involved going by way of Yreka. During the teens 27 hours was concidered a very fast time for this journey. Trvel from Bend to Klamath Falls was even more circuitous, requiring one to travel by way of the Dalles to Portland and thence through Yreka to Klamath Falls.

Helfrich gives the following account of Stations along Topsy road during its' heyday. Beginning at Keno one would tavel about 5 miles to the Chase Station which was an important hostelry from 1887 to 1909. The site is now about 1/2 mile soth of hwy. 66 and visable from this road. Proceeding southfrom here there were several farms such as the Conway place (near the present John C. Boyle dam) and the Neiper place. There were no regular stage stops however until one came to Topsy (Elgin) a short distance North of the present intersection with the Dorris rd. A school and a small sawmill were located at the far end of the meadow here about 1 mile to the East. Lumber from this and other small mills in the area was all taken by wagon to Dorris until the Kesterson operation came in with rails in about 1900.

Going on down the topsy grade one came upon the turnoff into the Frain place at the bottom. (This turnoff is now the PPL raod) The smaller place just down stream belonged to an Indian woman. Hlafrich thinks the school at the base of the grade was built about 1909.

18 miles from Keno one came to the Kerwin place. This is just past Rock Creek. The house, a substantial 2 story frame structure was on the south side of the road.

At about 20 miles one passed the Way Cemetery and at 21 miles the Way Ranch and the Cully Stowe (Properly Stough) cabin which was once a school house The Way ranch was a regular Stage stop. Helfrich thinks the ranch was occupied from the mid 80s to fairly recent times.

At 26.0 miles the Hessig Ranch (site of the rock wall on the South) was encountered. According to local lore one of the Hessig women died from being forced by her husband to work on the wall while pregnant. Hessig arrived in 1884 but the ranch was established before that.

At 27 miles One came to Beswick or Klamath Hot Springs which was settled by Beswick in 1873. He sold the resort in 1887 and it continued in operation until about 1915. Mr. Helfrich suggested I contact Vera Hutchinson for more detailed Information.

Interview with Vera Hutchinson
Nov. 1976
Re: Topsy Road

I interviewed Mrs. Hutchinson at her home at 5251 Walton Drive in Klamath Falls with her husband Lester also present, while some information came from Lester, most of the interview which took nearly four hours was directed toward Mrs. Hutchinson. Mrs. Hutchinson was born 1898 the daughter of Wm. Alonso "Lon" Frain owner of the Frain Ranch. Her Maternal grandparents were the Ways who operated the Way Station. She grew up on the Frain Ranch and attended the Topsy school. Both Mrs Hutchinson and her husband who is now 82 and arrived here in 1916 are alert and articulate. They are active in the local Historical Society. Mrs. Hutchinson was able to supply a large amount of detail to the account of the road already given me by Helfrich. However the general background I had already received from Helfrich was certainly a help in directing my questions to the Hutchinsons.

Mrs. Hutchinson said that the road originally went over Chicken Hill. It was named Chicken Hill because Thomas Way lost a large number of Chickens here while transporting them to Keno. She can recall that there were mileposts at the summit of Chicken Hill and Robbers Rock at the base of Tpsy Grade and that these two points were 5 miles apart. She recalls a Conley (or Conway?) place and a Neiper Hill on this upper section of the road. Also a Jess High home at the far end of the long Meadow by Topsy.

<u>Topsy</u> or <u>Elgin House</u> Was operated by Charley Elgin and his mother Elizabeth who actually did most of the operating. Charley was a bachelor being "too lazy to have a wife". The building was a 2 story frame house with dormer windows. It was partly green, at least the window trim, but otherwise unpainted. Meals were served here but there were few overnight visitors. Horses were not changed here and there was no large barn. The site now belongs to the Sargents of Dorris.

<u>School</u> The present school building was brought in from Pokegama in 1916.[1], [2] The building was taken apart and moved on horse drawn wagons. This building now belongs to Vera? She did not attend school in this building but in a previous building at the same site and also at another site above the rim about a mile Northeast of Topsy. A dancehall and a sawmill were also located at this site.

Vera says that sometimes she was the only pupil and that attendance was never more than 7 or 8 students.

Teachers in the Topsy school in order as she remembers them were:
Bernardine Hamilton
Molly Donaldson
Miss Goodall
A Miss Wolfe from Colorado who only stayed for about a month. She apparently became involved in an affair with Dr. Safely of Dorris who shot her through the knee during a lovers quarrel. Folks said it couldn't have been a flesh wound since Miss Wolfe was too skinny to have any flesh.
(these apparently taught before the present building was erected)
Following this there were:

---

[1]Note in margin "Bldg. 1b on B.L.M." may be a photo referance (?).

[2]Building has fallen in on itself and is no longer restoreable.

Vera Hutchinson

Winifred Spencer
Miss French, an old maid who lived in a spare room at the school building.
Mrs. Wight
Helen McCarnack
Alice Porter
Alice Kos, now residing in Prospect [Recently deceaced 1989]

School depended on the weather and the school year usually lasted only about 3 months, 6 weeks in the Fall and another 6 in the Spring. Grades 1 through 8 were taught together, with much of the teacher's time being devoted to individual tutoring. Subjects included arithmetic, spelling and geography. A number of texts were used but Vera does not recall the names of any of them. Klamath Falls had the only High School in the County at the time. There was little interest in anything beyond the barest rudiments of education at the time, especially for boys. (It does seem, however, that primary education and basic literacy were regarded as important).

The Frain place Was originally taken up by Tom Staten (or Stayton) but Martin Frain (Vera's grandfather) bought it in 1889, In 1892 his 3 sons William Lorenzo, Frederick and Roderick bought the place and two years later William Lorenso bought out his 2 brothers. A 2 story frame house with a dormer window was built in 1910 and was burned in 1939. Vera has photos of this and a former cabin. (Two other structures, the shop and the barn still stand slide #1, #5, #9) The property was sold to COPCO in 1928 but the family continued to live there until 1932.

The spencer place just downstream was built around 1900. The original inhabitant was Martha Bryan, and Indian woman. Spencer subsequently bought it (slide #3).

They raised hay, fruit, and misc. produce, cattle, sheep, and hogs. About 400 headof cattle were kept. The only foodstuffs purchased from outside were flour, sugar, and green coffee beans which they parched and ground. Cattle were sold to buyers from Montague, Yreka, and Klamath Falls with some of the better ones being shipped to SanFrancisco. They sold only 2 year old steers. Cattle were fattened at the ranch. A steer brought about 1 1/2 cents a pound and yearly gross income for the ranch was $800 to $900. This was considered a prosperous farm "a veritable paradise".

They made one trip a year to Ashland or Klamath Falls (usually Ashland) for supplies, dental work, eyeglasses, ect. Usually purchased 500 or more pounds of flour. 100 to 200 pounds of sugar add 100 of coffee. The trip to Ashland took three days each way and they camped out enroute. They also camped at the edge of town during the ashland stay as they considered a hotel too expensive.

Her father purchased his first automobile in 1916, an Overland touring car. After that they went most often to Klamath Falls to shop, a trip which took about 2 hours. The first automobile which Vera can remember was a Stutz (Vera is very positive as to the marque) steamer which ran to Beswick as a stage, she recalls that it was bright red with polished brass trim and very oranate. She recalls this must have been about 1910. She recalls they often had to pull early autonbiles out of the mud or up steep grades with horses. In particular remember having to tow Mr. Petz back to Topsy road from the Frain place after he had made the error of driving down the steep grade, apparently while drunk and lost. By 1920 automobile ownership had become universal among the farmers along the road.

Kerwin Ranch Later sold to Raymond. The Kerwins were and Irish couple and vey well liked and hospitible people. They frequently served tea and cakes to passersby. There were two sons. One of these "had lost his mind over religion" and had spells. The other son was normal. They had a small farming operation and took an occasional overnight boarder but this was not a regular stage stop.

Vera Hutchinson

Vera recalls Kerwin as a hard worker and a fine singer though he occasionly got drink with rather comical consequenses. She recalls one incident when the elder Kerwin and his normal son overimbibed at a party in Beswick and went wading fully clad in Nigger Creek. She recalls that Mrs. Kerwin died on Christmas Eve but does not recall the year. (It must have been prior to 1916) Lon Frain transported the "corps" to Yreka with a horse drawn wagon. The place was abandoned about 1922 when Mr. Raymond died.[3]

Way Station This was a major stop operated by Vera's maternal grandparents. There was a big frame house (2 story) with about 8 bedrooms. Downstairs there was a living room for the men and a parlour for the ladies, and a long dining room with home made furniture. There was much overnight traffic and the place was usually full. Grandmother Way could recognize the approaching teams from the sound of the bells on the horses, Those of each freighter having a somewhat different sound so that she was able to identify the approaching guest and prepare for him. Her grandfather was a blacksmith. The Stough cabin (photo page 27)was originally built to serve as a school for the Way and Hessig children.

There were usually about 12 diners at a time around the big table. A typical meal was very hearty with a main course of roast beef or less often chicken or chicken and dumplings. All bread and other baked goods were made on the site. The price of a meal was 50c and a bed was 25c. Thomas Way and his Wife, Mary Elizabeth had two boys and 5 girls. They farmed primarily to supply food for themselves and the restaurant rather than for market and their income was almost entirely from the stage station.

Waw place This is the cabin (still standing) on the small meadow on the state line. Mr. Waw was an elderly bachelor.

Hessig place This is marked by the rock fence on the South side of the road and has been occupied at least since early 80s. The Hessigs raised a lot of cattl which they butchered themselves to supply beef to the logging camps at Snow and Pokegama

Beswick (Klamath Hot Springs) Now owned by Laubacker. Present dance pavillion was built on the site of the Stone Hotel which burned in 1911. The nearby building which now has a metal roof was known as the "Social Hall" (apparently a euphemism or more elegant term for "dance hall". In addition to the original hotel which Joe Beswick built in 1872 and the Other building atop the hill to the south of the road (photo page 28, slides 76,77) there were three rows of small cabins. There were often 100 or more guests at the resort including some who camped in tents. There were guides for fishing and hunting trips, as well as hot mud baths. The resort was taken over by a Mrs. Edson (possibly a relative of Beswicks) who operated it until she sold out to the Hessigs in 1920. The resort has not operated since that time.

The dances at Beswick which Vera often atteneded as a girl began at sunset on Saturday and lasted until sunrise Sunday morning. With the dancers pausing for a midnight supper. Music was supplied by a piano, violin and organ, all played by locally recruited talent, Veras father got $5.00 for an all night stint on the fiddle, although this was sometimes supplemented by tips. There were usually about 50 people in attendance at the dance and the price of admission, including the midnight supper was 75c. When this was raised to $1.00 about 1916 there was considerable grumbling and attendance dropped. In addition to Saturdays there were special dances on Christmas and other holidays. Turkey shoots, especially at Thanksgiving were another popular form of social recreation. There was also a billiard hall

---

[3]Hugh Kerwin Father 1825 to 7-28-1922 Bogus CA.
William Joseph Sept. 30 1877 to 1-9-1902 Liverly Stable on Topsy grade.

and saloon in Beswick and another saloon at Truits 1 1/2 miles South from Beswick. (there do not appear t have been any saloons on the Oregon side).

There were no churches in the area and Vera does not recall organized religion as playing any significant part in daily affairs. A preist occassionally visited the Kerwins and was in attendance when Mrs. Kerwin died. Sunday was observes as a day of rest and was marked by visiting, having neighbors over for dinner ect.

Going further toward Ager were the Lennox place the Spannaus place and the Keaton place. The trip from Ager to Beswick was easy going and the freighters generally made the trip (20 miles) in one day with a meal stop at the Jonesplace (JJJ ranch) The Jones ranch was also a well known moonshining operation. A second day was generally required from Beswick to Way, and a third day from Way to Chace or Keno. In bad weather the freight wagons might take 5 days for the entire trip. The stages which changed horses along the way were able to make the trip overnight.

Additional recollections There are three men buried in an Oak grove this (North) side of Hessigs. They drowned while trying to break up a log jam on the river nearby.

Charley Butler was a young man, a bachelor who lived acroos the river and upstream a short distance from the Frain's. He reportedly was a Univ. of Chicago graduate. (Vera has a photograph of him). He often stayed with the Frains. One morning after staying overnight he got up early and left the house. Later Lon Frain called him for breakfast. When he did not respond Lon followed his tracks in the snow. As the trail approached the bridge Butler appeared to have broken into a run. The tracks ended on the bridge where he had jumped off, an apparent suicide, his body was found about 4 months later near Beswick. This happened when Vera was quite small. Probably about '06.

The flood of 1905 took out all the bridges and waterwheels (used fror irrigation) along the river.

In the early 1900s the Hessigs attempted to build a telephone system powered by dry cells and using oyster cans as speakers. Her father, Lon, said the system was really no more effective than sticking ones head out the window and shouting.

Tallow candles were used for lighting. these could be manufactured at home. Lamps would have requred one to buy kerosene and haul it in. Mantle lamps made their appearance in the early 20s.

Most clothing was made at home and very little cloth was pruchsed, rather used garments were cut down or reused.

Most of the income from cattle went to pay taxes or was reinvested in farm inprovements. In addition to the staples mentioned earlier, crackers, rice and macaroni were purchased from outside

Salmon were plentiful in the river and they had lots of pork and beef, Venison and bear meat were also important to the diet. The men made and annual 1 day trek to the Klamath basin to hunt Ducks. Duck was considered a great luxury and this trip was more of a social occasion than a serious attempt to fill the larder. Deer and bear however were hunted for subsistence rather than sport.

Otter and mink were trapped for additional income (Mrs Hutchinson showed me some fine pelts her father had taken)

Vera Hutchinson

In 1890 Lon Frain and a friend killed an 800 lb grizzly in the area. The recieved a $100 reward from local stockmen who had been losing cattle and another $8.00 for the hide.[4]

Lester Hutchinson came to this area as a hobo in 1916. After being thrown off a train near siskiyou tunnel he made it to Hornbrook where he was told there was work available building the Copco Dam. Lester started to work the following day and remained with the company for 45 years.

WWI brought some effect. Lester enlisted and served in the artillery but his unit was not sent overseas. Vera's father sold horses to the army

<u>Valentine Griffith</u> Was a well known freeloader and itenerant sheep shearer in the area during the early years of the century. After his children grew up and left home his wife deserted him. He was considered the laziest and dirtiest person in the area. His clothes were capable of standing alone when he removed them. (Vera has a photo of this individual)

---

[4]There is a pencil notation "Old Reel Foot" in the margin.

opened in 1912. Later moved to an unused office bldg later moved to foot of grade and

Teachers in order as recalled in 1960 were

Albert Richardson
Imogene Ashbaugh
Bernardine Hannon
Miss Wolf
Molly Donelson
Frances Goodall
Winnie Spencer
Restora French
Mary Wight
Mrs. Stark
Helen McCornack
Bess Briscoe
Audrey McPherson

Interview with Bill Hoover
Nov. 10, 1976
Re: Topsy Rd. area

Mr. Hoover was born at Keno in 1884. Shortly thereafter they moved to a place on the North side of the River about 2 miles upstream from Way. At 92 he has "good days" and "bad days" fortunately I interviewed him on one of his good days. The interview took place at the home of a relative, Ken Mitts, 4439 Barry St. Klamath Falls Or. Mr. Hoover is hard of hearing but his voice is firm and clear and his recollections seem coherent. He does not always respond directly to the question asked. However, I preferred to let him associate his memories at will rather than press him for specific answers Therefore the interview which lasted about 1 1/2 hours was quite disorganized However, significant information gained.

Hoover recalls Bob Emmit who built the present Topsy Grade. His older brother worked for Emmit (Since Bill Hoover shot and killed one of his brothers in a hunting accident I avoided any questions about family which might serve to recall this incident).

Topsy was the name given the Elgin place as far back as Hoover can remember. He never heard anything about a black woman ever living there. So far as he Knew the Elgins were the first to live there. He says there is supposed to be a woman buried along the Dorris rd about a half mile East of Topsy. His father showed him the mound where the grave was. There was no marker and he doesn't know if the woman was Black or White or When she died.
He recalls George Wright and that Wright worked brushing out the power line.

He relates that in the rock shelter at shovel creek there were once many arrowheads embedded in the cave roof.

Has recallection of the Frains, recalls that Mart built a little cabin near the main house which was occupied by Lon and his family. After Mart became too arthritic to get around his son would carry him to the main house for meals. When Mart died the roads were very bad and they had a hard time getting the body to the Way cemetary.

Questioned about cattle he recalls that some were sold to Edson Folk in Gazelle, The only cattle scales in the area were at Lennox (now under Copco Lake) These scales were built over a pit which held the mechanism and could weigh 7 or 8 steers at a time. Driving cattle from the Frain place to Lennox took about 3 hours. The whole drive from the Topsy area to Montague took about two days as the weather was warm and cattle could not be driven too rapidly.

Many cattle were shipped to Sacramento. He cannot remember just when trucks were first used to transport cattle to market, but can recall caravans of 100 or more truck and trailer units hauling cattle out of Ft. Klamath. In later yaers he says that more calves in the 700 to 800 lb range were sold while earlier most of the animals sold had been fully grown.

He worked at Pokegama, usually as a faller in about 1912, There were over a hundred workers there then and quite a few had families with them. The single men boarded at the cookhouse while the families lived in individual cabins ors tents. There was a big store about 60 by 100 feet which handled all sorts of merchandise. The cookhouse was also large and full time meat cutter was employed just to prepare the beef which was purchased in halves and quarters (See Hessig place in Vera Hutchinson interview)

Hoover Interview

Dixie There was a house here for the firewarden employed by Weyerhauser (or U.S.F.S.) Loren Close, now living in Ashland once had the job. He used to walk up to the top of Grizzly peak to Watch for fires.

At the top of the Shovel Creek Chute there was a landing about 200' square bult of hewn logs. The logs were brought here by a four car train from old pokegama and skidded down the chute to the river. After New

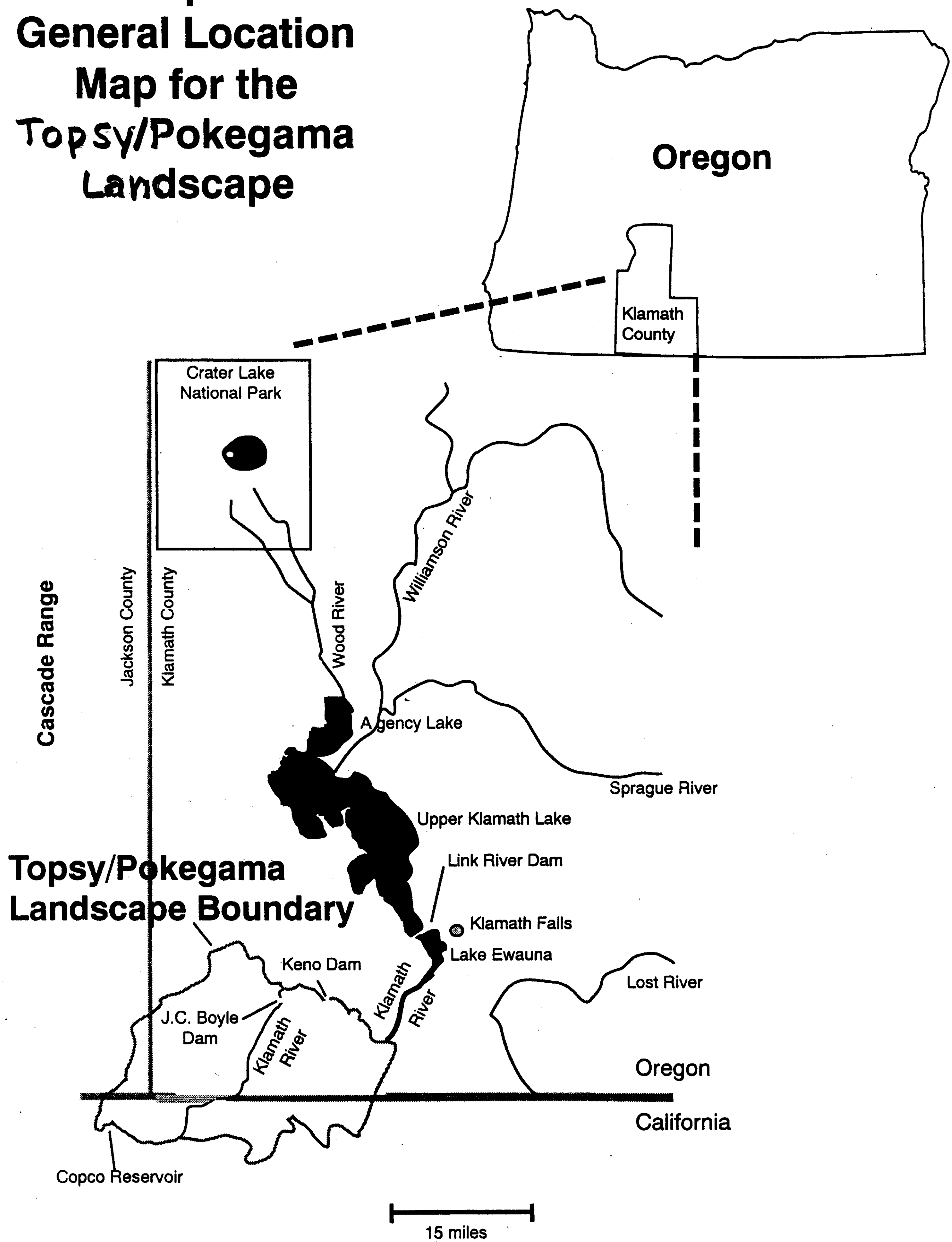
pokegama was built and the rail line extended from Thrall the timber was Sawed at Pekegama and shipped out as lumber. The Shovel Creek slide relates only to old Pokegama.

In 1897 when Bill Hoover was 14 he worked at the bottom of the shovel crrek chute. The chute flattened out about 300 feet before it hit the river and logs would sometimes become hung up here. Bills job was to keep the chute clear. They had an old very large horse named "Danger". Bill recalls an incident in which his inexperience as a driver led to Danger's falling into the chute on his back with all four legs extended, a situation from which he was extricated only after much difficulty, with poles and jacks. Hoover and another man handled the bottom of the chute, each working a twelve hour shift with Hoover taking the night shift. The shared a small cabin nearby. There was a store about 1 1/2 miles down river where they could get supplies.

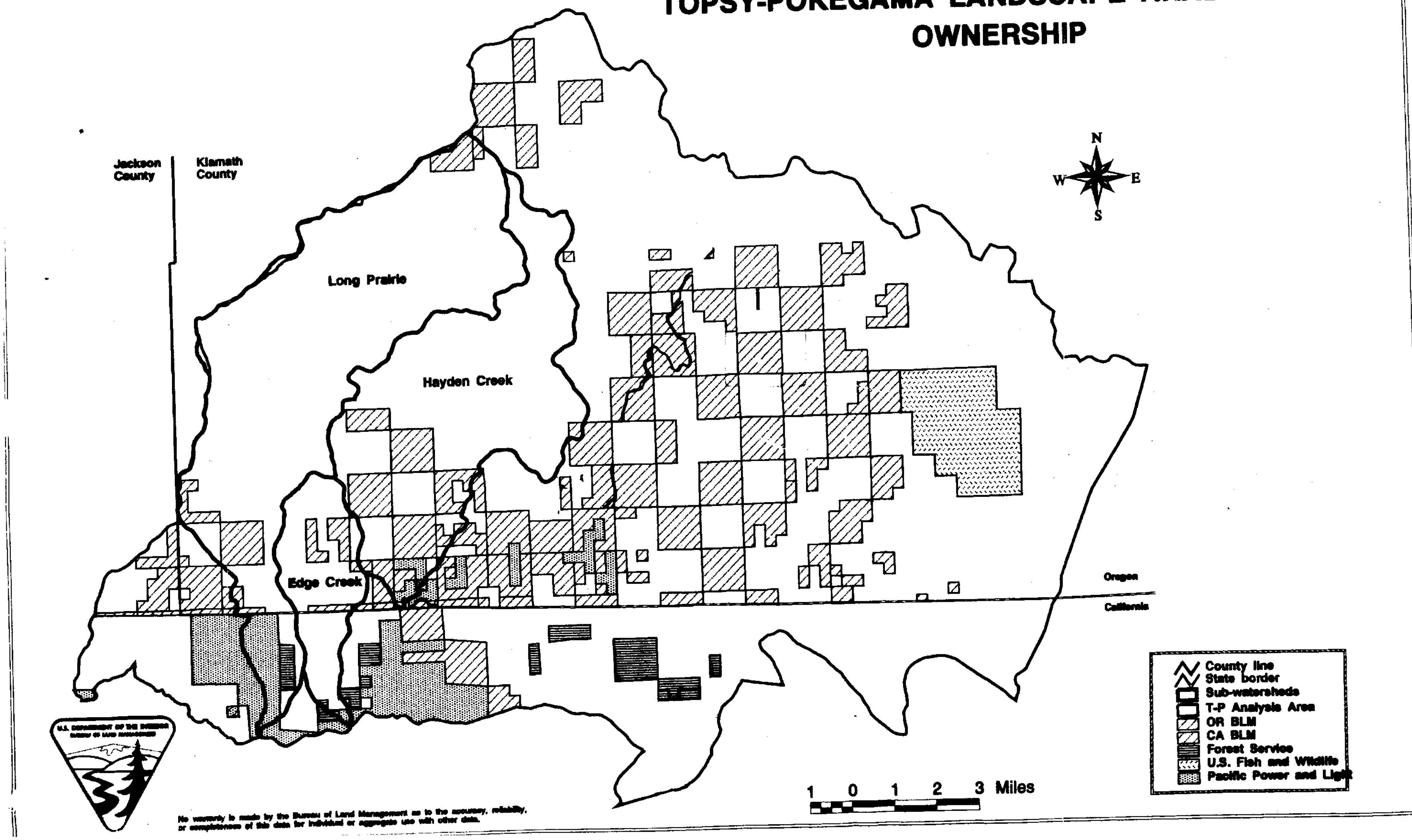
He relates there was a creamery in Montague owned by a dutchman named Si Copas, which made an excellent ice cream that cost $1.00 a gallon it could be packed in ice and kept frozen long enough to be taken to the Frain place ect. up the river. Copas was a bachelor. He was recalled as a generous man who frequently assisted his neighbors financially. "Everybody owed him money and hardly anybody ever paid him".

He relates that there are salt caves at the foot of the hill below Way cemetery on both sides of the river. There are cakes of salt 3 or 4 inches thick here left by the evaporation of saline springs. This salt was much used by the Indians from the Klamath basin, Hoover, who is part Shasta is quite certain that at the time of contact the sites along the Klamath River canyon were occupied by the Klamath Basin people and that the Shastas did not penetrate this region. Bill says the white people never made use of the salt caves as salt was a very cheap commodity and could more convieniently be purchased.

Map 1
General Location Map for the Topsy/Pokegama Landscape

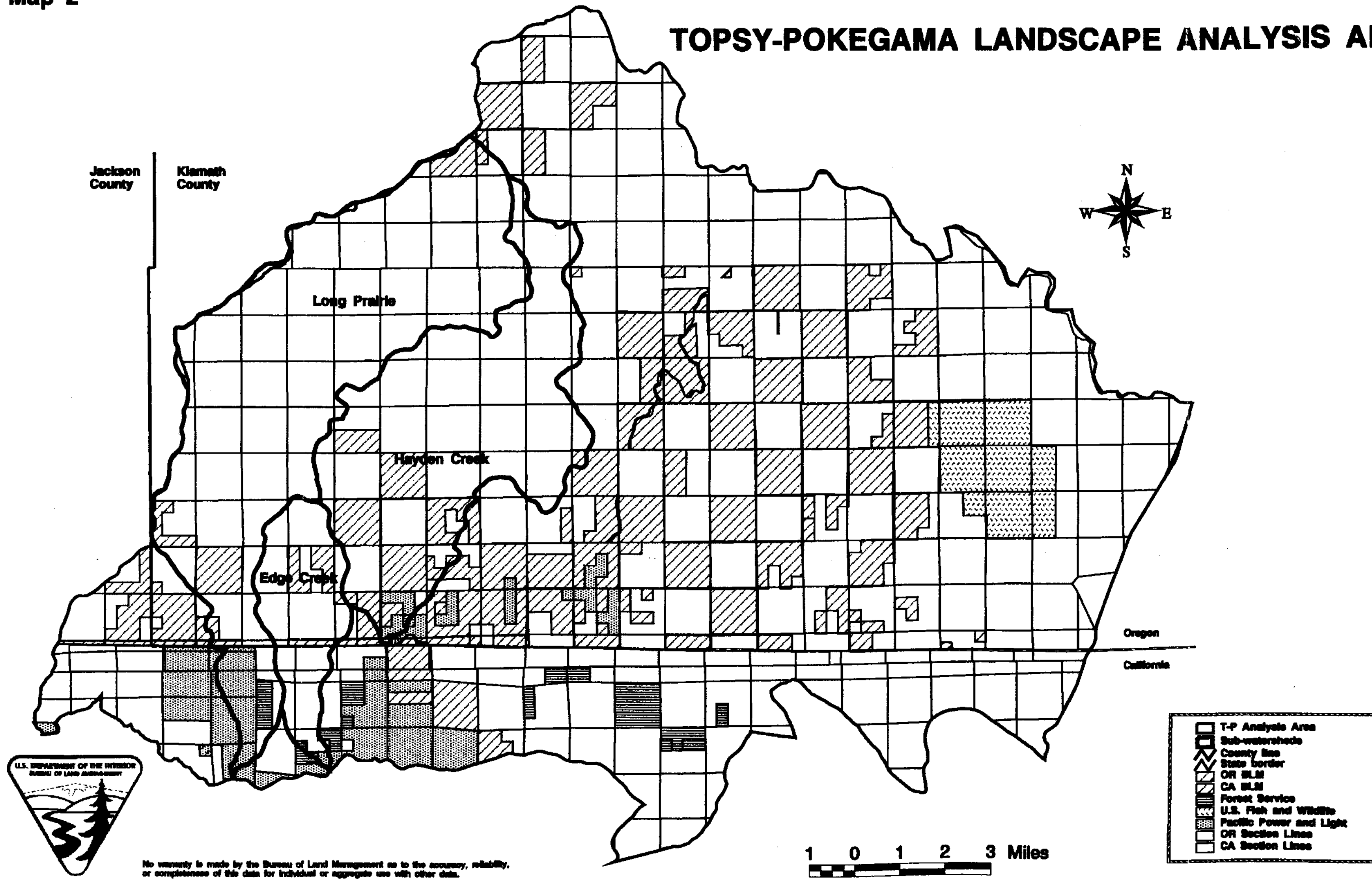


TOPSY-POKEGAMA LANDSCAPE ANALYSIS AREA: OWNERSHIP



Map 2

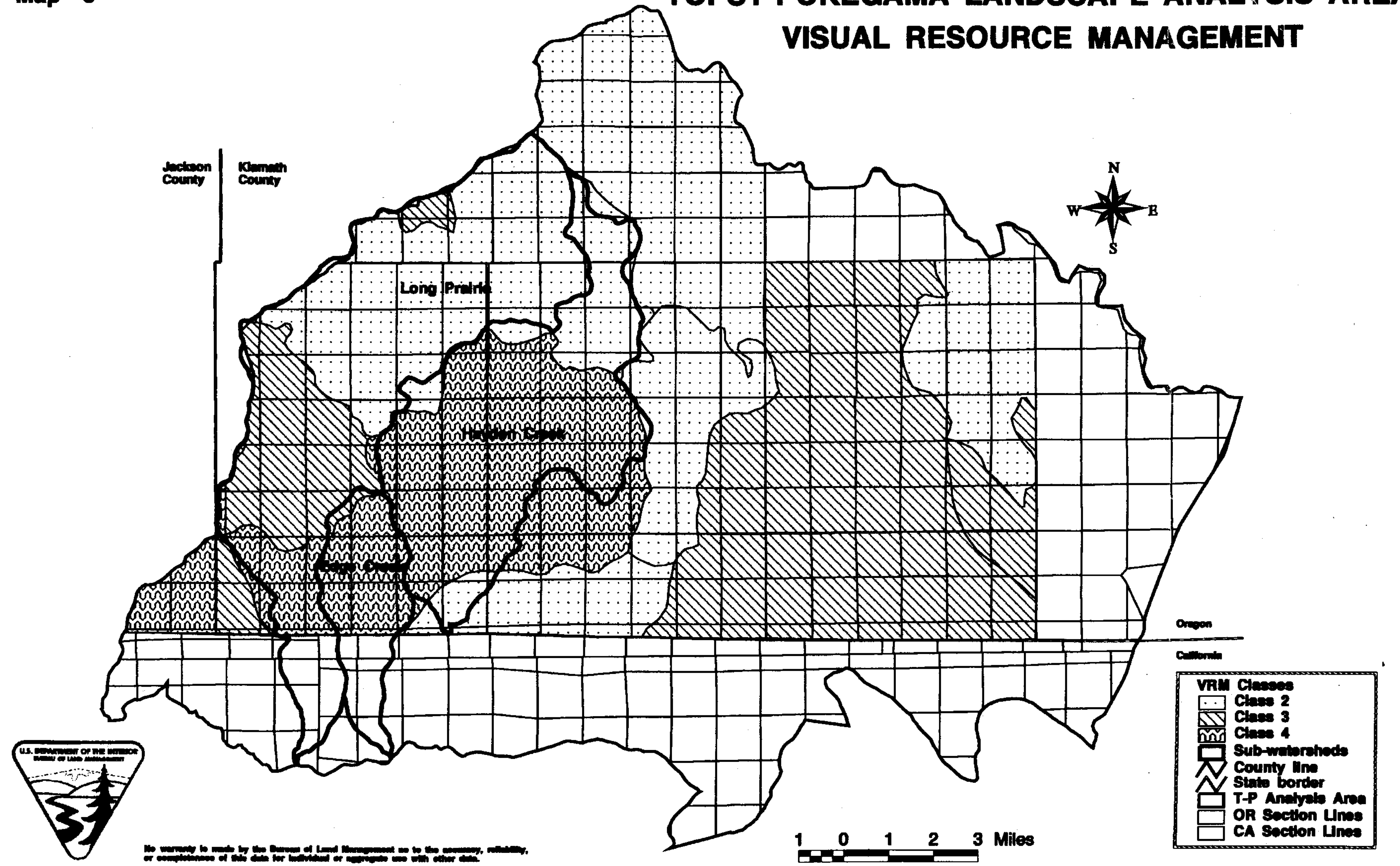
TOPSY-POKEGAMA LANDSCAPE ANALYSIS AREA



No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of this data for individual or aggregate use with other data.

Map 3

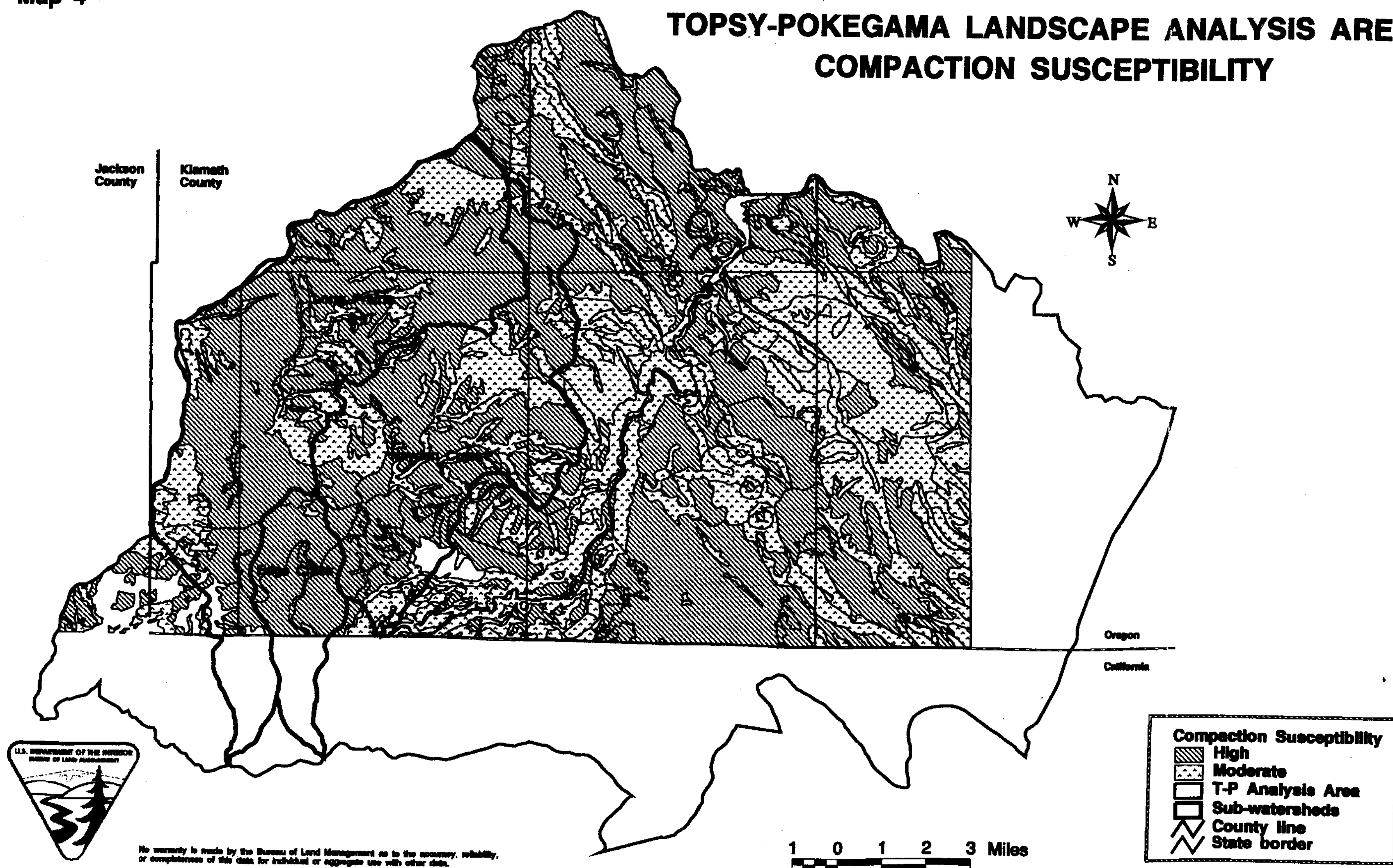
TOPSY-POKEGAMA LANDSCAPE ANALYSIS AREA: VISUAL RESOURCE MANAGEMENT



No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of this data for individual or aggregate use with other data.

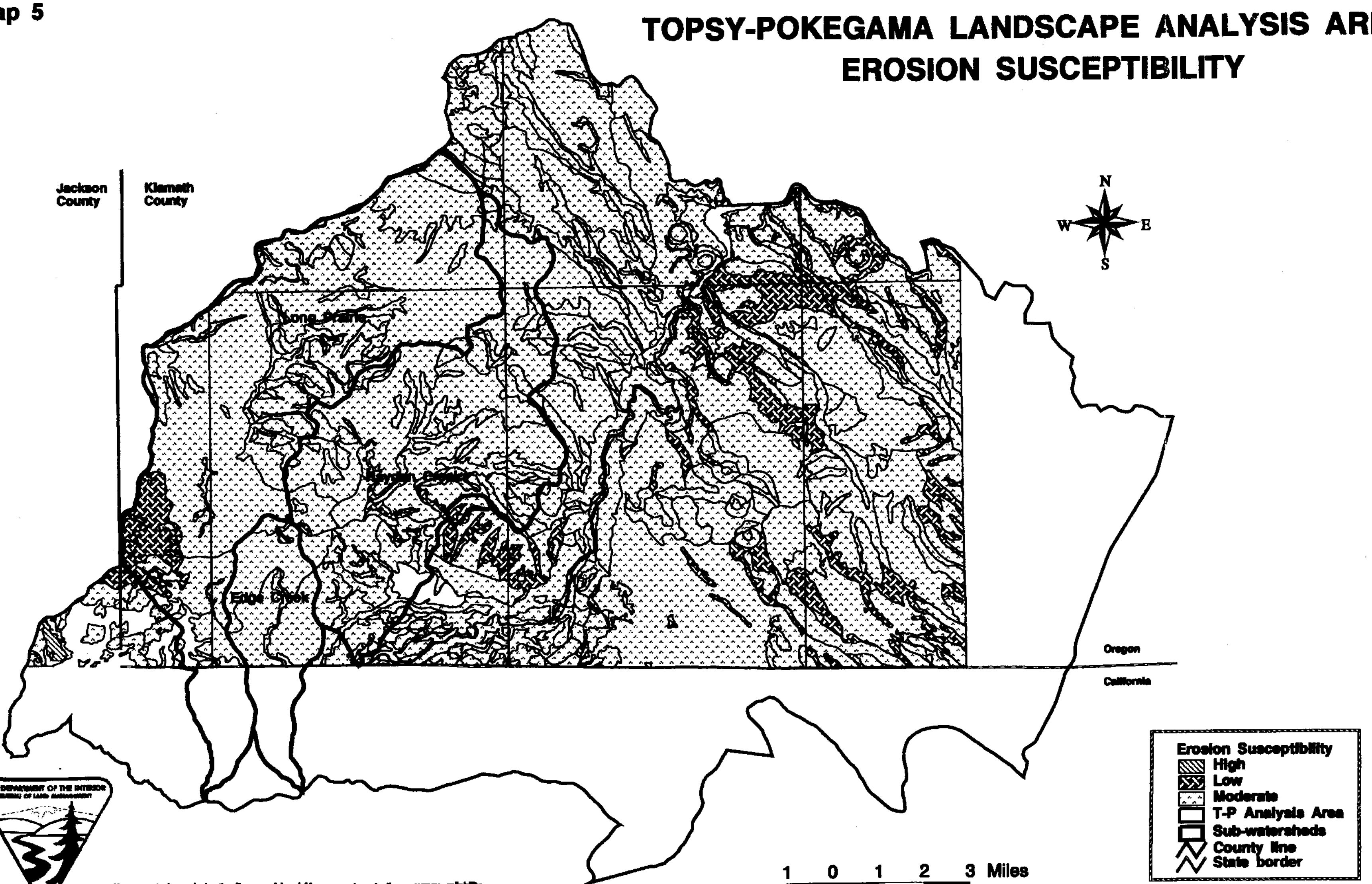
Map 4

TOPSY-POKEGAMA LANDSCAPE ANALYSIS AREA: COMPACTION SUSCEPTIBILITY



Map 5

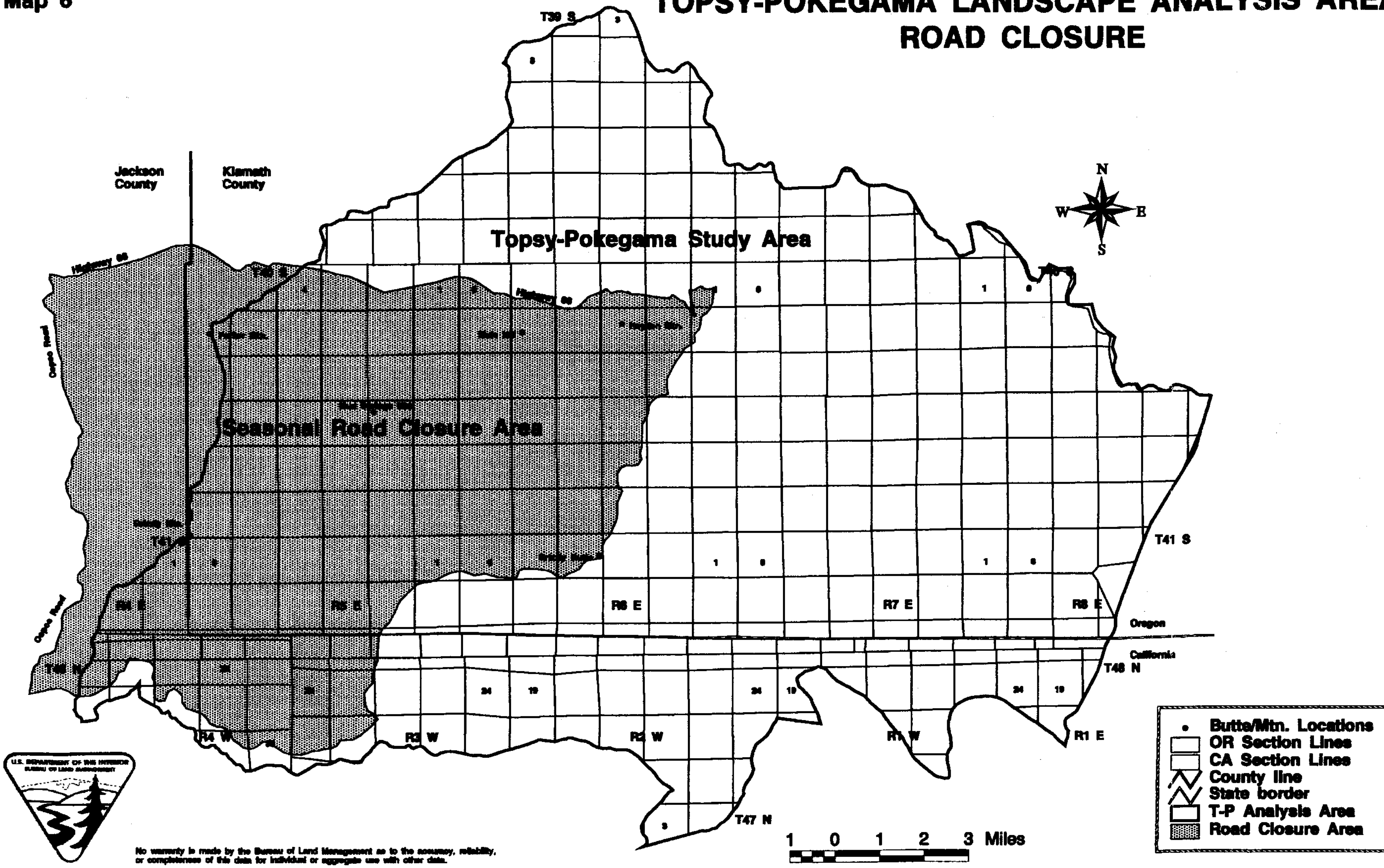
TOPSY-POKEGAMA LANDSCAPE ANALYSIS AREA: EROSION SUSCEPTIBILITY



No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of this data for individual or aggregate use with other data.

Map 6

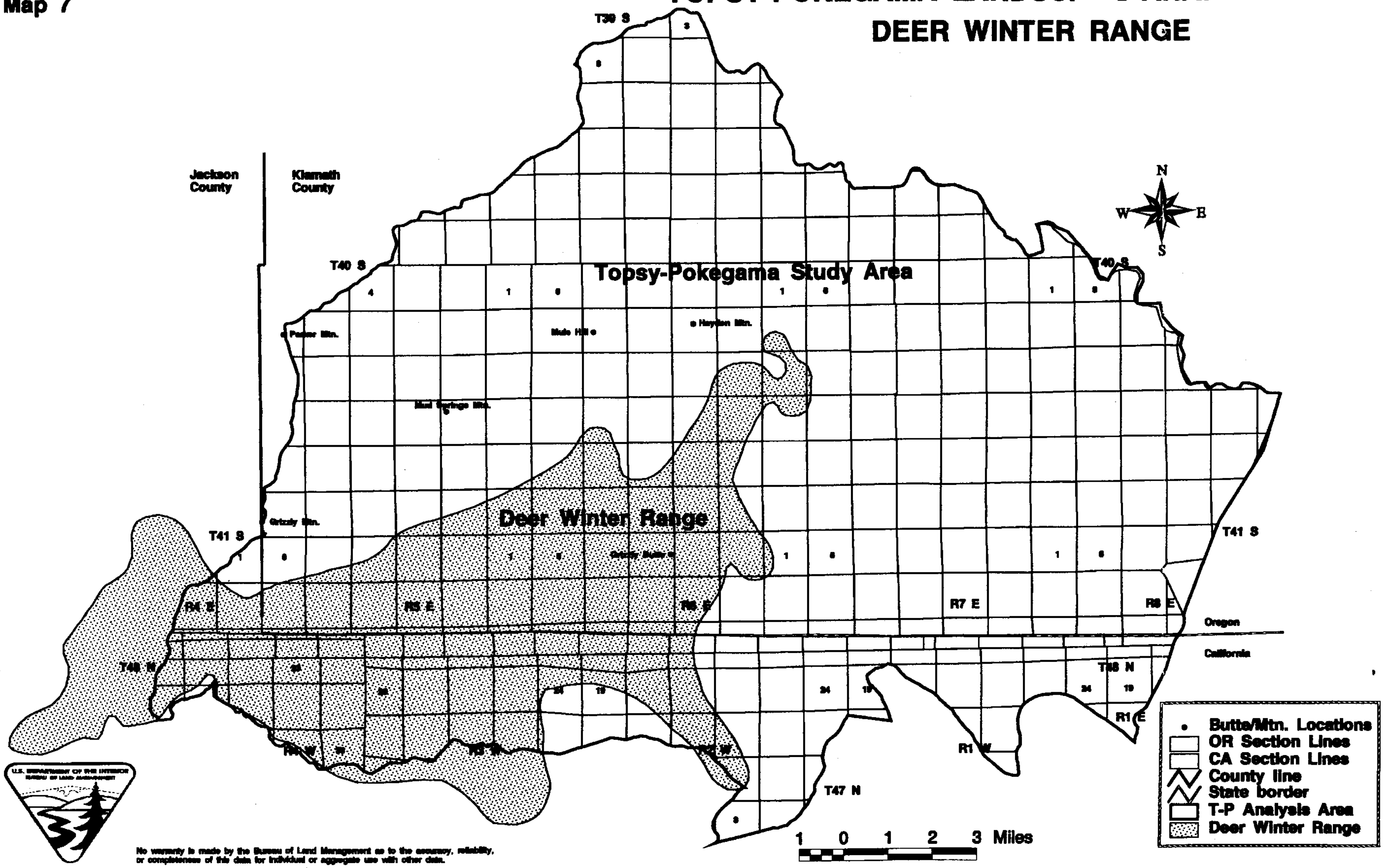
TOPSY-POKEGAMA LANDSCAPE ANALYSIS AREA: ROAD CLOSURE



No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of this data for individual or aggregate use with other data.

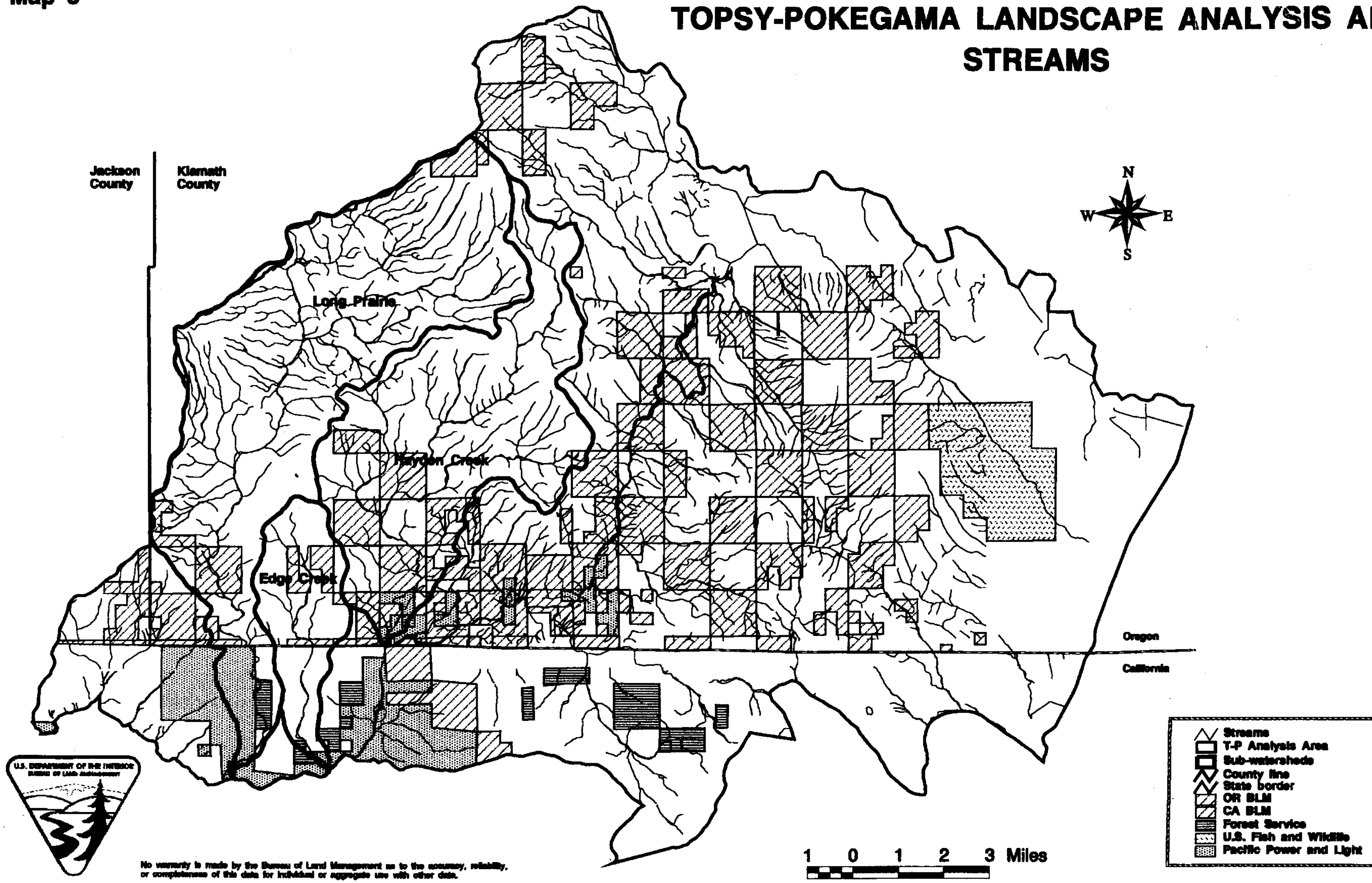
Map 7

TOPSY-POKEGAMA LANDSCAPE ANALYSIS AREA: DEER WINTER RANGE



Map 8

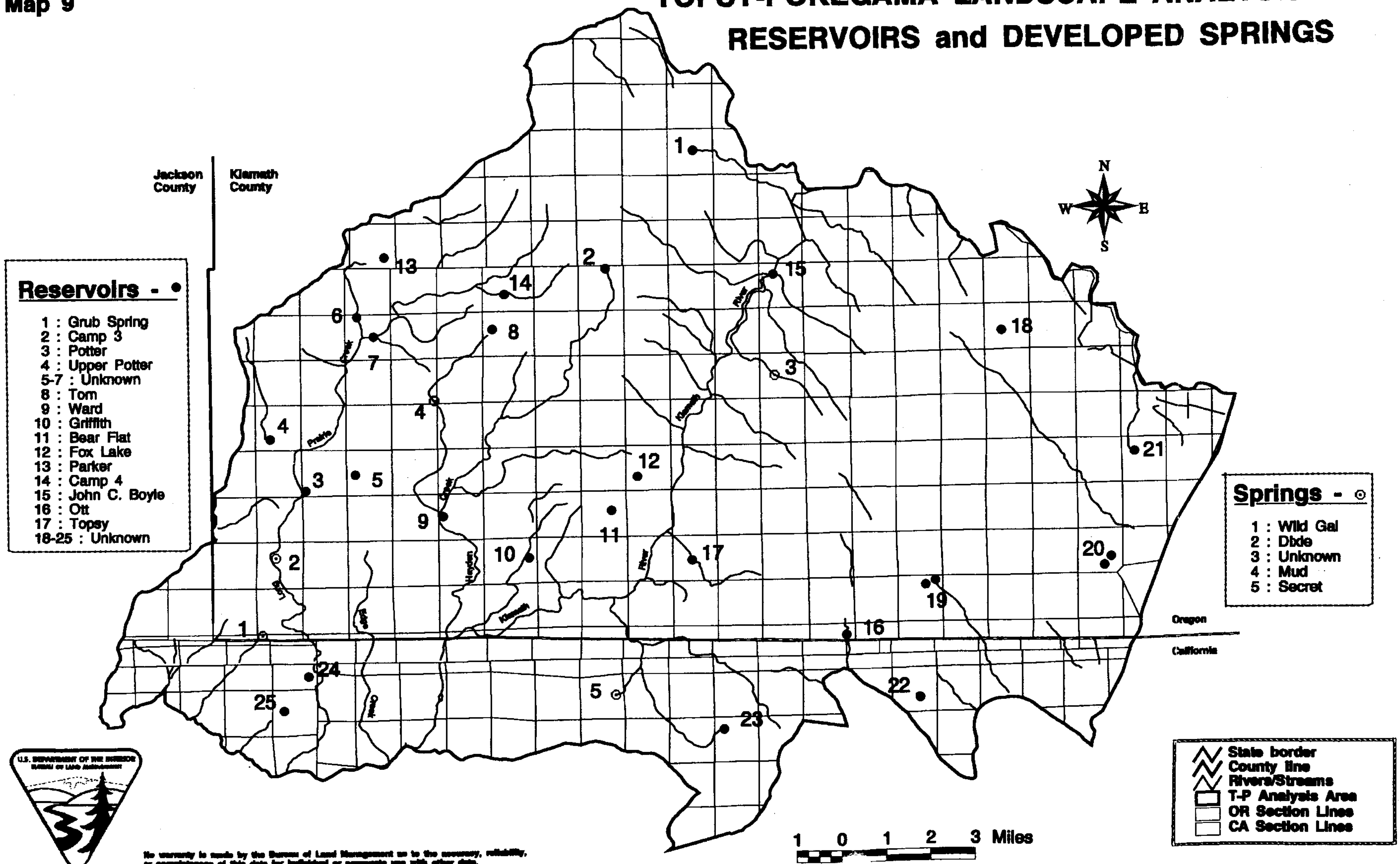
TOPSY-POKEGAMA LANDSCAPE ANALYSIS AREA: STREAMS



No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of this data for individual or aggregate use with other data.

Map 9

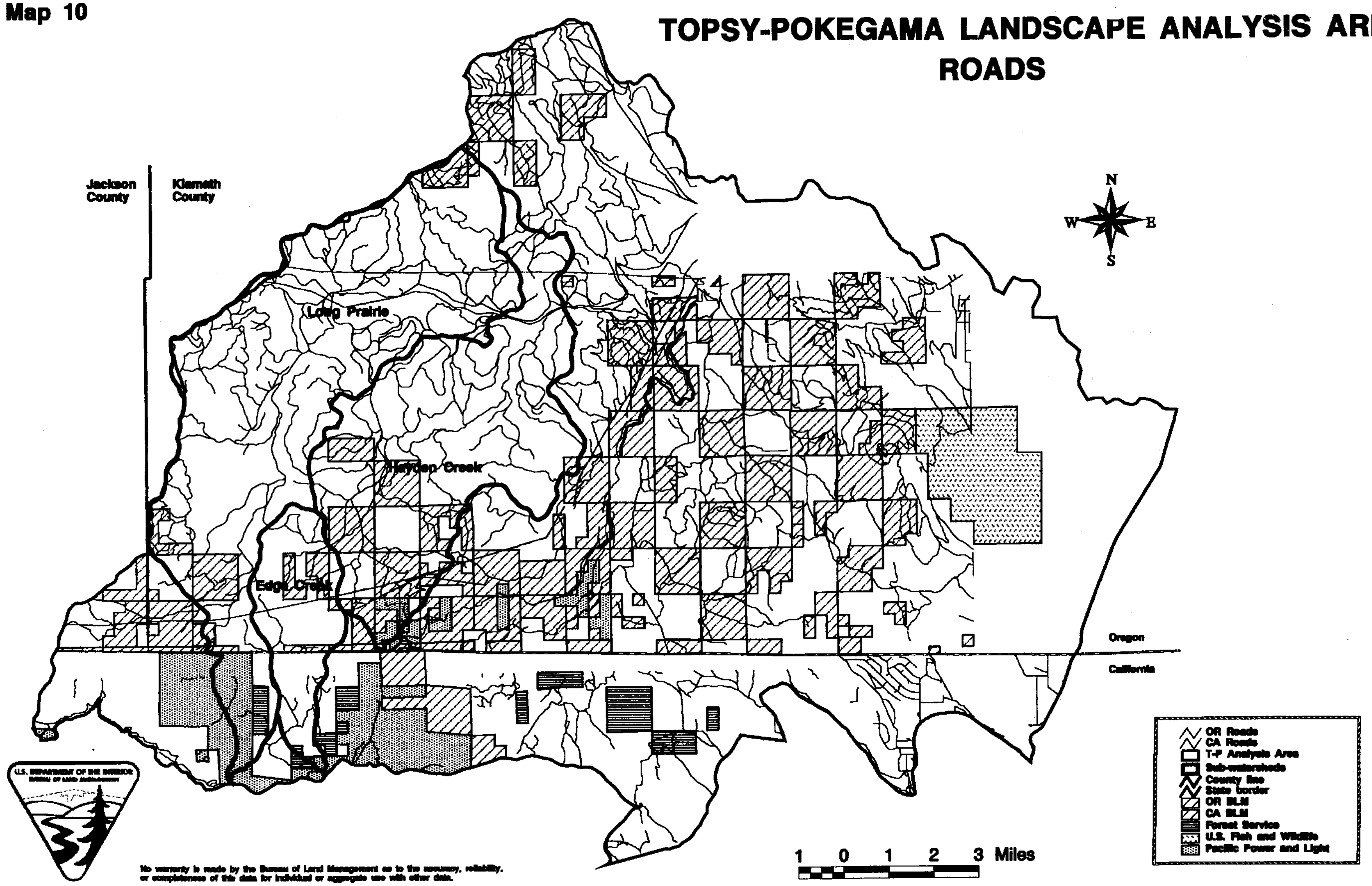
TOPSY-POKEGAMA LANDSCAPE ANALYSIS AREA: RESERVOIRS and DEVELOPED SPRINGS



No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of this data for individual or aggregate use with other data.

Map 10

TOPSY-POKEGAMA LANDSCAPE ANALYSIS AREA: ROADS

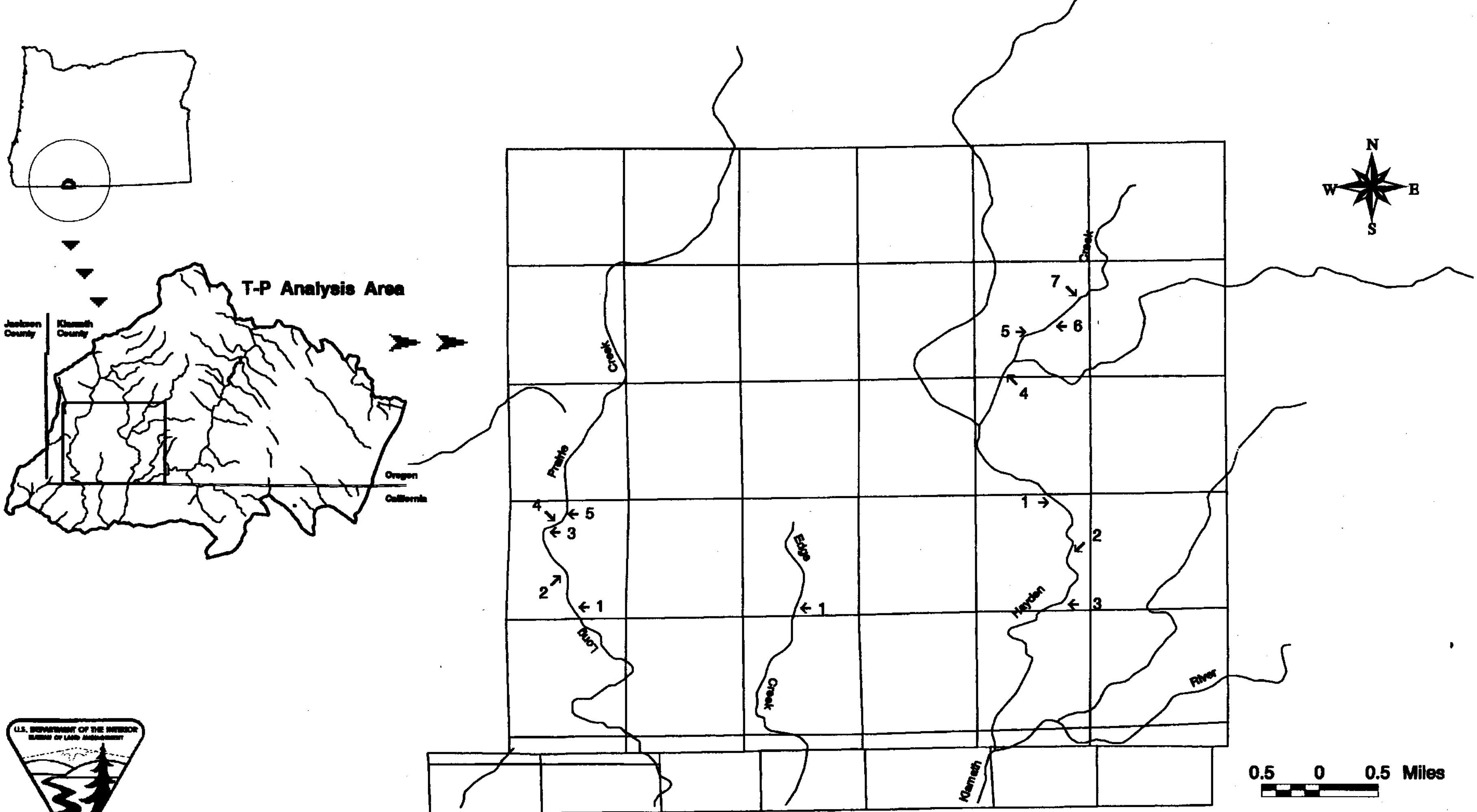


No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of this data for individual or aggregate use with other data.

Map 11

TOPSY-POKEGAMA LANDSCAPE ANALYSIS AREA:

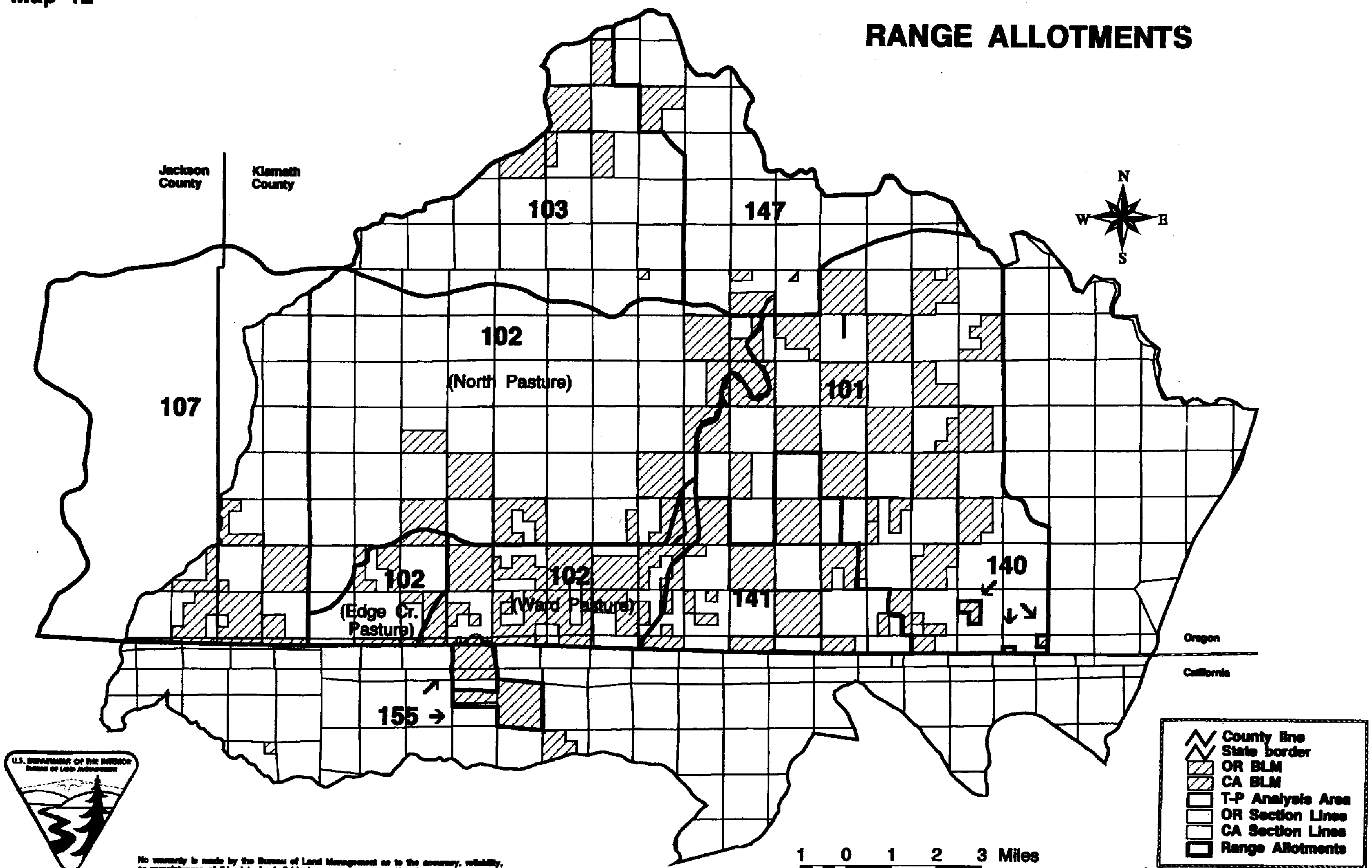
BLM RIPARIAN PHOTO POINTS / PROPER FUNCTIONING CONDITION SURVEYS



No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of this data for individual or aggregate use with other data.

Map 12

TOPSY-POKEGAMA LANDSCAPE ANALYSIS AREA: RANGE ALLOTMENTS



Map 13

TOPSY-POKEGAMA LANDSCAPE ANALYSIS AREA: PROPOSED ARCHAEOLOGICAL DISTRICT