United States
Department of
Agriculture

Forest Service

Pacific
Southwest
Region

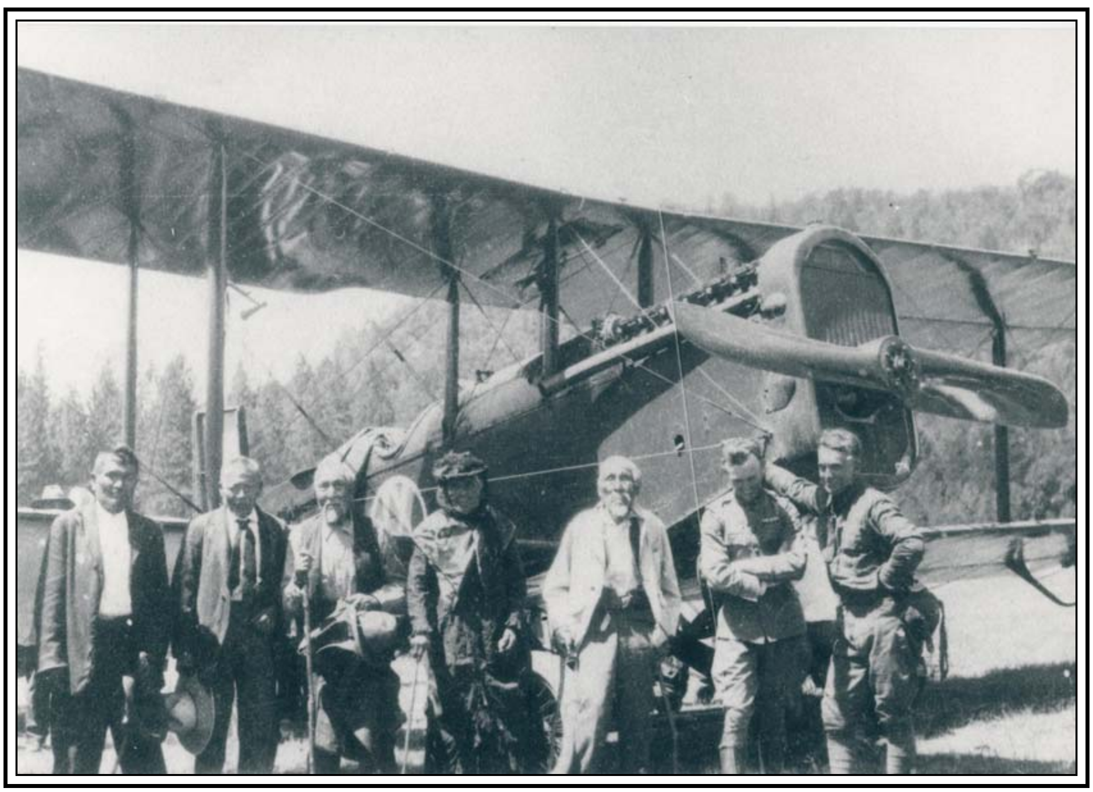
Lower-Middle Klamath Watershed Analysis

Six Rivers National Forest
Orleans Ranger District

Version 1.0

R5-MB-011

March 2003



Early Forest Service fire patrol plane. The first plane to land in Orleans, California circa 1920.

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Located within Humboldt County, Klamath Province, CA
March 2003

Cover Photo: This photo was taken during a 4th of July celebration in the town of Orleans at the heart of the Lower-Middle Klamath Analysis area. In showing a group of Karuk elders and other townspeople posed in front of what was then the most modern piece of fire fighting equipment, it depicts several features related to the historical or reference condition of the Lower-Middle Klamath area. Within the photo are individuals who likely knew the time before Europeans arrived in Orleans and who witnessed the start of the modern fire suppression era.

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INTRODUCTION

Watershed Analysis Overview

Purpose

Watershed analysis is ecosystem analysis, using existing information, at the watershed scale. The purpose is to provide a way that the watershed can be understood as an ecological system, and to develop and document an understanding of the processes and interactions occurring within it. This watershed analysis characterizes the development of features, conditions, processes, and interactions related to aquatic, riparian, terrestrial, and social systems within the Lower-Middle Klamath (LMK) Analysis Area of the Six Rivers National Forest (SRNF) up to the present day.

Watershed analyses, including this specific analysis, are not intended to address all ecosystem components of the landscape. Rather, they respond to key issues, management objectives, regulatory constraints, human values, and resource conditions that are pertinent to the given area. These topics are assessed in terms of biological, physical, and social importance and include such things as beneficial uses, vegetative patterns, and disturbance regimes. Watershed analyses also include identification of management opportunities, which will provide background for the development of future management decisions.

The watershed analysis process is also used as a vehicle for implementation of land and resource planning direction. It is an intermediate analysis between land management planning and project planning, which can provide the purpose and need for proposed projects. The LMK Watershed Analysis will guide the type, location, and sequence of appropriate management activities within this part of the SRNF, as provided by general management direction in the SRNF Land and Resource Management Plan (LRMP) (USFS 1995). It is purely an analysis step and does not involve National Environmental Policy Act (NEPA) decisions. It provides a means of refining the desired condition of the Analysis Area given the Goals and Objectives, Management Areas, and Standards and Guidelines from the LRMP, current policy, and other applicable state and federal regulations.

Factors Driving this Watershed Analysis

The primary reasons for conducting a watershed analysis within the LMK area at this time are the perceived needs to implement watershed restoration actions related to the recovery of anadromous salmonid fish species federally listed under the Endangered Species Act (ESA) of 1973, and to implement fuels reduction around local communities, municipal water-sources, and private lands, as outlined by the National Fire Plan (USDA 2000) and the SRNF Fire Management Plan (USFS 2001). Analysis of non-system roads and maintenance level 1, 2, 3, 4, and 5 roads within the LMK Analysis Area will be included in a roads analysis being conducted separately, but concurrently, across the SRNF, and will be included as an appendix to this document at a future date.

Document Organization

The collective knowledge for this analysis has been assembled in accordance with guiding principles and methodologies contained in *The Revised Federal Guide for Watershed Analysis - Ecosystem Analysis at the Watershed Scale* (Regional Interagency Executive Committee and Intergovernmental Advisory Committee 1995). The watershed analysis process is issue driven, therefore the LMK Watershed Analysis Team focused on what they believed to be the main watershed-specific problems or concerns, rather than attempting to address everything in the ecosystem. The Analysis Team identified and described the ecological processes related to the greatest concerns, established how well or poorly these processes function, and determined the conditions under which management activities could be taken to correct them. During the analysis, participation and involvement of affected tribes, other agencies, and the public were encouraged.

The following is a summary of the six steps utilized in conducting watershed ecosystem analysis:

Step 1 – Characterization

The purpose of this step, detailed in Chapter 1, is to place the LMK Analysis Area in context within the river basin, province(s), or broader geographic area in order to identify the primary ecosystem elements that need more detailed analysis later. It briefly describes the dominant physical, biological, and human features, characteristics, processes, and uses of the Analysis Area. It also identifies the most important land allocations, LRMP objectives, and regulatory constraints that influence resource management in the Analysis Area.

Step 2 – Issues and Key Questions:

Chapter 2 covers this step, which is to identify the variety of uses, processes, and values associated with the Analysis Area. It focuses the analysis on key elements of the ecosystem that are most relevant to the management questions, human values, or resource conditions within the Analysis Area. Also involved in this step is the formulation of “key” analysis questions by using the indicators most commonly used to measure or interpret these ecosystem elements. Answers to the key questions form the basis for the completion of Steps 3 – 5.

Step 3 – Current Conditions

This step, which is addressed in Chapter 3, documents the current range, distribution, and conditions of the relevant ecosystem elements identified in Step 2. The documentation in this step is more detailed than the characterization in Step 1.

Step 4 – Reference Conditions

Step 4 develops an historic reference for comparison with current conditions. This step explains how existing conditions from Step 3 have changed over time as a result of human influence and natural disturbances. Steps 3 and 4 are found in Chapter 3 of this document.

Step 5 – Interpretation

Interpretation, which is covered in Chapter 4, involves the synthesis of Steps 3 and 4. This step compares existing and historic conditions of specific landscape elements and explains significant differences, similarities or trends, and their causes. Desired conditions for each issue are discussed.

Step 6 – Recommendations

This step, contained within Chapter 5, identifies appropriate management activities that may move the ecosystem towards management objectives or desired conditions. Management opportunities specified in Step 6 are expressed in general terms; they identify what may need to be done and why, but they do not make decisions or detail how something gets done. Ultimately, this step provides the purpose and need for implementation of individual projects that are designed to achieve desired conditions.

An Iterative Process

The watershed analysis process is incremental, which means that new information from surveys, inventories, monitoring reports, or other analyses can be added at any time. To aid with this, specific data gaps and monitoring needs related to the main watershed concerns or management opportunities, are identified in Chapter 5.

This document builds upon a watershed analysis that was prepared during 1999 for a portion of the LMK Analysis Area, specifically for the Hazel Project, located in Lower Boise Creek. Refer to the *Focused Watershed Analysis for Riparian Reserve Delineation – Lower Boise Creek, Orleans Ranger District,* available at the Orleans Ranger District office.

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1. CHARACTERIZATION OF THE ANALYSIS AREA

Watershed Setting

Geography

The LMK Analysis Area, which is located in northwestern California, encompasses 60,078 acres of various ownership and important land allocations as shown in Table 1. The Analysis Area comprises 19% of the Lower Klamath River Basin above its confluence with the Trinity River at the town of Weitchpec (Figure 1). The Analysis Area is not a discrete watershed but rather a collection of sub-watershed lands on the Orleans Ranger District exclusive of the three large tributaries to this section of the Klamath River (Bluff, Camp, and Red Cap Creeks) that have been or will be analyzed separately.

Table 1 Ownership and Land Allocations in the LMK Analysis Area.

Land Ownership	Land Allocation	Acres
Hoopa Valley Indian Reservation		**4,983**
Yurok Indian Reservation		**215**
Karuk Indian Reservation		**32**
Private		**6,984**
National Forest Lands:	Late-Successional Reserves	13,327
	Congressionally Withdrawn (Research Natural Area)	683
	Administratively Withdrawn	8,856
	Interim Riparian Reserves	9141
	Matrix	15,857
	National Forest Lands Subtotal	**47,859**
Total		**60,078**

Climate

Northwest California has a very predictable and relatively wet climate (Hickman 1993). It is characterized by warm, dry summers, and cool, wet winters. However, periods of drought have occurred. It is thought that drought conditions existed six times since 1600 in California and that the period from 1890 to 1980 was considerably wetter than the average for the past 360 years. The climate is also influenced by coastal fog, which reaches inland along the Klamath River into the western part of the Analysis Area.

Precipitation records for the town of Orleans, which is situated roughly in the center of the Analysis Area, indicate seasonal dry and wet periods. The annual precipitation during the period of record (1885 to present) ranges from 22 (1923-24) to 83 (1973-74) inches, with an average annual precipitation of 64 inches (records available at the Orleans Ranger District Office). Snow is common within the Analysis Area at elevations above 2500 feet, but generally melts quickly except on higher, shaded, north-facing slopes. In the past, major flooding has occurred when warm rain followed a heavy snowfall.

Geology

The LMK Analysis Area is underlain by three geologic terranes of the Klamath Mountains province: metasedimentary and metavolcanic rocks of the Galice Formation (about 60% in the western and central part of the area), metasedimentary rocks of the Hayfork Terrane (about 20% in the eastern part), and serpentinitic volcanic sediments (melange) of the Rattlesnake Creek Terrane (about 10% in the northeast part). The remaining 10% is comprised of a small area in the southwest corner of the Analysis Area that is underlain by South Fork Mountain schist (a terrane of the Coast Ranges province), and various igneous bodies of dioritic to ultramafic composition that occur throughout the Analysis Area. Extensive deep-seated landslide deposits, predominantly on the schist, Galice metasedimentary, and Rattlesnake Creek terranes, overlie approximately 20% of the Analysis Area.

The different bedrock units have tended to develop distinctive landscape and vegetative characteristics, which affect hydrology, habitat values, and other aspects of resource management. Galice metavolcanic terrane and Hayfork terrane tend to be more competent (stable), and therefore, support steeper, uniform slopes. The terrain also varies somewhat between the mainstem Klamath River corridor where broad floodplains and terraces have developed, and the surrounding tributary drainages, which are more dissected (sharply cut) and generally have steeper slopes. Landslides of various types are a common feature of the landscape, encompassing roughly one-third of the Analysis Area. In addition to the large, deep-seated landslide deposits noted above, much of the steeper terrain has been formed by shallow landsliding over thousands of years. Most tributaries to the Klamath River also have developed inner gorge landforms in response to prolonged tectonic uplift of the landscape. The stream network is primarily dendritic (branching) since it appears to be more controlled by geomorphic processes than by underlying bedrock structure. However, the Klamath River does follow fault zones in some sections where weakened rocks are more susceptible to slope failure and stream incision.

Management Areas

The SRNF LRMP provides the objectives and direction for National Forest System (NFS) lands within the LMK Analysis Area. The SRNF is divided into 17 management areas. Table 2 shows the principal management areas within the LMK Analysis Area. The Adorni Resource Natural Area (RNA), which was established for its representation of the Port-Orford-cedar (POC) vegetation type in the Klamath Mountain Province, covers approximately 683 acres of the Analysis Area near the confluence of Aikens Creek and the Klamath River. This RNA is a part of a network of areas designated in perpetuity for research and education, and to maintain biological diversity across NFS and other public lands. Given that POC is the target element of the RNA, the greatest risk to the integrity of this RNA is the introduction of the fatal, root disease: *Phytophthora lateralis* (Port-Orford-cedar root disease), which will be discussed more later in this document.

Figure 1 Lower-Middle Klamath Vicinity Map.

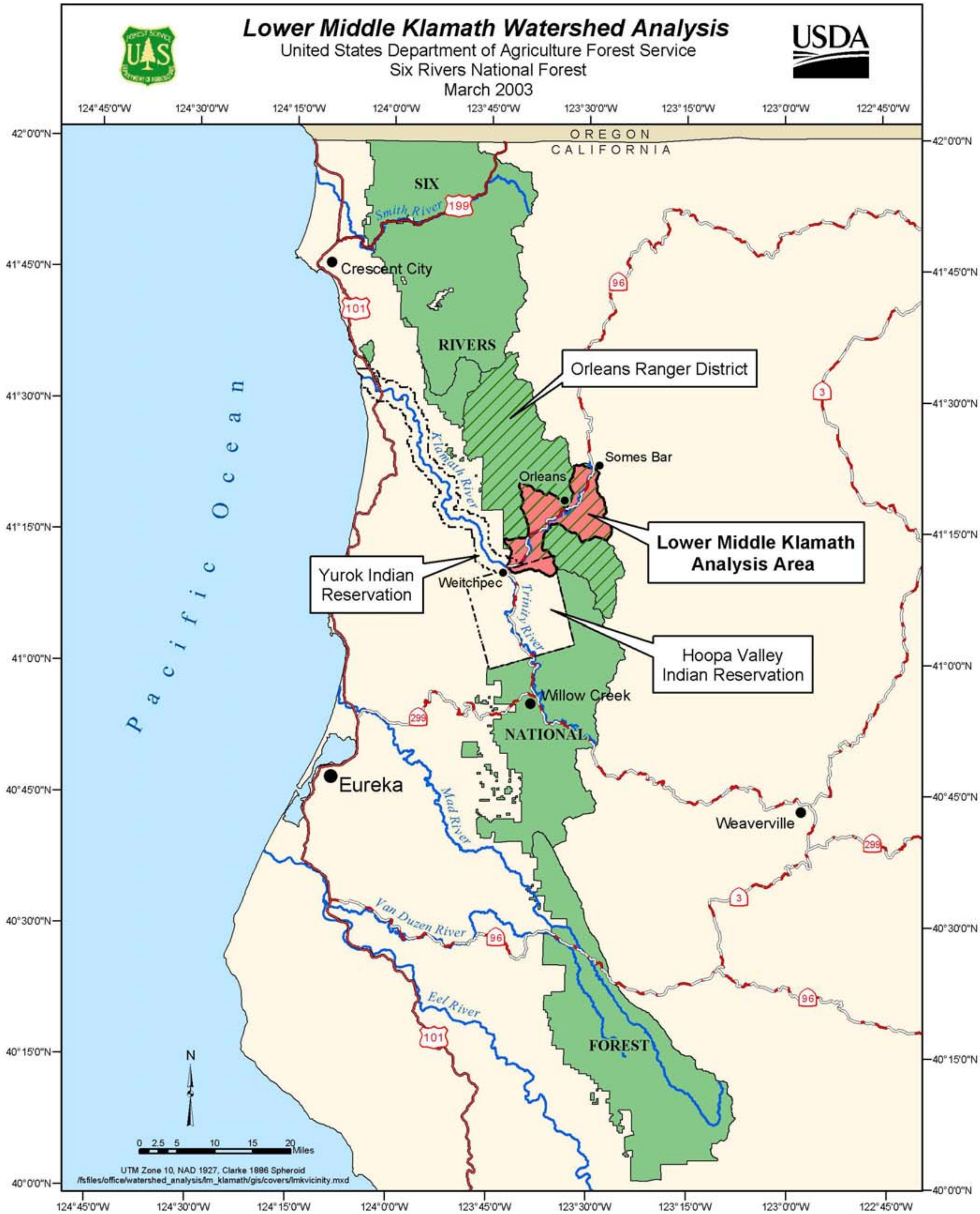

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Table 2 SRNF Management Areas and Goals Affecting the LMK Analysis Area.

Management Area	Goal
5 – Research Natural Areas (RNA)	To provide opportunities for research, observation and study of undisturbed natural ecosystems.
8 – Special Habitat	To provide mature and old-growth habitat for plants and animals associated with mature and old-growth forests
9 – Riparian Reserves	To give special management considerations to and protect the integrity of ecosystems bordering bodies of water and wetlands for riparian and aquatic-dependent species.
15 – Recreational River	To maintain and enhance the outstandingly remarkable anadromous fisheries values for which the river was designated, while providing for public recreational uses that do not degrade those values.
17 – General Forest	To provide multiple-use development opportunities and a sustained yield of timber in a manner that preserves ecosystem function, biodiversity, and landscape integrity.

Vegetation and Fire

Vegetation Management

The issues related to the analysis of vegetation vary by scale. The watershed is an intermediate scale for terrestrial vegetation analysis. The LMK Analysis Area is situated along the western edge of the Klamath Mountains Section as defined by the National Hierarchy of Ecological Units. This physiographic unit is characterized by a particular combination of climate, geology, and landforms, which distinguish it from the adjoining northern California Coast Ranges Section.

The LRMP further subdivides these physiographic Sections within the SRNF into three ecologically distinct zones (north, central, and south), which differ in climate, vegetation, and fire regime. The northern half of the Orleans Ranger District is within the north zone, which is characterized by a wetter climate and a longer period between stand-replacing disturbance events than the central zone. The portion of the Orleans Ranger District southeast of Highway 96 is within the central zone.

LRMP direction for vegetation management utilizes the concepts presented in *Sustaining Ecosystems: A Conceptual Approach* (Manley et al. 1995). The goal of vegetation management is to provide a mix of habitat types that are characteristic of recent historical conditions before intensive timber harvest. For each vegetation zone on the SRNF, the LRMP established a Historic Range of Variability (HRV) and Recommended Management Range (RMR). The HRV defines an estimated range of seral stages by vegetation series, which likely existed in the past few hundred years. The RMR is a subset of the HRV that defines a narrower range of variability to buffer against unpredictable catastrophic events such as fire. For example, the RMR for old-growth vegetation is to maintain this seral stage at the higher end of its HRV because large or repeated high intensity fires could eliminate large areas of old-growth that might not be able to recover for centuries.

The LRMP recommends that vegetation should be managed within each zone to meet the RMR for each series and seral stage. These near-natural vegetation conditions are desired in all land allocations (Table 1), and will be created through natural processes such as wildfire, flood, disease, and natural plant succession, as well as land management activities such as timber harvest and fire/fuels management. The LRMP assumes that by providing a mix of vegetation series and seral stages similar to what existed in the recent past, ecological processes and conditions needed to sustain existing plants, animals, and organisms are most likely achievable. Within individual stands, a diversity of stand structures and species composition will exist that vary depending on the vegetation type, slope position, disturbance regime, past stand history, and vegetation objectives.

General Forest lands and a portion of the Retention and Partial Retention Visual Quality Objective lands are combined in a land allocation category called Matrix. About 33% of NFS lands within the LMK Analysis Area have been designated as Matrix lands. These lands are to be managed for a variety of resource uses and values including timber outputs. Of all the outputs that the SRNF provides, timber harvesting has the largest economic impact on Humboldt, Del Norte, and Trinity counties. Controversy over timber harvest and the protection of threatened and endangered (TE) species led to the 1993 Forest Summit, and *Record of Decision for the Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl* (USFS and BLM 1994), commonly referred to as the Northwest Forest Plan (NWFP). Direction from the NWFP has been incorporated into the LRMP.

Vegetation Composition

Like many other areas in the Klamath Mountains Section, mixed hardwood/coniferous forests, coniferous forests, oak woodlands, grasslands, and riparian plant communities, dominate the LMK Analysis Area (Table 3). Most of the mixed hardwood/conifer forests are in the tanoak series, which has a consistent Douglas-fir component in the overstory. The other conifer series include Douglas-fir, white fir, red fir, Jeffrey pine, knobcone pine, and POC. The hardwood component of this area is primarily in the canyon live oak series. The oak woodlands have a limited extent and are represented by the Oregon white oak and black oak series.

The seral stage distribution (Figure 2, Table 4) in the Analysis Area has been influenced primarily by disturbance from fire, flooding, mass wasting, and timber harvesting. The distribution of mature stands (early and mid-mature) are the result of stand replacing fires that occurred around 1865 and 1910, whereas the late-seral stands are mainly the result of repeated low and medium intensity fires. The pole stands within riparian areas of the mainstem Klamath River and its tributaries are mainly the result of the 1964 and other floods. The high amounts of pole and shrub/forb stands are typically the result of timber harvesting.

Figure 2 Vegetation Seral Stage.

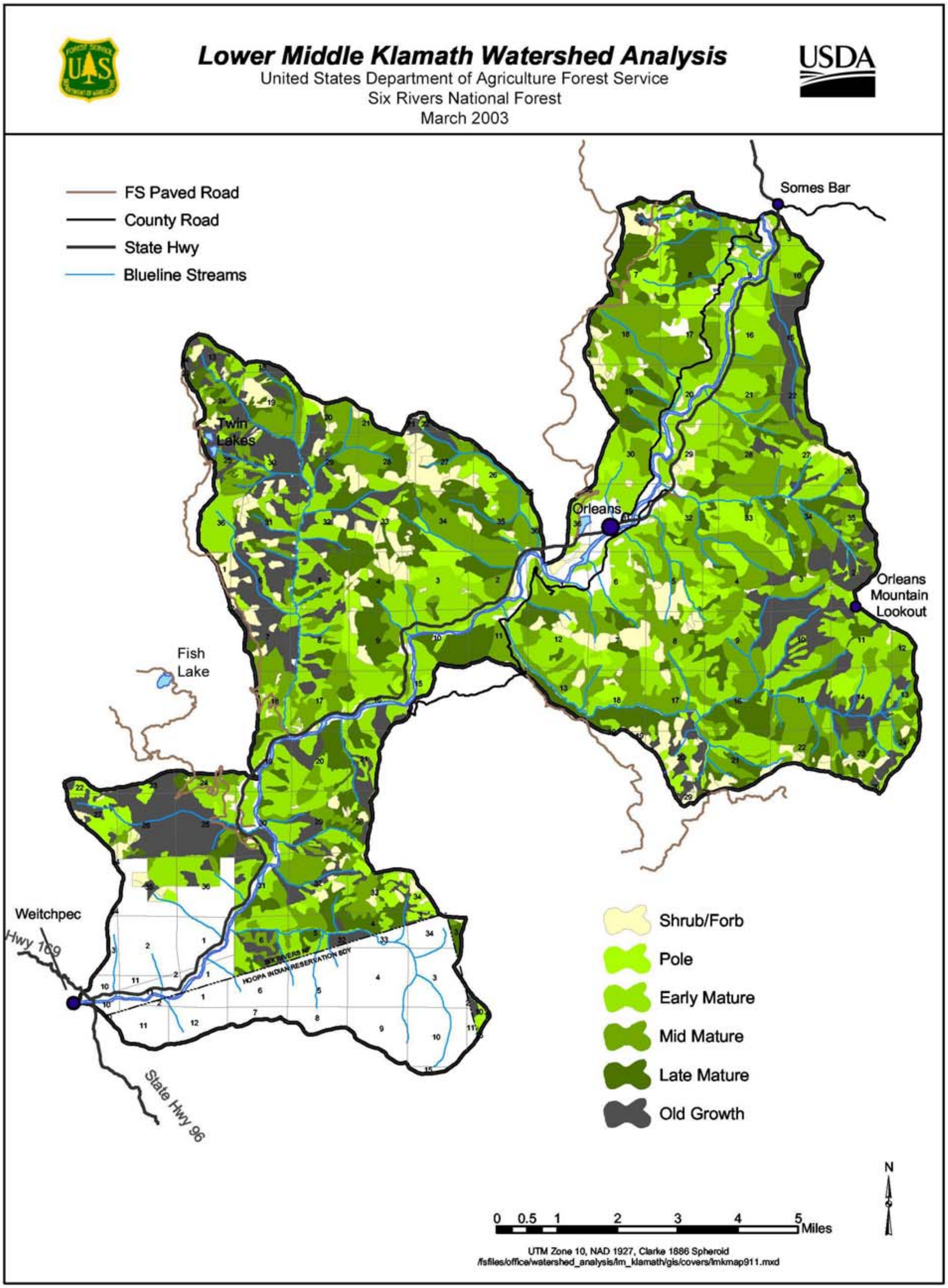

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Table 3 Distribution of Broad Vegetation Categories and Series on Forest Service Lands in the Analysis Area.

Vegetation Category	Series	Acres	Percent
Hardwood/Conifer:	tanoak	**34,463**	**68.8%**
Conifer:	Douglas-fir	8,435	16.8%
	white fir	3,214	6.4%
	Jeffrey pine	1,273	2.5%
	red fir	577	1.1%
	knobcone pine	118	0.2%
	Port-Orford-cedar	104	0.2%
	Conifer Subtotal	**13,721**	**27.2%**
Hardwood:	canyon live oak	**983**	**2.0%**
Oak woodland:	white oak	70	< 0.1%
	black oak	341	0.7%
	Oak woodland Subtotal	**394**	**0.8%**
Riparian:	alder	23	0.1%
	riparian	364	0.7%
	Riparian Subtotal	**387**	**0.8%**
Grassland		**142**	**0.3%**
Serpentine barrens		**10**	**< 0.1%**
Totals		**50,116**	**100.0%**

Table 4 Distribution of Vegetation Seral Stage on National Forest Lands in the Analysis Area.

Seral Stage	Acres	Percent
shrub/forb	4,124	8%
pole	3,798	8%
early-mature	14,396	29%
mid-mature	12,439	25%
late-mature	7,774	16%
old-growth	7,586	15%
Totals	**50,116**	**100%**

Sensitive, Rare and Survey and Manage Plant Species

There are no known or suspected TE plants within the Analysis Area; however, Forest Service Sensitive plants do occur. Robust false lupine (*Thermopsis robusta*) is the only sensitive plant documented in the Analysis Area. It occupies early successional habitat including road banks (e.g. 11N05, 12N12, 12N13). Its known distribution is restricted to localized areas in the LMK area and the Middle Klamath River Basin. There are several plants documented in the Analysis Area that are considered rare by the California Native Plant Society. One species, the Orleans iris, is common to the LMK area and the Middle Klamath River watersheds.

Potentially suitable habitat exists in the Analysis Area for other sensitive and rare plant species. Specialized habitats for sensitive and rare plants within the watershed include outcrops, serpentine areas, riparian areas, and wetlands. Mature mixed evergreen and montane coniferous forests provide potentially suitable habitat for three sensitive species, mountain lady's slipper, fascicled lady's slipper, and bensoniella. Marble mountain catch-fly, a proposed sensitive species, is documented in the watershed to the east of the Analysis Area. Its potential habitat is characterized as early successional. These plants occupy recently disturbed settings including road banks.

In addition to being sensitive plants, bensoniella, fascicled lady's slipper and mountain slipper are also Survey and Manage (SM) vascular species. There are no documented occurrences of these species in the Analysis Area but potentially suitable habitat exists. Non-vascular species documented in the Analysis Area include, *Ptilidium californicum* (bryophyte), *Calicium viride* (lichen), and *Otidea leporina* (fungi). Substrate for the former two species includes mature to old-growth Douglas-fir and white fir trees. Substrate for *Otidea* is soil with a humus and litter layer. Potentially suitable habitat exists for two aquatic lichens that are mentioned below in the *Riparian-Dependent Species* section and two terrestrial lichens, *Dendriscocaulon intricatulum,* which occupy the bole of oak trees in California and *Usnea longissima,* which occurs in a mature forest canopy, as litterfall on understory vegetation and on the forest floor.

Noxious Weeds

The LRMP raises the concern about non-native invasive species and identifies various Standards and Guidelines related to their management. Invasive species (also termed "weeds") displace native species and dominate habitats, thereby reducing species diversity and altering plant community structure. Indirectly and cumulatively, their potential site dominance and persistence can alter soil chemistry to the detriment of native plant re-establishment, displace habitat elements for native fauna, and increase erosion rates (Bossard et al. 2000). Weed establishment can also reduce property values, the forage quality of pastures, and quality of riverside recreation.

As a result of invasive species mapping in 2001, various weeds were documented in the Analysis Area: yellow star thistle, scotch broom, Himalayan berry, Dyer's woad, meadow knapweed, perennial pepperweed, diffuse knapweed, and spotted knapweed. All of these species are priority weeds for the Forest. The latter two species are state-listed A weeds; Dyer's woad is B-listed (CDFA 1996). A-listed weeds are those prioritized for control at the state level. B-listed weeds are subject to control at the discretion of the County Agricultural Commissioner. Roads, domestic livestock and equipment movement are primary vectors for weed seed introduction and spread. With the exception of openings along the Klamath River and disturbed areas near residential dwellings, most of the weeds occur on public right-of-ways (e.g. state or USFS roadsides) therefore opportunities exist for control. Of significance is the westward spread of spotted knapweed, diffuse knapweed and Dyer's woad. Currently the leading edge of spotted knapweed is on river bars of the Klamath River, downriver from the town of Orleans. Dyer's woad is moving west along Highway 96 and along FS route 15N01. The most current information indicates its leading edge just beyond the Analysis Area boundary, near Weitchpec.

Riparian-Dependent Plant Species

A number of sensitive, rare, and SM plant species can be associated with riparian and aquatic habitats. Potential habitat exists within the LMK Analysis Area for one vascular plant species (*bensoniella*) and two aquatic lichens (*Leptogium rivale* and *Dermatocarpon luridum*). *Bensoniella* occupies streamsides and also occurs on the edge of wet meadows. Both lichen species occupy submerged or seasonally submerged rocks or boulders in streams. Riparian areas with a mature conifer and hardwood component provide ideal habitat for these groups of species due to the relationship between habitat characteristics associated with riparian areas, such as moisture, shading, and moderated temperatures, and habitat needs of many bryophytes (in particular) and lichens. Seeps and wet meadows provide habitat for nodding semaphore grass, Howell's montia, meadow sedge, and flaccid sedge.

Forest Products

LRMP goals for vegetation, including timber and special forest products, require that they be managed to reflect the range of conditions characteristic of recent, historic vegetation patterns and disturbance regimes (USFS 1995, IV-74).

Timber Harvest

Significant quantities of high quality timber were harvested from the LMK Analysis Area between the mid 1950s and the late 1980s. This harvesting was done primarily to replace older stands of poorly growing or sparsely stocked trees with well stocked, even-aged stands of thrifty conifers. The vast majority of these stands were regenerated through the clear-cut harvesting system, which included site preparation by tractor piling or broadcast burning, followed by hand planting of conifer trees.

Since the late 1980s timber harvesting in the Analysis Area has been limited to the periodic removal of roadside hazard trees. Harvest plans for the near future (e.g. the Hazel Vegetation Management Project) focus on intermediate thinning treatments in 60 to 80 year old stands rather than the regeneration of older stands. As the previously regenerated stands (plantations) approach the 30 and 40-year age classes, they also will provide opportunities for economically viable commercial thinning treatments. As a result of the shift in the type of trees to be harvested, from large old trees to younger and smaller diameter trees, there will be a significant reduction in the quality and value of timber products removed.

Vegetative Special Forest Products

There are three general types of Special Forest Product (SFP) uses that occur within the Analysis Area: traditional Native American subsistence use, general personal use, and commercial use. Traditional Native American uses involve a wide variety of products, seasons of gathering, and locations of gathering. The primary food products gathered include the tanoak mushroom, tanoak acorns, and a variety of berries, bulbs, and roots. The primary basketry materials gathered here include hazel sticks, willow roots, ferns, and bear grass blades. General personal uses include the gathering of firewood, a variety of mushroom species, and, to a much lesser degree, berries, nuts, and fruits. Commercial uses of SFPs include the gathering of firewood, tanoak mushrooms, and floral products, such as huckleberry, cedar boughs, and scotch broom.

Fire

Fire has been a significant factor in the formation of western ecosystems. Within the LMK Analysis Area, fire has been the dominant natural disturbance factor. However, fire frequencies and intensities have been highly variable, and wildfires have not always resulted in complete stand mortality. The Douglas-fir forests of the Klamath sub-region are among the driest forest types in which Douglas-fir is dominant and where Douglas-fir old-growth is recognized (Old-Growth Definition Task Group 1986). The Analysis Area's complex geology, land use history, steep topography, and variable fire history have prevented generalizations about fire history and its ecological effects (Agee and Edmonds 1992). Given the extensive history of Native American settlements along the Klamath River, Native Americans probably had significant impacts on ignition patterns, frequencies, and extents of wildfires within the Analysis Area.

Fire/Fuels Management

The LRMP goal for Fire/Fuels Management is to provide well-planned and well-executed fire protection and fuel management programs (including fire use through prescribed burning) that are responsive to land and resource management objectives (USFS 1995, IV-116). The SRNF Fire Management Plan (USFS 2001) (FMP) assigns Fire Management Units (FMU) to correspond with the three ecologically distinct zones (north, central and south, as mentioned in the Vegetation Management Section above). Therefore, the Analysis Area is split between the north and central zone FMUs, along the Klamath River. As defined in the FMP, management objectives for both FMUs are to (1) reduce the occurrence of human caused wildfire, (2) reduce the negative effects of natural disturbances and uncontrolled wildfire, and (3) change vegetation attributes to fall within the range of management recommendations.

Aggressive fire suppression and prevention since the 1940s has allowed fuel to accumulate and forest types that are less fire resistant to become more widely distributed. The stand structure now includes more down/dead material and ladder fuels of shrubs and shade-tolerant, understory tree species. This structure often creates the potential for crown fires and increased tree mortality and habitat degradation. As early as 1918 Orleans District Ranger Harley recognized the negative impacts of aggressive fire suppression. A letter he wrote in 1918 bemoans the consequence of keeping wildfires to a minimum size, resulting in "more thick underbrush, windfalls, and general humus as a forest cover than before the service was in effect…the Forest Service has kept the fires out, and now cattle cannot live here on account of the thick brush."

The urban/wildland intermix component exists in this Analysis Area within or adjacent to the communities of Orleans, Somes Bar, Weitchpec, and the Hoopa Valley Indian Reservation (HVIR), and all were identified as "communities at risk" from wildfires in the Federal Register (August 17, 2001, v66:n160). In addition, the Yurok Indian Reservation (YIR) was also listed as a "Fire-Threatened Community in California" within the 2001 California Fire Plan. Pearch Creek is also a high priority area within the National Fire Plan because it is a municipal watershed. Vegetation patterns resulting from clusters of both historic and recent, human-caused ignitions are evident along the Klamath River and Highway 96. Residential development, recreational use, and special forest product opportunities have increased the probability of ignitions, and have complicated the success of wildfire suppression and fuel treatment strategies within the Analysis Area. Recent wildfires in this area (Windy Fire: 2000-70 acres, Dance Fire: 2001-30 acres, Slate Fire: 2001-35 acres) highlight the increased threat to these communities. As a result, the local Fire Safe Council has recognized these complex issues, and is actively trying to analyze and improve the situation.

Air quality issues, as related to health impacts, are also a concern when dealing with large area wildfires (e.g. 1987 wildfires on the Klamath NF and the Megram Fire in 1999), and when deciding on priorities and timing of prescribed burning projects.

Water Quality and Fisheries

Traditionally, aquatic ecosystems have been analyzed at the local or project scale. With the decline of anadromous fisheries, the relevance and importance of examining aquatic ecosystems at larger scales has become imperative. Placing the LMK Analysis Area within the context of the larger Klamath River Basin enables the relative importance of these sub-watersheds to be compared with others. It also helps to clarify the role of refugia and watersheds for "at risk" anadromous fish stocks within the Klamath River Basin. Many issues, concerns, and values identified at the Klamath River Basin scale are useful in understanding how the LMK Analysis Area functions.

Hydrologic Regime

The Klamath River system is the second largest river system in California, draining an area of approximately 10,039 square miles in California and 5,560 square miles in Oregon. The LMK Analysis Area is about 94 square miles in size and includes 23 miles of the mainstem Klamath River between the confluences with the Salmon and Trinity Rivers. It also includes some smaller tributaries flowing into this portion of the Klamath River as represented in Table 5 and Figure 3.

Table 5 Characteristics of Sub-Watersheds within the Analysis Area.

LMK Sub-watersheds	Total Acres	Interim Riparian Reserve Acres	Miles of Stream
Aikens Creek	2,526	303	7.7
Boise Creek	9,987	1,130	38.4
Cavanaugh*	6,598	267	13.0
Crawford Creek	3,913	269	13.4
Hopkins Creek*	5,759	209	20.8
Ikes	8,931	1,274	32.5
Pearch Creek	4,195	553	17.7
Red Cap Gulch	5,075	481	16.7
Slate Creek	8,748	730	32.8
Whiteys Gulch	4,346	458	14.2
Totals	**60,078**	**5,674**	**207.2**

*Note: In Table 5 portions of these sub-watersheds are outside NFS lands. Interim Riparian Reserve acres are for NFS lands.

The mean annual discharge of the Klamath River, which includes the flow from the Trinity River, is 17,300 cubic feet per second (cfs). The mean annual flow of the Klamath River at Orleans, which lies within the Analysis Area, is 8,200 cfs. The drainage area of the Klamath River Basin above Orleans is 8,475 square miles. Therefore, the mainstem within the Analysis Area is greatly influenced by upstream conditions and flows. Water flow and water quality is influenced directly and indirectly by the Keno and Irongate dams as well as by agricultural water diversions and agricultural runoff that typically contain both nitrates and phosphates.

Watershed Management

Aquatic Conservation Strategy

Under the direction of the NWFP and its Aquatic Conservation Strategy (ACS), ensuring the quality of aquatic and riparian resources is one of the SRNF's main priorities. The LRMP seeks to provide diverse, high quality habitat capable of maintaining or enhancing ecologically functional wildlife populations and stocks of fish that are currently at risk. A principal goal of the LRMP for management of riparian corridors is to maintain water quality, stream temperatures, stream bank stability, wildlife habitat corridors, and sources of large woody debris for fish habitat structure and channel stability to ensure viability of dependent species (USFS 1995). The ACS outlines specific management direction to protect and enhance aquatic and riparian resources on federal lands. Watershed analysis is one of the four main elements of the ACS. The other three elements include the establishment of Interim Riparian Reserves (IRR), watershed restoration, and enhanced protection of key watersheds.

Wild and Scenic Designation

The mainstem Klamath River up to 100 yards below Iron Gate Dam is in both the federal and state Wild and Scenic Rivers Systems. In the federal Wild and Scenic Rivers System, the National Forests technically administer most of the Klamath River components, although no plans have been issued to date. The Klamath River was included in the federal system in 1981. The California Wild and Scenic Rivers Act (SB107) was passed by the State Legislature in 1972 to prevent the further construction of dams on several rivers, including the Klamath mainstem from Iron Gate to the Pacific Ocean, but not including or protecting the Klamath tributaries.

Fisheries Management

The LMK Analysis Area supports approximately 56 miles of known or suspected fish habitat, and 7 acres of lake habitat (Figure 4). Apart from several small lakes or ponds found on private property, two lakes are found within the LMK Analysis Area. Upper and Lower Twin Lakes, both at 3700 feet elevation on the west side of the Slate Creek sub-watershed, are important biological and recreational features. Streams in the Analysis Area are particularly important for endemic or locally distributed fish species and stocks. Twenty-seven species of fish are known to occupy this area throughout the year. Within this geographic area, most anadromous fish species show a declining trend in abundance.

The primary vehicle for protecting and maintaining fish habitat on the SRNF is to protect, enhance and maintain habitat quality and quantity. Protection requires that fisheries concerns are addressed in all potentially impacting land management activities and projects. In meeting these goals for fish, Standards and Guidelines are designed to focus the review of proposed and certain existing projects in order to determine compatibility with ACS objectives (USFS and BLM 1994). These Standards and Guidelines are designed to maintain and restore the productivity and resiliency of riparian and aquatic ecosystems. Enhancement of fisheries and riparian resources are attained through stream and riparian habitat improvement projects in cooperation with many federal and state agencies, local tribes, and community members.

Figure 3 Perennial and Intermittent Streams.

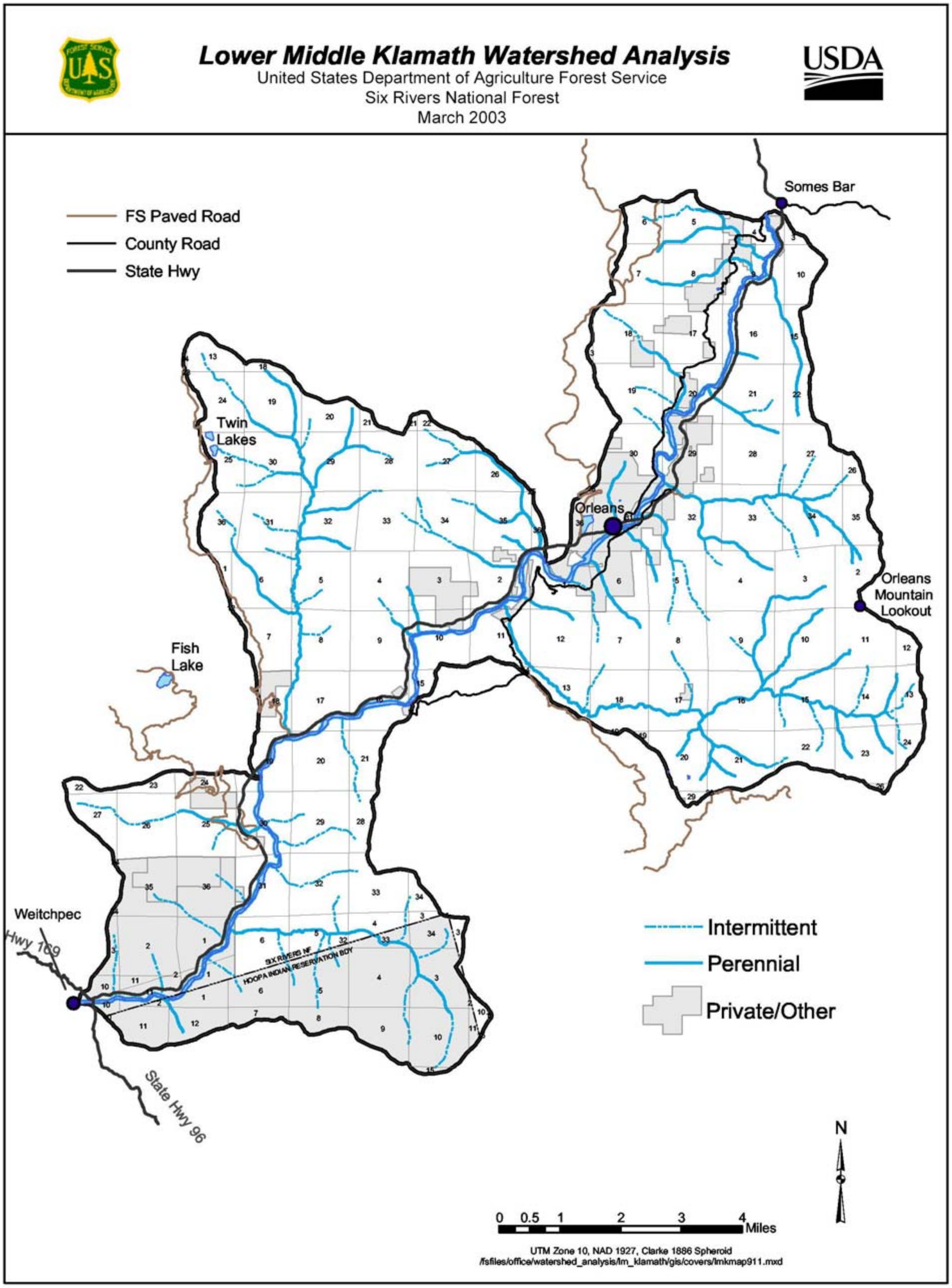

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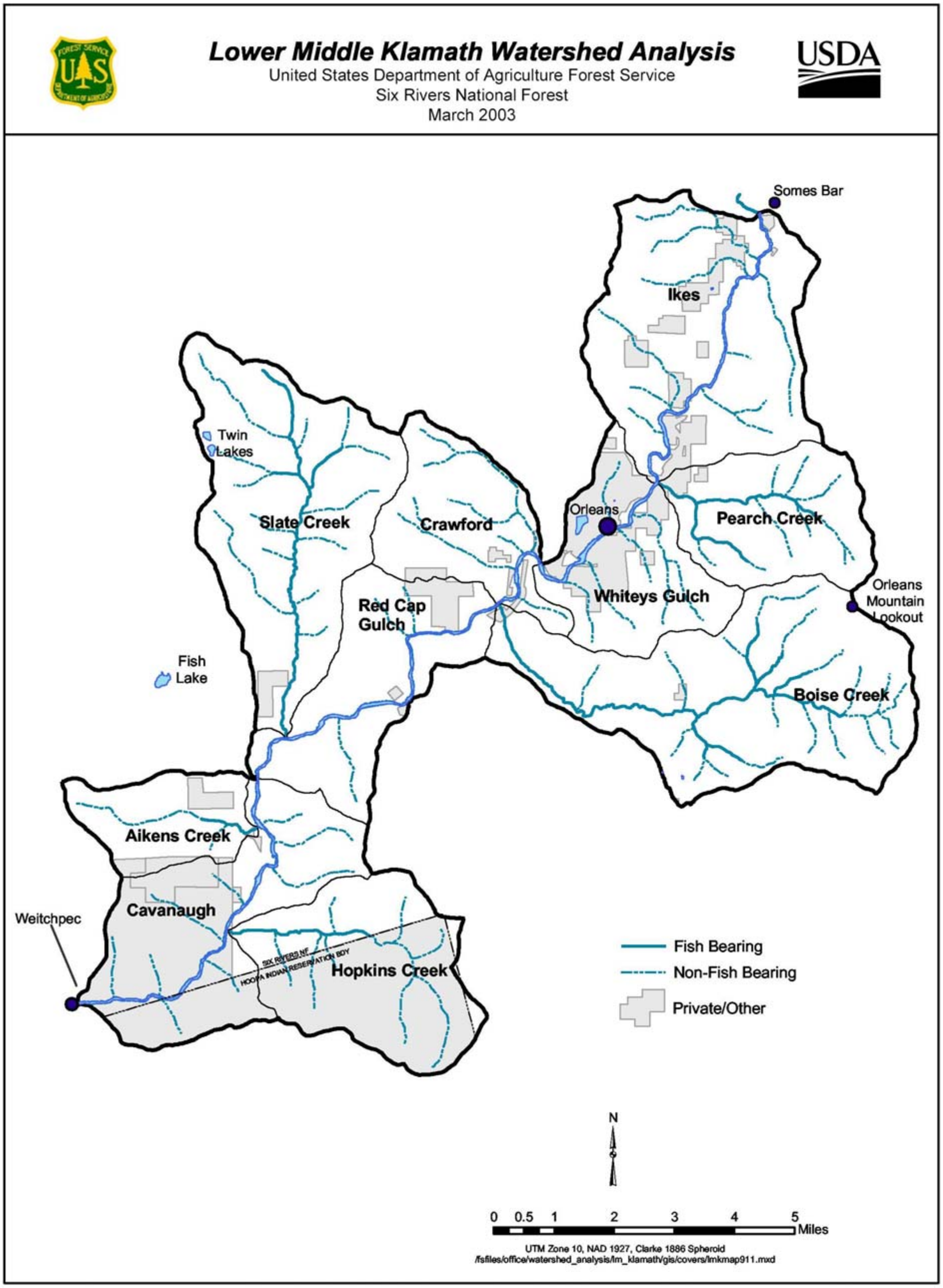
Figure 4 Fish bearing and non-fish bearing streams.



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Endangered Species Act

Section 7 of the ESA provides some of the most valuable and powerful tools to conserve federally threatened or endangered species, assist with species' recovery, and help protect critical habitat. It mandates all federal agencies, including the U.S. Department of Agriculture (USDA) Forest Service (USFS), to determine how to use their existing authority to further the purposes of the ESA in order to assist in recovering species, and to address existing and potential conservation issues. Under this provision, federal agencies often enter into partnerships with the U.S. Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service (NMFS) for implementing and funding conservation agreements, management plans, and recovery plans developed for species listed under the ESA.

NMFS conducts consultation on all activities that affect listed anadromous fish species, as delegated by the Secretary of Commerce. However, the ESA provides no specific guidance for determining what constitutes a distinct population when considering possible listing decisions. Therefore, NMFS developed a policy that stipulates a population (or group of populations) must be considered "distinct" for purposes of the ESA if it represents an evolutionary significant unit (ESU) of the species. For purposes of conservation under the ESA, an ESU is a distinct population or group of populations that must (1) be substantially reproductively isolated from other populations and (2) contribute substantially to the ecological/genetic diversity of the biological species. NMFS considers a variety of factors in evaluating the level of risk faced by an ESU.

Issues pertaining to the viability of fish stocks are more appropriately assessed at larger watershed scales (e.g. coast-wide, multiple river basins, or an ESU). However, smaller sub-watersheds like the LMK Analysis Area (that may constitute a portion of an ESU) can be extremely important in summarizing biological and environmental information for fish conservation and recovery. Due to recent dramatic declines of some fish species that inhabit the LMK Analysis Area, certain fish populations have been designated a special status and are considered "at risk", as further described below.

Threatened and Endangered Fish

On May 6, 1997 NMFS announced its determination to list the southern Oregon/northern California (SONC) coho salmon (*Oncorhynchus kitsutch*) ESU as threatened under the ESA (62 FR 24588). Threatened species are defined as any species likely to become endangered in the foreseeable future throughout all or a significant portion of its range. The SONC coho salmon occur between Cape Blanco, Oregon, and Punta Gorda, California, which includes the LMK Analysis Area. SONC coho critical habitat was designated by NMFS on May 5, 1999. However, on March 11, 2002 NMFS announced that it would seek judicial approval of a consent decree to withdraw its current habitat designations for 19 salmon and steelhead populations. The move was in response to litigation challenging the process by which critical habitat designations were established. NMFS will undertake a new, more thorough analysis consistent with a recent decision of the United States 10th Circuit Court of Appeals, and proceed to re-issue critical habitat designations after the analysis is completed.

Forest Service Sensitive Fish

In 1990, spring-run chinook salmon (*O. tshawytscha*) were designated a sensitive species by the USFS due to significant declines in escapement. On February 1, 1995 NMFS was petitioned to list chinook salmon throughout its range in California, Oregon, Washington, and Idaho, and to designate critical habitat under ESA. Following their status review, a number of ESU's were designated throughout its range, but listing was not warranted for spring-run chinook found within the Klamath River Basin.

Summer-run steelhead trout (*O. mykiss*) found within the Klamath Basin were designated as a USFS sensitive species in 1990. On March 16, 1995, NMFS published a proposed rule to list Klamath Mountain Province steelhead as threatened (60 FR 14253). This proposal included all steelhead populations occurring in coastal streams between Cape Blanco, Oregon, and the Klamath River Basin in Oregon and California. However, NMFS determined that listing was not warranted for this ESU on April 4, 2001.

In 1998, North American green sturgeons (*Acipenser medirostris*) were placed on the USFS sensitive species list for the Klamath River Basin. On June 12, 2001 NMFS received a petition to list this species as threatened or endangered, and to designate critical habitat under ESA. NMFS found the petition presented substantial scientific information indicating that it was warranted, and as a result this species is currently under status review.

Magnuson-Stevens Act

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act set forth some new mandates for NMFS, regional fishery management councils, and federal action agencies, such as the USFS, to identify and protect important marine and anadromous fish habitat. The councils, with assistance from NMFS, are required to delineate essential fish habitat (EFH) in fishery management plans or plan amendments for all managed species. Federal action agencies that fund, permit, or carry out activities that may adversely impact EFH are required to consult with NMFS and respond in writing to their recommendations. In addition, NMFS is required to comment on any State agency activities that could impact EFH. The purpose of addressing habitat in this act was to provide for one of the nation's overall marine resource management goals, which is maintaining sustainable fisheries; as evidenced by all wildlife resources, suitable habitat is absolutely essential for species sustenance. Although the concept of EFH is similar to that of critical habitat under ESA, measures recommended by NMFS or another council to protect EFH are advisory, not prescriptive. An effective EFH consultation process is vital to ensuring that Federal actions serve the Magnuson-Stevens Act resource management goals.

Klamath Act

Congress adopted Public Law 99-552, referred to as the Klamath Act, on October 27, 1986. The purpose of the act was to authorize a 20-year Federal and State cooperative Klamath Basin Conservation Area Restoration Program for the rebuilding of the river's fish resources. Congress observed that "floods, the construction and operation of dams, diversions and hydroelectric projects, past mining, timber harvest practices, and road building have all contributed to sedimentation, reduced flows, and degraded water quality, which has significantly reduced the anadromous fish habitat in the Klamath-Trinity River system." This program continues to identify and address key issues necessary in restoring the habitat and fisheries produced by the Klamath River Basin.

The Klamath Act created a Klamath River Basin Fisheries Task Force and the Klamath Fishery Management Council (KFMC). This fourteen-member task force was directed to assist the

Secretary of Interior with implementing the cooperative restoration program. The eleven member KFMC was directed to conduct public hearings for the purpose of developing and making recommendations concerning harvesting regulations to the California Fish and Game Commission, Oregon Department of Fish and Wildlife, Pacific Fishery Management Council, Bureau of Indian Affairs (BIA), and the Hoopa Valley Council.

Terrestrial Wildlife Species

The LMK Analysis Area supports a variety of wildlife species. There are an estimated 120 bird species, 60 mammal species, 16 amphibian species, and 17 reptile species that are known or suspected to utilize habitat within the Analysis Area at some period throughout the year.

Wildlife Management

LRMP goals for wildlife are to (1) maintain viable populations of all native and desirable non-native wildlife species occurring on the SRNF by providing the variety, distribution, and amount of wildlife habitat types necessary, and maintaining a biologically diverse and functional forest landscape condition, and (2) maintain or improve populations of endangered, threatened, and sensitive species by providing suitable habitats that are capable of meeting species requirements (USFS 1995, IV – 96). In meeting these objectives for wildlife, a variety of mitigations have been established in the form of Standards and Guidelines. Occasionally, these mitigations, that were designed to conserve wildlife, may become regulatory constraints to implementing other resource management activities and practices. For instance, activities generating loud or continuous noise must be restricted during the periods shown in Table IV-11 on page IV-98 of the LRMP (USFS, 1995).

Concerns about viability are reflected in the designation of special status, LRMP objectives, and regulatory constraints for the wildlife species known or suspected to occur in the LMK Analysis Area. These species and designations are addressed below.

Threatened and Endangered Wildlife

Wildlife species currently listed under the ESA that are known or suspected to inhabit the LMK Analysis Area include the northern spotted owl (NSO), bald eagle, and marbled murrelet (all listed as “threatened”). The peregrine falcon was recently de-listed but will continue to be managed under the LRMP, while being treated as a USFS sensitive species.

Some of the more important Standards and Guidelines for federally listed and sensitive wildlife species, which may influence resource management in the LMK Analysis Area, call for (1) consultation with USFWS to be conducted in accordance with the ESA (for listed and proposed species, and/or their designated critical habitat) and (2) preparation of biological assessments/evaluations for endangered, threatened, proposed, and sensitive species for every project to determine if the project may affect these species.

Within the Analysis Area, there are all or portions of 31 historically active NSO home ranges, two currently active peregrine falcon territories, one historically active peregrine falcon territory, and two currently active bald eagle territories. The Analysis Area is roughly 19 to 35 air miles from the ocean and lies within marbled murrelet zones 1 and 2 (USFS and BLM 1994). No marbled murrelet nest sites are known in the Analysis Area.

LRMP objectives stipulate that nesting habitat for bald eagles and peregrine falcons are to be managed through the zone concept. The Nest Site Protection Zone contains the nest tree or cliff and the habitat directly influencing nest site conditions. Management activities within this zone are intended to protect the biological and physical integrity of the nest sites and to minimize human disturbance. This zone is included in lands designated as Management Area 8 – Special Habitat. Timber harvest prescriptions within these zones are to be designed to create, maintain, or enhance habitat for the species of concern.

Management direction regarding NSO habitat is to be consistent with that for Management Area 8 - Special Habitat, including the protection of 100 acres of owl habitat around all known owl activity centers. Formal consultation with the USFWS is required when suitable habitat would be reduced below 500 acres within 0.7 miles, or below 1,340 acres within 1.3 miles, of nests or activity centers. Critical habitat has been designated for NSOs (Figure 25).

Management direction for marbled murrelet sites (none are yet known of in the Analysis Area) is also consistent with that for Management Area 8 – Special Habitat. Critical habitat for marbled murrelets corresponds to the Late-Successional Reserves (LSR) located within marbled murrelet zones 1 and 2 (Figure 25).

Forest Service Sensitive Wildlife

USFS sensitive wildlife species that are known or likely to occur within the Analysis Area include the peregrine falcon, northern goshawk, willow flycatcher, Townsend's western big-eared bat, American marten, Pacific fisher, southern torrent salamander, foothill yellow-legged frog, and western pond turtle. With exception of the peregrine falcon, current population information for these species is lacking. There are two goshawk management areas within the LMK Analysis Area. No specific management areas have been established for any other sensitive species within the Analysis Area.

Most of these sensitive species require older forest structure, and all require relatively undisturbed, mature habitats for at least some part of their life cycle. Although the pond turtle, the torrent salamander, and the foothill yellow-legged frog are generally aquatic, they are included in the terrestrial wildlife section of this document because they are partially dependent on upland terrestrial habitat features and processes. Habitats for sensitive species are to be managed to maintain well-distributed populations throughout their ranges, and to prevent them from becoming federally listed as threatened or endangered under ESA. The LRMP calls for seasonal noise restrictions around active nests, dens, or maternity areas of non-amphibian sensitive species. In addition, the LRMP also identifies seasonal noise restrictions for the black bear (a harvest species) and the following species of concern: great blue herons, ospreys, and golden eagles.

Survey and Manage Species

Within the LMK Analysis Area, there are several terrestrial animal species listed as Survey and Manage (SM) in the LRMP. The *Final Supplemental Environmental Impact Statement* and *Record of Decision for Amendments to the Survey and Manage, Protection Buffer, and other Mitigation Measures Standards and Guidelines* released in November 2000, and January 2001 respectively, and the Annual Species Review, used new information to change the status of some SM species from what was published in the LRMP. These SM species are not necessarily imperiled, but there are concerns over their long-term persistence in heavily managed forests, in part because relatively little is known about them. Management recommendations for these species call for protection of previously known sites or pre-disturbance habitat surveys. If these species are found, various protection measures are then recommended. These protection measures, or management recommendations, may constrain achievement of other management objectives.

SM species that require pre-disturbance surveys and are known or suspected within the LMK Analysis Area are the Trinity shoulder-band snail (*Helminthoglypta talmadgei*), and the Oregon red tree vole (*Arborimus longicaudus*). However, the Oregon red tree vole's range is believed to be only northwest of the Klamath River (USDA, USDI 2000). Species for which known sites are to be managed include those mentioned above as well as the Oregon shoulder-band snail (*Helminthoglypta hertleini*).

Cavity-Nesting Birds and Bat Roosts

The original "Protection Buffer" species from the LRMP, have been placed in different categories such as "Certain Cavity-Nesting Birds" and "Some Bat Roosts", or eliminated from consideration by the 2001 Record of Decision. The species from the "Certain Cavity-Nesting Birds" category that are most likely to occur within the Analysis Area are white-headed woodpeckers and flammulated owls. Management recommendations in the 2001 Record Of Decision for these species call for maintaining at least 1 soft snag greater than 15 inches in diameter every 1.7 acres. In order to protect bats, including the fringed myotis, silver haired bat, long-eared myotis, long-legged myotis, and Townsend's western big-eared bat (sensitive), the new management recommendations call for protecting caves, abandoned mines, abandoned wooden bridges, and abandoned buildings, as well as prohibiting timber harvest within 250 feet of occupied sites.

With the exception of the sensitive species and the SM species, concerns for the management of these species did not surface as a main issue in this watershed analysis. Opportunities to benefit these species or their habitats, along with opportunities to benefit other wildlife species are identified in Chapter 5.

Management Indicator Species

The LRMP selected 38 wildlife species and 3 fish species as Management Indicator Species (MIS) or species assemblages (groups of species with similar habitat requirements) (Table 6). These species use a wide variety of habitats potentially affected by resource management activities on the SRNF (see Appendix I). Indicator species were selected based on their roles in their respective biotic assemblages or community. Many MISs occupy a niche in their particular assemblage that may be sensitive to management related activities or natural disturbances. On the basis of available scientific information, management planning teams shall estimate the effects of changes in the amount and suitability of MIS habitats and population trends from proposed management activities.

With the exception of the threatened and sensitive species, concerns for the management of MIS species did not surface as a main issue in this watershed analysis. Opportunities to benefit some of these species or their habitats are identified in Chapter 5.

Table 6 Six Rivers National Forest Management Indicator Species.

Individual Species	Tanoak/Madrone Assemblage
Northern Spotted Owl (Threatened)	Hammond's Flycatcher
Pileated Woodpecker	Western Tanager
Black Bear (Harvest)	Black-headed Grosbeak
American Marten (Sensitive)	
Fisher (Sensitive)	**Snag Assemblage**
Black Tailed Deer (Harvest)	Flammulated Owl
	Western Screech Owl
Bog/Seep/Wet Meadow Assemblage	Red-breasted Sapsucker
Southern Torrent Salamander (Sensitive)	Downy Woodpecker
	Hairy Woodpecker
Marsh/Lake/Pond Assemblage	White-headed Woodpecker
California Red-legged Frog* (Sensitive)	Vaux's Swift
Western Pond Turtle (Sensitive)	Brown Creeper
Wood Duck	Western Bluebird
	Douglas Squirrel
River/Stream/Creek Assemblage	
Cutthroat Trout* (Sensitive)	**Down Woody Debris Assemblage**
Winter Run Steelhead/Rainbow Trout (Harvest)	Arboreal Salamander
Summer Steelhead (Sensitive)	Clouded Salamander
Tailed Frog	Blue Grouse (Harvest)
Common Merganser	Dusky-footed Woodrat
Ruffed Grouse (Harvest)	Western Fence Lizard
Winter Wren	
American Dipper	**Black Oak/White Oak Assemblage**
Yellow-breasted Chat	Acorn Woodpecker
	Scrub Jay
	Lazuli Bunting
	Western Gray Squirrel (Harvest)

*Note: In Table 6 these species are not thought to occur within the LMK Analysis Area.

Harvest Wildlife Species

The harvest species listed here are a subset of the game species that are known or suspected to occur within the LMK Analysis Area. They include black-tailed deer (*Odocoileus hemionus*), and black bear (*Ursus americanus*), along with the ruffed grouse (*Bonasa umbellus*), the blue grouse (*Dendragapus obscurus*), western gray squirrel (*Sciurus griseus*) and (though not a wildlife species) the rainbow trout (*Oncorhynchus mykiss*). Other harvest wildlife species that are not MIS species, but that are known or suspected to occur within the LMK Analysis Area, and are hunted there, include the Roosevelt elk (*Cervus elaphus roosevelti*), the mourning dove (*Zenaida macroura*), the band-tailed pigeon *(Columba fasciata*), California quail (*Callipepla californica*), mountain quail (*Oreortyx pictus*), mallard (*Anus platyrhynchos*) and the wood duck (*Aix sponsa*). Management of these harvest species did not surface as a main issue in this watershed analysis, but opportunities to proactively manage for some of these species are identified in Chapter 5.

Human Needs and Uses

Human actions can have a profound influence on ecosystem function. Conversely, ecosystem functions can have a profound effect on human values. Since the LMK Analysis Area includes towns, residential areas, and aboriginal tribal territories, there is considerable interest in how this watershed analysis can promote an understanding of human/ecosystem interactions and identify opportunities to improve resource and employment conditions.

Cultural Setting

Local Towns

The communities of Orleans, and portions of the communities of Somes Bar and Weitchpec and portions of the YIR and HVIR, lie within the LMK Analysis Area. Somes Bar has a population of about 125, and its main industries are organic farming, timber management, and recreation. Facilities in Somes Bar include a store/post office, an elementary school, a fire station, and residential areas. Orleans has a population of 680, and the main industries are logging, recreation, organic farming, several small service type businesses, and other individual enterprises, which are mostly natural resource based or provide services to those using natural resources in the area. State, county, and federal government agencies, including a public elementary school, a county dump, and a California Department of Transportation facility, which houses equipment and a local crew of six to eight employees, also operate in and near Orleans. The USFS maintains a facility for the Orleans Ranger District of the SRNF (including the Ukonom District of the Klamath National Forest which is administered by the SRNF). This office employs about 30 permanent employees, and hires about 20 - 30 employees in temporary, seasonal jobs. The town of Weitchpec, which has a population of 150, has a store/gas station, an elementary school, and a church.

Local Tribes

Aboriginal uses of the Karuk, Yurok, and Hupa occurred within the Analysis Area. Though the three tribes share many subsistence technologies, spiritual beliefs and practices, and have ancestral ties to the geography, they are distinct peoples. The Karuk aboriginal and contemporary use dominates the Analysis Area whereas the Yurok's strong presence is in the western portion and the Hupa in the southwestern portion. Today all three tribes are federally recognized and have an active role in the economic, social, and natural resource issues within the LMK Analysis Area.

Local Economy

The economic stability of the area has fluctuated greatly. Tens of thousands of Euro-Americans flooded the area in the mid-1800s to mine gold, however, as the element became harder to obtain, gold mining vanished quickly, less than a generation after it had started. The economy grew again in the first half of the twentieth century due to its reputation as a premier fishing destination with abundant runs of salmon and winter steelhead. This recreation-based industry has diminished in the second half of the twentieth century due to numerous factors, both natural and human-caused, that severely depleted stocks of these fish. After World War II, the area again flourished when the logging of Douglas-fir trees began locally. This boom continued until the late 1980s when regulations surrounding the ESA and other resource protection measures resulted in the large timber companies having to look elsewhere for easily obtainable resources.

Recreation Management

The Secretary of Interior designated the Klamath River, under the National Wild and Scenic Rivers Act (WSRA) of 1968, as a recreational class river on January 19, 1981. This designation was based upon the river's free-flowing condition, its water quality, and its outstanding value of anadromous fisheries. The recreational classification applies to river segments that are readily accessible by public roads and have experienced substantial human modification to the scenery. The WSRA corridor widths have been delineated to follow the IRR management area boundaries in order to protect anadromous fisheries.

The SRNF LRMP identifies several goals for such recreational rivers, which are to (1) protect the recreational rivers and their immediate environments for the benefit and enjoyment of present and future generations, (2) maintain and enhance the outstandingly remarkable values for which the rivers are designated, while providing for public recreational and resource uses that do not adversely impact or degrade those values, and (3) manage recreational activities to assure that the character and quality of recreational use will not cause adverse impacts of the resource values for which the rivers were designated.

A variety of recreational activities take place throughout the Analysis Area, with most uses being concentrated near the Klamath River and along Highway 96. The Klamath River is used for fishing, rafting, kayaking, canoeing, swimming, and sunbathing. Other opportunities include camping, hiking, picnicking, hunting, scenic driving, mountain biking, and wildlife viewing. Special community events include, the Orleans "old-timers" picnic and parade and an annual Easter egg hunt. Also, in August of 2000, Highway 96 between Willow Creek and Happy Camp was designated as the Bigfoot Scenic Byway. This section of highway finished a loop consisting of four scenic byways in northwestern California, which passes through the Analysis Area and provides great beauty and a variety of recreation opportunities for the touring traveler. Recreationists have access to USFS recreation facilities within the Analysis Area, which include trails, campgrounds, and river access sites.

Road System

USFS system roads are not public roads in the same sense as those under the jurisdiction of public road agencies, such as the State or County (FSM 7705). USFS roads are authorized only for administration and utilization of NFS lands. The four types of use are: (1) administrative use by the USFS, (2) emergency fire and rescue, (3) recreation, and (4) commercial or permittee. Although generally open and available for public use, road use designation is at the discretion of the Secretary of Agriculture. Commercial users, permittees, or contractors may be required to share in the cost of developing, improving, and maintaining these roads.

There are five maintenance levels (ML) on USFS roads, from ML1, which are closed to vehicular traffic, to ML5, which provide a high degree of user comfort and convenience. The five maintenance levels can be put in three groups: (1) ML1, which are intermittent service roads that are closed to vehicular traffic at least once a year, (2) ML2, which are roads open for use by high clearance vehicles but not suitable for passenger car traffic, and (3) ML3 and higher roads that are subject to the Highway Safety Act, and are open to the general public for mixed recreational and commercial use.

There are 176.6 miles of Forest Service system roads in the LMK Analysis Area, of which 42.6 miles are ML1, 63.2 miles are ML2, and 70.8 miles are ML3 or higher. Road surface types consist of asphalt, concrete, crushed aggregate, and pit-run or native soil materials. Most of these roads were built for commercial use (logging), and, when used as haul routes for current or future projects, are maintained by the party responsible for the timber harvest. In the past five years, there have been fewer timber sales in the Analysis Area, so road maintenance has decreased accordingly. At the same time, USFS funding for road construction and maintenance has dropped to one-third of the average level in the 1980s. As a result of these two factors, many of the roads in the area are in poor condition. In the absence of timely road maintenance, minor road problems can become more damaging to aquatic habitat and may persist for decades.

Transportation Management

According to the LRMP, roadless areas (formerly designated as Roadless Area Review and Evaluation II or RARE II) in key watersheds are to have no new (i.e. net) road construction (USFS 1995, II-6). However, there are no key watersheds in this Analysis Area.
Also, watershed analyses are to include an analysis of all the roads occurring within the Analysis Area. Analysis of ghost, non-system and maintenance level 1, 2, 3, 4, and 5 roads within the LMK Analysis Area will be included in a roads analysis being conducted separately, but concurrently, across the SRNF, and will be included as an appendix to this document at a future date.

LRMP goals for transportation facilities are to provide public access to NFS lands for the use and enjoyment of its natural resources and to provide a safe, efficient, and cost-effective transportation system.

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2. ISSUES & KEY QUESTIONS

The purpose of this section is to focus the analysis on the key elements of the ecosystem that are most relevant to the management questions, human values, or resource conditions within the LMK Analysis Area. The issues and key questions outlined below are addressed throughout the remaining analysis to the extent possible, given the level of existing information. The locations of answers to each question are indicated in parentheses.

Vegetation and Fire

Vegetation Ecology and Port-Orford-cedar

Issues

Natural and human disturbance in the Analysis Area has altered plant communities. Disturbance agents such as fire, timber harvesting, road building, fire suppression, and Native American burning, have altered the seral stage distribution in this landscape. In addition, human spread diseases, such as POC root disease, have the potential to alter plant community species composition. Through these agents the resilience of some plant communities to catastrophic or large-scale disturbance may have been altered. There may be opportunities for vegetation management in mature stands that could enhance their resilience to disturbance and improve the seral stage distribution of the landscape.

Key Questions

1. *How has human and natural disturbance affected the Historic Range of Variability and the Recommended Management Range?* **Answered**: Chapter 3 & Chapter 4

2. *What is the potential impact of Port-Orford-cedar root disease on Port-Orford-cedar plant community composition and function?* **Answered**: Chapter 3

3. *Are there opportunities for vegetation management that would increase resilience to disturbance and enhance the late-seral characteristics of stands?* **Answered**: Chapter 5

Noxious Weeds

Issues

Non-native, invasive plant species, also known as noxious weeds, are present in the area, some as localized populations. The dominance and persistence of weeds displaces native species (flora and fauna) and alters various ecosystem processes. Invasive species may also reduce property values, the quality of pastureland, and quality of riverside recreation. Potential exists for these species to spread into currently uninfested areas by vectors such as roads and equipment relocation. Opportunities exist to manage localized and leading edge populations.

Key Questions

1. *What are the most invasive species of noxious weeds within the Analysis Area?* **Answered**: Chapter 3
2. *What activities exacerbate the introduction, spread, and ability to manage invasive plant species?* **Answered**: Chapter 3
3. *What are the trends for further introduction and spread?* **Answered**: Chapter 4
4. *What control options are available?* **Answered**: Chapter 4

Fire

Issues

Recent wildfire events within the Analysis Area highlight the potential threats related to wildland fire, both to local communities and to resource values. Landscape level fires, including Native American burning, have been virtually eliminated from this area for 60 to 80 years. The resulting vegetation patterns and structure present severe problems related to treating within and adjacent to the wildland/urban intermix and across the landscape.

Key Questions

1. *What was the pre-European fire regime?* **Answered**: Chapter 3
2. *What is the trend of fire risk for lightning versus human-caused fires?* **Answered**: Chapter 3
3. *What is the fire hazard, and what are the potential on-site and off-site/indirect effects of wildfires within the Analysis Area?* **Answered**: Chapter 3
4. *What are the impacts on air quality and visibility of wildfires compared to prescribed burns within and adjacent to the Analysis Area?* **Answered**: Chapter 3
5. *What would be the impacts of returning to the pre-European fire regime, and is this achievable and sustainable?* **Answered**: Chapter 4
6. *What efforts can help minimize fire risk, especially human-caused risk?* **Answered**: Chapter 4
7. *What combination of fuel treatments (prescribed fire, fuelbreaks, thinning, mechanical treatments) could help to reduce the fire hazard, and where are the priority areas to treat?* **Answered**: Chapter 4
8. *Given the change in fire regime, what are the potential impacts to communities and resources if fuels are not aggressively treated?* **Answered**: Chapter 4

Water Quality and Fisheries

Erosion Processes and Water Quality

Issues

Aquatic ecosystems in the Pacific Northwest have adapted to disturbances that impact water quality, aquatic species, and habitat in the short term, but rejuvenate the aquatic ecosystem in the long term. During the past 40 years, parts of the Analysis Area have experienced moderately high levels of timber harvest and moderate road densities. Due to the inherent instability and erodibility of this landscape, these human-caused disturbances may have compounded the impacts associated with natural disturbances. The degree to which erosion rates, riparian areas, water quality, instream habitat, and aquatic populations have been altered from historic conditions, and the reasons for these changes are of key concern.

Key Questions

1. *How have the distribution or intensity of hillslope processes changed over time in the Analysis Area?* **Answered**: Chapter 3 & Chapter 4

2. *What effects have natural and human-caused disturbances (including storm/flood events, landslides, fire, logging, road construction or maintenance, and mining) had on mass wasting and erosion processes?* **Answered**: Chapter 3 & Chapter 4

3. *To what degree and in what types of locations have management activities affected mass wasting or erosion processes within the Analysis Area?* **Answered**: Chapter 3 & Chapter 4

4. *Where have management activities tended to produce adverse effects on beneficial uses (water quality, aquatic and riparian habitat, fisheries), either directly or indirectly?* **Answered**: Chapter 4

5. *How and to what extent can these adverse effects be counteracted?* **Answered**: Chapter 4

6. *Where are domestic water sources located, and how vulnerable are they to sedimentation from natural or human-caused landscape disturbances?* **Answered**: Chapter 3

7. *What water quality parameters in the Analysis Area may be detrimental to native aquatic organisms?* **Answered**: Chapter 3

8. *For the areas where beneficial uses have been impacted, when will they be considered recovered?* **Answered**: Chapter 4

9. *How do water quality parameters and erosion processes within the Analysis Area compare to the entire Klamath Basin?* **Answered**: Chapter 3

10. *To what extent have flow characteristics of the mainstem Klamath River been altered, and how has this affected key dependent aquatic species?* **Answered**: Chapter 3

11. *To what extent are cumulative watershed effects evident within the Analysis Area?* **Answered**: Chapter 4

Soil Productivity and Protection

Issues

Soils are a fundamental resource on which most other ecosystem values are based. Many of the soils in the Analysis Area are vulnerable to impacts from land management, depending in large measure on the particular location and type of management involved. Erosion hazard is high in some areas due to steep slopes that are inherently unstable. Some soils with low organic matter are very susceptible to damage from fire, while other soils are subject to loss of porosity when compacted under moist conditions. Maintaining the soil profile in a near-natural condition throughout most of this Analysis Area, with the exception of permanent roads or facilities, must be a primary goal in order to sustain other ecosystem functions.

Key Questions

1. *What soil types exist that are especially sensitive to natural or management disturbances such as wildfire, fuel treatments, or logging, and in what locations are special mitigations warranted?* **Answered**: Chapter 3 & Chapter 4

2. *What are the major uncertainties in protecting soil productivity within this Analysis Area while conducting management activities?* **Answered**: Chapter 4

3. *How should the relative risks and benefits to long-term soil productivity, related to actively managing versus not managing, be evaluated when planning or executing projects?* **Answered**: Chapter 4

4. *What are the key factors for protection of various soils within the Analysis Area when conducting treatments, such as fuels reduction, to preserve other ecosystem values?* **Answered**: Chapter 4

5. *How should cumulative effects to soils be analyzed relative to future projects?* **Answered**: Chapter 4

Riparian Areas

Issues

Riparian and aquatic systems often reflect the ecological condition of an entire watershed. Riparian areas are important links between terrestrial and aquatic ecosystems, and they provide critical habitat for numerous species. Riparian Reserves are a USFS land allocation intended to protect riparian areas. Riparian corridors within the Analysis Area have been subjected to natural and human-caused disturbances, which may have diminished their function or value to dependent biotic communities.

Key Questions

1. *How have vegetative conditions of riparian areas changed over the past century, and what were the causes of those changes?* **Answered**: Chapter 3

2. *What effects have natural and human-caused disturbances, including fire, had on riparian areas throughout the Analysis Area during the past century?* **Answered**: Chapter 3

3. *Given the historic and recent impacts of natural and human-caused disturbances, what is the potential, and what are the principal mechanisms for large woody debris recruitment within riparian areas?* **Answered**: Chapter 3

4. *How have the abundance and distribution of riparian species of concern and their habitats changed as a result of natural and human caused disturbances?* **Answered**: Chapter 3

5. *How well do riparian areas function as wildlife travel corridors within the Analysis Area?* **Answered**: Chapter 3

6. *What riparian dependent species of concern (e.g. amphibians, migratory birds, mammals, etc.) exist in the Analysis Area?* **Answered**: Chapter 3

7. *What specialized habitats exist for species of concern (e.g. amphibians, Survey and Manage species, etc.), and have they been located?* **Answered**: Chapter 3

8. *What criteria should be used to establish appropriate riparian reserve widths or to guide management adjacent to or within riparian areas, in order to protect and restore beneficial uses?* **Answered**: Chapter 4

Fish Species and Habitat

Issues

The Analysis Area contains a significant portion of the Lower-Middle Klamath River and tributaries that provide essential habitat for anadromous fish and other aquatic species. The Klamath mainstem conditions directly affect tributary fish populations by providing adequate passage for adults into tributaries, by facilitating movement of juveniles into and between tributaries, providing rearing habitat for fry and juveniles produced in tributaries, and providing adequate conditions for smolts as they emigrate from tributaries and migrate to sea. Although limited, some small tributaries within the Analysis Area provide important habitat for holding refugia, spawning, and rearing fish. Several fish populations within the LMK Analysis Area are declining, considered at risk, and are listed as federal endangered species or Forest Service Sensitive species.

Key Questions

1. *Which fish species were historically significant and why; what were their distribution and relative abundance; and how has this changed today?* **Answered**: Chapter 3

2. *What fish species have been identified as being at risk, and what are their current trends?* **Answered**: Chapter 3 & Chapter 4

3. *What human-induced factors have the most influence on the quality and distribution of suitable fish habitat for at risk species?* **Answered**: Chapter 3

4. *How have exotic and hatchery-raised fish affected native fish populations in this part of the Klamath River?* **Answered**: Chapter 3 & Chapter 4

5. *Which sub-watersheds in the Analysis Area are critical for the maintenance, protection, and restoration of at risk species?* **Answered**: Chapter 4

Terrestrial Wildlife Species

Issues

The Analysis Area provides habitat for many terrestrial wildlife species. There are concerns about the viability of some of the species identified in Chapter 1. Some of these species are mostly aquatic, but are addressed in this section because terrestrial processes affect them. These include species federally listed as threatened, species that the USFS has labeled sensitive, and SM/Protection Buffer species from the SNRF LRMP.

Key Questions

1. *What conditions and factors have led to viability concerns for these (threatened, sensitive, etc.) wildlife species?* **Answered**: Chapter 3

2. *What are the types and distribution of habitats, and where known, populations and trends of these wildlife species within the Analysis Area?* **Answered**: Chapter 3

3. *What are the ecosystem processes or management practices that are likely to have the greatest impact or threat to these species?* **Answered**: Chapter 3

4. *What are the current Standards and Guidelines for Survey and Manage animal species?* **Answered**: Chapter 3

5. *What types of management opportunities exist that can benefit wildlife and meet other resource goals?* **Answered**: Chapter 4 & Chapter 5

Human Uses and Needs

Social

Issues

Residents and communities that are within or adjacent to the LMK Analysis Area, as well as other members of the public, use the resources in a variety of ways, and value these watersheds for diverse reasons. USFS management of public lands affects these uses and values. Tribal governments and people are concerned about the management practices the SRNF may implement, particularly as they relate to access via roads and trails, potential catastrophic fires, quality of their lives and experiences, and local community economics and infrastructure. The Yurok and Hoopa have federally reserved rights associated with lands, natural resources, fisheries, and water within the Analysis Area. This creates a trust responsibility associated with the management of NFS lands and resources related to potential effects of USFS management activities to federally reserved trust resources and rights.

Key Questions

1. *How do these watersheds contribute to the economies of local communities?* **Answered**: Chapter 3 & Chapter 4

2. *How have current watershed conditions affected subsistence fishing associated with federally reserved trust rights of the Yurok and Hoopa, and how can management practices minimize these effects on tribal trust resources?* **Answered**: Chapter 4

3. *How do the watersheds in the Analysis Area and their resources contribute to, or affect, people's sense of place or quality of life?* **Answered**: Chapter 3 & Chapter 4

4. *Why do people value their specific access to the Analysis Area, and why is this access important to them?* **Answered**: Chapter 3 & Chapter 4

5. *What is the make-up of the various communities in the Analysis Area?* **Answered**: Chapter 3

6. *What were the historical settlement and use patterns of the communities in the Analysis Area?* **Answered**: Chapter 3

7. *What are the perspectives on resource management among the communities and groups within the LMK Analysis Area?* **Answered**: Chapter 3

8. *What are the federally reserved trust resources and responsibilities within the LMK Analysis Area?* **Answered**: Chapter 3

Recreation

Issues

Recreational uses within the Analysis Area continue to change through time. These changes are in response to a variety of factors, both external/indirect and localized/direct. There is a concern about how to meet the most important desires of current and potential recreation users while staying within USFS budget limitations.

Key Questions

1. *What are the current recreational uses within the Analysis Area?* **Answered**: Chapter 3

2. *What are the future trends for recreational uses?* **Answered**: Chapter 3

3. *What improvements or new facilities are needed in order to meet the most critical recreation demands in the Analysis Area?* **Answered**: Chapter 4

4. *What opportunities exist on Forest Service system lands to better meet the current and future demands of recreationists?* **Answered**: Chapter 5

Special Forest Products

Issues

Due to the proximity to prehistoric village sites, the town of Orleans and state Highway 96, many SFP have been harvested from the Analysis Area over time. Native Americans cultured and utilized many of these products for thousands of years. In recent years, demand has increased for commercial utilization of some SFPs. General personal use of some SFPs has also increased. Conflicts have arisen between traditional Native American gathering and other utilization of some products (e.g. tanoak mushrooms). Uncertainties exist about the ecological roles and sustainable levels of harvest for many of these species and products.

Key Questions

1. *What are the projected commercial and personal use demands for Special Forest Products over the next decade?* **Answered**: Chapter 4

Timber Production

Issues

The LRMP establishes a sustainable level of timber production to be provided from Matrix (Table 1) lands. The Analysis Area contains a significant area of highly productive Matrix lands and valuable tree species that can supply a portion of the demand for wood products. The SRNF's ability to provide wood products within the Allowable Sale Quantity (ASQ) (i.e. allowable timber output) while maintaining ecosystem health is a key concern.

Key Questions

1. *What portion of the Allowable Sale Quantity is expected from the Analysis Area, and is this figure realistic based on Land and Resource Management Plan assumptions?* **Answered**: Chapter 3

2. *What effects may the established Standards and Guidelines for Recommended Management Ranges have on the potential level of timber production that could be realized?* **Answered**: Chapter 4

Road System

Issues

There is an extensive road system located in the Analysis Area with several state and county roads that provide the only access to the communities there. These main access roads are necessary for the community of Orleans to function. The topography in the Analysis Area is steep and results in frequent slides on the main access roads. Keeping these main roads open and passable is a high priority for the people living in this Analysis Area.

From state and county roads, the USFS road system provides for vehicular access to the Analysis Area for a wide variety of human uses. This road system is currently used for USFS administrative needs, fire management, commercial timber activities, recreation, hunting, woodcutting, special forest products gathering, sightseeing, etc. This transportation system was developed over an extended time largely for the purpose of resource extraction. Road maintenance activities have declined proportionally to the current reduction of resource extraction. As maintenance activities continue to decline, the potential exists for unsafe conditions for humans, and road-related impacts to streams, riparian areas, native plants, and wildlife.

Key Questions

1. *What are the management objectives and social concerns associated with roads in the Analysis Area?* **Answered**: Chapter 3

2. *How and why were the roads developed in the Analysis Area?* **Answered**: Chapter 3

3. *What types of roads exist in the Analysis Area, and what are their features and functions?* **Answered**: Chapter 3

4. *Do roadless areas exist within the Analysis Area that are subject to the Roadless Rule?* **Answered**: Chapter 3

5. *What types of problems are typically associated with roads within the Analysis Area?* **Answered**: Chapter 3

6. *What are the parameters associated with road maintenance in the Analysis Area?* **Answered**: Chapter 3

7. *Have major roads in the Analysis Area (Forest Service, county, or state) historically had landslides that needed to be removed to provide continued access to the community of Orleans, and required disposal of material on Forest Service land, and have possible slide disposal sites been located and/or permitted?* **Answered**: Chapter 3

8. *To what degree and in what types of locations have roads affected mass wasting or erosion processes?* **Answered**: Chapter 4

9. *What type of road maintenance is needed to minimize resource damage and provide for public safety?* **Answered**: Chapter 4

3. CURRENT & REFERENCE CONDITIONS

The purpose of this section is to develop both a reference condition, which will enable comparisons of how ecological conditions have changed over time as the result of human influences and natural disturbances, and a current condition. This discussion will also allow further analysis about how reference and current conditions interface with key management plan objectives that are outlined in the SRNF LRMP, as well as develop information relevant to the issues and key questions presented in the last chapter.

Reference conditions are primarily built from a multitude of sources ranging from anecdotal information and knowledge of ecosystem processes and functions to data extrapolations based on old aerial photographs. Therefore, reference conditions are both quantitative and qualitative, and are influenced by professional judgment.

Current conditions are generally derived from existing data and published reports. For this analysis professional judgment has been used to apply knowledge gained from data collected outside the Analysis Area where specific data is lacking from within this area.

Vegetation and Fire

Vegetation Ecology

Vegetation – Reference

The reference conditions for vegetation have been interpreted from paleontological and dendrochronological data, modeling of past fire regimes, and records of recent impacts to vegetation structure and composition. The paleoenvironment data shows what vegetation composition was most probably like in the prehistoric past. The model of past fires or HRV was developed to show, based on the best estimates, what the structure of vegetation was like in the last 200 years. The recent (last 50 years) impacts to vegetation include timber harvesting, fire, and forest pathogens.

Paleoenvironment

Vegetation composition has shifted through time due to changes in climate and subsequent disturbance regimes. Over the last 10,000 years climate changes have resulted in changes in species composition throughout the Analysis Area. Pollen analysis done on Pilot Ridge, 40 to 50 miles southwest of the Analysis Area, confirms these changes in composition. The pollen analysis showed that tanoak and chinquapin are fairly recent arrivals to this area. These two hardwood species show up in the pollen record at about 2300 B.P. It was during this period when the climate became wetter, which was more conducive to these species. The current composition of the mixed evergreen forest (Douglas-fir-tanoak and Douglas-fir-Quercus) did not begin to take place on this portion of Pilot Ridge until about 2,700-2,800 (radiocarbon) years ago. The pollen data also showed a decrease in the abundance of Douglas-fir and an increase in oak (*Quercus sp.)* species in the period 8,500 to 2.300 B.P.

In the last 13,000 years humans have had a significant impact on the landscape throughout California. In the Analysis Area, the Karuk, Yurok, and Hoopa tribes utilized portions of the Analysis Area and managed vegetation for their cultural and social needs. Native Americans affected vegetation composition, stand structure, and seral stage distribution through plant gathering, cultivation, and burning especially. Although evidence of Native American burning is clearly present today, the overall impact of these practices within the Analysis Area is unknown and often obscured by more recent management activities.

In more recent times, the dendrochronological data from California tree ring analysis indicates that there have been several periods of drought over the period of 1600-1960 (Fritts and Gordon 1980). An especially long, severe drought occurred over the period 1865-1885, and probably resulted in high fuel accumulations (due to tree mortality), followed by large-scale, stand replacing fires. In addition, the wet period immediately following, from 1885-1915, probably contributed high fuel accumulations of live material. These high fuel loads (both living and dead), combined with standard dry Mediterranean summers, probably also resulted in large, stand-replacing fires. Both of these widespread fire events have shaped much of the present vegetation seral stage distribution on the SRNF. Evidence of these stand-replacing fires is currently available in the SRNF vegetation seral stage maps. Stand ages of conifer stands classified as mid-mature and early-mature demonstrate the intensity and extent of these fires. These even-aged stands are approximately 135 and 90 years old respectively. Their ages roughly correspond to the 1865-1885 and post 1915 period and are evidence of large-scale stand replacing fire disturbance. Preliminary reconstruction of these two fire periods shows a mosaic pattern of fires that burned across the landscape, encompassing the vast majority of the LMK Analysis Area.

Historic Range of Variability

- *How has human and natural disturbance affected the Historic Range of Variability and the Recommended Management Range?*

Within the SRNF, management is directed at long-lived coniferous and hardwood forests that, over the time frame of this analysis, appear to be the potential natural communities for the Forest. They have distinct disturbance regimes and climate associated with their position near the Pacific Ocean. A coarse-filter analysis of vegetation series and seral stages is used here to examine the historic range of terrestrial vegetation variability. It is conducted at a scale sufficiently large enough to examine ecosystem process and function over a time period suitable to the attributes we are measuring (vegetation series and seral stages) (King 1993). The HRV is for seral stages in the primary vegetation series on the forest (Table 7). These series are the tanoak, Douglas-fir, white fir and red fir series. The HRV percentages are relevant for analysis at the scale of the Forest zones. The Forest zones are three areas (north, central, and south) that are distinguished by species composition and seral stage distribution differences. These differences in vegetation are a reflection of the different disturbance patterns, geologic material, and climate conditions of these three zones. The LMK Analysis Area is part of both the north and central zones.

The HRV analysis is then compared with existing conditions (Jimerson et al. 1997). For the purpose of this analysis the HRV was calculated for a 200-year period from 1790 to 1990. Trying to reconstruct the HRV prior to this is very difficult, even in very old ecosystems, because of the lack of information on climate and disturbance regimes (Atzet 1993). A key to the HRV analysis is the assumption that if we are within the HRV, we will maintain processes and function (USFS 1992). Conversely, if we are outside the HRV, we may not maintain ecosystem processes or function.

Table 7 HRV and RMR for Seral Stages within Tanoak, Douglas-Fir, and White Fir Series of the Six Rivers National Forest.

Series Seral stage	HRV% North Zone	RMR% North Zone	Existing % North Zone 1990[1]	Existing % North Zone 2000[2]	HRV% Central Zone	RMR% Central Zone	Existing % Central Zone 1990[1]	Existing % Central Zone 2000[2]
tanoak								
early-mature	9 – 25%	9 – 17%	19%	22%	11 – 18%	11 – 14%	17%	21%
mid-mature	2 – 23%	10 – 20%	18%	15%	11 – 19%	12 – 17%	22%	17%
late-mature	2 – 13%	7 – 13%	17%	18%	9 – 19%	14 – 19%	16%	18%
old-growth	29 – 48%	38 – 48%	24%	27%	22 – 50%	36 – 50%	20%	24%
Douglas-fir								
early-mature	7 –23%	7 – 15%	24%	22%	13 – 23%	13 – 18%	33%	28%
mid-mature	2 –29%	5 – 24%	25%	26%	10 – 27%	12 – 20%	37%	36%
late-mature	2 – 16%	9 – 16%	18%	17%	9 – 14%	12 – 14%	10%	12%
old-growth	27 – 45%	36 – 45%	14%	19%	22 – 34%	28 – 34%	13%	15%
white fir								
early-mature	13 – 34%	13 – 23%	20%	12%	15 – 23%	15 – 19%	20%	10%
mid-mature	3 – 20%	8 – 16%	24%	29%	11 – 20%	14 – 18%	20%	21%
late-mature	1 – 12%	6 – 12%	17%	17%	8 – 16%	12 – 16%	17%	13%
old-growth	23 – 31%	27 – 31%	26%	30%	30 – 41%	35 – 41%	29%	26%

[1]In Table 7 existing condition percent mapped in 1990.
[2]In Table 7 existing conditions updated in 2000 to include the Megram fire and ingrowth.

The HRV analysis involves computer modeling stands backward in time in 50 year increments from 1990 to 1790 to develop a historic range of seral stage variability (Jimerson et al. 1997). RMRs were then identified for the primary series and seral stages. Vegetation series by zone were selected for analysis because they are thought to represent a narrow range of the environment, and carry with them a discrete disturbance regime. The purpose of the RMR analysis is to describe a range of seral stage conditions by vegetation series that could provide management alternatives for sustaining healthy ecosystems. These seral stage ranges are used as a course filter to assess the potential impacts of various management practices. Those projects that have the potential to alter a vegetation seral stage outside of what is thought to be sustainable (RMR) are modified or dropped, and those that show no potential significant effects on sustainability may go forward. Managing within these ranges is our best professional judgment on how to manage for the maintenance of biological diversity. It is thought that maintaining representative amounts of various potential natural vegetation types and their seral stages will protect viable populations of most species (85-90%) and maintain biological diversity (Noss 1987, Hunter 1991).

HRV/RMR Comparison

A comparison of the HRV/RMR for the north and central zones to the existing conditions in these zones gives an indication of how things have changed over time (Table 7). For example the percent of old-growth in the tanoak series in the north zone varied between 29 and 48% (HRV for the past two hundred years) and our best estimate of ecological sustainability is to manage between 38-48%. The amount of old-growth tanoak in the north zone was estimated to be 24% in 1990, and 27% in the year 2000 (Table 7). Clearly these percentages are outside the HRV and RMR. This change is due to several factors but can be primarily related to human disturbance from past timber harvesting. Because the existing condition for old-growth tanoak is outside the RMR, vegetation management prescriptions should be designed to return this seral stage to within the RMR. This can be done in two ways: (1) conduct no further harvesting in the old-growth seral stage, and allow natural ingrowth from the late-mature seral stage to reach recovery and (2) treat early-mature and mid-mature seral stages with innovative silvicultural prescriptions (Jimerson and Jones 1993) designed to accelerate stand development toward late-seral conditions thereby reaching recovery quicker than what would occur naturally. We can see from Table 7, that natural ingrowth is working to increase the amount of old-growth vegetation. For example, old-growth tanoak has increased over the last 10 years from 24 to 27% in the north zone and from 20 to 23% in the central zone. Similar increases have also occurred in the Douglas-fir series in the north and central zones, and the white fir series in the north zone. The only major vegetation type showing a decrease in old-growth composition is white fir in the central zone. This reduction of 29 to 25% is the direct result of the loss of old-growth white fir from the Megram Fire (Jimerson and Jones In Prep).

The mature seral stages show us an entirely different situation. Here, due to the small amount of past timber harvesting in mature stands, we are mainly within or above the RMR. The only exception is early-mature white fir, which, due to natural ingrowth, has moved from the early-mature seral stage to the mid-mature seral stage. This points to the large number of mature acres that are available for management treatment. These stands could be treated through: (1) use of innovative silvicultural prescriptions to accelerate their development toward old-growth condition, (2) harvests to meet the SRNF timber management targets, (3) treatment to construct shaded fuel breaks in the upper 1/3 slope positions to aid in controlling wild-fires, and (4) a combination of the treatments listed above designed to meet multiple objectives.

Recent Past (past 100 years)

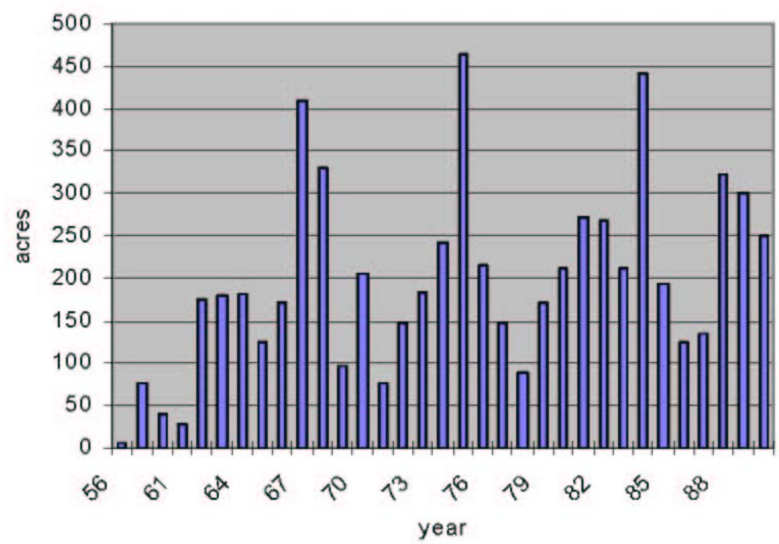
Information from sources throughout the West indicates that fire suppression and prevention in the last 60 years has resulted in changes in vegetation composition and structure. Selected writings, oral interviews, and fire analyses indicate that there has been an increase in the density, and a marked change in the composition of vegetation. The extent of these changes is not well understood, but anecdotal information from the Analysis Area gives some indication of what has occurred. A letter from the Orleans District Ranger written in 1918 mentioned that the consequences from the extinguishing of fires by the Forest Service have been that “more thick underbrush” has replaced “open range”.

While the density of some stands may be increasing due to fire suppression, other stands have opened up by regeneration and selection harvests (Figure 5). Timber harvesting began in the Analysis Area in 1956. The peak years for acres harvested were 1967 (409 acres), 1975 (463 acres), and 1984 (442 acres). There have been peaks in harvesting approximately every 10 years with gradual declines in harvest between these peaks. Timber harvesting has been on the decline since 1990 due to political and environmental constraints.

Vegetation – Current

The current condition of vegetation in the Analysis Area is based on data from the ecology vegetation mapping on the SRNF. This map is based on interpretation of 1990 aerial photos with approximately 25% field verification. The map was updated after the Megram Fire due to the extensive acres of stand-replacing fire that changed the seral stage distribution in the central zone. The attributes of this map include vegetation series, subseries, seral stage, overstory size class, and total canopy closure, with conifer and hardwood canopy closure. The vegetation series and subseries are based on the potential natural vegetation classification that is ongoing in northern California.

Figure 5 Acres per Year of Timber Harvests in the Analysis Area.



Potential Natural Vegetation is the vegetation that would exist on the landscape due to specific biotic and abiotic factors without human influence. The classification of these vegetation types is based on a hierarchical system. This system begins with the vegetation series that represents the dominant overstory and regenerating species in a stand. The next level of the classification is the subseries. The subseries is a combination of the series name and the tree or shrub species that indicate environmental change within a series.

Vegetation Composition

The vegetation types of the LMK Analysis Area are typical of the low to mid elevation portions of their representative zones. Like the zones, the watersheds within the Analysis Area are dominated by the tanoak, Douglas-fir, and white fir series. These vegetation series are distributed according to elevation, parent material, and available soil moisture. Red fir and white fir dominate at high elevations in areas with low soil and air temperatures. Jeffrey pine is found on soils developed from serpentine parent material, and is found mainly in the Slate Creek watershed. The influence of soil moisture on vegetation series distribution is most significant in the distribution and extent of the vegetation series. For instance, a majority (66%) of the acres in the LMK Analysis Area are composed of tanoak. This series is found on sites with moderate to high available water holding capacity. The Douglas-fir series is found on warmer, drier sites with lower available water holding capacity. The portions of the Analysis Area with low to very low available water holding capacity in both of these series can be related to the high frequency of canyon live oak in these stands. Canyon live oak is often found on steep, rocky slopes with shallow soils. The tanoak-canyon live oak subseries make up 25% of all tanoak series in the Analysis Area. Forty percent of the Douglas-fir series is made up of the Douglas-fir-canyon live oak subseries. Although the tanoak series is generally associated with areas with moderate to high soil moisture, and the Douglas-fir series with moderate to low soil moisture, the presence of canyon live oak in the Analysis Area indicates a shift in this association.

The main disturbance factors affecting plant species composition in the Analysis Area are wildfires and floods. It is believed that all stands in the Analysis Area have been affected by fire at sometime during their development. These fires would have been high to low intensity. Flooding along the Klamath River and in Slate, Boise, and Hopkins Creeks have also changed plant species composition. Flooding along the river has produced areas of fine soil material where alders and other riparian species thrive.

Another human transported disturbance agent in the watershed that may change species composition is POC root disease. This disease kills POC leaving areas open that once had a dense canopy. This influx of light could change the species composition of the shrub layer that normally grows beneath these stands.

Human caused disturbances such as timber harvesting and road building create habitat for exotic and weedy species that are not always seen in undisturbed areas. These exotic, pioneering species can establish themselves in a stand for long periods of time. Some of these species can alter the composition of some plant communities permanently.

Vegetation Seral Stages

Vegetation structure refers to the height, spacing, and overall density of vegetation in a particular plant community. Structurally diverse stands have trees of several different heights and diameters, with both shrubs and herbs in the understory. The different stages of development in a stand, or seral stages, have different structural characteristics that increase with stand age (Figure 6). The main disturbance factor affecting vegetation structure in the Analysis Area is the frequency and intensity of wildfires.

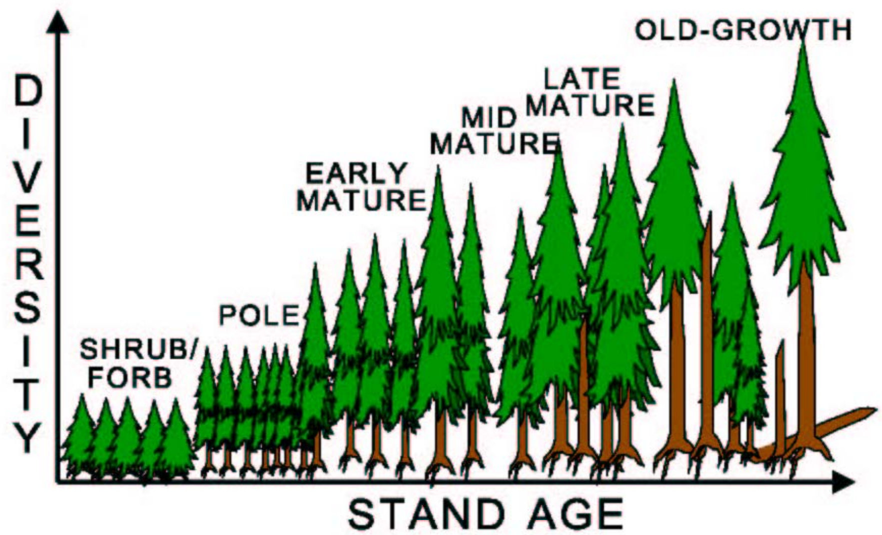
Vegetation structure will be discussed in terms of the five seral stages described in the tanoak and Douglas-fir field guide (Jimerson et al. 1996). These seral stages are: shrub/forb, pole, early-mature, mid-mature, late-mature and old-growth (Figure 6).

Seral Stage Distribution in Context of the North and Central Zones

The seral stage distribution in the watersheds of the Analysis Area does not exhibit any unique quantifiable characteristics when compared to their respective zones. Most seral stages in these watersheds represent a small portion of the zones. For example, the northern portion of the LMK Analysis Area and Slate Creek contribute less than 5% of every seral stage to the north zone. In the central zone, the southern LMK area contributes 8% of the early-mature stands and 7% of both the mid-mature and late-mature stands. Boise Creek contributes 5% of the early-mature stands to the central Zone.

In terms of harvested acres, the Analysis Area contributes 18% of mid-mature harvested stands to the north zone as well as 16% of the late-mature. Boise Creek contributes 7% of the early-mature harvested stands. All other watersheds contribute small amounts of the harvested acres to their respective zones.

Figure 6 Structural Diversity of Forest Seral Stages.



Distribution of Seral Stages in the Analysis Area

This section will display the seral stages by vegetation series in the Analysis Area (Table 8). Most of the conifer series are dominated by the early-mature and mid-mature seral stages. The early-mature and mid-mature seral stages dominate in the tanoak series with late-mature and old-growth. Forty five percent of the Douglas-fir series is in the early-mature seral stage. Old-growth is the dominant seral stage in the white fir series followed closely by early-mature and mid-mature seral stages. Old-growth and mid-mature seral stages also dominate in the Jeffrey pine series. The red fir series is dominated by early-mature stands.

Factors Affecting Seral Stage Distribution

Timber harvesting has had the most significant recent (last 50 years) impact on seral stage distribution (Table 9). Eighty seven percent of the shrub forb stands and 58% of the pole stands are the result of timber harvesting. Twenty one percent of the Analysis Area has experienced some form of timber harvesting either through clear-cut or selection harvests. The harvested early-mature, mid-mature, and late-mature and old-growth stands represent stands that have been selectively harvested. Twenty five percent of both the tanoak and Douglas-fir series have been harvested. Only nine percent of the white fir series has been harvested.

Although forest pathogens probably have not altered the seral stages of stands in this watershed they do have an effect on stand structure and composition. A variety of pathogen and insect problems exist within the Analysis Area, and, with exception of white pine blister rust (*Cronartium ribicola*) and POC root disease, these organisms are native. Damage and mortality resulting from these organisms is primarily evident as isolated, dead, or dying trees or small pockets of dead trees, which create canopy gaps, increased decadence, and added diversity within stands. Pathogens, which are of silvicultural concern, include dwarf mistletoe (*Arceuthobium spp*.), Black stain (*Leptographium wageneri*), Armellaria (*Armillaria spp*.), and blister rust. Insect species that cause damage and/or conifer mortality include a variety of bark beetles (*Dendroctonus spp*.) and wood-borers (*Melanophila spp*.).

Table 8 Seral Stage Distribution by Vegetation Series in the Analysis Area.

	SERAL STAGES						
Vegetation Series	**Shrub/Forb**	**Pole**	**Early-Mature**	**Mid-mature**	**Late-mature**	**Old-growth**	**Totals**
Tanoak	3,172	2,832	7,742	8,606	6,784	5,327	**34,463**
Port-Orford-cedar			8	13		82	**104**
White Fir	268	99	821	696	379	951	**3,214**
Red Fir	13	11	349	49		155	**577**
Jeffrey Pine	147	65	205	352	182	322	**1,273**
Douglas-fir	252	503	3,780	2,722	429	749	**8,435**
Alder	3	17	3				**23**
Grassland	142						**142**
White Oak			70				**70**
Black Oak			341				**341**
Canyon Live Oak	36	39	908				**983**
Knobcone Pine		117	1				**118**
Serpentine Barrens	10						**10**
Riparian	81	115	168				**364**
Grand Totals	**4,124**	**3,798**	**14,396**	**12,439**	**7,774**	**7,586**	**50,116**

Table 9 Harvested Seral Stages by Vegetation Series in the Analysis Area.

Seral Stage	**Tanoak**	**Douglas-fir**	**White fir**	**Jeffrey pine**	**Port-Orford-cedar**	**Riparian**	**Totals**
shrub/forb	3,156	230	195	6	1	0	**3,589**
Pole	1,927	166	77	9	0	0	**2,180**
early-mature	1,446	1,349	17	56	0	41	**2,909**
mid-mature	1,428	324	8	0	0	0	**1,760**
late-mature	701	19	7	0	0	0	**727**
old-growth	33	0	0	0	0	0	**33**
Total acres harvested	**8,690**	**2,088**	**305**	**72**	**1**	**41**	**11,197**
Percent harvested	**25%**	**25%**	**9%**	**6%**	**2%**	**11%**	**21%**

Port-Orford-cedar

Port-Orford-cedar (*Chamaecyparis lawsoniana* (A. Murr.) Parl.) is a member of the Cypress Family (*Cupressaceae*) and the largest in size of its genus (*Chamaecyparis)*. This species and its narrow range are what remain of a genus that was found distributed throughout much of central and southern Europe, western Asia, and western North America during the Tertiary (Zobel et al. 1985). Fossil locations in western North America date back as far as 50 million years (Edwards 1983). Today, POC is found only from coastal central Oregon to northwest California, primarily in the Coast Ranges, Siskiyou and Klamath Mountains, and in a small disjunct population in the Scott Mountains. The range of POC spans a range of 174 miles north to south and 90 miles east to west, and covers an estimated 435,000 acres (176,000 hectares) (Jimerson 1999a). Intensive mapping of POC plant associations (Jimerson et al. 1999) has been conducted in California. Current estimates of the extent of POC that could be mapped on federal lands are approximately 40,000 acres.

Although POC has a narrow geographic distribution, but it occupies many different environments from sea level to 6400 feet (1950 meters) elevation at its most interior locations, which contributes to its high species diversity (biological diversity). It is found on all aspects, but primarily those with northern exposures or topographic shading. Landforms include glacial basins, streamsides, terraces, and mountain side-slopes from lower to upper-1/3 slope positions. Soils are derived from a variety of parent materials, including sandstone, schist, phyllite, granite, diorite, gabbro, serpentinite, peridotite, and volcanic rocks. The soils are primarily Entisols, Inceptisols, Alfisols, and Ultisols included in the mesic and frigid temperature regimes, and udic and xeric moisture regimes. POC also shows adaptability to a wide range of summer evapo-transpiration stress, from very high humidities along the coast to very low summer humidities inland. This great ecological amplitude of POC is believed to reflect a geographic concentration of genetically based characteristics that developed in a larger geographic range, which included parts of Idaho, Montana, California, Oregon, and as far as east as Nebraska (Edwards 1983).

Up until the early 1950s, natural stands of POC had few serious pests (Roth et. al. 1987). Then a root disease (*Phytophthora lateralis*) appeared from unknown sources, although the nursery trade is highly suspect. The fatal POC root disease has now spread throughout its native range except for the populations in the Trinity River watersheds. The disease spreads by motile aquatic zoospores, nonmotile soil-borne chlamydospores, and root grafting. To date there is limited genetic resistance to the disease, but there is active research in this field, which has had some promise.

POC plant associations are key elements of the biodiversity of southwest Oregon and northwest California. Its plant communities display among the richest plant species diversity of all forest types in the region (Jimerson and Creasy 1991). Within the LMK Analysis Area POC plant associations account for a total of 623 acres (Table 10), or about 1% of the 60,078-acre Analysis Area. Most of these acres are found in two watersheds: Slate Creek (315 acres) and Aikens Creek (284 acres). The POC vegetation types are found in the tanoak and POC series. The majority of acres are found in the low elevation tanoak-POC sub-series (517 acres), with lesser amounts in the mid-elevation serpentine types in the POC series (104 acres). The tanoak-POC/evergreen huckleberry type (318 acres) is the most extensive plant association in the Analysis Area (Table 10). It is followed in extent by the tanoak-POC/salal (62 acres), POC/huckleberry oak (50 acres), POC-incense cedar-alder (33 acres), tanoak-POC/red huckleberry (31 acres), and other plant associations of lesser extent (Table 10).

Table 10 Distribution and Extent of Port-Orford-cedar Plant Communities by Watershed in the Analysis Area on the Six Rivers National Forest.

Stream Name	Plant Association	Acres
Aikens Creek	Tanoak-Port-Orford-cedar-California bay/evergreen huckleberry	16
	Tanoak-Port-Orford-cedar/Evergreen Huckleberry-Western Azalea	22
	Tanoak-Port-Orford-cedar/Evergreen Huckleberry	168
	Tanoak-Port-Orford-cedar/Dwarf Oregon-grape/Twinflower	2
	Tanoak-Port-Orford-cedar-Alder/Riparian	6
	Tanoak-Port-Orford-cedar/Red Huckleberry	31
	Tanoak-Port-Orford-cedar/Salal	35
	Port-Orford-cedar/Western Azalea	1
	Port-Orford-cedar-Douglas-fir/Huckleberry Oak	3
Aikens Creek Total		**284**
Cavanaugh	Tanoak-Port-Orford-cedar/Evergreen Huckleberry	1
Cavanaugh Total		**1**
Crawford	Tanoak-Port-Orford-cedar/Evergreen Huckleberry	23
Crawford Total		**23**
Slate Creek	Tanoak-Port-Orford-cedar-California Bay/Evergreen Huckleberry	8
	Tanoak-Port-Orford-cedar/Evergreen Huckleberry	150
	Tanoak-Port-Orford-cedar/Dwarf Oregon-grape/Twinflower	14
	Tanoak-Port-Orford-cedar-Alder//Riparian	8
	Tanoak-Port-Orford-cedar/Salal	27
	Tanoak-Port-Orford-cedar/Huckleberry Oak	6
	Port-Orford-cedar/Salal	1
	Port-Orford-cedar/Pacific Rhododendron-Salal	5
	Port-Orford-cedar/western Azalea	14
	Port-Orford-cedar-Douglas-fir/Huckleberry Oak	47
	Port-Orford-cedar-Incense Cedar-Alder	33
Slate Creek Total		**315**
Grand Total		**623**

Ecological classifications that describe these indicator species and the environmental gradients they represent can be used in the development of a conservation strategy for POC. These include the classifications produced by Atzet et al. (1996), Jimerson and Daniel (1994), Jimerson et al. (1995 and 1996), and Jimerson et al. (2000). These classifications, in conjunction with genotypic variability analysis by plant association (Millar et al. 1991), will greatly aid in the identification of POC genotypes and environments necessary for the continued existence of the species. In addition, these classifications can serve as blueprints for restoring POC plant associations decimated by the root disease.

Port-Orford-cedar Root Disease

- *What is the potential impact of Port-Orford-cedar root disease on Port-Orford-cedar plant community composition and function?*

The extent of POC root disease in the LMK Analysis Area is displayed in Table 11. It appears that the disease was introduced into the LMK and adjacent areas by vegetation gathering, most likely bough collectors. The low number of infested acres in the Analysis Area would suggest that the root disease is of limited consequence. This is misleading in light of several factors: (1) POC communities, as stated earlier, need to be analyzed at the range-wide scale (extent, percent infested, risk), which will allow us to assess the potential risks to both biological and genetic diversity (cumulative effects analysis) (Table 12), (2) the risk of introduction of POC root disease needs to be assessed utilizing the California risk assessment database (Table 13), and (3) the location of the infection in LMK area and the juxtaposition of the Analysis Area adjacent to a high human use and infestation pocket in the Fish Lake and Blue Lake areas. The proximity of these areas to POC stands in the LMK Analysis Area will likely lead to the introduction of POC root disease unless an aggressive prevention program is implemented (Betlejewski, personal communication 2002).

Table 11 Infection Status of Port-Orford-cedar Plant Communities by Watershed in the Analysis Area on the Six Rivers National Forest.

Watershed	Uninfected Acres	Infected Acres	Total Acres
Aikens Creek	279	5	**284**
Cavanaugh	1	0	**1**
Crawford	23	0	**23**
Slate Creek	315	0	**315**
Grand Totals	**616**	**5**	**623**

A range-wide assessment of POC plant associations in the LMK area shows that the POC/Salal, POC/western Azalea, Tanoak-POC/Evergreen Huckleberry-Western Azalea, Tanoak-POC-Alder//Riparian and Tanoak-POC-California Bay/Evergreen Huckleberry associations (Table 12) have moderate to high infestation rates. This increases the importance of the uninfected stands in the Analysis Area. In particular, the Tanoak-POC-Alder//Riparian and Tanoak-POC-California Bay/Evergreen Huckleberry riparian associations with 23% and 29% infested range-wide, respectively, are in jeopardy. The loss of these associations will not only affect biological and genetic diversity, but habitat for anadromous fish as well.

Port-Orford-cedar Risk Assessment

Past risk assessments of the potential for introduction of POC root disease have been conducted at the site-specific scale. As a result they fail to assess cumulative impacts and the potential for effects on the biological and genetic diversity of the species. The POC risk assessment described here utilizes the POC plant association mapping work completed for federal lands in California (Jimerson et al. 1999). The mapping work was updated to include risk (low, moderate, or high) polygons that rate the potential for introduction of POC root disease. Risk polygons were drawn around each sub-watershed and labeled according to the categories listed below.

Table 12 Range-wide Infection Assessment of Port-Orford-cedar Plant Communities in the Analysis Area on the Six Rivers National Forest.

Plant Association	Percent Of Plant Association Infection Category			
	Unsure	Not infected	Infected	Totals
Port-Orford-cedar/Salal	0%	89%	11%	100%
Port-Orford-cedar/Pacific Rhododendron-Salal	0%	98%	2%	100%
Port-Orford-cedar/Western Azalea	1%	92%	7%	100%
Port-Orford-cedar-Incense Cedar-Alder	0%	100%	0%	100%
Port-Orford-cedar-Douglas-Fir/Huckleberry Oak	0%	96%	4%	100%
Tanoak-Port-Orford-cedar/Dwarf Oregon-grape/Twinflower	0%	100%	0%	100%
Tanoak-Port-Orford-cedar/Salal	1%	94%	5%	100%
Tanoak-Port-Orford-cedar/Huckleberry Oak	0%	100%	0%	100%
Tanoak-Port-Orford-cedar/Pacific Rhododendron-Salal	3%	97%	0%	100%
Tanoak-Port-Orford-cedar/Evergreen Huckleberry	1%	93%	6%	100%
Tanoak-Port-Orford-cedar/Evergreen Huckleberry-Western Azalea	0%	84%	15%	100%
Tanoak-Port-Orford-cedar/Red Huckleberry	0%	100%	0%	100%
Tanoak-Port-Orford-cedar-Alder//Riparian	0%	77%	23%	100%
Tanoak-Port-Orford-cedar-California Bay/Evergreen Huckleberry	3%	71%	26%	100%

Port-Orford-cedar Root Disease Risk Categories

Category 1. Uninfected POC stands, which are in Congressionally or LRMP designated areas such as wilderness, roadless areas, or RNAs, with no roads within 500 feet of any part of the stand. This category is rated as a low risk of POC root disease introduction.

Category 2. Uninfected POC stands, which are not in Congressionally or LRMP designated areas such as wilderness, roadless areas, or RNAs, with no roads within 500 feet of any part of the stand. This category is rated as a low risk of POC root disease introduction.

Category 3. Uninfected POC stands protected by a permanent barrier. This category is rated as a moderate risk of POC root disease introduction.

Category 4. Uninfected POC stands protected by a seasonal gate or barrier. This category is rated as a moderate risk of POC root disease introduction.

Category 5. Uninfected POC stands in watersheds with no identified protection. This category is rated as a high risk of POC root disease introduction.

Category 6. Infested POC stands. This category is rated as a high risk of POC root disease spread.

The range-wide percent of each plant association found in the Analysis Area by risk category is displayed in Table 13. The risk analysis shows high risk ranging from 3 to 50%. This points to the fact that most of the 14 POC plant associations found in the LMK Analysis Area are in jeopardy. Five of these associations have greater than 40% of their extent in the high-risk category and 9 have above 30% of their extent in the high-risk category. Only two of the associations have a high risk rating less than 20%.

Table 13 Range-wide Risk Assessment of Port-Orford-cedar Plant Communities in the Analysis Area on the Six Rivers National Forest.

	POC Root Disease Risk Rating %			
Plant Association	**High**	**Low**	**Mod**	**Totals**
Port-Orford-cedar/Salal	39%	30%	31%	100%
Port-Orford-cedar/Pacific Rhododendron-Salal	49%	4%	47%	100%
Port-Orford-cedar/western Azalea	35%	33%	32%	100%
Port-Orford-cedar-Incense Cedar-Alder	3%	33%	64%	100%
Port-Orford-cedar-Douglas-Fir/Huckleberry Oak	28%	36%	36%	100%
Tanoak-Port-Orford-cedar/Dwarf Oregon-grape/Twinflower	44%	42%	14%	100%
Tanoak-Port-Orford-cedar/Salal	32%	35%	34%	100%
Tanoak-Port-Orford-cedar/Huckleberry Oak	22%	30%	47%	100%
Tanoak-Port-Orford-cedar/Pacific Rhododendron-Salal	15%	47%	38%	100%
Tanoak-Port-Orford-cedar/Evergreen Huckleberry	29%	41%	30%	100%
Tanoak-Port-Orford-cedar/Evergreen Huckleberry-Western Azalea	41%	26%	33%	100%
Tanoak-Port-Orford-cedar/Red Huckleberry	32%	14%	54%	100%
Tanoak-Port-Orford-cedar-Alder//Riparian	50%	24%	27%	100%
Tanoak-Port-Orford-cedar-California Bay/Evergreen Huckleberry	46%	33%	21%	100%

The risk assessment along with the extent of the plant association, percent infected, and potential to effect other resources (i.e. fish, rare plants, and SM species), can be used to assess the risk to POC and its biological and genetic diversity (Table 14). This multi-factor assessment identifies only one plant association with an overall low rating. Six plant associations are rated as a moderate risk, and seven plant associations are rated as a high potential risk to POC biological and genetic diversity.

Note: For the above table, # Acres = total acres of plant association range-wide, % Infested = % of plant association infested range-wide, % High Risk = % of plant association with high risk of introduction of root disease, Rip Com = riparian community, and Other Res. = other resource concerns.

The LMK watershed analysis is the first POC analysis to use this type of information to assess risk at the range-wide level. The percent cut-off levels established in this assessment should be used to evaluate management of POC. They should be considered preliminary. The input of selected POC Conservation Team members and other scientists will be used to establish cut-off levels of acceptable risk that trigger further action.

Port-Orford-cedar Roads Assessment

Roads within the LMK Analysis Area are rated here by overall risk to POC plant associations using the assessment contained in Table 14. Roads with a high-risk rating include 11N06, 10N15, 10N04, 10N11, 11N01, 11N05K, 11N05, 11N49, 11N18A, 10N05, 11N06, 11N06A, 11N36A and 11N11. Roads with a moderate risk rating include 11N05, 12N12F, 12N12 and 11N46. In order to limit the potential for introduction of the fatal root disease these roads should have seasonal gates or be permanently closed (Portions of road 11N05 are both high and moderate risk).

Table 14 Multiple-Factor Management Action Rating Assessment for Port-Orford-cedar Plant Associations Found in the Analysis Area on the Six Rivers National Forest.

	Management Action Rating Factors					
Plant Association	# Acres	% Infested	% High Risk	Rip Com	Other Res.	Overall Rating
Port-Orford-cedar/Salal	465	11%	39%	N		Mod
Port-Orford-cedar/Pacific Rhododendron-Salal	1211	2%	49%	Y	H	High
Port-Orford-cedar/western Azalea	1386	7%	35%	Y	H	High
Port-Orford-cedar-Incense Cedar-Alder	109	0%	3%	Y	H	High
Port-Orford-cedar-Douglas-Fir/Huckleberry Oak	1962	4%	28%	N		Mod
Tanoak-Port-Orford-cedar/Dwarf Oregon-grape/Twinflower	470	0%	44%	N		Mod
Tanoak-Port-Orford-cedar/Salal	3723	6%	32%	N		Mod
Tanoak-Port-Orford-cedar/Huckleberry Oak	99	0%	22%	N		Low?
Tanoak-Port-Orford-cedar/Pacific Rhododendron-Salal	197	3%	15%	Y	H	High
Tanoak-Port-Orford-cedar/Evergreen Huckleberry	3282	7%	29%	N		Mod
Tanoak-Port-Orford-cedar/Evergreen Huckleberry-Western Azalea	891	15%	41%	Y	H	High
Tanoak-Port-Orford-cedar/Red Huckleberry	280	0%	32%	N		Mod
Tanoak-Port-Orford-cedar-Alder//Riparian	5453	23%	50%	Y	H	High
Tanoak-Port-Orford-cedar-California Bay/Evergreen Huckleberry	4177	29%	46%	Y	H	High

Adorni Research Natural Area

The 430-acre Adorni Research Natural Area (RNA) is located within the Aikens Creek drainage of the Analysis Area. It is a part of a nation-wide network of areas set aside to maintain the biological and genetic diversity of selected vegetation types. These areas are designated in perpetuity for research and education across USFS and other public lands. Adorni is one of four areas designated by the USFS as a RNA for its representation of the POC vegetation type. Old-growth POC occurs in patches along the watercourses dissecting the area. The RNA also contains old-growth Douglas-fir and tanoak stands. The topography is generally steep, except across the western edge of the area, which supports more moderate terrains. Active slumping occurs along both of the major streams, especially around Aikens Creek. Part of the western area, towards Burrill Peak, was salvage logged in 1965 to remove blowdown (Sawyer 1981).

Currently, the Adorni RNA may be at risk for introduction and infestation of POC root disease. Public access along the road situated upslope of the RNA, which serves as the northern boundary, activity on the private property located upslope, and the proximity to the large infestation pocket in Fish and Blue Lakes, constitute the greatest risks to the ecological integrity of the RNA due to the risk of introducing the fatal root disease.

Noxious Weeds

- *What are the most invasive species of noxious weeds within the Analysis Area?*

- *What activities exacerbate the introduction, spread, and ability to manage invasive plant species?*

Noxious Weeds – Reference

Species of weeds not indigenous to North America, termed non-native or exotic, were introduced during various periods of colonization and settlement. It has been suggested that the earliest introductions were linked to the trading networks connecting Indian communities to Spanish settlements in Mexico (Hendry 1931). The most recent historic introduction of non-native weeds coincided with pioneer settlement in California after the 1860s (Frenkel 1970). Various editions of the flora for California reflect the continuing increase in non-native species in the last 50 years from 725 species in 1959 to an estimated 1,025 in 1993 (Randall et al. 1998).

A majority of the species considered weeds in California are native to Mediterranean and Eurasian countries with fewer representatives from North Africa and Australia. Species are more likely to become established in areas climatically similar to that of their native range. Non-native species were transported from other countries to California in ship ballast and grain shipments. Early introductions were associated with the establishment of missions, shipping commerce, and port activities. Subsequently, in many cases, weeds were introduced to the inland mountains by the transport of materials from coastal ports (Frenkel 1970).

With increasing human activity in the west, including the clearing of land for homesteads and pastures, the use of livestock, and the transport of commodities, sites suitable for establishment of non-native species became more prevalent and also contiguous with the development of transportation routes.

Noxious Weeds – Current

A variety of biological and physiological attributes, as well as species persistence, ensure the successful establishment of weeds into new settings. Non-native species are prolific seeders, and develop fruits adapted to long-range dispersal (e.g. barbed fruits that readily attach to clothing and fur-bearing animals, plumed seeds for wind dispersal). Areas where human activities or livestock has disturbed vegetation and soil, and little canopy cover remains are more susceptible to colonization by non-native species than areas of dense vegetation or moderate to full canopy; however, there are exceptions.

Of the estimated 1,025 non-native species currently in California, less than 10% are considered serious threats (Randall et al. 1998) due to their harmful ecological and economical effects. Species that fall into the latter category are identified as priority species for the Forest (due also, in part, to their relatively limited extent), and include: spotted knapweed (state-listed A weed), diffuse knapweed (state-listed A weed), and Dyer's woad (state-listed B weed). Species such as yellow starthistle, scotch broom, spanish broom and himalaya berry may become priority species for management if they occur as satellite populations (isolated, localized) (Table 15).

Table 15 Noxious Weeds Documented in the Analysis Area.

Species	State – listing*	Life History	Life Form	Root System	Bloom Period	Reproduction/ Growth	Seed Bank / Persistence
Spotted knapweed	A	Biennial/short-lived perennial	Forb	taproot	June – Oct	Seed/resprout	Unknown
Diffuse knapweed	A	Annual/short-lived perennial	Forb	taproot	July – Sept	Seed/resprout	Unknown
Dyer's woad	B	Annual/biennial /short-lived perennial	Forb	taproot	April – June	Seed/resprout	Unknown
Yellow starthistle	C	Annual/short-lived perennial	Forb	taproot	May – Oct	Seed /resprout	Y/variable up to 10 years untreated
Scotch broom	C	Perennial	Shrub	Deep taproot	April – June	Seed/basal sprouting	Y/variable 30+ years
French Broom	C	Perennial	Shrub	Deep taproot	March – May	Seed/basal sprouting	Y/multiple years
Spanish Broom	None	Perennial	Shrub	Deep taproot	April – June	Seed/resprout	Unknown
Himalaya blackberry	None	Perennial	Vine	rhizomatous	June – Sept	Seed & Veg/ resprout.	Y

*Note: In Table 15 State Listing: A = Eradication, containment, at the state and county level; B = Eradication, containment, at the discretion of the commissioner; C = Action to retard spread outside of nurseries at the discretion of the commissioner, Y = yes, develops a seed bank.

The sensitive and rare plant species, false yellow lupine, Marble Mountain campion, and Orleans iris are considered to be pioneer species that favor early occupancy of disturbed, open settings, including roadsides. Given their association with roadsides, localized spread of noxious weeds could potentially displace occurrences of these species. Pioneer species, in general, are targets for displacement by weed species. Being typical pioneer plant groups, geophytes (bulb-forming plants such as lilies and irises), legumes (lupines, vetch), and medicinal herbs, such as mugwort, are vulnerable to the displacement effects of noxious weeds once they are established.

Priority species within the Analysis Area are associated with the following settings in order of priority: roadsides and pull-outs (state Highway 96, Forest Service maintained roads), landings, disturbed openings near communities, river access areas, river bars, pastures, and localized sites of instability (e.g. Aikens Creek slide). Of the estimated 240 miles of road within the Analysis Area, only a small portion has been systematically surveyed (45 miles or 18.75%) to provide data about these species.

In addition to road-related settings, areas with little to no canopy cover such as pastures or cultivated fields are also susceptible to weed establishment and spread. Ground disturbance related to public use and the dynamics of the riverine environment increase the likelihood of weeds spreading and establishing in these settings.

The ecology of weeds allows for easy introduction, spread, and persistence. For example, through development of a taproot, spotted knapweed is highly adept at capturing available moisture and nutrients in a given area. Seed production as high as 146,000 seed per square meter has been reported (Schirman 1981). One study reported that 30% of the seeds remained viable after 8 years of burial in the soil (Davis et.al. 1993). Mature plants are also self-compatible, which is an advantage when pollinators are not active. Management must consider these attributes for spreading and persistence (e.g. multiple-year site treatment).

Like many weeds, the initial introduction of spotted knapweed is associated with disturbance. Once established, this weed can gradually invade areas that are relatively undisturbed. Weed expansion is typically associated with a decline in cover of certain species and a general decline in species richness altogether (Tyser and Key 1988).

In the vicinity of a weed population, any new or ongoing ground disturbance activity that opens the canopy or occurs in an open setting can increase the likelihood of weed introduction and spread. Examples of activities that fall into this category include: road management (roads under the jurisdiction of the SRNF, county or state), incidence of wildfire, wildfire suppression, wildfire rehabilitation activities, overgrazing, river access trail use, importation of foreign material (e.g. rock for fill, mulch), and the utilization of heavy equipment in any activity. With a major state highway, a major river corridor, and the community of Orleans within the Analysis Area, disturbance is a fact of life.

Given the ability of weeds to easily spread, and their association with disturbance, management needs to rely heavily on education, and early detection and treatment of leading edges or satellite populations. Equal with this approach, cooperation from all stakeholders within the Analysis Area is essential. Venues for cooperation exist (e.g. Weed Management Areas, Fire Safe Councils, California Indian Basketweavers), but how to address the issue of noxious weeds has not been addressed between these groups.

Fire

Fire Occurrence – Reference and Current

The typically dry summers, localized human fire activity, steep topography, and existing vegetation types and seral stages within the Analysis Area indicate that wildfires have been a major component of the LMK ecosystem. Early fires showed a dominance of human causes, with many references to “probably incendiary to burn brush.” North and south of the LMK Analysis Area Keter (1993, 1995, and 1996) found that Native American burning was a widespread component of the landscape due to the long-term existence of Native American tribes in the area and their traditional uses of various vegetative materials that could be enhanced with fire. Reported fire causes on several early fire report forms, which indicated Native American traditional burning until the 1910's, included:

- Indians burning hazel sticks (1915).
- Burning for hazel brush (1916).
- Unknown; probably Indians burning trash and leaves under oak trees to facilitate gathering acorns (1917).

Lightning appears to be a minor component of fire causes this watershed. It appears that lightning storms typically followed the ridges, and occurred in the higher headwater areas.

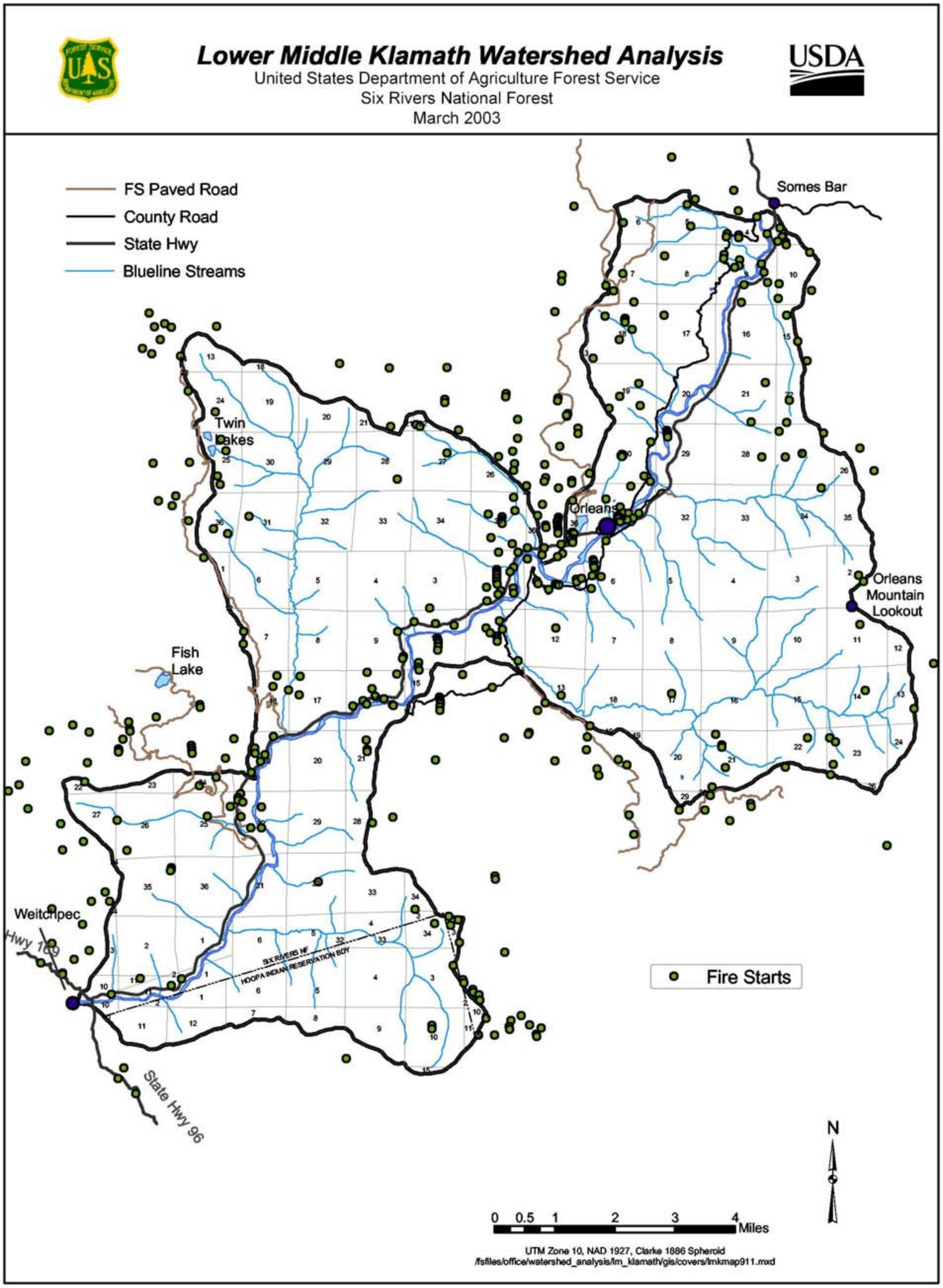
Available SRNF fire report forms for the LMK Analysis Area date back to 1910. Approximately 457 fires (19,411acres) were recorded within the SRNF portion of the LMK area between 1910 and 2001. Table 16 shows a breakdown of wildfire acres and numbers for the SRNF portion of the Analysis Area, summarized by decade and the most recent five-year period (1997-2001).

Table 16 History of Human and Lightning Caused Fires (1910-2001).

	Human		Lightning		Human		Lightning	
Years	**Acres**	**%**	**Acres**	**%**	**Count**	**%**	**Count**	**%**
1910-1919	4796	100%	21	0%	48	96%	2	4%
1920-1929	10665	97%	309	3%	57	88%	8	12%
1930-1939	29	100%	0	0%	6	60%	4	38%
1940-1949	1	100%	0	0%	10	77%	3	22%
1950-1959	2887	97%	88	3%	42	88%	6	12%
1960-1969	72	83%	15	17%	41	75%	14	25%
1970-1979	14	88%	2	13%	47	89%	6	11%
1980-1989	137	90%	15	10%	40	78%	11	21%
1990-2001	288	80%	72	20%	101	90%	11	10%
1997-2001	139	80%	35	20%	58	98%	1	2%
Totals	**18889**	**97%**	**522**	**3%**	**392**	**86%**	**65**	**14%**

In addition to these data, limited fire history information was available for the HVIR (1986-1998). Many wildfires were recorded along state Highway 96 within the reservation boundary, and it can be assumed that these were human-caused. These fire history data show the continued trend of a prevalence of human-caused fires, both by acreage and number, within this watershed. The main fire occurrence within the Analysis Area continues to be along the Klamath River/Highway 96 corridor (Figure 7). Also, fires started along this corridor could easily present a problem to and grow into adjoining watersheds. Focusing on the most recent five-year period (1997-2001), the human-caused fire breakdown was: incendiary (25), unspecified miscellaneous (22), debris burning (5), campfire (4), equipment use (2), children (0), and smoking (0). For this most recent five-year time period, the majority of human-caused fires occurred in July and August, which are high recreation months.

Figure 7 Fire Starts.



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Even though lightning accounts for a relatively small percentage of the fire starts and acreages, records show several "mini lightning busts", with 3 – 4 fire starts within a 24-hour period. The largest series was four starts in July of 1927, resulting in a 300-acre fire. Out of seven recorded lightning busts, five have happened since 1980, with the majority of these being less than 1 acre, and the largest being 12 acres in 1986. The lightning fire starts appear to follow ridgeline patterns (Figure 8).

Also of importance is the trend in size and number of fires since the early 1910s. Table 17 summarizes fire acreage and number by decade and the most recent five-year period (1997-2001), showing a drastic decline in burned fire acreage since the 1950s. At the same time, the average number of fires per year has stayed relatively constant at around 5 fires per year. The most recent five-year period (1997-2001) shows the average number of fires more than doubling and a noticeable increase in acres burned per year.

Table 17 Summary of Fire History by Decade.

Years	Acres	% Acres (1910-2001)	Average Acres/yr	Number	% Number (1910-2001)	Average Number/yr
1910-1919	4817	25%	482	50	11%	5
1920-1929	10974	57%	1097	65	14%	7
1930-1939	29	0%	3	10	2%	1
1940-1949	1	0%	0	13	3%	1
1950-1959	2975	15%	298	48	11%	5
1960-1969	87	0%	9	55	12%	6
1970-1979	16	0%	2	53	12%	5
1980-1989	152	1%	15	51	11%	5
1990-2001	360	2%	30	112	25%	9
1997-2001	174	1%	35	59	13%	12
1910-2001	19411		211	457		5

Fire Risk Rating

- *What is the trend of fire risk for lightning versus human-caused fires*

To assess past fire occurrence trends and expected future fire occurrence, a risk rating is calculated using a standard formula. This standard risk formula is based on the number of fire starts, the number of years of historical information, and the number of acres involved. Risk ratings and ranges of values used in this assessment are shown in Table 18.

Risk rating = [(x/y)*10]/z

x = number of starts recorded for the chosen area
y = number of years the records cover
z = number of acres analyzed, displayed in thousands (52.224 – acres within Forest Service and private land)

Table 18 Fire Risk Ratings and Values.

Risk	Values	Interpretation
Low	0 - .49	At least one fire expected every 20 or more years per thousand acres
Moderate	.5 - .99	At least one fire expected in 11-20 years per thousand acres
High	> 1.0	At least one fire expected in 0-10 years per thousand acres

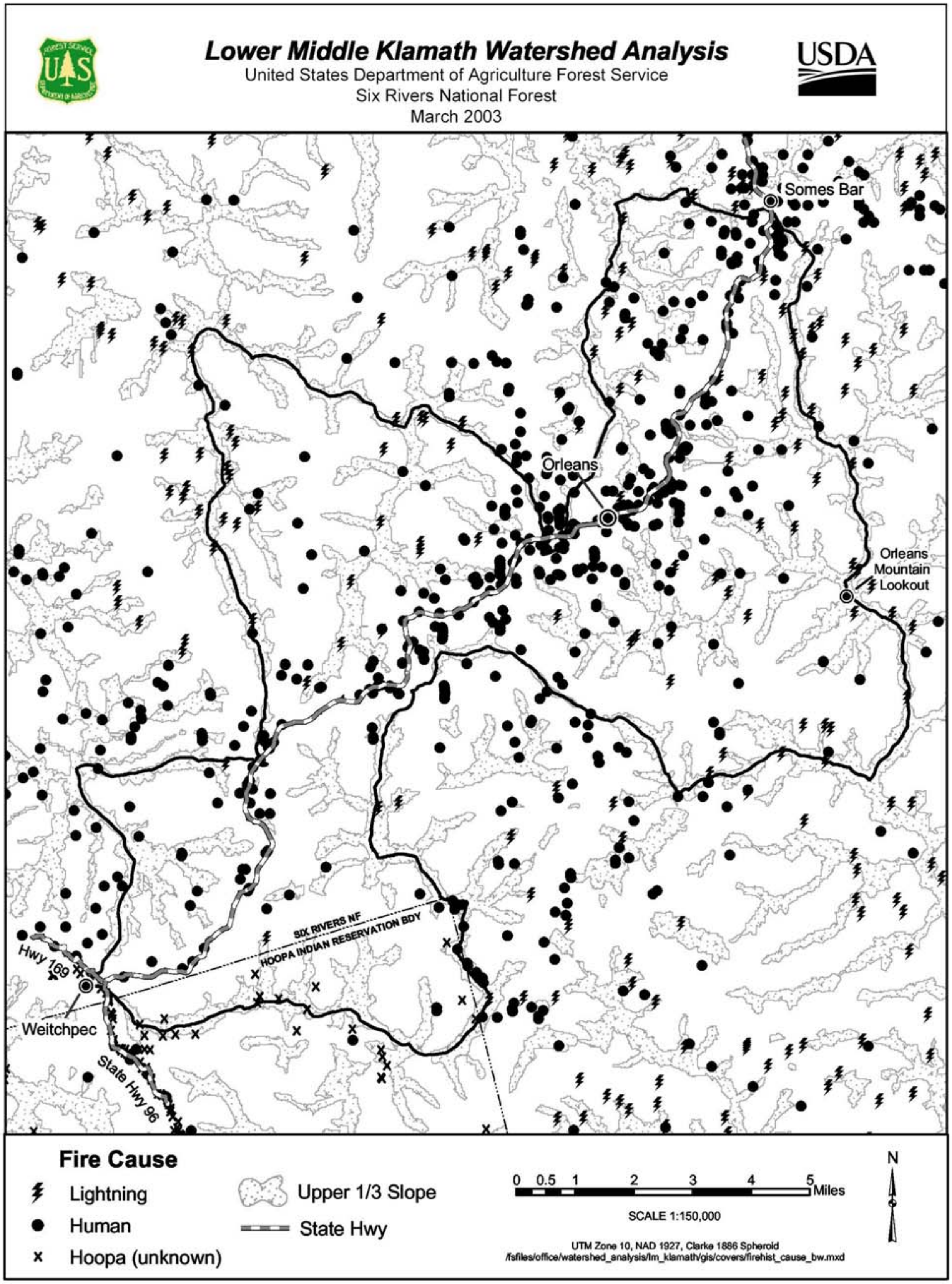
Table 19 shows the risk values and ratings for the SRNF portion of the Analysis Area, in order to provide a sense of the trend in risk by decade, and other groupings of time periods between 1910 and 2001.

Table 19 Risk Values and Ratings for National Forest Lands within the Analysis Area.

Period	Number	Number Of Years	Risk Value	Risk Rating
1910-1919	50	10	0.96	high
1920-1929	65	10	1.24	high
1930-1939	10	10	0.19	low
1940-1949	13	10	0.25	low
1950-1959	48	10	0.92	moderate
1960-1969	55	10	1.05	high
1970-1979	53	10	1.01	high
1980-1989	51	10	0.98	moderate
1990-2001	112	12	1.79	high
1910-2001	457	92	0.95	moderate
1910-1959	186	60	0.59	moderate
1960-2001	271	32	1.62	high
1997-2001	59	5	2.26	high

The overall high-risk rating (i.e. at least one fire expected in the next 10 years per thousand acres) since 1960 and the very high rating for the last 5 years indicates that human caused risk is a major and continuously growing concern in the LMK area. Since “incendiary” and “unspecified miscellaneous” are the recorded causes for 50 of the 59 fires in this time period, this indicates a definite challenge for prevention efforts. Expanding recreation opportunities on the SRNF could also contribute to this increasing risk. The high human-caused fire occurrence immediately adjacent to the LMK Analysis Area on the HVIR could also be a concern. Given all these factors, this area is expected to continue to experience a high risk rating in the future, (i.e. at least one fire in the next 10 years per thousand acres). This risk-potential, in combination with the state of the fuels within and adjacent to these watersheds, could present a substantial threat to local communities and the Hoopa and Yurok Indian reservations.

Figure 8 Fire History by Cause 1910 - 2001.



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Fire Hazard – Reference

- *What is the fire hazard, and what are the potential on-site and off-site/indirect effects of wildfires within the Analysis Area?*

Fire hazard pertains to projected fire behavior and subsequent suppression effectiveness once a fire starts. Reference fire hazard conditions can be inferred from personal accounts and several studies within the Klamath subregion. Personal accounts from early fire reports, as shown below, indicate fire behavior that could be considered severe:

- "The spread was rapid owing to the entire area being on a southern exposure and the ground being covered with this fall's oak leaves." (1929)
- "burnt rapidly from start" (1929)
- "The fires burned rapidly into one big crown fire which swept to the top of the ridge before night. It was impossible for two or three men to do anything on the fire under the conditions. They could not hold the fire on the ridge; they could not go to the creek and work up the side as the fire had not yet reached the creek, nor could they build line on the slope and hold it. The fire was too big and burning too fast." (1928)
- "The fire was set at three known places spaced several hundred yards apart, in exceedingly thick brush at the bottom of a steep side-hill. Low humidity and high winds were the cause of its rapid spread, the day following its start." (1926)
- "The fire was set in a thicket of heavy brush and at a time of high wind which caused such a rapid spread." (1925)
- "The fire was scattered over such a wide country that the crowning flames had a good headway before nightfall." (1925)

According to Agee and Edmonds (1992), when fire return intervals are reduced to 50 years or less (as suggested by the work of Adams and Sawyer on the Orleans Ranger District (1980) in drier and warmer environments, such as found in the LMK Analysis Area, a certain pattern of succession occurs after wildfires. Beginning after a stand-replacement fire, the Douglas-fir regenerating on the site may survive several low to moderate severity fires that thin the Douglas-fir ("resisters"), remove the understory white or grand fir ("avoiders"), and topkill the associated hardwoods such as madrone, oaks, and tanoak ("endurers"). Several recurrences of such fires will create a stand with several age classes of Douglas-fir and hardwoods, representing regeneration after the last disturbance. Not every fire will result in Douglas-fir regeneration, suggesting many fires had little effect on the overstory canopy (Thornburgh 1982, Wills 1991). Understory-tolerant conifers of other species may be represented in post-fire regeneration. Large logs may be provided by residual Douglas-fir (or ponderosa or sugar pine, where they are present) that have died from insects, diseases, or the last fire or have blown over. In pre-settlement time, the log and snag density was likely lower than at present because of more frequent fires. Such stands usually will be intermixed with others that have experienced a variety of fire intensities, so that the landscape is patchier than in wetter Douglas-fir forests of Oregon and Washington.

Fire Hazard – Current

An assessment of current wildfire hazard includes projected fire behavior (given current fuel conditions) and associated suppression effectiveness (given available suppression forces). Projected fire behavior can be expressed in terms of rates of spread (ROS) and flame length

(FL). These two fire behavior parameters can be calculated from inputs of fuel model (SRNF, fuel models were derived from subseries and seral stage), slope class, and weather (Andrews 1986). Calculated values and maps of ROS and FL were only possible for the SRNF portion of the Analysis Area. It can be assumed that aggressive fire prevention and suppression over the last 50-80 years has allowed for an increase in stand density and general flammability for the entire area. Wildfires that exceed initial attack could become much more intense and destructive, especially if there is a significant drawdown of firefighting forces due to higher priority wildfires elsewhere (e.g. in areas with higher populations).

These two critical fire behavior parameters, rate of spread and flame length, also affect resistance to control, and must be considered in the assessment of fire hazard at the watershed scale. Flamelengths are also related to suppression effectiveness, in terms of whether hand crews, equipment, or aerial attack can successfully suppress a wildfire. Fires that require aerial attack would be associated with the greatest potential for larger, more destructive wildfires that have extensive crown fire and higher tree mortality.

Fire Behavior

For this analysis, fire behavior fuel models (Anderson 1982) were used with a two-fuel model concept (Andrews 1986) to reflect understory conditions for the majority of the conversions. These fuel models were geographically overlaid with standard National Fire Danger Rating slope classes (Deeming et al. 1977), and given typical June and August weather data for input into the BEHAVE fire model (Andrews 1986), which then calculated ROS and FLs.

Separate rates of spread and flame lengths were calculated for each individual fuel model and fuel model combination. For the two-fuel model combination, ROS were weighted by percent cover. FLs were assigned based on the fuel model with the greatest assigned percentage. Both a June and an August weather scenario were used, to represent typical average and severe summer time conditions, as shown below:

	June	August
Midflame windspeed (mi/hr)	5	7
1-hr timelag fuel moisture	6	2
10-hr timelag fuel moisture	8	4
100-hr timelag fuel moisture	14	8
Live herbaceous fuel moisture	133	75

(Fuel moistures are designated by “hour” timelag categories, which correspond to diameter size classes: 1-hr = 0-.25 in., 10-hr = .26-1.0 in., 100-hr. = 1.1-3.0 in.)

For map representation and discussion purposes the groupings for ROS and FL, with their corresponding suppression effectiveness assessments, are as follows:

Value	ROS (ft/min)	FL (ft)	Suppression Effectiveness
Low	0-5	0-2	3-person hand crew or engine
Moderate	5.1-11	2.1-4	5-person hand crew or engine
High	11.1-22	4.1-6	engines/hand crews/water tender plus aerial attack
Very High	22.1-33	6.1-8	all above plus dozers/aerial support
Extreme	33.1+	8.1+	beyond initial attack, into extended attack

Figure 9 August Fire Behavior.

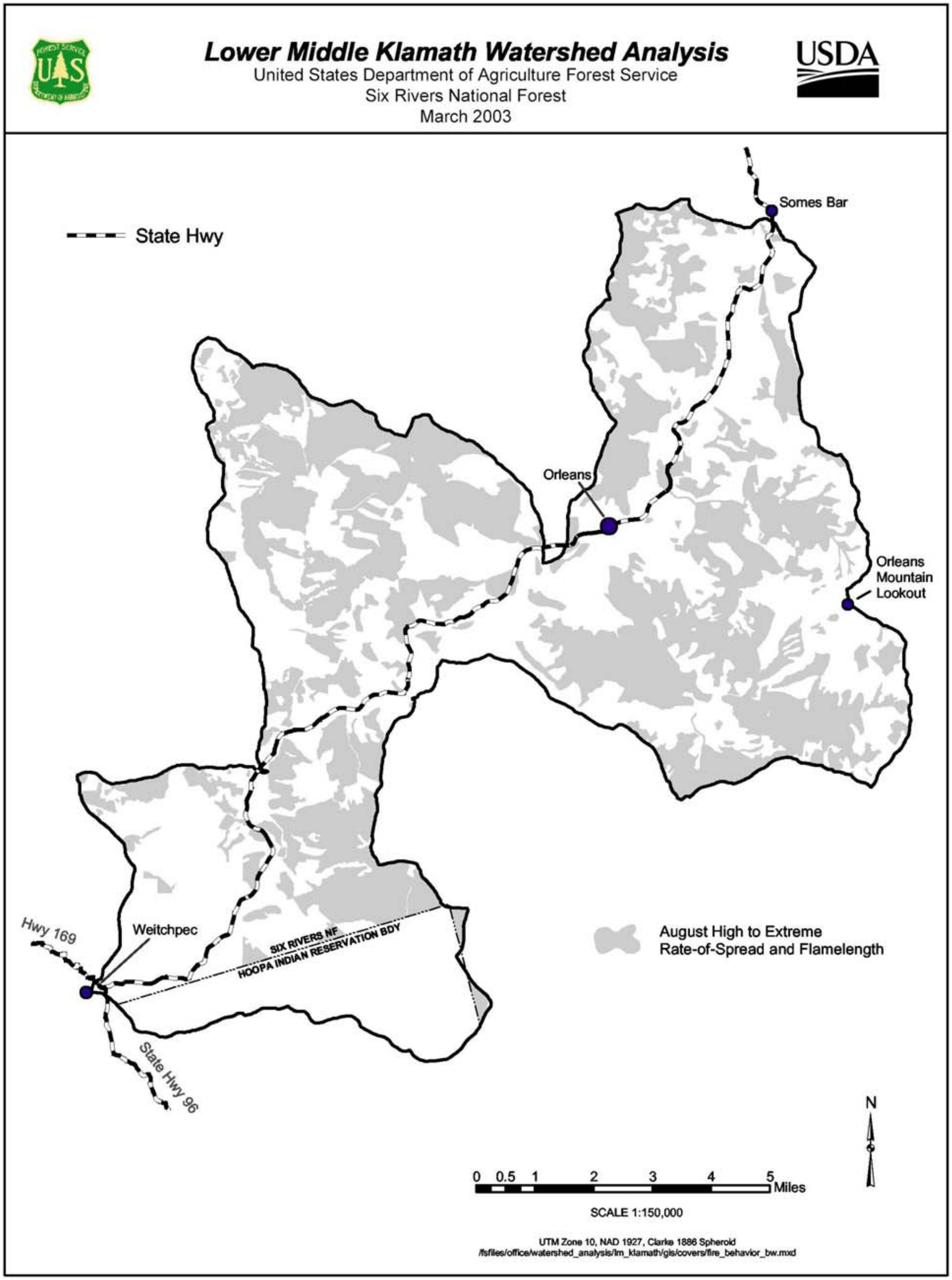

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Table 20 shows distributions of calculated ROS and FLs for the June and August weather scenarios for the SRNF portion of the Analysis Area. For display purposes only, the coincident high, very high, and extreme August ROS and FLs are included in this document (Figure 9).

Table 20 June and August ROS and FLs for the Analysis Area.

Value	ROS (June)	ROS (Aug)	FL (June)	FL (Aug)
Low	43%	0%	55%	52%
Moderate	25	46	31	0
High	27	8	12	29
Very High	1	29	2	1
Extreme	4	17	0	18

The coincidence of high to extreme August ROS with high to extreme August FLs covers 45% of the Analysis Area, with this breakdown by individual watershed, 49% of Boise Creek, 52% of Slate Creek, and 42% of the LMK area (Figure 9).

The communities of Orleans, Weitchpec, Somes Bar, and the Hoopa Valley Indian and Yurok Indian reservations were listed in the Federal Register (August 17, 2001, v.66, n.160) as communities at high risk from the threat of wildfires. Figure 9 shows the juxtaposition of these high to extreme fire behavior parameters to these communities.

Fire Suppression

Of equal importance to an assessment of hazard and suppression effectiveness is the determination of suppression availability once a fire does start. Suppressing fires while they are small requires a mix of initial attack resources that are mobile and quickly available. The current organization for the USFS and California Department of Forestry (CDF) emphasizes ground attack as the primary initial attack resource, with support from aerial forces for extended attack. The Analysis Area falls within the Orleans Ranger District, which has three engines available. Engines are also available from Hoopa (2), Salyer (2, in addition to a water tender), CDF (at Elk Camp), Trinidad, and Fortuna. Recent National Fire Plan funding has added a 10-person crew at Orleans, and a 20-person fire crew is also available at Lower Trinity Ranger District. CDF could supply crews from Alderpoint, Eel River, High Rock, Konocti, and Deadwood Camp, and still more resources could come from the Klamath National Forest (KNF). Local air support could include Kneeland, Happy Camp, and Scott River helicopters and air tankers out of Rohnerville, Medford, Redding, and Chico. Local volunteer fire departments could also respond. Response times for the closest engines outside of the Orleans Ranger District are 40-60 minutes. Beyond these closest resources listed above, response could be in the order of 3-4 hours, which could result in larger wildfires.

Due to the mainly rural population of the Analysis Area, fires within or adjacent to this area would have a lower priority when compared to more populated wildland interfaces and intermixes found throughout the state. This could be a significant factor when forces are drawn down past effective levels, possibly resulting in significantly larger and more destructive wildfires. For example, the extremely busy fire seasons of 1987, 1996, and 1999 resulted in standard resource orders being delayed for two to three days.

Once crews do arrive, two major factors affect suppression effectiveness within the LMK area: steep topography and the inaccessibility of large portions of the watershed. According to

Biswell (1989), a fire burning on nearly level ground doubles in ROS when it goes up a 25% slope, and doubles again when the slope is 40%. Given that 69% of the area has greater than 40% slopes, a large portion of the Analysis Area is unroaded (especially on the eastern edge, which is adjacent to the Hog Fire of 1977), ground forces would be hampered, and aerial attack would be needed for the majority of wildfires within the Analysis Area.

Fire Regime

The combination and interaction of fire extent, frequency, and severity that occur in an ecosystem are known as a fire regime. Fire regimes range from low severity, short interval (stand maintenance) to high severity, long interval (stand replacing). Various human activities (e.g. fire suppression) and natural events (e.g. droughts, windthrow) can affect individual components of an area's fire regime, and the interpretation of changes or trends must assess all of these factors. Vegetation type and distribution and fire history studies indicate that the LMK Analysis Area falls within a mixed severity, short interval fire regime (Agee 1993, Brown and Smith 2000, Frost and Sweeney 2000).

Fire Extent

The spatial extent of past fires refers to the size of the area affected by a fire and the landscape patterns that result (Agee 1993). The extensive fires of 1987 and 2002, within southwest Oregon and northern California, indicate that low probability of precipitation probably allows fires to "die down", but not be extinguished during periods of low winds or moderate weather, and remain capable of renewed spread under patterns of windy or warmer weather. Once started, fires in these Douglas-fir forests can continue to burn until autumn rains come, therefore, they can often cover large areas (Agee 1993). Taylor and Skinner (1998) conducted a fire history study in a LSR within the Klamath Mountains that included an analysis of fire extent. The study analyzed tree species composition, structure (diameter, age), and fire scars from 75 upland plots distributed across approximately 4,000 acres. The average fire size from 1627 to 1987 was approximately 900 acres, and during this time16 fires burned more than a third of the study area.

Fire report form records for this area also indicate that early fires were typically large. Large fires required narratives that gave reasons for why the fire became large. The following quotes from some of these fire report forms give an indication of vegetation types, slopes, aspects, and weather parameters that, given an ignition, probably also resulted in large wildfires during earlier time periods:

- "brushy, steep country"
- "steep brushy country with considerable dead timber"
- "steep and rugged country over this entire area which was covered with heavy oak and fir timber, in spots, also lots of huckleberry brush"
- "the spread was rapid owing to the entire area being on a southern exposure and the ground being covered with this falls oak leaves"
- "at 12:30 am the fire started to crown, low humidity, steep slopes and condition of cover"
- "the fire was scattered over such a wide country that the crowning flames had a good headway before nightfall"
- "no modern devices were available, save back pack pumps, which were very effective, back fires were used successfully"

- "fire set at three know places spaced several hundred yards apart, in exceedingly thick brush at the bottom of a steep side-hill, low humidity and high winds were the cause of its rapid spread, high winds crowned the flames in thick brush inside the lines about 11:30 am"
- "steep slopes, inflammable cover (a thicket of heavy brush) and the afternoon wind"
- "steep country with a slope of approximately 40%, a south exposure, and a heavy under-growth of brush"
- "steep and rugged country a portion of which was covered with heavy oak brush"
- "rough, steep brushy country, with a crossing of the Klamath River by boat at night, very risky"

Slope breakdowns for this area validate these references to steep slopes, since 46% of the area has greater than 55% slopes.

This watershed Analysis Area is vastly different from previously analyzed watersheds on the SRNF, due to the high occurrence of large wildfires since 1910 (30 fires larger than 100 acres). Figure 10 shows the spatial pattern of these large wildfires, which burned entire landscapes up to the ridges or down to the river. The largest recorded pre-1950 fire was 4035 acres (incendiary, 1929), and the largest post-1950 fire was 2865 acres (incendiary, 1959). Monthly precipitation records exist for Orleans from 1885-2002. The large fire in November 1929 was associated with a lower than average precipitation year (29.57 in. for 1929 vs. an average of 46.60 in.), that had virtually no rain (.59 in.) after June (compared to an average of 11.87 in.).

A steady pattern of 1-2 fires/year greater than 10 acres has occurred almost every year since 1985. The 19,411 total acres burned during this period is approximately 37% of the watershed (only USFS and private land), and fires greater than 10 acres (18,970 acres total) accounted for 97% of the total acreage burned and 14% of the number of fires.

The individual wildfire size history for this watershed area also shows a marked decline in large fire occurrence since the 1960's (Table 21). These data below show the marked reduction in large fires after the 1950s due to the excellent effectiveness of aggressive fire suppression and prevention.

Table 21 History of Large Fires within the Analysis Area.

	Fires ≥ 10 acres			Fires ≥ 100 acres		
Years	Human-caused	Lightning-caused	Total	Human-caused	Lightning-caused	Total
1910-1959	43	3	46	20	1	21
1960-2001	11	3	14	0	0	0
1910-2001	54	6	60	20	1	21

Fire Frequency

- *What was the pre-European fire regime?*

Reference fire frequencies can be determined somewhat easily using fire slabs from trees that were several hundred years old when cut down. Several fire frequency studies have been undertaken in the general vicinity of the LMK watershed area. The pre-European fire regime includes the influence of Native American burning, which according to fire report forms was still an obvious factor in the early 1900s. Adams and Sawyer (1980) found intervals between fires in Douglas-fir dominated mixed evergreen forests to be 17.2 years for the Orleans Ranger District. They concluded that the all-aged nature of these stands, infrequent scarring of trees, and frequency of fires strongly suggests that ground fires, as opposed to crown fires, were the common mode of burning. A white fir/Douglas-fir series fire history study that used plots within the Orleans Ranger District showed mean fire-free intervals to be 36.7 years, with a range of 20.1 to 52.2 years (Stuart and Salazar 2000). Fire frequencies averaging 20 years have been found in Douglas-fir forests of the eastern Siskiyou Mountains (Atzet et al. 1988), and Agee (1991) documented a similar fire return interval in the eastern Siskiyous between 1740 and 1860, before significant European settlement. In the Salmon River watershed on the KNF, Wills (1991) found pre-settlement mean fire return intervals of 10 to 15 years for Douglas-fir/hardwood forests. Within a Douglas-fir dominated landscape in a late-successional forest reserve in the Klamath Mountains, Taylor and Skinner (1998) found median fire return intervals of 12 to19 years.

Area fire frequencies are mean fire-return intervals meant to represent landscape rather than point fire frequencies (Agee 1993). A simple method for determining area frequency is called the natural fire rotation (NFR), which was first proposed by Heinselman (1973). His NFR is the average number of years required in nature to burn over and reproduce the total area under consideration. Variation or periodicity is not directly considered in the calculation, which, as Heinselman (1973) recognized, masks the variability in fire between and within community types. Heinselman described the NFR as a valid measure of the role of fire in the total system, which needs interpretation at the community level. The formula is:

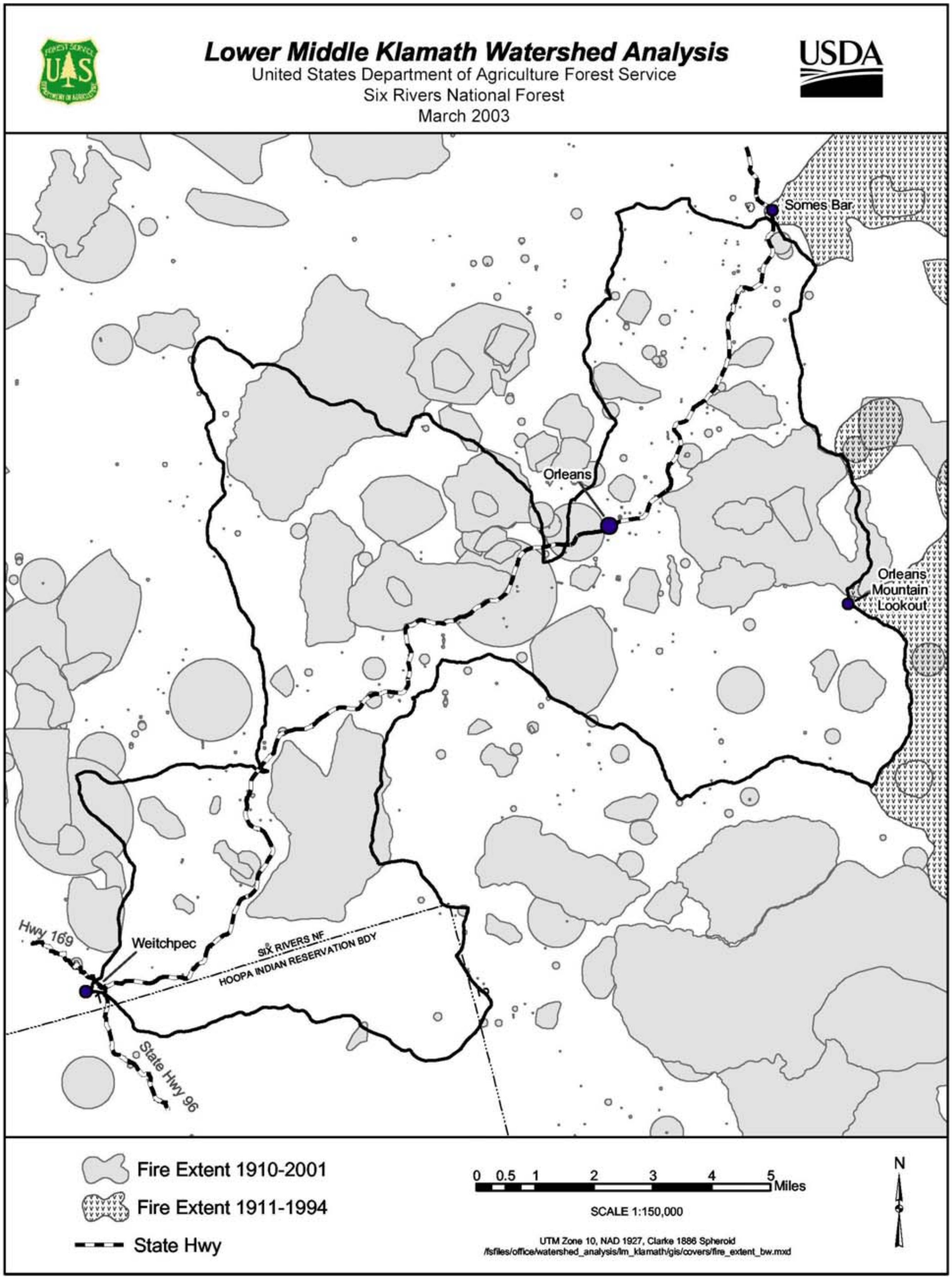
$$\text{NFR (yr)} = \frac{\text{Total time period}}{\text{proportion of area burned in period}}$$

Using the SRNF recorded fire acreages and the acreage for the SRNF portion of the LMK area of 47,859 acres, and recognizing the fire suppression change after the 1950s, Table 22 shows the NFR results for the LMK Analysis Area. These results indicate the shift that has taken place in NFR towards a much longer time to naturally regenerate an area. Wildfire has essentially been removed as a natural component of the LMK ecosystem.

Table 22 Natural Fire Rotation for Specific Time Periods in the Analysis Area.

Years	Area burned (acres)	Natural Fire Rotation (years)
1910-2001	19,411	227
1910-1959	18,796	127
1960-2001	615	3268

Figure 10 Fire Extent 1910 – 2001.



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Fire Severity

Fire severity is the effect of fire on the ecosystem. Severity is largely dependent on the quantity, type, and distribution of available fuels and the rate at which that fuel burns. There is a tendency for fire severity to be inversely related to fire frequency (i.e. the more frequent the fires, generally the less severe the effects). Reference severities are difficult to assess without extensive analysis of vegetation succession and fire scarring, and only moderate to high intensity wildfires create effects that are discernable (e.g. mortality). Numerous studies throughout the western United States have indicated that aggressive fire suppression and prevention in the 20th century has resulted in stands that are denser and that have a greater ladder component. Without fire suppression and prevention, a higher frequency of fires (either from lightning or Native American burning) would have been less intense, however, possibly larger in size. Therefore, rates-of-spread may have still been high under late summer conditions, but flame lengths and overall fire intensities would probably have been much less severe, except during stand replacing fires (i.e. under severe weather conditions). The Analysis Area, as part of the Klamath sub-region (as defined in the Recovery Plan for the Northern Spotted Owl), has a high potential for habitat loss from wildfire (Agee 1993) due to higher fuel loads and more uniform, multilayered canopies.

Taylor and Skinner (1998) looked at patterns of past fire severity that were interpreted from age-class structures in the Seiad LSR, which is adjacent to the Applegate Adaptive Management Area. They found fire severity to be related to relative topographic position and slope orientation. Patterns of past fire severity, inferred from age-classes and patch size patterns, indicate that upper slopes, ridge tops, and south and west-facing slopes experienced more severe fires than lower or east and north-facing slopes. This means that lower slopes and north and east aspects are more likely than other topographic positions to sustain or promote long-term, late-successional conditions. Also, the LMK watershed experiences canyon fog from the coast, which can moderate early morning temperatures and relative humidities, especially lower in the canyons. The significance of this for riparian areas is that upper reaches of stream courses, especially where there is no permanent water, are likely to have burned more severely than lower reaches. In terms of fire severity, the lower riparian areas are probably similar to east and north-facing uplands, while the upper riparian areas are probably more like south and west-facing slopes. Agee and Edmonds (1992) deduced that historical breakdowns of fire intensities would be expected to be more biased toward the lower damage classes, which have patchy and variable fire severity.

Jimerson (2002) reconstructed stand replacing events on the SRNF using ecology plot data that included stand ages. This analysis indicated that a large portion of the LMK Analysis Area was involved in major wildfire events around 1865 and 1910. These events were probably related to the extended drought periods recorded by Fritts and Gordon (1980) in California from 1865 to 1885.

Fire severities are rarely recorded unless there is extra funding for aerial reconnaissance following a major wildfire. Severities can sometimes be inferred from recorded information on fire report forms such as character of fire or percent mortality. Table 23 gives examples of this from early fire report forms for wildfires greater than 100 acres. These data, which record surface and crown fires, show the mixed severities in many large wildfires. Also, the mortality data show that many early fires were reburns because young regrowth, which would have been associated with wildfires rather than plantations, is mentioned.

Table 23 Character and Mortality Described in Early Fire Report Forms for Large Wildfires (>100 Acres).

Fire Name	Discovery	Character	Mortality
Hopkins Creek	8/29/10		950/4500 mbf green, 300/500 ac. of 12 year old young growth*
Pearch Creek	8/6/11		110/150 mbf green, 200/200 ac. of 10 year old young growth*
Little Red Cap	9/10/15		4/4 ac. of 4 year old young growth*, range lost for 8 months
Marine Rock	8/5/18		Range lost for 195 days
Crawford Creek	7/19/17		2/10 ac. of 12 year old young growth*, range lost for 61 days
Boise Creek	8/8/17		10/10 ac. of 10 year old young growth*
Ullathorne Creek	8/6/17		180/200 ac. of 15 year old young growth*
Pearch Creek	8/6/22	surface fire	40/120 ac. of 10 year old young growth*
Whitmore #4	7/10/25	surface fire	10/10 ac. of 40 year old young growth*
Cheenitch Creek	7/16/26	surface, ground, and crown fire	
Crawford Creek	8/5/26	surface, ground, and crown fire	30% of 200 ac. of 1-20 year old young growth*
Crawford Creek #2	7/29/27	ground and crown fire	
Slate Creek	8/30/28	surface and crown fire	
Boise Creek	8/21/29	surface fire	
N. Fork Boise Creek	9/13/29	surface, ground, and crown fire	
Big Rock	11/14/29	surface and ground fire	
Ullathorne Ridge	11/14/29	surface, ground, and crown fire	
Hopkins Creek	11/18/29	surface, ground, and crown fire	
Mine	8/11/59		125 acres young growth* destroyed

*Note: In Table 23 young growth includes up to 60-year-old trees

The extensive events of the 1987 fire season (250,000 acres on the KNF) barely spared the LMK Analysis Area, but the intensities experienced by surrounding forests shed some light on potential fire severities within this watershed. In areas immediately adjacent to the Analysis Area, the Hog Fire (1977) and the Off Fire (1973), both on the Klamath NF, grew to 80,000 acres and 9,000 acres, respectively. Gross et al. (1989) analyzed three large 1987 wildfires on the Siskiyou National Forest and found a mosaic of burn intensities. Less than half of each fire was burned at high intensity, with the balance burned at moderate and low intensity.

Fire severities were mapped for the SRNF portion of the 1999 Megram Fire, which burned within 1 mile of southeast corner of the LMK Analysis Area. Approximately 30% of the Megram Fire had greater than 70% mortality, as mapped 1 year after the fire. Several areas have 3-5 miles of continuous complete stand mortality within the burned perimeter.

The recent Windy Fire of 2000, which burned 70 acres, mainly burned at night, and resulted in mixed severity. On the other hand, the Dance Fire of 2001, which burned 30 acres, was wind-driven, burned in the afternoon, and resulted in approximately 70-80% high severity.

Condition Class – Current

Condition classes (Schmidt et al. 2002) can also provide information related to changes in historical fire regimes. Condition Classes (fire risk levels ranging from 1 – 3 with 3 being worst) are a function of the degree of departure from historical fire regimes resulting in alterations of key ecosystem components such as species composition, structural stage, stand age, and canopy closure. These alterations within Condition Class 2 and 3 can result in moderate to dramatic changes to fire size, frequency, intensity, severity, or landscape patterns. In turn, the effects of insects, disease, or an eventual fire may cause an increased threat (Condition Class 2) or a significant or complete loss (Condition Class 3) of one or more defining ecosystems components.

Condition Classes, based on vegetation series and seral stage, were derived for the entire Forest within the fiscal year 2001 (USFS, SRNF Fire Management Plan) (http://www.r5.fs.fed.us/sixrivers). Table 24 and Figure 11 show the LMK Analysis Area Condition Class distribution, which indicates a high risk of losing key ecosystem components throughout the watershed. The LMK Analysis Area is very evenly distributed among the three Condition Classes, compared to the overall distribution for the entire Forest. This may be reflective of the extensive burning and large wildfires (i.e. greater than 100 acres) that frequently occurred in this watershed. The widespread occurrence of Condition Class 3 in and around Orleans and Weitchpec shows the potential wildfire threat to this community. Also, it is becoming obvious that Condition Class 1 areas are quickly transitioning into Condition Class 2 areas, which have widespread ingrowth of brush and small to medium size trees, and that Condition Class 2 areas are advancing into Condition Class 3 areas, which have medium size trees that are moving into the large category.

Table 24 Condition Classes for the Analysis Area Compared to the Entire Six Rivers National Forest.

	LMK WA		SRNF
Condition Class	**Acres**	**Percent**	**Percent**
Not Mapped	20.77	0%	
1	16612.47	32%	22%
2	16778.40	32%	19%
3	18945.26	36%	60%
Totals	**52356.90**	**100%**	**100%**

Air Quality – Reference

- *What are the impacts on air quality and visibility of wildfires compared to prescribed burns within and adjacent to the Analysis Area?*

It can be assumed that air quality and visibility during prehistoric periods would have been good, except during periods of extensive or multiple fires, or stand replacing wildfires that produced large volumes of air pollutants. This condition was probably very evident during the extended drought periods recorded by Fritts and Gordon (1980) in California, including the periods 1600 to 1625, 1665 to 1670, 1720 to 1730, 1760 to 1820, and 1865 to 1885.

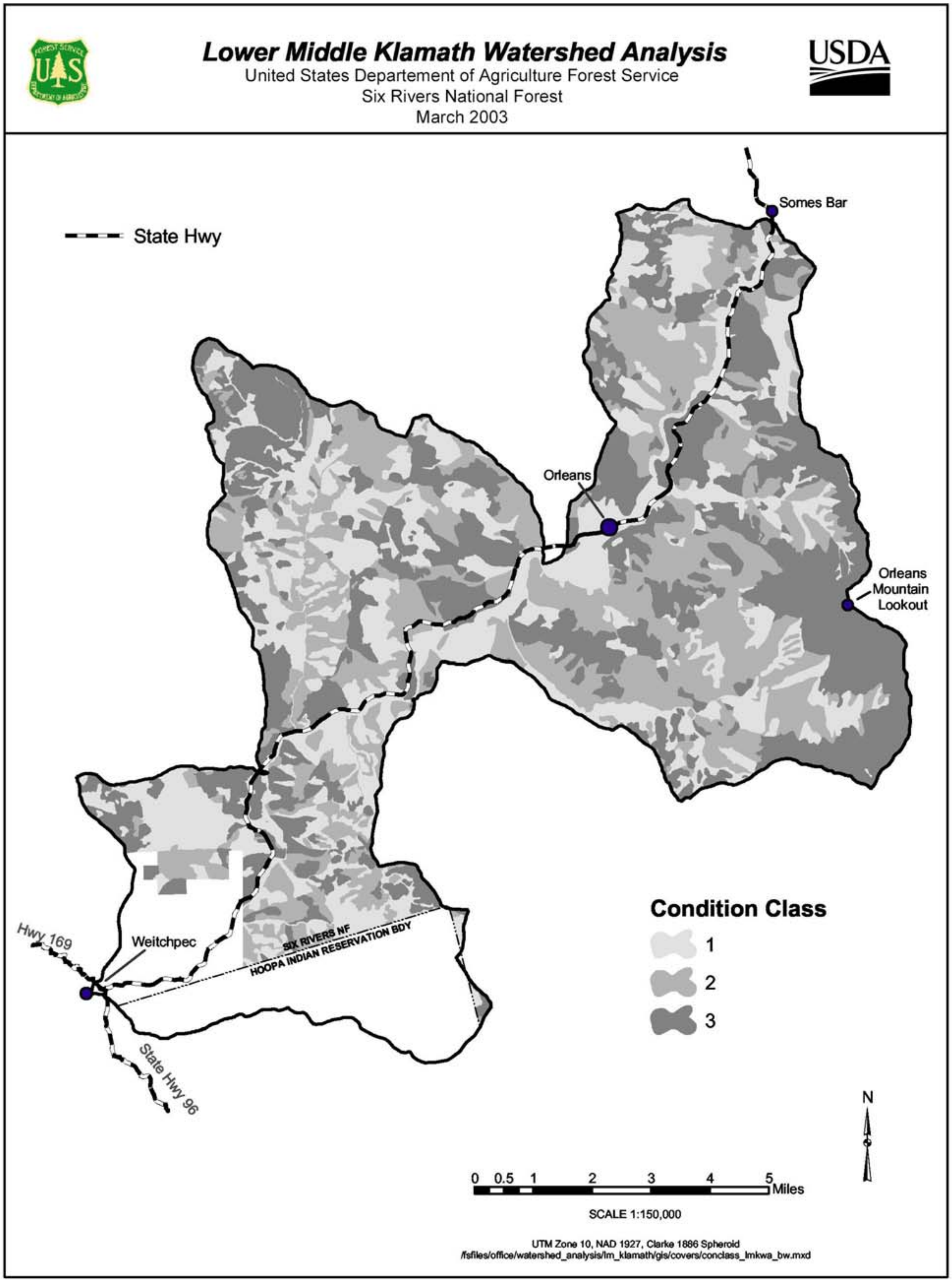
Air Quality – Current

Effective smoke management means maintaining desired air quality by avoiding unacceptable combinations of concentration, duration, and dispersal of smoke. The central principle of smoke management is to promote dispersion of smoke and other pollutants that have the potential to cause health and visibility impacts. This is especially the case in the vicinity of communities, major highways, and wilderness areas where the best available predictive models and strategies would need to be used to minimize the negative impacts on the local residents and visitors. Also, given the many recent severe air quality conditions due to *wildfires*, the local public seems to be much more tolerant, in comparison, to the lesser smoke impacts from *prescribed fires*.

The LMK Analysis Area falls within the North Coast Unified Air Quality Management District (AQMD). Air quality in this air basin is generally considered good, and all federal standards are consistently achieved, including those for ozone, carbon monoxide, particulate matter, and nitrogen dioxide. The overall area is considered to be in "attainment" (i.e. has previously and currently meets ambient air quality standards) by federal standards. California standards for PM10 (particulate matter smaller than 10 microns) have not been met for the AQMD, and this is mainly attributed to smoke from wood stoves.

Smoke from wildfires and prescribed burns can be a major contributor of PM10 levels, and this is of particular interest to human health. The elderly, children, asthmatics, and people with chronic heart or respiratory disease are immediately affected by heavy PM10 emissions. Long-term exposure can have more widespread detrimental effects. Smoke from the 1987 wildfires was so extensive (smoke lingered for several weeks) that there were reports of bats flying during the day (S. Pfister, personal communication, 2000). The Megram Fire of 1999, which burned to about 1 mile away from the southeast portion of the LMK area, resulted in extensive periods of heavy smoke that produced both federal and state states of emergency due to air pollution from smoke. Most recently, the fire season of 2002 produced extensive smoke impacts in this area due to wildfires on the KNF and within the Smith River National Recreation Area and southern Oregon.

Figure 11 Condition Class Distribution.



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Written journal accounts from Orleans Mountain lookout include several references to smoke:

- “French Camp fire throwing out big smoke cloud; rolls in here as thick as cream in late p.m.” (8/11/35)
- “visibility poor on all sides but gets better in late p.m.” (8/13/35)
- “I can’t pick up any dope on Applegate fire, the drift smoke is heavy in north, considerable haze with drift smoke in p.m.” (8/14/35)
- “big smoke in redwoods, southwest wind swings it this way in afternoon and evening and blots everything out” (8/20/35)
- “down at the office they are greatly worried over lightning, because of poor visibility” (8/26/35)
- “visibility bothered by drift smoke from Siskiyou Forest fires, very heavy up Happy Camp way” (9/30/35)
- “smoke rolls in and covers country like a blanket of fog” (9/24/36)

The LMK Analysis Area lies approximately 2.5 miles away from both the Marble Mountains Wilderness (a Class 1 wilderness) and the Trinity Alps Wilderness (a Class II wilderness). The Clean Air Act, as amended in 1977, declared as a national goal the “prevention of any future, and the remedying of any existing impairment of visibility in mandatory Class I Federal areas in which impairment results from man-made air pollution.” Smoke from management ignited prescribed fires occurring in or adjacent to Class I wilderness areas has to be managed in a manner that causes the least impact on air quality related values (FSM 2324). The Clean Air Act further states that visibility will be an Air Quality Related Value for Class 1 areas.

Included in these visibility standards is the Regional Haze Rule, which the U.S. Environmental Protection Agency (EPA) announced in 1999 as a major effort to improve air quality in National Parks and wilderness areas, including the Marble Mountain Wilderness. The term “regional haze” means haze that impairs visibility in all directions over a large area. The rule requires states, in coordination with the EPA, National Park Service (NPS), USFWS, USFS, and other interested parties, to develop and implement air quality protection plans to reduce the pollution that causes visibility impairment. The first state plans for regional haze are due in the 2003-008 timeframe. The Western Regional Air Partnership met in late 2002 to develop and assess the economic consequences of these state plans (http://www.wrapair.org/index.html). Because of wind patterns within the canyon around the community of Orleans this haze issue could develop into a problem as it did during the extensive wildfires of 1987, the Megram Fire of 1999, and the wildfires of 2002.

The objective for Class II airsheds is to keep air pollution below federal air standards, which are designated for a moderate degree of protection from future air quality degradation.

Water Quality and Fisheries

Riparian and aquatic conditions address erosion processes and other disturbance regimes that affect water quality, riparian and aquatic habitat quality, and occurrence of dependent species. The following descriptions attempt to characterize the riparian and aquatic conditions that existed prior to land management activities, and place them within the probable range of conditions under which these ecosystems have evolved. They are qualitative professional judgments based on various sources including anecdotal information, general knowledge of ecosystem processes and functions, and visual evidence from old aerial photographs. Descriptions of current conditions are based on the best available data pertaining to aquatic and riparian conditions within the LMK Analysis Area. They are also derived from the application of current knowledge about relevant physical processes and the functions of those ecosystem elements in maintaining viable populations of dependent species.

The Klamath River Basin has experienced considerable land use change during the past 150 years. Mining and logging were the major land uses that affected streams and rivers throughout the Basin. Hydraulic mining disturbed channels and floodplains in many parts of the Lower Basin during the late 1800s. Pulp mills and effluent discharge created additional water quality impacts. Irrigated agriculture and grazing came later, but the major development of irrigation and hydropower in the Basin occurred over 50 years ago. All of these disturbances represent a significant departure from conditions in the Basin prior to European settlement and occupancy (Klamath River Basin Fisheries Task Force 1990).

Anadromous fishery resources of the Klamath River have been a significant factor in the social and economic fabric of northwestern California and southern Oregon. This rich history extends back thousands of years for the Native Americans whose regional cultures evolved around the natural wealth of the Klamath River. Vitality of these anadromous fish populations and the quality of their habitats has been a concern since the early 1900s. All anadromous fish populations in the Klamath River Basin have declined precipitously, and some now face the risk of extinction.

Klamath Basin Hydrology

- *To what extent have flow characteristics of the mainstem Klamath River been altered, and how has this affected key dependent aquatic species?*

Hydrologic changes in the Klamath River have produced biological changes within the mainstem and most tributaries of the Analysis Area. Alteration of the natural flow regime within the Klamath River Basin resulted from the construction of large dams on both the Trinity and Klamath mainstems during the early to mid-1900s. Presently, six large hydropower facilities exist on the Upper Klamath River. Link River Dam, a U.S. Department of the Interior (USDI) Bureau of Reclamation (BOR) facility, controls water releases from Upper Klamath Lake. Pacific Power owns and operates five facilities that regulate streamflow in the Klamath River canyon downstream of Link River Dam. These facilities include Keno, Copco 1 & 2, John C. Boyle, and Iron Gate dams.

The Iron Gate Dam was completed in the 1950s. This is the lowest dam on the Klamath River (approximately 50 miles below Link Dam), and it blocks salmon migration into the Upper Basin. Iron Gate regulates instream flow variations of the Lower Klamath River resulting from the operation of plants located further upstream. The flow agreement that was recommended to the Federal Power Commission (now the Federal Energy Regulatory Commission or FERC) specified 1300 cfs (cubic feet per second) from September through April, 1000 cfs during May, 710 cfs during June and July, and 1000 cfs during August.

The BOR has taken the preliminary steps to develop a Klamath Project Operations Plan to address many issues surrounding water management and other planning in the Basin. This plan is intended to manage water effectively within the context of BOR's legal obligations as follows: (1) meet the requirements of the ESA; (2) fulfill federal trust responsibility to federally recognized tribes within the Klamath Basin; (3) provide deliveries of project water; and (4) preserve wetland and wildlife values.

In May 1995, the National Biological Service (NBS) Mid-continent Ecological Science Center characterized baseline hydrologic conditions in the Klamath Basin. This Phase 1 report was prepared to aid in determining flow-related factors that might be involved in restoring anadromous fish in the Klamath River (Cambell 1995). Seventeen U.S. Geological Survey (USGS) gages were selected for building a hydrologic baseline at selected points within the Basin. Clear hydrologic changes were identified from the analysis, and reduced flow volume due to drought was noted as the most significant single change in the record. Alterations in the hydrologic regime of the Klamath River were suspected to have had complex effects. Changes in the timing, volume, and location of flow and construction of reservoirs have coincided with or perhaps even induced changes in other aspects of the river environment such as transport of sediment, accumulation of organic material, creation of fish passage obstructions, increased temperature, and increased biological oxygen demand. Changes in flow regime are generally reflected in increased winter flows and reduced summer flows when compared to historical conditions (BOR 2001)

The *Evaluation of Interim Instream Flow Needs in the Klamath River - Phase II* (BOR 2001) provides a complete physical and fish habitat characterization of the river from the Iron Gate Dam down to the Klamath estuary. This report focuses on the various instream flow regimes available from the Iron Gate Dam that could maximize fish habitat utilization for different species and lifestages. The report is still being assessed, and a preferred instream flow regime to maximize beneficial uses and water quality has yet to be recommended. The Phase II report confirms the findings in the earlier Phase I study that flows lower than approximately 1000 cfs during the late summer would likely increase the environmental risk to anadromous species due to prolonged exposure to warm water temperatures. The Phase II report also concluded that there is very little flexibility for reservoir operations at the Iron Gate Dam to mitigate adverse temperature effects that depend on flow.

Principal factors affecting anadromous fish populations within the Analysis Area and the Middle Klamath Sub-basin include high water temperatures, poor water quality (e.g. pH and dissolved oxygen), suspected loss of spawning gravels, flow reductions from some tributaries (e.g. Scott and Shasta Rivers), flow depletions within the Upper Klamath Basin, and altered characteristics in the timing and magnitude of mainstem flows. In addition, state Highway 96 and other roads that parallel the Klamath River or tributaries have impacted fish habitats and access. Apparent alterations in the channel due to upstream dams have been associated with armoring of the streambed and lack of gravel recruitment from blocked upstream sources.

Klamath Mainstem Hydrologic Regime

Hydrologic conditions in the LMK Analysis Area are affected mainly by the areal and seasonal distribution of precipitation and the influence of snowmelt runoff. Variations in topography and geologic structure further affect the pattern of runoff, as well as the use of surface and ground waters.

Historical records of precipitation reveal a period of extreme floods and droughts within the Klamath Basin, including the LMK Analysis Area. The annual precipitation at Orleans during the period of record (1885 to present) varied from 22 to 81 inches. Average annual precipitation is about 64 inches. Approximately 85% of the average annual precipitation occurs between

October and March, with the remainder occurring as occasional spring/summer storms. USFS rainfall records indicate that the 1920s were the driest decade, the 1950s were the wettest decade, and the 1980s were about average. Recent large floods occurred in December 1955, December 1964, February 1974, and January 1997.

A USGS gauging station (No. 11523000) located on the Klamath River at Orleans from 1924 to the present recorded a maximum discharge of 307,000 cfs on December 22, 1964. Annual and bankfull peaks are significantly less than half the magnitude of historic large flood events. These large flood events are relevant to understanding recent flow conditions and sediment transport that has occurred in smaller tributaries of the mainstem Klamath.

Hydrologic Regime of LMK Tributaries

Since 1997, the Orleans Ranger District has collected annual low flow data on Slate and Boise creeks between August and November. Low stream flows typically range between 1.0 and 6.7 cfs for these tributaries during this period. However, there are no comparable hydrologic records for other tributaries of the Lower-Middle Klamath River. Hence, flows must be estimated from regression equations on the basis of precipitation, stream gradient, drainage area, and distance from the coast. Estimated flow regimes for Boise, Slate, Hopkins and Pearch creeks are compared with gauged flows on the Klamath River at Orleans in Table 25.

Table 25 Estimated Hydrologic Regime of Tributaries within the Analysis Area Compared to Klamath River Gauging Data.

	Boise Creek	Slate Creek	Hopkins Creek	Pearch Creek	Klamath River at Orleans
Mean Annual	57	61	36	24	8,200
7-day, 2-year low	2.8	3.2	2.5	1.7	2,000
2-year peak	1,200	1,400	680	500	61,000
25-year peak	3,500	3,800	2,000	1,500	220,000
100-year peak	5,000	5,300	2,900	2,100	340,000

Note: In Table 25 all figures are in cubic feet per second (cfs)

The LMK Analysis Area is subject to rain-on-snow events. Extremely high streamflow may occur when a warmer than normal winter storm coincides with a pre-existing moist snow pack on the ground. Under these conditions, the precipitation melts the snow pack and rapidly releases large quantities of water to streams. These events play an important geomorphic role by influencing the stability of hillslopes as well as the physical characteristics of stream corridors, thereby affecting aquatic productivity in the Lower-Middle Klamath mainstem and its tributaries.

Erosion Processes

Erosion Processes – Reference

The Klamath River carries a relatively high sediment load, as indicated by large and extensive alluvial deposits (terraces and fans) and typically high turbidity levels throughout the winter months. The Klamath Basin Assessment (USFS 1997), completed by the Klamath, Six Rivers, and Shasta-Trinity National Forests in 1996, noted that the geologic terranes and geomorphic types that occur downstream of Happy Camp are especially susceptible to sediment delivery from mass wasting and accelerated erosion. These sensitive terrains may encompass as much as 20% of the total landscape. Their capacity to generate sediment can be and often has been exacerbated by human disturbance of these lands.

Geologic Setting

There are six main geologic units that underlie the LMK Analysis Area. Some of the units are terranes (collections of associated rock types), as shown in Figure 12.

- South Fork Mountain quartz-mica schist underlies 5% of the Analysis Area. These slopes contain many large, ancient deep-seated landslide deposits, and are moderately susceptible to debris slides, debris flows, and accelerated gully erosion.

- Galice Formation slate, phyllite and semi-schist underlies 42% of the Analysis Area. Galice metasedimentary rocks also contain extensive ancient landslide deposits, and have slope stability characteristics similar to the schist unit, although they appear to be more susceptible to debris slides.

- Galice Formation metavolcanic rocks underlie 11% of the Analysis Area. They typically consist of resistant and fairly competent greenstone and greenstone breccia that form steep slopes with fewer ancient landslide features than Galice metasedimentary bedrock.

- Rattlesnake Creek Terrane, comprised, in this area, of a dominantly metavolcaniclastic and serpentinite melange, underlies 5% of the Analysis Area. Ancient landslide deposits are fairly common, and slopes exhibit a considerable range of landsliding and erosion characteristics.

- Western Hayfork Terrane metasedimentary and metavolcanic rocks underlie 22% of the Analysis Area. They are substantially less prone to mass wasting than the preceding units, but are moderately erodible, and contain many older rockslide/rockfall areas.

- Scattered igneous rock masses of dioritic, gabbroic, and ultramafic composition underlie 11% of the Analysis Area. These units are generally distributed along the major tectonic boundaries (thrust faults) between the preceding four terranes. The ultramafic units are the most extensive (8% of the Analysis Area), are typically serpentinized, and are moderately susceptible to landsliding on intermediate to steep slopes.

Alluvium covers the remaining 4% of the Analysis Area, and Quaternary landslide deposits overlie about 27% of the bedrock units.

Drainage density varies somewhat across these geologic units and is important because it reflects the ability of a watershed to generate streamflow and deliver sediment. Drainage density is influenced by competence of the underlying geology, topographic relief and hillslope steepness, as well as regional differences in precipitation. As a general rule, stream flow responds more quickly to a given precipitation event in a watershed with higher drainage density, resulting in quicker runoff and potentially higher stream power to transport sediment.

Table 26 lists the drainage areas, stream densities, and predominant geologic terranes within the five main tributaries.

Table 26 Drainage Density and Geologic Composition of Tributaries within the Analysis Area.

Tributary	Drainage Area (sq.mi.)	Drainage Density (mi./sq.mi.)	Geology
Boise	15.6	4.0	40% Galice metasediments, 40% Western Hayfork terrane, 10% Galice metavolcanics, 10% Rattlesnake Creek terrane & ultramafics; plus 17% landslide deposits
Slate	13.7	3.5	60% Galice metasediments, 25% ultramafics, 15% Galice metavolcanics; plus 19% landslide deposits
Hopkins	9.0	2.7	60% Galice metasediments, 40% Galice metavolcanics; plus 22% landslide deposits
Pearch	6.6	3.8	20% Galice metasediments, 75% Western Hayfork terrane, 5% ultramafics; plus 12% landslide deposits
Aikens	3.9	3.1	48% schist, 43% ultramafics; plus 59% landslide deposits

Landscape Evolution and Disturbance Regimes

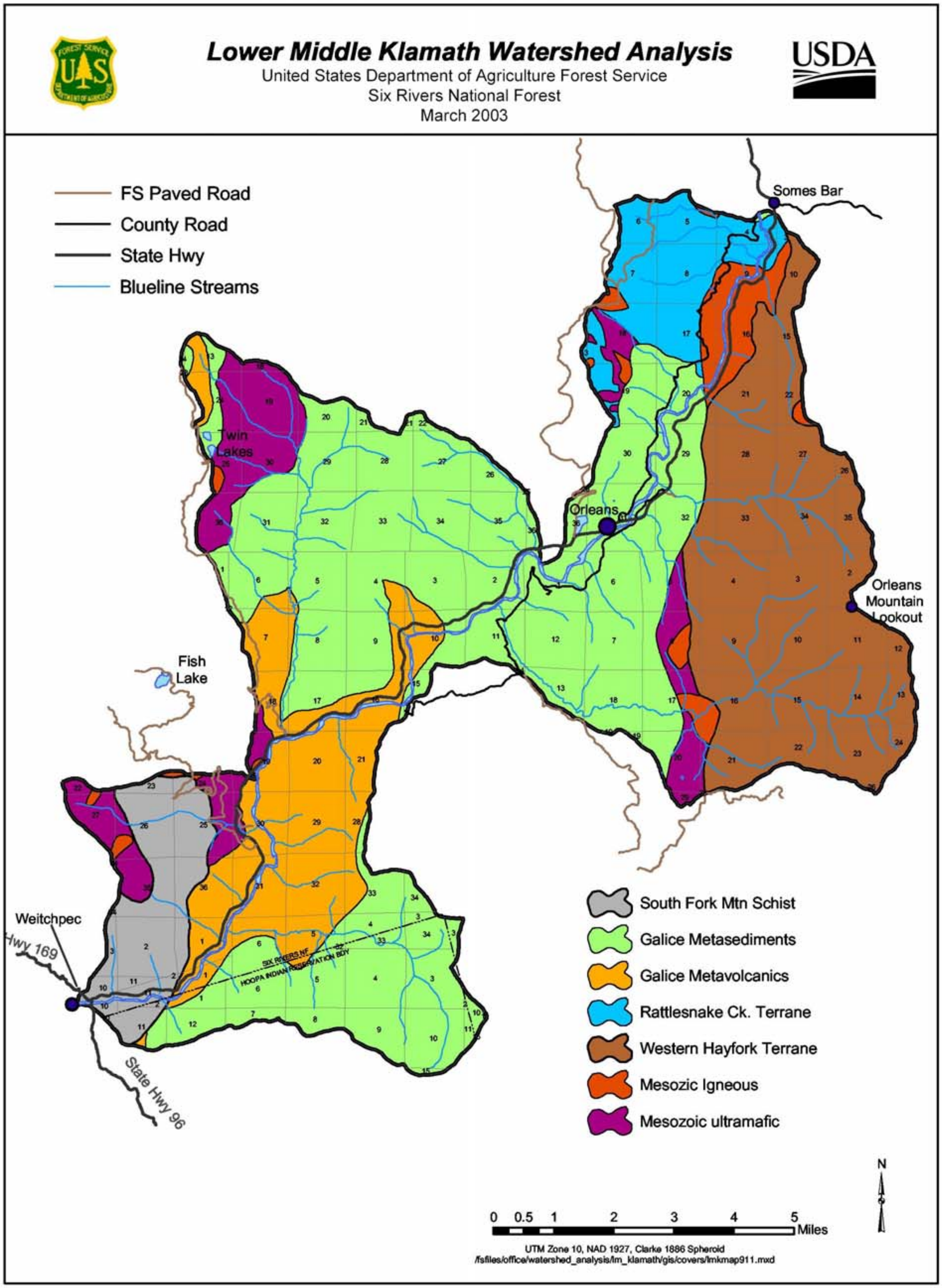
- *How have the distribution or intensity of hillslope processes changed over time in the Analysis Area?*

- *What effects have natural and human-caused disturbances had on mass wasting and erosion processes within the Analysis Area?*

- *To what degree and in what types of locations have management activities affected mass wasting or erosion processes?*

The landscape of the Analysis Area is typical of the Klamath Mountains Province, with deep canyons and steep slopes, relatively high gradient, high-energy streams, and widespread mass wasting. This landscape has evolved over millions of years during which it has undergone catastrophic changes with long intervening periods (hundreds to thousands of years) of relative stability. Both large and small-scale physical disturbances have been an integral part of this evolution, and the various flora and fauna have adapted to these circumstances. During earlier glacial epochs, the terrain likely experienced especially intense erosion and mass wasting, which have left their imprints on the landscape as headwall basins and massive landslide scars and deposits that are now covered with vegetation but are still recognizable by their morphology (Figure 13, a more detailed version is available electronically)

Figure 12 Geology.



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Our short historical window only provides a limited sample of the full spectrum of disturbance. Two catastrophic, landslide-producing floods occurred during the historical period in 1861 and 1964, but other floods have also caused substantial erosion and mass wasting. Floods even greater than 1861 or 1964 undoubtedly occurred in prehistoric times; such extreme flood events are believed to have occurred in 1750 and 1600. Clearly, the reference condition for this region includes landsliding and sedimentation that were occasionally very widespread and caused drastic changes in riparian and aquatic ecosystems.

However, prehistoric conditions also would have included long intervals (from decades to perhaps centuries) with relatively less active geomorphic processes. This would have been accompanied by relatively low sedimentation rates from landslides and erosion, and therefore, would have provided long periods for riparian and aquatic systems to recover from catastrophic events. This pattern of disturbance and recovery was probably distributed somewhat randomly throughout the LMK Analysis Area with different parts in different stages of recovery at any particular time. This pattern also would have been affected by variation in geologic and geomorphic sensitivity, because different bedrock units and landforms would have responded differently to extreme natural events.

Surface erosion has varied greatly across this landscape because of variations in soil and parent material, slope steepness and position, and vegetative cover. Mass wasting processes tend to accelerate other erosion processes by abruptly altering all three of these conditions. Over thousands of years, soil formation outpaces erosion so that soils deepen and become more fertile. In a geologically active setting such as the Analysis Area, the average rate of soil formation is probably only somewhat faster than natural erosion rates. On some sites such as ancient landslide benches and elevated stream terraces, deep soils have time to form, and are protected from erosion, while on other sites such as old landslide scars, erosion persists and little or no soil development occurs. Wildfires have been a second complicating factor in the erosional history of the Analysis Area because they alter or remove the vegetation cover to some extent, and if very intense, may alter physical soil properties that cause short-term increases in surface erosion due to rilling and gullying. Since intense fires have likely occurred in this area for thousands of years, locally high rates of erosion have occurred here prior to any human disturbance of the landscape. In some locations, these rates could have been as high as or higher than sites that have been recently clear-cut and broadcast burned. (The previous Vegetation and Fire section contains further discussion on reference conditions for vegetation and fire history.)

Riparian and aquatic communities have adapted to these disturbance regimes and erosion processes. For extended periods, stable riparian and aquatic conditions would have resulted in high productivity and integrity of dependent communities, while at other times, these communities would have been recently impacted by large-scale disturbance, and struggled to recover.

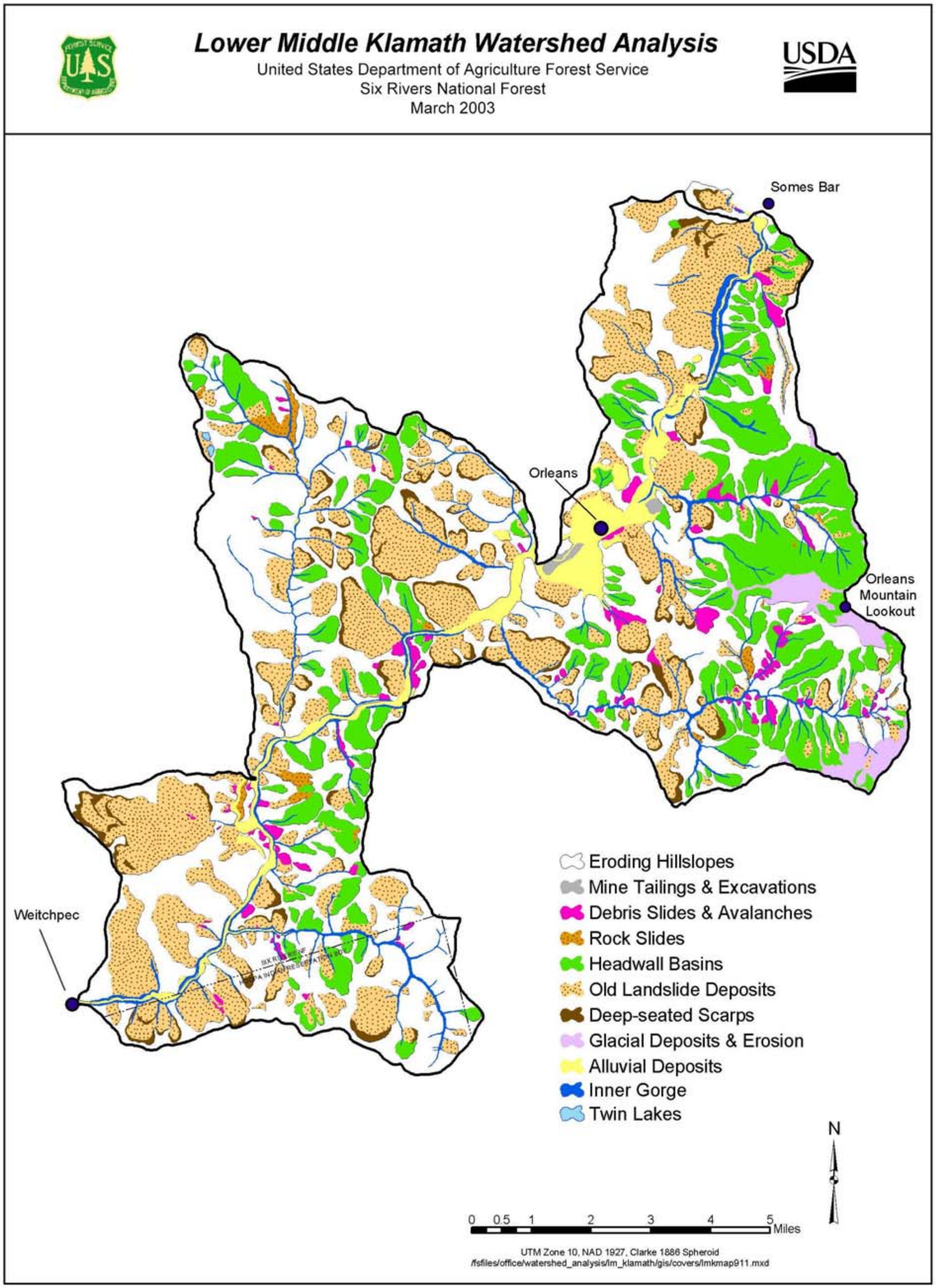
Pre-Management Erosion Conditions

A comprehensive analysis of historic aerial photos was conducted for this watershed analysis (discussed below under ***Erosion Processes – Current***). With respect to erosion processes, 1944 aerial photos show relatively unaltered hillslope conditions that predate human disturbance of most of this landscape. Prior to 1944, Native Americans and turn-of-the century miners occupied the Analysis Area. Native American influences on erosion processes were probably not significant because their subsistence needs were localized along the mainstem riverine areas and in some of the surrounding lands. On the other hand, historical records indicate that mining activity probably had substantial impacts on erosion processes and sediment delivery along the mainstem and some tributaries, although most visual evidence within the riparian corridor had been erased by 1944. State Highway 96 and some county roads were present, but Forest Service road construction and timber harvest did not begin until the late 1950s. The historic aerial photos provide useful insights about how the modern landscape has changed from the past and what the role of management has been in those changes. However, they only provide a snapshot in time from the full range of hillslope and fluvial conditions that the Analysis Area has experienced over past centuries, or may experience in the future.

The primary visual evidence of erosion processes on the 1944 aerial photos consists of recently active landslide scars and recent alluvial deposits. A total of 251 active landslides were present of which 60% were smaller than one acre and 14% were larger than three acres. Active landslides were estimated to cover 367 acres or 0.6% of the Analysis Area. Slides were most common along the Klamath mainstem with a moderate number in Pearch and Boise creeks. They were twice as prevalent in upper and middle-slope positions as in lower (inner gorge) slope positions. About 80% were natural features, while the rest were associated with state and county roads or old mining areas. Nearly all of the slides appeared to have delivered at least 20% of their volume directly to streams, which could have had some adverse effects on aquatic or riparian habitats. Many of these slides also appeared to be ongoing sources of sedimentation from surface erosion, but this was probably only a small fraction of the sediment delivered by the original slope failure.

On the 1944 photos, fresh alluvium can be seen through the dense riparian canopy along most of the mainstem Klamath River and in scattered locations along tributaries. A considerable fraction of this sediment could be the legacy of 19^{th} century mining, which was widespread along the Klamath mainstem from Happy Camp downstream, as well as deposition from earlier flood events. Reports by the State Division of Mines & Geology indicate that large-scale placer and hydraulic mining was ongoing from the 1860s through the 1940s in several locations within the Analysis Area, predominantly within a few miles of Orleans. Hundreds of acres of stream terrace deposits were processed down to bedrock (typically 30-50 feet), and most of the tailings were disposed of into the Klamath River. Since many of these placer deposits were very old, elevated terraces and would have included substantial older landslide debris as well as stream deposits, they likely included a substantial fraction of older soils mixed with alluvial sand, gravel, and boulders. Most of the mining appears to have occurred during the wet part of the year when tributary water was available to be diverted to run the hydraulic “giants”. Hence, a substantial fraction of the fines in the tailings could have been transported further downstream. There is no way to estimate reliably how much of that sediment aggraded the Klamath River in this Analysis Area. Although mining activity fluctuated considerably during this 80-year period, it probably delivered several million cubic yards (cu yds) of sediment to the river annually during peak production years, which equates to a disturbed area of about 50 acres excavated to a depth of 30 feet. This is similar in magnitude to sediment delivery from landsliding associated with the 1964 flood across the entire 60,078-acre Analysis Area (discussed below).

Figure 13 Simplified Geomorphology.



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Most of the active landslides visible in 1944 were interpreted to be shallow debris slides, flows or avalanches. About 10% of the active slides appeared to be deep-seated, while almost 20% were rockslides. The various types of landslides have different short-term and long-term sedimentation effects. Shallow slides are generally smaller in volume but deliver a large fraction of their volume, as well as much large organic debris, directly to stream channels. In contrast, deep-seated slides usually involve much larger volumes but occur less frequently and deliver only a small fraction of their volume to stream channels during the initial failure. However, some types may continue to fail seasonally, or the depositional area of the deep-seated slide may be a chronic source of smaller secondary failures. Deep-seated slides may also have profound effects on slope and channel morphology because of their size. Rockslides tend to deliver relatively coarse material very sporadically.

Much older, dormant landslide features, both shallow and deep-seated, underlie about half of the Analysis Area (Figure 13). Slightly more than half are ancient, deep-seated landslide deposits (Qls) that are widely distributed throughout all geologic units except the Western Hayfork Terrane, which covers only 4% of that unit. They are especially abundant in the schist terrane, covering 63% of that unit. Active landsliding is often spatially associated with older landslide deposits because the colluvium typically forms less competent slopes and more readily entrains water during major storms, which favors slope failure. However, only about one-fifth of the active slides observed in 1944 were associated with older landslide deposits, which is atypical for the Klamath Mountains Province.

Dormant shallow landslides are most common in two north-south bands, one from Slate to Hopkins Creek and the other in the steep headwaters and along the Klamath River canyon on the east side of the Analysis Area. Galice Formation rocks and the Hayfork Terrane underlie these areas predominantly. Recently, active slides are more uniformly distributed and not strongly associated with these dormant shallow landslide features. Dormant shallow landslides visible on the 1944 photos are more numerous and cover much more area than the active landslides observed during historic times, showing that prolonged landsliding has shaped the landscape.

In summary, shallow landsliding has probably been a more common erosion process in the LMK Analysis Area than is indicated by geomorphic mapping because smaller debris slides are more quickly obscured by subsequent revegetation. Field studies have generally found that shallow slope failure has been a more extensive erosion process than is indicated by aerial photo inventories, both in terms of recent and older (dormant) features. It is probably the case that, over long time frames, deep-seated landsliding has a more profound effect on the total landscape, while shallow landsliding is a more effective and frequent mechanism for delivering sediment and other debris to stream channels.

Erosion Processes – Current

Extensive areas of stable bedrock as well as other areas of highly unstable and erodible terrain underlie the LMK Analysis Area. Therefore, erosion rates are quite variable across this landscape. Total erosion rates are a combination of surface erosion and mass wasting processes. Based on previous erosion studies in northwest California, it is likely that mass wasting processes have been far more important in terms of volume than surface erosion in most of this Analysis Area. However, surface erosion generally delivers mostly fine-grained sediment, while landslides deliver both coarse and fine-grained sediment, as well as boulders and large wood that become important structural components of streams. The highest surface erosion rates have probably been associated with (1) active gullying in finer-grained lithologies including South Fork Mountain schist, Galice slate and phyllite, Rattlesnake Creek Terrane and shear zones, and (2) steeper slopes on coarser-grained igneous and sedimentary rocks (especially in the Western Hayfork Terrane), as well as poorly revegetated landslide scars and areas that have experienced recent intense wildfire or in some cases, clear-cutting. A following section on Soil Resources presents further discussion about surface erosion.

Lower-Middle Klamath Landslide Study

An inventory of historically active landslides was prepared for this watershed analysis to estimate sediment volumes mobilized by mass wasting. Storm events and land management activities have had important effects on erosion and mass wasting in the Analysis Area. Three large storm/flood events occurred between 1960 and 1975, including the 1964 flood that caused widespread landsliding throughout Northern California, as well as lesser storms in 1972 and 1975. These disturbances had dramatic impacts throughout the LMK Analysis Area. During this period, road building and timber harvesting had occurred in parts of the Analysis Area. When the storms occurred, slopes that had been clear-cut or on which roads had been constructed were more susceptible to mass wasting processes than other undisturbed slopes.

The analysis consisted of examining 1944, 1960, 1975, 1990 and 1998 aerial photos that bracket the major floods that have affected the area the most. The following attributes were recorded for each landslide identified on aerial photos:

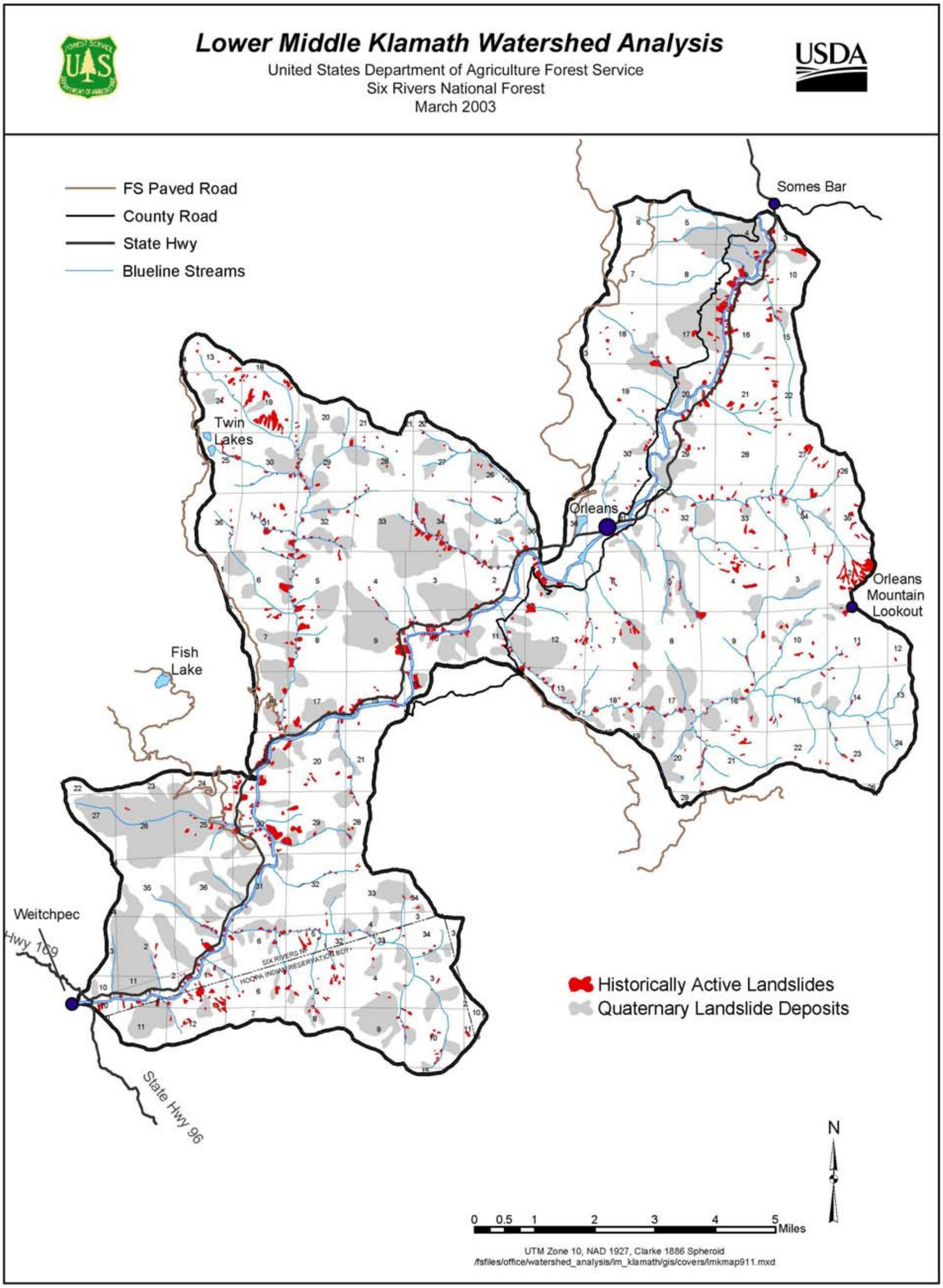
- estimated size in acres
- landslide type (shallow slide, debris flow, rockslide, avalanche or deep-seated)
- management influence (Highway 96, Forest or County road, harvest, natural)
- occurrence within older landslide terrain
- hillslope position
- estimated percent delivery to stream system
- change from previous aerial photo year
- detectable aggradation of stream channel below feature

General Trends of Landslides

In 1944, there were 247 active landslides within the study area. By 1998, 763 additional landslides had occurred, all but 75 of which had appeared by 1975 (Table 27). In addition, 88 of the older slides had experienced detectable enlargement, while 72 others had remained essentially static scars that probably continued to deliver some sediment. Twenty-eight percent of the 1944 features were rockslides that probably did not deliver much sediment over the period of record. The spatial distribution of active landslides is shown in Figure 14.

Estimated landslide volumes were derived from previously collected field data relating landslide areas to volumes on similar terrain in other parts of the SRNF. These data have been used to calibrate a general relationship between area and volume, which was developed in Grouse Creek by Raines and Kelsey (1991) for shallow debris slides (see Appendix H for a detailed explanation).

Figure 14 Landslides.



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Sediment delivery in tons was then calculated from the estimated percent delivery and a density conversion factor of 1.54 tons per cu yd (Table 28). Volumes and tons delivered include small increments for shallow slides that appeared static for a particular time interval, and, therefore, were probably chronic sediment sources. However, static slides are not counted as enlarged in Tables 27 or 28. These estimates, especially when summed for the various categories discussed below, are considered accurate to about ±30%.

Table 27 Summary of Landslide Trends and Estimated Volumes Mobilized (cu yds) in the Analysis Area, 1944 – 1998.

Present in 1944		Appeared or Enlarged 1960		Appeared or Enlarged 1975		Appeared or Enlarged 1990		Appeared or Enlarged 1998	
Count	Est. Vol.	Count	Est. Vol.	Count	Est. Vol.	Count	Est. Vol.	Count	Est. Vol.
247	2,217,400	29	97,900	74	583,100	3	71,800	10	38,500
		165	823,200	89	432,600	1	12,000	3	10,100
				523	2,564,400	5	54,100	11	47,400
						29	81,800	0	700
								46	85,500
247	**2,217,400 (31%)**	**194**	**921,100 (13%)**	**686**	**3,580,100 (50%)**	**38**	**219,700 (3%)**	**70**	**182,200 (3%)**
Grand Total = 7,120,500 cu yds									

Table 28 Summary of Landslide Trends and Estimated Sediment Delivery (tons) in the Analysis Area, 1944 – 1998.

Present in 1944		Appeared or Enlarged 1960		Appeared or Enlarged 1975		Appeared or Enlarged 1990		Appeared or Enlarged 1998	
Count	Est. Tons	Count	Est. Tons	Count	Est. Tons	Count	Est. Tons	Count	Est. Tons
247	1,339,600	29	91,900	74	549,600	3	84,200	10	23,900
		165	533,700	89	475,400	1	12,800	3	12,300
				523	2,695,000	5	68,500	11	63,300
						29	62,200	0	400
								46	85,600
247	**1,339,600 (22%)**	**194**	**625,600 (10%)**	**686**	**3,720,000 (61%)**	**38**	**227,700 (4%)**	**70**	**185,500 (3%)**
Grand Total = 6,098,400 tons									

Note: In Table 27 and 28, shaded cells denote first appearance and other entries denote enlargement.

An estimated 6.1 million tons of sediment were delivered from all 1010 landslides for the period of record. Approximately one-quarter (1,339,600 tons) was delivered before 1944. The balance (4,758,800 tons) was delivered between 1944 and 1998, 71% from new slides and 29% from apparent enlargement of earlier slides during those 54 years. A higher proportion of active slides in lower (streamside) slope positions occurred from 1944 to 1975 and after 1990 than during the other time intervals. Sediment delivery was proportionally much higher from 1960 to 1975 (61%) than the amount of slide volume generated (50%).

Management Influence on Landslides

Approximately 35% of all slides and 40% of slides active after 1944 were directly or indirectly related to management activities based on aerial photo interpretation (i.e. proximity to management disturbance that preceded the slide). About one-third of all management-related slides have been associated with state Highway 96. The remaining slides appeared to be due solely to natural causes. Nearly two-thirds of post-1944 landslide debris (4,903,100 cu yds) was delivered to streams, of which about 13% was associated with Highway 96 and 31% with other management, while the remaining 56% was from natural slides (Table 29). These estimates of management-related sediment delivery should be considered an upper limit, since few, if any, of these slides were wholly caused by the spatially associated management disturbance.

Table 29 Landslide Incidence and Estimated Tons Delivered to Streams Relative to Management Influence, 1944 – 1998.

Influence / Percent of Total	1944-60	1960-75	1975-90	1990-98	Total
Highway 96 / 13%)	81,300	435,300	65,300	42,100	**624,000**
County Roads / 8%	43,100	266,300	22,500	56,600	**382,200**
Forest Roads / 5%	82,900	148,800	7,400	2,300	**241,400**
Forest Roads + Harvest / 10%	20,900	433,600	1,300	300	**456,200**
Harvest / 8%	33,200	305,600	11,700	31,600	**382,200**
Mining / <1%	--	--	--	--	**--**
Natural / 56%	364,200	2,130,400	119,500	52,600	**2,666,600**
Totals	**625,600**	**3,720,000**	**227,700**	**185,500**	**4,758,800**

It is noteworthy that larger shallow slides that deliver the greatest amount of sediment have been disproportionately associated with Highway 96 (28% were one acre or larger), compared to other management-related slides (18% were one acre or larger) or natural slides (17% were one acre or larger).

Table 30 Landslide Incidence and Estimated Volumes Relative to Sub-watersheds, 1944 – 1998.

Sub-watershed	Acres	Total No.	No. per 1000 acres	No. Active post-1944	Tons Delivered post-1944	Post-1944 tons/acre
Aikens Ck	2,526	30	12	30	203,600	81
Boise Ck	9,987	117	12	94	315,600	32
Cavanaugh Ck	6,598	112	17	106	602,900	91
Crawford Ck	3,913	80	20	77	513,800	131
Hopkins Ck	5,759	104	18	104	562,700	98
Ikes	8,931	158	18	116	504,400	56
Pearch Ck	4,195	84	20	42	122,200	29
Red Cap Gulch	5,075	99	20	90	557,600	110
Slate Ck	8,748	164	19	132	696,700	80
Whiteys Gulch	4,346	62	14	60	628,100	144

Landslide Variation Among Sub-watersheds

Landslide rates and associated sediment production have varied considerably among sub-areas within the Analysis Area (Figure 14 and Table 30). Slide frequencies were lower in the Aikens, Boise and Whitey's Gulch sub-areas. Sediment delivery rates were highest in the Crawford, Whitey's Gulch and Red Cap Gulch sub-areas. Sediment delivery was also moderately high in Hopkins Creek and the Cavanaugh Creek sub-area.

About one-third of all slides as well as those active after 1944 occurred in the mainstem Klamath corridor. Sediment delivery from those slides was relatively high, accounting for 37% of both total and post-1944 sediment delivery from about 20% of the Analysis Area. About half of all slides along the mainstem and 56% of the sediment they delivered after 1944 were management-related, and 91% of that sediment delivery was associated with Highway 96 or county roads.

Among the ten sub-watersheds, five of which partly overlap the mainstem corridor, the proportions of management-related slides and sediment delivery varied substantially, as shown in Table 31. "Hot spots" of management-related sediment delivery not associated with Highway 96 appear to have been in the Aikens, Cavanaugh, Hopkins, and Whitey's Creek sub-areas and, to a lesser extent, in the Pearch and Boise sub-watersheds. Management related values > 4% have been arbitrarily selected as suggesting a relatively significant effect.

Landslide data for the ten sub-areas are further summarized in Table 32, which highlights the ratio of all management-related sediment delivery to natural sediment delivery.

Landslide Variation Among Geologic Units

Landslide frequencies and sediment production have also varied considerably among the different geologic units in the Analysis Area. Pre-1944 slides were most abundant in Mesozoic intrusive rocks and Western Hayfork terrane, whereas the largest volumes were associated with Galice metavolcanics (46%), and to a lesser extent with Western Hayfork terrane (21%) and Galice metasediments (19%).

The post-1944 data show a somewhat different pattern (Table 33). Overall, half of the 851 slides active since 1944, and 60% of all sediment delivered after 1944 originated from Galice metasediments or older deep-seated landslides (Qls) within that unit. The next most prolific landslide source terrane was Galice metavolcanics, which accounted for 20% of the total sediment delivery from one-fifth of the landslides. Landslide incidence was also moderately high in Mesozoic intrusive rocks (14% of all slides and 12% of total sediment delivery). Relative to their extent in the Analysis Area, Galice metavolcanics and Mesozoic intrusive rocks have had somewhat higher sediment delivery rates than Galice metasediments, and substantially higher rates than the other geologic units. However, the highest delivery rates are associated with older, deep-seated landslide terrain, particularly that within the Galice units. On average, old landslide terrain delivered 4.5 times more sediment per unit area from mass wasting than other hillslopes during the 54 years of record. One anomaly is the very low rate of recent landslide sediment delivery from landslide deposits within the schist unit where those deposits are especially abundant.

Table 31 Percentage of Mass Wasting Sediment Delivery by Sub-Watershed, Time Interval and Management Influences.

	Highway 96	Roads	Harvest	Natural
Aikens Ck				
pre-1960	0%	30%	0%	7.3%
1960-75	5.6%	17.6%	0%	27.5%
1975-98	5.6%	2.4%	0%	4.1%
Boise Ck				
pre-1960	n/a	0.8%	0%	30.3%
1960-75	n/a	1.6%	2.0%	59%
1975-98	n/a	4.7%	0%	1.6%
Cavanaugh Ck				
pre-1960	7.4%	1.9%	1.5%	19.9%
1960-75	3.1%	12.9%	9.6%	39.1%
1975-98	0.4%	0.1%	1.9%	2.3%
Crawford Ck				
pre-1960	0.4%	0.1%	2.7%	9.1%
1960-75	8.9%	3.6%	27.9%	45.5%
1975-98	0.3%	0%	0%	1.5%
Hopkins Ck				
pre-1960	n/a	0.3%	3.3%	4.0%
1960-75	n/a	14.7%	30.2%	40%
1975-98	n/a	0.5%	5.4%	1.7%
Ikes Ck				
pre-1960	7.8%	2.1%	0%	29.8%
1960-75	14.7%	1.1%	0%	21.8%
1975-98	10%	1.2%	0%	11.4%
Pearch Ck				
pre-1960	n/a	0%	0%	77.3%
1960-75	n/a	4.5%	3.6%	12.9%
1975-98	n/a	0.1%	0.3%	1.4%
Red Cap Gulch				
pre-1960	12.9%	0%	0%	15.2%
1960-75	34.1%	0%	0%	35.4%
1975-98	1.6%	0.1%	0%	0.9%
Slate Ck				
pre-1960	0%	1.4%	0%	42.2%
1960-75	0.1%	2.2%	1.2%	51.9%
1975-98	0%	0%	0%	1.0%
Whitey's Gulch				
pre-1960	n/a	6.9%	2.8%	5.9%
1960-75	n/a	46.2%	21.4%	7.6%
1975-98	n/a	7.6%	0%	1.5%

Note: In Table 31, management-related values >4% are shaded.

Table 32 Percent of Post-1944 Sediment Delivery from Landslides by Sub-Watershed and Management Influence.

Sub-watershed	Highway 96	Other Mgmt	Natural	Mgmt-to-Natural Ratio
Aikens	0.5%	2.1%	1.6%	1.6
Boise	n/a	0.8%	5.9%	0.1
Cavanaugh	1.4%	4.0%	7.3%	0.7
Crawford	1.1%	4.0%	5.7%	0.9
Hopkins	n/a	6.4%	5.4%	1.2
Ikes	4.5%	0.4%	5.9%	0.8
Pearch	n/a	0.8%	2.4%	0.3
Red Cap	5.6%	0.0%	6.2%	0.9
Slate	n/a	1.1%	13.6%	0.1
Whitey	n/a	11.1%	2.1%	5.4
Total	**13%**	**31%**	**56%**	**Average = 0.8**

Note: In Table 32, shaded values are substantially above the average (0.8).

Table 33 Landslide Incidence and Estimated Sediment Delivery Relative to Geologic Units within the Analysis Area, 1944 – 1998.

Geology	Acres	# of Active Slides	Tons Delivered	Tons/acre	Tons/acre/year
Galice meta-sedimentary (Jgs)	20,070	257	1,142,400	57	1.1
Galice metavolcanic (Jgv)	6,361	119	537,100	84	1.6
Hayfork terrane (HFT)	12,321	75	153,000	12	0.2
Rattlesnake Creek terrane (rct)	2,615	6	30,400	12	0.2
Mesozoic intrusive (Mzi)	5,214	90	353,500	68	1.3
schist	1,611	7	42,100	26	0.5
Qls	11,885	297	2,500,300	210	3.9
(within Jgs)	5,765	173	1,698,400	295	5.5
(within Jgv)	1,584	61	425,600	269	5.0
(within HFT)	547	12	75,900	139	2.6
(within rct)	384	5	29,400	77	1.4
(within Mzi)	1,291	32	207,300	161	3.0
(within schist)	2,314	14	63,700	28	0.5

Many of the post-1944 landslides in metavolcanics were associated with Highway 96, and tended to be larger in size. About three-quarters of the sediment delivery in the Highway 96 corridor, along the Klamath mainstem, originated in the metavolcanic unit. The high incidence of landsliding along the mainstem may be due to the interaction of this geologic unit with the large highway cuts and fills.

Soil Resources

- *What soil types exist that are especially sensitive to natural or management disturbance such as wildfire, fuel treatments, or logging, and in what locations are special mitigations warranted?*

Soils are a dynamic resource that supports many physical, biological, and ecological functions in the environment. Soils consist of mineral particles, organic matter, and numerous organisms. Therefore, soils have biological, chemical, and physical properties that can change in response to management disturbances.

Soils in the LMK Analysis Area vary with parent material, topography, biological processes, and age. Eleven major soil families occur in the Analysis Area, as well as other generic, poorly developed soils and areas of rock outcrop (Table 34). These different soils have variable textures and other characteristics that make them more or less sensitive to natural disturbances such as wildfire, and to land management activities such as timber harvesting, road building, and fuel reduction projects.

Table 34 Soils Families and Sensitivity to Management within the Analysis Area.

Soil Family	Approx Percent Of Analysis Area	Overall Sensitivity to Mgmt Disturbance
Aiken, deep	1%	Low to moderate
Clallam, mod. Deep	20%	Moderate to high
Goldridge, deep	5%	Moderate
Holland, deep	16%	Moderate
Horseshoe, deep	1%	Low to moderate
Hugo, mod. Deep	39%	Low to moderate
Ishi Pishi, deep	<1%	Low to moderate
Maymen	1%	Moderate
Nanny, mod. Deep	1%	Moderate
Oragran	2%	High
Weitchpec, mod. Deep	<1%	High
Xerochrepts, haploxeralfs, xerorthents, rock outcrops	14%	Low

Wildfires can negatively impact soils, particularly if the fires are intense and of long duration. With intense wildfires, soils may become hydrophobic (water-repellent), thereby reducing infiltration rates and increasing surface runoff and surface erosion through rilling and gullying. In addition, organic matter in the duff layer and possibly the A-horizon (i.e. the top soil layers) can be consumed in severe wildfires within heavy fuels, thereby reducing long-term soil productivity. The loss of organic soil cover can also lead to increased surface erosion.

Susceptibility to burn damage and surface erosion hazard rating (EHR) are two indicators useful in evaluating risks to soils from both wildfires and fuel reduction projects. These indicators are listed for each soil family in the 1993 SRNF Order 3 Soils Survey (available at the SRNF Supervisors Office 1330 Bayshore Way, Eureka, CA 95501). Susceptibility to burn damage relates to the potential for substantial reduction in soil organic matter that would lower soil productivity. Some soils have textures and sufficient organic matter that will accommodate partial loss of organic matter without reduced productivity better than other soils. These characteristics are used to rate different soils for their susceptibility to damage from burning. Given the level of generalization in the Order 3 Soils Survey, these characteristics should be sampled and verified in the field to guide project implementation or mitigation.

Soil EHR indicates how susceptible the soil surface is to sheet and rill erosion after the soil has been disturbed. Many management activities have the potential to increase erosion substantially above natural erosion rates or soil formation rates. Potential consequences of accelerated erosion include reduced productive capacity of the soil and adverse effects on water quality. Maximum EHR ratings are based on little or no vegetation cover present during the average long-term occurrence of 2-year, 6-hour storm events. When such a rainstorm occurs, accelerated erosion could result in most years on some of these soils, and generate unacceptable resource impacts.

Soil compaction susceptibility characterizes the potential for soils to be damaged by heavy equipment. Soil compaction typically occurs when moist or wet soils are compressed and the pore space between soil particles is reduced. Soil compaction and reduced soil porosity are directly linked. Compaction changes soil structure, reduces the size and continuity of pores, and increases soil bulk density. Soils can become compacted from vehicular use (timber harvest operations and roads), large animals (cattle and horses), and even people. Compaction becomes a problem when porosity is reduced to the point that water infiltration, percolation, and moisture storage within the soil column are insufficient to support natural levels of plant growth and nutrient cycling. The potential of soils to become compacted varies with seasonal moisture levels and is primarily a function of soil texture (i.e. proportions of gravel, sand, silt, clay, and organics in a given soil type). The SRNF Order 3 Soil Survey contains soil texture descriptions that were used to estimate potential risk of soil compaction. Figure 15 shows the average soil compaction hazard within the LMK Analysis Area. The majority of the soils within the Analysis Area display a moderate potential for soil compaction. The greatest potential for soil compaction is found within the Ikes sub-area, which ranges from low to high potential for soil compaction. No other area within the LMK Analysis Area has soils with a high potential for soil compaction.

Table 35 shows the percentage of soils within each sub-watershed having moderate to high susceptibility to burn damage, moderate to high EHRs, and moderate to high potential for soil compaction. Soils susceptible to burn damage are most extensive in the Aikens and Slate Creek sub-areas. EHRs are relatively high in the Aikens, Crawford, Red Cap Gulch, and Slate Creek sub-areas. Risk of soil compaction for all soils within the Analysis Area is mostly moderate with the exception of Pearch Creek, where most soils have a low risk of soil compaction, and the Ikes sub-area, where some soils on the west side of the Klamath River have a higher risk of compaction.

Major concerns about protecting long-term soil productivity arise when high susceptibility to burn damage coincides with high erosion hazards. Figure 16 shows the combined distribution of susceptibility to burn damage and EHRs within the Analysis Area. Slate and Aikens sub-watersheds contain the largest areas with both high susceptibility to burn damage and high EHRs. Some parts of the Ikes sub-area also have this overlapping condition. On the other hand, substantial portions of the Analysis Area do not exhibit soils with a high or even moderate potential for damage to soil productivity.

Table 35 Percentage of Soils Sensitive to Burn Damage, Accelerated Erosion and Compaction by Sub-Watershed.

Sub-watershed	Percent Susceptible to Burn Damage of		Percent EHR of		Percent Compaction Hazard of	
	High	Moderate	High	Moderate	High	Moderate
Aikens Creek	66%	0%	23%	44%	0%	75%
Boise Creek	1%	48%	1%	25%	0%	79%
Cavanaugh*	5%	7%	3%	4%	0%	22%
Crawford	0%	30%	29%	30%	0%	95%
Hopkins Creek*	0%	6%	0%	6%	0%	24%
Ikes	5%	31%	5%	40%	11%	38%
Pearch Creek	0%	10%	0%	1%	0%	10%
Red Cap Gulch	6%	29%	24%	29%	0%	76%
Slate Creek	21%	32%	24%	37%	0%	91%
Whiteys Gulch	0%	46%	0%	35%	0%	64%

*Note: In Table 35 sub-watershed denoted with an * the data is only for Forest Service Lands and not adjoining private or tribal lands

When soils with both relatively high susceptibility to burn damage and EHRs are overlain with areas of high fire risk (i.e. Condition Class, See Vegetation and Fire section above), the extent of soils that could be damaged by uncontrolled wildfire or inadvertently during fuel treatment projects becomes apparent. The areas with high fire risk and soil characteristics that would be vulnerable to high severity fire are shown in Figure 17 and summarized in Table 36. Areas of concern are scattered throughout the Analysis Area, but the greatest risks appear to be concentrated in portions of Boise, Slate, and Aikens creeks as well as along Highway 96 in the Red Cap Gulch sub-area.

Figure 15 Soil Compaction Class.

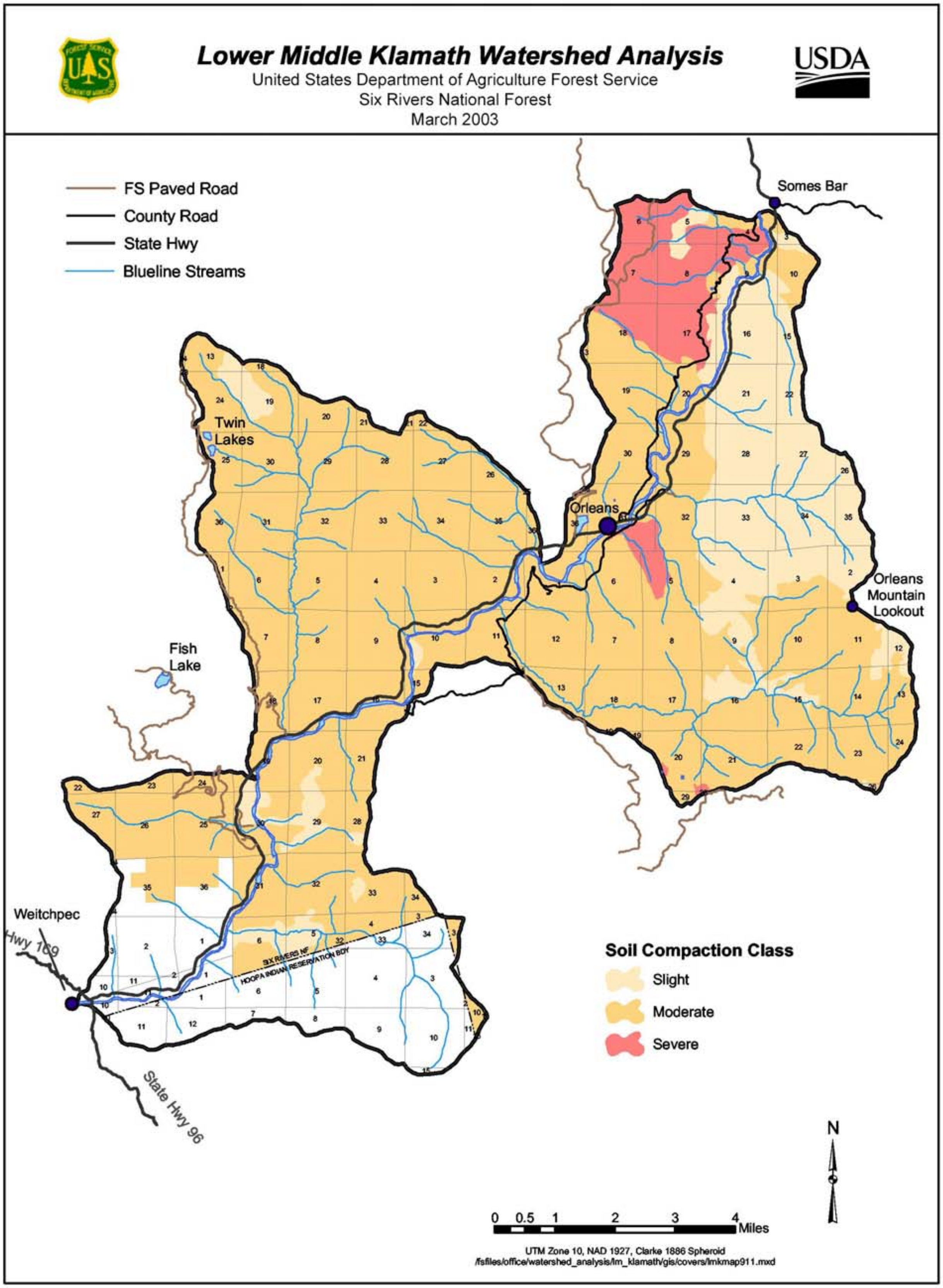

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Figure 16 Soil Burn Damage Potential and EHR.

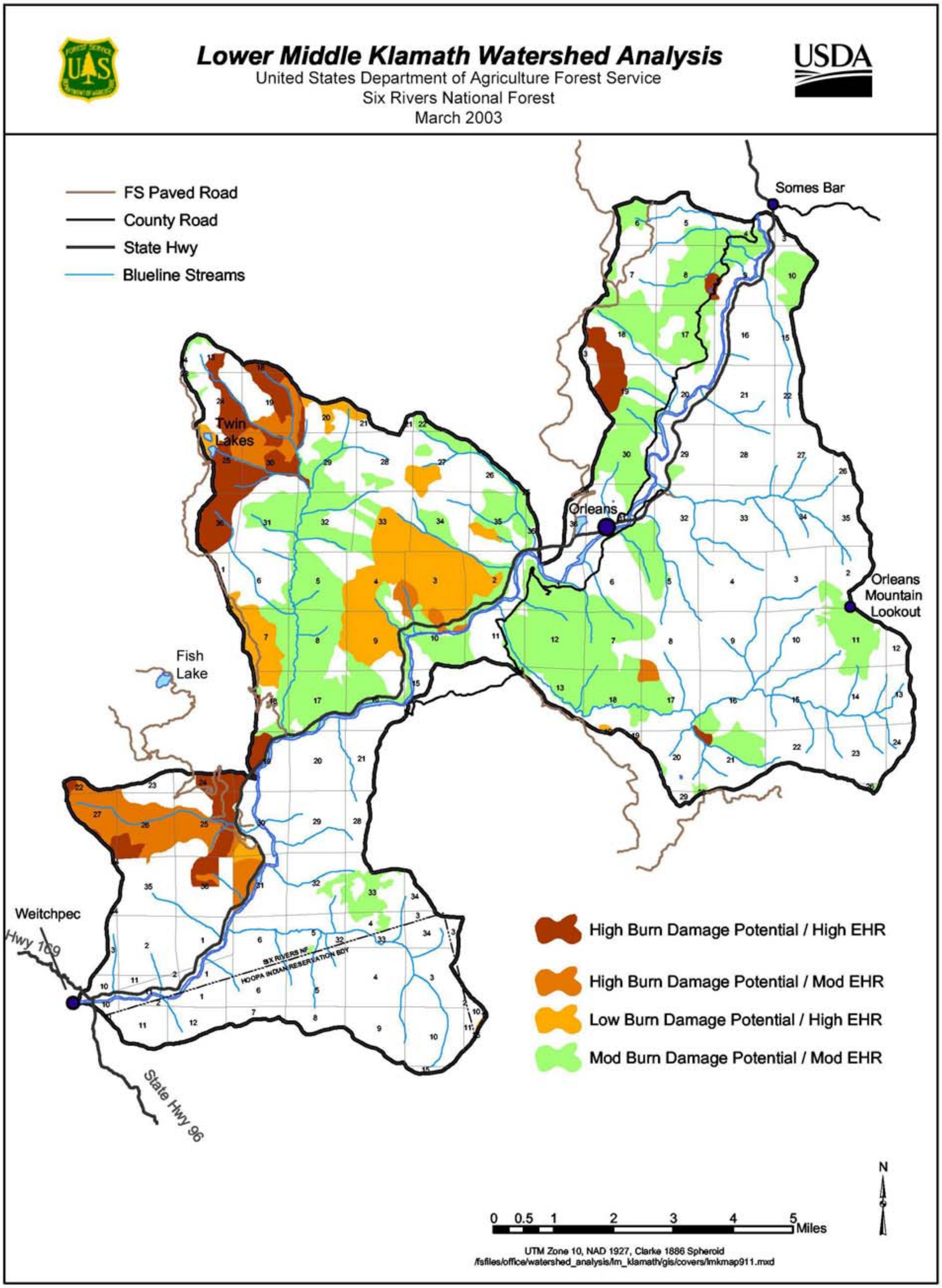

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Figure 17 Combined Soils and Fire Risk.

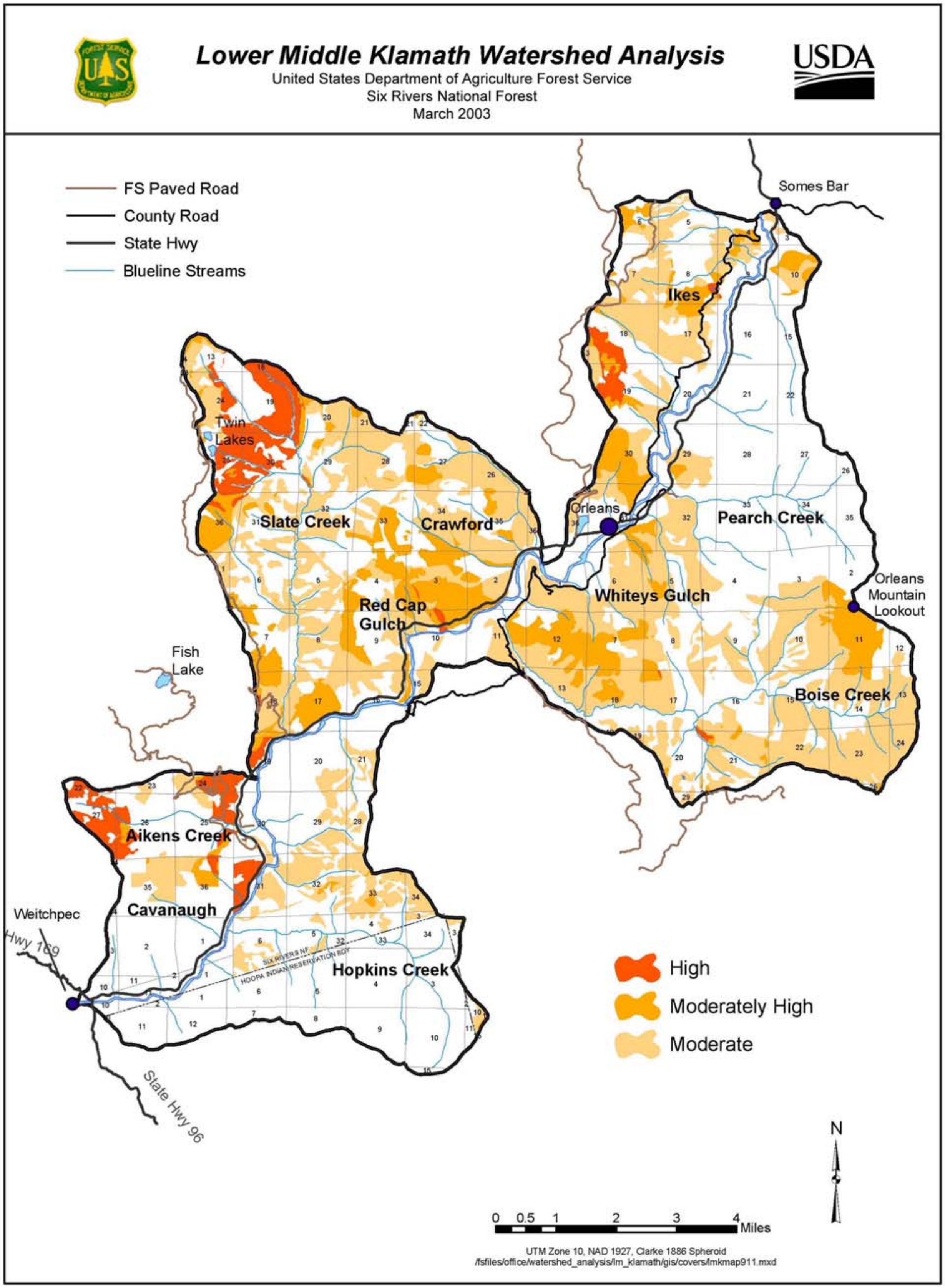

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Table 36 Extent of Combined Fire Risk and Soil Damage Potential by Sub-Watershed.

Sub-watershed	% Soils with High Combined Fire Risk and Soil Damage Potential	% Soils with Moderately High Combined Fire Risk and Soil Damage Potential	% Soils with Moderate Combined Fire Risk and Soil Damage Potential
Aikens Creek	27%	3%	4%
Boise Creek	<1%	27%	21%
Cavanaugh*	3%	4%	3%
Crawford	8%	20%	31%
Hopkins Creek*	-	2%	8%
Ikes	3%	10%	20%
Pearch Creek	-	1%	2%
Red Cap Gulch	4%	21%	13%
Slate Creek	15%	15%	20%
Whiteys Gulch	-	21%	25%

*Note: In Table 36 for sub-watersheds denoted with an * data is only for Forest Service Lands and not adjoining private or tribal lands

Riparian Resources

Riparian Corridors and Stream Channels – Reference

The condition of riparian and aquatic habitats in the LMK Analysis Area has varied through time, primarily as a result of channel changes caused by mass wasting and sedimentation during major floods. Theoretically, in the first few decades after a major flood, there would be numerous fresh landslides adjacent to channels, considerable secondary erosion from landslide scars, widespread accumulation of sediment and debris in most stream channels, and increased exposure of the channel due to loss of riparian cover. This would have caused elevated water temperatures, reduced aquatic habitat quality, and reduced stream productivity for salmonids. During longer and more stable recovery periods, large conifers that provided dense shade and occasional inputs of large woody debris (LWD) to the channel would have dominated riparian areas. A large proportion of the aquatic habitat would have been highly suitable for salmonids, with cool water temperatures and complex instream structure. Erosion and sediment production and transport would have been roughly in balance throughout the whole watershed, providing abundant, clean substrate for spawning and rearing of salmonids.

Little direct information exists regarding prehistoric conditions, processes, and functions under which the riparian and aquatic ecosystems of the LMK Analysis Area evolved. However, useful inferences can be drawn from aerial photographs taken in 1944 since relatively little land management had occurred by 1944, particularly in the tributary channels. The 1944 aerial photos reveal extensive riparian cover, much of which was old-growth conifer. The flood of 1861 reportedly had widespread impacts in the region, but the effects are not noticeable on these older aerial photos and probably were eliminated or concealed in the intervening 83 years.

Inferences about other past riparian and aquatic processes and functions can be drawn from the extent and density of riparian cover in the 1944 photos. Stream temperatures were probably low where there was substantial shading along most tributary streams. It is also reasonable to infer from the few active landslides, relative to the present and other sediment sources visible in 1944, that aggradation and channel widening were fairly minimal in the tributary stream channels. Although extensive sedimentation is not apparent in the 1944 photos, considerable sediment could have been stored in these channels. Total sedimentation in the watershed might have been comparable to current conditions, but it appears that much of the sediment was fairly well stabilized by vegetation and channel structure such as logs and boulders. Therefore, it can be inferred that less sediment was available for transport during high flows compared to the present, which would have resulted in more optimal riparian and aquatic conditions.

Lower-Middle Klamath Mainstem

The processes and functions of riparian and aquatic systems are strongly influenced by the geologic and geomorphic characteristics of the adjacent terrain. The mainstem Klamath River between the Salmon River at Somes Bar and the Trinity River at Weitchpec is characterized by many recently active landslides, as well as ancient features that are dormant or static (not moving). The 1944 aerial photos reveal that many landslides occurred along the old Highway 96 alignment. Many of these landslides, both above and below the highway, directly contributed material to the Klamath River. Naturally occurring, inner gorge landslides that are not related to Highway 96, also occur along the mainstem. Roughly equal numbers of landslides that were attributable to either natural causes or the highway were present in 1944.

Between Somes Bar and Weitchpec, the Klamath River is mostly a transport-dominated channel, although there are extensive areas of recent alluvium and older elevated stream terraces in the middle section. There are extensive sections with steep canyon walls that may provide some topographic channel shading. The riparian canopy probably does not provide much shading of the channel. Similarly, the mainstem has likely had an open riparian canopy for centuries, with extensive floodplains and terraces interspersed with long transport reaches and numerous pools.

Sediment levels in the mainstem have varied in response to disturbance events such as floods and episodes of widespread landsliding. Most of the sediment has, for centuries, probably originated from unstable terrain along the mainstem corridor as well as influx from upstream. Major tributaries have probably tended to be of secondary importance as far as sediment input.

Tributaries of the Lower-Middle Klamath Mainstem

In the 1944 aerial photos, riparian corridors, along main tributary streams within the Analysis Area, exhibit such a dense coniferous riparian canopy that they are only discernible through stereographic relief. In these photos, most tributary channels are not directly visible, although small openings are evident next to scattered inner gorge landslides. It seems there were very few landslides within tributary watersheds, and nearly all were attributable to natural causes. The tributaries appear to have been pristine with little or no land management activity. Ridge-top roads existed in some parts of the Slate and Boise sub-watersheds, but no erosion impacts associated with these roads are evident in photos. The flood of 1861 reportedly had a large impact on many Klamath River tributaries. Effects of the flood on the tributaries flowing in the LMK Analysis Area are not readily evident on the 1944 aerial photos, however, some older, dormant debris slides are visible that may have resulted from 19th century floods. It appears that the 1861 flood did not produce as much landsliding and resultant damage to riparian areas as the 1964 flood, and that most of the impacted areas had fully healed by 1944. Given the extent of the riparian conifer cover visible in 1944 and the time that it takes for the conifers to mature (75 to 120 years), it is reasonable to conclude that these tributaries had not experienced a major disturbance capable of altering sediment routing and LWD recruitment for many decades, or perhaps since the 1861 flood.

Riparian Corridors and Stream Channels – Current

- *How have vegetative conditions of riparian areas changed over the past century, and what were the causes of those changes?*

Current conditions of riparian areas in the Analysis Area have been shaped to a large extent by recent natural events, including the 1964 flood, as well as human disturbance of the landscape through extensive logging and road building. Landsliding and hillslope erosion triggered by floods in the 1960s and 1970s resulted in substantial changes to the Klamath mainstem and all main tributaries. The January 1997 storm had extensive impacts within the easterly part of the Klamath Basin, particularly in the Salmon River watershed. Similar channel impacts were not evident within the LMK Analysis Area, although there was some localized channel adjusting due to inner gorge landsliding.

Lower-Middle Klamath Mainstem

As described above under ***Riparian Corridors and Stream Channels - Reference***, the mainstem Klamath within the Analysis Area does not have extensive shade-producing riparian cover. The predominant riparian vegetation along the mainstem corridor consists of willow and alder. The 1997 storm event uprooted much of the riparian vegetation along the riverbanks, and several reaches experienced significant deposition and erosion of bars and terraces. It is unclear what these adjustments mean in terms of fish habitat since little pre-1997 information exists for the mainstem (McBain and Trush, Associates 1995) that can be compared to post-1997 storm conditions. Sequential aerial photos reveal moderate channel changes within the main river over the past 50 years, including bar formation and migration due to greatly increased rates of inner gorge landsliding.

Tributaries of the Lower-Middle Klamath Mainstem

Examination of sequential aerial photos from 1944 through 1998 reveals extensive riparian corridor and stream channel changes in tributary drainages. In 1960, there were a few inner gorge landslides scattered among the Slate, Boise, Pearch, Hopkins, and Crawford drainages that created riparian canopy openings and downstream sediment aggradation. These channel adjustments appear to have been fairly minor, without significant riparian or aquatic impacts. These landslides, and the resultant canopy openings, were probably a result of the 1955 flood.

The most dramatic change in riparian canopy and stream channel condition is visible in the 1975 aerial photos. Most of the tributary streams appear to have experienced disruption of riparian areas ranging from severe localized impacts to complete removal of riparian canopy along the stream corridor. Slate and Hopkins creeks seem to have experienced the greatest riparian disturbance with extensive inner gorge landsliding and resulting channel widening and aggradation. It appears that channel and riparian disturbance in Slate Creek occurred from its headwaters to the mouth; while most of the channel disturbance in Hopkins Creek was in the upper watershed on HVIR lands where direct logging disturbance of riparian corridors had also occurred. Boise Creek appears to have experienced extensive riparian canopy removal and channel widening, but the effects were concentrated in the lower reaches. Trail Creek, a tributary to the South Fork of Boise Creek appeared to have been "gutted" by a debris flow. Pearch, Crawford, and Ullathorne Creeks were impacted by the storms of 1964, 1972, and 1975, but the impacts did not appear as extensive as in Slate, Hopkins, and Boise Creeks because fewer inner gorge landslides and disrupted riparian areas are seen, and evidence shows that extensive deciduous riparian vegetation had become reestablished by 1975.

The most recent aerial photos show that much of the coniferous riparian canopy disrupted by floods between 1960 and 1975 has been replaced by dense deciduous vegetation. Although the long-term woody debris recruitment potential may have been set back, the shade component has been re-established through encroachment of alders and other riparian vegetation. Channel openings remain along most tributaries (particularly Slate Creek), but overall, riparian canopy conditions have substantially recovered since 1975. A comparison of 1995 and 1998 aerial photos reveals very minor opening of riparian corridors as a result of the 1997 storm in Lower Boise Creek; all other main tributary corridors appear virtually unchanged.

IRRs are areas along streams intended to protect beneficial uses and the processes and functions inherent to riparian areas when management activities are proposed within or adjacent to them. IRRs apply to unstable areas, perennial streams, and intermittent/ephemeral streams with evidence of annual scour. Figure 18 shows the IRRs for the LMK Analysis Area. The present condition of the IRRs varies among tributary watersheds of the LMK Analysis Area as described above. Landslides associated with past storm events and management activities have left a legacy of impacts that are still visible in the 1998 aerial photos. In addition to active landslides associated with storm events, past timber harvesting and wildfires have also had an impact on seral stages within IRRs. The extent of active landslides, past harvest activities, and vegetative seral stage within IRRs for the ten sub-watersheds is shown in Table 37.

- *Given the historic and recent impacts of natural and human-caused disturbances, what is the potential, and what are the principal mechanisms for large woody debris recruitment within riparian areas?*

- *What effects have natural and human-caused disturbances, including fire, had on riparian areas throughout the Analysis Area during the past century?*

Conditions within Riparian Reserves, as shown in Table 37, agree with observations made from aerial photo trend analysis. Many of the riparian areas have been disturbed historically through natural storm events, landslides, wildfires, and timber harvest activities. Except for the Crawford sub-area, and to a lesser extent the Ikes, Hopkins, and Whitey's Gulch sub-watersheds, vegetative composition of Riparian Reserves has not been altered substantially as a result of past timber harvest (Figure 19). IRRs in most sub-areas have 30% or more late-mature or old-growth vegetation, with up to about 50% in Aikens and Slate Creek. Ikes and Whitey's Gulch have the least old-growth vegetation.

Figure 18 IRRs Including Wetlands, Unstable, and Potentially Unstable Lands.

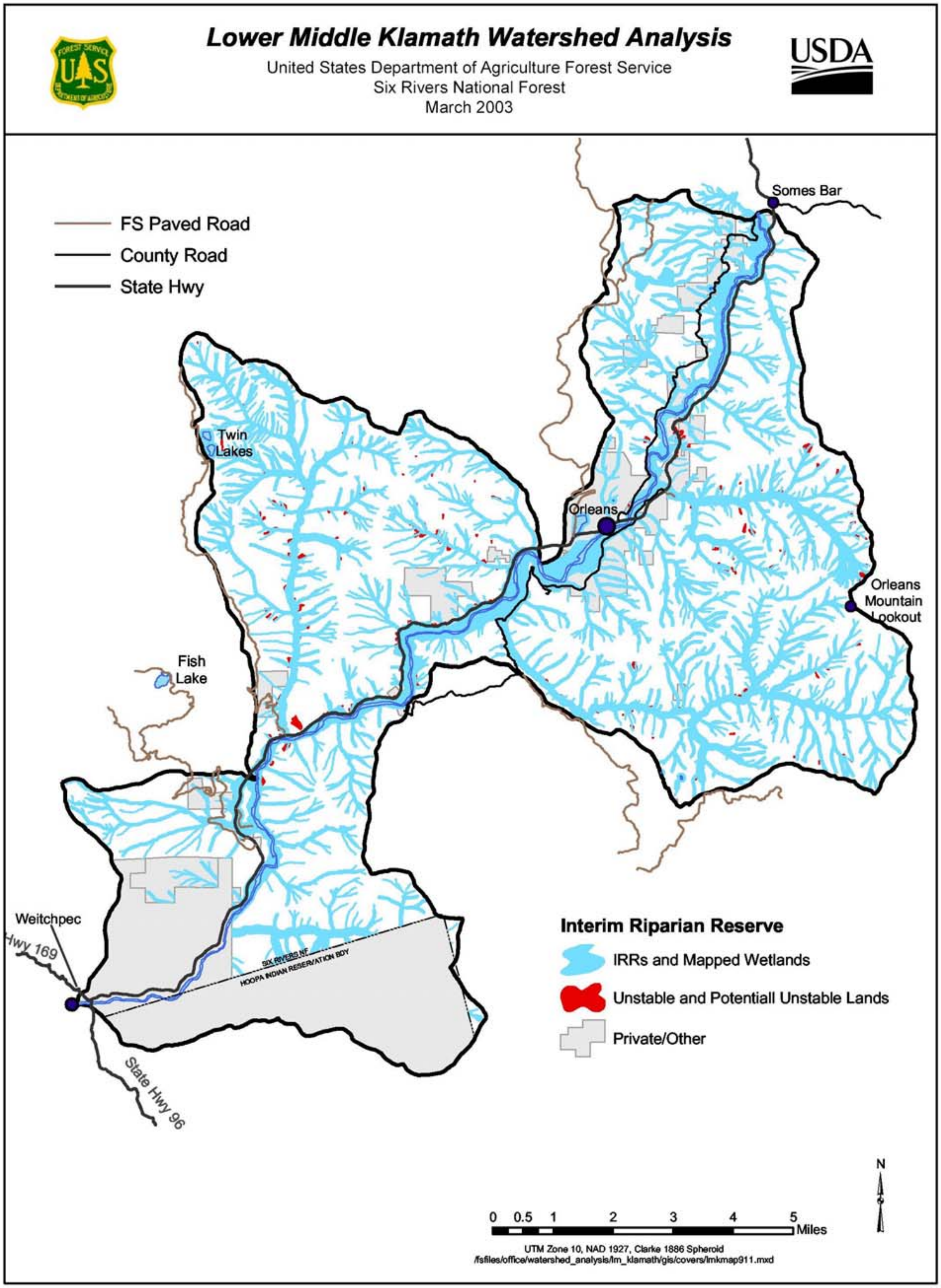

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Figure 19 IRR Large Wood Recruitment Potential.

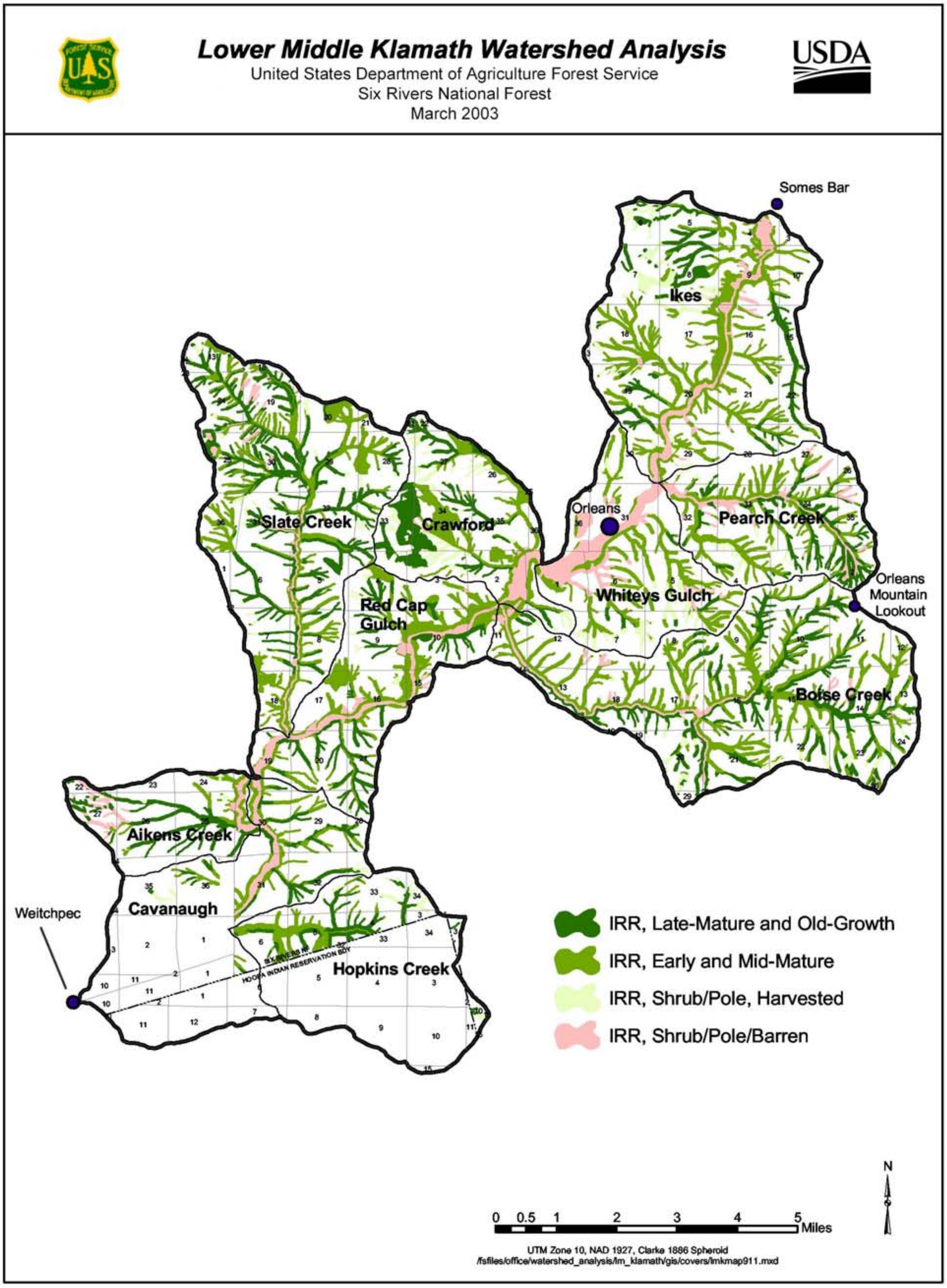

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Table 37 Current Conditions Within Interim Riparian Reserves.

Sub-watershed	IRR Acres	% Active Landslides within IRRs	% IRRs Substantially Harvested	% IRRs in Late-mature or Old-growth	% IRRs in Early or Mid-Mature	% IRRs Natural Shrub / Pole / Barren	% IRRs with High or Very High Fire Risk
Aikens Creek	663	not mapped	3%	52%	22%	24%	37%
Boise Creek	3251	85%	4%	35%	54%	7%	30%
Cavanaugh	768	not mapped	4%	32%	45%	19%	29%
Crawford	1098	70%	21%	30%	35%	14%	31%
Hopkins Creek	581	not mapped	11%	43%	45%	<1%	21%
Ikes	2951	not mapped	10%	20%	58%	13%	32%
Pearch Creek	1469	60%	4%	32%	49%	15%	36%
Red Cap Gulch	1652	not mapped	2%	28%	49%	21%	20%
Slate Creek	2688	75%	4%	48%	42%	6%	28%
Whiteys Gulch	1528	not mapped	11%	3%	47%	38%	27%

Late-mature or old-growth seral stages are the likely current sources of large wood recruitment for these streams due to decadence or windthrow. The principal mechanism for woody debris recruitment in stream channels is trees falling into riparian areas through natural mortality, landslide movement, wildfire, or windthrow. In steep tributary channels, which are characteristic of most stream channels within the Analysis Area, woody debris recruitment is an important function providing in-channel structure, sediment routing, and wildlife habitat. In the uppermost reaches of tributaries where stream power is limited and wood cannot be readily transported by the stream, woody debris serves mostly as a nutrient source and wildlife habitat.

All of the sub-areas except Aikens also have a substantial component of early to mid-mature vegetation. These seral stages may not provide much large wood currently except as shallow landslides occur, but are likely to be primary sources for recruitment several decades in the future. Aerial photos from 1998 show that many of these riparian areas currently have a large component of deciduous riparian vegetation (probably alders) compared to the 1944 photos in which most riparian areas were dominated by old-growth conifer cover. These observations suggest that the intermediate-term recruitment potential for LWD has been reduced from recent historic levels. This reduction may be detrimental to riparian functions such as channel structure, sediment routing, and habitat cover. It is possible that sub-areas with relatively low percentages of late-mature and old-growth vegetation in riparian areas (e.g. Ikes and Whitey’s Gulch) currently, have potentially had longstanding deficits in LWD recruitment.

Slate, Hopkins, and Boise creeks are the largest sub-watersheds within the Analysis Area, and significant sections of their main channels, on NFS lands, have late-mature and old-growth riparian characteristics (Figure 19). However, aerial photos show that the upper parts of

Hopkins Creek generally have very little mature vegetation left in harvested riparian areas. Despite the noted increases in deciduous vegetation after the 1964 and other floods in these sub-watersheds, the Riparian Reserves along their main channels have not been significantly impacted in terms of potential for long-term LWD recruitment. The role of LWD is more critical in larger, complex stream channels like Slate, Hopkins, and Boise creeks because it may provide more channel control and habitat diversity for aquatic species than in smaller streams. The potential for LWD recruitment may have been altered in Ullathorne Creek and in some of the smaller tributaries within the Ikes and Whitey's Gulch sub-areas where past timber harvesting has occurred to a greater degree than in other areas.

It is important to note that despite the massive disturbance of the 1964 and later floods to riparian areas, large flood events are a natural process. The 1964 flood generated many landslides and delivered much sediment and woody debris to stream channels. Even though many of the riparian areas now have a smaller conifer vegetation component than before 1964 and may have a lower LWD recruitment potential in some areas, LWD delivered during the 1964 flood still remains an important part of current channel function. Fluctuation of LWD growth and delivery is a natural process, and riparian conditions within the LMK Analysis Area appear to be within their natural range of variability relative to LWD.

Historically, wildfires have occurred throughout the LMK Analysis Area. Some of the tributaries have experienced large wildfires during the 20th century, notably Slate, Boise, and Pearch creeks. It is difficult to determine what this past legacy of wildfires means in terms of current potential for wildfire within riparian areas. The extent of high to very high fire risk (i.e. Condition Class) within riparian areas (Table 37) varies between 20 and 37% across the landscape. Given the fact that many of these stands have already had a reduction in late-mature and old-growth riparian vegetation from past floods, a high risk of stand-replacing fire in a substantial fraction of the Riparian Reserves could pose a significant concern for beneficial uses and riparian dependent species. Figure 11 illustrates areas of high or very high fire risks. It is apparent that the largest contiguous area of high wildfire risk within Riparian Reserves is located in the headwaters of Slate Creek and, to a lesser extent, in the headwaters of Boise and Pearch creeks. Both intermittent and small perennial streams are potentially at risk and cover roughly one-fifth of the Slate Creek watershed. Most of the Riparian Reserves at risk for wildfire are lower-order intermittent and perennial streams located in the upper one-third of the hillslopes. There are also specific areas of high risk along the mainstem Klamath River and adjoining Highway 96. With the exception of specific areas in Pearch and Ullathorne creeks, there are no large contiguous sections of the main perennial stream channels at high risk for wildfire within the Analysis Area.

Riparian Species Of Concern

- *What riparian dependent species of concern (e.g. amphibians, migratory birds, mammals, etc.) exist in the Analysis Area?*

- *What specialized habitats exist for species of concern (e.g. amphibians, Survey and Manage species, etc.), and have they been located?*

Riparian-Dependent Plant Species

This section will address a sample of species associated with mature riparian environments that are also considered to be uncommon to rare in their extent. Since plant surveys of riparian areas within the Analysis Area are lacking, only species that have the potential to occur in this area will be discussed.

In general the plant species mentioned below are those associated with relatively stable riparian settings with mature, conifer overstories. Mature, intact riparian vegetation provides the humidity, shade, and substrate/forest longevity necessary for species persistence. Rarity of species can be due to micro-site specificity, dispersal limitations, and the necessity to develop interspecific relations. Longevity of conditions at a site is an asset for species that lack long-range dispersal mechanisms and require affiliation with other organisms (e.g. mycorrhizal) for growth and persistence. Suitable habitat would not likely be associated with dynamic stream reaches, areas chronically in the shrub/pole or early seral conditions, or sites with substantial previous harvest. As described in Chapter 3 Aquatics, riparian conditions vary by tributary watersheds. The largest percentage of the riparian reserve system within late-mature/old-growth condition is in Aikens and Slate creeks and includes their main channels and tributaries.

Bensoniella (*Bensoniella oregana*), a member of the Saxifrage family, occurs primarily in association with wetlands and meadows, and to a lesser degree with riparian areas. Both habitats are typically in the true fir zone, a limited vegetation type in this Analysis Area. Ecological conditions important to this species include partial shade and moist soils. Structural elements that may be important to the species are the presence of LWD, perhaps a moisture-retentive micro-site. Dispersal agents (e.g. herbivory) are not well known for bensoniella. Besides dispersal of seed immediately under the plant, abiotic factors such as water and wind appear to be the primary mechanisms of dispersal (Hoover and Holmes 1998). Other rare Saxifrages associated with riparian areas are *Mitella caulescens* and *Saxifraga nuttallii*.

Species richness and biomass of bryophytes and lichens can be particularly high in mature riparian areas. Bryophytes and lichens lack roots, drawing most of their water and nutrients from the atmosphere. Maintenance of humidity levels associated with riparian areas is critical to many species. Shifts in atmospheric humidity, light, and air quality will influence the composition, abundance, and persistence of species. The potential diversity of substrates and structure including conifer trees, sub-canopy hardwoods, streamside deciduous hardwoods, boulders, and logs associated with late-mature and old-growth riparian forests contribute to species richness as well (Neitlich and McCune 1997).

Reproduction of these organisms is primarily asexual, reproducing vegetatively by fragmentation, whereby fragments of the plant (thallus) break off from the parent plant and are dispersed by wind or gravity. Dispersal limitation is one factor contributing to the rarity of the lichen (*Usnea longissima)* (Keon 2001). Given the relatively slow growth of some species and reproduction primarily through fragmentation, continuity of microclimate characteristics and suitable substrate are important habitat elements.

Mature riparian forests with conifer overstories, hardwood components, and structural elements associated with older forests (e.g. presence of large logs, multi-canopy) provide suitable substrate and conditions for a diversity of lichens and bryophytes. Presence of mature riparian forests along the mainstem and tributaries of Aikens and Boise creeks and tributaries of Slate Creek, coupled with the maritime influence brought in by the Klamath River, provide potential habitat for several rare non-vascular species: (1) *Tetraphis geniculata,* a bryophyte that grows on advance-decay class logs in moist stable sites, (2) *Schistostega pennata,* which is considered a gap phase species, and occurs in areas of high-humidity on the root ball of overturned trees, (3) *Rachomitrium pacificum*, which occurs on rocks in riparian or riverine settings, and *(4) Usnea longissima*, a lichen that is epiphytic on late-mature and old-growth conifer species.

Riparian-Dependent Wildlife

Of the wildlife species of concern within the Analysis Area (endangered, threatened, Sensitive, or SM), there are several that depend on riparian areas for some stage of their life cycle. These species are listed below, and a further description of how they occur within the LMK Analysis Area can be found in the following Terrestrial Wildlife section of this chapter.

Bald eagle (Threatened)
Bald Eagles generally nest where they can overlook a large body of water, and generally do most of their foraging in proximity to water. They depend on the Klamath River, but not directly on the tributaries within the Analysis Area. However, factors throughout the Analysis Area that affect the availability of fish and waterfowl may also affect bald eagles.

Willow flycatcher (Forest Service Sensitive)
This species is detected during the fall, are believed to be post-breeding dispersants from upstream of the Analysis Area. They forage along the margins of the Klamath River corridor to build up the fat reserves (i.e. bulking) necessary for their migration to the tropics. They prefer wet meadows or relatively stable willow/alder dominated riparian zones near slow moving waters for nesting. However, no nests or nesting activity have been found within the rather sub-optimal habitats that exist in the LMK Analysis Area.

Northwestern pond turtle (Forest Service Sensitive)
These turtles live and forage in ponds and slow moving reaches or side-channels of the Klamath River. They are also known to occupy MaGain's pond and Twin Lakes. Nesting, hibernation, and migration occur on land, generally within 0.6 miles (1 km) of water.

Southern torrent salamander (Forest Service Sensitive)
These salamanders find ideal habitat in proximity to cold, clear streams, seepages, or waterfalls. They are likely to occupy the headwater and high gradient areas of the tributaries flowing into the Lower-Middle Klamath River.

Foothill yellow-legged frog (Forest Service Sensitive)
The species utilize the margins and near-shores of relatively low gradient waters within the LMK Analysis Area. Their egg and larval stages are entirely aquatic. Adults often bask on exposed rock surfaces near streams.

- *How have the abundance and distribution of riparian species of concern and their habitats changed as a result of natural and human caused disturbances?*

- *How well do riparian areas function as wildlife travel corridors within the Analysis Area?*

Riparian habitats within the LMK Analysis Area are dynamic by nature, reflecting the substantial seasonal variations in moisture. Riparian associated wildlife species are generally adapted to these types of disturbances, at least at the population level. Comparisons of current and baseline data on the abundance and distribution of populations of riparian associated wildlife species of concern is generally lacking, making the understanding of how populations have changed over time elusive. Bald eagles were known to nest in the LMK Analysis Area into the 1940s, but then suffered severe population declines here and throughout their range in the lower 48 states primarily as a result of eggshell thinning caused by metabolites of the pesticide Dichloro-Diphenyl-Trichloroethane (DDT) bio-accumulating in breeding eagles. Banning the use of DDT, and, perhaps, the prey availability of spawning shad to augment recovering salmonid populations, have allowed the re-colonization of nesting bald eagles within the Klamath River Basin.

As stated previously, landsliding and hillslope erosion triggered by the 1964 flood resulted in substantial changes to the vegetation in the Klamath mainstem and all main tributaries. It is likely that changes, such as the filling of side-channel pools with sediments, and loss of surrounding mature willow stands, have negatively affected the abundance and distribution of willow flycatchers, (which may have nested in the Analysis Area at one time), northwestern pond turtles, and foothill yellow-legged frogs. Negative effects to southern torrent salamander populations as a result of natural and human caused disturbances such as high intensity fire, logging, road building, and erosion in proximity to headwater areas, may have occurred if they caused elevated water temperatures, decreases in dissolved oxygen (DO), or increases in siltation.

Changes in wildlife species habitats generally reflect the changes in vegetative conditions already discussed above, and they have been greatest in Slate, Hopkins, and Boise creeks. These changes, mostly in the form of landsliding and the flood-related scouring of riparian vegetation, probably had the greatest negative impact on foothill yellow-legged frogs and, where changes occurred in headwater areas, also on southern torrent salamanders.

Wildlife Travel Corridors

The function of riparian areas as wildlife travel corridors within the LMK Analysis Area is not well understood, but probably varies with the physical size and habits of the various species. Fishers have been found to use riparian areas disproportionately for travel and escape (Buck et al. 1983). Larger species with larger home ranges travel more and seek out less steep travel-ways. Riparian areas as wildlife travel corridors probably have greater utility in arid and semi-arid areas, where vegetative cover is more or less restricted to the riparian areas, or in areas heavily developed for agriculture.

Within the LMK Analysis Area, with the exception of the mainstem Klamath and some of the lower tributaries such as Lower Slate and Boise creeks, riparian areas tend to be extremely brushy with steep inner gorges and gradients. In these areas, ridges generally provide greater ease of travel for wildlife, with wildlife trails intersecting, rather than following, riparian areas. Where stream gradients are less steep, or along river bars or benches, game trails are evident, suggesting that these areas are used as wildlife travel corridors.

Water Quality

Water quality parameters important to the LMK Analysis Area include temperature, sediment, DO, and nutrient loading from agricultural runoff. Sediment delivery is discussed above under the Erosion Processes section of this chapter.

Water Quality – Reference

Lower-Middle Klamath Mainstem

Very little information exists with respect to historical water quality conditions within the lower mainstem Klamath River. Presumably, sedimentation rates within the lower mainstem were always high given the extent of inner gorge landslides visible on the 1944 aerial photos. In the absence of dams, winter storm flows may have been higher than at present, which may have resulted in the river having a greater capacity to transport sediment through the system and possibly create instream channel structure and morphology more suitable for spawning and rearing habitat for salmonids, however, there are no historic geomorphic data to validate or refute this proposition. Summer water temperatures within the Klamath mainstem may have always been on the high end of the tolerance range for some salmonid species. In reaches where water velocity was low and water depth minimal, lowered DO levels may have occurred. High nutrient loads of ortho-phosphorus would not have been a concern historically since these are bi-products of modern land management activities.

Tributaries of the Lower-Middle Klamath Mainstem

Given the nearly pristine appearance of tributary watersheds in the 1944 aerial photos, ambient conditions in riparian areas are believed to have had cool, moist air and filtered light, which would have provided good habitat for riparian species. Likewise, summer stream temperatures were probably at the low end of their historic range, presumably below 65 ^{o}F, which would have provided good conditions for aquatic species. Based on the relatively small number and size of active landslides visible along tributaries in the 1944 aerial photos and the general absence of downstream channel widening commonly associated with excessive sediment loads, it is likely that sediment was moving through tributary stream channels in a manner that was not adverse to aquatic communities in the long term. In addition, the abundant conifers visible in the riparian canopy suggest that there was sufficient LWD available for recruitment and incorporation into the channel. Sediment routing through the tributaries was probably efficient because of the steep channel gradients.

Water Quality – Current

- *How do water quality parameters and erosion processes within the Analysis Area compare to the entire Klamath Basin?*

- *What water quality parameters in the Analysis Area may be detrimental to native aquatic organisms?*

Water quality of the Klamath River is listed as impaired throughout its length by both Oregon and California under Section 303(d) of the Federal Clean Water Act. The Klamath River in Oregon is considered impaired as a result of temperature, DO, nuisance phytoplankton growth, and pH. The Klamath River in California is considered impaired due to temperature, excessive nutrients, and DO. The basis for listing the Klamath River as impaired was aquatic habitat degradation due to excessively warm water temperatures and algae blooms associated with high nutrient loads, water impoundments, and agricultural diversions.

Current conditions in the Klamath River have resulted from the accumulation of more than a century of various impacts. Agriculture, mining, timber harvesting, hydropower development, and water resources development have had a profound impact on water quality and habitat conditions, resulting in dramatic declines in anadromous fish populations relative to their historic levels. Excessively warm water temperatures and enriched nutrient conditions are the primary cause of water quality problems in the Klamath River. The water quality interactions between the Klamath River and its tributaries within the LMK Analysis Area, and the influences of water quality on anadromous fish stocks are discussed later in this chapter.

Temperature in the Klamath Mainstem

The Klamath River has probably always been a relatively warm river, although there are no historical data to confirm this. The Klamath River is situated in a region of relatively high water temperatures, with up to 10 days each year reaching temperatures of 80^{o} F in the Lower Basin. Stream temperatures reflect both the seasonal change in net radiation and daily changes in air temperature. Substantially elevated temperatures are frequent and prolonged in the Klamath mainstem.

Increased water temperatures are known to increase biological activity. A rule of thumb is that a 50^{o} F increase in water temperature will double the metabolic rate of cold-blooded organisms. Salmonid egg and alevin development, and subsequent timing of emergence from gravel, have been shown to be closely associated with stream temperatures. A rise in summer water temperature may also increase the growth rate and productivity of some aquatic organisms.

According to the 1995 NBS study, short records and missing data preclude a thorough analysis of water temperature trends. However, since the construction of the Iron Gate Dam, data indicate a small, basin-wide warming trend of about 0.045^{o} F per year, but were not able to show whether the frequency of high temperature events has increased. The NBS study further concluded that upstream impoundments have altered the annual thermal regime by reducing mean July temperatures by 3.6^{o} F. The net result is that hatching and emergence of salmonids can occur approximately one week earlier than in a more “natural” thermal regime.

The EPA has established general national criteria for coldwater fisheries, which specify that weekly average seasonal temperatures should (1) meet site-specific requirements for successful migration, spawning, egg incubation, fry rearing, and other reproductive functions of important species, (2) preserve normal species diversity or prevent appearance of nuisance organisms, and (3) not exceed a value more that one-third higher than the optimum or lethal temperature, whichever is lower, for sensitive species (EPA 1986).

The optimal temperature range for most salmonid species is approximately $53.6\text{-}57.2^{o}$ F. Lethal levels will vary according to factors such as the acclimation temperature and the duration of the temperature increase, but they generally range from $68\text{-}77^{o}$ F. Using a weekly mean temperature of 59^{o} F as a threshold for chronic salmonid stress and a daily mean temperature of 68^{o} F as an acute threshold, the 1966-1981 Klamath River temperatures at Orleans exceeded the acute and chronic thresholds a substantial portion of the time (Bartholow 1995). The highest temperatures were recorded from July through September as shown in Table 38.

The Klamath River has experienced increasing problems with high water temperatures, which have been spotlighted by recent “fish kills”. The California Department of Fish and Game (CDFG) documented a large fish kill that began in mid-to-late June 2000 and continued into late

July, and affected more than 60 miles of river between Coon Creek and Pecwan Creek. Direct mortality was likely caused by a combination of at least two pathogens endemic to the Klamath Basin*: Ceratomyxa Shasta* (ceratomyxosis) *and Flavobacterium* (columnaris). Estimates of the magnitude of the kill ranged between “tens of thousands to around three thousand” juvenile chinook salmon and steelhead. High water temperatures in the mainstem Klamath River and several tributaries may have exacerbated the problem.

Table 38 Average Daily Maximum Water Temperature of the Klamath River at Orleans by Month from 1966 to 1981.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
oC	6.8	7.7	9.0	11.5	14.4	18.6	22.4	22.2	20.1	16.2	11.4	7.5	14.0
oF	44.2	45.9	48.2	52.7	57.9	65.5	72.3	72.0	68.2	61.2	52.5	45.5	57.2

During late September of 2002, a minimum of 33,000 adult salmon, steelhead trout, and other fish species were killed in the Lower Klamath River. This kill was considered highly significant because approximately 25% of the projected 2002 total in-river run of Klamath/Trinity fall chinook salmon were killed prior to spawning. Of the salmonids lost in the lower half (mouth of the Klamath to Blue Creek) of the fish kill area, CDFG estimated that 95.2% were fall chinook salmon, 0.5% were coho salmon, and 4.3% were steelhead trout. These estimates were similar to those developed by the USFWS for the entire kill area (mouth of the Klamath to Coon Creek Falls). The CDFG estimated that 68% of the chinook salmon killed were naturally spawned fish and 53% of the steelhead killed were naturally spawned fish.

The pathological cause of death for fall chinook salmon, coho salmon, and steelhead during September 2002 was disease from ciliated protozoan *Ichthyopthirius multifilis* (ICH) and the bacterial pathogen *Flavobacter columnare* (columnaris). Both pathogens occur naturally in the Klamath River and other aquatic systems worldwide. CDFG concluded that low flows restricted fish passage, increased fish density, and, thereby, caused the 2002 fish kill on the Lower Klamath (CDFG 2003).

Altered thermal regimes are a growing problem in rivers throughout the Pacific Northwest including the Klamath River. It is important to note that considerable stress may be occurring to fish even if direct mortality is not observed. Low stream flows compound high water temperature problems, because a smaller volume of water is more easily heated and cooled, causing larger diurnal changes in the water temperature of the Klamath River (Trihey and Associates 1996). Quantification of sub-lethal thermal effects is sketchy. Combined with poor water quality, potential lack of thermal refugia at tributary mouths, and other factors such as disease, elevated stream temperatures can take their toll on aquatic organisms.

With the onset of continuous temperature sensor technology, the SRNF Orleans Ranger District began a stream temperature-monitoring program in 1996. Twenty-three monitoring sites are currently in operation from May through October between the confluence of the Salmon and Trinity rivers. Eleven sites are along the Klamath River mainstem between river mile (RM) 66.25 and RM 43.05. The other twelve sites are located in various tributaries to the Lower-Middle Klamath River.

Results from USFS data and other studies along the Klamath River have shown that once water temperatures become warm they typically remain that way, except for stream reaches gaining significant groundwater inflow. Based on USFS data since 1997, stream temperatures directly below the Salmon River, at RM 65.25 of the Klamath River, typically decreased as a result of the influence of the Salmon River. For example, stream temperature data at this site was 2.0 to 4.0°F lower than the Klamath River, at RM 66.25 from June 30 through October 23, 2001. The additive nature of cold water from the Salmon River and other tributaries within the Lower-Middle Klamath River can play an important role in reducing thermal stress and mortality of fish, especially between July and September.

Temperature in Tributaries of the Klamath Mainstem

Cool water flowing into the Klamath mainstem from tributary streams is vitally important to dependent aquatic populations. These tributaries provide beneficial effects to mainstem Klamath River water quality and habitat condition, as well as thermal refugia for anadromous salmonids. The connectivity of high quality Middle Klamath River tributaries provides critical habitat to many aquatic species at risk.

Based on aerial photo interpretation, it is possible that water temperatures have been slightly elevated in tributaries within the LMK analysis are due to the effects of the 1964 flood when much riparian vegetation cover was lost. Since 1964 most of the riparian cover has regrown with deciduous vegetation and conifers. Summer water temperatures within the tributaries of the Analysis Area are good, and rarely exceed 70^{o} F, even in the hottest summer months.

During the critically dry water year of 2002, the maximum stream temperatures for these tributaries were between 61°F and 71°F. Diurnal fluctuations ranged between 2°F and 6°F. Other years of stream temperature monitoring since 1996 show similar patterns during the same sampling period. Little is known about the influence of these tributaries on the mainstem. Cool water from smaller tributaries may be as critical as larger tributaries in maintaining water quality in the Klamath and providing thermal refugia for fish.

Other Water Quality Parameters in the Klamath Mainstem

The Department of Water Resources (DWR) has monitored the Klamath River at selected stations for more than 20 years. Water quality data was summarized in a 1987 Klamath River study between Hamburg and Orleans (DWR 1987) and are briefly described below. The waters of the Klamath River and its tributaries were found to be strongly bicarbonate in character and generally containing low concentrations of chlorides and sulfates. The acidity and alkalinity (pH) of the Klamath usually ranges from a neutral value of 7.0 to 9.0, with the higher alkaline values occurring in the summer during periods of high biological productivity. Nutrient concentrations found in the Klamath River are generally higher than those found in most other northern California waters. Periphyton growths in the upper reaches of the Klamath River are usually carried downstream and cause additional impacts to the river. During the summer months, the Klamath River usually appears turbid, however, this condition is probably the result of organic coloring rather than suspended sediment. Dissolved oxygen levels in the Klamath River are quite variable. Based on monthly daytime measurements taken over 20 years, annual patterns in the Klamath River are typical of other northern California rivers that have high oxygen levels in the winter months, due to higher solubility of oxygen in cold water, and lower concentrations during the months of June through August, when the water is warmer and biological processes affect the system.

Campbell (1995) analyzed water quality data for 22 sites in the Klamath Basin, applying the 1986 EPA criteria. A number of EPA water quality parameters were classified as impaired or unimpaired for these USGS locations on the Klamath River. The most common water quality criteria found to be at detrimental levels were: (1) DO concentration – (11 of 22 sites), (2) pH - (Upper Basin, 5 of 22 sites), (3) ammonia - (Upper Basin, 5 of 22 sites), and (4) ortho-phosphorus - (Upper Basin, 4 of 22 sites). However, temperature was the most common water quality criterion that was exceeded (at all 22 site locations).

The fact that the Klamath River is listed for temperature, nutrients, and DO is especially important due to the relationship between these three water quality parameters. As described by Campbell (1995), increased water temperatures and lower saturated oxygen concentrations typically occur in the Klamath River during summer months, which is the same time of the year that the growth and respiration cycles of aquatic plants affect DO concentration. These three parameters interact synergistically, and can have a much greater impact on water quality and fish than either temperature or DO alone (Campbell 1995).

In 2001, a number of water quality monitoring programs began within the Klamath River as a result of PacifiCorp's relicensing process. Currently, the Arcata Office of the USFWS, the Karuk and Yurok tribes, and other partners are characterizing water quality conditions in the Lower-Middle Klamath River by collecting grab samples, using continuous water quality probes, sampling algae, and accomplishing other synoptic water quality surveys. Results from these studies were unavailable to include in this analysis.

Other Water Quality Parameters of Tributaries

The water quality of tributary streams within the Analysis Area is excellent. There are no known land management activities that would impact the water quality of the tributary streams other than sediment. Dissolved oxygen, pH, and nutrients (e.g. ortho-phosphorus and ammonia) are not concerns or threats to native aquatic organisms in these tributary streams. Since these tributaries are essentially in their wildland condition, DO, pH, and nutrients are all within their natural range of variability. The water quality within the tributaries has not experienced pressures from agriculture that could result in changes in water quantity, pH, nutrients and DO.

Klamath Basin Watershed Condition Ranking

Comparing the LMK Analysis Area to that of the larger Klamath Basin in terms of both natural and land management disturbances and its impact on both water quality and beneficial uses is important for several reasons. The Klamath Basin is a large complex aquatic ecosystem that has experienced extensive alterations in hydrology, water quantity and quality, and fish habitat condition, which have resulted in declining anadromous fish stocks. In order to understand the limiting factors that are responsible for the declining fish stocks, it is important to have an overview of the range of conditions and key indicators throughout the Basin. This knowledge will facilitate opportunities for restoration of key areas that promise the greatest likelihood of success and point out other areas that are lower priorities due to degraded condition and land ownership constraints.

A Klamath River Basin Assessment was completed that characterized the sub-watersheds within this basin by defined aquatic condition indices. This approach used physical and biological parameters that traditionally act as good indicators of aquatic habitat condition. Ratings were determined by available data and judgments of resource professionals with an index qualification. The physical and biological parameters used are listed below.

- **Fish Community Integrity** is an index designed to identify geographic areas of greatest ecological integrity relative to native fish species within the Klamath River Basin. These areas have the highest potential to provide for the maintenance and recovery of native fish populations. This index incorporated the following: (1) species richness and composition, (2) trophic composition, and (3) abundance and condition of fish species by watershed.

- **Number of Species at Risk** identified "at risk" of extinction or State sensitive fish species within their existing range. The measure was intended to account for watersheds presently supporting the largest number of species potentially "targeted" for State and Federal protection. Watersheds having larger numbers of "at risk" fish species rated higher than those with fewer species.

- **Natural Sediment Index** was designed to reflect areas with high natural sediment potential. The index identifies geographic areas of greatest physical integrity relative to watershed conditions and in-channel habitat within the Klamath River Basin. These areas have the highest potential to provide for the maintenance and recovery of native fish populations and other aquatic dependent species. The index incorporates landslide potential and stream density and ranks lands with the greatest erosion potential and stream density as high.

- **Road Density** is a common index that expresses roaded areas as miles of road per area.

- **Huma*n* Disturbance Index** was designed to reflect the change in the natural sedimentation potential that is associated with human activities such as, but not limited to, road construction and harvesting. This index combines the landslide and surface erosion potential with road density information.

- **Sediment Production Index** was designed to characterize watersheds according to their potential to experience sedimentation in the future. The sediment production index incorporates information from the landslide and surface erosion index, stream density, and road density.

- **Existing Channel Habitat Condition** ratings were developed using channel condition, water quality and quantity, habitat connectivity, and fish community integrity. This measure was intended to account for the existing physical habitat conditions within watersheds with respect to natural potential. Most of the ratings are based on best professional judgment of overall watershed conditions.

- **Restoration Priority** was based on equal weighting of the current status of native fisheries resources, the relative integrity and risk to watershed habitat conditions, and the administrative feasibility of maintaining or restoring each of the geographic areas assessed.

A full discussion of conditions throughout the Klamath Basin can be found in the Klamath River Basin Assessment report. Table 39 shows the watershed condition ratings as they pertain to the LMK Analysis Area. Most of the tributary watersheds within the Analysis Area ranked as either moderate or high in terms of restoration potential relative to the rest of the Klamath Basin.

Table 39 Klamath Basin Watershed Condition Ratings for the Analysis Area (USFS 1997).

Characterization	Slate Creek	Boise, Crawford, Ullathorne Creeks	Tributaries Near Orleans Including Pearch Creek	Hopkins Creek & Adjacent Tributaries*
Fish Community Integrity	moderate	moderate	low	low
Number of Species at risks	high	high	high	high
Natural Sediment Index	high	moderate	high	high
Road Density	low	moderate	high	high
Sediment Production Index	moderate	moderate	high	high
Human Disturbance	low	moderate	high	high
Existing Channel habitat condition	moderate	moderate	low	low
Restoration Priority	high	moderate	moderate	moderate

*Note: In Table 39 portions of the Hopkins Creek and adjacent tributaries are outside the LMK Analysis Area. Data reflects portions within the Analysis Area.

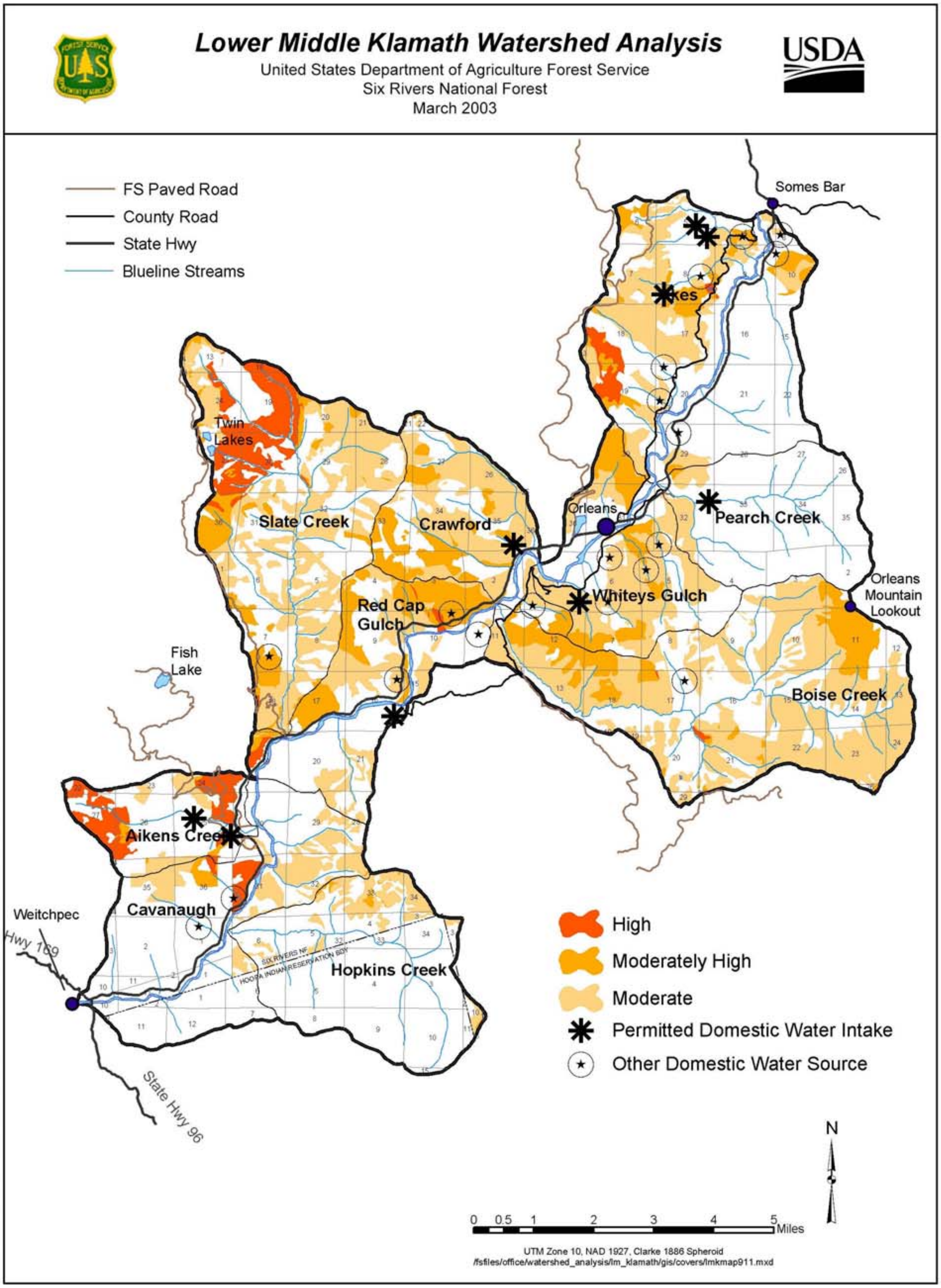
Domestic Water Sources

- *Where are domestic water sources located, and how vulnerable are they to sedimentation from natural or human-caused landscape disturbances?*

There are numerous domestic water sources located throughout the Analysis Area, most of which are located along small tributaries near the Klamath mainstem. Most of the water sources have surface or shallow subsurface intakes that are dependent on surface water quality. Eight domestic water sources within the Analysis Area are under Forest Service special use permits. The number of non-permitted sources is not known but estimates range from 25 to, a more realistic, 50 or more. The known locations of permitted water sources and estimated locations of non-permitted water sources are illustrated in Figure 20.

Tributaries that supply domestic water sources are Saint Rest's Creek, Cavanaugh Creek, Jo Marine Creek, Aikens Creek, Allen Creek, Slate Creek, Chimmekanee Gulch, Owl Gulch, Whiteys Gulch, Crawford Creek, Big Rock Gulch, Cheenitch Creek, Pearch Creek, Sawmill Gulch, Wilson Creek, Rosaleno Creek, Mud Creek, and Donahue Flat Creek. The primary domestic water source is located on Pearch Creek, which provides high quality water for the town of Orleans. Crawford Creek is the source for the Orleans Mutual Water Company that supplies water to 32 homes. The Orleans Mutual Water Company is exploring the option of increasing their coverage beyond Eyesee Road to the Camp Creek side for fire protection.

Figure 20 Combined Soils and Fire Risk & Domestic Water Sources.



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The large number of non-permitted domestic water sources within the LMK Analysis Area underscores the need to be careful when planning and implementing land management activities so that domestic water sources are not impaired. Figure 20 also illustrates the potential risk of wildfire and soil erosion on domestic water sources. For the most part, domestic water sources are located in areas with a low to moderate risk of severe wildfire and associated soil erosion. However, more site-specific information would have to be gathered to refine this information.

Fisheries

Lower-Middle Klamath Fisheries – Reference

- *Which fish species were historically significant and why; what were their distribution and relative abundance; and how has this changed today?*

Early Tribal Fishery

For thousands of years, the Klamath River provided fish throughout the year to meet the needs of the Karuk, Yurok, Hoopa, and Klamath tribes. Eighteenth-century accounts of California's vast fisheries resource describe its importance to the subsistence, commercial, ceremonial, and tribal activities of Native Americans. In addition to salmon, steelhead and lamprey were typically part of the aboriginal fishing harvest. Eulachon, green sturgeon, and various species of sucker were equally as important to tribes in the Lower and Upper Klamath River Basin.

Within the Analysis Area, the importance of anadromous fish to aboriginal societies is well documented in the ethnographic literature. Hewes (1942, 1947), Rostlund (1952), and Kroeber and Barrett (1960) have summarized these data in detailed studies. Of the species of Pacific salmon in the genus *Oncorhynchus*, only two appeared abundant and these species undoubtedly dominated aboriginal fish harvests. These salmon were often referred to as pawat, pavat, numi-nepui, nepewo (spring and fall chinook salmon); and achawun, ichwon, tsegwun, tsegun (coho salmon).

During the 1800s spring chinook salmon were abundant and likely the main run of salmon within the Klamath-Trinity system (Emmett et al. 1986). The arrival of this salmon in the spring was often celebrated with a traditional ceremony starting at the mouth of the Klamath and extending upriver throughout the Basin. The foregoing distinction is important because the native people, for whom anadromous fish were either the most important or a major staple in the food economy, almost exclusively inhabited river drainages in which the spring salmon run occurred (Swezey and Heizer 1977).

Most settlements were located at the mouths of tributaries; consequently, these areas had larger concentrations of houses than in other areas. Also the largest settlements were located at falls, rapids, or at the mouths of the major tributaries. Falls or rapids were the most favored fishing locations because their passage through these areas were more predictable and less liable to alteration by flooding (Chartkoff and Chartkoff 1975), and these areas confined the fish to narrow channels, which made the job of trapping easier (Kroeber and Barrett 1960).

Kroeber and Barrett (1960) describe four large settlements within the LMK Analysis Area: Red Cap Creek (Wuppam), Ullathorne Creek (Tuyuvak), Orleans (Panamnik), and the Salmon River

(Shakiripak or Shihtiri). The confluence of the Salmon River was the most densely settled area of the Karuk territory (Chartkoff and Chartkoff 1975). This site was a community designated fishing area and people came from great distances to fish there. It had been reported that fish were so numerous that 30 or 40 fish were caught in one net at a time (Roberts 1932). For additional information, see the ***Human Uses and Needs*** section of this chapter.

Historic Fish Distribution and Abundance

Approximately 23 miles of the Klamath River lie within the Analysis Area between the Trinity and Salmon Rivers. This section of the Klamath River is not only a migration corridor for fish but provides fish passage and holding and spawning areas for adults, facilitates movement of juveniles into and between tributaries, provides rearing habitat for fry and juveniles produced in tributaries, and provides habitat for smolts as they emigrate from tributaries and migrate to sea.

Historically, migratory fish populations such as chinook (*Oncorhynchus tshawytscha)* and coho (*O. kisutch)* salmon, steelhead (*O. mykiss)*, lamprey (*Lampetra spp.)*, and, to a lesser extent, pink (*O. gorbuscha*) and chum (*O. keta*) salmon inhabited the Klamath River. Within the Analysis Area it is assumed that all tributaries with sufficient access and habitat, such as Pearch, Boise, Slate, Hopkins, and Aikens creeks, also supported these species. Steelhead, the anadromous form of rainbow trout, were fairly common and widely distributed, and because of their leaping ability, likely inhabited other tributaries such as Crawford and Ullathorne Creeks. Green sturgeon (*Acipenser medirostris*) also migrated up the Klamath River and other large tributaries such as the Trinity and Salmon rivers between February and July to spawn.

The historical (pre-development) distribution of anadromous species within the Klamath River extended above Upper Klamath Lake into the Sprague and Williamson Rivers and Spencer Creek (Coots 1962; Fortune et al. 1966). One of the most immediate limitations on the distribution of coho, chinook, and steelhead within the Klamath Basin resulted from dam construction in the early 1900s. For at least 90 years, salmon and steelhead have been blocked from their important historic spawning grounds in the Upper Klamath above Copco Dam, which cut off access for salmon and steelhead to the Upper Klamath Basin, resulting in extirpation of the runs that went into Oregon.

Table 40 shows estimates of historic and present miles of habitat utilized by these anadromous species based on the 1997 Klamath Basin Assessment (USFS 1997). Historic miles of habitat are confirmed or suspected ranges, and likely represent a conservative estimate of habitat utilized. The amount of habitat lost for steelhead is likely even greater than shown because they spawn in smaller tributaries. Present distributions were based on existing or suspected ranges and professional judgment.

Population sizes of fish runs prior to the 1900s are difficult to determine. Based on descriptions of the salmon runs near the turn of the century provided by Snyder (1931), they exceeded several million fish. Using estimates derived from available stream miles within the Basin, and applying well-accepted estimates of escapement and spawning, the estimated run size of salmon (in adult equivalents) in the pre-development Klamath Basin would have been about 0.66 to 1.1 million fish (Institute of Fisheries Resources, 1997). As shown in Table 40, an estimated 8 to 55% of historical salmonid habitat is no longer fully utilized by these species. This undoubtedly decreased the production capacity of these species within the entire Basin, including the LMK Analysis Area.

Table 40 Estimated Historic and Present Miles of Stream Habitat Utilized by Anadromous Salmonids within the Klamath Basin (USFS 1997).

		Est. Miles of habitat		% No Longer Fully Utilized
Common Name	**Scientific Name**	**Historic**	**Present**	
Coho salmon	*Oncorhynchus kisutch*	1200	950	20%
Fall chinook salmon	*Oncorhynchus tshawytscha*	1225	900	27%
Spring chinook salmon	*Oncorhynchus tshawytscha*	1000	450	55%
Winter/Fall steelhead	*Oncorhynchus mykiss*	2050	1900	8%
Summer steelhead	*Oncorhynchus mykiss*	1000	750	25%

Lower-Middle Klamath Fisheries – Current

Multiple Fishery of Today

Today, the fishery resources of the Klamath River continue to be an important social and economic aspect of northwestern California, southern Oregon, and the LMK Analysis Area in particular. The Klamath River area offers different types of fishing opportunities including an active tribal fishery, in-river sport fishery, and both ocean commercial and ocean recreational fishery. Presently, the Yurok, Hoopa, Karuk, and Klamath tribes continue to fish within the Klamath Basin. The Karuk and Yurok tribes, which are located within the Analysis Area, largely depend on chinook, coho, steelhead, green sturgeon, and pacific lamprey for subsistence and ceremonial purposes to this day. Also, Yurok tribal members have the opportunity to operate a commercial fishery along the Klamath River within the YIR (Figure 1).

In the ocean, commercial trolling and recreational fishing for chinook salmon occurs within the Klamath Management Zone north of Fort Bragg, California to Cape Blanco, Oregon.
Under the management of the Pacific Fishery Management Council, seasons and quota limits are set annually. In-river recreational fishing on the Klamath River likely began in the late 1800s, and continues for chinook salmon and steelhead today. Since 1986, the river recreational fishery has been regulated by a quota system based on predicted population returns. Recreational fishing within the Analysis Area continues to grow seasonally, especially when large annual returns are expected and angler quotas are raised. Nine commercial fishing guides are known to operate on the Lower-Middle Klamath River.

In addition to the traditional anadromous fishery, some streams and lakes within the Analysis Area are open to fishing for a variety of resident fish species. Resident rainbow trout, small-mouth bass, and other warm water species attract a diversity of recreationists.

Current Distribution of Fish Species

At present, habitat of anadromous salmonids is limited in the Klamath River Basin to the mainstem and tributaries downstream of Iron Gate Dam. Dam construction started as early as 1912 with Chiloquin Dam, followed by Copco Dam in 1917, and blocked access for migrating salmonids into the Upper Basin. Upstream distribution of salmonids in several tributaries throughout the Basin has also been limited due to multiple factors such as roads, water diversions, agriculture, grazing, development, mining, and logging.

It appears that as much as 20% of historical anadromous habitat may have been lost or substantially disturbed within tributaries of the Analysis Area. Over the past 150 years, some of this decline most likely resulted from road construction, the creation of barriers to upstream migration, and streambed alteration resulting from mining and other activities. Some of this decrease in suitable habitat occurred on smaller tributaries such as Hopkins, Crawford, Ullathorne, Pearch, and Donahue Flat creeks (see Fish Habitat section below for additional information).

Fish species composition varies annually and spatially, and understanding these assemblages can help determine the makeup of species in an area, the interactions among them, and their relationship to the environment. In general, fish assemblages within the LMK Analysis Area are either (1) a mixed anadromous fish-resident fish assemblage in the Klamath River mainstem and most of the lower reaches of the tributaries or (2) a resident rainbow trout assemblage found in upper reaches of the tributaries.

The LMK Analysis Area provides approximately 36 miles of anadromous fish habitat (23 miles in the Klamath River and 13 miles in adjoining tributaries). Chinook and coho salmon, lamprey, green sturgeon, and steelhead inhabit some of this mixed anadromous habitat. All of these fish species utilize the Klamath River at some point in their life cycle. Each of these species has various habitat preferences for spawning and rearing. Even though some tributaries have limited habitat for a given species, other species may still persist there. Based on available data, spring-run chinook, summer-run steelhead, pacific lamprey, and green sturgeon are only known to occupy the Klamath River mainstem, even though they are found in larger tributaries outside of the Analysis Area.

An estimated 20 additional miles of suitable resident fish habitat also exist within the Analysis Area. Currently, a typical combination of species comprising a resident fish assemblage in the lower sections of the tributaries includes juvenile rainbow trout, Klamath small scale sucker, speckled dace, and both species of sculpin. Resident rainbow trout are found in the upper parts of these tributary streams where gradients are high and water temperature is cold.

Relative Abundance and Trend

Small species populations have a greater risk of extinction than large populations because of stresses resulting from environmental variation, demographic stochasticity, genetic processes, and ecological interactions. Identification of the threshold size, above which a population is considered safe from extinction due to reduced population size, is critical. Viable populations must have a trend that is stable or increasing. Most west coast populations of anadromous fish show large fluctuations, but the general trend has been downward, especially in wild populations of the Klamath Basin, including the LMK Analysis Area. Recently, much attention has been focused on these species' declines as further described below.

- *What fish species have been identified as being at risk, and what are their current trends?*

Moyle (2002) describes the Lower Klamath Sub-Province (the portion of the Klamath Basin located in California) as a region that contained 21 native fish species, 17 of which were saltwater dispersants, mainly anadromous lamprey (2 species), sturgeon (2 species), salmonids (6 species), smelt (2 species), stickleback (1 species), and (1 species) sculpin. The only freshwater dispersants are Klamath speckled dace, Lower Klamath marbled sculpin, Klamath small scale sucker, and Pacific brook lamprey.

Of the 21 native fish species historically known to be in this Lower Klamath Sub-province, only 15 were likely found within the Analysis Area portion of the Klamath River. Two of these species, pink and chum salmon were historically present but today there appears to be no self-sustaining stock of either species within the Basin. Out of the remaining 13 species, coho salmon, spring-run chinook, summer-run steelhead, green sturgeon, and river lamprey appear to be the most at risk.

Coho Salmon

The southernmost populations of coho salmon occur in California, and it is here that native coho stocks have declined dramatically. The severity of the decline and number of extirpated populations increases the closer one gets to the limit of their historical southern range, indicating that freshwater habitats in these marginal environments are unable to support coho populations as they did in the past. Brown and Moyle (1991) estimated that naturally spawned adult coho salmon returning to California streams in the late 1980s were at less than 1% of their mid-century abundance, and indigenous wild coho populations in California did not exceed 100 to 1300 individuals. They also stated that only 46% of California streams, which historically supported coho populations, and for which recent data were available, no longer supported runs. As stated in Chapter 1, in 1997 NMFS announced its determination to list the southern Oregon northern California (SONC) coho salmon ESU, which includes the LMK Analysis Area, as “threatened” under the ESA (62 FR 24588).

Within the Analysis Area, there are few historic records of coho salmon. Currently, a few adult coho are observed in Boise, Slate, and Aikens creeks during fall chinook surveys. The USFWS has been operating a downstream juvenile migrant trap on the mainstem of the Klamath River near Big Bar. Incomplete trapping records and lack of quantified emigration estimates provide limited information in terms of trends, but they do indicate the presence of coho at different life stages during certain times of the year. Based on the actual number of coho captured (Table 41) and abundance indices developed for juvenile coho salmon, there were an average of only 548 smolts from 1997-2001. The trap data may indicate a depressed status of coho populations in the Klamath River. Juvenile salmonid counts in streams near Orleans have also determined their presence or absence in these tributaries, but this information has limited value for determining exact population abundance. It is clear that coho do not exist every year in these tributaries, possibly indicating the loss of one or more brood-years.

Table 41 Hatchery and Wild Juvenile (Smolts, Young-of-the-Year) Coho Salmon Captured at Big Bar Rotary Screw Trap 1997-2001 (USFWS 2001).

Year	Days Trapped	Wild Smolts	Hatchery Smolts	Young-of-Year
1997	126	17	3	13
1998	97	1	2	12
1999	118	4	6	38
2000	92	8	3	45
2001	54	49	312	155

Recovery planning efforts are underway for the SONC coho salmon ESU. A technical recovery team for coho salmon was created in October 2001. Their goal is to develop an area-based recovery plan that contains measurable criteria for determining when de-listing from the ESA is warranted, establishes a comprehensive list of site-specific management actions necessary to achieve the plan’s goal for recovery of the species, and estimates the cost and time required to carry out those actions.

Spring-run Chinook

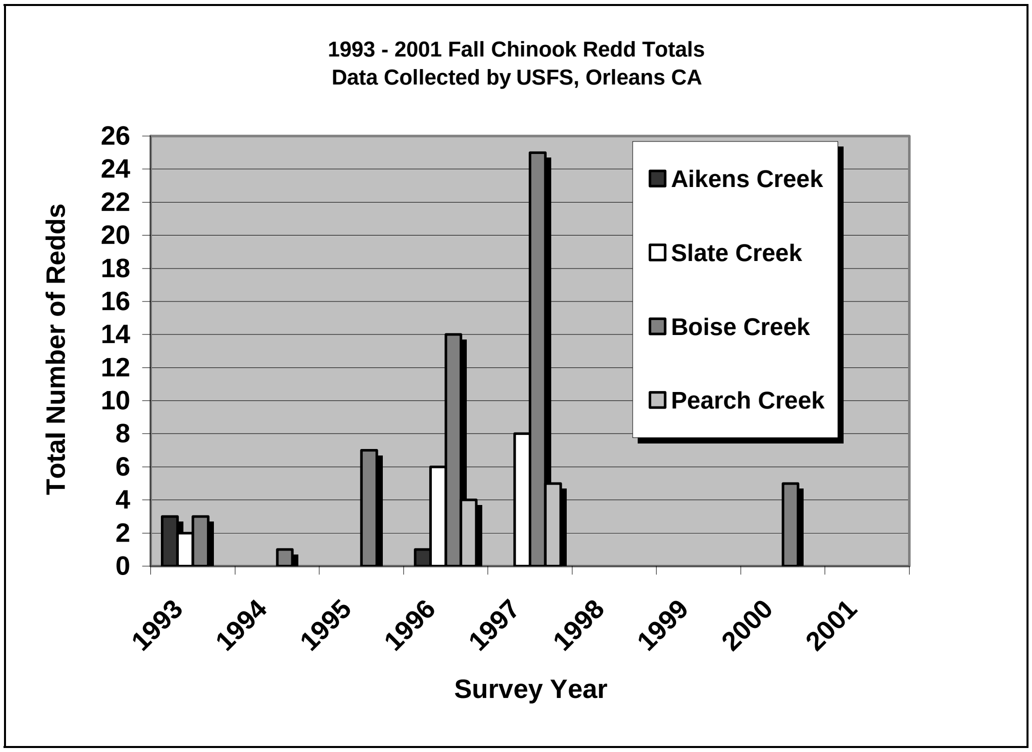
The spring-run chinook salmon was once the most abundant population of salmon in California. By 1931, the Klamath River spring chinook population seemed to have almost disappeared, and the depletion of other salmon runs was progressing at an alarming rate (Snyder 1931). Currently, native spring-run chinook seem to be on the verge of extinction, while few return annually to the Klamath River. The severity of this trend is evident in their current range and distribution. The Salmon River, a large sub-basin northeast of the Analysis Area, supports the only remaining wild population of spring-run chinook in the Klamath Basin. For the last twenty years, spring chinook counts have been conducted within the Salmon River Sub-basin. Results show low numbers of adults and large fluctuations in the return. In 1990 the USFS designated spring-run chinook salmon as a “sensitive species” due to significant declines in escapement. In 1998, this run plummeted to below 300 spawning adults.

Various native stocks of fall chinook are likely the healthiest populations of anadromous salmonids in the Pacific Northwest. However, wild populations of fall-run and late-fall chinook within the Klamath Basin are difficult to measure because of the large hatchery influence over the years. Chinook typically spawn in larger tributaries (e.g. Bluff, Red Cap and Camp Creeks) but they are known to inhabit Boise Creek, as well as Slate, Pearch, and Aikens creeks to a lesser degree when conditions are favorable. Adult fall chinook surveys on the Orleans District begin usually in late September and continue into early January or until flows limit surveyor access. Based on USFS surveys since 1993, fall chinook redd totals used to determine escapement within these small tributaries have been low. In combining redd totals among all of these tributaries for each year, the largest number of redds observed since 1993 were noted in 1997, totaling only 38 redds or approximately 87 chinook (Figure 21). Fall-run chinook are also known to spawn within the Klamath River mainstem (USFWS 1994, 1995). In 1994, 6 fall chinook redds were counted in the Klamath River between the Orleans bridge and Hopkins Creek (Cyr, personal observation). However, little spawning activity has been observed in this portion of the mainstem since that time.

Summer-run Steelhead

Species of steelhead in the Klamath Basin have shown a significant decline since the early 1900s, especially summer-run steelhead. Busby et al. (1994) reported that the hatchery influence of summer/fall-run steelhead in the Klamath Basin during the 1980s numbered approximately 10,000 while the winter-run component was estimated to be approximately 20,000. Summer steelhead monitoring during July and August has occurred on the Orleans Ranger District since 1980 and trend data indicate adult summer steelhead runs to be extremely low. This is also evident in larger tributaries in the area such as Camp, Bluff, and Red Cap creeks. As stated in Chapter 1, summer-run steelhead trout found within the Klamath Basin were designated as a Forest Service Sensitive species in 1990.

Figure 21 Recent Fall Chinook Redd Totals within the LMK tributaries (USDA 2001).



Green Sturgeon

The ecology and life history of the green sturgeon has received little study. Therefore, is difficult to assess the population dynamics of green sturgeon found in the Klamath River. This species is thought to be one of the largest freshwater fish in the world, and spends much of its life in the marine environment, coming into rivers mainly to spawn. Green sturgeon are only known to use the Klamath-Trinity, Sacramento, and Rogue river systems as principal spawning areas. Now they are thought to be the only spawning locations for this species in North America (Moyle 2002).

In 1970 near Orleans some green sturgeon were tagged and later captured in a commercial drift net inside Willapa Bay, Washington and in the Umpqua River at Reedsport, Oregon. Ongoing research of green sturgeon is underway with the USFWS, CDFG, and the Yurok, Hoopa and Karuk tribes (Shaw, personal communication). The overall objective of the study is to learn more about sturgeon habitat use so that survival and spawning success can be better described. Final results of the study are expected to be available in 2004.

The largest spawning population of green sturgeon in California is thought to be in the Klamath River (Moyle 2002). They typically spawn in deep, swift waters like those found in the Analysis Area. As stated in Chapter 1, the North American green sturgeon has been listed as a Forest Service Sensitive species for the Klamath River Basin since 1998, and is currently under status review to be listed under ESA.

River Lamprey

There are four species of lamprey (Klamath River, Pacific, Pacific brook, and river) likely occupying the Lower-Middle Klamath River, and little is known about them. Pacific lamprey is the most common species and, like salmon, appears to have a number of distinct runs. Local tribes still fish for these species, particularly Pacific lamprey. In 2002, the Karuk Tribe, in cooperation with Marquette University, initiated a Pacific lamprey research project on the Klamath River (Soto, personal communication). The intent of the study is to estimate run-size, characterize habitat use, and determine general life history patterns for this species, and it may also provide information about other lamprey species in the Analysis Area, such as river lamprey.

River lamprey (*Lampetra ayresi*), were once widely distributed within coastal streams between Alaska and California. Trends in populations of river lamprey within the Klamath River are unknown, but numbers appear to be very low. Its distribution, abundance, life history and habitat requirements need more investigation.

Factors Contributing to the Decline of Fish Species at Risk

- *What human-induced factors have the most influence on the quality and distribution of suitable fish habitat for at risk species?*

Despite hatchery programs, habitat restoration efforts, and increasingly restrictive fishing regulations, salmon and steelhead populations have continued to decline in recent years. The causes of fish declines in the Klamath Basin are complex and probably interactive. The decline of these fish species can be attributed to a variety of factors including mining, dam construction and water release, road construction, timber harvesting, and stream habitat alterations, most of which are discussed below. Other important, but often overlooked, factors include climatic change, large flood events, droughts, El Nino, wildfires, changes in water quality and temperature, introduced species, reduced genetic integrity from hatchery production, predation, disease, and poaching.

Mining

Many of the communities in the Klamath River Basin owe their origin to the gold mining boom of the middle 1800s in the Klamath Mountains. The towns of Orleans and Somes Bar were located near the largest gold mining sites of the period (Wells 1881). Gold was first discovered in 1848 at Redding Bar near Douglas City. The news brought a massive migration of miners and settlers into the region. Mining operations literally lined the banks of the Lower-Middle Klamath River. It appears that miners had a claim on every major alternate river bar along the Klamath River between the mouths of the Salmon and Trinity rivers, which included the Analysis Area.

After the summer of 1852, the mining population around Orleans steadily increased (Melendy 1960). From about 1860 to 1944, at least 35 gold mining claims were in operation along the Klamath River between Somes Bar and Weitchpec. Most claims operated only during the winter, when water was available from small tributaries in the area, and had intermittent operation due to storm damage. The majority of the claims were 20 to 100 acres and operated by 2 to 4 people. Most were placer mines that used high-pressure monitors, with water taken from adjacent tributaries, to move gravel on river bars and terraces above the Klamath River.

They usually had ditches under 2 miles in length and used less than 1000 miner-inches of water under a wide range of pressures and nozzle sizes. Water was also pumped out of the hillslopes where the placer deposits originated. Ditches, pipes, reservoirs, giants, sluice boxes, and mercury were all used to extract the gold.

A few claims, however, were large. For example, the Orleans Mining Company owned 1310 acres and built 10.5 miles of ditch and flume. They employed 12 people, operated 24 hours per day year round, had sluice boxes that were 420 feet long, used 3000 miner-inches of water for 7 months of the year, and lost over 10 pounds of mercury each month. The Orleans Mining Placer Company owned 2500 acres in and around Orleans and built at least 16 miles of ditch. The Perche Hydraulic Placer Claim used sluice boxes over 1000 feet long and used 3000 miner-inches of water for 7 months of the year. An account of this time stated that the Klamath River dried up to a small stream as the summer season advanced because of mining.

Many tributary channels were realigned and altered at their confluence with the Klamath River due to mining activities. For example, it appears that the channel at the confluence of Pearch Creek and the Klamath River was dramatically altered as all of the streambed material was removed down to bedrock. Along with the mining activities, diversion ditches and small gulches for sluicing the claims were developed from tributaries. The Rough and Ready Placer Mine near the mouth of Boise Creek was only 120 acres, but they built over 4 miles of ditch and flume adjacent to Boise Creek to divert water for operations. In the 1930s, more permanent mining dams were noted in a quite a few tributaries of the Klamath River including Hopkins and Camp Creeks (Taft and Shapovalov 1935). Lower Klamath tributaries within the Analysis Area such as Rosaleno, Donahue Flat, Wilson, Pearch, Boise, Crawford, Hopkins, Ikes, Five Mile, Saints Rest, and Cavanaugh creeks appear to have been the most severely impacted. In 1961, CDFG stream survey reports for Rosaleno, Donahue Flat, and Wilson creeks describe mine tailings, sloughs, and other post-mining equipment still left in these stream channels.

Disturbance of alluvial deposits in the lower reaches of tributaries likely contributed sediment to the Klamath mainstem for years following operation of claims. Also, mining activities on the Klamath River, which still had a natural flow regime during this period, ensured that all available sediment below flood elevation was unconsolidated and subject to transport. Small periodic floods during this period transported large quantities of sediment. Floods recorded in 1852, 1861, 1864, 1875 and 1880 all reportedly swept the Klamath River clear of all mining improvements (Wells 1881).

In later years, miners cited observations of large populations of spawning salmon during this mining period as evidence that silt and mud from operations were not harmful to fish. Without knowledge of the size of salmon and steelhead runs before the advent of mining, it is very difficult to estimate any relative population decline. Runs may well have been reduced 30% or more and still remained large enough to be remarkable to miners working in the streams. Later studies, he noted, revealed that salmon and trout migrate upstream through muddy water, but they seek clear tributaries in which to lay their eggs.

Undoubtedly, there were long-lasting impacts to the Klamath River system both outside and inside the Analysis Area resulting from this mining period. Aquatic and riparian habitats were substantially disturbed, oversimplified, or lost entirely. Channel conditions at the mouths of some tributaries no longer facilitated salmonid access for immigration and emigration. Stream banks and upland habitat that were once stable and vegetated were removed. Millions of yards of material were moved from the banks, terraces, and channels of the Klamath River and its tributaries. Pools were filled in due to excessive sediment. Active channels of many tributaries lost suitable habitat conditions for spawning and rearing. The level of activity, timing, and duration of mining likely resulted in direct mortality of fish. Detrimental effects on certain brood years of anadromous fish may have also occurred. It is even noted “during the period of placer mining, large numbers of salmon were speared or otherwise captured on or near their spawning beds, and if credence is given to the reports of old miners, there then appeared the first and perhaps major cause of early depletion (Snyder 1931). For additional discussions on historic mining, see ***Mining*** under the ***Social and Human Uses – Reference*** section of this chapter.

Today, mining practices have become scarce in the Klamath Basin and the Analysis Area. The primary extraction method has now become small, portable suction dredges used under permits issued by CDFG. On federal lands, the USFS requires each suction dredger to obtain a CDFG permit, and file a “notice of intent” and “plan of operation.”

Upper Klamath River Dams and Water Quantity and Quality

The Klamath Project is located in southern Oregon and northern California and provides irrigation water for approximately 220,000 acres in three counties of Oregon and California. Project water is stored primarily in Upper Klamath Lake in the headwaters of the Klamath River Basin and Gerber and Clear Lake Reservoirs in the Lost River watershed. The development of dams in this location of the Klamath River began with Klamathon Dam prior to 1900. Copco No. 1 was completed in 1918, Link River Dam was completed in 1921, Copco No. 2 in 1925, and finally Iron Gate Dam in 1962.

Although a myriad of human induced and natural factors affect at risk fish species in the Analysis Area, Klamath Project operations largely affect the quantity, quality, and timing of water available for release during the year. In turn, flow releases from the Iron Gate Dam affect the quantity and quality of fish habitat in the mainstem of the Klamath River. The Iron Gate Dam is located at approximately RM 190, or 124 miles upriver from the Analysis Area. Investigations into an appropriate flow regime below the Iron Gate Dam have resulted in several recommendations for flows to address interests in the Klamath River Basin. At present, the BOR has management control of Upper Klamath Lake elevations and Iron Gate Dam releases. The BOR proposal for annual operation of the Klamath Project is due in 2002, and FERC relicensing of the Iron Gate Dam hydroelectric project is expected in 2006.

Water Quantity and Quality Effects on Fish Habitat

Withdrawal of water from the Klamath River has a critical relationship to the timing of different life stage needs of at risk fish species. It is important to analyze these species and their life stages in the context of the entire community and ecology of the river. Hardy (1999) provided an interim species and life stage periodicity for anadromous species in the entire mainstem of the Klamath River. Based on this data and other available literature, a revised life stage periodicity for the fish species at risk in the Analysis Area was developed and is shown in Table 42. This table depicts typical spawning periods, early developmental stages, and migration patterns for at risk fish species. Refinement of this information may occur as part of the ongoing studies in the Basin.

Table 42 At Risk Fish Species' Life Stage Periodicities for the Mainstem Klamath River between the Salmon and Trinity Rivers.

Stock/Species/Life Stage	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Spring-run Chinook Fry				■	■	■	■	■				
Spring-run Chinook Juvenile	■	■	■	■	■	■	■	■	■	■	■	■
Spring-run Chinook Adult Migration						■	■	■	■	■		
Spring-run Chinook Spawning	■	■									■	■
Coho Fry					■	■	■	■	■			
Coho Juvenile	■	■	■	■	■	■	■	■	■	■	■	■
Coho Adult Migration	■	■	■	■	■							■
Coho Spawning		■	■	■	■							
Summer-run Steelhead Fry						■	■	■	■	■		
Summer-run Steelhead Juvenile								■	■	■	■	■
Summer-run Steelhead Adult Migration	■	■	■	■	■	■	■	■	■	■	■	■
Summer-run Steelhead Spawning				■	■	■	■					
Green Sturgeon Juvenile	■	■	■	■	■	■	■	■	■	■	■	■
Green Sturgeon Adult Migration					■	■	■	■	■	■	■	■
Green Sturgeon Spawning						■	■	■	■	■		
River Lamprey Juvenile	■	■	■					■	■	■	■	■
River Lamprey Adult Migration	■	■	■	■	■	■	■					
River Lamprey Spawning					■	■	■	■	■	■		

The quantity and quality of habitat defines the limits of a fish population. Fish species need suitable conditions and resources to occupy a given river location both temporally and spatially. Some of the most significant fisheries impacts within the Klamath River relate largely to the effects associated with the quantity and timing of water available for release annually. Water releases from the Iron Gate Dam can affect the quantity of fish habitat for these at risk species in various ways:

- Loss of access or passage into suitable habitat
- Decrease in available habitat or movement into and between habitats
- Change in run timing, upstream and downstream migration
- Spawning delays or possible straying
- Reduced outmigration success
- Increase in competition, intimidation, or predation
- Decrease in available resources (e.g. feeding success)
- Increase in mortalities (e.g. stranding fry and juveniles)
- Reduction in numbers, reproduction, and distribution

Consideration of water quantity for fisheries habitat without equal consideration of the relative quality of fish habitat is no longer possible. Water quality is regulated by the development of criteria and standards developed by the EPA. Water quality standards must often meet certain requirements for various fish species, especially salmonids. A brief discussion of water quality conditions within the Klamath River was previously described in the ***Water Quality*** section of this chapter. Quality of fish habitat in the Klamath River may be affected by:

- Nutrient rich water from the Upper Basin that enters the Lower Klamath Basin
- Extreme phytoplankton blooms, especially during summer months
- Large swings in pH and DO
- Elevated water temperatures in the Klamath River from May through October
- Large diurnal water temperature fluctuations
- High summer water temperatures exacerbating already poor water quality conditions
- Increase in disease and pathogens endemic to the Klamath Basin that cause direct mortality (e.g. recent "fish kills" within the Klamath Basin)
- The interaction of temperature, nutrients, and DO, which can have a much greater impact on water quality and salmonids than any of these alone

During the summer Iron Gate flows can make up a substantial portion of the Klamath River flows within the Analysis Area. This is particularly true during dry water years. As a result, some of these impacts may become exacerbated during this period of time.

Roads

Poor road design, location, construction, reconstruction, lack of maintenance, disposal techniques, and improperly placed or inadequately sized culverts can cause mass soil movement, surface erosion, gullies, stream bank erosion, and blockage of upstream and downstream migration of fish, all of which may impact at risk fish species and their habitat. Based on recent road condition surveys within the LMK Analysis Area, the sites along roads with the highest erosion potential were found at stream crossings, where the most common problem was the potential for stream diversion. In the absence of timely road maintenance within the Analysis Area, minor road problems can become more damaging and may persist for decades, likely increasing resource damage.

Watersheds currently containing the highest quality fisheries habitat or those with the greatest potential for recovery should receive increased protection and priority for restoration work. Some areas pose a greater resource risk. For example, 34 miles of road were surveyed in the Slate Creek watershed. Some of these are midslope, maintenance level 1 or 2 roads and others have saturated fills, showing signs of incipient failure. The level of acceptable risk in this watershed is lower and restoration priority is higher because of existing downstream coho salmon habitat.

Logging

Many studies have been done on the effects of logging practices on fisheries habitat. Although any harvesting system may have some negative habitat impact, the extent to which each type of harvest activity affects fisheries habitat depends considerably on the choice of equipment, layout of the harvest unit, and mode of operation. Harvest systems include tractor, high-lead cable, skyline, and helicopter. Roads can account for a sizeable portion of erosion and resource damage as discussed above. Laws currently regulate timber harvest activities on federal lands and many policies have changed over the past 45 years to protect aquatic resources. Today Riparian Reserves are defined as lands adjacent to streams as well as unstable or potentially unstable areas where special Standards and Guidelines direct land use.

Twenty-one percent of the Analysis Area has experienced some form of harvesting, either clear-cut or selection harvests. Crawford and Slate creeks have had the largest acreage harvested with 1221 and 1048 acres, respectively. Thirty-one percent of the Crawford Creek watershed has been harvested, mostly by patch cuts starting in the 1950s. Approximately 13% of the landslides identified on aerial photos between 1944 and 1998 appear to be associated with timber harvest (See earlier section on ***Erosion Processes***). The highest percentage of landslide sediment delivery associated with timber harvest occurred between 1960 and 1975 within Hopkins (30%), Crawford (28%), and Whitey's Gulch (21%). About 18% of the total acres harvested within the Analysis Area were located within riparian areas. Most of these riparian areas appear to be small, 1st-order, intermittent and ephemeral channels on middle or upper slopes. The highest percentage of timber harvest activity within these riparian zones occurred within the Ikes (23%) and Crawford (19%) sub-watersheds, especially during the 1960s and 70s. It is apparent that some impacts to fish habitat have resulted from past timber harvest and other related activities. The extent of the impact varies throughout the Analysis Area.

Fish Habitat – Reference and Current

The distribution and relative abundance of these at risk fish species were previously described in the ***Fisheries*** section above. This section primarily focuses on describing historic and current habitat conditions within the mainstem of the Klamath River and other small tributary watersheds in the Analysis Area. Historical data are limited and some inferences are made based on current information.

Lower-Middle Klamath Mainstem

The Lower-Middle Klamath River mainstem provides approximately 23 miles of anadromous fish habitat within the Analysis Area between the Salmon and Trinity Rivers. Spring-run chinook, coho, river lamprey, green sturgeon, and summer-run steelhead are all considered at risk species that inhabit some of this mixed anadromous habitat, and each of these species are largely affected by the quantity, quality, and timing of water available for release during the year. Each of these fish species requires a dynamic river system for long-term survival and productivity.

Reference Habitat Conditions

Only generalizations can be made regarding what fish habitat conditions were like within the Klamath River prior to the 1800s. It is known that the river was still wild and its flow was uncontrolled. The annual hydrograph likely peaked during the winter months due to storm runoff and during the spring due to snowmelt. High flows likely scoured the channel and floodplain, preventing establishment of large areas of mature riparian vegetation. Willows would have been predominant near the channel with LWD not abundant in the river system. Seasonal floods would have mobilized the channel bottom and maintained pools and large alternate river bars that were used by local Native Americans. The Karuk and Yurok people inhabited villages along the mainstem and seasonal burning occurred to aid with production of food crops and resources from surrounding areas. Riparian vegetation in certain areas along the river corridor was more open and dominated by hardwood stands.

Large floods were documented in 1861-62, although good prehistoric flood evidence reveals others of similar severity occurred around 1600 and again about 1750. Recent flood events were recorded in 1890, 1915, 1955, 1964, and 1974. Some of these natural events triggered widespread landsliding. Based on early accounts, the Klamath River was severely impacted by intensive mining activities starting in the mid-1800s, as discussed previously. As a result, the riparian areas along the Klamath River likely had short periods of recovery during the early mining era. Large amounts of sediment were transported during some of these floods, especially during the mining period. Dramatic changes to the riparian corridor and river channel occurred. Floods and low flows generally had beneficial effects on fisheries. Floods helped maintain habitat diversity, while low flows allowed for recolonization by macroinvertebrates. Adult migration and juvenile outmigration were triggered by changes in flows, along with other seasonal fluctuations.

Current Habitat Conditions

The USFWS completed mesohabitat typing from Iron Gate Dam to Weitchpec during July and August of 1997 when Klamath River flows ranged between 2000 and 3000 cfs (USFWS and Hoopa Valley Tribe 1998). Mesohabitat types are often used in large riverine systems to describe existing habitat conditions. Habitat types were defined for the Klamath River mainstem between the Salmon and Trinity River as follows:

Habitat Types

Low Slope (LS):
- substrate usually uniform
- active channel usually comparatively wide
- little to no standing waves
- little to no backwater effect

Moderate Slope (MS):
- substrate primarily consisted of large cobble and boulders
- active channel was moderately confined
- standing waves approximately ½ to 1 foot in height
- little backwater effect upstream of slope

Steep Slope (SS):
- substrate primarily consisted of small and large boulders
- active channel was confined
- standing waves throughout mesohabitat type measuring 1-3 feet in height
- high backwater effect, usually a large pool upstream of slope

MS/SS, LS/MS:
- visual estimation difficult due to characteristics of both mesohabitat types. In the example MS/SS, the moderate slope was given the dominant characteristic and steep slope the subdominant.

Run (R):

The dominant mesohabitat type was categorized as a pool or slope depending on backwater effects. Data forms and files indicate a RUN as LS/R denoting a low slope with RUN characteristics or P/R designating a pool with RUN characteristics.
- gradient was low
- moderate velocity throughout
- depth was 4 feet or greater
- channel confined
- little to no standing waves

Pool (P):

- scour in wetted channel
- eddy effect along wetted edge
- maximum depth greater than 4 feet
- backwater effect

Spilt Channel (SPC):

- channel divided by large island
- an estimated 10-50% diverted into secondary channel

Side Channel (S/C):

- small finger of water diverted into a secondary channel
- less than 10% of flow
- formed by overflow through a cobble bar

The length, width, and maximum depth of each mesohabitat type were taken during this survey of the Klamath River. Further analysis of the data is summarized in Table 43. A total of 218 mesohabitats were identified: 183 were Klamath mainstem units and 35 were side channels. Pools (77), moderate slope (28), low slope (23), and steep slope (33) habitat units were the predominant units (See shaded area in Table 43). Side channels were equally distributed throughout this entire survey reach, and accounted for 1.3 miles of habitat. Sixty-nine percent of the side channels were classified as pools or moderate slope units.

Table 43 Mesohabitat Data on Mainstem Klamath River from the Salmon to the Trinity River (USFWS 1997).

					Max Depth				Side-Channels			
Type	#	%	Miles	% Miles	<10	10-20	21-30	31+	#	%	Miles	% Miles
LS	23	12.6%	2.1	8.9%	22	1	0	0	5	14.3%	0.3	20.0%
LS/MS	1	0.5%	0.1	0.4%	1	0	0	0	0	0.0%	0.0	0.0%
LS/P	2	1.1%	0.1	0.4%	1	0	0	0	0	0.0%	0.0	0.0%
LS/R	2	1.1%	0.2	0.9%	1	1	0	0	1	2.9%	0.0	3.9%
MS	28	15.3%	2.3	9.8%	26	1	0	0	9	25.7%	0.3	21.0%
MS/LS	1	0.5%	0.2	0.9%	1	0	0	0	0	0.0%	0.0	0.0%
MS/SS	4	2.2%	0.3	1.3%	4	0	0	0	0	0.0%	0.0	0.0%
P	77	42.1%	15.4	65.5%	9	42	14	7	15	42.9%	0.6	47.7%
P/LS	1	0.5%	0.1	0.4%	1	0	0	0	0	0.0%	0.0	0.0%

The survey data were divided into three smaller reaches of relatively equal length: Salmon River to Orleans Bridge (upper), Orleans Bridge to Slate Creek (middle), and Slate Creek to the Trinity River (lower) to further evaluate fisheries habitat conditions. Pools comprised over 65% of the total mainstem area and were the predominant type within each of these reaches. Steeper slope habitats were subdominant in the upper reach from the Salmon River to the Orleans Bridge, while moderate slopes were in the lower two reaches. Channel widths were measured from one wetted edge of the channel to the other. The upper reach was more constricted. The average wetted channel width measurement for the upper reach was 147 feet, middle reach (169 feet), and lower reach (162 feet).

One hundred and seventy-four Klamath mainstem habitat units had maximum depth measurements taken during the survey. Forty-one percent of these units were over 10 feet deep. Seven pools were over 30 feet deep, and mostly bedrock formed lateral scour pools. Most of these pools were found in the upper reach.

These physical data help to describe existing fisheries habitat conditions within the Klamath mainstem for at risk species. For example, coho fry and juveniles rear in the Klamath River from March to June. Fry usually swim close to the edge or hold in side channels to seek cover. Coho typically rear in this river environment for one year before migrating to the ocean. Marginal slack water is particularly important for young-of-year coho since prey items in the mid-stream are hard to capture because of their weak swimming abilities at this stage of development. As they continue to develop, they tend to move out into higher velocity water. Therefore, side channels and marginal slack water are extremely important for coho during early stages of their development.

Spring-run chinook can enter the Klamath River as early as February. Migrating adults tend to hold in deeper pools as they migrate upriver into the Salmon River before spawning in the early fall. Some of these cool water pools near tributaries that are greater than 10 feet deep provide essential habitat. Green sturgeon also utilize deep pool habitat in the Klamath mainstem, especially those over 30 feet, to hold and spawn.

Tributaries of the Lower-Middle Klamath Mainstem

Available anadromous fish habitat is limited within smaller tributaries of the Analysis Area. Approximately 13 miles are considered suitable for spawning and rearing of coho, steelhead, chinook, and river lamprey. Boise and Slate creeks contain the most suitable habitat, about one-half of the total. Other tributaries like Pearch Creek, Hopkins Creek, and, to a lesser degree Aikens Creek, make up a large portion of the remaining habitat. Tributary streams that are not accessible to anadromous species or do not provide suitable habitat are also critical to salmonid survival. Many of these streams are small, well shaded, and provide high quality, cool water to the Klamath River. They are located next to important upstream and downstream habitats. Juvenile chinook, steelhead, coho, and many other species are often found holding in the lower reaches and/or at the confluence of these tributaries within the Analysis Area, especially from July through September.

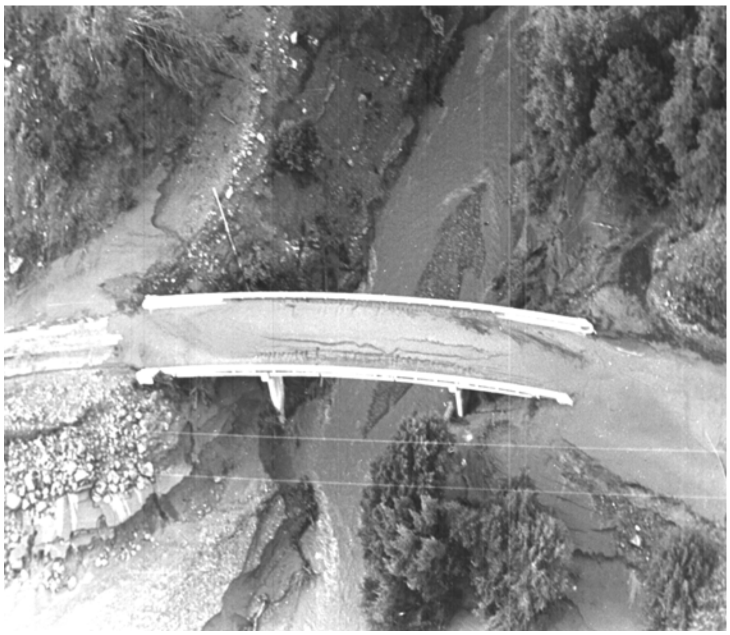
Boise and Slate Creeks – Reference and Current Habitat Conditions

Mining operations in the late 1800s appear to have impacted the lower reach and some of the tributaries of Boise Creek (see ***Mining*** section above). The 1944 aerial photos of both Boise and Slate Creeks reveal dense riparian cover. A few ridge top roads were present, but no erosional impacts associated with these roads were evident. Some of the upper portion of the Slate Creek drainage appeared to be burned from a past fire. Some small slides were visible in Lower Slate Creek and in Boise Creek below Trail Creek. Many large conifers were noticeable along these channels. The extent and density of riparian cover and the absence of management suggest that ambient conditions in riparian areas probably provided good habitat for riparian and aquatic species. Likewise, summer stream temperatures were probably at the low end of their historic range.

The condition of riparian and aquatic habitats in the Boise and Slate Creek watersheds has varied greatly since 1944, primarily as a result of channel changes caused by mass wasting and sedimentation during major floods, as well as by human disturbance of the landscape.

Sequential aerial photos (1960, 1975, 1990, 1998) reveal extensive riparian corridor and stream channel changes. In 1960, there were still very few openings in the riparian canopy. By 1975, substantial opening of riparian canopies had occurred, principally along the mainstems, and much of the lower mainstems had become aggraded by landslide debris. For example, Figure 22 shows the Highway 96 Bridge on Lower Slate Creek following the 1964 flood. Notice the bank failures along Forest Service Road 11N05 and the amount of sediment deposition left on the bridge. These effects were also very noticeable in Boise Creek below the confluence of the Little South Fork due to a debris flow that "gutted" one of its tributaries.

Figure 22 Slate Creek Bridge on Highway 96 Following the 1964 Flood.



Boise Creek surveys by the USFS and CDFG began in the late 1960s. In a 1979 survey, the lower two miles of the mainstem of Boise Creek were characterized as a straight channelized path with little meandering or change in slope. Few pools were present although several good spawning areas were observed. The lack of pools appeared to be the most significant limiting factor for fish production in the lower two-mile section. In the next two-mile section upstream, some bedrock areas were present, which limited upstream movement of fish, and a few areas contained large accumulations of woody debris. Overall, the stream channel appeared stable except for a few areas of bank instability.

In 1982, Oscar Larson & Associates prepared a watershed report for a proposed hydropower project in Lower Boise Creek. Three sections of the anadromous reach were distinguished downstream of a bedrock falls barrier at RM 3.7. Pools were not as plentiful in the lower section than in the middle and upper sections. Riffle/run types were dominant in the lower section, and pools over four feet in depth were formed primarily by bedrock. In the middle section, pool habitat was excellent, and was formed by woody debris, cut banks, bedrock, and rock falls. In the upper section, pool habitat was good, and formed primarily by rock falls and bedrock. The USFS conducted another survey in 1991, which yielded similar results. Pools deeper than 3 feet comprised approximately 7% of the total survey length, while about 3% of channel substrate was composed of fines smaller than 1 mm.

The USFS again surveyed the anadromous section of Boise Creek in 1997. Two survey reaches were identified. Reach 1 began at the confluence and extended up to a small tributary at RM 2.6, and Reach 2 continued from that point to a natural barrier at RM 3.7. Eleven percent of the habitat units were glides, 23% were pools, and 66% were riffles. The pool-to-riffle ratio was 2:3 in the upper reach and 1:4 in the lower reach. Pools greater than 3 feet in depth comprised about 8% of the total survey length. Percent substrate was measured for six different sizes as shown in Table 44. All pool tails were sampled for percent fines using a grid measurement. The average percent fines was 7.3% for 57 pools sampled in the lower reach, and 9.5% for 29 pools sampled in the upper reach.

Table 44 Mean Substrate Percentages in the Lower 3.7 Miles of Boise Creek (USFS 1997).

Habitat Type	Fines	Gravel	Cobble	Small Boulder	Large Boulder	Bedrock
Glide	12%	26%	27%	10%	3%	22%
Pool	19%	28%	18%	9%	4%	22%
Riffle	10%	22%	29%	18%	7%	14%

Spawning gravels were abundant in the lower reach. Large woody debris in the active channel was also sampled during this survey. Sampling criteria required the length to be at least one-half the wetted channel width in order to be counted. A total of 1090 pieces 4-16 inches (in.) diameter at breast height (dbh), 108 pieces 17-31 in. dbh, and 76 pieces 32+ in. dbh were counted. There were five pieces larger than 16 in. per 1000 feet of channel in the upper reach, and 9 pieces per 1000 feet in the lower reach. Following the winter storm of 1997, additional LWD was deposited in the lower reach of Boise Creek. A total of 25 small inner gorge landslides were noted during the 1997 habitat assessment. Three were larger than 0.5 acres while 19 were smaller than 0.1 acre.

Stream surveys on Slate Creek were conducted in 1968, 1973, 1979, and 1990. In 1968, the lower two miles of Slate Creek were surveyed. A brief description of the remains of a 1964 logjam clearance project was noted. This removal project raised a concern for the surveyor because the amount of woody debris left after project completion created a partial barrier to fish passage about 150 yards upstream of the Highway 96 bridge. It was recommended that portions of the remaining logs be cut annually. No other comments were made regarding LWD accumulations within this survey reach. Bank stability within the survey reach was described as average to poor. The 1973 survey noted landslide activity in T 11 N, R 8 W, S 32. Some active slides were visible in this lower reach that created periodic stream blockages. The floodplain was noted as being approximately 200 feet wide in some areas, and some recent flood terraces were 7 to 15 feet high. In the 1979 stream surveys, the first 1000 feet of channel above the mouth were aggraded with large amounts of sediment. The source of this alluvium was minor bank erosion and several large areas of downcutting and landslide activity. Riparian vegetation was mainly comprised of small alders.

The USFS habitat-typed approximately 6 miles of the mainstem of Slate Creek in 1990. Channel gradients ranged from 2-4%. A total of 647 mainstem habitat units and 136 side channel units were classified. The predominant habitats were high gradient riffles (200), step runs (98), runs (79), and mid-channel pools (60). Pools comprised 7.6% of the total habitat. Average wetted channel width was 13 feet. A considerable number of small active inner gorge slides were described throughout the entire survey. Logjams with varying sizes of LWD were found spanning or partially spanning the channel, especially in the upper one-third of the surveyed reach.

In summary, it is obvious that recent floods (especially the 1964 event) had an impact on Boise and Slate creeks, but these watersheds are in the early stages of recovery. Large deciduous trees comprise the riparian vegetation. Stream temperatures remain low. Based on stream temperature monitoring since 1997, peak summer water temperatures in both watersheds have remained below 68°F throughout the hottest months of the summer during this five-year period. Diurnal fluctuations of water temperature can range up to 5°F in each watershed. During the summer, Boise and Slate creeks provide important thermal refuge for at risk fish species that escape from the warmer Klamath River.

Recruitment of LWD is prominent in certain reaches, creating excellent pool habitat and cover. Some of these lower channels have good-to-excellent spawning gravel. Salmon and, at times, steelhead production in Slate Creek is limited by its aggraded streambed at the confluence with the Klamath and its naturally low (sometimes subsurface), late summer and fall flows. During good water years, chinook and steelhead can easily gain access at the confluence. However, in average or dry years, these fish can be forced to hold in the Klamath River until water levels raise enough to enter this stream.

Hopkins, Pearch, and Aikens Creeks – Reference and Current Habitat Conditions

A significant portion of the remaining suitable habitat within the tributaries of the Analysis Area is found in Hopkins, Pearch and, to a lesser extent, Aikens Creek. The Hopkins Creek sub-watershed is approximately 5,760 acres, and flows northwest to the Klamath River. Approximately 65% of the headwaters are within the HVIR. Some early accounts from the 1930's describe a permanent mining dam that was impassable to fish at the confluence of Hopkins Creek and the Klamath River (Taft and Shapovalov 1935). Aerial photos of the area from 1944 show little activity within this entire drainage. The riparian corridors have a dense conifer canopy, and no roads or land management activities are apparent.

Even today, the confluence of Hopkins Creek can be a problem for anadromous salmonids. The mean width of the lower two miles of this stream is about 16 feet, but the mouth is about 80 feet. Therefore, the mouth is much shallower than the mean depth of this reach (approximately 1 foot). The stream gradient for the lower 30 feet of the channel is about 28%. Fish access into this drainage can be difficult during average and dry water years, or until late fall rain increases flow. Dominant substrates are small and large boulders, and many sections have bedrock control. Very few pockets of spawning gravel exist.

The channel gradient for the first two miles of Hopkins Creek is 3-18%, with an average of about 6%. Small cascading falls of 3-5 foot height are found within this reach. Step pools within this riffle-dominated reach range from 12 to 66 inches deep. Alders are the dominant riparian species and most are 8-16 in. dbh. Stream canopy closure is estimated to be around 80%. Water temperatures typically remain cool throughout the summer months as in Boise Creek. Much of the LWD within the stream is in the small size range (4-16 in. dbh), but some medium and large key logs are concentrated in certain areas.

Early mining activities were also prevalent on Pearch Creek (see ***Mining*** section above). It is assumed that the channel at the mouth of Pearch Creek was dramatically altered by some of these activities, and all of the streambed material was removed leaving only bedrock. The first known survey of Pearch Creek was made by CDFG in 1968. Two mining flumes were noticed that were falling into disrepair, one in the mainstem and the other in the South Fork. In this survey, the confluence of Pearch Creek was thought to be a barrier to fish especially during the summer months. It was noted that in the lower 50-75 feet, the gradient of the stream increased appreciably, dropping 20-30 feet in that distance.

In 1977, CDFG personnel surveyed 1.5 miles of Pearch Creek. Riparian vegetation (mainly alder, willow, and maple) varied from dense in the upper part of the survey reach to nonexistent in interspersed stretches where channel conditions were poor (rubble bars, braided channels, wasting sideslopes). Riparian canopy averaged 40% in the middle section to 20% in the lower section. Pearch Creek was described as a moderately steep-gradient stream (average 10%) with a stair-stepping nature, characterized by small pools interconnected by cascades and small chutes, with a pool to riffle ratio of 1:4. A higher percentage of fines were found in the lower reach. Aquatic insects were in moderate abundance, but few fish were observed. The seasonal migration barrier at the mouth of Pearch Creek was also well documented. Similar findings were also reported in 1979 and 1982 for Pearch Creek.

In the summer of 1996, local landowners received funding to modify the anadromous barrier and improve access at the mouth of Pearch Creek. Large boulders were placed at the mouth to create vortex weirs and step pools to aid with anadromous fish passage. For the next two years, chinook salmon were observed spawning in this lower reach. Following the winter storm of 1997, this enhancement no longer provided adequate holding habitat for fish passage. Since that time, no spawning adult chinook have been seen in this reach.

Pearch Creek may rank in the top 5% for pristine water among districts in the state according to testing done by the State. Stream temperatures within Pearch Creek remain cool even during late summer. Summer water temperatures collected from 1999-2001 indicate temperatures remaining below 62° F. A large deep, back-eddy pool is located on the Klamath River near the confluence of Pearch Creek that provides key thermal refugia for salmonids and other fish.

Aikens Creek is another relatively small anadromous watershed, but it also provides some important habitat for these at risk species. Aikens Creek drains approximately 2,500 acres along 3.5 miles of its mainstem. This stream flowed into Bluff Creek until the 1964 flood changed the location of Bluff Creek's lower reach. Aikens Creek now flows directly into the Klamath River. Approximately 100 feet above Highway 96 is a 4-6 foot cascading falls that steelhead can ascend, however a 10-foot high bedrock falls exists immediately above the first falls that is likely a barrier to all anadromous fish.

A number of stream surveys have been conducted since 1980 that describe the existing condition of Lower Aikens Creek. Some alder, willow, and maples have started to reestablish along the riparian corridor of Aikens Creek since the 1964 flood. Little soil exists on the north side to promote growth of riparian plants. Surveys in the mid-1980s describe a relatively monotypic stream channel with little habitat diversity. During that time, the Orleans Ranger District in cooperation with CDFG and the Karuk Tribe added instream boulder clusters to create pools and improve habitat conditions for steelhead. In February of 1995, a large landslide deposited over 100,000 cubic yards of sediment across and below Highway 96, but above Aikens Creek. A total of 950 feet of silt fence and 278 hay bales were placed to capture large quantities of sediment that could have dramatically impacted Aikens Creek.

Today Aikens Creek provides about one mile of suitable anadromous fish habitat for coho, steelhead, and chinook. All of these species have been observed spawning and rearing in this small tributary. Stream temperatures usually stay below 66°F in the summer. A large pool near the confluence provides optimum habitat for rearing and migrating salmonids.

Other Sub-watershed Habitat Conditions

A number of other small tributaries are found within the Analysis Area. Most of these streams such as Crawford, Ullathrone, Donahue Flat, Rosalena, Wilson, and Cheenitch creeks do not provide much suitable anadromous habitat, but they are generally well shaded and provide high quality water to the Klamath River. Juvenile and adult salmonids are often observed holding in the Klamath River near the confluence of these tributaries, and, when accessible, in their lower reaches during mid-to-late summer. The increased frequency and duration of high stream temperatures in July, August, and September within the Klamath mainstem underscores the importance of maintaining these cool water tributaries for these species.

Influence of Exotic and Hatchery Fish

- *How have exotic and hatchery-raised fish affected native fish populations in this part of the Klamath River?*

Exotic Species

Thirteen native fish species and at least this many, if not more, exotic species are known to occupy the Analysis Area. Some of these introduced species are: American shad (*Alosa sapidissima*), Golden shiner (*Notemigonus crysoleucas*), Brown bullhead (*Ameirus nebulosus*), Brown trout (*Salmo trutta*), Brook trout (*Salvelinus fontinalis*), Brook stickleback (*Culaea inconstans*), Black crappie (*Pomoxis nigromaculatus*), Green sunfish (*Lepomis cyanellus*), Bluegill (*L. macrochirus*), Pumpkinseed (*L. gibbosus)*, Largemouth bass (*Micropterus salmoides*), Spotted bass *(M. punctulatus)*, Yellow perch *(Perca flavescens),* and Wakasagi *(Hypomesus nipponensis)*.

Exotic fish have radically changed the ecology of the Klamath River. Many of these species are hardy and better adapted to the typically warmer temperatures that occur during the summer in the mainstem Klamath River. Some adverse interactions that may occur between exotic fish species and native fish include:

- **Competition** between two species for a resource (usually food or space) in limited supply can result in one species being eliminated.

- **Predation** by exotic species on native fish can severely impact a localized population.

- **Habitat Interference** occurs when an exotic species changes habitat characteristics by its activities and the change forces native species to leave or suffer reductions.

- **Disease** is a poorly understood mechanism by which one species can replace another. For example, some exotic fish can bring disease and parasites that can affect native fish.

Hatchery Fish

Hatcheries have been one of the mainstays of California's salmonid management efforts. A hatchery was built at the Iron Gate Dam to mitigate for loss of upstream anadromous salmonid habitat due to dam construction. The Iron Gate hatchery produces fall chinook, coho, and steelhead. Because salmon and steelhead populations in California have declined despite the presence of hatcheries, their value has been questioned. In fact, there is a growing recognition that the decline of wild stocks of salmon and steelhead or their failure to recover from declines may be partially due to the negative effects of hatchery-reared fish.

One of the main concerns of hatcheries is genetic risk. Human intervention with rearing fish may cause genetic change that can impact fish species diversity (e.g. inbreeding) and the health of the population. Hatchery programs vary and, therefore, the risks vary by hatchery. Hatchery-produced fish often differ from wild fish in their behavior, appearance, and/or physiology. Hatchery environments are quite different from stream environments, and, consequently, hatchery fish tend to have different foraging, social, and predator-avoidance behavior. Hatcheries can also have outbreaks of disease. Once fish are released, these fish can quickly transmit disease to wild fish. The ecological risks of hatchery fish are similar to the impacts that may occur between native fish and exotic fish species as previously described.

Hatcheries can also benefit wild populations. Hatchery operations can help maintain a population at a safe level until factors for decline can be addressed, such as habitat degradation and loss. They can also be a catalyst for recovery by providing a boost to an existing population or reintroducing fish into vacant habitat. By collecting broodstock from the wild, a successful hatchery can produce more returning adults than would have occurred in the wild.

In summary, growing numbers of exotic species are continuing to invade altered river systems like the Klamath River. Some of these possible impacts from competition, predation, habitat interference, and disease are not well understood and are very difficult to demonstrate. Most of these exotic species are hardy and can easily adapt to their new environment, which results in impacts to native fish populations and their remaining habitat. Hatcheries are not a substitute for addressing the root causes of salmon and steelhead decline. Since it is hard to identify risks that hatcheries pose for wild fish populations, it is not easy to predict whether damaging effects may occur within the Klamath Basin. On the Upper Klamath, fishery managers with the CDFG at the Iron Gate hatchery are working towards operating their facility in a manner to minimize impacts on naturally spawning fish by using strict production constraints not to exceed their mitigation goals.

Terrestrial Wildlife Species

Wildlife Species at Risk– Reference

- *What conditions and factors have led to viability concerns for these (threatened, sensitive, etc.) wildlife species?*

This section will describe how ecological conditions have changed over time, and which conditions and factors have led to viability concerns for the TE, Forest Service Sensitive, and SM wildlife species that were identified in Chapter 1. In many cases it is primarily factors outside the Analysis Area, which may still be relatively common locally, that have led to declines in these species.

Prehistoric information on wildlife species and their habitats is generally scarce. Local Native American legends and information that can be gathered from traditional animal based regalia and other sources suggest that of the Federally Listed species, bald eagles were known to occur within the Analysis Area prior to outside contact. Owls are featured in stories, but it is difficult to know which of the approximately 11 species of owl occurring in this area were being referred to. Although, stories about marbled murrelets have been handed down from the past by coastal tribes, it is not clear whether the species occurred within the Analysis Area (Ralph et al. 1995).

Of the Forest Service Sensitive wildlife species, peregrine falcons were known from legends, as were northwestern pond turtles, northern goshawks, and frogs. Martens and fishers were, and continue to be, used in Native American ceremonial regalia. This is not to suggest that Native American uses contributed to species decline, but just that ecological conditions during pre-contact times were favorable enough for these species to occur in the Analysis Area. This is probably also the case for the other Sensitive wildlife species.

Nothing much is known about the occurrence of the rather obscure SM wildlife species in pre-contact times. Indeed, relatively little is known about their ranges and distribution, or habitat associations for most of these species today.

Following the time of Euro-American contact in the 1850s, ecological conditions affecting these species, mostly as a result of human influences, changed substantially. Unregulated market and subsistence hunting by early settlers and miners is likely to have led to declines in western pond turtles, as did the introduction of exotic bullfrogs, which eat juvenile pond turtles and juvenile native frogs (Holland 1991). Widespread placer mining probably negatively affected foothill yellow-legged frogs, and also resulted in depressed fisheries, which, in turn, probably reduced bald eagle numbers.

Regulations set by the USFS shortly after its establishment in the area in 1905 reduced the amount and frequency of Native American under-burning, primarily used to manage for large acorn-bearing oaks. This, along with widespread fur-trapping by early settlers, probably led to declines in martens and especially fishers, which have a strong association with large oaks for the denning cavities they provide. It is believed that increased sub-canopy vegetative in-growth, due to the restrictions in Native American burning, and later advances in fire suppression effectiveness by the USFS, contributed to declines in high-quality goshawk habitat as well, and may have also reduced the amount of open pond turtle upland nesting habitats. These processes are believed to have occurred within the Analysis Area and other areas within these species ranges.

Grazing by livestock has been attributed to declines in willow flycatcher habitat and pond turtle rearing habitat elsewhere in the state. Today, populations of non-native bullfrogs occupying the same habitats as western pond turtles are likely continuing to suppress turtle recovery in the Analysis Area, and have been attributed to declines in populations of foothill yellow-legged frogs. Poorly timed water releases from upstream reservoirs that scour egg masses from their oviposition substrates, and decreased waterflows that can affect adult survivorship may have also contributed to declines in foothill yellow legged frog numbers (Jennings and Hayes 1994). In addition to altered flow regimes of dammed waterways, siltation from roads, logging, and natural causes are factors that have led to concerns over foothill yellow-legged frogs within the Analysis Area.

Perhaps the greatest changes in ecological conditions for these species both within the Analysis Area and elsewhere, was a post-WWII boom in road-building and large tree logging managed by the USFS. Along with allowing greater access for trappers seeking fisher and marten pelts, the logging and road building began to result in declines of late-seral stage forest habitats used by spotted owls, goshawks, marbled murrelets, and the two furbearers. In some areas where timber harvesting has contributed to increases in water temperatures, decreases in oxygen, or increases in siltation, southern torrent salamanders are rare or absent. Widespread clear-cut logging of older forest stands has probably had the greatest impact on the viability of these species. Approximately 11,197 acres (21% of watershed), mostly in the tanoak series, have been harvested in the LMK Analysis Area. Besides the loss of late-seral habitats, timber harvesting has also resulted in the loss of recruitment of large diameter snags and down logs, which are important habitat elements for many of these species.

Introduction and widespread use of the insecticide DDT, primarily for mosquito abatement within the southeastern United States, occurred during this post WWII period. Metabolites of DDT were subsequently found to cause eggshell thinning leading to dramatic declines in bald eagle and peregrine falcon numbers.

Viability concerns that have led to the inclusion of the Townsend's western big-eared bat as a Forest Service Sensitive species stem primarily from this bat's extreme sensitivity to human disturbance. An increase in the popularity of recreational caving, the closure of the entrances to abandoned mines and caves for safety purposes, and the demolition of abandoned buildings across the range of this bat have led to significant declines in populations and occupied range (Pierson and Fellers 1998). However, within the Analysis Area, factors affecting viability are limited given the Standards and Guides for protection of habitats within the NWFP.

Wildlife Species at Risk – Current

- *What are the types and distribution of habitats, and where known, populations and trends of these wildlife species within the Analysis Area?*

- *What are the ecosystem processes or management practices that are likely to have the greatest impact or threat on these species?*

- *What are the current Standards and Guidelines for Survey and Manage animal species?*

The current status of wildlife species within the LMK Analysis Area is poorly understood. Few current or up-to-date wildlife surveys have been conducted within the sub-drainages. Based on existing survey information, species range maps, Orleans District incidental wildlife sighting reports, and the California Wildlife Habitat Relationship database, we estimate there are 33 herptile, 120 bird, and 60 mammal species present within the Analysis Area. In order to handle the disjunct nature of the LMK Analysis Area, at times in the following discussion the Analysis Area is discussed in terms of its four major components: Boise, Hopkins, and Slate Creek sub-watersheds and the Klamath mainstem, which, for this discussion, includes all the remaining area.

Threatened And Endangered Species

Watershed analysis provides an avenue to assess habitat conditions for species and habitats of concern. This information is then available for use in planning and subsequent, ESA Section 7 consultation and monitoring. There are two federally threatened species known to nest within the Analysis Area: the NSO and the bald eagle. Another federally threatened species, the marbled murrelet, is suspected of inhabiting the portion of the LMK Analysis Area west of the Klamath River.

Northern Spotted Owl (*Strix occidentalis caurina*) – Federally Threatened

Suitable Habitat

Current population information is limited by surveys that were conducted in 1991, 1992, and 1993 for specific timber sale areas. Suitable NSO habitat will be referred to as combined nesting and roosting habitat (NR). Habitat selected by NSOs typically exhibit moderate to high canopy closure with a multi-layered, multi-species canopy dominated by large overstory trees, a high incidence of large trees with large cavities, broken tops, and other indications of decadence, numerous large snags, heavy accumulations of logs and other woody debris on the forest floor, and considerable open space within and beneath the canopy. These attributes are usually found in old-growth, but are sometimes found in younger forests, especially those that contain remnant large trees or patches of large trees from earlier stands (Thomas et al. 1990).

The number of acres of suitable NR habitat on the SRNF was established by a query of the tanoak, POC, white fir, and Douglas-fir series (Jimerson 1993), which excluded the subseries within white fir classified as white fir-white fir, and white fir-red fir. These two subseries have been omitted from the SRNF definition of suitable habitat. Acres in the appropriate series were considered suitable if the stands contained trees at least a 21in. dbh (mid-mature, late-mature, and old-growth seral stages), with at least 60% canopy cover and at least 40% conifer cover. Foraging habitat (F) was defined as stands containing trees at least 11in. dbh with similar cover.

There are approximately 24,116 acres (46%) of NR habitat on SRNF land in the LMK Analysis Area (Table 45). With the exception of Whiteys Gulch and Cavanaugh Creek, the percentage of suitable NR habitat appears to be fairly evenly distributed between the sub-watersheds on SRNF lands (Figure 23).

Suitable NR and F habitat within the sub-watersheds, broken out by seral stage, is displayed in Table 45. Determination of suitability did not consider size of patches or isolation of patches. The Analysis Area was analyzed based only on suitable series (tanoak, Douglas-fir, POC, white fir) and seral stages.

Activity Centers

There are 22 known spotted owl activity centers within the LMK Analysis Area, and 9 with portions of their estimated home range (1.3 mile-radius circle), falling within the LMK area (Figure 24 and Table 46). The majority of these activity centers were established based on survey data recorded from the 1990 through 1992 timber sale survey effort.

Table 45 Spotted Owl Nesting and Roosting Habitat Acres by Sub-Watershed and Seral Stage.

Sub-watershed	Seral Stage	Foraging	Nest/Roost	Total
Aikens Creek	Early-mature	317		
	Mid-mature		123	
	Late-mature		103	
	Old-growth		1,069	
		317 (13%)	**1,295 (51%)**	**2,526**
Boise Creek	Early-mature	2,705		
	Mid-mature		2,228	
	Late-mature		1,601	
	Old-growth		1,306	
		2,705 (27%)	**5,135 (51%)**	**9,987**
Cavanaugh*	Early-mature	901		
	Mid-mature		246	
	Late-mature		275	
	Old-growth		414	
		901 (34%)	**936 (35%)**	**2,683**
Crawford	Early-mature	245		
	Mid-mature		1,063	
	Late-mature		984	
	Old-growth		108	
		245 (6%)	**2,156 (55%)**	**3,913**
Hopkins Creek*	Early-mature	383		
	Mid-mature		232	
	Late-mature		448	
	Old-growth		281	
		383 (20%)	**961 (50%)**	**1,918**
Ikes	Early-mature	2,088		
	Mid-mature		2,436	
	Late-mature		1,270	
	Old-growth		579	
		2,088 (23%)	**4,286 (48%)**	**8,931**
Pearch Creek	Early-mature	549		
	Mid-mature		1,186	
	Late-mature		554	
	Old-growth		369	
		549 (13%)	**2,109 (50%)**	**4,195**
Red Cap Gulch	Early-mature	1,697		
	Mid-mature		392	
	Late-mature		1,221	
	Old-growth		360	
		1,697 (33%)	**1,974 (39%)**	**5,075**
Slate Creek	Early-mature	1,835		
	Mid-mature		1,142	
	Late-mature		886	
	Old-growth		2,163	
		1,835 (21%)	**4,191 (48%)**	**8,748**
Whiteys Gulch	Early-mature	1,442		
	Mid-mature		868	
	Late-mature		87	
	Old-growth		0	
		1,442 (33%)	**954 (22%)**	**4,346**
Grand Totals		**12,260 (23%)**	**24,116 (46%)**	**52,321**

*Note: In Table 45 sub-watersheds denoted with an * have lands outside SRNF, but within the Analysis Area.

Figure 23 Northern Spotted Owl Nesting and Roosting Habitat.

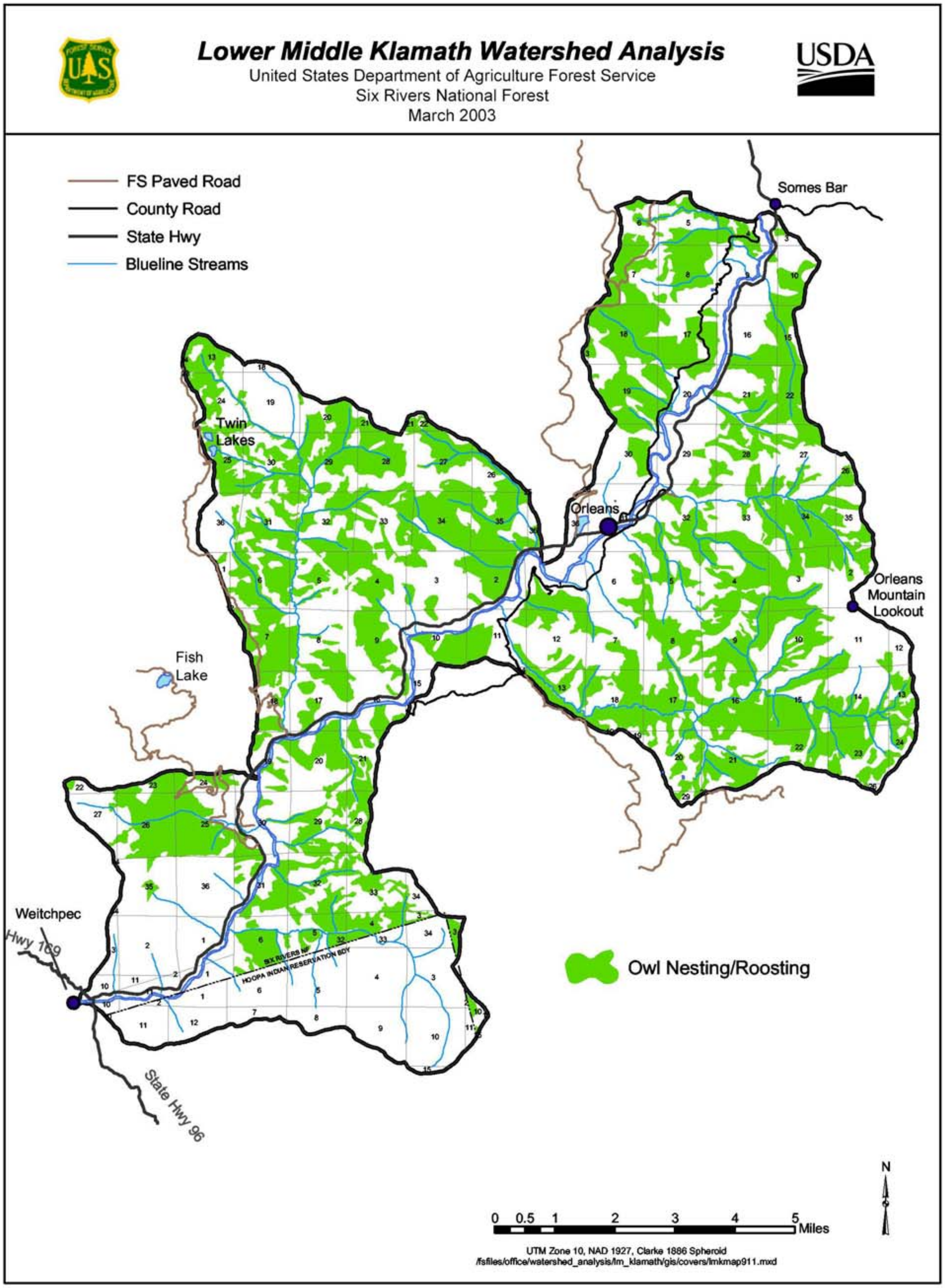


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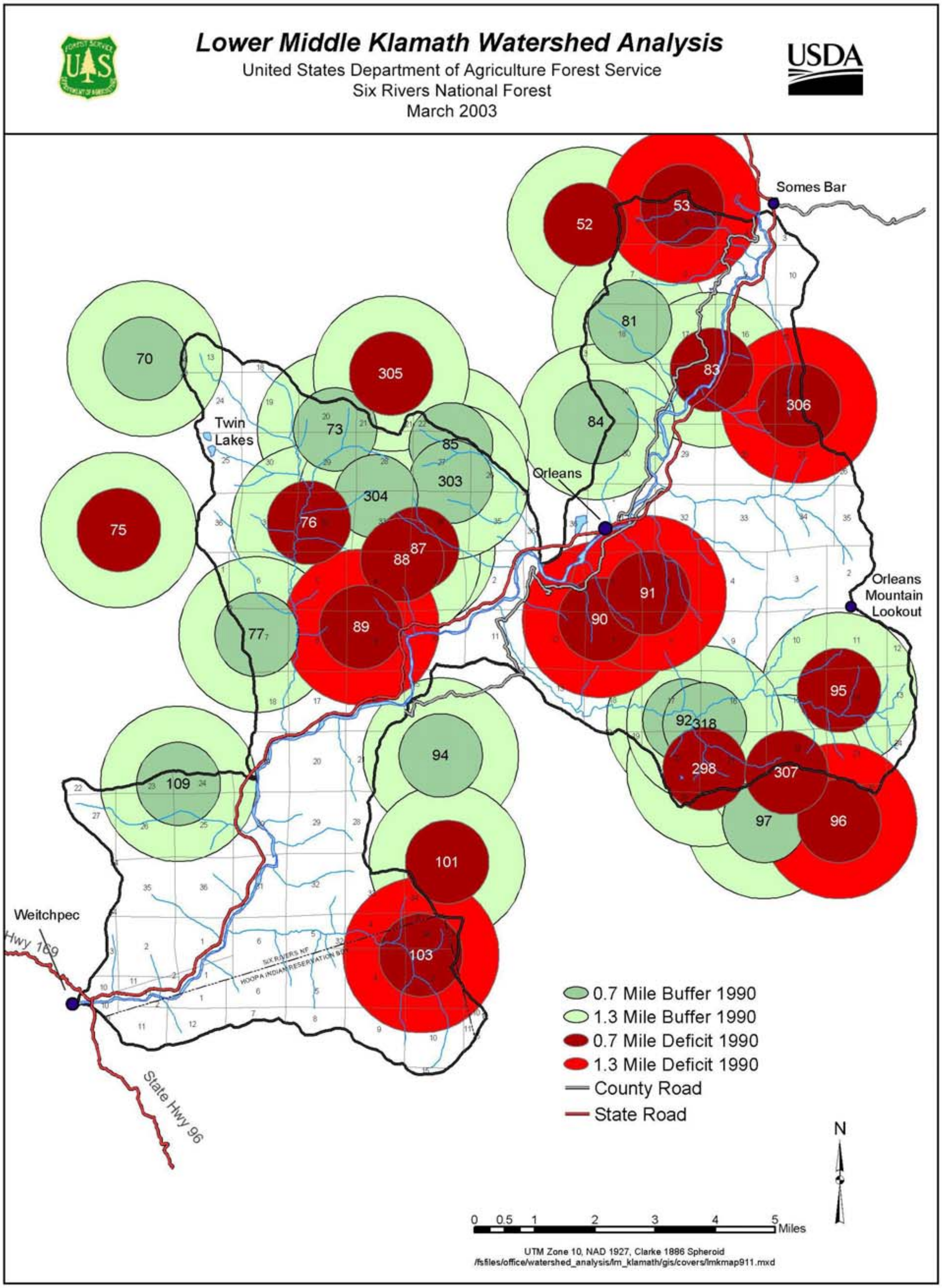
Figure 24 Buffers Around Spotted Owl Activity Centers.



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Take Analysis

The USFWS considers an owl territory to be "taken" when the number of suitable nesting/roosting (NR) acres drops below the following levels: 500 acres NR within a 0.7-mile radius circle around the activity center or 1340 acres within a 1.3-mile radius circle. Take analyses were conducted for the 31 activity centers with estimated home ranges that fall within the LMK Analysis Area (Table 46). Eleven activity centers in the Analysis Area are below the take threshold within only the 0.7-mile circle, and 7 territories are below the take threshold in both the 0.7 and 1.3-mile circles. Projects that propose to reduce suitable habitat from owl territories below the “take” threshold or that cause territories to go below the “take” threshold require formal ESA consultation with the USFWS.

Late-Successional Reserves

The NWFP identified LSRs, which are large areas to be managed to protect and enhance habitat for NSOs and other plants and animals associated with mature and old-growth forests.

The LMK Analysis Area contains 13,144 acres (22 %) of designated LSR RC304. The LMK overlaps the southern extent of this large LSR (Figure 25) that is bounded by the Klamath River. The entire LSR is 118,959 acres, of which 11% falls within the LMK Analysis Area. Ninety-four percent (8,236 acres) of the Slate Creek sub-watershed is within LSR RC304. The mainstem Klamath sub-area also contains designated LSR, with 4905 acres, or 13% of the sub-watershed area. Approximately 6,269 acres, or 47 % of LMK portion of this LSR, is considered NR habitat. Of the 6269 acres of NR, 1541 acres (25 %) is in the mid-mature seral stage.

There are two large LSRs (greater than 1,000 acres) within 10 miles of LSR RC304: RC346 on the KNF is approximately 6 miles east and RC305 is approximately 6 miles south within the Red Cap Creek watershed.

Outside of these large LSRs, owl sites known prior to 1994 received the protection of 100-acre LSRs, which are made up of the best 100 acres of habitat surrounding the activity center or nest. There are 13 of these 100-acre LSRs within the LMK Analysis Area (Figure 25).

A Forest-wide LSR assessment has been completed and is available at the Orleans Ranger District or the SRNF Supervisor’s Office in Eureka.

Habitat Connectivity

Northern spotted owls require forest conditions equivalent to at least 11 in. dbh trees with 40% or more total canopy cover for successful dispersal. The role of dispersal habitat for NSOs is to provide relatively secure travel or dispersal areas between patches of old-growth forest. The principle is that LSRs should provide healthy clusters of owl pairs, resulting in juveniles that could successfully disperse to surrounding LSRs and suitable habitat blocks. Dispersal habitat for spotted owls and other late-seral-dependent species is intended by the NWFP (USFS and BLM 1994) to be primarily provided by Riparian Reserves.

There are approximately 38,770 acres of potential dispersal habitat (64%) in the Analysis Area, based on vegetation series (tanoak, Douglas-fir, POC, white fir), seral stage (early-mature, mid-mature, late-mature, and old-growth), and canopy closure (>=40%). Within the sub-watersheds, all but Hopkins Creek are well above 50% of the sub-watershed as suitable dispersal habitat. Hopkins Creek is an apparent anomaly because most of it is in the HVIR and the analysis excluded non-NFS lands.

Table 46 Acres of Suitable NSO Habitat within 0.7 and 1.3 Miles of Known Activity Centers and Year of Last Survey.

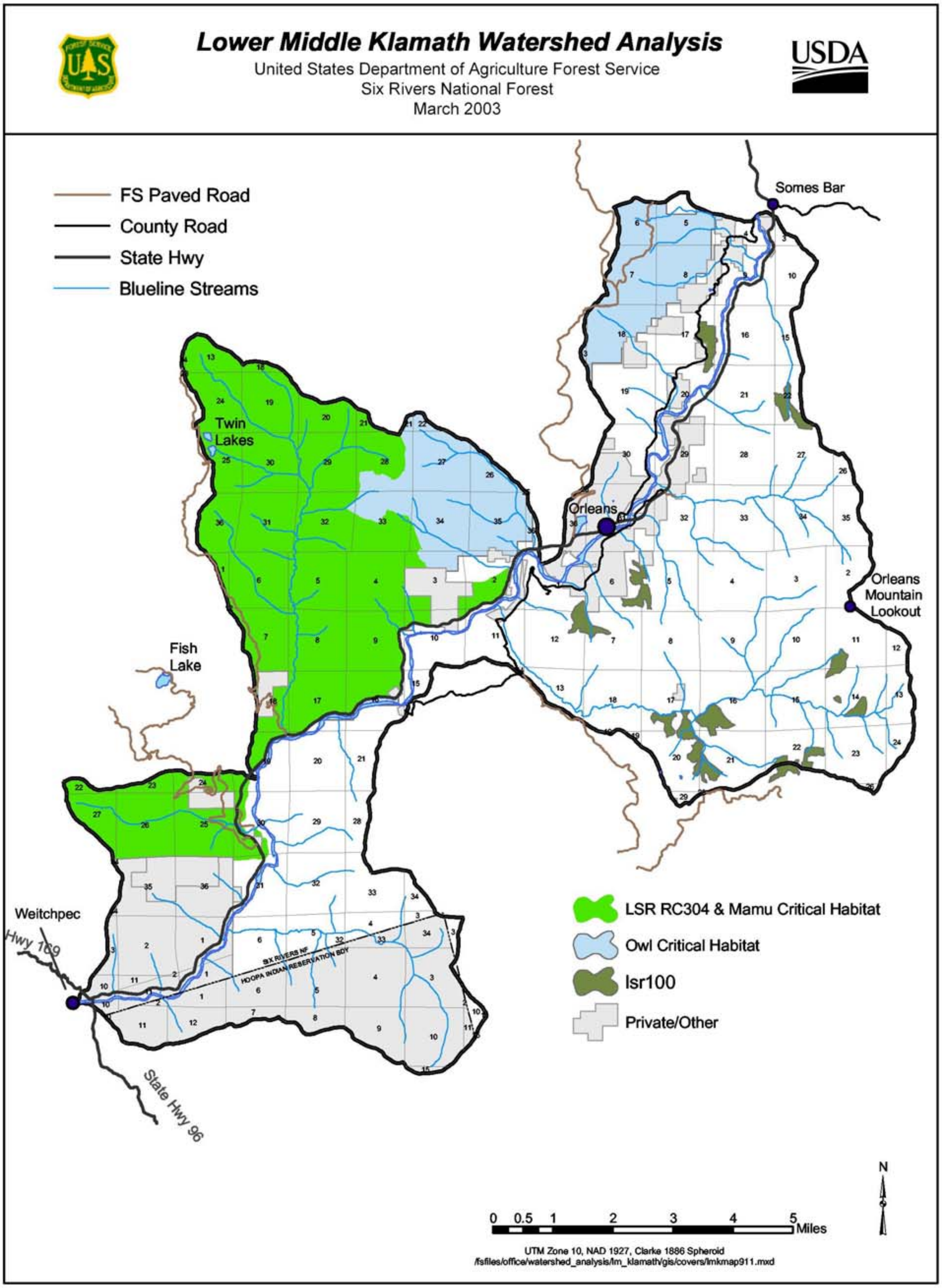
Owl #	Territory Name	NR Acres 0.7 Mile	NR Acres 1.3 Mile	Year Last Surveyed	Take Status
52	Wilder Creek*	470	1646	1992	Deficit at 0.7
53	Donahue Flat	337	983	1983	Deficit at 0.7 and 1.3
70	Rock Prairie*	585	2,103	1992	OK
73	Dyer Gulch	593	1,801	1991	OK
75	Garnit*	411	1,479	1985	Deficit at 0.7
76	Slate Creek North	497	1,836	1991	Deficit at 0.7
77	Slate Creek	605	1,618	1991	OK
81	Wilson Creek	769	2,129	1991	OK
83	Ishi Pishi	346	1,433	1991	Deficit at 0.7
84	Sawmill Gulch*	549	1,627	1996	OK
85	Cape Horn	536	1,781	1991	OK
87	Ullathorn	430	1,703	1991	Deficit at 0.7
88	Moses	395	1,587	1989	Deficit at 0.7
89	Red Cap Gulch	384	1,251	1991	Deficit at 0.7 and 1.3
90	Whitey's Gulch	226	1,084	1995	Deficit at 0.7 and 1.3
91	Short Ranch	361	1,160	1991	Deficit at 0.7 and 1.3
92	Boise Creek East	560	1,819	1992	OK
94	Allen Creek*	667	1,874	1996	OK
95	Orleans Mountain	460	1,657	1992	Deficit at 0.7
96	North Fork Red Cap Creek East*	420	1,180	1992	Deficit at 0.7 and 1.3
97	North Fork Red Cap Creek West*	660	1,710	1992	OK
101	Leary Creek*	469	1,408	1992	Deficit at 0.7
103	Hopkins Butte	388	1,274	1996	Deficit at 0.7 and 1.3
109	Aikens Creek	651	1,984	1991	OK
298	Trail Creek	493	1,776	1992	Deficit at 0.7
303	Crawford Creek	562	2,018	1991	OK
304	Lower Dyer Gulch	541	1,979	1991	OK
305	Cedar Camp Road*	436	1,593	1991	Deficit at 0.7
306	Ikes Creek	473	1,088	1991	Deficit at 0.7 and 1.3
307	Little South Fork Boise Creek*	411	2,066	1992	Deficit at 0.7
318	Short Ranch South	542	1,858	1992	OK

*Note: In Table 46 the ten activity centers denoted with an * are outside the Analysis Area but have portions of estimated home ranges within.

Critical Habitat

Critical habitat for NSOs was designated by the USFWS in 1992 to protect the physical and biological features essential to the conservation of the species. Projects that might have an effect on the Primary Constituent Elements of NSO critical habitat, which are forested lands that are used or potentially used for nesting, roosting, foraging, or dispersal, require consultation with the USFWS.

Figure 25 LSR, Marbled Murrelet, and Northern Spotted Owl Habitat.



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A portion (17,365 acres) of the large critical habitat unit (CHU) CA-2 lies within the LMK Analysis Area, and approximately 9,015 acres of this area is NR habitat. There are 11,943 acres of LSR RC304, 853 acres of Administratively Withdrawn, 301 acres of private, and 4,260 acres of Matrix lands that overlap with CHU CA-2 within the LMK Analysis Area.

Threats

Northern spotted owls are most threatened by habitat loss from commercial clear-cut logging of older forest stands and high intensity wildfire. Stand-replacement type logging has been significantly reduced within the Analysis Area since the late 1980s, but the threats from potential high intensity wildfire remain a concern for NSOs.

Excessive smoke and noise above ambient levels during the reproductive season have potential to disrupt reproductive efforts of NSO pairs nesting in proximity. Stimulating spotted owls to give territorial calls in response to calls imitated by surveyors, especially during daylight hours, can put these owls at risk from their predators. Sub-canopy in-growth, related to disruption of normal fire cycles, may be reducing the availability of otherwise suitable foraging habitat. Spotted owls are preyed upon primarily by great horned owls and northern goshawks, and are driven from their territories, or, in some cases, hybridized by eastern barred owls. Spring weather conditions have been found to factor heavily in annual fecundity (Franklin 1997).

Trend

Without regular surveys for new sites or monitoring of existing spotted owl activity centers, there is a data gap that makes it difficult to assess the trends in local spotted owl populations.

Regeneration cutting of late-seral stands, although being a main factor contributing to loss of spotted owl habitat, has been greatly reduced or eliminated in recent years. It is unknown how or if past cutting and habitat loss are still having a residual effect on spotted owl survival and reproduction.

There is a potential within the Analysis Area for more severe wildfires, which continues to threaten NSOs with habitat loss. The phenomenon of sub-canopy in-growth of vegetation that would naturally have been held in check under natural fire regimes is possibly having a negative effect on the amount of open sub-canopy foraging habitat available. On the other hand, normal forest growth is expected to gradually increase the amount of area suitable for, at least, foraging and roosting, and the passage of time is likely to result in the formation of additional nesting structure.

In addition, a project designed to increase the amount of nesting habitat for northern flying squirrels (a main prey item for spotted owls) through the construction of artificial nesting cavities within the 1.3-mile radius home range circles of 3 spotted owl activity centers (52, 53, and 81) has been implemented in the Rosalina Creek sub-drainage of the mainstem Klamath.

Given the Standards and Guidelines identified within the NWFP, land allocations (LSR and CHU's), and the current level of management on NFS lands, the rate of spotted owl habitat loss has been greatly reduced.

Bald Eagle (*Haliaeetus leucocephalis*) – Federally Threatened

Suitable Habitat

Bald eagles nest near lakes and rivers in large (greater than 36 inches in diameter), old trees that are in open, uneven-aged, mature/old-growth forests. They feed primarily on warm water fish in the summer and salmon, waterfowl, and carrion in the winter.

The Pacific Bald Eagle Recovery Plan (USFWS 1986) lists the Klamath River as a key habitat area, and has assigned to the SRNF the Bald Eagle recovery goals of providing habitat to support four breeding territories and two wintering areas.

Nest Sites

There are presently two active eagle nests within the LMK, plus another near Soldier Creek on the former Ukonom Ranger District. These nests contribute to the four territories meeting the Recovery Plan goals for the SRNF. The Allen Creek nest was found in 1994 near the confluence of Allen Creek and the Klamath River. The nest borders both the Red Cap Creek watershed and the LMK Analysis Area, and is addressed in both watershed analyses. The Allen Creek nest successfully fledged 2 young in 1994 and 1995, 1 young in 1996 and 1997, was inactive in 1998, not surveyed in 1999, fledged 1 young in 2000, and appears to have failed in 2001. The nest has been surveyed to protocol from 1994 to 1998, and again in 2000 and 2001. The second eagle's nest called Wakaar (Karuk Indian name for eagle) is located near Camp Creek. This territory was discovered in 1994, however eagles did not successfully nest that year. Since 1995 these eagles were in a new nest, within 500 meters of the old nest, and fledged 2 young, then 1 in 1996, 2 in 1997, 1 in 1998, and failed in 1999. Juvenile remains were recovered under the nest in 2000, and 1 young fledged in 2001.

Management Zones

Within the LMK Analysis Area, the Allen Creek territory has 309 acres designated as Nest Site Protection Zone, 1,318 acres designated as Primary Disturbance Zone, and 1,042 acres designated as Foraging. The Wakaar territory has 630 acres designated as Nest Site Protection Zone, 1,744 acres designated as Primary Disturbance Zone, and 2,146 acres designated as Foraging (Figure 26).

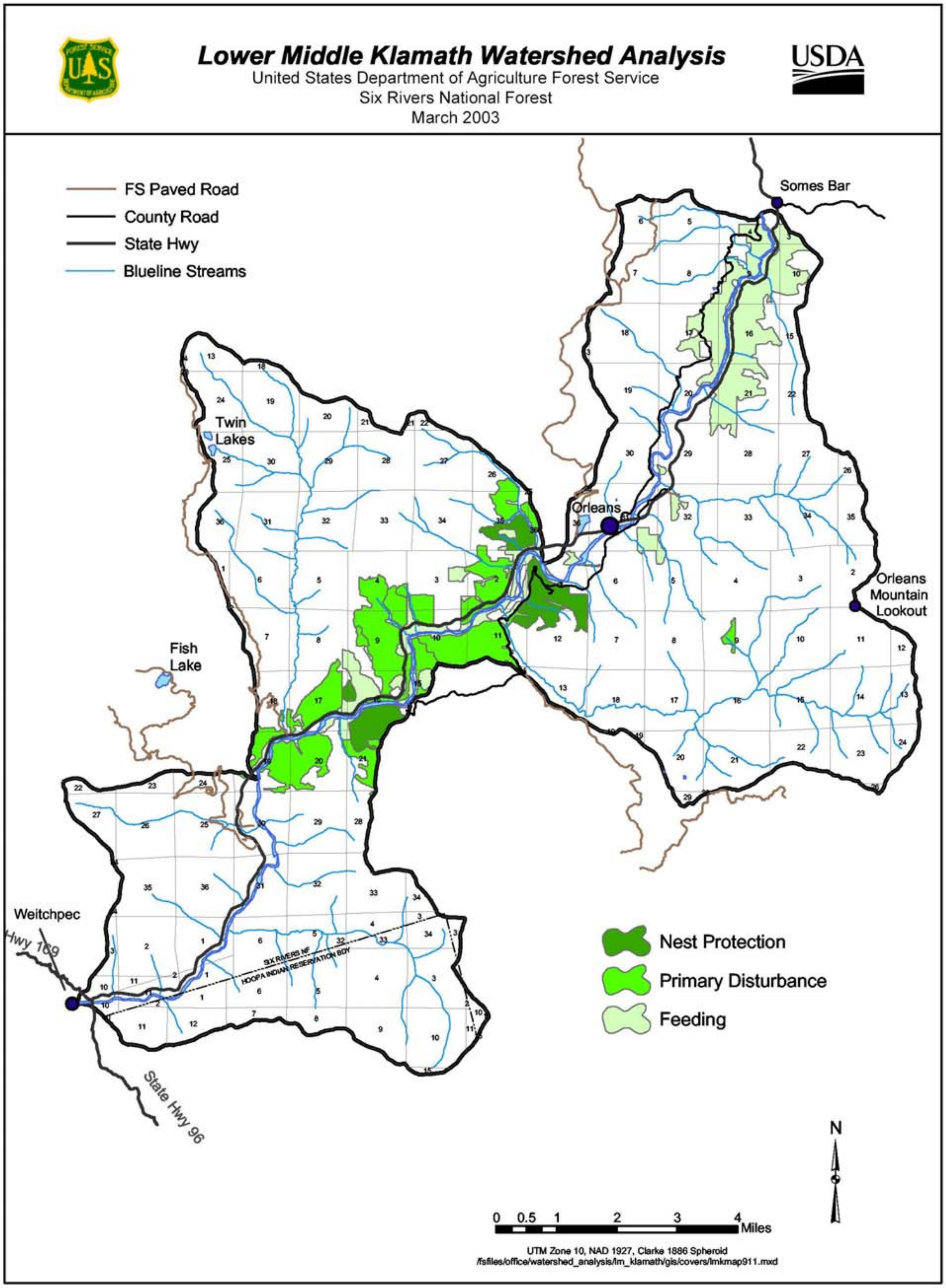
Perch sites and prey abundance will be maintained and improved by maintaining habitat. The Forest will minimize conflicts between eagles and recreational users in feeding areas where eagle activity is being significantly altered.

Threats

Bald eagle reproduction can be threatened by human-related disturbances near the nest during the January to September nesting season. While this is especially true for people on foot, or causing noise disturbance, the Wakaar pair have become habituated to vehicular traffic near their nest on the Red Cap Road, and have been known to procure fish from fishermen near their nest along the Klamath.

Loss of suitable nest trees from logging, landslides, and high intensity wildfire are threats to bald eagles, although known nest trees on NFS lands are not allowed to be logged. Factors that affect the availability of fish and waterfowl can also affect bald eagles. Adult bald eagles have few, if any, natural predators other than humans, who may kill bald eagles to protect livestock or collect feathers. Avian predators such as ravens and terrestrial tree-climbing predators like fishers probably prey on juveniles.

Figure 26 Eagle Zones.



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Trend

In the last ten years there has been an increase in eagle activity within the Klamath River Basin, including the LMK Analysis Area that may be a result of the ban on DDT. Prior to the rise in numbers of locally breeding bald eagles, there was an apparent increase in the numbers of osprey nesting along the Klamath River. This has been attributed to a reduction in the effects of DDT contamination in osprey as well; this may be of significance to the trend in bald eagle numbers, since bald eagles often pirate fish caught more efficiently by osprey.

Marbled Murrelet (*Brachyramphus marmoratus*) – Federally Threatened

Suitable Habitat

Suitable marbled murrelet nesting habitat is considered to be late-mature and old-growth coniferous forest, or younger forests with large trees and limbs interspersed to provide nesting opportunities (Ralph et al. 1995). For this watershed analysis suitable habitat was based on vegetation series: tanoak, POC, and Douglas-fir, seral stage: mid-mature, late-mature and old-growth, and total canopy cover: >=60%. There are approximately 22,197 acres of potentially suitable nesting habitat within the LMK Analysis Area. This estimate is fairly liberal until further refinement of habitat classification is conducted. Marbled murrelets have never been recorded within the LMK Analysis Area, but detections have been made on the Orleans Ranger District in 1995 near Onion Mountain and in the Upper Bluff Creek drainage.

Critical Habitat

The LMK Analysis Area falls within marbled murrelet Zones 1 and 2 (USFS and BLM 1994). The USFWS has designated Critical Habitat for the marbled murrelet within LSRs in Zone 1 and Zone 2. Critical Habitat for marbled murrelets has been identified within the LMK Analysis Area as LSR RC304 (Figure 25). The Primary Constituent Elements of marbled murrelet Critical Habitat are: (1) Individual trees with potential nesting platforms and (2) Forested areas within 0.5 mile of individual trees with potential nesting platforms, and a canopy height of at least one-half the site-potential tree height. This includes all such forest habitat, regardless of contiguity.

Range and Distribution Study

Within Marbled Murrelet Zone 2, the SRNF has conducted a range and distribution study of over 1,400 surveys at more than 350 sites in the Douglas-fir forests with a tanoak component and had no detections (Schmidt et al. 2000). As a result of these surveys, USFWS wrote a letter of technical assistance July 17, 2000 (Reference 1-14-1997-61.2). This letter described the Central Study Area as encompassing a large portion of Zone 2 including the Orleans Ranger District. In the letter, USFWS supported the recommendation to discontinue any further surveys for murrelets in the Study Area of Zone 2, and agreed that implementation of existing and future projects in this area will not result in harassment of nesting marbled murrelets; therefore, Section 7 ESA consultation relative to disturbance of marbled murrelets will not be necessary.

Threats

Marbled murrelets are threatened by habitat loss throughout its range primarily from logging and marine oil spills. Recent oil spills along the California coast are known to have killed substantial numbers or marbled murrelets. Stand-regeneration logging of suitable late-seral conifer forests in the past, especially west of the Klamath River, has resulted in reductions of suitable habitat within the LMK Analysis Area. High intensity stand-replacing wildfire may also have caused habitat loss, and continues to pose a threat. Reproductive efforts can be threatened by smoke or noises above ambient levels. Ravens, crows, and jays are known to prey on juveniles in the nest, while peregrine falcons are known to prey on adult marbled murrelets.

Trend
Since there is no existing or accepted methodology for inland surveys of population trend, no ongoing trend monitoring is being conducted on the SRNF. Therefore, it is difficult to assess the trend in local marbled murrelet populations. Range-wide monitoring of marbled murrelets in their marine environments suggest that this species is in decline, with adult mortality exceeding juvenile recruitment into the breeding population. Large areas of suitable nesting habitat protected in Redwood State and National Parks between near-shore foraging habitats and the LMK Analysis Area, as well as the large LSR RC304, are likely to provide adequate nesting habitat for at least the existing population.

Forest Service Sensitive Species

Forest Service Sensitive species are species given special consideration by the USFS due to concerns about future population viability. Habitats for Forest Service Sensitive species are to be managed to maintain well-distributed populations throughout their ranges, and to prevent them from becoming federally listed as threatened or endangered under ESA.

Sensitive wildlife species known or suspected to use habitats within the LMK Analysis Area currently include the peregrine falcon, goshawk, fisher, marten, willow flycatcher, Townsend's big-eared bat, southern torrent salamander, and western pond turtle.

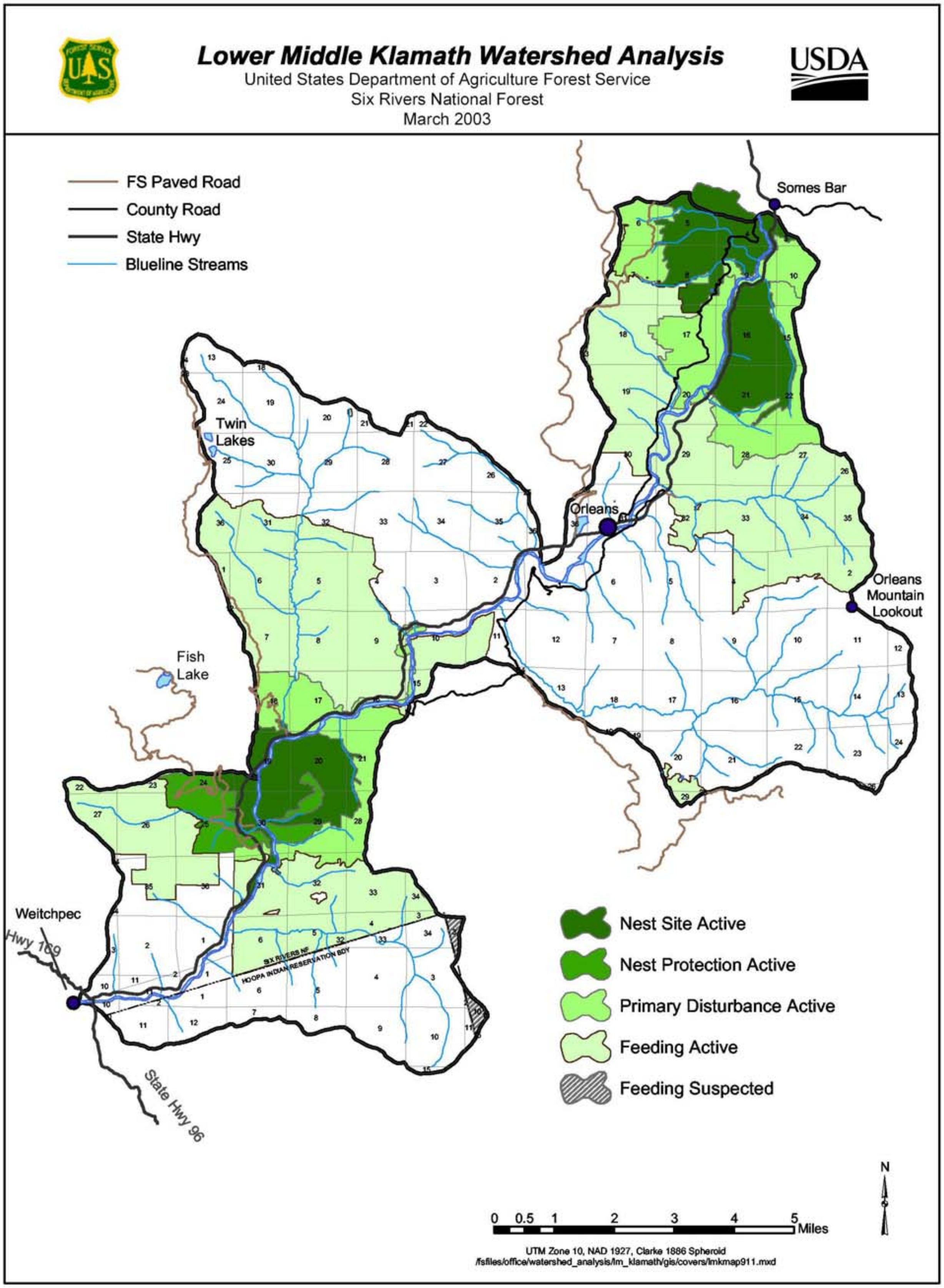
American Peregrine Falcon (*Falco peregrinus anatum*) – FS Sensitive

Suitable Habitat
In the Pacific states, suitable peregrine falcon habitat consists of high cliffs with ledges for nesting and perching. Ridge-top snags are also an important habitat component. Cliff nests, called eyries, are typically near a body of water with an adequate prey base. The diet of peregrine falcons consists almost entirely of birds.

Nest Sites
There are six known falcon eyries on the Orleans Ranger District (including the former Ukonom District). One eyrie is located within the Red Cap Creek Watershed (Red Cap Creek Territory); another is near the confluence of Rock Creek (Rock Creek Territory, Ukonom District). There is a peregrine eyrie near Murderer's Bar on the Salmon River (Murderer's Bar Territory, Ukonom), and one located near the Salmon River on Sugar Loaf Mountain (Indian Rock Territory, Ukonom). There are two eyries located within the Analysis Area: one eyrie is located near Aikens Creek, another is located in the Three Sisters formation at the head of Five Mile Creek on the northwest flank of Somes Mountain. Portions of the Nest Protection and Disturbance Zones for the Indian Rock eyrie are within the LMK Analysis Area (Figure 27).

Presently the only known reproductive falcon eyrie in the LMK Analysis Area is located near the mouth of Aikens Creek. Falcons using the Aikens Creek eyrie are believed to be descendants of a pair that was first detected on Shelton Butte in 1975 (Boyce and White 1979). Shelton Butte was inactive for several years, and a new peregrine eyrie was suspected and eventually detected in Bluff Creek, which, due to the rarity of the peregrine falcon and the proximity to the Shelton Butte site, is assumed to be an alternate of Shelton Butte. The cliff substrate at the Bluff Creek site was very unstable (Glaise geologic formation), and eventually sloughed off during the winter of 1987.

Figure 27 Peregrine Falcon Zones.



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Aikens Nest Site – The present Aikens site was suspected as early as 1989; however, it was not confirmed until 1991. This eyrie is a stick nest in close proximity to a highway and campground. Observations of falcons in the Bluff Creek watershed indicate they are year round residents. The Aikens Creek site was first found to be reproductive in 1994 when 1 young was fledged. In 1995 2 young were fledged, and in 1996 3 young were fledged. In the winter of 1996 the ledge at the Aikens Creek site was enhanced. In 1997 the enhanced nest was not used and a new nest location was suspected, but not located by Forest Service biologists. However, observations in the vicinity of the nest during the breeding season, and the sighting of an adult with 2 young at the mouth of Bluff Creek in the end of July, suggest that the territory was active. In 1998 the pair was seen incubating an egg, but the egg never hatched. Only minimal monitoring of this site has occurred since 1998 with no confirmed status. Muting or whitewash (excrement) was visible at the Aikens Creek site in the winter of 2000 suggesting peregrine presence, but nesting status was not confirmed. Lack of muting and the occurrence of swallow nests near the historical eyrie at the Aikens Creek site in 2001 suggest it was not used.

The LMK Analysis Area contains 1,894 acres of designated Nest Site Protection Zone, 2,141 acres of Primary Disturbance Zone, and 10,095 acres of Feeding Zone for the Aikens Creek Falcon pair.

Five Mile Nest Site – The Five Mile Peregrine Falcon nest site has been surveyed to protocol since 1979 when the territory was first confirmed to be occupied. It was not until 1982 that young were successfully fledged, and this is the only year that young have been confirmed to have fledged. Peregrines at this site have not been reproductive since 1985. The birds occupied the site from 1980 to 1987. Since 1987, the territory has been inactive except for occupied behavior in 1990. The site is approximately 5 miles north of the town of Orleans in the headwaters of File Mile Creek. The historic nest cliff is at an approximate elevation of 3200 feet. The rock is metasedimentary and is a southern exposure. An artificial ledge was put in place in 1981 by the SRNF. The LMK Analysis Area contains 1,340 acres designated as Nest Site Protection Zone, 2,114 acres designated as Primary Disturbance Zone, and 6,924 designated as Feeding Zone for the Five Mile falcon pair.

Indian Rock Nest Site – Indian Rock has been documented as active peregrine falcon nest since 1986. The nest site is located on the KNF and the designated Feeding Zone is outside the LMK Analysis Area. The LMK Analysis Area contains 1,656 acres designated as Nest Site Protection Zone, and 1,120 acres designated as Primary Disturbance Zone for the Indian Rock falcon pair.

Other Nest Site – Within the LMK Analysis Area there are also 179 acres of Feeding Zone designated for a pair of peregrine falcons in the Red Cap Creek watershed.

Threats

Peregrine falcon reproductive efforts can be negatively affected by human disturbances around nests. Consideration should be given to the amount of ambient disturbance certain falcon pairs have become acclimated to when determining what types of activities are likely to disturb them.

Trend

Although monitoring of peregrine falcon sites has become somewhat sporadic compared to when they were federally listed under the ESA, there is some evidence to suggest that the reproductive success of local populations is being depressed. There appears to be adequate nesting habitat and prey availability to support pairs at both Aikens Creek and Five Mile, yet the Five Mile site appears to be abandoned, and Aikens Creek may have failed or been abandoned in 2001 as well; however, it is possible that this pair may use an alternative site that is not easily viewed. These apparent abandonments along with relatively poor reproductive success at other sites on the former Ukonom Ranger District suggest that either the adult peregrines have become aged or died, or that some unidentified organochloride or similar compound is still being magnified through the food chain so that it is adversely affecting falcon reproduction in ways similar to DDT. It is important to note that a significant portion of the prey for the local population is made up of neotropical, migratory songbirds that may be carrying bioaccumulating compounds still legal for use in other countries (Pagel and Jarman 1991).

Northern Goshawk (*Accipiter gentilis*) - FS Sensitive

Suitable Habitat

The goshawk in northern California generally uses single-layered, mature and old-growth stands of conifer and deciduous habitats with a canopy cover of 70% or greater. Meadows, riparian areas, and other small openings are important landscape elements for the goshawk that are commonly interspersed with forested stands. Preferred nesting habitat includes north facing slopes near water and small openings in the forest. Large horizontal limbs of trees with a mean dbh of 11 inches at least provide suitable nesting structures. Snags and dead-topped trees are important for observation and prey-plucking perches. Goshawks feed mostly on birds of various sizes, but they also eat small mammals. Their foraging habitat consists primarily of open, un-fragmented, mature stands, small forest openings, and meadows (Hall 1984). There are approximately 23,426 acres of suitable goshawk nesting habitat in the Analysis Area, based on vegetation series of tanoak, POC, Douglas-fir, and white fir, seral stages of mid-mature, late-mature, and old-growth, and canopy closure of greater than or equal to 60%.

Threats

The greatest threat to goshawks is from loss of suitable habitat due to stand-regeneration logging and stand-replacing wildfire. Smoke, noise, and human disturbance around the nest can create the potential to disrupt reproductive efforts. Sub-canopy in-growth from disruption of normal fire cycles may be reducing the amount of foraging habitat available in the Analysis Area. Spotted and great horned owls are known to prey on goshawk juveniles.

Trend

Typically, timber crews laying out timber sales in late-seral forest habitats discover most goshawk nest areas. Since this type of timber activity has greatly diminished on the Orleans Ranger District, including the LMK Analysis Area, and monitoring of known sites has been sporadic, it is difficult to accurately assess the trends in the local population. Although goshawks are known to occasionally move their nest area from year to year, what monitoring that has occurred locally suggests that goshawk populations are in decline. This is likely to be due to the residual effects of extensive logging of late-seral stands up until the late 1980s coupled with the effects of sub-canopy in-growth due to active fire suppression by the Forest Service. It is believed that the more open, older forest understories associated with more natural fire regimes could support larger populations of goshawks.

Pacific Fisher (*Martes pennanti pacifica*) – FS Sensitive

Suitable Habitat

Moderate to high quality fisher habitat is similar to that preferred by the spotted owl. Fishers occupy multi-storied, mature and old-growth, mixed conifer and deciduous-riparian habitats with moderate to dense canopy closure (greater than 50%) and scattered patches that have six to eight large snags per acre and abundant accumulations of downed woody debris (Buck et al.

1983). Fishers use cavities in large trees, snags, logs, rock areas, brush piles, and concentrations of downed woody debris for denning and nesting. Large black oaks have been found to be especially important for the natural cavities they provide for denning and nesting (Higley 1998). Fishers often forage in proximity to accumulations of dead wood; therefore, both standing snags and down-log densities are important. Fishers use ridges and streamside areas covered by closed canopy forests when moving between quality habitat areas.

Suitable habitat area for fishers was queried using the same parameters as spotted owls. There are an estimated 22,426 acres of suitable habitat in the Analysis Area. There have been 15 incidental sightings reported within the watershed between 1966-1991 (Six Rivers Wildlife Sighting Database). Fishers were detected at all 3 sooted-track-plate arrays in or bordering the LMK Analysis Area during a survey in 1996 conducted by Carlos Carroll in order to validate a suitable habitat model (Carroll, personal communication 1996). In the model, Carroll rated most of the LMK Analysis Area as having a “medium” level of predicted probability of fisher occurrence. No dens have been found in the LMK Analysis Area.

Threats

Fishers are threatened with habitat loss from stand-regeneration logging of older forest stands, and stand-replacing wildfire. The loss of large black oaks due to the shading by emergent conifers may be limiting fisher occurrence in otherwise suitable areas.

Trend

Comparison of maps generated by Carlos Carroll that show areas where his model predicted probability of fisher occurrence based heavily on the presence of large hardwoods, with the actual fisher detections in his study, suggest first that his model was robust in its ability to predict fishers, and second, that loss or lack of large hardwoods in the LMK Analysis Area is negatively affecting fisher population trends. Large black oaks appear to be in decline in the LMK area as well as surrounding areas primarily due to their intolerance to the shade caused by emergent Douglas-fir trees. Under natural and Native American influenced fire regimes, there were likely to be greater densities of large black oaks across the landscape. This factor could be influencing the trend in local populations of fishers.

On the other hand, dense brush and sub-canopy in-growth related to regeneration forestry and fire suppression, may be favoring fishers by allowing them more areas where they can forage for prey under a protective canopy of brush or conifer plantations, which may be unavailable to avian predators due to the vegetative densities.

Long time local residents report anecdotally that presently there are greater numbers of fisher, but fewer numbers of porcupine (*Erethizon dorsatum)*, which is a fisher prey item, than in the past.

American Marten (*Martes americana*) – FS Sensitive

Suitable Habitat

The status of marten populations on the SRNF and in the Analysis Area is not known, and it is considered an uncommon species here. American marten prefer habitat that is characterized by dense (60-100% canopy), multi-storied, multi-species, late-seral coniferous forests. Moderate and high quality habitats contain 2-3 large snags and 10-20 large logs per acre, both of which are important elements for denning and resting. Martens also require travelways comprised of closed canopy forests in order to move between foraging areas (Freel 1991). During an ongoing graduate research project on coastal martens on the Orleans Ranger

District, there appears to be a habitat association with the dense rhododendron/salal (*Rhododendron sp., Galtheria salal*) brush types under mature conifer canopies.

There appear to be at least 2 subspecies of marten on the Orleans Ranger District and probably within the LMK Analysis Area. One of these subspecies occupies higher elevation habitats, generally above 3000 feet, while the other occupies lower, coastally influenced forest habitats below 3000 feet. The Klamath River may separate these 2 subspecies.

A map of marten habitat suitability developed in 1997 by Carlos Carroll shows much of the LMK Analysis Area to be in low to moderate habitat suitability with the largest block of moderately suitable habitat occurring in the headwaters of Boise and Pearch Creeks.

There was one reported incidental sighting of a marten within the LMK Analysis Area in 1992 (SRNF Wildlife Sighting Database) and another unreported incidental sighting on private land within the Analysis Area (Riggan, personal communication 2001).

Threats

Loss of suitable habitat through stand-regeneration logging of older forest stands or to stand-replacing wildfire are the greatest threats facing martens currently. They may be excluded from areas of otherwise suitable habitat by competition from Pacific fishers.

Trend

With so few records of marten it is difficult to assess population trends. A recent review of trapping and survey records from northern California conducted by Bill Zielinski of PSW Arcata, CA suggested that the coastal subspecies of marten had become extinct (Zielinski and Golightly 1995). However in 1996, detection was made within the historic range of this subspecies in the Upper Bluff Creek drainage of the Orleans Ranger District. Subsequent intensive surveys within the Bluff Creek watershed, which borders the LMK Analysis Area, have shown what appears to be a small remnant population believed to be of the coastal marten subspecies. The establishment of LSRs and a drastic reduction in the amount of annual loss of suitable habitat to logging may be allowing the recovery of local marten populations.

Townsend’s Big-eared Bat (*Corynorhinus townsendii*) – FS Sensitive

Suitable Habitat

This bat, which is a moth specialist, is mainly associated with caves, but also uses abandoned mineshafts and buildings for colonial breeding and roosting areas. Metal bridges with concrete footings are used as night roosts of females with their pre-volant juveniles primarily because of the latent heat they retain. Townsend’s big-eared bats are extremely sensitive to disturbance, especially from recreational cavers. Surveys recently conducted by the state of California found a maternity colony in a mineshaft on private land just beyond the northern border of the Analysis Area (Pierson and Fellers 1998). Single males have been found roosting in an old barn on private land within the Analysis Area. The USFS published a final rule on Cave Resource Management in the NWFP that establishes criteria for nominating, evaluating, and designating significant caves for sensitive bats and has been incorporated into the LRMP.

Threats

Loss of suitable roosting, reproductive, and hibernating habitat from the closures of mines and caves and the demolition of abandoned buildings are the greatest threats to these bats. Human disturbance is also a major threat to Townsend’s big-eared bats (Ibid.).

Trend

Population size trends for Townsend's big-eared bats are believed to be downwards within the state of California due to the closure of abandoned mine shafts, the deterioration of abandoned buildings, and an increase in recreational mining (Ibid.). These factors are probably somewhat in effect within the LMK Analysis Area, at least with regard to the loss of buildings. An abandoned mine shaft believed to be used by Townsend's big-eared bats just north of the Analysis Area was recently gated in order to comply with the SRNF Standards and Guides. These types of measures will hopefully slow the rate of decline.

Willow Flycatcher (*Empidonax traillii*) – FS Sensitive

Suitable Habitat

Willow flycatchers typically nest within about 5 feet of the ground in dense shrubs within wet meadows or willow/alder-dominated riparian zones that contain open areas for foraging. They appear to prefer both the presence of low, dense shrubs such as willows (*Salix sp.*) and/or alders (*Alnus sp.*), and still or slow moving water within their breeding territories. This type of habitat is found within LMK Analysis Area but is fairly limited. Existing vegetation information is not precise enough to estimate the amount of potentially suitable willow flycatcher habitat within the watershed, but the best suitable habitat within the LMK is probably found along the mainstem Klamath River, in those areas where the density of alders and willows is highest.

There are numerous records of willow flycatchers within the LMK Analysis Area. The majority of these records occurred during the late summer and early fall near the mouth of Red Cap Creek. The Pacific Southwest Research Station's Redwood Sciences Laboratory, in Arcata, CA has been operating mist-netting stations in the riparian zone near the mouth of Red Cap Creek since 1992. In 1994, 44 willow flycatchers were banded at this site. The majority of these birds were banded during fall migration (late August, early September) and are believed to be using the Klamath River corridor for foraging in order to build up their fat reserves for their annual migration from their breeding grounds in the Upper Klamath Basin to their wintering areas in the neotropics.

Breeding status of the willow flycatcher within LMK Analysis Area has not been confirmed. It is suspected that willow flycatchers may be nesting on the Orleans Ranger District along the Klamath River and possibly in the riparian zones of tributaries. One confirmation of successful nesting along the Klamath River in California occurred at the mouth of Seiad Creek (about 36 miles from the Analysis Area) on the Oak Knoll District of the KNF in 1995 (Alexander, personal communication).

In July of 1998 an adult willow flycatcher was seen delivering food to an adult-dependant juvenile in a young plantation dominated by pole sized Douglas-fir and root-sprouted tanoak, about 10 miles northwest of the Analysis Area. Plantations, especially in forests with strong coastal influence, have recently been identified as potential nesting habitat for willow flychatchers. The crucial habitat elements appear to be dense shrubs, foraging openings, and proximity to water where insects with aquatic life stages are available.

Threats

Livestock grazing, and nest parasitism by brown-headed cowbirds (*Molothrus ater*) are the greatest threats to willow flycatchers within their breeding range (Sanders and Flett 1989). The livestock grazing in the LMK Analysis Area occurs only on private land, in areas with minimal, if any, suitable willow flycatcher habitat. Brown headed cowbirds are known to inhabit the Analysis Area and may be affecting willow flycatchers that are attempting to breed.

Trend
In California, willow flycatchers have shown both historic and recent population declines (Ibid.). The primary cause of these declines is probably the loss and degradation of riparian habitats. The habit of willow flycatchers to place their nests near the edges of willow clumps makes nests susceptible to being knocked over by cattle. Livestock grazing can also indirectly affect willow flycatcher habitat by altering vegetation and hydrology. Also, livestock can graze the lower branches of riparian deciduous shrubs and consume or trample young riparian plants. Land uses adjacent to willow flycatcher habitat that can change the hydrology of the area and have an indirect negative effect on the habitat include ground water extraction/impoundments, timber harvest, and associated ground-disturbing activities. In addition, willow flycatchers are frequently parasitized by brown-headed cowbirds.

In the LMK Analysis Area it appears that willow flycatchers are using the area primarily in preparation for migration rather than for nesting. It is possible that local riparian willow habitats are too unstable due to annual storm related disturbances.

Northwestern Pond Turtle (*Clemmys marmorata marmorata*) – FS Sensitive

Suitable Habitat
These turtles occupy aquatic habitats during spring and summer and adjacent upland habitats during fall and winter, with known seasonal migrations. Over-wintering sites appear to vary between habitat types. In pond and lake habitats, some turtles spend winter on land, and others remain in ponds during the winter. In river habitats, turtles over-winter on land. Hatchlings remain in the nest over the winter, and emerge in spring. Eggs are laid in shallow holes dug by females in friable soils with sparse vegetation and good solar exposure (Holland 1991).

Known aquatic river habitat includes slow flowing areas, such as side channels. During high flows turtles retreat into oxbow or other wetland habitats adjacent to the river and return when flows decrease. Turtles move overland between aquatic habitats often at distances exceeding 1 kilometer. Aquatic habitat structure includes access to areas of deep, slow water with underwater refugia. Adults and juvenile turtles favor emergent basking sites such as rocks and floating logs. Hatchlings are relatively poor swimmers and tend to seek areas with slow, shallow, warmer water, often with emergent vegetation. Migration, hibernation, and nesting occur on land and, therefore, the terrestrial component of the habitat is equally important to the survival of the species.

Within the LMK Analysis Area pond turtles are known to exist in MaGain's Pond, which is on private land near Orleans, within the slower reaches and side-channels of the Klamath River, and in Twin Lakes at the headwaters of Slate Creek.

Threats
Juvenile predation, primarily by exotic bullfrogs, is the greatest threat faced by northwestern pond turtles. Loss of suitable nest sites due to excessive vegetative cover may also be threatening turtle populations.

Trend
Although the Klamath River region still supports significant populations of pond turtles, and is viewed as a population refugia within the state of California, there are still concerns about the age structure of this population and its implications for future population viability. Pond turtle adults can live for decades, and once they pass the hatchling stage they have relatively high

survivorship, but hatchlings are very susceptible to predation by bullfrogs (among other predators) that now inhabit many of the same aquatic habitats. Suitable upland nesting areas may be decreasing due to brush encroachment into grassy openings that were historically kept open by more frequent wildfires.

Southern Torrent Salamander (*Ryacotriton variegatus*) – FS Sensitive

Suitable Habitat

Southern torrent salamanders are nearly always seen in or very near cold, clear steams, seepages, or waterfalls. Their typical haunt is the splash zone, where a thin film of water runs between or under rocks. Seepages running through talus provide ideal habitat. Larvae are sometimes found with adults, but they usually occur in a little deeper water. Larvae may be abundant in gravel with water percolating through it. Torrent salamanders are closely tied to water sources, but during periods of wet weather they occasionally venture into the surrounding forest (Leonard et al. 1996).

Southern torrent salamanders have been found within the LMK Analysis Area near a spring fed inlet into LePerron Pond, and in the Lower Boise Creek and mainstem Klamath drainages.

Threats

Factors such as logging, road-building, and high intensity wildfire that cause increases in water temperature, decreases in oxygen and increases in siltation in areas of occupied habitat are the main threats to southern torrent salamanders.

Trend

Southern torrent salamander populations appear to be in decline, especially in the warmer, interior portions of their range. It is difficult to assess population trends within the LMK Analysis Area due to limited survey data.

Foothill Yellow-legged Frog (*Rana boylii*) – FS Sensitive

Suitable Habitat

The foothill yellow-legged frog is found in or near rocky streams in a variety of habitats including valley-foothill hardwood, valley-foothill hardwood-conifer, valley-foothill riparian, ponderosa pine, mixed conifer, coastal scrub, mixed chaparral, and wet meadow types. Adults often bask on exposed rock surfaces near streams. Egg clusters are attached to gravel or rocks in moving water near stream margins.

This species is common and abundant within the LMK Analysis Area, especially along the margins of the Klamath River and near slow moving waters of tributaries.

Threats

Primary threats in all areas appear to be altered flow regimes, which impact both eggs and adults, and introduced exotic predators such as brook trout, brown trout, and bullfrogs. Other possible impacts include grazing, mining, and any activities that modify stream flow or affect stream substrates. Oviposition sites are especially vulnerable (Leonard et al. 1996).

Trend

Populations of foothill yellow-legged frogs are declining or absent in much of the southern portion of their historic range. This species occurs at many localities in coastal drainages north of the Salinas River system in California, some of which harbor significant numbers of frogs. In the Analysis Area, although yellow-legged frogs are not uncommon in suitable habitats, they are at risk due to exotic predators, poorly timed water releases from upstream reservoirs that scour egg masses from their oviposition substrates, and decreased water flows that can force adult frogs to move into permanent pools where they may be more susceptible to predation.

Survey And Manage Species

Red Tree Vole (*Arborimus longicaudus*) – Survey and Manage

Suitable Habitat

The Oregon red tree vole (RTV) is endemic to western Oregon and extreme northwestern California. Its distribution is limited to the moist coniferous forest west of the crest of the Cascade Mountains. Within the LMK Analysis Area, the distribution of RTV is believed to be west of the Klamath River.

The red tree vole depends on conifer tree (primarily Douglas-fir) canopies for nesting sites, foraging, dispersal routes, escape cover, and moisture. Red tree voles appear to be closely associated with late-successional forest habitat, and may be sensitive to habitat disturbance. For the purposes of pre-disturbance surveys, potential RTV habitat consists of conifer forests with at least 60% crown closure and conifers averaging at least 10 in. dbh.

Very few areas have been surveyed for RTV within the LMK Analysis Area, with the exception of recent surveys along roads and around private lands north of the main area of Orleans in preparation for a Roadside Fuels Reduction for Community Protection project. Analysis of these surveys is ongoing, but preliminary results suggest that multiple RTV colonies exist within the project area.

Standards and Guides

Within the known or suspected range and the habitat types or vegetation communities associated with this species, protocol surveys must precede the design of all ground disturbing activities. “Habitat Areas” are to be delineated to maintain habitat where RTVs are known or assumed to occur.

The line officer should seek specialist’s recommendations to help determine the need for a survey based on site-specific information. In making such determinations, the line officer should consider the probability of the species being present on the project site, as well as the probability that the project would cause a significant negative effect on the species’ habitat or the persistence of the species at the site.

Any management that occurs within a Habitat Area should not remove or modify nest trees, the canopy structure of the stand, or remove any of the dominant, codominant, or intermediate crowns. This includes activities that may isolate nest trees or alter the microclimate within the stand. Some activities may be appropriate if they maintain or improve, and do not degrade (short or long-term) the habitat conditions in the Habitat Area. Examples of these activities include planting, road decommissioning, trail and road maintenance, culvert replacement, manual vegetation maintenance, special forest product removal, and hand piling and jackpot burning to reduce fire hazard. Because RTVs are potentially affected by heat and heavy smoke that penetrates the crown, burning should not occur directly beneath nest trees or where heat and dense smoke would penetrate the crown.

Threats

The Oregon RTV has many life history characteristics that, given current information, cumulatively raise concerns for its long-term persistence, such as very small home range, low dispersal capability, a sensitivity to stand level disturbances, and extremely low reproductive potential relative to other microtines. This is also a species that turns over its subpopulations rapidly, which is a characteristic of all microtine rodents. Therefore, populations in younger forests must be reproductively successful every year or they will quickly go extinct.

General concerns for this species include:

- Forest fragmentation and isolation of late-successional patches that may prevent gene flow and detrimentally affect metapopulation dynamics,
- Continued loss of small isolated sites and increased geographic isolation of remaining populations,
- Management activities, which alter forest microclimate conditions, target the removal of mistletoe and older trees, and remove older stand types through regeneration harvest,
- The loss of suitable habitats to stand replacing wildfires, and the use of prescribed fire that generates heat or dense smoke that can move through the canopy of stands occupied by RTVs,
- Management activities and landscape planning that do not provide for dispersal between LSRs,
- The potential loss of genetic variability in populations, and
- The effects of reduction in patch size on short and long-term survival and successful reproduction.

Trend

The perceived threats to RTVs, as listed above, suggest that there has been and may continue to be a downward trend in at least some populations across the species range. However population trend is a data gap because there is a lack of information specific to the status of the populations, patterns of abundance, patterns of distribution, and habitat characteristics (USDA, USDI. 2000. Red Tree Vole Management Recommendations – Version 2.0).

Trinity Shoulderband Snail (*Helminthoglypta talmadgei*) – Survey and Manage

Suitable Habitat

On south-facing slopes this snail is usually associated with rock talus. Proximity to a stream and partial shading by trees and bushes may be needed to moderate temperatures and reduce evaporative loss within rock talus. On north facing slopes this snail can live on the forest floor away from streams, does not seem to need rock talus, and finds shelter under woody debris, moss, and leaf mold.

This species has been reported inside the LMK Analysis Area in an area described as “mine tailings at Orleans” (record from1954), which is thought to be near the Owl Mine at Township 11 North, Range 5 East, Section 35.

Standards and Guides

Within the known or suspected range and within the habitat types or vegetation communities associated with this species, surveys to protocol must precede the design of all ground disturbing activities. “Habitat Areas” are to be delineated to maintain habitat where Trinity shoulderband snails are known or assumed to occur.

The line officer should seek specialist's recommendations to help determine the need for a survey based on site-specific information. In making such determinations, the line officer should consider the probability of the species being present on the project site, as well as the probability that the project would cause a significant negative effect on the species habitat or the persistence of the species at the site.

Each occupied, known, and newly discovered site for this snail should be managed by establishment of a Habitat Area around occupied locations that is of a size sufficient to maintain the existing environmental conditions at the site. Existing vegetation and woody debris should be conserved. Inhabited rock talus should not be destabilized. Fire should be avoided within Habitat Areas and used cautiously to reduce hazardous fuels directly adjacent to Habitat Areas. Ground disturbance, soil compaction, and use or spilling of chemicals need to be avoided.

Threats

Possible threats to the generally small and isolated populations of this snail include reduction of trees in and around inhabited sites, destabilization of inhabited rock talus slopes, application or spilling of chemicals, invasions by nonnative species, and direct effects of fire.

Trend

No information could be found on the trend of populations of Trinity shoulderband snails. Very little is known about the ecology of this snail. This species is considered to have a small and patchy distribution, and is generally not abundant where it occurs. However, observations in 1987 of a local abundance of what was thought to be this species near the mouth of Knownothing Creek, which is a tributary of the South Fork Salmon River in Siskiyou County, CA, in a burned-over area, suggests that wildfire can produce a bloom of herbaceous vegetation that may support an increase in the snail population. As the forest recovers, the snail population could fall back to a low level, but during the bloom this species may be able to disperse to other locations.

Oregon Shoulder-band Snail (*Helminthoglypta hertleini*) – Survey and Manage

Suitable Habitat

During the summer, the species is found under rocks or LWD, which serve as refuge sites from desiccation. During the wet seasons, the snail may be found away from refugia, foraging for green vegetation and fruit, feces, old leaves, leaf mold, and fungi. Mollusks that inhabit talus slopes, such as this species, also utilize the surrounding forest areas during moist, cool conditions, ranging out from the refugia to forage in litter of the adjacent forest floor. Vegetation within the surrounding forest not only moderates the temperature and moisture conditions within the rock habitats, but also provides food, loose soil, and litter conditions necessary for egg laying.

There have been no reports of Oregon shoulder-band snails within the LMK Analysis Area, but they are suspected to occur on the Orleans Ranger District. Specimens collected from the Merrill Creek area, near the mouth of the Salmon River and about 1 mile from the north end of the Analysis Area were recently re-identified as *H. hertleini* after having been initially identified as *H. cypriophila*.

Standards and Guides

Within the known or suspected range and the habitat types or vegetation communities associated with this species, "Habitat Areas" are to be delineated to maintain habitat where Oregon shoulder-band snails are known or assumed to occur.

Each occupied, known, and newly discovered site for this snail should be managed by establishment of a Habitat Area around occupied locations that is of a size sufficient to maintain the existing environmental conditions at the site. Existing vegetation and woody debris should be conserved. Inhabited rock talus should not be destabilized. Fire should be avoided within Habitat Areas and used cautiously to reduce hazardous fuels directly adjacent to Habitat Areas. Ground disturbance, soil compaction, and use or spilling of chemicals need to be avoided.

Threats

Possible threats to the generally small and isolated populations of this snail include reduction of trees or shading vegetation in and around inhabited sites, destabilization of inhabited rock talus slopes, application or spilling of chemicals, invasion by nonnative species, and direct effects of fire.

Trend

No information could be found on the trend of populations of Oregon shoulder-band snail. Very little is known about the ecology of this snail. This species is considered to have a small and patchy distribution, and is generally not abundant where it occurs.

Human Uses and Needs

Social

Social and Human Uses – Reference

- *What were the historical settlement and use patterns of the communities in the Analysis Area?*

The Karuk, Yurok, and Hupa tribes reside within and near the LMK Analysis Area, and have been, and still are, connected to each other through intermarriage, kinship, overlapping resource procurement areas, inter tribal resource trading, trading of various resources, and tribal as will as individual reciprocal participation at ceremonies. The observation of the anthropologist Kroeber, who regarded the world renewal ceremonies of the Karuk, Yurok and Hupa as a closed ceremonial system that was distinct from all other systems of Native American religion, holds true as much today as it did one hundred years ago. He saw the system as comprehensive, involving all persons in these tribes.

"Of well over a hundred and perhaps nearly two hundred Karuk, Yurok, and Hupa towns or settlements, only about a dozen held Word Renewal rituals – only they might properly make them, in native belief. But these were on the whole the largest towns. Moreover, inclusion of the towns of next size, those which equipped contributory dances, would raise the number of participating settlements to around forty; and these forty would contain more or less half the total population of the three nationalities. Not all members of this total population were in publicly recognized personal relation to the ritual system; but they participated at least as minor kinsmen, affinals, neighbors, or friends of those having acknowledged functions" (Kroeber and Gifford 1949).

The environment of the Lower-Middle Klamath River provided resources that allowed the Karuk, Yurok, and Hupa people to live in permanent villages and establish a material culture unique to the Pacific Northwest. Among other resources, these groups were dependent on anadromous fish as a major subsistence resource. For this reason, they tended to inhabit permanent village sites located along the major waterways within their territory. The Karuk, Yurok and Hupa tribes have resided historically in permanent villages with substantial houses that are located on the river terraces or flats adjacent to the Klamath and Trinity rivers. Their rectangular houses were semi-subterranean, and were usually made of cedar planks (Wallace 1978). The surrounding hills and mountains were visited seasonally to secure both plant and animal resources. Due to the richness of the natural resources found within the LMK area this same environment also lured trappers, miners, settlers, loggers, and the government.

Resource Use

The Karuk, Yurok, and Hupa practiced similar subsistence strategies and had cultural affinities with the aboriginal groups extending north along the Pacific coast into Oregon, Washington, and British Colombia. However, in this region of northwestern California, resource procurement strategies of these tribes can be divided into two major types, which were discussed by Kroeber (1925). The principal subsistence resources utilized by the Karuk, Yurok, and Hupa were anadromous fish and acorns.

Fishing grounds were traditionally inherited and owned by families. The right to fish at a family fishing site for a specified amount of time could be purchased from the family. Salmon, lamprey eel, and steelhead trout were caught in the river and tributaries during their annual migrations, which included the spring and fall runs. In some strategic locations fishing dams or weirs were constructed each year. Many devices and techniques allowed for efficient harvest of anadromous fish runs including fish weirs, basketry traps, dip, thrust, arc and A-frame nets, toggle harpoons, and application of botanical fish poisons. Historically, Karuk fishermen used weirs on the Klamath River. Weirs were typically made of heavy, crossed stakes of fir driven by cobblestone mauls into the streambed, with stones piled at the base of these crossed stakes. Horizontal poles were placed at the crossed stakes and used as a walkway for fishing. Smaller poles were lashed together or woven and placed on the upstream side of the crossed stakes. When the weir was not in use, the smaller poles were removed to allow fish passage. The weir framework was left in place until it was washed out by high water in early winter.

Acorns were collected in the fall. Tanoak acorns were preferred but most kinds were collected and utilized. Various plants in the hills were used for food resources (e.g. grass seeds and bulbs) and for basketry materials. Villages or extended families had ownership of some of these gathering areas, such as specific tanoak groves.

To the Karuk and other northwest California peoples, salmon is the staff of life in a sacred and ordinary sense. Throughout their existence in the Klamath River region, the Karuk, Yurok, and Hupa have acknowledged the fundamental importance of salmon in their values, myths, personal spiritual quests, esoteric rituals, and communal ceremonies. To this day salmon (along with acorn soup) is required as a necessary ingredient in the spiritual welfare and diet of the people. Mythical and ritualistic treatments of salmon and other fish among the Karuk are fairly well documented and interpreted.

The two most abundant and important species in Karuk livelihood were the King or chinook salmon (*Oncorhynchus tschawytscha*) and the tanoak (*Lithocarpus densiflora*). To the Karuk, salmon and acorn soup were the “best food” (pa’avahayeshiip). Some informants might add venison, principally from the fairly abundant Columbia black-tailed deer (*Odocoileus hemionis*), to the category of “best food”.

Other foods of secondary importance or preference included silver or coho salmon (*O. kisutch*), steelhead trout (*O. mykiss*), sturgeon (*Acipenser spp.*). Pacific lamprey eels (*Entosphenus trideotatus*), Roosevelt elk (*Crevus canadensis roosevelti*), black bear (*Eurarctos americanus*), hares (several species), and acorns from the Oregon, canyon live oak, sadler oak, and black oak (all members of *Quercus spp*.).

Smaller fishes (e.g. suckers, minnows, and sculpins), various forest birds and rodents, and wild seed, bulbs, roots, greens, nuts, and berries provided additional nutritional variety and insurance. An ethnobotany survey has described 239 species utilized by the Karuk. Of these, at least 60 were identified as food plants, including rye grass, wild oats, grass seeds (*Bromus hordeaceus*), soap plant bulbs, hazel nuts, squaw root, wild onion, raspberries, choke-cherries, huckleberries, wild peas, winter hemp seeds, madrone berries, and straggly goose berries. Half a dozen food plants also served as medicines for a variety of ailments, and 30 other species were described as medicines only. The domestication, curing, and use of native tobacco (*Nicotiana biglovii*) have been extensively documented in daily life ceremonies.

The Karuk, Yurok, and Hupa people historically began their year in September after the world renewal ceremonies were held. For the river people September, the fall of the year, was the beginning of their new year. The year of gathering began with the White Deerskin Dances in the fall when the salmon began their migration up the Klamath and Trinity rivers. During these fall months, acorns from numerous species of oak and tanoak trees, as well as other resources such as chinquapin nuts, pepperwood nuts, and the numerous berries that are found along the river corridor, were gathered. The gathering and storage of these resources continued through October and November. Little gathering occurred during the winter months of December, January, and February. February, March, April and May brought the spring migration of salmon and it was during these months that many fresh shoots, roots, berries, herbs, and basket material became available to harvest. The summer months of June, July, and August continued to provide edible, medicinal, and other useful plant resources. During the spring and summer the tribal groups migrated up the mountain slopes to collect plants, and to hunt deer and elk for winter stores.

The ability to have some control over their environment and, to a certain extent, influence other organisms within that environment would have been essential in creating dependable resource procurement areas. The dependability of seasonal resources could have been one of the factors that enabled the people to change subsistent strategies, from being small family groups of mobile hunter-gatherers who traveled long distances to groups who lived all year in one location. Trading partners and trade routes established between the tribes allowed for the flow of goods from one geographic area to another and increased their ability to live in one place year round.

Fire

Ethnographic accounts for the LMK Analysis Area as well as anecdotal statements from Native Americans and the first non-native people indicate that anthropogenic (human-caused) and natural fires were common prior to the historic era. The majority of, but not all, the edible and medicinal plants that the native populations utilized were enhanced by fire. The improved quantity and quality of the plant species would lure animals into the area. Improved forage would result in healthy animals and an increase in the number of offspring that a single animal could and would produce. In other words, the composition of the flora had a direct effect on the fauna.

Evidence of a more open canopy and a wider distribution of white and black oaks within and along the slopes of the Klamath and Trinity River in the 19th and the early 20th century has been documented in interviews with long-time residents and in historic photographs of the Klamath river corridor from Somes Bar to Weitchpec and along the slopes of the Trinity River south of Weitchpec. The environment of the LMK Analysis Area provided resources that allowed the Karuk, Yurok, and Hupa people to live in permanent villages and establish a material culture unique to the Pacific Northwest. Due to the richness of the natural resources found within the Analysis Area this environment also lured the explorers, trappers, miners, settlers, loggers, and the government.

History

The first contact between the three tribes and Euro-Americans took place in 1828 when the Jedediah Smith party traveled along the Trinity River on their way to the coast. Intensive contact began after the discovery of gold in 1848 in the upper reaches of the Trinity River. The coastal ports of Union (Arcata), Humboldt City, Buck's Port, and Eureka competed for primacy in supplying the Trinity mines. The first development within the region occurred in the early 1850's with the development of supply trails to the mines from the coast. During the first decade and a half that the trails were open there were numerous skirmishes with the local Indian population. An Indian agent of the federal government was dispatched to quell the troubles in northern California.

Many of the confrontations that occurred during this time are discussed in *Indian Wars of the Northwest* (Bledsoe 1885). The violence escalated and between about 1862 and 1864 the "Two Year war" between the settlers and Indians was being waged throughout the interior sections of Humboldt and Trinity counties. The conflicts, when they occurred, were nearly always one-sided with the weapons and lack of organization among the aboriginal groups being no match for the firearms and the well-supplied army troops of the settlers.

By 1865 the last of the violent conflicts with the Indian tribes had ended and this event opened up interior sections of Humboldt County to development and settlement. A number of settlers homesteaded in Hoopa Valley, eventually however, agreements were reached that created the HVIR (Figure 1). The reservation boundaries included the most strategically important part of Hupa territory: the Hoopa Valley within the "Hoopa Square". At the time of establishment of the HVIR, tribes in the surrounding area were expected to go to this reservation. Lands to the north and east of the valley within the LMK Analysis Area remained in public domain.

The communities in the LMK Analysis Area developed around a resource-based lifestyle that at some point in time included an active logging industry. As the timber industry grew within this watershed the local people developed their skills in this profession and began to diversify their small homestead income by becoming laborers in the timber industry. These small communities predate the logging industry unlike other local communities in northwestern California that were developed to support the industry. Consequently, the citizens of the area live here because of a long tradition and attachment to the land that predates the logging industry. At the same time, the data indicates that some of the community members migrated to the Orleans-Somes Bar area to work in the timber industry, grew to love the area, and stayed even when their ability to earn a yearly wage by logging stopped. The history of these communities is one of continuous adaptation to radically changing economic conditions. Through all, the residents managed to get by on a subsistence lifestyle that took advantage of the richness of the natural environment. People live here because their families have lived here for nearly a century or because their people have existed here *"since the beginning of time, and before that"*. They have long traditions of attachment to the land that outweigh the current economic situation.

Mining

The historic mining activity within the LMK Analysis Area is extensive. Placer gold was discovered at New Orleans Bar (Orleans), in 1850 and the California State Mineral report for Humboldt County during the period of 1887-1888 showed 15 large mining claims/syndicates operating within the of the Klamath River from Somes Bar to Weitchpec. However, the size of mining operations varied, with individual claims holding from 30 to 1,310 acres. Mining was so extensive that small farms were established in the Orleans area to provide food for the miners and livestock feed for their animals.

At the beginning of this period miners removed gold by mining placer gravel by hand. Drift mines, which were small tunnels dug at the level of the water and bedrock, were also used. After the easy gold played out the miners started using a method called the Coffer Dam or Wing Dam. In the 1870's small scale hydraulic mining was introduced into the LMK Analysis Area, which employed the technique of ground sluicing. This type of mining used a small monitor and very little water, and the placer deposits located at the outfall of creeks where mined this way. The end result was often the rearrangement of the river flats where the creeks ran into the Klamath River.

In the 1870's and on into the 1880's large scale hydraulic mining began within the LMK Analysis Area. The large-scale hydraulic mines required much capital and water to begin and maintain operations. Professional engineers were employed to develop complex water delivery systems that would divert the natural flow of the creek into the mines. The Orleans Bar Gold Mining Syndicate operated 4 large hydraulic mines simultaneously on double shift from 1888 to 1912.

Despite the large-scale operations, smaller scale mining continued along the Klamath and it's tributaries. According to the Eighth Annual Report of the State Mineralogist (1888), the important mines on the Klamath River between Weitchpec and Somes Bar included the Big Bar, French Bar, Red Cap, Two Yoc Bar, Saroorana (sic), which was leased by Chinese, Ferris, Orleans, Perche, Markerson, Uscillian, and Nelson mines, most of which were hydraulic operations with ditches and flumes to supply waterpower. The Orleans Mining Syndicate operated in Orleans within the Camp Creek area. Ditches and flumes were dug in the surrounding hill slopes to channel water to the hydraulic water monitor that operated on the river bar. In the 1890's, J C. Pearch mined away much of the flat land near the site of the modern Orleans Karuk Community Center (Times-Standard Newspaper, February 4, 1977).

Placer and hydraulic gold mining continued throughout this period, and even increased during the late 1930's. Pearch Mine near Orleans was a major hydraulic mine that was still in operation during this time. In the 1940's a dredge was put in the Klamath River channel below Orleans starting above Hillman's riffle. This area was dredged for a year, and all along the tailings were cast into the mainstem of the Klamath River. This resulted in a line of tailings in the channel that ran parallel to the line of the river. In 1955 a flood occurred on the Klamath River, and the line of tailings from the 1940 dredging diverted the main thrust of the flood to the south shore. The floodwaters eventually topped the line of tailings, but by then the river had diverted into the south bank of Chimmekanee Ridge, which permanently changed the course of the river. However, the rerouting of the Klamath River may not have been solely the result of the dredging operation, but rather could have been caused by a variety of factors.

Originally named Panamnik by the Karuk and then New Orleans Bar by the mining community, the mining camp of Orleans became the county seat of Klamath County as well as a trading and population center for the Klamath River mines. In 1874 the area around Orleans was surveyed and township and section lines were established. Also, by this time, Klamath County had financial problems stemming from the decline of mining and an inadequate tax base in the small and transient population, so the county was dissolved in 1874 and it's land annexed to neighboring Humboldt and Siskiyou Counties. For additional discussions on mining, see the ***Mining*** section of ***Fisheries*** under ***Factors Contributing to the Decline of Fish Species at Risk.***

Transportation

The Karuk, Yurok, and Hupa peoples had an extensive network of trails that were used for a variety of purposes. The trails linked the river villages to the high country, the hunting and gathering areas, and each other for trading, ceremonial, and social purposes. These trails were used for subsistence activities, trade with other groups to the north, south, east, and west, and religious purposes.

Although pack trails began to open up the country soon after mining began, no roads to New Orleans Bar were built until 1921. A ferry and a wire suspension bridge for foot traffic were available for crossing the Klamath River in the 1860's. A trail along the north bank of the Klamath River upstream to Somes Bar was recorded on a map of Siskiyou County (Theodoratus 1979). Two major trails, which linked the HVIR to Somes Bar, were recorded on an 1889 map. The first trail crossed Red Cap and Boise Creeks and joined the Klamath River trail at Orleans. The other trail followed the north side of the Klamath River from Weitchpec upriver beyond Somes Bar. Major improvements in the trails and bridges were not made until after the USFS was established in 1905.

Orleans Ranger District Development

The Forest Reserve Act of 1891 authorized the President of the United States to reserve certain forestlands in the public domain for the primary purpose of protecting watersheds in timbered areas. By 1892 there were fifteen forest reserves with a total of more than thirteen million acres. In February 1905, sixty-three million acres of the forest reserves were transferred from the USDI to the USDA's Bureau of Forestry (upgraded from division level in 1901). In April and May 1905, presidential proclamations created the Trinity and Klamath Forest Reserves in California, and in July of that year the Bureau was renamed the United States Forest Service.

When the USFS acquired a new National Forest, it set out immediately to construct roads, buildings, and communication systems to provide the means of managing the forest. In the KNF, a ranger station was built in Orleans in 1906; a telephone system was planned; and the need for trails discussed. Construction soon began on staff living quarters, barns, telephone lines, and trails. Within the next few years, funds were available and work was performed for additional ranger stations, fences, trails, and the telephone line to Orleans. By 1917 telephone wires connected the stations at Orleans and Somes Bar, and Greek contractors and workers were building a road between the ranger stations. The section of wagon road between Orleans and Weitchpec was completed in 1921.

The chronology of the settlement period of the LMK Analysis Area during 1905 through 1936 is incomplete because many of the old records are missing. Twelve homestead claims from 1906 through 1936 were surveyed. Generally the homesteads were located on river benches and settlers had small, fenced gardens and raised chickens and cattle. Most settlers had a horse or mule for transportation over trails to Orleans. Settlers sometimes had part-time or seasonal jobs as miners, carpenters, sailors, or USFS lookouts.

There were two Indian allotments recorded during the early 1900's. One claim was rejected because the tract had been opened earlier to homestead entry under the Forest Homestead Act of 1906. The other claim was for land settled by two miners around 1905. One of the miners died without a legal heir, but the son of the Indian woman who had lived with him was issued an allotment for the portion that had improvements and cultivation (USFS, Old Files: Orleans, California #52-25).

The CCC Era

The Civilian Conservation Corps (CCC) began in 1933 to relieve some of the unemployment caused by the Depression. Young men in the CCC performed much of the work on the National Forests in the 1930's. The USFS administered almost half of the CCC projects; employing men in fire fighting, fire prevention, and the construction of roads, trails, campgrounds, and administrative facilities. Some of the CCC workers were born and raised in the area, but only two individuals from any family were allowed to work for the CCC. Many of the CCC workers came to the Klamath River from other parts of the country. A few of these men married local women and stayed in the Orleans and Somes Bar area.

Grazing

Grazing within the LMK Analysis Area by transport animals and, to a lesser extent, cattle, was extensive on the moderate slopes prior to the establishment of roads. Afterwards, relatively little grazing was conducted. Crawford Creek and Camp Creek, with 35 cattle, were the only allotment areas within the Analysis Area during 1947. The usual grazing season was July 1 to October 15th, but Crawford and Camp Creek permits were only for the month of June.

Logging

The nation-wide, post-World War II building boom increased the demand for lumber. Private timber was insufficient to meet this need, so National Forests were logged at an increasing rate. Timber sales in all National Forests jumped from 1.5 billion board feet in 1941, to 4.4 billion board feet in 1970.

Timber sales on the SRNF before 1947 were negligible, with only 16,000 mbf cut on 1,675 acres, but demand was rising. Twenty-one lumber mills were located within or immediately adjacent to the SRNF, and several large companies had inquired about buying timber belonging to the National Forest. Demand for timber was the greatest in Orleans, Lower Trinity, and Mad River Ranger Districts.

Within the LMK Analysis Area, one mill existed in Orleans. This mill employed many Orleans residents in all aspects of timber harvest from felling trees to converting the timber to lumber and hauling the finished product to market. The Orleans mill closed in the 1970's and all the milling equipment was auctioned off. Leaving just the large empty tin buildings and a dry millpond.

Between the 1960's and the 80's, demand increased for timber within the LMK Analysis Area. However, the late 1980's and early 1990s saw a conflict between traditional timber management and resource protection. During this time timber management became increasingly difficult as more areas were designated for other uses.

Heritage Resources

In the late 1970's archaeological surveys were first undertaken within the Analysis Area in response to new legislation related to the survey and recordation of cultural resources. Over the decades of the 1970's and 1980's a substantial number of timber sales were surveyed for cultural resources. During the course of these surveys numerous heritage sites including spiritual locations, trails, historic camps, flake and tool scatters, and subsistence gathering locations were documented. To date approximately 15,000 acres have been surveyed within the LMK Analysis Area.

Within the Analysis Area are ceremonial villages and areas of ceremonial importance to the Karuk and Yurok tribes: *Amakiyaram*, *Panamnik*, *Sawaram*, Red Cap Creek, Somes Mountain, Orleans Mountain, Shelton Butte, Hopkins Butte, Burrill Peak, as well as the Bluff Creek and Weitchpec areas. Many of the trending ridge systems from the river canyons up to the high mountain peaks were the travel routes utilized by ceremonialists. The Hupa's ceremonial areas are located outside of the LMK Analysis Area boundary.

To date, 18 prehistoric sites have been recorded within the LMK Analysis Area. These sites were located along the lower mountain slopes adjacent to water sources, and in the higher reaches of the drainages along ridges or flat areas. Most of these low elevation sites contain primarily groundstone artifacts often with small amounts of chert and obsidian flakes. Archaeologists have noted the presence of formed artifacts including projectile points on many of the sites. Most formed artifacts date from the Late Period. Prehistoric trail routes and trail segments have been recorded within the Analysis Area.

The ceremonial area *Panamnik*, which is within the Analysis Area, has been determined as eligible for the National Register of Historic Places. Many of the prehistoric village sites within the Analysis Area are potentially eligible for the National Register of Historic Places but they have not yet been formally assessed to determine if they meet the National Register criteria for inclusion on the Register.

Within the LMK Analysis Area 12 historic cabins and or homesteads have been recorded. Many of these cabins are associated with small mining claims, and a few have been associated with logging activities. There have been 6 large mining claims/syndicates that have been recorded within the Analysis Area, even though many unrecorded mines and signs of exploratory mining can be found on a majority of high river terraces along the Klamath and Trinity River canyons. There are 5 sites that contain segments of mining ditches and or flumes. Since the mining activity within the LMK area was extensive there are many small mines and mining activity areas within the Analysis Area that have not yet been officially recorded.

Numerous trails laced the LMK Analysis Area during the past. To date, most of these trails have not been officially recorded. Twelve trails and/or trail segments have been formally recorded and most probably date to the prehistoric area.

Social and Human Uses – Current

- *What is the make-up of the various communities in the Analysis Area?*

The Analysis Area is predominately composed of public lands under the jurisdiction of the SRNF, the HVIR under the jurisdiction of the Hoopa Valley Tribal Council, and the YIR under the jurisdiction of the Yurok Tribal Council, and private lands. The local communities of Orleans, Somes Bar, and Weitchpec, have a long history with the LMK Analysis Area and have a high level of concern for the management of the environment, river resources, and economy that surround their communities.

The following sections discuss the findings as they pertain to the socio-cultural values that were obtained from published and unpublished written documentation. Data has been taken from written letters, reports, and planning documents of the Karuk, Yurok, and Hoopa tribes, as well as formal government-to-government consultation with Tribal Councils. Information was also obtained from other written materials generated by communities, tribal governments, and other federal agencies and groups utilizing or having interest in the Analysis Area.

Native American Tribes

Karuk

Karuk individuals and the Tribal Government are actively concerned about what occurs within the watersheds of the Analysis Area. The study area encompasses aboriginal lands utilized extensively by Karuk people. It includes over 35 documented village sites, numerous gathering, hunting, and prayer site locations, and the ceremonial areas of *Amekyarum* and *Panamnik*. The Analysis Area contains approximately 31 acres of Karuk tribal lands held in trust and about 0.62 acres of tribally owned land in fee status. These acreages are primarily tribal housing and office facilities. There is also about 52 acres of private domain allotment trust land owned by private individuals of Karuk ancestry.

The Karuk Tribe is a federally recognized tribe and, as such, has authority under their constitution to represent tribal members interests and rights. The majority of Karuk tribal members now reside in Orleans within Humboldt County, and in Somes Bar and Happy Camp within Siskiyou County. The tribal government seat and most primary tribal offices are located in Happy Camp. The Karuk Tribal Natural Resources Department has located their primary office in the community of Orleans adjacent to the Karuk Tribe/St. Joseph Health Systems clinic and the Karuk Tribal Head Start, which are all in a small building complex on the north side of Orleans. Additionally, the Karuk Tribal Housing Department has a small office in the Orleans area. The Karuk tribal government and Karuk community members are active in voicing socio-cultural values, in utilizing natural resources, working to protect culturally significant locations, and interacting with various land management agencies regarding these matters.

The Tribe has produced two management related documents that address their concerns, priorities, goals, and preferred management strategies on NFS lands which encompass aboriginal lands: *Karuk Ancestral Lands Forest Management Plan (1989)* and *Karuk Tribe Module for the Main Stem Salmon River Watershed Analysis (1996).* Both documents were developed to assist the Six Rivers and Klamath National Forests to understand the Tribe's sincere interest and responsibility to be actively involved in the management of watersheds within their aboriginal lands.

Hoopa

The Hupa people and their tribal government are active in the Analysis Area particularly on issues associated with the Klamath and Trinity River's water and fishery. The study area contains approximately 7,000 acres of HVIR that is adjacent to NFS lands and part of the YIR (Figure 1). The Hoopa Tribe is a federally recognized tribe and, as such, has authority under their constitution to represent enrolled tribal members interests and rights (Hupa refers to the people, Hoopa refers to the tribe, town, and reservation). The Tribe actively manages its natural resources including tribal resources within the Hopkins Creek and Cavanaugh sub-watersheds of the LMK Analysis Area. The Tribe and Hupa individuals are involved in voicing socio-cultural values to land management agencies. They express concern about the availability and quality of the materials they gather, protection and access to culturally significant locations, and concern about water quality and quantity in all aspects of life, but particularly in relations to producing healthy fisheries.

Yurok

Yurok individuals and the Yurok tribal government are active in the LMK area. The Analysis Area contains approximately 215 acres of the YIR, part of which is adjacent to NFS lands and HVIR (Figure 1). The Yurok tribe is a federally recognized tribe and, as such, has authority under their constitution to represent enrolled tribal members interests and right. Currently, there are three Yurok Tribal offices, two of which are located on Reservation lands and one that is in Klamath within Del Norte County. The primary tribal office is located in Eureka. The Yurok Community Center, which is located on the northern side of the bridge on Highway 96 in Weitchpec, is a multi-room facility that houses the United Indian Health Services offices and several Yurok Tribe department offices. Tribe and Yurok individuals represent socio-cultural values to land management agencies. They express concern about the availability and quality of materials they gather, protection of culturally significant locations, and, particularly, water quality and quantity, and the production of a healthy fishery.

The SRNF has existing individual government-to-government protocol agreements in place with the Karuk, Yurok, and Hupa's tribal governments to establish and formalize a government-to-government relationship. These agreements recognize the need to formalize the process of communication for land and resource management decision-making and for other governmental relations. The objectives of these protocol agreements are to have effective communication that is the best course in achieving the common goal of wisely managed and sustainable natural resources.

Local Communities

Orleans-Somes Bar

The Community of Orleans closely affiliates with the neighboring small community of Somes Bar, which is in Siskiyou County. In fact, many individuals will say they are from "Orleans-Somes Bar". Individuals living throughout the area receive their mail at the post office in Orleans. It is nearly impossible to consider one community without the other, since the residents see the area as a single community. The Orleans-Somes Bar Chamber of Commerce is very active in promoting the area and has an Internet web page. Their Internet site promotes the area's salmon and steelhead fishing, the Big Foot Company, the Big Foot Scenic Byway, and the full services of Orleans, Hoopa, and Willow Creek. Also a Community Action Plan is written for “Orleans-Somes Bar”. Somes Bar has a population of about 150 with a single retail business serving recreational users, local residents, and others. It is located on Highway 96 near the junction of the Klamath and Salmon rivers (Humboldt County Employment Training Department 2000, 96-98).

The area’s population is around 780 with the main industries being organic farming and small business and individual enterprise, most of which is natural resource based or service-oriented, which provide lodging, RV space, or recreational experiences. Some residents of the area are ranchers, some artisans, and there is a large retirement community. State, county, and federal government agencies also operate in this area. There are few employers in the Orleans area and by far the largest of these is the USFS, with the Orleans and Ukonom Ranger District Stations located there. Other businesses include The Mining Company Mall, which has a café, store, laundromat, twelve-room motel, and gas and diesel pumps. There is also a service station, one market, a variety store, an art gallery, computer center, and bait shop. Employment in the Orleans area tends to be seasonal (Ibid.).

This community is a mix of young and old, educated and uneducated, ex-timber company and forestry employees, and environmentalists. Despite this eclectic collection of ideals and world-views, differences within the community are often successfully set aside and community projects and goals accomplished. As a whole the community is very focused and active, and very capable, motivated, and cohesive in their goal-setting and achievement (Ibid.).

Community participation is strong in Orleans as evidenced by the six service organizations in this small local community. These community based organizations are: the Orleans-Somes Bar Chamber of Commerce, Assembly of God Church, Orleans Community Service Club, Humboldt Senior Resource Center-Orleans, Community Computer Center, and Fire Safe Council. The Karuk Tribe is actively involved in supporting community efforts and the various service organizations also. Together these groups have identified many community needs among various population groups, and each is actively pursuing means to facilitate a healthier community (Ibid.).

Weitchpec

The primary and most populated (about 150) community in the YIR is Weitchpec, which is located at the confluence of the Klamath and Trinity Rivers along Highway 96. The rivers divide the community of Weitchpec, and residents live on both sides of the small bridge that spans the Klamath River. The community of Weitchpec is a mix of Yurok tribal members, non-members who are of Native American descent, and non-Indians. From the community of Weitchpec northward on Highway 169 along the Klamath River, there is no reliable water, power, or telephone service. Residents in this region of the Humboldt County are the most geographically remote in terms of services of all residents of the County. There is a single retail business, a small grocer and gas station located on the southern side of the bridge in Weitchpec, which services local residents and tourists. There is also a take-out site for rafters and a well used fishing bar below the town. The Yurok Tribe has recently constructed a Community Center in Weitchpec that houses the United Indian Health Services offices and several Yurok Tribal offices. The Yurok Tribe and the Klamath-Trinity School District are the major employers in this remote area (Ibid. 243).

Government Consultation – Tribal Government's Perspective

- *What are the perspectives on resource management among the communities and groups within the LMK Analysis Area?*

Karuk Tribe

The Karuk Tribe have spent a considerable amount of resources and time communicating their goals for Karuk aboriginal lands regardless of who has management responsibilities for those lands. The key components of their goals and objectives that are relevant to the LMK watersheds are found in two major documents that the Tribe produced: *Karuk Ancestral Lands Forest Management Plan (1989)* and the *Karuk Tribe Module for the Main Stem Salmon River Watershed Analysis (1996).*

Karuk Ancestral Lands Forest Management Plan (1989)

The *Karuk Ancestral Lands Forest Management Plan* was developed by the Tribe to communicate the Tribe's goals, objectives, and desired conditions for the their ancestral lands to the Six Rivers and Klamath National Forests, which together manage the majority of the Tribe's ancestral lands. The Plan provides the Karuk's desired management objectives for Ikes, Pearch Creek, Whitey's Gulch, Boise Creek, Crawford, Ullathorne, Slate Creek, Aiken's Creek, and Hopkins Creek sub-watersheds through a set of management directions that would apply to the larger aboriginal territory. They developed Standards and Guidelines that would be acceptable to them. The following are the general goals and objectives the Plan identifies that could apply within the study area (Karuk Tribe 1989, Executive Summary):

- Provide maximum protection to cultural sites and cultural values.
- Develop and enhance as a primary resource locally the native fisheries that are culturally and ceremonially important to the tribe.
- Develop locally native fisheries in sufficient numbers to provide subsistence to tribal members.
- Develop locally native fisheries in sufficient numbers to provide economic benefits to tribal members.
- Provide economic benefits to tribal members though harvesting timber in an appropriate manner.
- Provide for the continuation of culturally important practices such as gathering.
- Resolve environmental conflicts due to timber management on ancestral lands.
- Provide for Karuk self determination, especially tribal government, in ways that maximize the Tribe's sovereign governing authority.

Karuk Tribe Module for the Main Stem Salmon River Watershed Analysis (1996)

The Karuk Tribe's Natural Resource Department wrote this document under contract for the KNF Main Salmon Ecosystem Analysis. The document provides comments on the KNF's Main Salmon River Watershed Analysis issues, and responds to management opportunities that were identified by the Forest Service's ecosystem analysis team. It also provides an inventory of the results of Karuk scoping issues and presents a prioritized list of concerns and recommendations regarding land management throughout Karuk aboriginal territory. The following is extracted from Section VI of the report "Inventory of Karuk Scoping Issues" that was prepared in response to a request by the KNF to identify and rank issues of major management concern through Karuk territory (Karuk Tribe of California 1996, VI-1 – VI-15): (Take note that the list below, which is not in any order, includes only a summary of those recommendations that seem to address resources or issues within the LMK Analysis Area and does not include all the issues identified in the document.)

- Refine the current boundaries of the Cultural Management Areas at *Inam*, *Katamin*, and *Panaminik*. The KNF's Land and Resource Management Plan identifies that the KNF and the Tribe will jointly develop Memorandum of Understandings (MOU) to address *Inam*, *Katamin*, and *Helkau*. The *Panaminik* area was not covered in the Klamath's LRMP because it is located wholly on the SRNF and within the Analysis Area. The Tribe recommends establishing one stand alone MOU that addresses management of the *Inam*, *Katamin*, and *Panaminik* Cultural Areas. The *Helkau* area is not within the Analysis Area.

- The tribe seeks agreements with the USFS that recognize and respect aboriginal resource rights, including the gathering of mushrooms, firewood, and traditionally utilized medicinal, ritual, and basketry materials without encumbrance, including the requirement of permits. Culturally significant fauna, flora, and processes of resource procurement need protection through the development of comprehensive policies. There is a need for better compliance with the areas set aside to provide for subsistence harvesters in order to ensure those areas are not being heavily affected by commercial harvesters.

- The protection of archaeological sites within ancestral territory is of great concern to the Karuk Tribe. With close coordination between the tribe and the Forest, effective strategies for monitoring and protection of these irreplaceable cultural resources can be developed.

- Forest recreation and tourism could have serious negative effects on tribal interests and values if not developed appropriately. Interest in rafting, kayaking and other recreational activities is generally not a local interest. To date interest in recreation is coming and being promoted from outside the area and these same parties are largely realizing the profits. The Tribe feels strongly that local benefits should always be realized in return for the use of local resources. Recreation needs to be developed carefully, with attention to the effects on nearby communities and these goals in mind.

- Fire salvage policy is a major concern to the Tribe. A history of misuse of fire salvage sales has resulted in the expectation that virtually every such sale will be contested. The mistrust that has become the norm in relation to salvage sales carries over into a generalized mistrust of USFS timber harvest policy by the Tribe, environmentalists, and local interests. Fire salvage policy in the future needs to be addressed through MOUs and carefully considered, cooperatively designed, fire salvage sales.

- Road stabilization, decommissioning, density, and use are all concerns for the Tribe. Tribal health and vitality requires continued survival of anadromous fish stocks. The inability of the Forest to adequately assess cumulative impacts from these unreasonable road densities continues to threaten this most significant cultural and natural resource. Because road construction is a major cause of siltation, there needs to be not only close scrutiny of all proposed road building, but a strong program of road decommissioning.

- The present policy of gating roads as a means of road protection once projects have been completed does not serve the public interest. The appropriate response to the problem of excessive road density is not the gating of roads and denying public access but the decommissioning these roads. Gathering within aboriginal territory remains a mainstay of Karuk culture. An environmentally appropriate level of ungated roads will guarantee the necessary access to gathering areas, which will reappear as a consequence of restored forest health.

- Fishery restoration is an issue of profound significance to the Tribe. Their dependence on these fish, and the spiritual relationship that exists between them, makes it essential for the Karuk Tribe to be involved in all aspects of fisheries management and habitat restoration. The Tribe's fishery related interests extend to general land management practices that affect the health and vitality of fisheries.

- It is a key goal of the Karuk Tribe to reinforce tribal communities within ancestral territory.

Yurok Tribe

Yurok Management Goals for the Klamath River Basin

The LMK Analysis Area includes ancestral lands of the Yurok Tribe, and the Hopkins Creek sub-watershed includes portions of the YIR. The Tribe has federally reserved trust rights within and without the YIR. Trust resources within the Cavanaugh compartment that the Tribe and tribal members utilize include various commodities such as water, fish, timber, wildlife, vegetation, and land. There are several domestic water sources within the Analysis Area. Recently the Tribe identified its management strategy and goals for the Klamath River Basin in a letter to President Bush:

- The Klamath and Trinity River fishery are indispensable to the Yurok Tribe's culture, religion, and economy. The Yurok people have depended on the Klamath and Trinity rivers for their food, cultural ceremonies, transportation, commercial trading, and religious life. The ancestral territory of the Yurok Tribe was centered on the rivers, and today the YIR extends for 1 mile on each side of the Klamath River for 45 miles from the Pacific Ocean to the confluence of the Klamath and Trinity rivers. Because of the Klamath Rivers' importance, one of the Tribe's highest priorities is to protect and preserve the resources of the rivers, and, particularly, to restore the anadromous fish runs to historic levels that sustained the Yurok people. Anadromous fish still continue to form the core of the Yurok tribal fishery. The Tribe is pursing its fishery restoration goals through a fish management and regulatory program, and, where necessary, litigation. The federal government has a legal duty to manage fisheries outside the YIR in such a way as to protect the Tribe's opportunity to harvest their legal share of fish.

- The goal of the Yurok Tribe is to restore the anadromous fishery in the Klamath and Trinity rivers to historic levels. The Tribe is devoting a large share of its budge to fishery management and regulation. They have enacted a fisheries ordinance to ensure that the fishery is managed responsibly, and is sustainable (Ibid.).

- There is a need for restoration and improvement to the natural resources on the YIR. Stream restoration and watershed improvement should be a priority. These projects will allow for improved economic gain in the future from the ameliorated environments in the forest (timber) and waterway (fisheries), and provide employment on the projects as they occur. There is also a priority for retention of Yurok culture and cultural knowledge among Yurok citizens (Yurok Tribe 1998).

Other Information Provided by the Yurok Tribe

- Fire suppression and/or lack of prescribed fires are important issues. Within the study area, various activities can either adversely impact or enhance Tribal member and governments' lifestyle and expectations. USFS activities involving fire have the potential to create adverse impacts. The past 100 plus years of fire suppression in the Analysis Area has created environment(s) that are not as healthy and diverse as in the past, are susceptible to catastrophic wildlife, are susceptible to devastating insect and/or disease outbreaks, and have reduced the number of wildlife species (as well as numbers within populations). If the USFS was to continue to manage the NFS lands of the Analysis Area in a manner in keeping with the past 100-plus years, the end result would be a continuation of a less than preferential lifestyle for the membership and, thus, a like position for the Tribal leadership.

  The resident plant communities within the entire study area have long adapted to regular, planned, low-intensity fires. Many of these plant communities occupy every level (ground cover through the mid to upper level of canopy) of the forest, are within the coniferous forest/woodland environments, and have been subjected to fire management regimes by the Yurok people for thousands of years. Over the millennia plant populations have been managed using fire in order to enhance the quality and quantity of various products on a sustainable basis. Additional benefits of regular occurrences of low-intensity burns are:

  - Lessen the potential for catastrophic fires by reducing fuel loading,
  - Lessen the potential of devastating outbreaks of insects and/or disease by promoting species diversity. Since most insects/diseases are plant specific, the more species that exist per acre, the less chance you will have of providing host species for certain "pests",
  - Increase the overall health of individual stands of timber, woodlands, and grasslands by removing those individual plants that are dead or dying, and help to maintain an adequate spacing between trees, thus maintaining the "carrying capacity" of environments,
  - Provide a regular seed bed for new growth. This, in turn, provides for a continuous source of browse and food for a wide variety of wildlife.

- Prescribed burns on culturally important species (beargrass, hazel, willow, etc.) is an important issue. In the recent past, the USFS has attempted to implement burns in order to enhance the quality/quantity of important basket making plant species. While this is a major concession, the USFS needs to be aware that each species has to be burned at a very specific period during the year. Often times, the required time period does not fit with the USFS and federal burn periods due to fear of starting a wildfire. While the Tribe can well understand the federal concerns, it is important to develop a procedure that, in time, will alleviate any potential concerns of wildfire. To accomplish this, a project designed to slowly reduce the fuel loading in the areas surrounding communities of basketry materials could be adequate. In addition, the USFS may meet with individual basket makers so they can begin to develop a schedule of time various plants need to be burned to promote quality.

- Tribal members live, hunt, fish, gather, recreate, swim, boat, get firewood, conduct ceremonies, and other religious activities within the LMK Basin.

- Commercial fishing by Tribal members occurs along the Klamath River, including the four miles within the study area. The Tribe has future commercial timber sales, restoration work, and fishery work planned within the Analysis Area.

- A major Tribal objective is to have unfettered access to USFS lands for cultural, ceremonial, and subsistence activities for tribal members, and road access for residential, domestic water sources, tribal management of its lands, and other purposes.

Hoopa Tribe

Hoopa Valley Indian Reservation Land Allocations (1993-2003)

This document identifies tribal lands and resources within the Cavanaugh and Hopkins Creek sub-watersheds of the LMK Analysis Area. The HVIR Forest Management Plan (HVIRFMP, Hoopa Tribe, 1993) provides direction for the management of Tribal lands, including lands in the Cavanaugh and Hopkins Creek sub-watersheds of the Analysis Area. There are a number of land allocations each with Standards and Guidelines. What follows are the general goals and objectives of the Plan that could apply within the Analysis Area:

- Within the Hopkins Creek sub-watershed there are wildlife corridors and activity centers associated with the Northern spotted owl (Hoopa Tribe, 1993. p.130).
- A small segment of the Wild and Scenic River Corridor associated with the Klamath River is within the Reservation boundary in the Cavanaugh sub-watershed (Hoopa Tribe, 1993. p.123).
- Within the Cavanaugh and Hopkins Creek sub-watersheds there is a Klamath River visual restriction zone or viewshed within Reservation lands (Hoopa Tribe, 1993. p.121).
- Within the Hopkins Creek sub-watershed the Plan identifies extremely unstable areas with extreme erosion hazards in the headwaters of Hopkins Creek (Hoopa Tribe, 1993. p.115).
- The Plan identifies the lands in the Hopkins Creek sub-watershed for timber harvesting (Hoopa Tribe, 1993. p.101).
- The Plan identifies traditional plants of special concern, abundant traditional plants, and traditional wildlife of special concern (Hoopa Tribe, 1993. pgs.93-94).

Other Information Provided By The Hoopa Tribe (Hoopa Tribe. 1997)

- Within the larger Analysis Area, tribal members gather fuel wood and other items. The Tribal lands within the Analysis Area has tribal members gathering fuel wood, mushrooms, and acorns. The Tribe's forest management plan has several land use allocations which explicitly delimit areas where forest practices are modified within the study area on the Reservation to ensure access to mushrooms and beargrass.

- The Tribe has trust land and resource property within the study area within the boundaries of the LMKR study.

- Within the larger areas, tribal members recreate including hunting, fishing, driving for recreation, firewood cutting, subsistence gathering, etc.

- There are commercial timber management operations on tribal land within the reservation boundary and within the study area.

Federally Reserved Trust Resources

- *What are the federally reserved trust resources and responsibilities within the LMK Analysis Area?*

While the focus of the legal history surrounding Indian rights to resources has mostly focused on water and fisheries, it is important to recognize that other resources such as wildlife and vegetation are extremely important to the tribes and no less reserved (USFWS et al. 1999, 3-212).

Fish Trust Resources
The establishment of the HVIR and the YIR vested the Yurok and the Hoopa with federally reserved trust resource rights for fish and water. Several court rulings have established that an important “Indian purpose” for the reservations was to reserve the Tribes’ rights to take fish from the Klamath and Trinity Rivers (USFWS et al. 1999). The Hoopa and Yurok tribes retain and fully exercise federally recognized fishing rights within the Klamath-Trinity Basin. Protection of these rights is a federal government trust responsibility. In managing these rights, the federal government recognizes the vested interest the Tribes retain in habitat, water flow, and fish production outside the reservations in the Klamath-Trinity Basin. Tribal fishing rights are vested property rights held in trust by the U.S. for the benefit of the Indians (Ibid.).

Due to the migratory nature of the Klamath runs of fish, the protection of downstream tribal fishing rights depends on coordinating regulations, policies, planning, and other activities with the Hoopa and Yurok tribes. The SRNF, while administering NFS lands and resources, holds a trustee responsibility for tribal interests related to federally reserved trust resources. The SRNF must properly consider off-reservation effects to on-reservation trust resources in management activities that might affect tribal fishing rights or other reservation resources.

It is important to note that the Yurok, Hupa, and Karuk are riverine people. The fishery is as important to their traditional and cultural life today as it has always been. They have great respect for the fact that all people have a need for a healthy Klamath and Trinity River Basin and fishery, no matter what the legal status of rights are. Historically they honored each other’s needs, uses, and right to the Basin fishery through their self-regulated building of fish dams and ceremonies. This respect continues today as they work shoulder to shoulder in coalitions and independently within each tribal government to restore the Klamath and Trinity River Basin, to obtain through the legal system adequate flows for the rivers, and to restore habitat related to the fishery, particularly native fish.

Please refer to the ***Fisheries – Current*** section above to understand the conditions and situation of the health of the fish resource on the Klamath River presently.

Water Trust Resources
Beginning in 1905 with the Supreme Court’s decision in *Winters v. United States*, 207 U.S. 564, federal law has recognized that creation of an Indian reservation carries with it a federal reserved water right sufficient to carry out the purposes for which the reservation was established. The purpose for which the HVIR and the YIR were established was to enable the people to continue their fishing way of life. The Hoopa and Yurok tribes have a federal reserved

right to an in-stream flow of water in the Klamath and Trinity Rivers sufficient to support the Tribes' rights to take its allowable share of fish within the Reservations (USDI 1995).

The HVIR has been granted "Program Authority" status under the several sections of the Federal Clean Water Act. Under that authority and following due process, the Hoopa Valley Tribe Water Quality Control Plan has water temperature, suspended sediment, turbidity, pesticide, and herbicide standards that are more stringent than those of the State of California. The Tribal Environmental Protection Agency has collected physical water quality parameters on Hopkins Creek, located within the Analysis Area, for a short time (1/6/00 – 2/03/00) as a "snapshot" of water quality conditions, which shows that current conditions meet the Tribe's water quality standards. Water leaving NFS lands and flowing into the HVIR is subject to meeting the Tribe's standards under their Water Quality Control Plan. Likewise, stakeholders downstream of Tribal lands have authority to enforce receiving waters' standards (Hoopa Tribe 2000, 35).

The Yurok Tribe is currently seeking "Program Authority" status under the several sections of the Federal Clean Water Act and is drafting a Water Quality Plan for the Yurok Reservation. The draft was not ready for review at this time.

Please refer to the ***Water Quality and Fisheries*** section for the conditions of the waters of the Klamath River.

Major Human Uses of Natural Resources – Local Community Perspectives

There are 7,231 acres of non-Reservation private lands within the LMK Analysis Area. Many of those owning property within this area have a primary residence elsewhere. These individuals may have a caretaker on their lands, may vacation there annually, and/or may plan to retire in the community. Much of the population that resides in the Orleans-Somes Bar area does not own property. Residents of Orleans-Somes Bar, Weitchpec, and outlying residents, whether they own property or not, are involved in their communities, utilize the local natural resources, and are interested in what takes place within the LMK Analysis Area.

The private landowners are concerned about the effects management activities may have on access to their property, their domestic water supply or the quality of the views from their property, as well as what kind of management takes place adjacent to their property. The Tribal governments are concerned with any activity that is on or adjacent to their lands, or activities within the larger watershed that affect heritage resources, cultural uses, water quality and quantity of the Klamath and Trinity Rivers, or the fishery.

Water quality and quantity, within the Klamath River is a significant value held by all segments of the various communities. Water quality and quantity is viewed as an economic necessity, a key aspect of the continuation of rural lifestyles, a necessity for the recreational and subsistence fishery, and imperative to sustain tribal cultural life ways. The desire to improve fisheries is tied to this value. Domestic and environmental water quality is viewed as vital to maintaining healthy sustaining communities and the quality of life that these communities desire.

The American Indian component of these communities has strong desires for cultural preservation. Preservation of religious sites and culturally supportive land use and management are other issues addressed by tribal governments and by individual tribal members. Issues over land use and land rights inevitably arise because the Analysis Area is primarily comprised of NFS lands. Tribal governments and individuals should actively work with the USFS and other agencies in developing policies and projects that are culturally supportive.

Those who own property in this area that is not their primary residence use this land to vacation, and, in some instances, retire. However, local residents utilize the natural resources around them and find that the "quiet, peaceful, natural beauty and the wilderness nature" are the most important values of living along the Klamath River. They connect these values to their personal well-being. They attribute their good health to clean air, spring water, beauty of the forest, wildlife, and a quiet atmosphere that enhances their quality of life.

Local Economy

- *How do these watersheds contribute to the economies of the local communities?*

The region is experiencing a continued loss of traditional natural resource extraction-based industries, while Humboldt County industries are still concentrated in two sections: timber and government. Population is growing at approximately 1% a year, unemployment is dropping, and there is progress on many fronts in creating economic prosperity. Total job growth has increased 13% since 1990 with most of this growth occurring in the services and manufacturing sectors. Humboldt County's 1998 total gross value of agricultural production, including timber, dairy, and agricultural products, declined 10.1% from 1997 and is 19% below the 1994 poverty level. Currently, timber production and dairy are the two largest industry clusters within the resource-based economy. The natural environment and the resources derived from it are an attraction to this area, which creates growing recreation-oriented services and businesses of the tourism industry cluster (Humboldt County Employment Training Department 2000, 2, 7, 11).

Recreation

The LMK Analysis Area is important to the Weitchpec and Orleans-Somes Bar business communities, and indirectly to the Hoopa Valley business community for its recreational opportunities and the economics they generate. Currently, some businesses refer their customers to specific locations within the Analysis Area for swimming, fishing, or hiking. There is a range of views about what activities could occur in the Analysis Area that would contribute economically to these communities such as increased timber output, development of commercial areas for special forest products, and recreational activities that would assist the community towards an eco-tourism economy; the trend is occurring toward the latter. However, there is also concern about how these and other activities could affect plant diversity, wildlife habitat, water quality, and recreational qualities, particularly fishing.

Wildlife related recreation, fishing, wildlife viewing, and hunting, on NFS lands provides economic benefits. A report published in 1999 on the economic impacts of fishing, hunting, and wildlife viewing on NFS lands provides evidence of the economic benefit of recreational fishing within the Analysis Area. The study concluded that over 40% of the money spent by California anglers for fishing activities on NFS lands was spent on trip related expenditures such as food and lodging, while the remainder was spent on equipment purchased primarily for fishing and other items specifically related to inland fishing (Maharaj and Carpenter 1999). In 1995, anglers spent an estimated 8,900 days sport fishing for salmon and steelhead along the Lower Klamath River. Based on an estimated value of $65 per day, the angler benefits of sport fishing for salmon and steelhead along the Lower Klamath River were $580,000 in 1995 (USFWS et al. 1999, 3-263 – 3-264).

The highlight of outdoor recreational opportunities consist of river related activities such as fishing, camping, hiking, swimming, rafting, and scenic viewing, and visitors make up the larger population of recreational users on the Klamath River. It is believed that publicity of local facilities, which include 9 fishing guides, many whitewater rafting companies, 7 private facilities that provide camping, lodging, and RV parking, and 3 Forest Service maintained campgrounds, may intensify usage and, consequently, increase tourist dollars into the area.

Other recreational resources that the communities within the Analysis Area hope will attract tourists include the Trinity (Highway 299) and Big Foot (Highway 96) National Scenic Byways, and the Klamath Recreational and Trinity Wild, Scenic, and Recreational River systems that merge at Weitchpec. Highway 96, which runs through Weitchpec and Orleans-Somes Bar, has also been designated a California Scenic Byway, and many tourist service development opportunities were opened after that designation.

Rafting & Fishing Guides

Whitewater rafting, a fairly new attraction to the Klamath River compared to fishing, is rising in popularity both in offering services and on the consumer end. There are 57 commercial whitewater rafting guides operating on the Lower-Middle Klamath River, with the peak season being mid-May to the end of October. Numerous commercial rafting companies, which advertise through Internet websites, offer family excursions on the Klamath River. However, only a small percentage of these companies are local. Nine commercial fishing guides operate on the Lower-Middle Klamath River, and some of the rafting guides offer fishing guide service as well. There are also local community members operating out of Orleans, Weitchpec, and Hoopa, who offer services on the Klamath River such as rafting and fishing guides.

See the ***Recreational Uses – Current*** section for more detailed information on these uses.

Special Forest Products

The SRNF's policy regarding the gathering of special forest products for personal use does not require special use permits unless the species being gathered is in need of management due to impacts, effects, health, or sustainability such as tan oak (matsutaki) mushrooms and firewood. Therefore, actual gathering of forest products for personal use exceeds the amount that is officially recorded. For example, many local residents, the majority of who are Karuk, Yurok, and Hupa, gather small amounts of numerous species of plants for subsistence, medicinal, and/or ceremonial purposes, none of which is officially recorded by a permit. Personal, special use permits are issued on the Orleans Ranger District for firewood, Christmas trees, conifer boughs, mushrooms/matsutaki, and poles.

Recent changes in the Orleans District personal use firewood policies, mostly having to do with Orleans combining with the Ukonom District (formerly Klamath National Forest), have led to inconsistencies with neighboring District firewood policies, and past practices. Dissatisfaction over personal use firewood is the number one complaint expressed by the general public at the Orleans District front desk (Harding, personal communication, 2003)

The recent discovery of Sudden Oak Death syndrome in Southern Humboldt County has resulted in quarantines against moving some or all parts of host species into neighboring uninfected counties. At this time this quarantine has the greatest effect on firewood, boughs, greens, huckleberry, and other floral greenery.

Wild crafting, Tan Oak mushroom harvesting, floral greenery, slate, gravel, sand, rock, firewood, medicinal herbs, fruit productions, produce farming, and minor timber harvesting are all commercial activities that occur within the LMK area. Table 47 shows the commercial special use permits that were issued for the Orleans Ranger District in 1999, 2000, and 2001; the permits were not specific to the Analysis Area, however, most of the District is within this area. The commercial extraction of special forest products on the Orleans Ranger District is low compared to the SRNF as a whole. For example, commercial permits issued for boughs in the year 2000 on the Orleans Ranger District made up 16% of all permits issued, and 34% of the total quantity gathered (poundage) for boughs across the entire SRNF. However, Orleans was the only District on the SRNF that issued commercial permits for firewood in the years 1999-2001.

Table 47 Commercial Use Special Use Permits – Orleans Ranger District for FY 99 – FY 01.

Year	Product	Quantity	# Permits
1999	Firewood	45 cords	5
1999	Boughs	1400 lbs.	4
2000	Boughs	1400 lbs.	3
2000	Firewood	28 cords	5
2000	Greens (Salal)	1000 lbs	2
2000	Mushrooms/Matsutaki	28 days	20
2000	Huckleberry	800 lbs	1
2001	Boughs	3400 lbs.	4
2001	Mushrooms/Matsutaki	28 days	22
2001	Christmas Trees	125 each	3
2001	Firewood	28 cords	5
2001	Greens (Salal)	988 lbs.	2
2001	Huckleberry	788 lbs.	2

Farming
In recent years, farming has increased dramatically in the Orleans area. Farms have been established on sizable flat pieces of private land. Orleans area organic fruits and vegetables, and most recently, wines, are well known along the Eureka, California coast due to numerous farmers' markets where local farmers can sell their produce.

Commercial Fishing
Yurok Tribal members have the opportunity to operate a commercial fishery along the Klamath River within the YIR. There is approximately 4 miles of the Klamath River within the LMK Analysis Area that is within the YIR and where commercial harvest of fish occurs.

Quality of Life

- *How do the watersheds in the Analysis Area and their resources contribute to, or affect, people's sense of place or quality of life?*

Subsistence Uses and Values
Residents adjacent to and within the Analysis Area are users of the land, vegetation, wildlife, and the Klamath River. These communities' living strategy tends to be oriented toward subsistence goods procurement and preservation on a seasonal basis. They express concern about the availability and quality of the materials they gather, protection and access to socio-

culturally significant locations, and water quality and quantity, particularly in relation to producing healthy fisheries.

Families supplement their income with subsistence hunting, fishing, and gathering. These occupations are engaged in seasonally, and are essential to the survival of many individuals. For the Yurok, Hupa, and Karuk people, these activities also serve as vehicles for the transmission of cultural knowledge. Multi-generational groups participate in these activities, as they are a means for elders to share stories, techniques, practices, and spiritual observances, with the younger generations. Therefore, interruption of, or non-participation in, these food gathering and preparation activities prevents participation in cultural knowledge that is vital to the continuation of the culture.

These communities are subsistence oriented, gathering fuel wood for winter heat, and mushrooms and berries to add to their food stores. Interview data, from interviews conducted in 1997 with various Orleans and surrounding communities residents and property owners, shows 65% of those interviewed do some sort of subsistence gathering. Firewood, berries, and mushrooms were the most identified plants gathered with 35% of interviewees indicating that their fuelwood and berries were gathered within the Analysis Area (SRNF 1997).

Although plant gathering is carried out among the larger populations in the Analysis Area, the Karuk, Hupa, and Yurok gather more plant resources more often than any other users within the study area. Acorns, berries, mushrooms, various wild fruits, plants used for basketry, and herbs are gathered annually. Several interviewees identified a concern for the protection of “family” gathering areas where they and their family have gathered plant materials for generations (SRNF 1997). Table 48 shows the plants that were most often identified in interview data as being gathered for subsistence.

There are a variety of other subsistence uses and values within the communities of the Analysis Area. Fishing and hunting are significant elements of these communities lifestyle that adds to their yearly food supply. Coho and chinook salmon are by far the most significant annual subsistence items brought into the homes of Karuk, Yurok, and Hupa, and they are a significant item to other local residents as well. Small family farming is common within the study area. There are also materials used in building structures that are gathered by these communities such as sand, gravel, and fence poles. For traditional ceremonial structures there is a need for cedar planks, slate slabs, and poles. Gathering subsistence items such as acorns, are associated with the ceremonies, however, larger amounts need to be gathered to provide sustenance for those hosting and attending these public ceremonies (SRNF 1997).

Table 48 Partial List of Subsistence Resources.

Species	Common Name
Chimaphila umbellata	Prince's pine root
Ceanothus integerrimus	Deer brush sticks
Myrtus communis	Myrtle sticks
Alnus rhombifolia	White alder root
S .coulteri	Pussy willow root
Pinus jeffreyi	Jeffery pine root
Pinus ponderosa	Yellow pine root
Berberis nervosa	Oregon grape root
Tricholoma magnivelare	Tanoak mushroom
Quercus kelloggi	Black oak acorns
Lithocarpus densiflorus	Tanoak acorns
Quercus garryana	White oak acorns
Vaccinium ovatum	Huckleberries
Arbutus menziesii	Madrone berries
Rubus spp.	Black berries
Arctostaphylos spp.	Manzanita berries
Osmaronia cerasiformis	Oso berries
Sambucus mexicana	Elder berries
Rubus spp.	Goose berries
Castanopsis chrysophylla	Chinquapin nuts
	Wild grapes
	Wild cherries
	Wild apples
Salix laevigata	Red Willow roots and sticks
Vitis californica	Wild Grape root
Xerophyllum tenax	Beargrass
Adiatum pedatum	Maidenhair fern
Woodwardia fimbriata	Woodwardia fern
Usnea sp.	Lichen
Alnus rubra	Red Alder bark
Corylus cornuta v. californica	Hazel nuts/sticks
Satureja douglasii	Yerba Buena
Angelica arguta	Angelica
Taxus brevifolia	Pacific Yew
Chameocypris lawsoniana	Port-Orford-cedar
Salix hindsiana	Gray Willow roots and sticks
Ledum glandulosum	Labrador tea
Umbellularia californica	California bay (pepperwood leaves/nuts)
Eriodictyon californicum	Yerba Santa

Botanical uses include uses of plant resources that are gathered for personal use but not for subsistence such as greenery for making wreaths, or fence posts used for deer fencing around home gardens. There is a moderate level of gathering for ceremonial purposes that include various plants that are used to store the ceremonial regalia or to make it. Medicinal plants are also utilized by these communities, with the tribal communities depending more upon the use of medicinal plants as part of their health regime. Greenery, Christmas trees, and conifer boughs are gathered primarily on a seasonal basis but they are important enough that interviewees identified them as significant items they gather. The following is a list of the botanical uses that were identified by interviewees:

- Greenery used for decoration purposes
- Christmas trees
- Conifer boughs used for decoration purposes
- Variety of herbaceous plants for medical uses (e.g. *Chimaphila umbellate,* Prince's pine)
- Variety of plants used for basketry, and crafts (e.g. hazel sticks, etc.)
- Variety of plants used in spiritual activities (e.g. *Angelica arguta*, etc.)
- Variety of trees/woods used for ceremonial structures, tools, and fence posts (e.g. POC)

The data indicated that there is a high level of hunting among local residents, but a low level among visitors to the area. Deer and birds were the primary species identified as being hunted. Wildlife is most sought after for subsistence hunting, followed by recreational hunting, and then wildlife watching. However, the Karuk, Yurok, and Hupa also use wildlife for ceremonial purposes (SRNF 1997). Table 49 shows some of the species utilized for traditional ceremonial purposes:

Table 49 Culturally Traditional Ceremonial Species.

Species	Common Name
Dryocopus pileatus	Pileated woodpecker
Martes pennanti pacifica	Pacific fisher
Odocoileus hemionus	Black-tail deer
Mustela vison	Mink
Bassariscus astutus	Ring-tailed cat
Oncorhynchus kisutch	Coho salmon
Oncorhynchus mykiss	Klamath Mtns. Province steelhead
Oncorhynchus tshawytscha	Chinook salmon
Diadophis punctatus	Ring neck snake
Lutra Canadensis	River otter
Haliaeetus leucocephalus	Bald eagle
Aquila chrysaetos	Golden eagle
Colaptes auratus	Northern flicker
Bonasa umbellus	Ruffed grouse
Dendragapus obscurus	Blue grouse
Cyanocitta stelleri	Stellars jay

Recreation

Fishing is a significant recreational draw to the Analysis Area. Locals and state and out-of-state visitors come to fish on the Klamath River because Orleans and the Weitchpec Gorge are widely known for their salmon and steelhead fishing. Most of the fishing occurs by the single-family recreation experience but there are a substantial number of fishing guides that operate on the Klamath River. The trend is that sport-fishing tourists spend two months at a time at commercially developed campgrounds in the area. They like to stay in campgrounds with upgraded facilities and RV space available. RVs can be spotted along the river bars and roadsides during fishing season. There is a limited number of Forest Service maintained campgrounds within the area.

The majority of the recreational uses within the Analysis Area are water-oriented activities. For example, recreational use of the Klamath River is fairly high compared to the low to moderate use of upland or mountainous areas within the Analysis Area. Fishing and swimming were the most identified recreational uses. Also, whitewater rafting is a fairly recent attraction to the Klamath River. Data indicate that 77% (locals and visitors) of individuals using the Analysis Area do so for recreation. Visitors make up the larger population of the recreational users on the Klamath River (SRNF 1997).

See the ***Recreational Uses – Current*** section for more details.

Spiritual and Religious Uses and Values

The Yurok and Karuk have concern for the protection of and their ability to use spiritual locations within the Analysis Area. Some locations reside along the Klamath River and others at higher elevations. Some locations exist where the larger community gathers for ceremonies such as the White Deerskin Dance, Jump Dance, and Brush Dance. Some mountain locations are associated only with the medicine people or ceremonial leaders, and others exist where the individual can seek spiritual experiences alone. The cutting of Christmas trees and the gathering of conifer boughs and other greenery were also mentioned by numerous interviewees as an important family event (SRNF 1997). See the ***Heritage Resources*** section under ***Social and Human Uses - Reference*** for more detailed information.

Domestic Water

Many private property owners rely on water from NFS lands for their domestic uses. There are approximately 9 special use permits associated with water systems in the Analysis Area. Individuals who have water systems under special use permits are very concerned about protecting and maintaining access to their house water source. Pearch Creek serves as a municipal watershed serving a portion of the Orleans community via the Orleans Community Services District, and Crawford Creek serves as a municipal watershed serving another portion of the Orleans community via the Delaney Community Services District.

There is a domestic water source in the Lower Cavanaugh sub-watershed on the HVIR (Hoopa Tribe 2000, 36). On the YIR within the Cavanaugh sub-watershed there are domestic water uses of the four creeks within the compartment. Both the Trinity and Klamath rivers are classified as “impaired by sediment” by the State of California, and the EPA has concurred. As Total Maximum Daily Loads (TMDL) are announced for the Klamath and Trinity rivers, human induced sediment loads reaching the river will be regulated regardless of the fact that fish or domestic sources may or may not be present. The TMDL’s are expected to take effect in 2002 (Ibid. 35).

Fire Uses and Values

Wildland fire is a serious concern to the peoples of these communities. This concern of rural communities across the country has been turned into action in the form of the National Fire Plan, (USDA Forest Service and US Department of the Interior, 2000) which is an accelerated interagency effort to step up, coordinate, and concentrate activity on reducing impacts of wildfires on rural communities. The Fire Plan focus is to reduce immediate hazards in wildland-urban interface areas, and to ensure that sufficient resources will be available for extreme fire conditions in the future. The communities within the Analysis Area have been designated as communities at risk for wildland fire and, as a result, have become the focus of reducing that risk through the coordination of Fire Safe Councils and tribal governments with various other agencies.

Orleans-Somes Bar Fire Safe Council was formed in May of 2001 and has begun a proactive, coordinated approach to address the risk of catastrophic fires in the communities of Orleans, Somes Bar, and surrounding areas. The long-term goal of the Council is to help plan, implement, and monitor the reinstatement of historic fire regimes primarily through strategic fuels reduction in a manner that protects life, property, improves forest health, and enhances the resources valued by its stakeholders. They believe the first step toward reintroducing fire at the landscape level is ensuring that private properties are safe from fire (Times-Standard, Numerous contributors. May, 2002. p.5).

The Karuk Tribe, a member of the Orleans-Somes Bar Fire Safe Council, is a strong proponent of re-establishing a fire regime that is supportive of a pre-European landscape that supplied the delicate balance to all flora and fauna within Karuk aboriginal territory. In order to accomplish this, the Tribe has begun a Hazardous Fuels Reduction Program strategy intended to begin the process of re-establishing a native vegetation composition. The Tribe believes that the protection of homes and communities is a logical place to begin their treatment strategies, but believe it is critical that these strategies expand to the landscape level for overall success of fuels reductions projects (Times-Standard, Numerous contributors. May, 2002. p.5).

The tribal governments are very involved with the SRNF advocating and participating in fire oriented planning and projects designed to re-instate fire into the landscape and, thus, enhance materials used in basketry. The Karuk and Yurok have a MOU with the SRNF which defines the governmental consultation protocol during an emergency wildland fire, and creates a process on how to best work cooperatively to protect heritage properties and any tribal lands and resources that may be threatened by a wildland fire.

Please refer to the ***Fire*** section for more details.

Access in the Analysis Area

- *Why do people value their specific access to the Analysis Area, and why is this access important to them?*

Local residents and visitors use Forest Service roads and trails in the Analysis Area for all types of activities. Many annual visitors have become attached to the locations they fish, hike, or camp, and are accustomed to the access they know. There is great concern over changing access and closing roads to these familiar locations. Visitors express that they usually have limited time to vacation, and that they do not want to spend it finding new access or locations. Rather, they would enjoy returning to a familiar location or “family spot” to participate in a familiar activity. The issues of road management, particularly gating, closing, and decommissioning bring intense reactions from various users.

Local property owners depend heavily on NFS roads to access their property. They are concerned about maintaining access to their property and many believe the Forest Service is arbitrarily closing, gating, or decommissioning roads. On another note, many local residents identified walking as a recreational and stress relieving activity that they participate in frequently. During the week they enjoy walking along trails for short distances near their homes, and often take hikes on the weekend into the higher mountain locations.

The larger communities rely on roads and trails to conduct their subsistence activities such as fishing, hunting, and harvesting plants. Often plants that are harvested may not be producing in an area they have typically been harvested, so roads are used to locate where the plants are producing or healthier. The local communities use roads and trails to participate in subsistence hunting and to access traditional or “family” hunting areas.

The heavily used recreational facilities and areas within or adjacent to the Analysis Area are all road dependent. A combination of roads and trail provide access to the Klamath River for activities such as fishing, swimming, rafting. Access to the Klamath River in canyon areas is primarily by trails that start at a road. Walking from a turnout along the highway can provide easy access to some sections of the Klamath River. Roads and trails in the Analysis Area also give access to the more isolated mountain camping, hiking, biking, or horse riding locations.

There are some who use Forest Service roads to commercially harvest or extract resources such as mushrooms, florals, and timber. They rely on these road systems to find the special forest products needed for their businesses. For efficiency’s sake they rarely go off-road to gather products because of the volume of the species they are harvesting. The Orleans-Somes Bar Chamber of Commerce is actively promoting the use of Forest Service roads and the Big Foot Scenic Byway in their efforts to bolster the local economy. They are also promoting the surrounding National Forests for mountain activities that involve road and trail systems such as biking, hiking, and horseback riding. The Chamber also promotes river access for fishing, swimming, rafting, and wildlife sighting. It is apparent that access to the recreational resources of the Analysis Area is an important strategy in their efforts to build local economy.

The Yurok Tribe indicated that they have a need to use NFS lands and roads immediately adjacent to the YIR in order to conduct resource management activities on Reservation land. They also indicated that the communities in the Weitchpec area utilize adjacent NFS lands for subsistence, spiritual, and recreational purposes. For the tribes access to spiritual locations and other culturally oriented activity areas are often dependent upon a combination of road and trail systems. The Hoopa Tribe also uses Forest Service roads to access portions of the study area on HVIR that are in the Upper Hopkins Creek area where they manage their land and resources.

Recreation

Recreational Uses – Reference

In the 1940’s the LMK Analysis Area saw an increase in recreational use. For example, in 1947 there were 2 campgrounds with 38 units and an additional 5 campgrounds that were proposed. Gerhard’s Resort on Bluff Creek was the only commercial resort, which offered tourist cabins, a store, and a filling station. Also, at this time many special use permits for summer homes were issued; however, these permits were terminated about 1962 when highway improvements required removal of the structures. Forest Service developed campgrounds in the Analysis

Area began with the construction of Pearch Creek and Bluff Creek Campgrounds by the CCCs in 1932. E-Ne-Nuk and Aikens campgrounds were constructed after the flood of 1964, which destroyed the Bluff Creek Campground and changed the course of Bluff Creek to empty into the Klamath River at it present location, which is upriver of the campground it once flowed through.

Recreational Uses – Current

- *What are the current recreational uses in the Analysis Area?*

Current recreational uses within the Analysis Area include fishing, rafting, kayaking, camping, hiking, mountain biking, sightseeing, bird watching, swimming, recreational dredging, gold panning, and hunting.

Fishing

The Klamath River has been a popular choice for experienced and novice anglers for many years. It has often been referred to as the "steelhead capital of the world". A wide variety of conditions along this stretch of river provide opportunities for all skill levels and all fishing style preferences. Good opportunities for bank fishing and the availability of guided drift boat fishing trips have drawn people from all over the western United States to fish for salmon, steelhead trout, and shad. The season for salmon is generally July to November, steelhead is September to April, and shad is late June to August.

The CDFG creel surveys conducted over the last three years on the Klamath River indicate that the Analysis Area receives an average of 1,963 fishing visits each year. These surveys also indicate an average of 6,150 angler hours spent in the Analysis Area each year, which equates to an average of just over 3 hours per angler visit.

There are currently 9 commercial guides that operate drift boat fishing trips on this section of the Klamath River. They typically fish 5-10 miles of river each day, and the average stay for visiting fishermen is between 3 and 5 days. Also, many local residents between Willow Creek and Happy Camp own drift boats and frequent the Analysis Area on day trips when the fish are running.

Rafting and Kayaking

Commercial rafting and kayaking in the vicinity of the Analysis Area, particularly on the Salmon River, has increased significantly over the last 15 years. There are currently 57 commercial outfitter guides offering rafting and kayaking opportunities on the Klamath and Salmon Rivers. In addition, a world-class kayak school was established on the Salmon River in the early 1990s, which has led to a significant increase in kayak use on both the Cal-Salmon and the Klamath River since that time. Although no valid use figures are known to exist for the Analysis Area, commercial use on the "Cal-Salmon" has increased from 392 user-days in 1981 to near 4,500 user-days today. A visitor capacity monitoring survey, and a private boat count survey, were conducted on the Cal-Salmon during spring and early summer of 2002. Although the surveys were conducted outside of the Analysis Area, the immediate proximity should provide good information about where visitors are coming from, what they like most about their visit, how much time and money was spent in the local area, and more. The results of these surveys should be available by October 2002.

Commercial rafting and kayaking within the Analysis Area occurs predominately at the north end of the Analysis Area, as a typical multi-day trip on the Cal-Salmon includes a one- day float into the Analysis Area and through Ikes Falls. These floats usually take out at Ikes Falls or Dolans Bar river access points. A relatively small amount of commercial trips start at Orleans Bridge and conclude at Big Bar. The Analysis Area includes whitewater difficulty classes of II, III and IV, with the more difficult runs found at the north end. Total commercial whitewater use within the Analysis Area is estimated to be approximately 1,500 users days per year.

Private rafting, kayaking, and canoeing is also becoming more popular each year, especially in the mid and lower portions of the Analysis Area due to the relative navigational ease of those segments of river. Other boating activities include tubing and jet boating. Private boating uses in the Analysis Area are estimated to total approximately 500 user-days per year, and are expected to continue to increase at a relatively steady rate.

Camping

Developed Campgrounds

With the convenient locations of developed campgrounds near the Klamath River and Highway 96, many people choose to camp in a developed campground and then access a variety of day-uses from there. There are currently 3 operating developed campgrounds within the Analysis Area. These are E-Ne-Nuk, Aikens West, and Pearch Creek. These campgrounds are located conveniently along Highway 96 and near the Klamath River. They serve both RVs and tent campers. E-Ne-Nuk has 11 sites, all of which can accommodate a 30' trailer. E-Ne-Nuk is open from late June to October 31st. Aikens Campground was closed in 1997 due to significant resource concerns. However, the campground, which is located east of Highway 96 outside the old entrance to Aikens Campground, remains open, and has 25 campsites of various sizes and degrees of development that can accommodate up to a 35' trailer. Aikens West is open all year. Pearch Creek can accommodate up to a 22' trailer and has 10 sites. Pearch Creek is open from mid May through the end of October.

Pearch Creek and E-Ne-Nuk are full service campgrounds. They both have sweet-smelling toilets that also meet the accessibility requirements for physically challenged individuals. Aikens West provides only portable toilets, but it also has the only RV/trailer sanitation dump station between Willow Creek and Happy Camp. All three campgrounds have potable water, but Aikens West only has water during the periods that E-Ne-Nuk is open. All three campgrounds usually have a resident host during the peak season. The average occupancy rate of these campgrounds over the entire operating season in the year 2000 was approximately 15%, however, during the fall fishing season occupancy is much higher. E-Ne-Nuk is typically full to capacity during September and October if the fishing success is relatively good.

A backlog of deferred maintenance has been slowly building since these campgrounds were constructed. Needs such as replacement of deteriorating or damaged tables, wood signs, and vehicle barriers, painting, replacement of damaged fire rings, installation of bear-proof trash cans, water treatment system upgrades and replacement of leaking water distribution lines, and road repairs have been identified and are planned for gradual completion of work over a period of several years.

Midway through the 2001 season, these developed campgrounds were approved for inclusion in the fee demonstration project, known also as "fee-demo". Under this program, the campground fees that are collected are to be applied towards deferred maintenance needs, fee collection expenses, and minor improvements within the complex of campgrounds from which they were collected. The expectation is that these additional funds will allow for more timely maintenance, repairs, and upgrades in the future.

Dispersed Camping
Dispersed camping occurs throughout the Analysis Area, but it is particularly concentrated near the river corridor. Within the river corridor dispersed camping occurs at Big Bar, Bondo, Dolans Bar, and Ullathorne river access sites. Camping is limited at Ullathorne by the small amount of NFS land at this site. In the forest outside the river corridor the most popular sites to camp are Lower Twin Lakes with one site, Le Perron Flat with 4 sites, and Orleans Mountain lookout with no sites.

Hiking

There are 6 trails located in the Analysis Area. Prospect Hill trail (6E02) is 3.1 miles long and is accessed at Eyesee road (15N01) and terminates at Ishi Pishi road. This trail is currently a low use trail and is in need of some routine maintenance. Somes Mountain trail (6E05) is 7.3 miles long and is accessed at 11N22 off Highway 96. Both of these trails serve foot and horse travel. The remaining 4 trails, the Boise, Bluff Creek, Red Cap, and Whitmore trails, provide access to the Klamath River for fishing and are accessed from Highway 96. One additional trail, the Bluff Creek Historic trail (5E01), starts inside the Analysis Area at Highway 96 and progresses into the Bluff Creek watershed. Its total length is 1.6 miles, and it is a relatively steep and narrow foot trail.

Other Uses

River Access
Seven vehicle river access routes exist within the Analysis Area, the Mouth of Salmon, Ikes Falls, Dolans Bar, Bondo Mine, Ullathorne, Orleans Bridge and Big Bar. Strategic access points for drift boats are Dolans Bar, Orleans Bridge, Ullathorne, and Big Bar.

Off Highway Vehicles (OHV)
There is one OHV road within the Analysis Area, which is approximately 3 miles in length and starts at Sunset Springs and ends at Orleans Mountain Lookout. This road receives occasional use by local residents with four-wheel-drive vehicles or motorcycles, and only minor or sporadic use by organized "4 X 4" or motocross clubs.

Swimming
Local residents use the Orleans Bridge river access, Camp Creek, and Red Cap Creek for swimming during the hot summer months.

Hunting
The mountainous terrain, numerous roads, and diverse forests conditions within the Analysis Area provide good hunting opportunities for many species of wildlife, including deer, bear, grouse, and quail.

Recreation Trends

- *What are the future trends for recreational uses in the Analysis Area?*

Rafting and Kayaking
Ikes Falls, in the upper reach of the Analysis Area, will continue to draw rafters and kayakers to its class IV rapid. With the gaining popularity of rafting and kayaking, coupled with the relative proximity to the major cities of Redding, Eureka, and Medford, use in this section of the Analysis Area is expected to continue to increase at a moderate rate until the social and environmental carrying capacity is approached, which is probably only a few decades away. The mid and lower reaches of the Analysis Area, with their more mild rapids, will continue to draw canoe, jet boat and drift boat use, and these uses are expected to increase at a relatively slow rate.

Fishing
In the last decade, concentrated efforts have been made to restore the once famous runs of salmon and steelhead to the Analysis Area and the greater Klamath Basin. Improved information flow via newspapers, radio, and the Internet about fish runs, fishing successes, and commercially guided opportunities, will continue to draw new anglers to the Analysis Area and adjoining areas. However, the ultimate numbers of fishing visits will be most closely tied to the health and number of fish present. Drift boats are becoming a very popular mode of fishing in the Analysis Area, especially through “the gorge” between Ullathorne and Big Bar accesses, and may soon surpass bank fishing in terms of total person-days of fishing use.

Hiking
Tied to the increases in fishing, boating, and camping, the demand for short day hikes is also expected to increase, especially near the campgrounds and river access sites.

Developed Camping
Developed facilities will continue to be upgraded and made more accessible to the physically challenged, which is expected to attract more visitors and result in extended stays. The backlog of maintenance needs (minor repairs, painting, reconstruction, etc) will be gradually reduced, resulting in high quality camping facilities while also maintaining the rustic nature of the campgrounds. Amenities such as flush toilets and showers are not expected to ever be available at these Forest Service campgrounds.

Fee collections over the last decade indicate a slow but steady increase of developed campground use within the Analysis Area. With the recent designation of the “Bigfoot Scenic Byway” for Highway 96, coupled with improved fishing and boating opportunities, it is expected that more overnight campers will be drawn to the Analysis Area in the future.

Dispersed Camping
Dispersed camping along the river corridor has been increasing in recent years, as people want to camp adjacent to the river to enjoy the wildlife and sounds of the river, and to have quick and easy access for fishing or boating. Current plans to install a permanent sweet-smelling toilet and additional information signs at Dolans Bar, will likely result in additional increases in dispersed camping at that site.

Mining and miscellaneous uses
The Analysis Area historically included numerous mining claims. Due to administrative constraints, dredging has decreased significantly over the last few years, however, recreational gold panning continues to occur on a very small scale.

Sightseeing and wildlife viewing are expected to increase in the future, largely as a result of the Bigfoot National Scenic Byway designation on Highway 96 and marketing efforts of the Orleans-Somes Bar Chamber of Commerce. There was a noticeable increase during the 2002 season in the amount of motorcycle touring that has taken place along Highway 96 through the Analysis Area. Similar increases in bicycle touring are expected to occur as individuals and groups begin to discover this opportunity.

The demand for local mountain biking opportunities started growing almost a decade ago, but the lack of suitable trails is seriously limiting this potential use.

Timber Harvest

Timber Harvest – Reference

The use of the ASQ was not implemented until the approval of the SRNF LRMP in 1995. Harvest and sale levels have declined rapidly within the Analysis Area since the late 1980's. Prior to the 1990's, timber sales in the Analysis Area produced greater volumes per acre due to the use of regeneration (clear-cut) prescriptions and management that occurred primarily in old-growth and late-mature stands. The protection of TE wildlife species also contributed significantly to this decrease in productivity. Historic volumes per acre of timber harvested within the Analysis Area are a data gap.

Timber Harvest – Current

- *What portion of the Allowable Sale Quantity is expected from the Analysis Area, and is this figure realistic based on Land and Resource Management Plan assumptions?*

The historic emphasis of National Forest timber management was to optimize tree growth for timber production. However, the present emphasis is to maintain the health of the ecosystem. Current direction dictates that only lands determined to be capable, available, and suitable for timber production should contribute to the calculation of ASQ, and thus, be managed for timber outputs. Capable lands are those where growth potential is at least 20 cubic feet per acre, per year. Available lands are those that have not been legislatively or administratively withdrawn from timber management. Some examples of lands that are unavailable are wilderness areas, LSRs, and Riparian Reserves. Suitable lands are those which can be reforested within five years and where timber harvest would not cause irreversible damage to soil productivity or watershed conditions.

Approximately 5,000 acres within the Analysis Area contribute to the forest ASQ and are suitable and available for timber management. This figure is based on the fact that the old-growth seral stages within the tanoak series, Douglas-fir series, and white fir series are currently below the RMRs within the central and north zones of the SRNF, which includes the Analysis Area. Late-mature seral stages within the same series in the central and north zones are needed as recruitment for the old-growth seral stages. Therefore, the old-growth and late-mature seral stages are not available for timber management in this decade.

Based on assumptions in the SRNF LRMP, the annual ASQ for timber management across the entire forest is 15.5 million board feet (mmbf). The Analysis Area should contribute approximately 1 mmbf or roughly 6% of the total SRNF ASQ per year.

ASQ is calculated based on the assumption that all seral stages on matrix lands within the Analysis Area will be managed, and that the predominant silvicultural prescription for timber management will be green-tree retention. Green-tree silvicultural prescriptions, as described in the NWFP (Standards and Guidelines: C-41, C-42) (USFS and BLM 1994), should retain at least 15% of the area associated with each cutting unit (stand). Of this retained area, 70% should be clumps of moderate to large area (2.5 acres or more) and 30% dispersed individual trees or smaller clumps less than ½ acre. Where possible, patches and dispersed retention should include the largest, oldest live trees, decadent or leaning trees, and hard snags, and be retained indefinitely.

Opportunities exist to manage the Forest to produce timber and forest products while providing for other resources, including wildlife, helping to accelerate the development of desirable structural components, maintaining or enhancing species diversity within stands and across broader landscape areas, and thinning to enhance fuel treatments.

Long-term forest management goals for the Analysis Area, as outlined in the LRMP, are 1) to create a healthy forest environment that maintains vegetative and biologic diversity by developing a landscape ecosystem management strategy, 2) maintain sufficient well distributed late-successional and old-growth habitat that ensures the viability of the Forest's threatened, endangered, and sensitive (TES) species, and 3) provide a sustainable, stable supply of outputs and services that will contribute to local, regional, and national social and economic needs on a long-term basis.

The General Forest Management Area occurs within the Analysis Area and includes forested land where commercial timber management can occur. These lands are within the Forest matrix land allocation and timber harvesting could be scheduled on lands identified as suitable throughout this management area. Silvicultural activities include timber harvest, reforestation, conifer release, precommercial thinning, and forest pest management.

The primary goals within this management area are to produce a sustained yield of timber, contribute younger seral stages to the overall vegetation mosaic of the forest, and conserve key components of functional habitat for mature and old-growth associated species. Forest stands of all ages would be managed to have a multi-storied structure. Both even-aged and uneven-aged silvicultural systems would be utilized. On upper and mid-slopes, where high intensity fires are most frequent, even-age systems would predominate. Lower on the slope, where high intensity fires are less frequent and smaller scale disturbances have a greater influence on stand development, a combination of even and uneven-age prescriptions would be utilized. Selection of stands for regeneration would be determined by an analysis of the amount and distribution of seral stages, as well as present and future wildlife habitat needs, conifer stocking, and stand vigor. Thinning, group selection, or individual tree selection would be used to accelerate the development of stand characteristics and species diversity desirable for wildlife species, increase timber growth and production, provide species and structural diversity, and help reduce the potential for crown fires. The desired condition of the general forest management area is that it would be a mosaic of forested stands comprised of a variety of vegetative species. The composition and structure of individual stands would vary depending on vegetative series and seral stage development.

Silvicultural prescriptions within the matrix contribute to management of the LSRs. Fire and fuels management in the matrix can reduce the risk of fire and other large-scale disturbances that would jeopardize the reserves.

Road System

Roads are generally recognized as the principal land management influence on erosion and sedimentation rates. The most common problems associated with roads are: (1) improper locations of road cuts and fills on unstable or erodible terrain, (2) improper design or construction of stream crossing fills, (3) undersized or improperly installed culverts, (4) inadequate or improper road maintenance, (5) steep hillslope gradients, (6) alteration of slope drainage by interception, and (7) concentration of surface and subsurface water.

As a part of this watershed analysis, the roads within the Analysis Area were inventoried. These inventories were based upon existing data, maps, and aerial photos. Forest Service system, non-system, and ghost roads were inventoried. In addition, the major county and state roads were included.

The objective of the inventories was to gain a better understanding of current conditions of the transportation system and determine what opportunities existed for road restoration, upgrading, downgrading, and decommissioning within these watersheds. The results of this inventory, the analysis of the conditions, and the presentation of opportunities and recommendations are contained within the Road Analysis for the LMK Watershed Area document, which is currently being completed and coordinated with the SRNF Roads Analysis. The LMK Roads Analysis will be attached as an Appendix when it is completed.

Roads – Reference

- *How and why were the roads developed in the Analysis Area?*

Historical practices show that roads were developed along watercourses because they were easier to construct there. The displaced rock and soil that was not used for the roadbed or prism during construction was cast into the stream or river.

Road development predates the USFS in the Analysis Area. Roads were developed to provide access for extraction of natural resources. As growth and resource extraction increased, the main arterials were developed and expanded by federal and state agencies. After the formation of the USFS, the demand for timber extraction continued to grow. Additional roads were developed to allow for additional timber removals. The local population grew and many of the arterial roads were taken over and administered by local county government.

- *Have major roads in the Analysis Area (Forest Service, county or state) historically had landslides that needed to be removed to provide continued access to the community of Orleans, and required disposal of material on Forest Service land, and have possible slide debris disposal sites been located and/or permitted?*

Red Cap Road and Highway 96 have historically had problems with road closures due to slides. These roads provide the sole means of accessing numerous residences and the only emergency vehicle access. Keeping these roads open and operational for the community and USFS fire crews is critical to the residents within the LMK Analysis Area. The disposal of this slide material has historically been an issue and has not yet been resolved.

Roads – Current

- *What are the management objectives and social concerns associated with roads in the Analysis Area?*

The zone immediately surrounding SRNF is predominantly rural and highly dependent upon the Forest's natural resources for its social and economic well-being. These resources link the people and communities of this area to the Forest through employment and environmental conditions that affect the lifestyles, population, and quality of life of the north coast region. Therefore, issues relating to transportation management and roads are frequently the focus of social concern.

The identification and decommissioning of unneeded roads is a management objective identified in the SRNF LRMP and is a national priority. Roads are most often decommissioned for watershed restoration purposes, or because they are no longer needed to manage NFS lands. The Forest LRMP states that road mileage on the Forest will be reduced by 250 miles over a ten-year period.

- *What types of roads exist in the Analysis Area, and what are their features and functions?*

The transportation system within the Analysis Area consists of a state highway, county roads, Forest Service roads, and private roads. State Highway 96 traverses the Analysis Area and is adjacent to the Klamath River, and has been designated as a National Scenic Byway. Roads 9R100 (Ishi Pishi Road) and 8Q100 (Red Cap Road) are the major county owned and maintained roads within the Analysis Area.

More than 3,000 miles of road on the SRNF are under the jurisdiction (legal right to control or regulate) of a public road agency or the USFS. They are classified as arterial, collector, or local roads. Arterial roads are primary travel routes that are usually higher standard roads operated for constant service; they serve large land areas, often connecting to public highways. Collector roads, which are usually lower standard roads operated for constant or intermittent service, move traffic from local roads or destinations to arterial roads. Local roads, which may be constructed for short or long-term service, connect destination points with collector roads.

The SRNF has developed and continues to maintain a forest transportation atlas in compliance with FSM 7711 and 36 CFR Part 212. This atlas contains all the roads that are a part of the USFS Road System and are contained within the database. These roads are considered to be system or classified roads. System roads are roads that have been assigned a road number, an operational maintenance level, and are tracked and maintained by the USFS.

Non-system roads are roads that show up on all or most maps for the area, are generally used by the public, but are not in the Forest Service road system database and are, therefore, not eligible for funding. Non-system roads were generally not constructed, maintained, nor intended for long-term highway vehicle use such as roads built for temporary access, other remnants of short-term use roads associated with fire suppression, timber harvest, oil, gas, or mineral activities, and traveled-ways resulting from off-road vehicle use.

In addition to non-system roads, there are “ghost roads” on the National Forest property. Ghost roads are roads that are not generally on a map and are not in the Forest Service road system database. Most ghost roads are partially overgrown and are generally unused. Many of the ghost roads were created by entities other than the USFS. Ghost roads can be two track roads created by off road vehicle use, trails, etc. As part of this watershed analysis, all non-system and ghost roads were inventoried and are included in the data presented herein.

Within the LMK Analysis Area, and the few surrounding roads that have been included in the road analysis, there are 188.8 miles of inventoried, classified and unclassified Forest Service road. An overview of the number of miles for each road type, including operational maintenance level (OML), is shown in Table 50.

Table 50 Mileage of Forest Service Road by Road Type.

Road Type	Miles
OML 1	42.6
OML 2	63.2
OML 3	33.3
OML 4	35.5
OML 5	2.0
Non-System	8.1
Ghost	4.1
Total	**188.8**

The spatial distribution of the road system across the landscape determines its impact on a number of resources. In assessing the potential cumulative effects of roads, the cumulative watershed effects process uses road density as a criterion for measuring the amount of potential impact or disturbance across a landscape. Road density (usually expressed as miles of road per square mile) is used as an indicator of habitat fragmentation, the potential for wildlife harassment, visual quality, recreation opportunities, the cumulative potential for erosion and sedimentation from road surfaces, and cumulative increases in peak flow due to runoff from road surfaces and ditches.

Approximately 70% of Forest Service system roads in the Analysis Area are located on the upper and middle hillslope position. The average road density is low, but some sub-watersheds have a higher concentration of roads than others. Crawford, Whiteys Gulch and Ikes sub-watersheds have the highest road densities in the Analysis Area (Table 51). Road locations and relatively low densities are unlikely to alter surface and subsurface flows significantly. Watersheds with higher road densities and extensive inboard ditches that drain into stream channels or intercept groundwater flow and convert it to surface flow may see some localized increase in peak flows during storm events. Out-sloped roads tend to disperse surface water and maintain a more natural flow path. Few NFS roads in the Analysis Area are out-sloped, so potential impacts may be of concern in some sub-watersheds.

Culvert density reflects the extent to which roads have modified the channel network and the potential risk associated with culvert failures. The relatively low density of crossings in the Analysis Area is attributable to the high proportion of roads on or near ridgelines where stream density is much lower. Table 52 displays the approximate number of stream crossings by sub-watershed.

Table 51 Road Density Estimates (State, County, Private and Forest Service Roads).

Sub-watershed	Road Density (mi/sq mi)
Aikens Creek	2.6
Boise Creek	1.93
Cavanaugh	0.7
Crawford	3.94
Hopkins Creek	0.34
Ikes	3.64
Pearch Creek	0.88
Red Cap Gulch	2.28
Slate Creek	2.47
Whiteys Gulch	3.57

- *Do roadless areas exist within the Analysis Area that are subject to the Roadless Rule?*

There are two roadless areas within the LMK Analysis Area (Figure 28). The boundaries of roadless areas appear to have been created so that the existing roads were to be just outside of the roadless areas. As a result roads 10N45 and 10N25 just barely enter the designated roadless area and the total mileage of road that enters the roadless boundary is negligible. Of the two roads that penetrate the roadless boundary, one is being proposed for decommissioning. It is likely that the boundary should match with the edge of the remaining road.

Table 52 Stream Crossing Density by Sub-Watershed.

Sub-watershed	Road Miles	Stream Crossings	Stream Crossings per Mile
Aikens Creek	10.25	19	1.85
Boise Creek	19.83	7	0.35
Cavanaugh	7.20	2	0.28
Crawford	24.09	24	1.00
Hopkins Creek	3.07	0	0.00
Ikes	43.68	11	0.25
Pearch Creek	5.79	4	0.69
Red Cap Gulch	18.12	14	0.77
Slate Creek	33.72	21	0.62
Whiteys Gulch	24.22	13	0.54

- *What types of problems are typically associated with roads within the Analysis Area?*

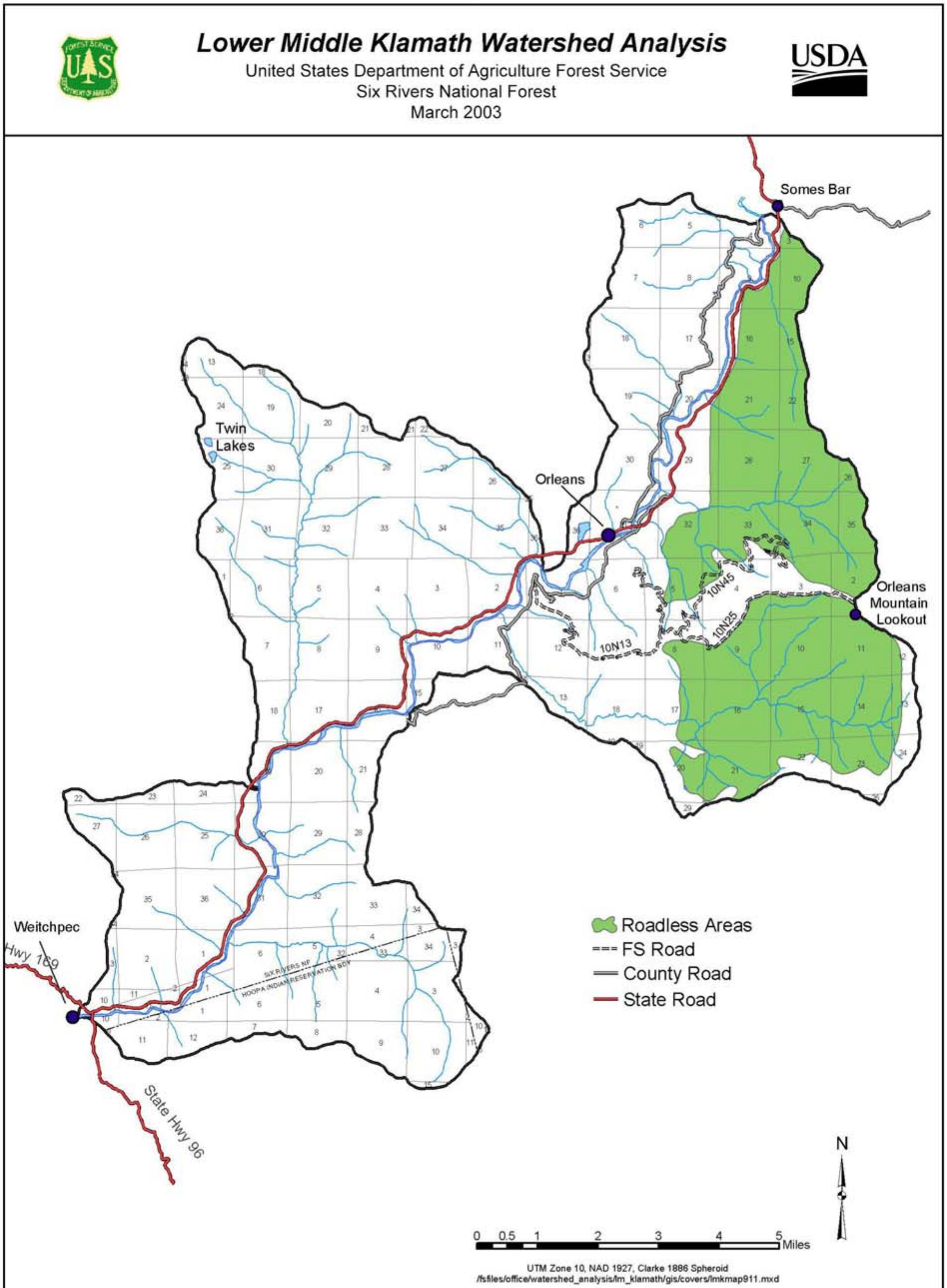
Road networks in many areas of the Pacific Northwest are the most significant source of management-related sediment delivery to anadromous fish habitats, often exceeding all other sources attributable to forest activities combined. Forest Standards and Guidelines pertaining to roads management provide a set of minimum protection and restoration measures designed to minimize effects of roads within Riparian Reserves consistent with Aquatic Conservation Strategy objectives. The existence of roads on unstable lands is a major liability to aquatic and riparian ecosystem function on the Forest. Throughout the Forest, sedimentation, channel degradation, and loss of woody debris have resulted from road failures, road construction, and road operation. Road construction and operation within steep or unstable riparian areas has disrupted ecological processes, including sediment and woody debris recruitment and routing, and has caused chronic disturbance to species and habitat that can potentially impede restoration effects.

Most drainage structures, especially stream crossings built in the 1950s to 1970s, either are not sized for a 100-year flood event, were poorly or improperly constructed, or exhibit a high potential for plugging and stream diversion which could lead to extensive erosion and sediment yield during a large storm and flood event. Humboldt log crossings built during the 1960s and 1970s are still a common type of drainage structure found on private lands. Many of these old log crossings show signs of deterioration and imminent failure. In many of the sub-watersheds, failure of these unstable sites could produce significant cumulative effects during the next large storm. While direct road-related sediment production (sheetwash, rill, and gully erosion) is smaller than sediment input from landslides, road-related failures are more likely to deliver sediment directly to streams. Therefore, potential sediment input from road-related failures can be highly significant.

Culverts may plug during storm events and pose a risk of introducing large quantities of sediment to stream channels. Culvert failure within riparian corridors may set in motion a series of events, the worst being sudden massive failure of the fill, resulting in debris torrents that in turn may devastate the stream and adjacent riparian corridor. Even minor failures may introduce sufficient sediment volumes to exceed the transport capacity of the channel, causing the channel to aggrade and widen, followed by fluvial adjustments that may take many years to complete.

The consequences of culvert failures can be minor or substantial. Minor failures introduce culvert fill material that exceeds the transport capacity of the channel, causing the channel to aggrade and widen. It can take several years for the channel to adjust and move the sediment downstream, but generally the effects are localized. Some culvert failures generate debris flows that entrain additional sediment as they move downstream. The impacts from debris flows can be far removed from the original culvert failure and take many years for the channel to adjust and riparian vegetation to reestablish. Stream crossings on steep terrain, with a lot of organic material upstream, have the greatest potential for debris flows.

Figure 28 Roadless Areas.



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Stream crossing diversions also pose significant risks in terms of off-site sedimentation. Diversions occur when a culvert plugs and the stream flow follows the roadbed instead of crossing the road and returning to the original channel. When the stream flow eventually crosses the road, it may create a new channel on the hillslope with considerable erosional consequences. Table 53 summarizes the diversion potential of stream crossings by sub-watershed. Data collected from field inventories indicate that most watersheds have a high percentage of diversion potential. In the past, stream crossings were typically designed to divert flow away from the fill should the culvert fail, which results in a diversion instead of a road prism failure.

- *What are the parameters associated with road maintenance in the Analysis Area?*

To ensure public and administrative safety, the USFS conducts routine road maintenance on system (or classified) roads to prevent sedimentation, drainage diversion, and slope failure problems that may result from road operation and use. Road maintenance activities are often necessary because of drainage problems. Drainage structures are constructed in locations to minimize impacts of road building on watersheds. Due to economical constraints, most Forest roads are designed and constructed in a manner that requires regular drainage structure maintenance. Routine road maintenance projects maintain the functionality of the designed drainage structures along roads.

Table 53 Stream Crossings and Diversion Potential by Sub-Watershed.

Sub-watershed	Stream Crossings	Stream Crossings with Diversion Potential	Percentage of Stream Crossings with Diversion Potential
Aikens Creek	19	14	74%
Boise Creek	7	5	71%
Cavanaugh	2	0	0%
Crawford	24	12	50%
Hopkins Creek	0	0	0%
Ikes	11	9	82%
Pearch Creek	4	2	50%
Red Cap Gulch	14	12	86%
Slate Creek	21	15	71%
Whiteys Gulch	13	10	77%

In addition to LRMP Standards and Guidelines, the Region 5 Forest Service Soil and Water Conservation Handbook established Best Management Practices (BMP) for road maintenance. The BMP Handbook contains explicit road building and maintenance guidance in section 12.22. There are 26 BMPs in section 12.22. All road maintenance operations are guided by BMPs.

In addition to maintaining drainage structures, routine maintenance projects will be completed by the Forest to meet its responsibilities under the Highway Safety Act (23 U.S.C. sections 401-410). The USFS has the responsibility to provide for the safety of the Forest visitor and to operate and maintain roads in accordance with regulations implementing the Highway Safety Act (23 U.S.C. sections 401-410). Regulations governing highway safety standards applicable to the USFS are found at FSM 1525.

With the recent reduction in timber harvest, road construction has been curtailed and road maintenance activities have declined in proportion to the reduction in resource extraction. The reduction in available funds for road maintenance is tied directly to fees charged to commercial entities for using the road system. As maintenance activities continue to decline, the potential exists for unsafe conditions and road-related resource damage to streams, riparian areas, native plants, and wildlife.

Operational Maintenance Level

The Transportation System Maintenance Handbook (FSH 7709.58) describes the various maintenance levels for managing USFS road systems. Roads assigned OMLs 3, 4, or 5 are to be maintained in accordance with the requirements of the Highway Safety Act as indicated by FSM 1535. The majority of maintenance activities occur on the higher maintenance level roads.

Forest Development Roads are those roads under the jurisdiction of the USFS. They are constructed to standards, which depend upon the need identified for the road. Roads are maintained and available for use at maintenance levels equal to the identified needs.

The Forest Supervisor considers the following factors when the maintenance levels are selected for each road (FSH 7709.58,10-12.3.1):

- Resource program needs, environmental and resource protection requirements, visual quality objectives, and recreation opportunity spectrum classes
- Road investment protection requirements
- Service life and current operational status
- User safety
- Volume, type, class, and composition of traffic
- Surface type
- Travel speed
- User comfort and convenience
- Functional classification
- Traffic service level

Roads may be currently maintained at one level and planned for maintenance at a different level at some future date. The OML is the maintenance level currently assigned to a road considering today's needs, road condition, budget constraints, and environmental concerns; in other words, it defines the level to which the road is currently being maintained.

The objective maintenance level is the maintenance level to be assigned at a future date considering future road management objectives, traffic needs, budget constraints, and environmental concerns. The objective maintenance level may be the same as, or higher or lower than, the OML. The transition from OML to objective maintenance level may depend on reconstruction or disinvestment.

Operational Maintenance Level 1
This level is assigned to roads that are closed to vehicular traffic but still exist on the Forest Service transportation system for potential future use. Maintenance is done to provide the basic care needed to protect the road investment and minimize damage to adjacent land and resources. This level is assigned to intermittent service roads during the time they are closed to vehicular traffic. The closure period must exceed 1 year. Basic custodial maintenance is

performed to keep damage to adjacent resources to an acceptable level and to perpetuate the road in order to facilitate future management activities. Emphasis is normally given to maintaining drainage facilities and runoff patterns. Planned road deterioration may occur at this level. Roads receiving level-1 maintenance may be of any type, class, or construction standard, and may be managed at any other maintenance level during the time they are open for traffic. However, while being maintained at level 1, they are closed to vehicular traffic, but may be open and suitable for nonmotorized uses.

Operational Maintenance Level 2
This level is assigned where management direction requires the road to be open for use by high clearance vehicles. Passenger car traffic is not a consideration. Traffic volumes are usually minor. This level provides the basic care described above and keeps roadway clear for safe passage.

Operational Maintenance Level 3
This level is assigned where management direction requires the road to be open and maintained for safe travel by a prudent driver in a passenger car. Traffic volumes are minor to moderate; however, user comfort and convenience is not considered a priority. Roads at this maintenance level are normally characterized as low speed, single lane with turnouts and spot surfacing. Some roads may be fully surfaced with either native or processed material. The functional classification of these roads is normally local or minor collector (has lower level roads branching off from it).

Operational Maintenance Level 4
This level is assigned where management direction requires the road to provide a moderate degree of user comfort and convenience at moderate travel speeds. Traffic volumes are normally sufficient to require a double-lane, aggregate-surfaced road. Some roads may be single lane and some may be paved and/or dust abated. The functional classification of these roads is normally collector or minor arterial (has one or more collectors branching off from it).

Operational Maintenance Level 5
This level is assigned where management direction requires the road to provide a high degree of user comfort and convenience. These roads are normally double-lane, paved facilities. Some may be aggregate-surfaced and dust-abated. The functional classification of these roads is normally arterial.

Maintenance Costs

In the past, when timber hauling was the primary road use, road maintenance was accomplished primarily with timber sale contracts where the private contractor provided maintenance during harvest operations. Currently, the Forest administers more direct road maintenance contracts to maintain roads at the levels necessary for resource protection and vehicular safety.

The current annual road budget (FY 2002) is approximately $783,000. This covers salary, equipment, contracts, supplies, overhead, and administrative costs. Approximately 75% of the budget is used on OML 3, 4, and 5 roads.

Over the past 15 years, the road maintenance budget for the Forest Service has been continually declining. This decline in funding creates a situation in which it is not feasible to fully maintain the existing road system at current maintenance levels. There are significant differences between the costs associated with each maintenance level. The most economical road system is one that achieves the required management objectives at the least cost. The current road system is maintained based upon available funding. Funding is directed to roads based upon the priority identified on the Forest or by national directives, which include public safety, resource concerns, etc.

4. SYNTHESIS & INTERPRETATION

This step of the analysis process is designed to synthesize and interpret information collected in the previous steps across resource areas. Emphasis is placed on understanding ecosystem processes and functions as they relate to the issues and key questions in Chapter 2, with the objective of identifying management techniques that can help achieve desired conditions.

Vegetation and Fuels Management

Trends and Changes HRV/RMR

- *How has human and natural disturbance affected the Historic Range of Variability and the Recommended Management Range?*

Changes in Plant Community Composition, Distribution, and Structure

The changes in vegetation that have taken place in the Analysis Area are primarily due to fire, fire suppression, climate changes, timber harvesting, and human spread disease. There is both anecdotal and quantifiable information to show that stand densities have increased in these watersheds over the last 100 years. In the last 30 years the stand densities of Douglas-fir, tanoak, and white fir have increased significantly. These increases can be attributed to both fire suppression and the wetter climate. A wetter climate may have increased natural succession rates adding to an increase in vegetation in many stands. The suppression of fires and a cessation of Native American burning have also contributed to increases in vegetation density.

Another significant change to plant community structure is the decrease in the amount of late-seral habitat compared to pre-harvest levels. Forty three percent of the old-growth for all vegetation series in the Analysis Area has been harvested. In the tanoak series 48% of the old-growth has been harvested. Thirty five percent and 22% of the old-growth has been harvested in the Douglas-fir and white fir series respectively. These changes in the amount of late-seral forest will guide future management.

A potential impact to plant community composition and structure is the spread of POC root disease. In the Analysis Area, there are dense stands of POC throughout Aikens Creek and some areas of Slate and Crawford creeks. A decrease in the density and structure of these stands may be imminent with the presence of the disease in this area. Measures are being put into place to mitigate the spread of the disease. There is root disease infection currently in the lower reaches of Aikens Creek, and Serpentine Creek, which is just north of the Analysis Area, is infected. Because of its proximity to the infected area, Aikens Creek is at high risk of infection, according to the recent POC Risk Assessment for the Klamath Basin. Crawford and the Lower-Middle Klamath are at moderate to low risk, and Slate Creek is at a moderate risk for infection. In the POC risk assessment, the main roads in these sub-watersheds have been identified and recommendations have been made for installing gates and barriers in certain locations. There is also a need for educating the public about precautions that should be taken when traveling from infected to uninfected areas. Part of the risk assessment identified gatherers as a group that gathers plant material from the Aikens Creek area.

Management Guidelines for Vegetation

Two guidelines are provided for managing vegetation in the LMK Analysis Area. The first guide is the RMRs, which were developed for the Forest zones. The second guideline concerns specific management for the primary vegetation subseries, and the information on the subseries is taken from the recently completed SRNF Large Scale Vegetation Assessment.

Recommended Management Ranges

RMRs are an extension of the HRV analysis. The HRV represents a wide range of seral stage conditions, and includes infrequent, high intensity disturbances. Because the Forest will always be subject to catastrophic events, it should not be managed for the extremes of the HRV; rather, it should be managed within a subset of the HRV that provides a buffer against catastrophic events. The RMR is the subset of the HRV and represents the range of seral stages that the SRNF believes can be managed within while maintaining ecosystem process and function. The criteria used to develop RMRs include the following:

- Recent climate conditions have been relatively moist when compared to historical conditions. Based on the moist climate and current disturbance regimes, there is an increased capability to maintain more acres in late-seral stages and fewer acres in early seral stages.

- The RMR should provide a buffer against unpredictable large-scale stand replacing events.

- The current management emphasis is to maintain habitat for late-successional forest related species.

Table 7 shows the RMR for tanoak, Douglas-fir, and white fir series in the north and central zones. Because the RMRs were developed for each zone the Analysis Area is divided into zones. The distribution of seral stages is expressed as a percent of the total acres of each series within a zone. This table can help to guide management by looking at where the Forest is over the maximum, under the minimum, or within the RMR. For example, for most of the series in each of these zones the old-growth seral stage is below the minimum RMR. This deficiency in old-growth can be remedied in the future by maintaining late-mature stands or accelerating late-seral characteristics in early and mid-mature stands. Early and mid-mature stands are generally over or within the RMR. The acres over the RMR in the early and mid-mature seral stages are potential areas for regeneration harvests. The current acres and percentages can only change when the seral stage is significantly altered.

Port-Orford-cedar

Up until the early 1950s, natural stands of POC had few serious pests (Roth et al. 1987). Then a root disease, *Phtophthora lateralis*, appeared from unknown sources, although the nursery trade is highly suspect. The fatal root disease has now spread throughout POC's native range, except for the populations in the Trinity River watersheds.

The potential effects of this disease to biodiversity are many. Foremost is the loss or significant decline of a major shade tolerant tree species found in many plant communities, in particular those found on serpentine soils and riparian habitats. Preliminary indications in areas decimated by the disease point toward changes in species composition and stand structure that could lead to degradation of riparian habitat.

The social values of POC are many and represent a history of use dating back to aboriginal North Americans. Native American tribes such as the Hoopa and Karuk of northwest California revere the wood, and use it in construction of ceremonial dance pits, sweat houses, and the living home. Undoubtedly, its greatest commercial value exists with the log export industry. The Japanese have paid as high as $5000 per thousand board feet due to the similarity of POC to Hinoki cypress, a highly valued tree of Japan.

Wildlife use of POC snags does not appear to be as high as pines or Douglas-fir (Jimerson 1992 and 1999b), but this is likely partially offset by the longevity of the snags. POC logs persist for a very long period due to their resistance to decay and large size. They provide structural diversity and long-term habitat in riparian areas where they are particularly important to fish, reptiles, and amphibians. The stabilizing effects and habitat contributions of large POC woody material and its root mass in stream channels have often been described as the primary geomorphic control for soil movement. Loss of POC in riparian ecosystems could lead to degradation of the stream channel over time, and lead to loss of anadromous fish habitat.

The thick, fibrous bark and resistance to decay following injury to the cambium combine to give POC special value in fire-disturbed ecosystems. Trees that have burned all the way through the bole, with two "legs" of cambium remaining, have persisted for decades in an otherwise healthy appearing state. This has special significance for natural regeneration of sensitive riparian environments following fire.

The stabilizing effects and habitat contributions of large POC woody material and its root mass in stream channels have often been described as the primary geomorphic control for soil movement. Loss of POC in riparian ecosystems could lead to degradation of the stream channel over time and lead to loss of anadromous fish habitat.

The limited distribution, wide environment gradients, high genetic diversity, high social values, importance to wildlife, and high species and community diversity point towards the need for a conservation strategy designed to maintain POC as a continuing element of our biodiversity. Such a strategy needs to be applied on a range-wide basis and incorporate all the factors described earlier. In particular, it must include areas protected from the disease that represent the biological and genetic diversity of the species that are well distributed throughout its range and are arrayed along the wide environment gradients described earlier.

The risk assessment along with the extent of the plant association, percent infected, potential to effect other resources i.e. fish, rare plants, SM species, can be used to assess the risk to POC and its biological and genetic diversity. This multi factor assessment identifies only one plant association with an overall low rating. Six plant associations are rated as a moderate risk and seven plant associations are rated as a high potential risk to POC biological and genetic diversity.

The limited distribution, wide environment gradients, high genetic diversity, high social values, importance to wildlife, and high species and community diversity point towards the need for a conservation strategy designed to maintain POC as a continuing element of our biodiversity.

Such a strategy needs to be applied on a range-wide basis, and incorporate all the factors described earlier. In particular, it must include areas protected from the disease that represent the biological and genetic diversity of the species that are well distributed throughout its range, and are arrayed along the wide environment gradients described earlier.

Adorni Research Natural Area

The greatest risk to the ecological integrity of the RNA is the risk of introducing the fatal POC root disease. The threats include public access along the road situated upslope of the RNA, serving as the northern boundary, activity on the private property located upslope as well and the close proximity to the large infestation pocket in Fish and Blue Lakes. The two RNA's in Region 6 established for POC have already become infested with the root disease, thereby increasing the importance of the Adorni RNA as one of the few remaining areas which support POC in association with mixed evergreen forest type. The other POC RNA in California is found in the mixed conifer type (Cedar Basin on the Shasta-Trinity National Forest). It contains many of the most rare plant associations found within the range of POC. The Cedar Basin RNA is also in jeopardy due to a newly discovered nearby infestation pocket and the need for management actions that reduce public access.

Noxious Weeds

- *What are the trends for further introduction and spread?*

Diversity and extent of noxious weeds in the Analysis Area is greatest along the main stem of the Klamath River and associated with Highway 96 and the adjacent community of Orleans. These areas support occurrences of spotted knapweed, dyer's woad, yellow starthistle, himalaya blackberry, and broom species (scotch, french and spanish). Some of these weed species are also associated with the lower stretches of Forest roads that intersect Highway 96 (e.g. Bluff Creek Road).

The highway and the river corridor provide a significant westward vector for weeds more commonly associated with eastern California (drier and warmer climes). A specific example of the westward vector played by the Klamath River is the recent detection of spotted knapweed at Camp Creek Bar, the confluence of Bluff Creek and the mainstem Klamath, and Dolan's Bar. It is likely that weed seed was transported downriver from larger populations located on the Salmon River. Given the ease with which weed seed disperses, the myriad vectors for long-range dispersal, and the ability of weeds to persist once introduced (thereby providing yet another source of seed), if left unchecked, weeds that are now relatively limited will continue to expand their territory in open, disturbed settings both westward and upslope from the their current distribution.

In its favor against widespread expansion of noxious weeds, the Analysis Area supports vegetation types not considered highly susceptible to weed establishment. The area is dominated by the tanoak (69%) and Douglas-fir (17%) vegetation series (See Chapter 3 ***Vegetation***). Habitats within these series are less susceptible to noxious weed establishment than those of more open canopied series such as grasslands that have been previously disturbed. The extent of grasslands in the Analysis Area is <1% of the total area. Barring landscape level or geophysically defined disturbances such as wildfire, landsliding, or flooding, expansion and temporal contraction of weed distribution and cover will likely remain associated with settings disturbed by human activity.

However, as discussed in Chapters 3 for ***Erosion Processes*** and ***Fire***, those landscape level and geophysical disturbances are expected events in the Analysis Area. Naturally unstable slopes occur in lower parts of drainages including those slopes along the mainstem Klamath and Highway 96, which is the same corridor where weed infestation in the Analysis Area reaches its greatest extent. Seasonal flood events can result in disturbance of riverbars, a setting in the Klamath River that supports spotted knapweed. Newly disturbed settings close to weed occurrences are most vulnerable to weed establishment. The incidence of stand-replacing wildfires also increases the chance that weeds will spread to areas that, prior to an intense wildfire, would have been considered unsuitable for weed establishment due to the presence of canopy cover. Thirty-six percent of the Analysis Area is within condition class 3 with a high to very high susceptibility to stand replacement. Furthermore, the origin of a vast majority of fires in the Analysis Area is the Highway 96/Klamath River corridor (see Chapter 4 ***Fire***), which is, again, the setting where weed infestation in the Analysis Area is most troublesome.

Wildfire activities related to suppression typically result in the importation of material from out of the area such as equipment, mulching material, supplies, and personnel (e.g. use of suppression resources from Idaho, Montana, Washington, and Oregon – states that maintain the largest infestations of knapweed in the country). As a part of post-fire rehabilitation (both suppression and burn area) importation of foreign material is also commonplace. In 2001, during rehabilitation monitoring, yellow starthistle was detected in a few isolated locations in the Megram Fire area, which had been mulched with rice straw. The nearest yellow starthistle occurrence was 8-10 miles away, at lower elevations, on roadsides just east of Hoopa. With an increasing trend toward stand-replacing fires and employment of direct attack methods, concern increases over the introduction and spread of noxious weeds into wildland settings.

Fire

Factors Contributing to High Fire Potential

Several factors indicate that the LMK Analysis Area has a high potential for large, sustained, severe wildfires:

- The recent period from 1990-2001 shows a high risk rating, which means at least one fire is expected in 0-10 years per thousand acres.
- Recent trends in fire occurrence show a substantial increase in the number of human-caused wildfires in the last 5 years (1997-2001). The main fire occurrence continues to be along the Klamath River, Highway 96 corridor. This area is generally at the bottom of steep slopes and usually gets strong afternoon, up-canyon winds.
- Previously common, large wildfires have been virtually eliminated from the Analysis Area since 1960.
- Fire behavior modeling indicates that 45% of the Analysis Area has the potential for high to extreme rate-of-spread and flamelengths during late summer weather patterns, with the greatest potential in Slate Creek.
- In the event of a wildfire, the steep topography (46% of the area at greater than 55% slope), large unroaded areas, extended arrival times, and lower suppression priority

than more populated areas could severely hamper ground-based suppression effectiveness.

- Condition Class modeling indicates that moderate to dramatic changes in fire size, frequency, intensity, severity, or landscape patterns can result in approximately 68% of the Analysis Area.

Large, sustained, severe wildfires could result in unhealthy air impacts to local communities. Wildfire and air quality factors are especially critical since the communities of Orleans, Weitchpec, Somes Bar, and the Hoopa and Yurok Indian reservations were listed in the Federal Register as communities at high risk from the threat of wildfires.

Returning to Pre-European Fire Regime

- *What would be the impacts of returning to the pre-European fire regime, and is this achievable and sustainable?*

Returning to more of a pre-European fire regime, which is a generally a low-intensity, short interval (stand maintenance) with scattered areas of high intensity, would contribute to a forest that is more resilient to the effects of wildfires, and reduce the probability of catastrophic fire. Catastrophic fires tend to occur when there is heavy fuel loading both horizontally and vertically, and often when this is combined with periods of drought or high winds, high temperatures, and low relative humidities. Crown fires are especially problematic to fire managers because their rates of spread are several times faster than surface fires, and spotting is frequent and can occur over long distances. In addition, near total tree mortality can be expected with greater smoke production, and foliar nutrients possibly lost from the site (Scott and Reinhardt 2001). On the other hand, low-intensity fires generally have less than 4-foot flamelengths and mainly burn surface fuels with only some scattered areas of torching and killing of shrubs and trees.

These low intensity wildfires would allow fire suppression to be conducted more effectively and safely, which could increase the protection of communities and natural resources. A fire resilient forest may contribute to greater opportunities for Wildland Fire Use (i.e. the management of wildland fire to achieve resource objectives) because a wildland fire can burn through an area of low fuel loading with minimal impacts to forest lands that have lower fire behavior.

Given that model results that showed 68% of the LMK Analysis Area occurring in Condition Class 2 or 3 it could take several fuel treatments over many years to return to a pre-European fire regime across the landscape. These multiple entries would need to focus on reducing vegetation density and fuel loading in order to return to a more historic condition. To achieve this goal, maintenance would be critical either through continued prescribed burning or through the appropriate management response (i.e. specific actions taken in response to a wildland fire to implement protection and fire use objectives), which could include Wildland Fire Use. If conditions continue to worsen the costs of implementing all the needed, restrictions, surveys, and mitigations will continue to escalate.

Minimization of Fire Risk

- *What efforts can help minimize fire risk, especially human-caused risk?*

Based on a standard risk formula, the Analysis Area shows a high-risk rating, which translates into at least one fire expected in 0-10 years per thousand acres. Since the fire history for this area shows a strong and growing prevalence of human-caused fires (especially in the last 5 years), it is imperative to try to reduce the number of human-caused wildfires through more and/or better focused education efforts, increased patrols during periods of high visitor use or high fire danger, and strengthening the Fire Prevention Program through increased staffing and additional training. Wildland fire prevention activities generally fall within one of three broad categories: education, engineering, and enforcement.

Education

Education is aimed at changing people's behavior or actions through awareness and knowledge about the increasing fuels build-up and subsequent increased potential for high severity fires, increased human caused fire risks, and methods to help reduce the fire risk. Education efforts can include printed materials/handouts, mass media efforts (e.g. radio, TV), one-on-one contacts or group presentations, strategically placed signs, displays at fairs, and participation in parades. Even arsonists may be deterred from starting more fires when given the right education about the consequences to themselves (e.g. jail and fines) and the environment.

Engineering

Engineering activities assess a potential or safety hazard and develop the means of eliminating that hazard. These activities are designed to shield an ignition source (e.g. spark arrester, powerline) or remove the fuel that could ignite from a spark or fire brand. Clearing fuels around homes, in campgrounds, and along powerlines would fall into the engineering category. Sign design and location placement are also engineering tasks. Focus areas for signing within the LMK Analysis Area could include Highway 96 where it enters the Analysis Area, junctions of roads leading from Highway 96 into high hazard areas, and in campgrounds or other recreation areas (e.g. river access points). Inspections are also a critical engineering activity:

- Structural hazard inspections prioritize private and residential areas as high, moderate, or low hazard areas, develop community interest to be part of their own prevention programs, and educate the public instilling an attitude of landscaping in a "Fire Wise" way.
- Industrial inspections increase awareness of operators (e.g. for logging, brush piling, road construction) on high hazard days, and ensure that operations are commensurate with the daily hazard.

Enforcement

Enforcement activities are designed to gain the compliance of Forest visitors and users with current fire regulations and all other Forest laws. Enforcement activities could be increased during periods of high fire danger or high visitor use through increased patrols and public contacts. Enacting fire restrictions and emergency closures are part of enforcement when specific weather and fuel conditions are reached.

A recently developed organization, the Orleans/Somes Bar Fire Safe Council, could be integral in reducing the fire risk throughout the Analysis Area. Fire Safe Councils are organized to facilitate coordination and collaboration among tribal, local, state, and federal organizations for long-term planning, fire management, and emergency response. This local Fire Safe Council has been very active since its inception in 2001 through the following activities:

- Convening community meetings to familiarize local community members with ongoing efforts and encourage their active involvement
- Educating landowners about natural fire regimes, the risk of fuels build-up, and the need for appropriate treatment
- Organizing fuel reduction work days on private landowner's property
- Conducting workshops and distributing newsletters to inform the public on fire risks and hazards and ways to reduce them
- Organizing neighborhood groups and electing representatives
- Submitting grant proposals to acquire funding for priority fuel treatment projects and/or equipment
- Distributing a critical info and fire protection survey that will be used to develop an emergency response book to help the Orleans Volunteer Fire Department to locate the caller and assess potential hazards before they arrive onsite, and a community Fire Safe Plan including prioritized fuel reduction projects on private lands

Road closures (both permanent and seasonal) could also assist in eliminating some human-caused fires. A Transportation Plan is necessary to address the tradeoff of access for fuel treatments and fire suppression versus road closures that eliminate certain human-caused ignition or would help reduce sedimentation. Especially in areas where road closures are not feasible, fuel treatments along roads should be pursued in high risk and value areas (e.g. near communities, within and adjacent to LSRs, and along Highway 96), with regular maintenance schedules to keep the fuel loadings low.

Reducing fire hazards does not reduce risks, but it does help reduce impacts from wildland fires, whatever the cause. We cannot eliminate all the risks of a fire starting, so it is critical to implement projects to reduce fire hazards and lessen impacts of high-intensity fire. These fuel reduction projects help reduce the amount of receptive fuel beds that contribute to the ease of a fire starting, and help reduce fuels that contribute to high-intensity fires.

Fuel Treatment Options

- *What combination of fuel treatments (prescribed fire, fuelbreaks, thinning, mechanical treatments) could help to reduce the fire hazard, and where are the priority areas to treat?*

Fuel treatment options can vary from hand or mechanical manipulation to prescribed burning or thinning of overly dense stands (Appendix G). Results from the "Effect of Fuels Treatment on Wildfire Severity" study (Omi and Martinson 2002) and several other fuel treatment projects associated with 2002 fires in Arizona and Colorado indicate that fully implemented fuel treatments can definitely lessen negative fire impacts. A priority of the Orleans/Somes Bar Fire Safe Council is to work cooperatively with local homeowners and agencies to develop and implement cost-effective projects including fuel reduction, fuelbreaks, prescribed burning, and other appropriate projects.

Areas mapped as Condition Class 2 and 3 especially show the need for mechanical/manual type fuels treatments to reduce both surface and ladder fuels before prescribed fire can be used, or where possible, Wildland Fire Use. This build-up of surface and ladder fuels would contribute to a high potential for torching, crowning, spotting, and, in general, more intense fire behavior. This fuel build-up would contribute to high intensity wildfires and make prescribed fire extremely hard to implement while trying to minimize mortality in the existing canopy. Even many of the areas identified as Condition Class 1 are starting to have too much surface and ladder fuels to allow prescribed fire alone without some pre-burn fuel reduction.

The impacts of steep slopes, distances from roads, and economics may affect what types and amount of fuel treatments can be implemented. On steeper slopes, mechanical treatments are very limited, so generally, manual treatments are used that are usually more expensive. Often, work is slower and harder to accomplish on steeper slopes, and may take several entries to achieve desired conditions. As projects get further from roads, production rates drop and costs increase. Mechanical treatment options also decrease as the distance from roads increase. The costs to treat fuel levels go up rapidly the denser and more continuous they become (i.e. higher hazard). Air quality mitigations and limited operating periods may also reduce the amount of time or the window of opportunity to accomplish burning projects.

Fuel treatments or a combination of treatments (e.g. prescribed fire, fuelbreaks, thinning, and mechanical/manual treatments) could help to reduce the fire hazard, and, when implemented along roads (including brushing and limbing for greater visibility), help make roads safer to drive. Improving access to or improving existing water sources and creating new water sources, could contribute to an increase in fire fighting effectiveness.

Priority Areas

The 2001 SRNF Fire Management Plan (FMP, USFS, 2001) identified the following priority areas for fuel treatments:

- Communities at risk
- Municipal watersheds
- Upper-1/3 slopes
- Major natural disturbances (e.g. wildfires, blowdown, insect, or disease infestations)

The first two parameters are part of the main focus of the *Cohesive Strategy – Protecting People and Sustaining Resources in Fire-Adapted Ecosystems* (USDA Forest Service 2000) and the Western Governor's Association's 10-Year Comprehensive Strategy *A collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment* (Western Governor's Association 2001). These two parameters are obviously critical for the communities of Orleans, Weitchpec, Somes Bar, the Hoopa and Yurok Indian reservations, and the Pearch Creek Municipal Watershed (along with domestic water sources identified in Figure 20). The upper-1/3 slopes provide strategic locations for control points for fuel treatments and fire management. Ridges and upper-1/3 slopes historically experienced more frequent lightning ignitions, and, as a result, had more open conditions than the rest of the landscape. Especially valuable opportunities may exist where established roads coincide with strategic, upper-1/3 slope locations.

The Cohesive Strategy (USDA Forest Service 2000), in addition to communities at risk and readily accessible municipal watersheds, also assigned high priority for hazardous fuels reduction to TE species habitat and other important local features where conditions favor uncharacteristically intense fires. Given that 45% of the Analysis Area shows the potential for high to extreme August ROS and FL and 68% of the area has the potential for moderate to dramatic changes in fire intensity/severity (from Condition Class modeling) and the existence of LSRs, Botanical Areas, and other resource areas of concern within the watershed, much of the LMK Analysis Area should be a high priority for landscape level fuel treatment. As mentioned in the Western Governor's Comprehensive Strategy in terms of priority setting, " Long-term emphasis is to maintain and restore fire prone ecosystems at a landscape scale." This area is obviously fire-prone.

The National Fire Plan (USDA, 2000) encourages working with local communities as a critical element in restoring damaged landscapes and reducing fire hazards near homes and communities. The local Fire Safe Council provides an excellent avenue for this cooperation, and, as the Orleans/Somes Bar Fire Safe Council develops their fuel treatment priorities on private land, these will also need to be incorporated into the planning process for coincident opportunities.

Impacts to Communities and Resources with No Fuel Treatment

- *Given the change in fire regime, what are the potential impacts to communities and resources if fuels are not aggressively treated?*

As evidenced at the beginning of this section, many factors are lined up that could result in large, sustained, severe wildfires in the near future. The effect on communities and resources could be devastating and long lasting.

Whether a fire is lightning or human caused, the high recent fire risk rating (since 1990), indicates that wildfires have a very good chance of occurring throughout the LMK Analysis Area, especially along the Highway 96/Klamath River corridor. When a fire does occur, given the predominant vegetation and topographic conditions, there is an increased risk of a fast moving, high-intensity fire. Without an aggressive fuel treatment program, fuels will only continue to build-up, and with the continued build-up more and more acres will exhibit high to extreme fire behavior potential.

High-intensity fires generally result in a large portion of the areas burned at a high or stand replacing intensity. These fast moving, high-intensity fires are very hard to contain due to extensive crowning and increased spotting distances. With the increase in extreme fire behavior, fire suppression effectiveness is severely hampered. As the densities of brush and understory continue to increase, access for fire fighting forces gets extremely limited and line construction rates are greatly reduced. Fire crews are often not able to use direct attack suppression methods, and are forced to move at least one or more ridges away from the fire to construct indirect fire line. Strategies can change to indirect attack (with fire line locations further away from a fire), which involve looking for more open vegetation or moving far enough away from the fire so there is time to construct fire lines and burn the lines before the fire gets there. Burning from these lines is still difficult because the fuels build-up creates a higher potential for the burn to cross the control lines if they are not large enough. This type of indirect attack can greatly increase the size of fires, and is not always successful since the fire has more time to increase its momentum.

Large, stand-replacing wildfires with high to extreme fire behavior could drastically affect the communities of Orleans, Somes Bar, Weitchpec, and the Hoopa and Yurok Indian reservations. These fast moving, high intensity fires often make it more difficult to get to isolated homes to do structure protection. Due to the high intensity of these fires, it is not always possible to perform structure protection safely or with a high degree of success. Even smaller fires, if they are located close to private property or are wind driven, could have severe impacts on populated areas. The recent Dance (2001), Windy (2000), and the Megram (1999) fires show the potential impact of fires to these community areas.

High-intensity fires can burn large areas with a mosaic of stand replacing impacts (See Appendix F for Vegetation impacts). These stand replacing type fires quite often destroy or degrade critical habitats to a point where they are no longer suitable to meet desired functions. High intensity fires can also provide habitat that is very suitable for the infestation and spread of noxious weeds. Uncharacteristically intense fire is detrimental to watershed function and water quality. By killing vegetation, burning organic matter in litter and soil, and sometimes forming impervious soil layers, severe fires can accelerate runoff from the watershed. More water is discharged over a shorter period of time, and peak flows are greater, which contributes to increased flood hazards. Bare soils and increased runoff can result in higher levels of sedimentation, and landslides could become more prevalent, which would, again, negatively affect the local communities.

It must be noted that during periods of extended or extreme drought, fuel treatments may not always be very effective. Also, extreme, wind driven, crown fires may still occur in areas that have had some fuel reduction treatments.

There is a critical need, in using the adaptive management concept, to implement projects and do monitoring. This would allow the implementation of fuel treatments so that the Forest can learn from its activities. Implementation of these projects needs to start now because it is not known when a fire may occur. While the SRNF needs to implement fuel reduction projects, there is also a need for fires to take place in the areas where fuel treatments have occurred, so that these treatments can be monitored for effectiveness.

There is a positive role for low to moderate intensity fires on NFS lands. The proper balance between protection and management must be achieved in order to make these forest stands resilient to future wildfire events.

Timber

- *What effects may the established Standards and Guidelines for Recommended Management Ranges have on the potential level of timber production that could be realized?*

Within the north and central zones, the old-growth seral stage is currently below the RMR for the tanoak and Douglas-fir series. The white fir series in the north zone has no old-growth seral stage within matrix lands. The white fir series in the central zone is below the RMR for the old-growth seral stage. The late-mature seral stage is within the RMR for the tanoak, Douglas-fir, and white fir series for both the north and central zones; however, this seral stage is needed as future recruitment for the old-growth seral stages in all series. Therefore, old-growth and late-mature seral stages would not be available to contribute to the Analysis Area’s portion of the SRNF ASQ.

The early and mid-mature seral stages of the tanoak, Douglas-fir, and white fir series within the north and central zones are within the RMR, with the exception of the early-mature white fir series. Therefore, management within these seral stages, with the exception of the early-mature white fir, would contribute to the Analysis Area's portion of the SRNF ASQ.

Based on the above key findings, opportunities exist within the watershed, utilizing an assortment of silvicultural prescriptions, to manage within early and mid-mature seral stages.

Protection of Soils Resource

- *What soil types exist that are especially sensitive to natural or management disturbances such as wildfire, fuel treatments, or logging, and in what locations are special mitigations warranted?*

Only about one-quarter of the soils in the Analysis Area have moderately high or high overall sensitivity to management disturbance in terms of compactibility, erosion hazard, or susceptibility to burn damage. These are predominantly in the Clallam, Oragran, and Weitchpec soil families.

The sub-watersheds with the greatest extent of sensitive soils are Aikens Creek, Crawford/Ullathorne Creeks, Red Cap Gulch, and Slate Creek. The sub-areas with higher a proportion of erosion hazard or burn damage potential coincident with high Condition Class are Aikens, Slate, and Crawford creeks, while Boise Creek, Red Cap Gulch, and Whitey's Gulch have a moderate overlap of soils and Condition Class.

- *What are the major uncertainties in protecting soil productivity within this Analysis Area while conducting management activities?*

Soils are highly variable across this landscape. The SRNF's Order 3 Soil Survey delineates composite map units that may contain similar or dissimilar soils (in terms of texture, erodibility, organic matter, and sensitivity to management disturbance). It does not provide the level of spatial detail to support specific project level planning, although existing information about the particular soils that occur on the Forest is fairly specific. The soils discussion in this watershed analysis is only the starting point for project development. Conclusions at this stage are relatively conservative in order to "red flag" areas of possible concern. Supplemental field data are needed to refine the spatial distribution of those soil characteristics that are pertinent to a particular management activity such as logging or fuel treatment.

The type of information that will be needed to protect soil productivity will depend on the type of project being implemented. Typical information will include the texture of the soil and its potential to be compacted, an estimate of both existing and post-project soil cover, and risk of damage to long-term productivity from burn damage or soil erosion due to site characteristics including inherent levels of soil organic material, current and projected fuel loads, and slope. These field observations of soil properties and cover should dramatically reduce the uncertainties of how to protect soil productivity in specific locations by such means as restricting ground disturbance, adjusting burn prescriptions, supplementing soil cover, etc. When designing projects or mitigation measures in many part of the LMK Analysis Area, extra attention needs to be given to ensure that adequate soil cover is in place to reduce the risk of surface erosion.

With fuel treatments (as with most management activities), there is often some uncertainty whether the prescription will achieve the desired result. Prediction of fire behavior is fairly accurate but not perfect. However, the burn window that the SRNF uses is quite restrictive in terms of antecedent moisture, temperature, humidity, and wind, and those constraints improve the likelihood that burning will actually achieve its objectives.

The length of time fuels remain on the ground after treatment of an area may affect how well soils are protected. If fuels remain untreated for several years and a wildfire occurs, the potential for adverse soil effects and accelerated erosion could increase because the larger fuels would be drier and closer to the ground surface, resulting in greater soil heating and more severe hydrophobic conditions.

Another uncertainty involves the relative risk of reburning residual fuels in a wildfire area within a few years compared to a future, possibly higher intensity, and probably uncontrolled wildfire on soils that have had more time to recover. Substantial soil recovery from the initial high severity wildfire may take from three to ten years. The key factor for protecting soils when deciding to reduce fuel levels on already burned areas is how well the burn prescription (in terms of antecedent soil moisture criteria) will limit the soil heating effects of prescribed fire.

- *How should the relative risks and benefits to long-term soil productivity, related to actively managing versus not managing, be evaluated when planning or executing projects?*

Natural resource management usually involves tradeoffs. In the case of fighting wildfires or reducing fuel loads to limit the potential resource damage of future wildfires, protection of soils that support many other ecosystem functions should be of paramount importance. However, this does not equate to a zero tolerance for any soil impacts. Instead, the objective is to preserve enough of the soils' functional productivity in the short term following management disturbance, while also promoting full recovery of soil productivity in a reasonable time period (typically within 5-10 years at most). In other words, a short-term, modest decrease in soil productivity to achieve some other benefit (e.g. lower risk of future watershed damage from wildfire) would be acceptable as long as the decrease is temporary and localized (i.e. only a small fraction of a project area or watershed), and it does not compromise other critical resource uses such as TES species.

The most fundamental impact to soil productivity is the loss of topsoil due to erosion at rates exceeding the formation of new soil on a site. This latter rate varies tremendously across a complex landscape like the LMK Analysis Area. Accelerated erosion may be a much more serious impact on some sites than others. Generally, areas where greater caution is warranted include steeper slopes with shallower, less developed soils, which are estimated to cover roughly one-third of the Analysis Area.

When proposing fuel reduction projects that involve burning of residual fuels, or when assessing strategies for wildfire suppression, areas that are most sensitive to burn damage (as shown in Figure 16) should be given special attention. We need to identify the critically sensitive soils where damage would constitute a significant setback in productivity that could take decades to recover. In most cases, defining thresholds of unacceptable change in soil properties, especially organic matter and soil cover, is a judgment call based on extended field observations rather than rigid, universal prescriptions.

Project-Level Soils Analysis

- *What are the key factors for protection of various soils within the Analysis Area when conducting treatments, such as fuels reduction, to preserve other ecosystem values?*

Project impacts to soils, including soil loss, will almost always be considered a potential issue for project development and NEPA analysis. Regional direction pertaining to protection and maintenance of soil productivity (FSH 2509.18), as well as all SRNF LRMP Standards and Guidelines pertaining to soil porosity and organic matter, need to be fully considered.

Proposed treatment areas need to be reviewed in the field to (1) evaluate the potential for any adverse effects on soils that could result from project activities, and (2) apply Standards and Guidelines accordingly, as specified in the LRMP. The intensity of field review would depend on the variability of relevant soil properties across the landscape in question. Where there is not much variability, a well-chosen sample of field sites may suffice, whereas a more thorough sampling would be warranted if soil conditions are highly variable or there is considerable uncertainty about possible effects of the proposed management activities.

Appropriate soil mitigation measures may include:

- Unit by unit evaluation of existing and post-treatment soil cover
- Estimating erosion potential and spreading slash or mulch accordingly
- Applying appropriate harvest methods on sensitive terrain (e.g. helicopter vs. tractor logging depending on slope steepness)
- Use of endlining in tractor units to lessen ground disturbance
- No management occurring in sensitive riparian areas
- Tractor yarding limited to less than the standard 35% slopes in especially sensitive watersheds
- Careful design and location of roads on gentle terrain wherever possible
- Selecting post-logging fuel reduction treatments that protect soils (e.g. handpile burning vs. lop and scatter, and no high intensity broadcast burning)

Application Of Soils Standards and Guidelines

Soil Porosity

The SRNF LRMP requires that for each timber harvest unit, soil porosity will be maintained to at least 90% of its natural condition over at least 85% of the project area. Reduced soil porosity generally results from soil compaction; when soils are compacted and porosity is reduced, the potential for surface erosion may be increased. In general, soil porosity and compaction are not likely to be major concerns in this area, compared to loss of soil from accelerated erosion or damage to soils from severe burning. For typical tractor logging operations in this terrain, the combined area of skid trails and landings is considerably less than the 15% threshold in the Standards and Guidelines. Limiting ground equipment to the dry part of the year also can very effectively mitigate soil compaction.

Most of the soils in the LMK Analysis Area have a moderate potential for compaction. Some areas with very gravelly, non-cohesive soils on the northeast side of the Klamath River and across the river from the mouth of Bluff Creek have a relatively low potential for compaction. An area in the west part of the Ikes sub-watershed has the highest compaction hazard (Figure 15).

When designing land management projects, care should be taken to ensure that construction of roads and skid trails and soil disturbances that would compact soils are limited to the extent practicable. Wet weather operations that are more likely to compact soils than activities when the soils are dry should also be limited or avoided.

Generally, the extent of ground disturbance is limited except where costs or logistics are prohibitive (e.g. some of the helicopter logging proposed in the Megram Project). Also, the USFS generally applies higher standards for logging and road building than on nearby private or state lands.

Soil Organic Matter

Soil organic matter is a key component of soil productivity. To protect soil productivity, the LRMP adopted the standard that soil organic matter in the upper 12 inches of soil should be at least 85% of the total soil organic matter found under undisturbed conditions for the same or similar soils. This standard is intended to be "a threshold value to identify detrimental soil disturbance in an activity area." The R5 Soils Handbook (FSH 2509.18) states that soil quality standards will be used to guide the selection and design of management practices and to document adjustments to management practices, soil conservation practices, or rehabilitation measures necessary to meet threshold values for the affected soil properties and conditions. Following project implementation, if objectives have not been met, the Forest Service would evaluate the need to adjust management practices and rehabilitate deteriorated soil conditions.

The soil organic matter standard is implemented during the development of the alternatives and by specifying design criteria and mitigation measures. The R5 Soils Handbook describes several options for meeting soil quality standards, including emphasis on handpiling and jackpot burning rather than broadcast burning, and a lop-and-scatter prescription for especially sensitive soils to augment natural soil cover and gradually replace organic material. Risks and tradeoffs between prescribed surface organic matter, potential for future wildfire, and the need to protect and rehabilitate existing damaged soils should be important factors in project design.

In addition to soil type, the condition and timing of fuels treatments should also be considered. Burning post-treatment or natural fuels only under or after wet weather conditions (when soils are wet or moist to a depth of 4 inches – typically a fire season ending event) to prevent excessive soil heating and further reduction of organic material can be very beneficial. Experience on the SRNF with fall and spring burning under these conditions has shown that the top duff layer is generally protected. Therefore, organic matter in the upper 12 inches underlying the duff layer will also be protected, and the standard will be met or exceeded.

High severity wildfire may cause extensive damage to soils, including loss of the O-horizon (duff and litter) and even consumption of organic matter in the A-horizon. These damaged soils warrant careful examination, and may need to be treated with caution or left untreated to protect them.

Cumulative Effects to Soils

- *How should cumulative effects to soils be analyzed relative to future projects?*

Unlike cumulative watershed effects, which are addressed over a watershed area, impacts to soils such as compaction, depletion of organic material, and removal by sheet erosion are addressed (FSH 2509.18) over an activity area where management is proposed or has occurred. Regional Handbooks do not specify a standard methodology (like the ERA-CWE model) to analyze cumulative impacts to soils across an activity area. Instead, the Forest Service strategy (formalized through NEPA in the LRMP) relies on adherence to soils Standards and Guidelines within any *activity area* (not watershed area), whether or not there is a single entry or multiple entries. Cumulative impacts to soil productivity can only result from repeated management disturbance of the same ground within a few decades (e.g. selective harvest with machine piling of fuels followed 15 years later by removal of residual commercial trees).

Cumulative effects to soils from past and current activities are disclosed by describing current soil conditions and by analyzing direct or indirect project effects. Any noted changes or impacts would influence the development of alternatives and mitigation measures that limit additional direct impacts to soils, such as from broadcast burning or mechanical fuel piling. Risks and tradeoffs between prescribed levels of surface organic matter, potential for future wildfire, and the need to protect and rehabilitate existing damaged soils would be important factors in project design. Cumulative effects to soils from known future management activities would need to be addressed if there were any overlap of those future activities with the currently proposed treatment areas.

Water Quality and Fisheries

Erosion Processes

- *How have the distribution or intensity of hillslope processes changed over time in the Analysis Area?*

It is difficult to generalize from the short historical window to longer time frames regarding average distribution or frequency of mass wasting and erosion. However, shallow and deep-seated landsliding appears to have been and continues to be the dominant process shaping the landscape and delivering large quantities of sediment to stream channels. Erosion from roads and other disturbed areas is an important chronic, but much smaller, source of fine-grained sediment.

Landslide sediment delivery and subsequent erosion of slide scars has been concentrated in lower parts of drainages on older landslide deposits and Galice bedrock, as well as along the Klamath mainstem/Highway 96 corridor in a variety of geologic and geomorphic settings. Sub-watersheds with the highest rates of sediment delivery are Crawford Creek, Red Cap Gulch, and Whitey’s Gulch. The lowest rates have been in the Pearch, Boise, and Ikes sub-watersheds, although Ikes has had quite a bit associated with Highway 96.

- *What effects have natural and human-caused disturbances had on mass wasting and erosion processes?*

- *To what degree and in what types of locations have management activities affected mass wasting or erosion processes within the Analysis Area?*

Landslide incidence associated with management has been relatively higher in the LMK Analysis Area (40% of slides active from 1944 to 1998, and 44% of sediment delivered) than in other parts of the Forest (typically 15-20%). Roads, particularly state and county roads, have been much more strongly associated with sediment delivery from landslides in the last 54 years than other human disturbance such as timber harvest; thirty-one percent of sediment delivery has been associated with roads, but only 13% with timber harvest. However, sediment delivery from historic mining far exceeded that associated with recent management of NFS lands.

The unstable or potentially unstable parts of the landscape with respect to Forest Service management actions (road construction/maintenance/decommissioning, silviculture), can be fairly well defined, based on 54+ years of landslide data and related geologic/geomorphic information (i.e. lower slopes, steeper slopes, older landslide terrain, particular geologic units).

Actual unstable terrain probably comprises 5-10% of the landscape, depending on the time since the last landslide-producing storm. Sensitive or potentially unstable terrain may encompass an additional 15-20% of the landscape. Apparently only a very small fraction of the landscape (<1%) was active during the 1997 and 1998 winter storms.

Water Quality

Effects on Beneficial Uses

- *Where have management activities tended to produce adverse effects on beneficial uses (water quality, aquatic and riparian habitat, fisheries), either directly or indirectly?*

- *How and to what extent can these effects be counteracted?*

- *For the areas where beneficial uses have been impacted, when will they be considered recovered?*

The beneficial uses within the LMK Analysis Area that must be protected against water quality degradation include domestic and agricultural water supply, recreation, commercial and sport fishing, and the viability of fish, wildlife, and other dependent resources (NCRWQCB 1994). All of these beneficial uses can be influenced by land management activities through altering the natural sediment regime, raising water temperatures by removing riparian cover, changing the timing and quantity of stream flow, and altering water quality by nutrient loading.

Lower-Middle Klamath Mainstem

Many of the Klamath River beneficial uses, primarily domestic water and cold-water fisheries, are in a degraded condition. The Klamath River, from its source to the mouth, is listed as water quality impaired (by both Oregon and California) under Section 303(d) of the Federal Clean

Water Act. The basis for listing the Klamath mainstem as impaired was aquatic habitat degradation due to excessively warm water temperatures, algae blooms associated with high nutrients, low DO levels, and altered flow regimes from the dams upstream.

Dams built in the early to mid-1900s have substantially altered the flow regime of the mainstem Klamath. The main effects have been a moderate attenuation of natural flow variation and a moderate reduction in summer low flow due to upstream withdrawals. These changes have likely affected the storage and mobilization of sediment for all except very high flow conditions, as well as increased summer temperatures in the mainstem. However, sediment storage along the Klamath mainstem within the Analysis Area was already severely elevated because of historic mining. Based on descriptions in California State Mining publications, sediment delivery from mining in the late 19th and early 20th centuries was widespread and probably much greater in volume than that attributed to active landsliding and associated erosion from 1944 to the present. Sediment delivery from historic mining undoubtedly far exceeded that associated with recent management of NFS lands. The drastic effects of mining are well illustrated by a substantial shift of the mainstem towards the south bank in the late 1920s due to one operation near the mouth of Camp Creek. This resulted in severe channel bank adjustments and landsliding along the adjacent valley wall.

It is important to realize that the degraded beneficial uses within the Klamath River are primarily a result of past floods and land management activities, including hydroelectric development and agricultural withdrawals upstream of the Analysis Area. Full recovery of beneficial uses within the mainstem Klamath River is a very complex issue because of the diverse stakeholders in the Basin. The most realistic opportunities for the SRNF lie in protecting, restoring, and maintaining high quality aquatic habitat conditions within the tributaries. Currently, there is no overall plan to address recovery of the beneficial uses, but a TMDL for the Klamath River is scheduled for completion in 2004 that will address the impaired beneficial uses.

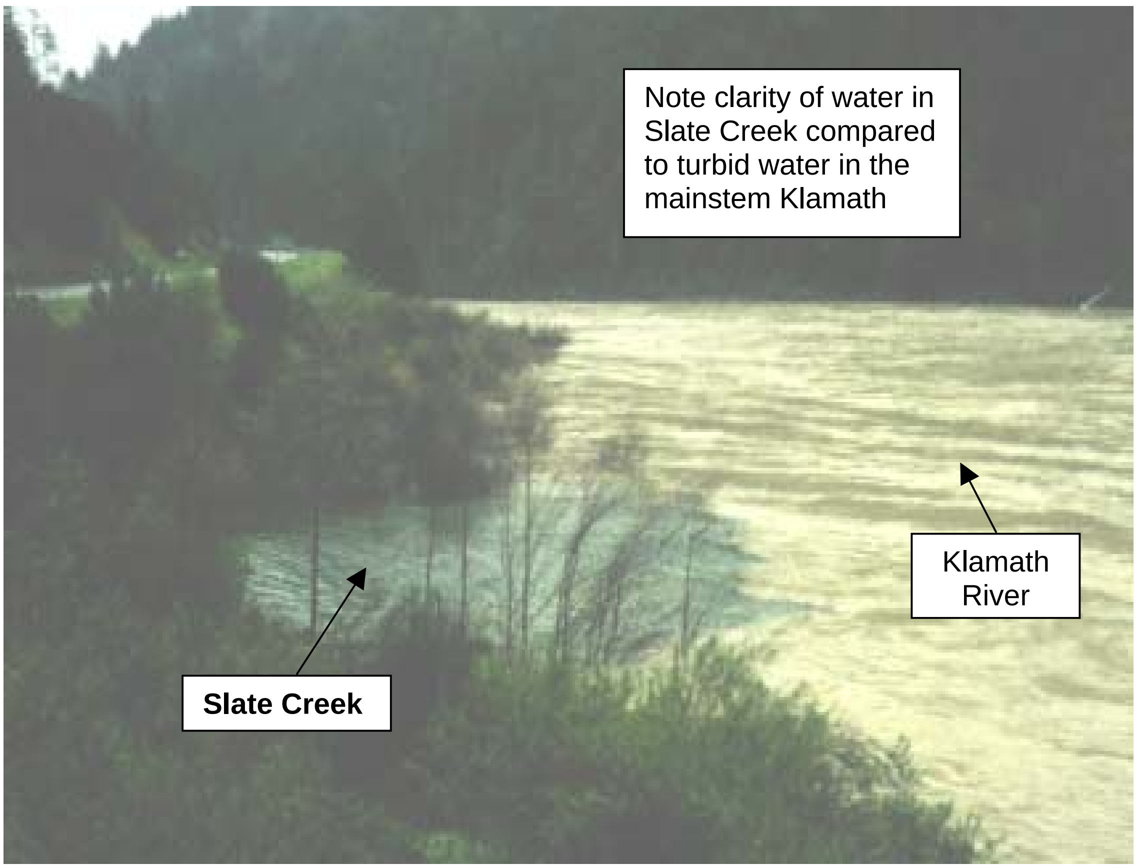
Tributaries of the Lower-Middle Klamath Mainstem

Based on current information, sediment generated from roads by mass wasting and surface erosion has the greatest potential to impact beneficial uses within the tributaries of the LMK Analysis Area in the event of a large storm. Protecting domestic water sources from management-related sedimentation and turbidity is of primary importance. There are numerous permitted and non-permitted domestic water sources on NFS lands in the Analysis Area, primarily on tributaries near the mainstem. The extent of non-permitted water use may be an issue for Fire Safe Councils and other projects that address fire prevention because they will focus on NFS lands adjacent to private property where these water sources are probably located.

Water quality for domestic water sources and fisheries habitat within the tributaries is good in terms of temperature, sediment, and turbidity. Summer stream temperature in these tributaries rarely goes above 70^{o} F even in the hottest summer months. While several of the tributaries were severely impacted by landsliding, channel widening, and associated loss of riparian vegetation between 1960 and 1975, they have since recovered considerably and do not appear to have been set back by recent storms (e.g. 1997). However, some larger landslide scars and sediment deposition from earlier events remain visible. Also, fewer large conifers may be available in riparian zones for recruitment as LWD because of earlier floods. Aerial photos reveal that some riparian corridors have well developed deciduous canopies that provide thermal regulation, even though the diminished conifer component has yet to be replaced in riparian areas that would normally be dominated by mature conifers.

Further evidence that tributaries have "recovered" considerably from the impacts of earlier major storms is the overall good to excellent fish habitat in Pearch, Boise, Slate, Aikens, and Hopkins creeks. Boise and Slate Creek still transport moderate to large sediment loads during storm events such as the 1997 flood (estimated as a 15-year event for the Analysis Area), as shown by the sediment fans at their confluence with the Klamath River. Despite this periodic remobilization of sediment, these streams still have excellent spawning and rearing habitat, as well as year-round cool water temperatures. When compared to the mainstem, the tributaries appear to be considerably less turbid during storm events than the Klamath River as shown in Figure 29 at the mouth of Slate Creek during high flow in January 1997.

Figure 29 Mouth of Slate Creek at the Klamath River Following the January 1997 Storm.



Recent surveys indicate that the current conditions of tributary channels and associated riparian areas are properly functioning and adequately support beneficial uses. Despite the impacts of the 1964 flood in Slate, Pearch, Boise, Hopkins, and Crawford creeks, the stream channels appear to have equilibrated to some degree with much of the formerly delivered sediment in fairly stable storage and few active sediment sources. These tributaries should remain in good condition relative to supporting beneficial uses until the next catastrophic flood or wildfire.

The active landslide study found that roads have been a substantial factor in historic sediment delivery (20% state and county, 10% Forest Service). Implementing road improvements for water quality protection, such as culvert upgrading and maintenance, reduction, or elimination of diversion potential, and decommissioning unneeded or high-risk roads can greatly reduce management-related sediment delivery. The legacy of land management disturbance since the

1964 flood may result in additional impacts on aquatic and riparian conditions when another major flood occurs. It is important that roads are "floodproofed" to the extent practicable before then. In particular, restoring and improving roads within Crawford Creek is a high priority because it is a domestic water source for roughly 32 houses. Over the past 40 years, this stream has experienced elevated turbidity during very high flows due to both natural and management-related sediment delivery, although it has been associated more with harvest areas than roads in this sub-watershed. While water quality in Crawford Creek is good at present, special attention should be given to both road maintenance and road decommissioning work so that the beneficial use is protected. The timing and amount of fill removal should be assessed in terms of the potential for increased turbidity downstream, and the Orleans Mutual Water Company should be contacted when work is being planned or implemented. Similar high-risk roads within Slate Creek need to be evaluated because of fisheries concerns.

Addressing the risk of wildfire and its potential to alter stream temperatures and sediment regimes within tributary streams is also important. Protecting the cool water refugia of tributaries is vital to the Klamath anadromous fisheries. In particular, efforts should be made to reduce the risk of stand-replacing fire within the riparian areas of these tributaries. Areas of highest risk of stand-replacing fire and soil erosion appear to be concentrated in parts of Boise, Slate, and Aikens Creek, as well as along Highway 96 in the Red Cap Gulch sub-watershed. These areas pose a concern in the event of a wildfire, and are good candidates for future fuel treatment projects.

The most important management intervention in promoting the natural recovery of riparian and aquatic ecosystems and protecting beneficial uses is to prevent further degradation that might slow recovery. Identifying and treating potential mass wasting and erosion sites to reduce the delivery of additional sediment will allow the system to remain on a recovery trend. Watersheds in the LMK Analysis Area are rated as high to moderate priority for watershed restoration within the Klamath-Trinity Basin. These higher ratings are based on the ability to influence positive change in restoring a healthy, functioning aquatic ecosystem. Sub-watersheds like those within the LMK Analysis Area that have the best potential for being restored should be a priority for any recovery strategy or future funding opportunity.

Defining complete recovery of a watershed and its aquatic ecosystem is complex and problematic. A better approach would be to say that a given watershed has been restored to the extent practicable when no further potential and correctable management-related sedimentation risks exist in the watershed. This would signify that whether or not the watershed is "healthy" and fully functioning, management emphasis should change from an active restoration focus to a custodial focus that allows nature complete the rest of the recovery.

Cumulative Watershed Effects

- *To what extent are cumulative watershed effects evident within the Analysis Area?*

The effects of management activities on water resources can be cumulative. A cumulative impact results from the incremental effect of an action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. While a watershed analysis is not the same as a cumulative effects analysis, it can provide most of the information on which to base a cumulative effects analysis and show what characteristics and processes the analysis should emphasize. Cumulative effects analysis is intended to evaluate whether or not a given proposed action may result in cumulative effects. Critical components include a description of what the past was like, how changes have occurred, and what the future may be like (Reid 1998). A key part of watershed analysis is to characterize the *cumulative disturbance* (both natural and management-related) that has occurred and assess its bearing on future natural or human-caused disturbances. Thus, an understanding of past trends is critical in forecasting future trends in watershed processes.

Lower-Middle Klamath Mainstem

Cumulative effects in the Klamath River cannot be evaluated at the scale of this analysis. That would be an issue for Basin analysis. Nevertheless, current studies clearly indicate that multiple problems, with respect to water quality (sediment, DO, nutrients, temperature, etc), water diversions and withdrawals (agriculture), water regulation from dams, and declining fisheries stocks, exist within the Basin that indicate that cumulative watershed effects exist.

Tributaries of the Lower-Middle Klamath Mainstem

All of the major fish-bearing tributaries (Pearch, Boise, Slate, Aikens, and Hopkins Creeks) are in good to excellent condition with respect to fish habitat. That is, the tributaries have high riparian canopy closure, cool summer water temperatures, and good spawning and rearing habitat. These tributaries support a variety of native anadromous salmonids including coho, chinook, and steelhead.

Most of these tributaries experienced extensive disturbance due to both natural and management-related landsliding associated with floods between 1960 and 1975. Impacts from mining in the late 19th and early 20th centuries are not as clearly documented, but it is known that extensive mining operations occurred throughout the Analysis Area, principally along the mainstem. Despite these natural and human disturbances, the tributaries have substantially recovered, and the disturbances described in preceding sections are seen as a legacy rather than a reflection of current conditions. None of the fish-bearing tributary streams listed above are considered impaired or exhibit cumulative watershed effects. Although some still have high sediment loads that are periodically mobilized during very high flows, these streams are considered properly functioning due to the quality of instream habitat, good riparian cover, and the amount of LWD that provides cover and channel structure.

Prolonged fire suppression may have had a cumulative effect on erosion processes by replacing the natural regime of frequent, moderate to low intensity fires with the potential for infrequent, high intensity fires that tend to have more serious erosional consequences. If a catastrophic wildfire were to occur, the *threshold of sensitivity* for cumulative effects would most likely be lowered.

The following critical processes and attributes need to be addressed in future cumulative effects analysis for proposed actions. The factors that could influence these processes are storm events, wildfire, and land management activities.

- Sediment delivery from potential mass wasting and surface erosion
- The likelihood of this sediment impacting downstream water quality and beneficial uses
- The condition of riparian corridors in terms of cover and LWD recruitment, and how these elements might affect downstream beneficial uses

Fisheries

Prior to European contact, the Klamath Basin provided for the needs of the Karuk, Yurok, Hoopa, and Klamath tribes with different runs of fish entering the river throughout the year. Spring chinook entered the river during high water in late spring and early summer, and in the late summer, the fall run began. The tribes also fished for fall and late fall-run chinook, coho, fall, winter, and summer steelhead, lamprey, green sturgeon, various species of sucker, eulachon, and occasionally sea-run cutthroat trout.

Despite variations in the size of the semi-annual runs, the tribes could typically procure enough salmon for their people. The abundance of fish once supported by the region's rivers is well documented, with stories that recount the challenge of fording the Klamath River because the salmon runs were so thick. It is estimated that prior to European settlement, the region's tribes annually consumed over 2 million pounds of salmon from runs that are believed to have exceeded half a million fish. All of these fish runs were part of the tribes' diet.

Tribal fishing had one of the highest yield-to-effort ratios (i.e. highly efficient) of any subsistence undertaking in all of North America (Swezey and Heizer 1977). This was due not only to the abundance of fish, but to the various fishing techniques developed by the tribes. As stated by Roberts (1932) "native technology was developed to the point of enabling their maximum use of the resource, while ensuring adequate propagation of the species". Their techniques included large nets, dip nets, weirs, traps, and spears, as well as numerous practices that assured the continuation of large fish runs. For example, management of weirs provided for upstream people to receive a fair share of the salmon, and most importantly, the weirs were kept open for extended periods to ensure that adequate numbers of salmon could reach their spawning grounds.

Historically, coho, chinook, and steelhead were widely distributed throughout the entire Klamath Basin. Dam construction since 1912 has blocked access for these species into the Upper Klamath River. Today, an estimated 8 to 55% of historic salmonid habitat is no longer fully utilized by these species. This undoubtedly decreased their production capacity within the entire Basin.

It appears that as much as 20% of historical anadromous habitat may have been lost or substantially disturbed within tributaries of the Analysis Area. Over the past 150 years, some of this decline likely resulted from road construction that created barriers to upstream migration, and from streambed alterations due to mining and other activities. Some of this obvious decrease in suitable habitat occurred on smaller tributaries such as Hopkins, Crawford, Ullathorne, Pearch, and Donahue Flat creeks.

The fishery resources of the Klamath River continue to be an important social and economic aspect of northwestern California today. Tribes continue to fish for subsistence, as well as for ceremonial and some commercial purposes. In-river sport fishing is also very popular and continues to grow seasonally, especially when large annual salmon and steelhead returns are expected and angler quotas are raised. Creel data from Weitchpec to Iron Gate Dam shows this reach of the Klamath River as having one of the highest uses by anglers (trips and hours fishing) during the 1999-2001 fishing seasons (CDFG 2002).

- *Which fish species have been identified as being at risk, and what are their current trends?*

- *What human induced factors have the most influence on the quality and distribution of fish habitat for at risk species within the Analysis Area?*

Only 15 of the 21 native fish species known to have occupied the Lower Klamath Sub-Province (Moyle 2002) were likely found within the Analysis Area historically. Two of these species (pink and chum salmon) were present, but today there appears to be no self-sustaining stock of either species within the Basin. Of the remaining 13 species, coho, spring-run chinook, summer-run steelhead, green sturgeon, and river lamprey appear to be the most at risk.

Brown and Moyle (1991) estimated that naturally spawned adult coho salmon returning to California streams in the late 1980s were less than 1% of their abundance at mid-century, and indigenous, wild coho populations in California did not exceed 100 to 1300 individuals. There are few historic records of coho salmon inhabiting tributaries within the Analysis Area. A few adult coho are occasionally observed in Boise, Slate, and Aikens creeks during fall chinook surveys. Juvenile counts in Orleans area streams have also determined their presence or absence in these tributaries, but this information has limited value for determining exact population abundance. It is clear that coho numbers are low and that they are not evident every year in these tributaries, possibly indicating the loss of one or more brood-years.

Prior to the early 1900s, the spring-run of chinook was the dominant run of salmon within the Klamath-Trinity river system (Snyder 1931). Today, spring-run chinook in the Klamath Basin are on the verge of disappearing (Moyle 2002). The Salmon River watershed northeast of the Analysis Area supports the only remaining wild population of spring-run chinook in the Klamath Basin.

Since 1980, USFS summer steelhead monitoring has shown this run to be very low within the Lower-Middle Klamath River. Typically less than twenty adult summer-run steelhead are observed annually during snorkel surveys within larger tributaries (Red Cap, Camp, and Bluff Creek) in the vicinity of the Analysis Area.

Little information is available regarding green sturgeon and river lamprey within the Analysis Area. Their abundance and distributions are also poorly understood. Because of our limited knowledge, it is difficult to assess the population dynamics of these species.

The trend of coho salmon, spring-run chinook, and summer-run steelhead has been downward, especially within native populations. The decline of these fish species is not the result of a single factor, and to focus on a single cause would be a misleading oversimplification. Some of the most significant human-induced factors that have influenced these species in the Analysis Area include early mining activities, the downstream effects associated with dam construction, and water release, roads, and logging.

- *How have exotic and hatchery fish affected native fish populations in this part of the Klamath River?*

Exotic and hatchery fish may be a factor that continues to affect native fish populations; however, the degree of impact is unknown.

- *Which sub-watersheds in the Analysis Area are critical for the maintenance, protection, and restoration of at risk species?*

Sixty-four percent of the anadromous fish habitat within the Analysis Area exists within the Klamath River. Regardless, this main river corridor plays a vital role in the ongoing maintenance, protection, and restoration of at risk fish species within this entire basin. This portion of the Klamath lies between two major sub-basins: the Trinity and the Salmon River. This riverine system (1) provides essential fish habitat for passage, holding, and spawning of adults, (2) facilitates movement of juveniles into and between tributaries, (3) provides rearing habitat for fry and juveniles produced in tributaries, and (4) provides habitat for smolts as they emigrate from tributaries and migrate to sea. Fish species, like green sturgeon (currently under status review for listing under the ESA), utilize this portion of the mainstem as a primary spawning location.

Although a myriad of human-induced and natural factors affect at risk fish species in the Analysis Area, Klamath Project operations continue to greatly affect the quantity, quality, and timing of water available for release during the year. In turn, flow releases from Iron Gate Dam affect the quantity and quality of fish habitat in the mainstem of the Klamath River. Ongoing research and analysis will continue as operational plans are developed.

Available anadromous fish habitat within smaller tributaries of the Analysis Area is limited. Approximately 13 miles are considered suitable for coho, steelhead, chinook, and river lamprey for spawning and rearing. Boise Creek and Slate Creek contain the most suitable habitat, totaling one half of the area. Other tributaries like Pearch Creek, Hopkins Creek, and, to a lesser degree, Aikens Creek make up a large portion of the remaining habitat.

However, other large tributaries such as Bluff, Red Cap, and Camp Creeks (which are outside of the Analysis Area) are located in this section of the Klamath River. These three key watersheds alone provide over 40 miles of suitable spawning and rearing habitat for some of these at risk species. As pointed out in the Klamath Basin Assessment (USFS 1997), some of the watersheds in the Lower and Middle Klamath River serve as an anchor for potential species recovery. A system of watersheds that serve as refugia is crucial for maintaining and recovering habitat conditions. Watersheds such as Wooley, Dillon, Independence, Clear, Elk, Indian, Thompson, and Grider are a part of this surrounding network of streams that create and maintain essential habitat for these at risk fish species and stocks. Many of these watersheds have high restoration potential because of existing habitat conditions. However, restoration within some of these watersheds may take several years to decades to be fully realized.

Tributary streams that are not accessible to anadromous species or do not provide suitable habitat are also important to salmonid survival. Many of these streams are small, well shaded, and provide high quality, cool water to the Klamath River. They are located next to upstream and downstream habitats. Juvenile chinook, steelhead, coho, and many other species are often found holding in the lower reaches and/or at the confluence of these tributaries within the Analysis Area, especially from July through September.

Multiple factors have contributed to the decline, and multiple factors may still be preventing recovery of these at risk fish species. The identification of one such factor does not rule out the possibility that others are also acting, perhaps synergistically, to exacerbate the decline. Watershed restoration should be based on watershed analysis and planning. This is essential to identify areas of greatest benefit-to-cost and greatest likelihood of success. Many of these tributary streams provide excellent opportunities to create and maintain fisheries habitat through time.

A number of cooperative watershed restoration projects are possible in this Analysis Area based on its location, mixed ownership, and tribal government interests. Much attention and money is being directed at recovering fish populations. Some of these species may have a low probability of long-term persistence. Although investing in the maintenance or recovery of extreme-risk species may be mandated, it is important not to lose sight of our remaining healthy, native fish populations as restoration strategies are developed.

Riparian Areas

- *What criteria should be used to establish appropriate riparian reserve widths or to guide management adjacent to or within riparian areas, in order to protect and restore beneficial uses?*

The NWFP specifies that IRR will exist only until *both* watershed analysis and site assessment are completed so that a more appropriate riparian reserve can be designed to fit the ecological setting and proposed land management treatment. Although some might expect that IRRs would be modified during the watershed analysis, appropriate widths cannot be delineated at a watershed scale because of the large spatial variability and the wide range of possible land treatments. Many crucial conditions and functions can only be broadly generalized or guessed at for areas where on-site observations have not been made. Site-scale information and analysis of proposed actions must be considered in almost any riparian reserve design.

Typical considerations and management recommendations for designing Riparian Reserves will be discussed below. In addition, the ecological functions that Riparian Reserves are intended to protect, as specified in the NWFP, will be highlighted.

Figure 18 shows the approximate extent of IRRs in the LMK Analysis Area based on (1) the height of site-potential trees and (2) unstable lands. IRRs encompass a substantial part of the LMK Analysis Area: 28% of the entire area (including private lands) and 32% of NFS lands (15,100 of 47,900 acres). Unstable lands account for about 40% of IRR acreage, while site-potential tree height accounts for 80% of the acreage (note that much land within one site-potential tree height of a stream is also unstable or potentially unstable land). These delineations are approximate for two important reasons:

- Streams were delineated from topographic maps and may not be an accurate representation of all stream channels. Field experience suggests that the actual extent of streams within the watershed is probably greater. However, although the stream network may be more extensive, IRR widths for intermittent or ephemeral streams based on site-potential tree height at some locations may exceed the actual aquatic or riparian protection needed. For example, small streams near ridge tops often do not have riparian plant communities that would support special populations required by some animals, and erosion and sediment control often need only 25 or 50 feet of “buffer” to protect local channel conditions and prevent damage that could be transmitted downstream to important aquatic habitats.

- Lands were identified as unstable on the basis of aerial photo interpretation and have not been extensively field-checked for accuracy. Slope stability needs to be determined by a combination of aerial photo interpretation and field examination; this could result in fairly different delineations of unstable lands from those shown in Figure 14.

Management Considerations in Delineating Riparian Reserves

The most important factor in designing Riparian Reserves is the deployment of an interdisciplinary team to review the site in the field with the proposed management in mind. A reasonable consensus among an interdisciplinary team in the field is the best practical approach to achieving ecologically and geomorphically appropriate riparian reserve design. The appropriateness of a particular design cannot be "proven", and documentation of reasoning is, at best, an incomplete description of the thought process of the group. Yet it is the deliberations of the interdisciplinary team that will integrate the necessary considerations, build a picture of sensitivities and risks, and critically evaluate options. The considerations that should go into designing Riparian Reserves are described below.

Fish and Wildlife

Riparian Reserves are expected to enhance the conservation of aquatic and riparian-dependent species, including amphibians, mollusks, and arthropods. Maintaining the connectivity of all parts of the aquatic ecosystem is necessary for healthy watersheds and good fish habitat. Vegetation, soils, and moisture conditions in riparian areas provide distinct microclimates, vegetation diversity, and important habitat components that are crucial to the survival of some species. Wildlife use of riparian areas is high because they provide more ecological niches than other habitat types.

A simple downward slope in the landscape, or a place where sediment movement has occurred to create a recognizable channel does not necessarily constitute a "riparian' habitat. These special wildlife microhabitats generally depend on the presence of surface or near-surface water and lush vegetation. Places with stable temperature throughout the year are rare in temperate forest environments, and these areas provide special habitats. Riparian Reserves should be wide enough to maintain low summer surface and ground water temperatures, high water clarity year-round, and a stable streamside microclimate (Chen et al. 1993). Extending some Riparian Reserves over intervening ridges will provide connectivity for gene flow among large basins.

Large Wood Recruitment

Terrains in which landslides are more likely to occur have been included in Riparian Reserves as "unstable and potentially unstable lands." Sources of large pieces of wood should be retained on such lands if it appears that they are likely to accompany landslide debris into fish-bearing streams. If these lands are included in Riparian Reserves, the rate of large wood input from landslide processes should not be substantially changed as adjoining lands are managed for timber.

Soil Erosion

Erosion rates are likely to remain at natural or background levels if soils are not compacted or excavated and if soil cover remains mostly in place. Streamside slopes should be carefully evaluated for erodibility to determine appropriate setbacks of ground-disturbing activities. Small, localized mass instability is often the site of accelerated erosion, but it can generally be detected only by on-site evaluation. Soils derived from finer-grained parent material such as slate, phyllite, or schist are usually more erodible than those derived from competent rock types, but may also support denser vegetation and more soil cover. Experience suggests that streamside buffers of 30-75 feet slope distance along gentler, upper slopes (0-40%) are generally adequate to prevent the introduction of eroded sediment into the stream system if ground disturbance is prevented or restricted to only small patches of bare ground with no soil excavation or compaction. Streamside buffers of 50-100 feet slope distance are necessary where typical slopes range between 50-70%. Inner gorge slopes that are subject to shallow mass movements and accelerated erosion due to very steep slopes and emergent groundwater border some streams. For these reasons, these steep inner gorge and some adjoining ground (to be determined on-site) should remain undisturbed by soil compaction, excavation, or removal of soil cover.

Streambed and Bank Erosion

The streambed and banks of some channels are controlled or stabilized by a combination of LWD, rocks, roots and bedrock. It is very important to preserve these components. Where LWD provides bed or bank stability, the source of large wood should be preserved. Where roots play a substantial role, the plants attached to the roots should be retained. Root extent varies by species and is difficult to ascertain. Tree roots typically extend as far as the crown spread, which can be as much as 25 feet for large trees. Therefore, retaining trees within 25 feet of root-controlled channels is usually adequate, subject to site-specific analysis. A few channels are controlled strictly by bedrock on both bed and banks, and vegetation is, therefore, not important for their integrity. Streams in weaker geologic terrains are generally more unstable and more commonly depend on roots and large wood for stability than those in competent terrain. Therefore, they will probably require wider Riparian Reserves and tolerate less vegetation removal than channels in more competent terrain.

Intermittent Streams

Intermittent and ephemeral streams having short flow duration and little or no riparian vegetation are ecologically distinct from streams and riparian areas downstream, and they support only a subset of the functions important for larger streams. These headwater streams are often numerous and found in areas proposed for timber harvest and road construction. Except where springs and wet areas occur, intermittent and ephemeral streams commonly do not have true “riparian areas” with dependent aquatic or riparian biota because they do not provide water flow of sufficient duration to have riparian-dependent vegetation. However, certain herpetofauna, soil arthropods, and insects may specialize in such intermittent stream habitats. If so, the area of intermittent flow can be protected with a small, exclusionary buffer (20-30 feet in some cases) where any direct disturbance would be prevented.

Since intermittent or ephemeral streams are connected to downstream habitats, they can transmit management impacts downstream during heavy winter rainfall and spring snowmelt. These channels may have value as travel corridors for some animals or provide subtle microclimatic differences on the local hillslope. Except where travel corridors are desired, protection may need to focus only on slope and channel stability to maintain natural or background erosion and sediment delivery rates.

It is not feasible to define the locations and extent of these types of streams at the watershed scale. We think that the uppermost 500 to 3000 feet of delineated streams are in this category, except where springs and wet areas occur. Some of these streams are located on unstable lands. The Aquatic Conservation Strategy requires that the instability of such areas not be exacerbated, and this consideration will usually determine the width of the riparian reserve.

To prevent accelerated erosion and sedimentation that could damage downstream habitats, experience has shown that the width of an area adjacent to headwater streams where ground disturbance and tree removal must be limited or avoided ranges from zero to about 100 feet, depending on considerations of landslide potential. Evaluations of necessary buffers must be made on the ground because the conditions and resource risks vary greatly.

The following is a list of considerations that should be used when evaluating streamside and riparian areas on-site at the project planning scale:

- Is proposed management compatible with Standards and Guidelines for Riparian Reserves? If so, how closely can the activity be managed within the riparian reserve and still maintain the values of the riparian reserve? How detailed a prescription is needed, given the proposed management and variability in important site characteristics? For example, can protections be tailored for each 100 feet, acre, or 10 acres of streamside?

- What kind of management is proposed or likely to be proposed? What kinds of short-term or long-term effects could occur? Are these effects likely here? What kind of controls can be placed to limit or prevent the effects? Are such controls practical and reliable (i.e. have they been consistently implemented and effective in similar situations)?

- What are the local habitat values? What attributes, functions, and processes create and maintain the Riparian Reserves? Are these habitats unique to the stream and streamside areas, springs, or wet areas? What species are known or suspected to be present? Do the organisms that rely on these habitats require connectivity to other habitats? What constitutes connectivity?

- How steep are the stream channel sideslopes? Is there an inner gorge or active mass wasting of the channel margin? What landforms extend further upslope (e.g. the toe zone of an old landslide)? Do the slopes appear unstable, and, if so, what are the indicators? What components of the vegetation (e.g. roots, litterfall, evapotranspiration) contribute to riparian functions, and how important is each? How might vegetation removal influence these functions, and for how long?

- What are the processes and functions that operate within the Riparian Reserves? For example, does woody debris play a strong role in channel structure and sediment routing? If so, what is the ability of the channel to transport wood downstream and in what manner (e.g. high stream flow or mass wasting)? What is the potential for long-term woody debris recruitment to maintain these functions? Do the sideslopes contribute LWD to the channel? Does this LWD function to stabilize the channel or mobilize sediment, or are its main functions within the IRR that of cover for wildlife and nutrient cycling?

- Is the channel actively eroding? Are the banks unstable? Does it appear that increased peak flows could lead to increased bed and bank erosion?

- What controls the downcutting and lateral cutting of the channel (e.g. wood, roots, rock, or some combination of these)?

- Is the channel pristine? If it appears pristine, are there similar channels in the area that have been subjected to management? Can effects of management and their causes be discerned?

- Is there evidence of management-related impacts? If so, what appears to have caused the impacts? Do any previous evaluations or monitoring exist?

Terrestrial Wildlife Species

Factors Affecting Wildlife

- *What types of management opportunities exist that can benefit wildlife and meet other resource goals?*

From the wildlife discussions in Chapter 3 it can be seen that the main factors that have affected, or are threatening most of the featured wildlife species stem from two main ecosystem processes or management practices. These are changes to the historic fire regime, and stand-regeneration logging of older forest stands.

Logging

The direct impacts from logging throughout the Pacific Northwest have been implicated in the declines in populations of such species of concern as spotted owls, marbled murrelets, goshawks, fishers, martens, torrent salamanders, and red tree voles. These impacts have reduced suitable habitat, and probably affected historical populations of these species in the LMK Analysis Area; however, in general, this area and the surrounding NFS lands have probably been less affected than surrounding areas of private lands that appear to have had more intensive forest management.

The annual amount of older forest habitat degraded or rendered unsuitable due to logging, and the amount of area available for stand-regeneration logging of older forest stands within the LMK Analysis Area has been greatly reduced since the establishment of the NWFP in 1994. The NWFP has led to the reduction or reversal of most logging related impacts to these wildlife species in the LMK Analysis Area today (See ***Timber Harvest – Reference*** in Chapter 3).

However, logging or mechanical vegetation removal can be used as an effective wildlife habitat improvement tool even for the above mentioned, late-seral forest adapted wildlife by opening up unnaturally dense stands to make prey more accessible, and by hastening the onset of late-seral structural conditions through thinning of young stands. Logging can also be used, often in conjunction with prescribed fire, to reduce fuel loading in strategic areas to help protect areas of suitable wildlife habitat from the potential effects of high intensity wildfire.

In addition, logging can also be used as a tool to restore such wildlife habitats as meadows and oak woodlands that are being encroached upon by conifers, and as a technique to create early successional stage habitats, which are used by such wildlife species as deer and elk.

Fire

Before there was logging in the LMK Analysis Area, fire created, or was used by Native Americans to create mosaics of earlier successional stage habitats across landscapes generally dominated by late-seral forest types. These diverse vegetative patterns have resulted in the diversity of wildlife found in these landscapes today, and should be maintained by the use of logging, prescribed fire, or some other means that mimics natural disturbances, in order to preserve healthy ecosystems. As discussed in Chapter 3, wildfire has had, and potentially will have, significant impacts on the wildlife species of concern within the Analysis Area. These impacts stem from two related aspects of the local fire regime.

The large wildfires of the past undoubtedly resulted in some habitat loss and direct mortality to individuals of most of the wildlife species of concern, but, with 10-50 year fire return intervals, these fires were generally larger than fires today, burned with mixed severity, and tended to keep the buildup of fuels in check (see ***Fire Hazard - Reference*** section of Chapter 3). In the long term, these fires tended to maintain or restore habitat diversity and, therefore, wildlife diversity.

Aggressive fire suppression and prevention has dramatically reduced the size of wildfires since the 1940s. Increased shrub and tree density (sub-canopy in-growth), including the shading out of large black oaks through several missed fire return intervals, may have resulted in some loss of habitat suitability for such species as spotted owls, goshawks, fishers, and nesting pond turtles. This buildup of fuels has also caused an increase in the potential for much more severe wildfires, resulting in the risk of severe negative effects to wildlife.

This increase in the potential for severe wildfires, resulting from 36% of the Analysis Area having a high to very high susceptibility to stand replacing fires, is considered a significant threat to such wildlife species of concern as the spotted owl, marbled murrelet, bald eagle, goshawk, fisher, marten, torrent salamander, red tree vole, and the two SM snail species.

Understory fuels reduction, through mechanical means or the use of prescribed fire or wildland fire use for resource benefit, can be an effective means of both protecting suitable habitat areas for the above mentioned wildlife species of concern from the potential for severe wildfires, and providing direct habitat improvements for such species as spotted owls, goshawks, pond turtles, deer, elk, and possibly the two SM snail species.

Additional discussions on the use of mechanical vegetation removal and fuels reduction can be found under the Vegetation and Fuels Management section of this chapter.

Other Wildlife Habitat Management Opportunities

Other wildlife habitat improvement techniques that have been or could be implemented within the LMK Analysis Area include:

- The creation of chainsaw cavities to promote northern flying squirrel nesting in order to indirectly improve prey availability for NSOs. This technique has been implemented within the estimated home range of 3 spotted owl sites in the Rosalina Creek sub-drainage, and could be implemented in other spotted owl territories.

- The placement of wood duck nest boxes near forest ponds. Nest boxes have been placed around Twin Lakes and LePerron Pond. There may be opportunities to augment or restore the nest boxes at these sites.

- The placement of bat roost boxes. Bat boxes have been placed in the headwaters of the Little South Fork of Boise Creek, and at the Orleans District Office, and could be placed elsewhere in the LMK Analysis Area, especially where bat-nesting opportunities have been reduced.

- Excavating ponds that are becoming filled with sediments in order to provide for such species as pond turtles, wood ducks, frogs, and fish. There may be opportunities to implement pond excavation projects at 2 pond sites within the Analysis Area.

Human Uses and Needs

Social and Human Uses

The overriding trend is the values associated with the Klamath River and its environs. The people who live near the river and those who travel yearly to it have a deep love for this river. It sets the rhythms to their lifestyle. Employment, local economy, resource amenities, religious/spiritual activities, cultural activities, subsistence, recreation, and lifestyle all center upon the Klamath River, with some aspects being more significant in some groups than others. Quality of life pervades all the groups as their number one concern.

Another trend in the data expresses the communities' and tribal governments' desire for a healthy ecosystem that includes burning. There is a concern that catastrophic fire could occur due to the large buildup of fuel on the forest floor. Along with this was an expressed need of interviewees was to harvest timber in order to enhance culturally significant vegetation and to enhance wildlife habitat. A healthy ecosystem was linked by a significant number of people to individual health and, therefore, community health.

The uses, values, and effects associated with the Klamath River are far-reaching, and not just related to local individuals and local communities. There are numerous organizations, often community based groups, working on Klamath River related issues: the Klamath River Taskforce, Trinity River Taskforce, Salmon River Restoration Council, Scott River Watershed Council, Klamath River Coordination Group, Klamath River Working Group, Klamath Watershed Council, and the Klamath River Compact Commission between the states of Oregon and California, just to name a few.

Local Economies

- *How do these watersheds contribute to the economies of local communities?*

The economy of these communities within and adjacent to the LMK Analysis Area has been disrupted in recent times. Many of those interviewed moved to this area to conduct businesses associated with timber harvesting and believe strongly that harvesting of timber is beneficial to the environment. Despite the fact that this industry is no longer supporting them, they stay because of the quiet, peaceful, natural way of life and the beauty of the Klamath River. These natural resource dependent communities are banking their future in recreation. Eco-tourism, such as rafting, is a major emphasis of the various small businesses that either generate from these communities or provide services within the watershed. The number one concern of all is the health of the Klamath River; they view it as the current and future backbone of any tourism industry. Community members desire to provide more service-oriented business to potential customers by entering into partnerships with the Forest Service in order to develop, administer, and market recreational opportunities. They desire more loop trails that will connect camping areas or fishing locations. They foresee the communities enhancing and developing support businesses such as private camping areas, RV parks, and supplies for recreational users.

Bigfoot Scenic Byway

Highway 96 was designated as “the Bigfoot Scenic Byway – where wildlife watches you!” on April 1, 2001. The Orleans-Somes Bar Chamber of Commerce worked hard to obtain this designation for the nation’s newest scenic byway. The Chamber is utilizing this designation in its efforts to attract tourism to the community, and promote this designation on their web site. The Chamber believes that the Wild and Scenic Klamath and Trinity Rivers designation along with the Bigfoot Scenic Byway, which completes a driving/riding loop that encompasses three additional scenic byways: State of Jefferson, Trinity, and Trinity Heritage, will be appealing for the driving type of tourist and will benefit the communities of Willow Creek, Hoopa, Weitchpec, and Orleans-Somes Bar.

Fish

The concern, support, and value of restoring the health of the Klamath River and its fishery resource are common to all the various communities within the Analysis Area. There has been an intensity of interest and concern about the Klamath River and its associated fisheries for numerous years. A variety of groups have risen to advocate a healthy river. The Klamath River Basin Act (Public Law 99-552) created a Klamath River Basin Fisheries Task Force to assist in the creation and implementation of a 20-year program to restore the anadromous fish populations on the river. In this Act Congress declared that the region’s streams should “provide fishery resources necessary for Indian subsistence and ceremonial purposes, ocean commercial harvest, recreational fishing, and the economic health of many local communities.” (USFWS et al. 1999)

Fisheries have been and continue to be a significant part of the local economy, whether it is through the industries it supports or the individual family’s economy. The Klamath River Basin Fisheries Task Force annual report in USFWS et al. 1999 identified the users who rely on a healthy fish population. Yurok Tribal members conduct both subsistence and commercial gill net fisheries in the Klamath River on the YIR. Hoopa Valley Tribal members fish exclusively on the Trinity River, which flows through their reservation. Members of the Karuk Tribe fish in the half-mile of Klamath River below Ishi Pishi Falls. River anglers pursue steelhead and shad in addition to chinook and coho salmon. Anglers harvest the fall chinook mainly along the Yurok Reservation in the Lower Klamath River. Steelhead, particularly the "half-pounders", are most popular with anglers upriver. The steelhead fishery is probably the Klamath River region's greatest attraction. The sport fishery's popularity is reflected in the pride of the local communities. The town of Klamath's symbol is the salmon surrounded by a heart, while, upriver, the town of Happy Camp proudly proclaims "Klamath River -- Steelhead Capitol of the World." The Klamath River Basin provides salmon for commercial trollers and hook-and-line fishermen in the Pacific Ocean mainly between Fort Bragg, California and Coos Bay, Oregon. Of the more than 600,000 chinook salmon taken in these waters annually since 1986, more than a third were of Klamath River origin (USFWS et al. 1999).

For the condition of the Klamath River fishery see the ***Fisheries*** section in Chapter 3.

Timber Harvesting

There is a strongly held view by a segment of the local population that the Forest Service should be producing more commercial timber harvests, and that timber harvesting should be and could be an economic element of the local community. They view that timber harvesting, in addition to producing economic stimulus, is an effective mechanism for producing healthy ecosystems. A significant number of private property owners indicated that they would be logging their lands in the future. A surprising number of owners stated that the primary reason for harvesting trees on their property at a future date was to send their children to college. This trend of supporting a certain level of commercial timber harvesting was common to the various groups involved; they see that some harvesting could not only be a benefit to the economy but to wildlife habitat, plant species diversity, and keeping some areas of recreation more open and easier to travel. However, they did not want commercial harvesting to create an “eye sore” within the viewshed of recreational areas or their homes.

Organic Farming

There is a modest business community of organic farming in the Analysis Area, which produces products that are sold at local and coastal farmer’s markets, and shipped to distant urban markets. Water quality and quantity, along with good access to markets, are the prime concerns of these farmers. Organic farming has been expanding recently as evidenced by more land being planted with wine grapes. The local area has been identified as having ideal climatic and soil conditions for viniculture.

Camping

There are limited public camping facilities and several private camping/loding facilities available within and adjacent to the Analysis Area. Camping is primarily associated with other activities, such as fishing, rafting, or hiking, and, therefore, the limited local commercial camping and lodging facilities are often full during the various fish runs. Tribal governments have raised concern and desire to close public campgrounds that are located upon prehistoric villages, and to remove the campground facilities in order to protect the heritage resources and burial locations associated with the village site. This has and may, in the future, limit the current public facilities along the river. This creates an opportunity for the commercial facilities to step up and fill this need for additional camping spaces. It also creates a challenge to work with these concerns in order to provide camping opportunities and river access for the recreational user, which will support the growing popular recreational river activities, while supporting cultural values.

River Rafting

Rafting is an already popular sport that seems to be growing in its popularity. Commercial enterprises have taken to the Internet with enthusiasm, advertising rafting opportunities on the Klamath River. The rafting community is likely to continue increasing due to excellent marketing and its growing popularity. At this time the number of rafting runs available commercially on the Lower-Middle Klamath River are few compared to the Upper-Middle Klamath (Happy Camp to Dillion Creek).

While rafters increase their use of the Klamath River, there is a significant use of the Klamath River, and other areas within Analysis Area, by Karuk and Yurok individuals for spiritual pursuits. There are numerous spiritual locations along the Klamath River and in the mountains. Some of these spiritual locations along the river can draw large numbers of people who camp while attending the ceremonies. The location, nature, and timing of these ceremonies are in conflict with the growing rafting business community and its recreational use of the river and takeout locations, particularly when ceremonies are being conducted, primarily over the summer months. The current rafting season on the Klamath River runs from May to October. The issue primarily involves the river from Happy Camp to Crawford Creek because this stretch of the Klamath River encompasses the ancient locales of the Karuk ceremonies. This spiritual use is not likely to decrease but, rather, increase. At the same time, the popularity of commercial rafting trips appears to be on the increase. The Forest Service is responsible for managing the land resources used by both groups and will need to develop effective working relationships and encourage cooperation among all who are involved in this issue. For more specific information on tribal spiritual values and rafting see the ***Government Consultation – Tribal Government's Perspective*** under the ***Social and Human Uses - Current*** and ***Recreational Uses - Current*** sections of Chapter 3, respectively.

Special Forest Products

- *What are the projected commercial and personal use demands for Special Forest Products over the next decade?*

There is some active use of the watersheds within the Analysis Area for commercial harvest of a variety of plants, most being used in the floral industry and secondarily for wild-crafting. Wild-crafters gather plants to use in developing products such as folk art, floral displays, paper, and various crafts, for commercial sale. The business community would like to see support of this economic opportunity and believes there is a large enough plant diversity and abundance that both a floral/shrub supply and a wild-crafting business could be supported.

If seasonal conditions are right and markets are favorable, the Analysis Area will also receive use for the commercial harvesting of tanoak mushrooms. Commercial harvesting of mushrooms is an up and down venture. However, the high use associated with commercial mushroom harvesting has been minimal over the last three years with very few commercial permits being issued out of the Orleans District Office. Commercial harvest of these various forest products in the Analysis Area will probably continue to be moderately low due to the remoteness from markets.

The Special Forest Product user group believes that any commercial permits for products, including mushrooms, that are offered for sale, should be limited to the local area first, and others later. There is desire to have the entire Analysis Area open for all types of commercial harvesting due to the abundance of plant diversity and easy access in some areas.

Commercial harvesting of plants that have been traditionally collected for subsistence has made this an issue in the local community. The concern being that the quantity of commercially exploited plants will be affected by overuse of the resource, and, in some cases, a lack of knowledge of how to harvest species without impacting their integrity.

The harvest of Special Forest Products may increase slightly within the Analysis Area but considering the amount of plants being gathered Forest-wide, competition in marketing these miscellaneous plants to buyers is fierce. Those not in a position to market outside the area will have limited opportunities. Some local wild-crafters have developed businesses over the Internet, which does increase their market capabilities.

The major economic endeavors of the peoples within the Analysis Area depend heavily on water. Whether they farm, provide lodging for river recreation users, provide commercial rafting or guide services, or commercially harvest fish or plants, water quality and quantity is necessary for the economic viability of their commercial enterprises.

Community Health

- *How do the watersheds in the Analysis Area and their resources contribute to, or affect, people's sense of place or quality of life?*

"Sense of place" describes the character of a physical location and the meaning, value, and feelings that people attach to it because of their experiences there. It integrates interpretations of a geographic place, including the biophysical setting, psychological influences (such as memories or emotions), and social and cultural influences. Changes in management can affect access to these special places or change their biophysical setting, affecting what people value or desire about an area, and, therefore, affecting their sense of place.

People's sense of place is directly tied to the characteristics of the area that invoke a special feeling or attachment to the area, including the larger landscape. Sense of place does not stop at boundaries of a National Forest, an Indian Reservation, or private property. There are several factors related to sense of place that the communities within the watersheds hold. The primary one is having an overall familiarity with the area. Many of the families have lived here several generations. The Karuk, Yurok, and Hupa believe they have attachments from time immemorial, and others have visited the area annually for generations.

Having a strong sense of place is directly connected to quality of life. These communities feel a strong sense of responsibility to the well-being of the forests and rivers that sustain their lifestyles. This feeling of responsibility is common to all user groups, from the individual, generational recreation user, to the local resident, to the tribal governments, and to the various organizations that have formed with the objective of assisting in the creation of a healthy river and landscape.

The Klamath River

As stated above, those who live near and travel annually to the Klamath River love this river, which sets the rhythms of their lifestyle. This distinct social group can be said to be living a riverine lifestyle. They orient their daily, weekly, yearly, or seasonal activities on what is occurring with the LMK Analysis Area's natural resources. The Klamath River is the center of the employment, local economy, resource amenities, religious/spiritual activities, culture, subsistence, relaxation or recreation, and lifestyles of everyone in the Analysis Area, with some of these aspects being more important in some groups than others. The number one concern of all groups is quality of life. A few interviewees related quality of life to their ability to earn a living logging. The majority identified that quality of life is linked to the beauty, serenity, calmness, and peacefulness of the Klamath River and the surrounding forests. It was very common to hear statements like: "*I believe we can attribute our good health to the clean air and spring water; the beauty of the forest, the wildlife, and the quiet atmosphere enhances the quality of our lives." "It provides a habitat for animals, birds, and fish that we enjoy sharing our lives with. The forest is green and beautiful, the river is blue and soothing and provides for the plants and animals of the area." "The Klamath River affects everything I do every day. I have to look at it everyday and utilize these resources year round."*

The Klamath River and its environs play an important role in the community as a stress relief, a get away, and in developing traditions within families, from fishing in certain locations to having family or cultural gatherings at certain river locations, or seasonal drives to view wildlife or flowers. In some communities this area offers the sustenance of life, such as Indian families who gather food, plant material for basketry, tools, ceremonial items, or travel to spiritual areas. In other communities the resources of the river and its environs provide their livelihood. The concern, support, and value of restoring the health of the river and its fishery resource are the same for all the various communities within the Analysis Area.

Subsistence

Subsistence activities are the oldest and most consistent use of the Analysis Area by Karuk, Yurok and Hupa individuals and communities. Each year subsistence gathering for such things as foodstuffs and materials for heat, shelter, health, tools, and spiritual practices continues as a matter of course and is tied to personal use of resources for the survival of the individual, group, or community. This activity, for many local residents, is individual in nature and is not tied to group values or cultural norms and beliefs. On the other hand, subsistence gathering and gathering of materials for other cultural uses are very basic activities that are an integral part of the ethnic life-ways of the Karuk, Yurok, and Hupa individuals and communities. In most instances the items gathered are not obtainable any other way (e.g. acorns).

While local resident subsistence use of plants is moderate, the Karuk, Yurok, and Hupa use is relatively high. Many local residents harvest the plant resources around them to enhance their food supplies, obtain herbal plants for cooking and medicinal reasons, and have firewood for heating. For some these activities are recreational, and for others it adds to their spiritual well-being and supports their rural life-ways. Many of these residents say that subsistence gathering is a stress reliever because it that allows them to walk in the forests and along the streams, and to gather strength from the environment around them.

There also is a local trend of immigration to the community, and many of these people desire a simpler lifestyle than they once had. These newer community members will generally begin to use the natural resources around them, as all the subsistence communities do, in order to supplement the lower income, compliment their life-ways, and fulfill a desire for a more natural way of living. In most cases, these local resident subsistence gatherers harvest materials wherever they find them, and do not relate this activity to deep-rooted cultural beliefs or a strong sense of place and tradition.

Traditional Cultural Subsistence

Large numbers of Karuk, Yurok, and Hupa continue to gather plants in this area as their ancestors did. Indian people from various tribes living along the coast travel to the Lower-Middle Klamath River primarily to gather plants and attend ceremonies. These individuals gather and hunt here due to a lack of access to traditional areas, private lands, and policies that restrict gathering on other state and federal lands. Although the Analysis Area, in may situations, is not their primary residence, it is still their homeland where they return each season to gather plants, hunt, and attend ceremonies that are important to them. These individuals are concerned with access to and the availability and quality of plants and animals. Generally, it is not important to them whether they obtain the needed items from one site or another.

However, for those who reside within or adjacent to the Analysis Area the location of where they gather is very important to them. These locations are considered family gathering areas, and the family takes responsibility for caring for them. The quality and quantity of plants, animals, and the surrounding environment near these locations are important. It is the quality of the environmental experience while gathering basketry materials, for example, that is as important as the quality of the materials being gathered.

Gathering is rooted in the past and will likely continue into the future. The trend indicates that it will remain high and that issues associated with availability, quality, and potential competition with commercial harvesters for culturally significant plants may increase. These users expect that the diversity of plants in the watersheds of the Analysis Area will remain high, and that access to them will remain open. They expect the Forest Service to enhance the forest materials that they gather, and are willing to assist in this by sharing their time and expertise in this area, for example, burning materials for basketry. It is also expected that "family" gathering grounds should be protected, primarily in the way families care for gathering grounds, rather than how others manage the area. Yet, many believe their ability to access and manage these family gathering grounds the way their ancestors did is prohibited or restricted by Forest Service policies and management, particularly regarding the use of fire.

Plants

The plants gathered today for Indian cultural uses need to be available in good quantity and quality. Riparian areas along stream canyons and floodplains provide the moisture and shade that culturally significant plants require for good quality and quantity.

The majority of cultural harvesting, particularly for food, occurred in the Douglas-fir/tanoak forests. Tribal prehistoric, historic, and contemporary activities within the watersheds of the Analysis Area affected current plant diversity. The present abundance of hardwoods and associated plants was assisted by the high use of fire, which enhanced hardwoods, particularly black oak, white oak, live oak, and tanoak, and cleared the ground of under-story that resulted in pests invading acorns. Fire also enhanced the grasses, shrubs, and ferns used in basket making, regalia making, and the making of tools of utility. Areas, particularly meadows or open areas, which would attract large game such as deer and elk and produce plants such as *Brodieae sp*. and various grasses were created by the use of fire.

The significance in managing these types of plant communities lay in the need for these tribal communities to have a sustainable, consistent source of food, which also includes wildlife. The primary motivating factor for managing with fire was oak communities, as well as the opening or clearing of areas and meadows to attract wildlife. Acorns were generally widely available, extremely nutritious, and became fairly reliable from year to year due to the tribes' management of oak habitat with fire. Oak communities also attracted deer and other wildlife that use acorns in their diet. Areas or meadows that were managed by fire in order to keep them open were often associated with the oak communities, and these too attracted deer and other wildlife. Locally, tanoak acorns were plentiful in mixed evergreen forests.

Serpentine soils contain Jeffrey Pine and Incense Cedar, both of which have cultural significance. Many of the plants used medicinally were and are more highly valued for their potency if gathered from serpentine soils.

The main disturbance factors affecting plant species composition in the Analysis Area are wildfire and flooding. It is believed that all stands in the Analysis Area were affected by fire at some time during their development.

Fire

Tribal members from the Karuk, Yurok, and Hoopa tribes have very strong opinions on the need to reintroduce fire so that plant resources can reap the benefits of proper burning. Tribes traditionally used burning practices for managing basketry materials, medicinal herbs, acorns, or clearing hunting areas. The ability to maintain a traditional way of life is tied to the quality and quantity of these various resources and, thus, to the use of fire to manage these resources. Basketweavers are the most outspoken and active group in this regard. They work with the USFS, their tribal governments, and other agencies and organizations to gain support for and funding to conduct what is referred today as "cultural burns". The plants they focus on are bear grass and hazel. Hazel sticks are desired for very finely woven baskets; however, hazel that is useable is very rare today. They feel it is critical to assure that hazel survives and is available and usable for future basketweavers. Burned hazel plants grow straighter, are more pliable, have durable sticks, and are more resistant to insects and disease. Beargrass leaves are softer and more pliable, and are easier to gather after a burn. Without fire these plants are rendered useless to weavers (Times-Standard, Numerous contributors. May, 2002. p.6).

Subsistence Fishing

Most members of the communities within the LMK Analysis Area fish for salmon and steelhead for recreation benefits, such as relaxation. However, it is also an important endeavor because often they rely on this catch as part of their yearly subsistence. In the case of steelhead, current restrictions on the take of wild fish, has limited its importance. However, most households have frozen or canned salmon in order to see them through the winter months. Numerous homes along the river have smoke houses to help cure the catch.

Salmon far exceeds other resources in its importance to the diet and cultures of the Karuk, Yurok, and Hupa community members. They not only need to obtain enough fish for their families' yearly needs but also for the subsistence needs of the community ceremonies that are held each year.

The local fishing communities have expressed concern for the Klamath River about sedimentation from roads and slides, warm water temperature, and low flow. They all have a concern about the consistent decline in the availability of fish. Even if there is a year of good fishing they are concerned that it may only be an anomaly. The entire subsistence fishing community is very concerned about the condition of the fishery and supports the efforts of agencies and individuals seeking to better the situation.

Domestic Water

A very basic subsistence need is water for drinking, cooking, and sanitation. Access to, and quality and quantity of water sources, are tied to the quality of life of local residents. A large number of residents depend upon water located on, or flowing from, NFS lands, and that is obtained through municipal services, special use permits, or sources on their lands for their domestic water. They express concern that management practices of the Forest Service may have an impact on their water sources in terms of quality or availability such as decreased or disrupted flows.

Quality of Life

There is a substantial amount of private property within the Analysis Area, including portions of three towns/communities and those owning private lands value the quality of life they have as a result of the surrounding NFS lands and the Klamath River. They have an expectation that the forests will be managed to maintain the natural settings and provide the resources that they utilize in order to maintain a rural lifestyle. There are a number of parcels that are used as summer homes or held for retirement. There is a trend of people retiring to the LMK area, and a developing trend of people moving to this area to “get back to the land” and live a much simpler life. Both of these trends are expected to increase due to the local communities’ marketing of the area to attract people for the quality of the rural lifestyle and the natural and scenic beauty of the area. The communities expect the Lower-Middle Klamath River to continue to contribute to their rural lifestyle and quality of life into the future. In recent years, the communities have begun to organize community action groups in order to develop a common vision for their future and to actively determine how the surrounding natural resources, NFS lands, Klamath River, and their quality of life will be sustained over time. This trend will increase and cause agencies to interact extensively with these groups and community members. By organizing in this manner, the Orleans-Somes Bar community has been able to increase the communities’ infrastructure and, thus, add to the quality of life. Management, use, and building of roads is an intense topic that is attached to quality of life issues as it relates to access to private property, culturally significant locations, and fishing, hunting areas, and recreation areas. Some property owners rely on roads that cross NFS lands to access their property, and are highly concerned about road closures and how they will affect them.

Many of the local families have seasonal employment. They have developed their life style around the seasons of the river and mountains in order to supplement the lower wages and high unemployment of the area. They do this by gathering foods and firewood and by gardening, hunting, and fishing. They expect to be able to continue living a simple and semi-subsistence lifestyle, and expect a healthy river and forest, which are needed to support a seasonally based subsistence lifestyle. This, they believe, affords them the quality of life that they cherish and that they attribute to their good physical health.

The interviewees identified major issues of unruly activities that they were concerned about and felt affected their quality of life. They gave examples such as long-term noise from road building/timber sales, partying at USFS campgrounds, shooting off guns at campgrounds, marijuana production and eradication, crime, violence, destruction of property, and deer poaching. Even though these activities were identified as major issues, for the most part they do not occur consistently; however, when they do occur it is very disturbing to these communities, which value the peace, calm, and quiet of their lifestyles.

Fire Safe Communities

The Orleans-Somes Bar Fire Safe Council is very proactive and is coordinated to address the risk of catastrophic fires in the communities of Orleans, Somes Bar, and the surrounding areas. They recently received a large federal grant to do community projects that reduce the risk of catastrophic fires. The long-term goal of the Council is to help plan, implement, and monitor the reinstatement of historic fire regimes, primarily through strategic fuels reduction in a manner that protects life, property, improves forest health, and enhances the resources valued by its stakeholders. They believe the first step toward reintroducing fire at the landscape level is ensuring that private properties are safe from fire. The Forest Service is considered a significant player in the reintroduction of a natural fire regime in the Analysis Area, since most of the surrounding lands are NFS lands. The Karuk Tribe is an active member of the Orleans-Somes Bar Fire Safe Council, which allows for greater cooperation and participation by all the locally represented governments. For more specific information on the Fire Safe Council see ***Fuel Treatment Options*** under the ***Fire*** section of Chapter 4.

The tribal governments are very involved with the SRNF, advocating and participating in fire-oriented planning and projects that are designed to re-instate fire into the landscape and enhance materials used in basketry. The tribes are interested and active in creating fire safe communities, as well as establishing a burning program that sustains a culturally supportive, healthy landscape on their lands, and NFS lands.

Overall, these communities expect healthy forest ecosystems, stability of wildlife and plant populations, clean water and access to NFS lands.

Tribal Trust Resources

- *How have current watershed conditions affected subsistence fishing associated with federally reserved trust rights of the Yurok and Hoopa, and how can management practices minimize these effects on tribal trust resources?*

Fishing Rights

Salmon, steelhead, sturgeon, and lamprey that spawn in the Trinity and Klamath rivers pass through the Hoopa Valley and Yurok Indian reservations and are harvested in tribal fishery. The fishing traditions of these tribes stem from practices that far pre-date the arrival of non-Indians. The United States has long recognized the rights of the tribes of the Klamath-Trinity River Basin to fish. The federal government, as trustee, has an affirmative obligation to manage tribal rights and resources for the benefit of the tribes. This obligates the Forest to examining any effects that a project, program, or policy may have to on-reservation trust resources, such as fish and water (USFWS et al. 1999, 3-207 – 3-208).

Certain runs of native anadromous fish have been decimated, which has impacted every aspect of tribal society and culture. Major declines of the Klamath-Trinity Basin’s fishery are due, in part, to significant increases in sedimentation, reduced flows, and degraded water quality due to such things as the construction and operation of dams, diversions and hydroelectric projects, mining, timber harvest practices, road construction, floods, and erosions from slides. These impacts have adversely affected the viability of anadromous fish stocks and habitat conditions of the Lower-Middle Klamath River. Many of these effects are associated with projects that affect the entire Klamath River Basin, such as the construction of dams and the management of water flows.

The LMK Analysis Area has watersheds that are rated with a high to moderate priority for watershed restoration efforts relative to the rest of the Klamath and Trinity River Basin. This rating is significant when considering that the bulk of the watersheds within the Klamath and Trinity River Basins have low to moderate priorities for implementing restoration. The designation of a high restoration priority is based on the ability to influence positive change in improving aquatic health for endangered fish species. In other words, restoration actions can be effective in restoring a more natural sedimentation regime in these watersheds that have endangered fish populations. This management practice is supportive of the Forest's trust responsibilities related to their off-reservation management activities and how they can positively affect on-reservation trust resources, in this case water as it relates to fish.

For detailed information on the condition of the fishery and water conditions see the ***Water Quality and Fisheries*** sections of Chapters 3 and 4.

Water Rights

In addition to fish, the Yurok and Hoopa Tribes have reserved rights to water. It has been legally determined that they have senior water rights on the Klamath and Trinity rivers and that federal agencies must operate projects consistent with vested, fairly implied senior Indian water rights. In other words, pursuant to statutory and fiduciary obligation, sufficient quality water must remain in the Klamath and Trinity rivers in order to support the anadromous fishery and other trust resources (USFWS et al. 1999, 3-211).

Tribes believe that current water flows are not enough to sustain the local fishery through all lifestages. This is an issue that is larger than the LMK Analysis Area and the SRNF. It is a current issue in the news, courts, and various federal agencies that have direct and indirect ties to the management of the Klamath River Basin.

It is important to note that the Yurok, Hupa, and Karuk are riverine people. The fishery is as important to their traditional and cultural life-ways today as it has always been. They have great respect for the fact that all have a need for a healthy Klamath River and fishery, and work cooperatively and energetically together no matter what the legal status of the fish or water rights are. Historically they honored each other's needs and uses of the Basin fishery through their self-regulated building of fish dams and ceremonies, and this cooperation continues today. They are working shoulder to shoulder in coalitions and taskforces, as well as independently within each tribal government to obtain, through the legal system, adequate flows, restore the habitat of the native fishery, and, ultimately, restore the Klamath-Trinity Basin's health.

Tribal Government Consultation

The SRNF has a variety of working relationships with the Karuk, Yurok, and Hoopa tribes, which covers areas such as wildland fires and governmental consultation protocols. Tribal governments are often involved in forest planning, implementation, and management. The expectation is that this governmental cooperation and partnership will continue to increase in the future, with tribes playing a significant role in the overall management of the natural resources in the Analysis Area.

The SRNF has formal governmental consultation protocols with the federally recognized tribes adjacent to or within the area of influence of the Forest, and conducts consultations with Tribal Councils routinely. This process is especially significant if the federally reserved trust resources of the Yurok or Hoopa tribes might be affected. Management decisions and actions that may have the potential to affect federally reserved trust resources will require priority attention and additional governmental collaboration. It is through the government-to-government consultation that potential impacts or effects are identified and ways are developed to eliminate or minimize these impacts or effects. This consultation process also opens up numerous opportunities to be innovative, creative, and mutually supportive as it relates to managing the natural resources of the Klamath River Basin

Access – Roads and Trails

- *Why do people value their specific access to the Analysis Area, and why is this access important to them?*

The local communities and individuals have social and economic dependencies on Forest Service roads and trails and the natural resources provided by access to them. Changes to a road system, or in road management, may affect local lifestyles, forest resource-related business, the collection of subsistence resources, and access to municipal waters supplies, power lines, and other local infrastructures.

Desire for and concern about access to private property, was an overriding trend in the data collected about access. There was concern about the closing of roads. Some people depend upon roads to access property and travel to distant spiritual locations. Some recreation activities were identified as road dependent, such as scenic driving or driving to access the river or areas for hunting. There is an expectation that roads should not be closed to the public, because they are on public lands. Many do not believe that closing roads is the answer to adequately address sedimentation. They believe that restricting off road vehicles (ORV) in certain areas, and considering the amount of roads constructed and how they were constructed, are appropriate ways to address sedimentation in the watershed. The overall feeling from interviewees was that freedom to move within the forest is an important value held by these communities.

Karuk, Yurok, and Hupa individuals have cultural, spiritual, and traditional values associated with access to specific places and resources within the Analysis Area. Often, the times when cultural activities take place and the trail that is traveled to get there are connected to deep cultural traditions. Since much of the Analysis Area has been roaded for years, some road access is now connected to cultural activities. For example, some people from outside the local community might also attend the public ceremonies. The need to manage these large ceremonial gatherings in terms of sanitation, camping, feeding, fire safety, public safety, and necessary equipment, has made certain roads essential for these gatherings.

Tribal governments utilize Forest Service road systems for a variety of purposes including access to their lands in order to manage and monitor natural resources and properties, which may include federally reserved trust resources. It is important to consult with the tribes to determine which roads provide access to tribal trust properties or resources on the reservations.

In some cases, Forest Service roads are the only means by which to access parts of Yurok and Hoopa Valley Reservation lands. Currently, some Forest Service roads are adjacent to, or pass through, reservation land, and sometimes the Forest Service uses tribal roads to access NFS lands; this provides the opportunity to develop mutual agreements for managing these roads.

Recreation

- *What improvements or new facilities are needed in order to meet the most critical recreation demands in the Analysis Area?*

River Access Improvements

Additional access routes connecting Highway 96 to the Klamath River's edge will be needed if the expected demands for bank fishing, drift boat fishing, boating/canoeing, and dispersed camping are to be met. Also, most existing vehicle access routes to the Klamath River are in need of minor road surface repairs and improvements to better control runoff and potential erosion, and to improve accessibility for low clearance vehicles. With the existing vehicle/boat accesses being relatively well distributed throughout the upper and mid sections of the Analysis Area, there is only a need for one additional vehicle/boat access route near the south end of the Analysis Area. The development of controlled parking areas, information and interpretation signs, and additional toilet facilities will be needed at the most popular river access sites, such as Big Bar and Dolans Bar, in order to protect the river environment from unnecessary damage and provide a quality recreation experience.

Camping Improvements

Increased maintenance and minor improvements/upgrades of existing Forest Service developed campgrounds will be very important to providing a quality camping experience in the future. The installation of a more dependable and technologically current water treatment system and new water distribution lines to serve E-Ne-Nuk and Aikens West Campgrounds will be necessary in order to meet the expected state water quality standards for potable water in the very near future.

Privately owned shower facilities that are open to overnight campers and travelers would improve the quality of recreation experiences and possibly contribute to longer stays in this area.

Trail Development

Additional foot trails are needed in various locations throughout the Analysis Area to meet expected demands for bank fishing, swimming, and dispersed camping. Short foot trails that follow along the river, and loops trails that connect to developed campgrounds or vehicle access points are highly desirable. Also, at least one mountain biking trail, preferably as a loop or with an important destination point, would help meet some of the demand from local residents and campers for non-aggressive mountain biking opportunities. Ideally such a trail would originate near a developed campground or Highway 96 and not contain any very steep sections, but any suitable trail that can be signed and shown on a map would meet the most critical need.

Noxious Weeds

The extent to which weeds will spread in the Analysis Area is certainly dependent upon the character of the land and the degree of disturbance. Open (areas with low canopy cover and vegetation cover), disturbed areas in the Analysis Area that include landings and other timber-related clearings, developed sites (residences, campgrounds), pastures, river access routes, and burned areas are most vulnerable to invasive plant establishment. Concurrently, introduction and spread are typically linked to various forms of human activity including river-related recreation (access trails, put-in sites, etc.), road maintenance, timber management, and wildfire suppression activities.

The Klamath River is a focal point for local residents and tourists engaged in various forms of recreation from kayaking and swimming to sport fishing (See ***Recreation*** section under ***Human Uses and Needs*** in Chapter 4). The high recreational use and associated disturbance along the riverbanks, which are sites in the Analysis Area that support such weeds as Dyer's woad and himilaya berry, will likely lead to localized increases in weed cover and density and possibly the introduction of new weed seed. Weeds such as yellow starthistle will homogenize the vegetation, grow over the trails, extending its sharp spines, and, thereby, reduce the quality of the river recreation experience.

With an increased awareness of noxious weeds on the Forest over the past three years, incidences of weed introduction related to projects have also been observed. A species of knapweed located in the vicinity of Offield Mountain just to the north of the Analysis Area occurs in a clearing that is likely related to logging that occurred nearby. The association with landings has also been observed for knapweed elsewhere. In both cases, weed seed was more than likely introduced on equipment or personnel associated with logging activities.

Road System

Noxious Weeds

Given the association of noxious weeds with chronically disturbed areas such as Highway 96 and lower road segments intersecting with this highway, road maintenance practiced by Caltrans, Humboldt County, and the Forest Service that lacks weed prevention measures will lead to weed seed introductions and an increase in weed density and extent. Although not observed to date in this county, stems of yellow starthistle were observed growing from gravel material that was going to be used for road maintenance in Trinity County. Roadside mowing, although a potential control method for some species if well timed, can actually accentuate the problem if conducted too early or too late in the life cycle of yellow starthistle. Weed management is very difficult along major highways. Standards and Guidelines associated with the importation of fill, mulching material, and equipment cleaning are, at a minimum, options that should be employed to slow the trend of weed introduction and spread along highways and roads.

Landsliding

- *To what degree and in what types of locations have roads affected mass wasting or erosion processes?*

Landslide sediment delivery has been especially high along the Highway 96 corridor. The most vulnerable segments may be somewhat predictable, based on past incidence in certain geologic units and geomorphic terranes. It may be appropriate to explore our mutual concerns with Caltrans and Humboldt County to develop risk assessments relative to winter access and potential sediment delivery from large failures. Risk assessment should distinguish between (1) potential for cutslope failure and delivery of sediment to the Klamath River, and (2) deep-seated instability affecting the roadway itself. The latter has not been a significant problem along most of this part of Highway 96, but there are identifiable areas that could be expected to be a problem in future major storms.

A related issue is estimating long-term slide debris volumes and the need for disposal sites; expected volumes are strongly dependent on the magnitude of landslide-producing events that are experienced/expected over some time frame. The Forest Service has a strong vested interest because of the strong implications for other Forest resources such as fish, recreation, etc.

Roads Treatments

Restoring and upgrading roads can be one of the most cost-effective watershed restoration treatments, particularly if erosional problems are treated before sediment reaches a watercourse or before potential road-related landslides occur. Cost-effective road treatments range from full decommissioning, which involves closing and stabilizing a road to eliminate potential for storm damage and the need for maintenance, to simple road upgrading, which leaves the road open. Upgrading can involve practices such as removing soil from locations where there is a high potential for triggering landslides, modifying road drainage systems to reduce the extent to which the road functions as an extension of the stream network, and reconstructing stream crossings (storm-proofing) to reduce the risk and consequences of road failure. The benefit from such restoration is immediate and long-term, and may reduce or eliminate maintenance needs depending upon the treatment. Correcting existing and potential road-related sedimentation is a major step towards bringing the landscape closer to natural erosion rates and processes.

Storm-proofing is the improvement of a road drainage system to withstand 100-year storm events without appreciable on-site or off-site damage. A secondary objective is to make roads that are less dependent on maintenance to function adequately. Storm-proofing is a tool that can be utilized when vehicular access for land management or public access is necessary and where decommissioning is not appropriate to meet these needs.

Some of the more common treatments include; increasing culvert size, modifying inlet geometry to better accommodate organic debris, reshaping roadbed geometry to correct stream crossing diversion potential, and shortening long, continuous inboard ditch lengths. These types of corrective measures are gradually being applied to the road network within the Analysis Area as time and funding permits.

Within the LMK Analysis Area, and the National Forest in general, maintenance funding is insufficient to maintain existing road infrastructure. Without road maintenance, potential risk for resource damage is increased. Within Key Watersheds, such as some in the LMK Analysis Area, the NWFP states that there will be no net increase in roads. This means that existing roads must be decommissioned before any new or temporary roads can be constructed.

Opportunities to reduce maintenance costs may be achieved through the elimination of unneeded roads (i.e. decommissioning), reduction of maintenance levels to appropriate minimums, and the pursuit of opportunities to reduce the maintenance requirements associated with different types of road design templates. When evaluating candidate roads for decommissioning, public and administrative use needs must be weighed against the savings that would result from the elimination of future maintenance costs and the benefits to be realized through the reduction in impacts to other forest resources.

The Forest Service could also consider meeting individually with private landowners to develop challenge cost share, stewardship, or other cooperative road maintenance agreements for roads used to access private property and pursuing agreements with local communities and user groups to share road maintenance responsibilities.

- *What type of road maintenance is needed to minimize resource damage and provide for public safety?*

Most road maintenance activities inherently minimize resource damage and improve public safety on forest service roads. Some types of road maintenance that have a more direct impact on minimizing resource damage include cleaning and/or upgrading culverts, surfacing roads to eliminate the potential for sediment discharge in the event of a stream diversion, cleaning ditches to provide for free flow of surface water, and removing debris from the inlet and outlets of culverts. Some types of road maintenance that have a more direct impact on providing for public safety on Forest Service roads include brushing the road to provide adequate sight distance, replacing and repairing road surfacing, and blading native and aggregate surfaced roads to decrease the potential for vehicles to leave the road prism because of rough road surfaces.

Specific Resource Concerns

Noxious Weeds

- *What control options are available?*

From a prevention perspective, the LRMP already contains Standards and Guidelines for the use of native plants over invasive, non-native species in the Forest's management activities. Last year, the Forest developed a Risk Assessment for Noxious Weeds (Memo, 2080 Noxious Weed Management 7/10/01; See Appendix E) to be undertaken at the project level. As a part of NEPA analysis, projects are evaluated as to their potential to introduce or spread noxious weeds. Moderate to high ratings often require mitigations to reduce the risk. With this practice in place, it is hoped that trends towards increased weed introductions in "wildland" settings can be abated.

In addition to policy within the LRMP, the SRNF Fire Plan addresses concerns relative to potential weed introduction associated with wildlfire suppression and fuels management. Furthermore, in a memo dated June 17, 2002, the Regional Office developed guidelines for rehabilitation and restoration, which identified guides for seeding and species unacceptable to use in emergency rehabilitation projects (FSM 2523). Between the memo and the plans, prevention measures focus upon the use of non-invasive plant species and material as well as equipment cleaning. The latter has not yet been universally applied for prevention of potential noxious weed introductions during suppression or rehabilitation.

Inventory and mapping are critical to identify new infestations and leading edges, thereby guiding subsequent treatment projects. 2001 marked the beginning of systematic roadside mapping in the Orleans area and included road segments within the Analysis Area. During that survey, satellite populations of diffuse knapweed and yellow starthistle were detected off the main highway. Upstream, the Salmon River joins with the Klamath River outside of the Analysis Area. High riverbars at the lower reaches of the Salmon contain spotted knapweed. This field season the stretch of the Klamath River from Somes Bar to Weitchpec was inventoried yielding detections of spotted knapweed on the riverbars. Inventory and mapping data gaps would be filled in coming years.

Methods to treat noxious weeds can vary by the particular weed. Success of treatment varies considerably and depends on the extent of the problem, seasonal variations, phenology of plants when treated, and the commitment to follow-up treatment to manage any seed bank. Eradication except in the case of small, satellite populations is rarely attainable. More often than not, weed occurrences are “contained” not eliminated.

There is considerable support for integrated approaches involving combinations of two or more methods. Herbicide application as a control method is not an option at this time on USFS lands, nor consistent with policy for county roads. Without the use of herbicides, treatment methods available for specific large-scale infestations include prescribed fire, biological control, and timed grazing. Besides biological control used for yellow starthistle on the Mad River Ranger District, these methods have not been actively pursued on the SRNF to date. Treatment priorities have focused upon leading edges and satellite populations using non-chemical integrated methods (e.g. hand-pulling followed by revegetation). Potential non-chemical methods for control of the priority weeds in the Analysis Area are identified by species in Appendix D.

An over-arching measure to reduce introduction and spread of noxious weeds is education. From a social perspective, quality of life, recreation, economics, and sense of place are all affected by the increased abundance of noxious weeds. Landscapes dominated by noxious weeds are degraded, which means displacement or even loss of native species (wildlife as well), loss of species richness, and potential loss of ecosystem services provided by native species. Fending off the spread of noxious weeds in orchards, on farms, and in pastures has an economic cost. Given the relationship to many values, uses, and activities in the Analysis Area, education across multiple jurisdictions about the issue and stewardship measures are critical to any successful weed management program. Stakeholders within the Analysis Area include the USFS, Caltrans, Humboldt County road maintenance, tribes, California Indian Basketweavers Association, Fire Safe Councils, Middle Klamath Watershed Council, rafting companies, seasonal visitors and local landowners. Development of cooperative agreements, memorandums of understanding, and local educational forums (e.g. workshops, press releases) is recommended.

5. MANAGEMENT RECOMMENDATIONS

This chapter will identify types of management opportunities and list possible management practices. Suggested criteria for the implementation of the management opportunities and the selection of treatment areas will be listed, as will data gaps and monitoring needs (if known) to facilitate better future management.

The synthesis and interpretation of discussions in Chapter 4 has led to five main areas of opportunity: (1) the protection of Port-Orford Cedar (POC) and its associated riparian communities, (2) vegetation and fuels management, (3) the restoration and management of the Klamath River and its tributaries, (4) the development of partnerships, and (5) various other opportunities related mainly to specific resource areas.

Protection of Port-Orford cedar

Opportunity 1 – Prevention of the Spread of POC Root Disease

A potential impact to the riparian plant community and instream aquatic habitat within the Analysis Area is the spread of POC root disease. There are dense stands of POC throughout Aikens Creek and some areas of Slate Creek and Crawford Creek. A decrease in the density and structure of these stands may be imminent with the presence of the disease in this immediate area. A loss of these stands could have a significant impact on existing aquatic resources including coho, chinook, and steelhead habitat. These trees function as: (1) a source of shade which controls temperature and in-stream primary production, (2) a nutrient source of detritus, (3) a way to control the routing of water and sediment, (4) instream structure which provides aquatic habitat, (5) substrate for biological activity, bank stability, and nutrient uptake; and (6) a means to retard the movement of sediment, water, and large woody debris during large storm events. These are all elements of a healthy and productive watershed. Should the POC root disease ever spread into these nearby watersheds, significant direct and indirect adverse effects to aquatic resources may result.

Measures are being put in place to mitigate the spread of the disease. Because of its proximity to an infected area, Aikens Creek is at high risk of infection according to the recent POC Risk Assessment for the Klamath Basin. Crawford Creek and the Lower-Middle Klamath River have a moderate to low risk, while Slate Creek has a moderate risk for infection. In the POC Risk Assessment, the main roads in these sub-watersheds were identified and recommendations were made for installing gates and barriers in certain locations. There is also a need to educate the public about precautions that should be taken when traveling from infected to uninfected areas. The primary objective of this project would be to prevent the import of the POC root disease and, thereby, protect the fishery resources that exist within these watersheds. Prompt implementation of the project is necessary in order to afford this protection before it is too late.

Possible Management Practices

- Begin an aggressive program aimed at slowing the spread of POC root disease within and outside of the LMK Analysis Area with the overall objective of reducing the risk to all POC plant associations.
- Assess the range-wide cumulative impacts of all management activities on POC utilizing the California risk assessment described in this analysis.
- Decommission high-risk roads within POC infected areas.
- Clean equipment before entering non-infected areas.
- Conduct site-specific actions such as road and trail closures (e.g. barriers and gates), and sanitize roadside POC (with yearly monitoring and treatment) that reduce the risk of spreading POC root disease within the LMK Analysis Area.
- Install seasonal or permanent gates, if they are not presently in place, on the following roads: 10N04, 10N05, 10N11, 10N15, 11N05, 11N05K, 11N06, 11N06A, 11N11, 11N18A, 11N36A, 11N46, 11N49, 12N12, and 12N12F.
- Sanitize the POC along 13N01 at the hairpin turn area above and draining into the Adorni RNA in sections 24 and 25 of T10N, R4E. This area should be treated yearly to ensure that all POC seedlings are removed.
- Move the POC gate on 13N01 nearer to the Aikens Creek crossing in order to control access to the area.

Criteria for Implementation or Selection of Treatment Areas

- Critical fisheries habitat at risk
- Watersheds that have POC root disease (Aikens Creek)
- Protection of the Adorni RNA

Data Gaps

It is currently unknown what genetic markers, if any, can be used to identify individual POC trees that are resistant to POC root disease. Identification of these resistant trees prior to stand infection could be valuable in areas where the disease is spreading and sanitation is planned.

Monitoring Needs

There is a need to monitor the spread and prime vectors of POC root disease.

Vegetation and Fuels Management

Vegetation

- *Are there opportunities for vegetation management that would increase resilience to disturbance and enhance the late-seral characteristics of stands?*

The opportunities listed in this section are designed to help meet the specific management recommendations for the HRV, the RMR, wildlife habitat improvement, and the control of noxious weeds. Many of the practices used to implement these opportunities will also benefit other resources through the reduction of the risk of catastrophic wildfire.

Opportunity 1 – Managing HRV/RMR

There are opportunities within the LMK Analysis Area to help meet Forest Goals for HRV and RMRs through long-term planning. Opportunities also exist within the Analysis Area, utilizing an assortment of silvicultural prescriptions, to manage within early and mid-mature seral stages. Examples of some of the management practices that would take advantage of these opportunities could include, but are not limited to, the following:

Possible Management Practices

- Allow natural ingrowth to occur, consistent with appropriate fuels models, in tanoak, Douglas-fir, white fir, and red fir late-mature and old-growth stands in order to increase the amount of late-seral vegetation in the LMK Analysis Area, and recover the ecological imbalance associated with past regeneration harvesting.
- Create small openings within early and mid-mature stands using the green-tree retention (GTR) silvicultural prescription. This prescription could be used to mimic natural disturbance.
- Thinning of early and mid-mature natural and managed conifer stands to accelerate the development of stand characteristics and species diversity desirable for wildlife species, increase timber growth and production, and provide species and structural diversity.
- Treat early-mature and mid-mature tanoak and Douglas-fir and mid-mature white fir with silvicultural prescriptions, such as thinning of intermediate and suppressed trees, designed to accelerate stand development towards late-seral conditions.

Criteria for Implementation or Selection of Treatment Areas

- Areas allowed to grow naturally would be in those sub-drainages where older forest stands are lacking.
- Where there is an excess of early and mid-mature seral stages above the RMR, the green-tree retention (GTR) prescription could be used in combination with other silvicultural thinning prescriptions.
- Thinning could be conducted to harvest trees that would otherwise die due to overcrowding as the stands grow, and to maintain stand density at a level that provides for stand health and desired diameter growth.
- Opportunities to thin suppressed trees may exist in the Whitey's Gulch and Red Cap Gulch sub-watersheds where there appear to be lower than average percentages of late-seral forest. There may also be opportunities to implement thinning within the estimated NSO home ranges that are deficit (See ***Terrestrial Wildlife Species*** chapter 3).
- Priority for management would be those early and mid-mature stands that would not otherwise maintain growth or accelerate development of late-seral stand structural attributes.
- The old-growth seral stage in the tanoak and Douglas-fir series in the north zone and the central zone is currently below the RMR. The late-mature seral stage within the tanoak, Douglas-fir, and white fir series in the north zone and the central zone is needed as future recruitment for the old-growth seral stages in all series.

Data Gaps

On the ground validation of timber stand conditions may be needed to improve computer growth models.

Monitoring Needs

There exists a need to monitor the effectiveness of silvicultural prescriptions in accelerating development of late-seral stand structural attributes.

Opportunity 2 – Opening Up Unnaturally Dense Stands for Wildlife Habitat Improvements

- *What types of management opportunities exist that can benefit wildlife and meet other resource goals?*

Wildlife habitat improvement projects can help meet the specific management objectives listed in the SRNF LRMP to: “Maintain viable populations of all native and desirable non-native wildlife species occurring on the Forest by providing the variety, distribution, and amount of wildlife habitat types necessary, and maintaining a biologically diverse and functional forest landscape ecosystem”. These objectives or goals focus special attention on TE species with the additional direction to: “Maintain or improve populations of endangered, threatened, and sensitive species by providing suitable habitats that are capable of meeting species requirements”.

Possible Management Practices

These types of wildlife management practices can benefit such sub-canopy predators as spotted owls and goshawks by making their prey more accessible, ideally without compromising other habitat parameters used by them or their prey. When implemented in dense, young stands, they can also be used to hasten the onset of late-seral forest structural conditions favored by these species, as well as other late-seral forest using wildlife such as marbled murrelets, fishers, and martens (USFS and BLM 1994).

Opening up dense stands or countering conifer encroachment can also benefit nesting western pond turtles, aid in meadow and oak woodland restoration, and serve as a technique to create early successional stage habitats used by deer and elk.

The types of situations where opening up unnaturally dense stands may result in benefits to wildlife include:

- Reducing sub-canopy vegetation that is thought to be inhibiting sub-canopy foraging within the estimated home range of a known or suspected spotted owl or goshawk pairs.
- Removing canopy that is shading potential northwestern pond turtle terrestrial nesting habitat.
- Removing overstory conifers that are shading out shade-intolerant black oaks.
- Clearing young conifers that are encroaching on meadows or oak woodlands.
- Removing canopy in areas that are lacking in early seral stage wildlife habitats.

Criteria for Implementation or Selection of Treatment Areas

- There may be an opportunity to reduce sub-canopy vegetation within the 2 Goshawk Management Areas as well as around other goshawk or spotted owl sites where vegetation sampling has determined that sub-canopy vegetation is reducing otherwise suitable habitat quality.
- The known northwestern pond turtle areas near which there may be opportunities to remove canopy shading, potential terrestrial nesting sites include the Twin Lakes area, and along the upper banks of the slower portions of the Klamath River.
- Areas where historic meadows are being encroached on by conifers and where opportunities to remove encroaching vegetation may exist include Red Cap Glade, near the Owl Mine, and near the Cooper Ranch.
- Pole and early-mature conifer stands with a pre-dominant component of black oaks, such as the area north of Wilson Creek, may be areas with opportunities to restore black oak woodlands.
- Areas where there are opportunities to create early seral stage wildlife habitats should be primarily driven by Timber.
- The opportunity to implement a wildlife habitat improvement project will often be dependent on the goals for a particular land designation, and on the results of surveys for certain potentially affected wildlife or their habitat, aquatic/riparian habitats, botanical and heritage resources, and an analysis of the results of those surveys.
- An analysis of the results of vegetation or fuels surveys may be a prerequisite of, or a driver for, wildlife habitat improvement projects. These opportunities may be dependant upon coordination with other management activities that might affect project site access, or project timing, and should be coordinated with preceding or future planned actions.

Data Gaps

Sub-canopy vegetation density information is often lacking in stand databases.

Monitoring Needs

Every wildlife improvement project should have a monitoring plan that is designed and implemented to assess the effectiveness of the treatment.

Opportunity 3 – Control of Leading Edge & Satellite Populations of Noxious Weeds

Recently, spotted knapweed was detected on river bars along the stretch of the Klamath River within the Analysis Area. To date, these occurrences are relatively manageable and one session of hand-pulling has already occurred.

Possible Management Practices

- Opportunity exists to continue the work that is underway with the community of Orleans, including the Middle Klamath Watershed Council, tribes, and other entities, to ensure localized populations are kept in check.
- Through cooperative means, focus can also be put on treating leading edges and satellite populations of priority weeds associated with primary roads.

Criteria for Implementation or Selection of Treatment Areas

- Existing inventory and mapping has identified broom species on Forest Service roads 12N12 and 10N12, yellow starthistle on 15N01, and dyer's woad on Highway 96 just east of Weitchpec.

Opportunity 4 – Education about Noxious Weeds

Possible Management Practices

- Develop forums for educating the community and visitors about noxious weeds.
- Posters/flyers could be developed for placement at river access points, local stores, and businesses (e.g. rafting/kayak outfitters and schools).
- Outreach to local schools could provide another educational opportunity.
- Weed education and inventory could be incorporated into the annual river clean-up event.
- Articles for the local media could be developed.

Opportunity 5 – Continued Noxious Weed Inventory and Mapping

Possible Management Practices

- Continued inventory and mapping, which are considered essential companions to treatment
- Inventory, which facilitates opportunities for early detection of localized populations that are relatively manageable

Criteria for Implementation or Selection of Treatment Areas

- Until the extent of a population is known, treatment cannot be effectively undertaken.

Data Gaps

Inventory and mapping has been limited to the primary roads within the Analysis Area. There has been no strategic inventory of any non-primary and spur roads. This information is needed to fully define the extent of noxious weeds' composition and abundance in the Analysis Area.

Monitoring Needs

The effectiveness of the available control methods has not been fully tested. Pilot projects are needed to monitor and evaluate treatment effectiveness within the Analysis Area.

Fire/Fuels

The LMK Analysis Area has a high potential for large, sustained, severe wildfires. The resulting impacts on communities and resources could be devastating and long-lasting. This critical situation must be dealt with in an integrated, aggressive fuels management program that focuses on landscape level opportunities.

Reducing the risk of stand replacing fire will, in turn, reduce the risk of adverse impacts to vegetation and soils and subsequent potential impacts to federally listed species and at risk anadromous fish stocks.

Sequencing of these opportunities would require that opportunities to reduce fuels in strategic locations and to increase fire prevention be implemented first because of the immediate wildfire risk to the communities, and the extensive number of human-caused wildfires within this watershed. Landscape level treatments could be implemented once the strategic treatments have been put in place.

Greater detail on Fire/Fuels management practices can be found in Appendix G.

Opportunity 1 – Reduce Fuels/Reintroduce Fire

Possible Management Practices

- Break up continuity of fuels, and reduce fuel levels in strategic locations and across the landscape through a combination of prescribed fire, hand-piling/burning, mechanical treatment, (including personal and commercial use firewood cutting), and wildland fire use (collectively, fuels treatments).
- Increase protection of forest and private resources through increased fire staffing and fuels treatments thereby reducing exposure of local residents to unhealthy air from wildfire smoke.
- Use fuels treatments to protect soil and water resources and important wildlife habitats from even greater impacts due to future wildfires.
- Utilize early and mid-mature stands in ridge top and upper 1/3-slope positions for construction of shaded fuel breaks.
- Create conditions that would contribute to more opportunities for Wildland Fire Use through the use of fuels treatments.
- Use fuels treatments to improve and maintain quality and quantity of collectable vegetation for cultural uses.
- Use fuels treatments to improve and maintain open or early-seral wildlife habitats.
- Reintroduce fire into the ecosystem so that the risk of adverse stand replacing fires is reduced.

Criteria for Implementation or Selection of Treatment Areas

Below is a list of the criteria, not in priority, to be used in determining areas for treatment. In many cases, areas may meet two or more of the criteria. These criteria are based on goals and priorities identified in the following reports: Western Governors 10-year Comprehensive Strategy (Western Governor's Association 2001), Cohesive Strategy – Protecting People and Sustaining Resources in Fire-Adapted Ecosystems (USDA Forest Service 2000), the SRNF 2001 Fire Management Plan (SRNF 2001), and input from the local Fire Safe Council.

- Areas that have a strategic location for fire suppression and resource protection
- Areas with a high fire behavior potential
- Along highly traveled roads
- Areas in the upper 1/3 of slopes
- South and west-facing slopes and some more easterly facing slopes

- Areas in proximity to private land and the Hoopa and Yurok reservations
- Areas that are accessed by the existing transportation system
- NFS land adjacent to community areas
- Along upper 1/3 slopes and strategic ridges that could help protect large community areas or several smaller ones
- Along access roads into community areas, with all other roads as potential candidates, depending on the Roads Analysis
- Areas of concern identified by resource disciplines, especially those that coincide with high hazard areas
- NFS lands that are classified as Condition Class 2 and 3, with the ultimate goal of Condition Class 1
- NFS lands that are classified as Condition Class 1 to maintain their lower risk condition
- Proximity to municipal and domestic watersheds
- Areas where future wildfire poses a significant threat to watershed values
- Areas located in middle or lower slope positions that are more likely to deliver sediment to streams
- Hillslopes susceptible to mass wasting
- Areas containing stream crossings that are have a risk of failure

Opportunity 2 – Increase Fire Prevention

Possible Management Practices

- Increase the presence and effectiveness of the prevention sector of the fire organization within the Analysis Area.

Criteria for Implementation or Selection of Treatment Areas

- Prevention staffing to spread the message to as wide an audience as possible
- Signing, public notices and messages, and inspections throughout the year, especially during the fire season
- Patrols along the Highway 96/Klamath River corridor
- Participation with the Orleans Fire Safe Council, including any of their projects that can be worked on locally and cooperatively

Data Gaps

Wildfires do not respect watershed or administrative boundaries; therefore, further analysis and discussion with the Hoopa and Yurok tribes, adjacent landowners, and the KNF could help to better determine fire hazard and associated effective fire suppression and fuel treatment strategies for the LMK watersheds.

Our data on reference fire regimes (i.e. extent, severity, and frequency) are somewhat limited for the Analysis Area. Prior to our fire-reporting period, which began in the 1910's, fire frequency data is lacking. Further data analysis would be of interest to more fully document fire regimes for the Analysis Area. This could include fire frequency studies in different vegetation types using fire slabs or the reconstruction of fire perimeters, and more extensive fire severity studies based on fire scars and stand ages.

Fire effects data are also lacking, including effects on native and exotic plant and animal species. Fire effects data on non-coniferous species (e.g. tanoak) would especially be of interest for the watersheds of the Analysis Area. Localized data collection and analysis are critical to refining and improving prescriptions and assessments of fire effects.

Monitoring Needs

Models such as FOFEM (First Order Fire Effects Model), which can be used to assess wildfire mortality based on species, trees per acre, diameter breast height, tree height, and flamelengths should be validated using future wildland fire and prescribed fire mortality.

Best Management Practices monitoring of fuel reduction treatment projects has demonstrated that these treatments result in no offsite erosion or impairment of water quality. It would be useful to confirm these observations on a few selected projects with quantitative data.

Fire monitoring plots should be initiated in the Analysis Area in selected vegetation types of interest (e.g. mature and old-growth) to assess the short and long term effects of fire on the ecosystem. The preferred protocol would be the one developed by the Western Region of the NPS, which collects data to document basic information, detect identified trends, and ensure that fire and resource management objectives are met (USDI National Park Service 1992).

Restoration and Management of The Klamath River and its Tributaries

Anadromous Fish

Anadromous fish populations require a dynamic river system for long-term survival and productivity. Effective restoration coupled with protection of habitats that remain relatively intact is critical to conserving fish species that are at risk. Restoration prescriptions vary widely but should be based on best available knowledge and innovative approaches. Numerous opportunities exist to meet these ends and are discussed below.

Under the direction of the NWFP and its ACS, ensuring the quality of our aquatic and riparian resources will be one of the SRNF's main priorities (USFS 1995). The recreational corridor of the Klamath River within the national Wild and Scenic River System follows the Riparian Reserve Management Area boundary, with adjustments for private lands and Small Tracts Act parcels. Fisheries habitat will be maintained and restored through the attainment of the ACS objectives.

Opportunities for maintenance of fish habitat should continue to focus on protecting existing high quality riparian and stream habitat by minimizing possible adverse impacts from proposed management activities, or mitigating effects from past activities.

Water in the mainstem Klamath River will continue to be a concern, particularly as it influences the health and condition of the fishery. Current restoration should focus on mimicking natural flow regimes, which largely regulate water, and the quantity and quality of fisheries habitat. More natural flow regimes would reconnect the various aquatic habitats in time frames that provide crucial functions for anadromous fish as well as other aquatic species (e.g. refugia during drought).

Restoration within the Klamath mainstem must also extend to deal with problems of excessive nutrients. Nutrient loading leads to increased growth of aquatic plants and algae in the channel that can decrease dissolved oxygen and habitat quality and retard water velocity at low flows, which, in turn, contributes to higher temperatures.

Fish passage conditions from the mainstem of the Klamath River into some tributaries (e.g. Pearch, Hopkins, and Slate creeks) are a concern under relatively low flow mainstem conditions. Tributary access could be adversely affected by minimum flows in dry or critically dry water years.

Opportunity 1 – Restoration of Riparian Vegetation

The influence of alder and cottonwood riparian plants on river bar dynamics is profound. Maintenance of alternate bar morphology preserves riffle habitat, pool depth, side channel integrity, in-channel water temperature variation, woody debris, and many other features. Riparian plant communities along these river bars are critical components of preserving and restoring anadromous fish habitat.

Possible Management Practices

- Continue the re-establishment of suitable vegetation along streamsides, on landslides, on derelict and eroding land, and on other disturbed areas.

Criteria for Implementation or Selection of Treatment Areas

Restoration of riparian habitat should focus on:

- Areas with a high likelihood of sediment delivery into a watercourse
- Areas with a medium to high likelihood of successful vegetative stabilization
- Sites that are part of a complex of landslides that, although they may be individually small, cumulatively would contribute significant amounts of sediment and could be potentially stabilized by planting
- Sites, either individually or as part of a complex of sites, that have a sufficient amount of plantable area to warrant the effort of accessing them and at least a medium likelihood of successful vegetative stabilization

Data Gaps

Relative to non-vascular species within the Analysis Area, there has been little to no inventory within Riparian Reserves to determine the composition, abundance, and the riparian association of lichens and bryophytes. Systematic inventory to identify riparian associated non-vascular species would provide a better guide to determining riparian reserve widths than is now possible.

Monitoring Needs

Monitor areas where riparian vegetation has been planted in order to verify its successful establishment.

Opportunity 2 – Road Work to Minimize Sedimentation Risks

Roads within the Analysis Area have been much more strongly associated with sediment delivery from landslides than other human disturbances, such as timber harvesting. Roads accounted for 31% of estimated landslide sediment delivery, compared to 13% from timber harvesting. A significant portion of this road related sediment delivery has been directly into the Klamath River from state and county roads.

In order to reduce sediment delivery associated with roads, it is important to explore opportunities to decommission high risk or unneeded roads and upgrade needed roads in order to minimize potential sedimentation risks to aquatic species. It is also important to reduce road related sedimentation risks in watersheds that are domestic water sources.

Possible Management Practices

- Decommission roads including full re-contouring of roads so that they blend in with the surrounding landscape.
- Re-contour all stream crossings to their natural shape, and ensure that the remaining road prism between stream crossings is free of stability concerns, free-draining, and essentially maintenance-free.
- Road upgrading including correcting stream crossing diversion potential, upgrading undersized culverts, out-sloping and correcting drainage problems, and providing better road surface protection such as more gravel on roads that are prone to rilling and gullying.

Criteria for Implementation or Selection of Treatment Areas

- Areas located in middle or lower slope positions that are more likely to deliver sediment to streams
- Hillslopes susceptible to mass wasting
- Areas containing stream crossings that have a risk of failure and large fill volumes
- Watersheds with substantial beneficial uses that are at risk, and that contain many roads with sedimentation risks
- Watersheds that either have at risk fisheries stocks (Slate, Boise, Pearch, Aikens, or Hopkins creeks), or provide domestic water (Pearch and Crawford creeks)
- Watersheds that have POC root disease (Aikens Creek)
- Areas with substantial miles of native surface roads that are prone to rutting are good candidates for upgrading and decommissioning.

Data Gaps

Reviews on the condition of lower standard roads in the Analysis Area are needed, especially non-system and maintenance level 1 and 2 roads with native surface, in order to consolidate site-specific treatment recommendations for road improvements or decommissioning. Confirmed locations and conditions of gates and other closure devices are lacking.

Detailed data about geomorphic processes, principally sediment transport and storage, within the Klamath mainstem are lacking. As a result, it is difficult to compare in a meaningful way current channel conditions to historic conditions, which once supported huge salmon runs.

The 1964 flood inundated and eroded many older alluvial deposits along the Klamath River. Mining, roads, and logging have all contributed sediment to the Klamath River, and together these natural processes and human activities have produced a large sediment load that is migrating downstream over long periods of time. This slow migration can only be evaluated by studying the distribution, characteristics, and age of alluvial deposits in this reach of the Klamath and its adjoining watersheds. In addition, a sediment budget for some of these watersheds would probably help resolve questions about too much or too little sediment (e.g. spawning size gravels).

Monitoring Needs

Evaluations of post-project success of road decommissioning and upgrading work, particularly after large storm events when the restoration work is truly tested, should be continued. Also, opportunities to quantitatively monitor both short and longer term biological (aquatic bugs) and physical (sediment) responses to restoration treatments need to be explored. Most likely such opportunities will occur through partnerships with universities, research, and grant funding.

Establish long-term trend monitoring areas to assess the success of road restoration efforts (i.e. upgrading and decommissioning) in reducing storm driven road landslides and sediment inputs. This effort should be linked to the Active Landslide Geographic Information System database that has records of all natural and management associated landslides from 1944 to present and tied to the ERFO (Emergency Repair of Federally Owned roads) program.

With the scheduled completion of the Klamath TMDL in 2004 there will be an initial need to share information on sediment sources, temperature data, and any information on nutrient levels. Continued monitoring of sediment and temperature will most likely occur on tributaries within NFS lands, however the Forest Service does not anticipate having to monitor for nutrient levels within the tributaries. The Forest Service acknowledges that it does not have any quantitative data on nutrient levels from the tributaries, however, it is logical that since the tributaries are forested and not subject to grazing or agricultural development, nutrient levels should be within natural background rates. If quantitative data is requested the Forest Service will collect limited grab samples.

Continue existing aquatic monitoring to meet our tribal trust responsibilities regarding fish and water quality.

Opportunity 3 – Improvements to Access for Aquatic Species

Obstructions to upstream migration frequently restrict distribution of salmonids. When barriers to fish movement exist, reaches downstream of the blockage may become overcrowded with spawners or juvenile fish, while suitable areas upstream lie unused. Even a partial seasonal obstruction, which only poses a barrier under certain flow conditions, can be a serious problem. Fish access into Hopkins, Slate, and Pearch creeks can be difficult for some anadromous fish species during dry or critically dry water years, or until late-fall rain increase flow conditions.

Possible Management Practices

- Identify and improve access for fish and other aquatic species into tributaries within the Analysis Area.
- A number of various restoration principles (non-explosive or explosive) could be used to lower the height of the existing natural waterfall or create some resting pools at the mouth of Pearch Creek, thus potentially improving access for a variety of fish species.

Criteria for Implementation or Selection of Treatment Areas

- Identify the specific habitat factors limiting aquatic species production.
- Identify the critical habitat needs for various species to determine the scope, direction, and monetary investment required to meet restoration objectives.

Data Gaps

The understanding of exactly when various conditions exist that will result in critical obstruction to upstream migrations during various stream flows in different years is a data gap.

Monitoring Needs

Monitoring of restoration efforts needs to take place in order to determine the success or failure of these efforts. For example, instream fishery projects in tributary streams such as Pearch, Slate, and Boise creeks should be monitored to determine the long-term viability and utilization.

The movement of fish and other aquatic organisms over natural and human-induced obstacles needs to be evaluated.

Developing and Maintaining Partnerships

Anadromous Fish

Opportunity 1 – Collaboration and Partnership

Most successful watershed restoration projects share one critically important common feature: they bring together diverse groups of people who share the common goal of restoring the health and productivity of their watershed. An effective restoration program within this Analysis Area requires coordination and planning within and among agencies, tribal governments and other interested parties. We must continue to work together to restore the integrity of our landscape and our native fisheries, riparian areas, forests, and streams. Watershed restoration has often proven to be a lengthy, difficult, and costly process. Finding common ground to remedy some of the problems will take patience and a sustained effort. Working with tribal governments and their natural resources staff is an integral part of building this watershed restoration partnership. Some community coalitions motivated by residents' desires to improve their surroundings are forming to assist and build support for restoration efforts.

Possible Management Practices

- Continue dialogue with other federal, state, and tribal governments and private entities on instream flow needs and water quality concerns.
- Partner with local tribal scientific staffs to coordinate, share data, develop mutual management strategies, and by consulting with the Tribal Councils on off-reservation management activities that have a potential to affect on-reservation fish and aquatic resources.
- Continue involvement with Klamath Project Operations, the FERC re-licensing effort, the Klamath River Restoration Task Force, and the future development of the Klamath River TMDL.
- Improve communication with local community members, tribal governments, and agency personnel.
- Consider the options for entering into partnership and cooperative cost sharing agreements, and jointly searching for grant opportunities.
- Work with fish and watershed committees to help with resource issues.
- Share available data.
- Improve communication through periodic meetings, workshops, and conferences on fishery related topics.
- Management decisions should be made by the cooperation of all the Klamath Basin's stakeholders within the context of the entire Basin in order to address upstream land-use activities that affect water quantity, quality, and habitats.

Criteria for Implementation or Selection of Treatment Areas

- Focus in areas that have the greatest resource risks, as well as areas that have the greatest potential to respond to restoration treatments.

Opportunity 2 – Cooperative Fisheries Inventorying and Monitoring

A number of fisheries inventory and monitoring projects by federal, state, tribal, and private interest organizations occur every year within the Analysis Area. Data and information sharing could greatly increase efficiency and cost. More importantly, given the dire status of some of these fish species, scientific priorities need to be established, and answering the most important questions first needs to be ensured.

Possible Management Practices

- Cooperatively evaluate and assess the habitat needs of fish and other aquatic species, and define and redefine habitat quality within the Analysis Area.
- Work to establish a detailed understanding of what aquatic species require at each stage of their life cycle, and what these species need to thrive.
- Assist ongoing fisheries research projects to help determine the distribution, abundance, life history, and habitat requirements of at risk fish species (e.g. lamprey, and green sturgeon).
- Assist with USFWS downstream monitoring efforts at Big Bar.
- Cooperatively conduct spawning surveys with local tribes within the Analysis Area.

- Develop partnerships with tribes to conduct a long-term effort to monitor water quality for TE fish species habitat across jurisdictions, in order to take a basin-wide approach to water quality as it relates to fish.
- Help with evaluating the effects of hatchery practices and the introduction of exotic species.
- Assist with ongoing status reviews and recovery plans (e.g. for coho salmon).
- Work on protecting and restoring designated high quality habitat.
- Market existing monitoring program to demonstrate benefits, facilitate collaboration, and develop strong support within and outside the agency.

Criteria for Implementation or Selection of Treatment Areas

- Those areas that have been identified as priorities based on being able to achieve the greatest benefit.

Data Gaps

Identifying the full number of fisheries inventory and monitoring projects planned or ongoing by organizations other than the Forest Service could be a data gap.

Monitoring Needs

Monitor results and adjust management as new information becomes available.

Noxious Weeds

Opportunity 1 – Develop Cooperation to Address Weed Problems

Possible Management Practices

- Develop a forum for cooperation among the entities responsible for road maintenance and management including the Forest Service, Caltrans, and Humboldt County Roads.
- Develop coordinated policies related to use of weed-free fill sources and mulch material on county and state roads.
- Since equipment used in road maintenance can be a primary vector for weed seed transport, equipment-cleaning practices should be employed.
- Employ a mowing schedule that can aid rather than hinder weed control.

Social

Opportunity 1 – Cooperative Recreation Development

Possible Management Practices

- Work cooperatively with the tribal governments and the Orleans-Somes Bar community to develop a recreation strategy.
- Establish partnerships and other relationships that would provide a cooperative and collaborative approach to recreation planning such as strategy development, interpretation, or care and maintenance of facilities.
- Consult and work with tribal governments on recreation management, policies, and facilities, including any recreation planning or strategies.
- Identify interested local organizations, tribal governments, local businesses, etc. who would have the interest and infrastructure to enter into partnership agreements for interpretation, maintenance, signing, monitoring, and other activities associated with developing and maintaining segments of recreation trails.
- Investigate if Cal-Trans would be interested in establishing a cooperative rest station on Highway 96 at the day-use location immediately south of Bluff Creek.
- Investigate with Cal-Trans what is needed to establish a scenic vista and picnic site near Red Cap Gulch overlooking “the gorge”.
- Seek partnerships for the construction and maintenance of additional foot or mountain bike trails that may pass through multiple ownerships, especially near the Klamath River, or that have good vistas of the Klamath River or town of Orleans.
- Through partnerships with the Yurok and Karuk tribes, develop an interpretive site that highlights the cultural values associated with the Aikens and Bluff Creek areas.

Criteria for Implementation or Selection of Treatment Areas

- Opportunities that would assist and support the community’s and tribal government’s goals and objectives of providing services and recreational experiences to the recreating public
- Opportunities that are supportive of cultural and traditional activities, and that protect heritage resources
- Protects or enhances heritage resources and culturally significant locations and activities

Data Gaps

The needs and expectations of the recreating public using this area may be a data gap.

Landslides

Opportunity 1 – Coordination to Reduce the Risk of Landsliding

Within the Analysis Area, many of the larger active slides have been associated with Highway 96 or county roads, and these roads have delivered a significant amount of sediment into the Klamath River. Because of the proximity of Highway 96 and several county roads to the mainstem and their historic contribution of sediment from lower hillslopes, we need to coordinate a road management strategy with state and county agencies. Critical issues include ongoing maintenance practices, reactivation of dormant slide areas, lack of slide disposal areas in this stretch of Highway 96, and reducing the risk of road-related sediment delivery to stream channels. In addition, fish passage concerns in tributary streams along state and county roads need to be explored.

Possible Management Practices

- Develop participating agreements to assess and fix potential fish migration barriers.
- Develop participating agreements to evaluate sedimentation risks and seek grant funding to correct them.
- Share and evaluate existing information, or collect new information together with state and county personnel to improve the understanding of and ability to predict areas of chronic slope instability and sediment source areas associated with landsliding along the Klamath mainstem corridor.

Criteria for Implementation or Selection of Treatment Areas

- High use roads
- Roads in proximity to anadromous stocks with high sedimentation risks

Data Gaps

Data is needed about which tributaries are suitable for fish habitat and, if so, whether culverts from state and county roads exist that are acting as migration barriers.

Develop better landslide stability data along the Highway 96 corridor in order to assess long-term risks of slope failure and the associated potential volume of material that might be mobilized, and the extent of waste disposal areas that might be needed.

Monitoring Needs

Continue to update the active landslide data layer periodically and re-analyze patterns of occurrence, especially related to management activities.

Other Opportunities by Resource Area

Wildlife

Opportunity 1 – Construction and Placement of Wildlife Nesting or Roosting Structures

Creation of nesting or roosting structures for wildlife is a management technique that can help provide for the specific habitat requirements of a variety of wildlife species. It can also be used to provide benefits for a prey species that may also indirectly benefit a specific predator such NSOs. This wildlife habitat improvement technique can be useful for providing artificial structures where past management or conditions have reduced available natural structures or where these structures are known or thought to be a limiting factor in achieving optimal habitat conditions.

Possible Management Practices

- Placement of bat roosting boxes
- Placement of wood duck nest boxes
- Placement of other bird nest boxes for secondary cavity nesting birds
- Construction of chainsaw cavities to promote nesting opportunities for northern flying squirrels

Criteria for Implementation or Selection of Treatment Areas

In corresponding order to the above practices:

- In areas where snags have been reduced, or under bridges, especially near bodies of water where bats typically forage
- Around forest ponds lacking natural cavities suitable for wood ducks
- In area where natural cavities are inadequate to provide for populations that other habitat parameters could support
- In suitable northern flying squirrel habitat within spotted owl foraging areas

Data Gaps

It would be ideal to gather data on habitat suitability and to assess the likelihood that structural improvements would be successful.

Monitoring Needs

Monitor improvements to document use.

Opportunity 2 – Shallow Pond Excavation

Possible Management Practices

- A backhoe or excavator could be used to remove lake bottom sediments during the dry season in anticipation of greater water holding capacity after treatment.
- Re-sealing of pond bottoms with material such as bentonite clay may be necessary following excavation.

Criteria for Implementation or Selection of Treatment Areas

- Sites within the LMK Analysis Area where the wildlife habitat quality of existing shallow or ephemeral ponds could be increased by excavation in order to provide suitable habitats that are capable of meeting the requirements of northwestern pond turtles and other pond using wildlife. Two such sites are at Twin Lakes and LePerron Pond.

Data Gaps

An inventory is needed of areas that could be developed or restored as ponds.

Monitoring Needs

Developed or restored ponds should be monitored for wildlife use and water holding ability. Geologic stability should also be monitored in the vicinity of the pond development.

Social

Opportunity 1 – Support the Local Economy

Possible Management Practices

Watershed restorations projects, fuels reduction work, and road decommissioning could be administered to:

- Provide maximum contracting opportunities for local businesses and tribal governments to stimulate and sustain the growing local interest in business opportunities in restoration type of work.
- Emphasize activities that will benefit local and regional economies and support the local community's economic objectives in providing quality recreational experiences to the destination and traveling recreational user.
- Provide greater opportunities for commercial and personal use firewood gathering.

Opportunity 2 – Care for Tribal Trust Resources

Possible Management Practices

- Retain, restore, and protect watershed functions that promote high quality habitat for native fish and other aquatic organisms, in cooperation with tribal governments, as per trust responsibilities.
- Assure the Yurok's 1995 request to manage the Lower-Middle Klamath River watersheds with fisheries as a top priority; this is an integral part of management practices in the Analysis Area.
- Work with tribal planning staffs to assure that management plans, practices, and policies along the National Forest/reservation boundaries are compatible.
- Cooperatively identify, with tribal staffs, areas of high potential for future fires that could spread to the Yurok and Hoopa Valley reservations, and reduce this potential risk by jointly conducting appropriate management activities.
- Work with the tribal governments to identify their needs for access through NFS lands in order to manage tribal trust properties and the tribal communities' needs for access to domestic water supplies and other uses.
- Develop formal agreement for mutual road management of significant access roads.

Criteria for Implementation or Selection of Treatment Areas

- Projects pertaining to tribal trust responsibilities should be prioritized using input from the affected tribes.

Data Gaps

The Yurok Tribe has identified that the tribal government and members need unfettered access of NFS lands for cultural, ceremonial, and subsistence activities, as well as road access for residential domestic water sources, tribal management of its lands and resources, and for other purposes. The extent of which, what, how, and where Yurok tribal government and tribal members utilize plant resources, culturally significant locations, roads and trails, are essentially unknown for the Cavanaugh, Hopkins, Aikens, and Ullathorne sub-watersheds of the Analysis Area, or the western side of the Orleans Ranger District.

The LMK Analysis Area includes land under other jurisdictions. Further analysis and discussion with the Yurok and Hoopa tribes needs to take place in order to identify needs and uses of combined reservation and NFS lands, and fire hazard and associated effective fire suppression and fuel treatment strategies for these adjacent lands.

Opportunity 3 – Culturally Sensitive Management

Possible Management Practices

- Support by management practices the Karuk Tribe's recommendations in their 1989 Karuk Ancestral Lands Forest Management Plan and 1996 Module for the Main Stem Salmon River Watershed Analysis.
- Work with tribes and Indian organizations, such as the California Indian Basket-weavers Association, to support their efforts in documenting traditional burn practices.
- Utilize management methods on public lands that establish a dialogue and understanding between traditional ecological knowledge and scientific ecological knowledge.
- Support through management practices the Yurok Tribe's recommendation regarding developing and implementing a prescribed burn program that will allow for burning in manners that generate the best qualities of culturally important species (e.g. beargrass, hazel, willow, etc.).
- Work with tribes and traditional practitioners to develop and identify management practices and strategies to contain the spread of POC root disease in ways that are culturally supportive.

Criteria for Implementation or Selection of Treatment Areas

- As prioritized by the affected tribal entities

Data Gaps

There is a need for detailed information concerning traditional burn practices utilized to manage many culturally significant plant species, including such species as beargrass and hazel, that public agencies can refer to when implementing burn plans. A burn prescription which combines scientific knowledge and traditional cultural knowledge on how, when, and the importance of burning plants for traditional cultural uses is lacking.

Scientific knowledge of POC root disease is lacking.

Monitoring Needs

Cooperatively monitor the effects of various types of burning practices in an effort to bridge a data gap by using scientific research to interpret traditional land management practices.

Opportunity 4 – Roads and Trails

Possible Management Practices

- Work with local communities and tribal governments in identifying road and trail access that is supportive of the local infrastructure, and long term planning goals.
- Analyze the potential of roads identified as no longer needed to meet SRNF resource management objectives, for conversion to recreation trails that would support the community's economic goals of providing a trail system supportive of the recreation user.
- When decommissioning roads or doing restoration work, analyze the use of culturally significant plants to re-establish the vegetation or in seeding.
- Design small business contracting opportunities for road stabilizing or decommissioning so that local businesses and tribal governmental entities may effectively compete.

Criteria for Implementation or Selection of Treatment Areas

- Refer to the SRNF Roads Analysis and to the Roads Analysis for the Lower Middle Klamath Analysis Area.

Recreation

None of these opportunities are sequence dependent on any others, however site-specific analyses are needed before actual treatment sites can be identified.

- *What opportunities exist on Forest Service system lands to better meet the current and future demands of recreationists?*

Opportunity 1 – Recreation Developments

Possible Management Practices

- Develop another vehicle/boat access route between Highway 96 and the Klamath River at the south end of the Analysis Area in the vicinity of Skunk Flat.
- Reconstruct the foot access trail, or an alternate route, that connects the Bluff Creek overlook and parking area to the Klamath River near the mouth of Bluff Creek.
- Develop several more foot access trails between Highway 96 and the Klamath River at locations that would access good bank fishing opportunities.

- Construct short hiking or loop trails near campgrounds, popular vehicle river access sites, or day-use sites.
- Design one or more of these trails to accommodate mountain bikes as well.
- Develop a well-designed parking area, day-use area with picnic tables, interpretive signs and information boards, and fish cleaning station near Highway 96 and immediately south of Bluff Creek.
- Install an improved water treatment facility and new water distribution lines to serve E-Ne-Nuk and Aikens West campgrounds and the parking/day use area immediately south of Bluff Creek.
- Continue to perform repairs, maintenance, and minor improvements at developed campgrounds to eliminate the backlog of identified needs.
- Perform road surface blading, and possibly surface hardening, at those vehicle/boat access sites that tend to become rutted, pot-holed, or loosened, to provide more dependable year-round access for 2WD low clearance vehicles.
- Develop controlled parking areas, install information and interpretive signs, and install additional SSTs at Dolans Bar and Big Bar river access sites.
- Include in the design of these areas, designated places for dispersed camping so as to better control the environmental impacts and minimize conflicts between the various user groups.

Criteria for Implementation or Selection of Treatment Areas

- Prioritization of treatments based on established need
- Coordination of treatments with other affected entities such as Caltrans, tribal governments, and existing recreation based businesses

Data Gaps

The identification of good bank fishing sites for foot access trails, and areas suitable for loop or mountain bike trails is a data gap.

Monitoring Needs

Monitoring the use of new recreation developments will be needed to justify future developments.

A. LITERATURE CITED

Adams, S. and O.J. Sawyer. 1980. Past fire incidence in mixed evergreen forests of northwestern California. Unpublished document, California State University, Humboldt. On file, Six Rivers National Forest, Eureka, CA. 22 pp.

Agee, J.K. 1991. Fire history along an elevational gradient in the Siskiyou Mountains. Northwest Science, 65(4):188-198.

Agee, J.K. 1993. Fire ecology of Pacific Northwest forests. Island Press. Washington, D.C. 493 pp.

Agee, J.K. and R.L. Edmonds. 1992. Forest protection guidelines for the Northern Spotted Owl. Appendix F of Recovery Plan for the Northern Spotted Owl - Draft. pgs. 419-480.

Alexander, John D. (then) Wildlife Technician, Oak Knoll Ranger District, Klamath National Forest Personal communication. 1995

Anderson, H.E. 1982. Aids to determining fuel models for estimating fire behavior. USDA Forest Service General Technical Report INT-122. Intermountain Forest and Range Experiment Station, Ogden, UT. 22 pp.

Andrews, P.L. 1986. BEHAVE: Fire Behavior Prediction and Fuel modeling System - BURN Subsystem, Part 1. USDA Forest Service General Technical Report INT-194. Intermountain Forest and Range Experimental Station, Ogden, Utah. 130 pp.

Atzet, T. 1993. The range of natural conditions: SWEAT team report. USDA Forest Service, Siskiyou National Forest, Grants Pass, OR. 2 pp.

Atzet, T. and D.L. Wheeler. 1982. Historical and ecological perspectives on fire activity in the Klamath Geological Province of the Rogue River and Siskiyou National Forests. USDA Forest Service, Pacific Northwest Region, Portland, OR. 16 pp.

Atzet, T., D. Wheeler, and R. Gripp. 1988. Fire and forestry in southwest Oregon. FIR Report, 9(4):4-7.

Atzet, T., D.E. White, L.A. McCrimmon, P.A. Martinez, P. Reid Fong, and V.D. Randall. 1996. Field Guide To The Forested Plant Associations Of Southwest Oregon. R6-NR-ECOL-TP-17-96, USDA Forest Service Pacific Northwest Region, Portland, OR. 353 pp.

Bartholow, J.M. 1995. Review and Analysis of Klamath River Basin Water Temperatures as a Factor in the Decline of Anadromous Salmonids with Recommendations for Mitigation. In: Compilation of Phase 1 Reports for the Klamath River Basin, May 1995, River Systems Management Section, NBS-Mid-Continent Ecological Science Center, Fort Collins Colorado.

Betlejewski, F. 2002. Personal communication. USDA Forest Service Region 5 and 6 Port-Orford-cedar Coordinator.

BIA (USDI Bureau of Indian Affairs). 1982. Anthropological study of the Hupa, Yurok, and Karuk Indian Tribes of Northwestern California. Contract No. J50C14205074.

Biswell, H.,H. 1989. Prescribed burning in California wildland vegetation management. University of California Press, Berkeley, California. 255 pp.

Bledsoe, A.J. 1885. Indian Wars of the Northwest. BioBooks (Reprint), Oakland, CA.

BOR (USDI Bureau of Reclamation). 2001. Evaluation of Interim Instream Flow Needs in the Klamath River - Phase II.

Bossard, C.C., J.M. Randall, and M.C. Hoshovsky. 2000. Invasive Plants of California's Wildlands. University of California Press, Berkeley, CA. 360 pp.

Boyce, D.A., and C.M. White, Principle investigators. 1979. A Peregrine Falcon Nesting Habitat Survey on U. S. Forest Service Lands in Northwestern California – 1979. Submitted to: U. S. Forest Service Contract 53-9A47-9-17 by Wilderness Research Institute, Arcata CA. 75 pp.

Brown, L.R., and P.B. Moyle. 1991. Status of Coho Salmon in California. Report to the National Marine Fisheries Service, submitted July 1991. 144pp.

Brown, J.K., and J.K. Smith, Eds. 2000. Wildland fire in ecosystems: effects of fire on flora. General Technical Report RMRS-GTR-42, v.2. USDA Forest Service Rocky Mountain Research Station, Ogden, UT. 257 pp.

Buck, S., C. Mullis, and A. Mossman. 1983. Corral Bottom – Hayfork Bally Fisher Study: Final Report. Unpublished document. Presented to the USDA Forest Service, February 1983. 136 pp.

Busby, P.J., T.C. Wainwright, and R.S. Waples. 1994. Status review for the Klamath Mountains Province steelhead. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-NWFSC-19, 130 pp.

Campbell, S.G. 1995. Klamath River basin flow-related scooping study – phase 1. Unpublished draft. River Systems Management Section, National Biological Survey, Denver CO. 42 pp.

Carroll, C.R. 1996. Personal Communication. Director, Klamath Center for Conservation Research, Orleans CA.

CDFA (California Department of Food and Agriculture). 1996. CDFA Divisition of Plant Industry, Pest Ratings of Noxious Weed Species and Noxious Weed Seed.

CDFG, Redding California. (California Department of Fish and Game). 2002. News Release September 14, 2002: Fishing Hot: Quota Safe. 2 pp.

CDFG (California Department of Fish and Game). 2003. September 2002 Klamath River Fish Kill: Preliminary Analysis of Contributing Factors, 58 pp + Attachments

Chartkoff, Joseph L. and K.K. Chartkoff. 1975. Late Period Settlement of the Middle Klamath River of Northwest California. American Antiquity, 40:172-179.

Chen, J., J.F. Franklin, and T.A. Spies. 1993. Contrasting microclimates among clearcut, edge and interior of old-growth forest. Agricultural and Forest Meteorology 63:219-237.

Coots, M. 1962. Shasta River, Siskiyou County, 1958 king salmon count with yearly totals from 1930-1961. California Department of Fish and Game. Inland Fisheries Branch. Marine Resources Administrative Report. No. 62-64.

Cyr, LeRoy. Orleans District Fisheries Biologist. Six Rivers National Forest. Personal observation. 1994.

Davis, E.S., P.K. Fay, T.K. Chicoine, and C.A. Lacey. 1993. Persistence of spotted knapweed (Centaurea maculosa) seed in soil. Weed Science, 41:57-61.

Deeming, J. E., R.E. Burgan, and J.D. Cohen. 1977. “The National Fire-Danger Rating System – 1979.” USDA Forest Service Gen. Tech. Rept. INT – 39, Intermountain Fores and Range Experiment Station, Ogden, UT. 63 pp

DWR (Department of Water Resources). March 1987. Klamath River Water Quality Study – Hamburg to Orleans. 71 pp. + Appendices.

Edwards, S.W. 1983. Cenozoic history of Alaskan and Port-Orford-cedars (*Chamaecyparis spp.)*. Ph.D. dissertation. University of California, Berkeley, CA. 271 pp.

Emmett, R.L., D.R. Miller, and T.H. Blahn. 1986. Food of juvenile Chinook, *Oncorhynchus tshawytscha,* and Coho, *O. kisutch,* salmon off northern Oregon and southern Washington coasts, May-September 1980. California Fish Game 72:38-46.

EPA (U.S. Environmental Protection Agency). 1986. Quality criteria for water. EPA 440/5-86-001. Office of Water Regulations and Standards, Washington, DC.

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.

Franklin, A.B. 1997. Factors Affecting Temporal and Spatial Variation in Northern Spotted Owl Populations in Northwest California. Submitted in partial fulfillment of the requirements for the Ph.D., Colorado State University, Fort Collins, CO, Fall 1997. 182 pp.

Freel, M. 1991. A Literature Review for Management of the Marten and Fisher on National Forests in California. Unpublished document. USDA Forest Service, Pacific Southwest Region. 22 pp.

Frenkel, R.E. 1970. Ruderal Vegetation some of Califonria Roadsides. University of California Publications in geography, v.20. University of California Press, Berkeley, CA.

Fritts, H.C., and G.A. Gordon. 1980. Annual precipitation for California since 1600 reconstructed from western North American tree rings. California Department of Water Resources Agreement Number 853367. 45 pp.

Frost, E.J., and R. Sweeney. 2000. Fire regimes, fire history, and forest conditions in the Klamath-Siskiyou Region: An overview and synthesis of knowledge. Prepared for the World Wildlife Fund, Klamath-Siskiyou Ecoregion Program, Ashland, OR, December 2000. 59 pp.

FSH (Forest Service Handbook) 2509.18, Soil Management Handbook. http://www.fs.fed.us/im/directives/

FSH (Forest Service Handbook) 7709.58. Transportation System Maintenance Handbook. http://www.fs.fed.us/im/directives/

FSM (Forest Service Manual) 1525. Public Service Programs. http://www.fs.fed.us/im/directives/

FSM (Forest Service Manual) 1535. Interdepartmental. http://www.fs.fed.us/im/directives/

FSM (Forest Service Manual) 2080, Noxious Weed Management. July 10, 2001. http://www.fs.fed.us/im/directives/ (See Appendix E)

FSM (Forest Service Manual) 2324. Wilderness Management. http://www.fs.fed.us/im/directives/

FSM (Forest Service Manual) 2523, Seeding Plan for Burned Area Emergency Rehabilitation (BAER) and Other Emergency Rehabilitation Projects. http://www.fs.fed.us/im/directives/

FSM (Forest Service Manual) 7705. Transportation System. http://www.fs.fed.us/im/directives/

FSM (Forest Service Manual) 7711. Transportation Planning. http://www.fs.fed.us/im/directives/

Gross, E., Steinblums, I., Ralston, C., and H. Jubas. 1989. Emergency watershed treatments on burned lands in southwestern Oregon. In Berg, N.H. (Tech. Coord.). Proceedings of the symposium on fire and watershed management: pgs. 109-114. USDA For. Serv. Gen. Tech. Rep. PSW – 109.

Hall, P.A. 1984. Characterization of Nesting Habitat of Goshawks *(Accipiter gentilis)* in Northwestern California. Submitted in partial fulfillment of the requirements for the M.S., Humboldt State University, Arcata, CA, June 1984. 70 pp.

Harding, Vonnie. Information Assistant, Orleans Ranger District, Six Rivers National Forest, February 2003.

Hardy, T.B. 1999. Evaluation of Interim Instream Flow needs in the Klamath River-Phase 1. Institute for Natural Systems Engineering, Utah Water Research Laboratory, Utah State University. 53 pp + Appendices.

Heinselman, J.L. 1973. Fire in the virgin forests of the Boundary Waters Canoe Area. Minnesota Quat. Res. 3:329-382.

Hendry, G.W. 1931. The adobe brick as a historical source. Agricultural History. 5(3):110-27.

Hewes, G.W. 1942. Economic and geographical relationships of aboriginal fishing in Northern California. California Fish and Game 28:103-110

Hewes, G.W. 1947. Aboriginal use of fishing resources in Northwestern North America. Unpublished Ph.D. dissertation. University of California, Berkeley.

Hickman, J. C. 1993. The Jepson Manual: Higher Plants of California. University of California Press, Berkeley, CA. 1400 pp.

Higley, M.J. 1998. Hoopa Valley Indian Reservation Fisher Study: Progress Report. Unpublished document. Sponsored by the USDI Bureau of Reclamation (5-FG-20-13120), USDI Bureau of Indian Affairs, and the Hoopa Valley Tribe. 16 pp.

Holland, C.D. 1991. A Synopsis of the ecology and status of the Western Pond Turtle (*Clemmys marmorata*) in 1991. Prepared for the US Fish and Wildlife Service, National Ecology Research Center, San Simeon Field Station. 141 pp.

Hoopa Tribe. 1993. Hoopa Valley Indian Reservation Forest Management Alternatives for the period 1993-2003. Hoopa Valley Tribe, Hoopa, California.

Hoopa Tribe. 1997. Letter regarding the Lower-Middle Klamath Watershed Analysis, July 18, 1997 to SRNF, Eureka, CA.

Hoopa Tribe. 2000. Environmental Assessment of Hopkins Creek CY 2000 Allowable Annual Cut Project. Prepared by Hoopa Tribal Forestry, Hoopa Tribal Fisheries, and Hoopa Tribal Environmental Protection Agency, Hoopa, California.

Hoover, L.D. and R. Holmes. 1998. Management recommendations for Bensoniella (*Bensoniella oregana* (Abrams & Bacigal) C. Morton), ver.2.0. Management Recommendations for Vascular Plants. On file, Six Rivers National Forest, Eureka, CA.

Humboldt County Employment Training Department. 2000. Regional Workforce Preparation Mapping and Survey Project, Humboldt County, California.

Hunter, M.L. 1991. Coping with ignorance the coarse-filter stategy for maintaining biodiversity. In: K. Kohn, Ed. Balancing on the Brink of Extinction: the Endangered Species Act and Lessons for the Future. Island Press, Covelo, CA. pgs. 266-281.

Institute for Fisheries Resources. 1997. The Cost of Doing Nothing: The Economic Burden of Salmon Declines in the Klamath Basin. Report No.2, 37 pp.

Jennings, M.R. and M.P. Hayes. 1994. Amphibian and Reptile Species of Special Concern in California. Unpublished document. Final Report submitted to The California Department of Fish and Game Inland Fisheries Division. 255 pp.

Jimerson, T.M. and R.M. Creasy. 1991. Variation in Port-Orford-cedar plant communities along environmental gradients in Northwest California. pp. 122-133. In: R.R. Harris, D.C. Erman, H.M. Kerner, Tech. Coords. Proceedings of the Symposium on Biodiversity of Northwestern California. University of California, Berkeley, CA. 308 pp.

Jimerson, T.M. 1992. Uses of sugar pine by cavity nesting birds. pp. 45-50. In: B.H. Kinloch, M. Marosy, M.E. Huddleston, Eds. Sugar Pine Status, Values, and Roles in Ecosystems. Proceedings of a symposium, March 30 – April 1, 1992, University of California, Davis, CA. 225 pp.

Jimerson, T. M. 1993. Preliminary plant associations of the Klamath Province, Six Rivers and Klamath National Forests. Unpublished document. USDA Forest Service, Pacific Southwest Region, Six Rivers National Forest, Eureka CA.

Jimerson, T. M. and D.W. Jones. 1993. Combining ecological classification and silvicultural prescriptions to achieve desired future forest conditions. In: L.H. Foley, compiler. Silviculture: From the cradle of forestry to ecosystem management. Proceedings of the National Silvicuture Workshop, November 1-4, 1993, Hendersonville, NC. GTR SE-88. USDA Forest Service, Southeastern Forest Experiment Station, Ashville, NC. pgs. 99-112.

Jimerson, T.M. and S. L. Daniel. 1994. A field guide to Port-Orford-cedar plant associations in Northwest California. R5-ECOL-TP-002. USDA Forest Service, Pacific Southwest Region, San Francisco, CA. 154 pp.

Jimerson, T.M., L.D. Hoover, E. A. McGee, G. DeNitto, R.M. Creasy, and S. L. Daniel. 1995. A field guide to serpentine plant associations and sensitive plants in Northwest California. R5-ECOL-TP-006. USDA Forest Service, Pacific Southwest Region, San Francisco, CA. 338 pp.

Jimerson, T.M., E. A. McGee, D.W. Jones, R.J. Svilich, E. Hotalen, G. DeNitto, T. Laurent, J.D. Tenpas, M.E. Smith, K. Heffner-McClellan, and S. L. Daniel. 1996. A field guide to the tanoak and the Douglas-fir plant associations in Northwest California. R5-ECOL-TP-009. USDA Forest Service, Pacific Southwest Region, San Francisco, CA. 546 pp.

Jimerson, T.M., K.A. Wright, L.M. Chapman, and E.A. McGee. 1997. Using past and present forest seral stage distribution to develop an ecologically based management strategy for the Six Rivers National Forest. pgs. 107-131. In: First Biennial North American Forest Ecology Workshop proceedings, June 24-26, 1997. North Carolina State University, Raleigh, NC.

Jimerson, T.M., E.A. McGee, and J.K. Jones. 1999. Port-Orford-cedar plant association mapping in California. USDA Forest Service, Six Rivers National Forest, Eureka, CA. 37 pp.

Jimerson, T.M. 1999a. Port-Orford-cedar: Extent, Values, Threats and Diversity. pgs. 119-121. In: "Phytophthora Diseases of Forest Trees", First international meeting on Phytophthoras in forest and wildland ecosystems, August 30 – September 3, 1999, Grants Pass, OR. Oregon State University and USDA Forest Service, Southwest Oregon Forest Insect and Disease Technical Center.

Jimerson, T.M. 1999b. The Importance of Snags and Logs In Port-Orford-cedar Stands. Presented at: The ecology and management of Port-Orford-cedar, A Symposium, July 7-10, 1999, Gold Beach, OR.

Jimerson, T.M., E. A. McGee, and G. DeNitto. 2000. Supplement to: A field guide to Port-Orford-cedar plant associations in Northwest California: Port-Orford-cedar plant associations in the Trinity and Sacramento River drainages. On file, Six Rivers National Forest, Eureka, CA.

Jimerson, T.M. and D.W. Jones. In Prep. Megram: blowdown, wildfire and the effects of fuel treatment. In: Fire Conference 2000: The first Congress on Fire Ecology, Prevention, and Management, proceedings.

Jimerson, T.M., D.W. Jones, and K. Wright. In Prep. Reconstruction of Large Scale Stand Replacing Fires on the Six Rivers National Forest.

Karuk Tribe of California. 1989. Karuk Ancestral Lands Forest Management Plan. Technical assistance provided by Siskiyou Forestry Consultants, Arcata, CA.

Karuk Tribe of California. 1996. Karuk Tribal Module for the Main Stem Salmon River Watershed Analysis Scoping of Tribal Issues for Karuk Aboriginal Territory. Prepared for USDA Forest Service, Klamath National Forest, Yreka, CA. Under contract Forest Service Control PO 43-9-W8-5-7017 by the Department of Natural Resources, Karuk Tribe of California, Orleans, CA.

Keon, D.B. 2001. Factors limiting the distribution of the sensitive lichen (*Usnea longissima*) in the Oregon Coast Range: Habitat or Dispersal? M.S. thesis, Oregon State University, Corvallis, OR.

Keter, T.S. 1993. Mus-yeh-sait-neh: A Tolowa Village on the Smith River. On file, Six Rivers National Forest, Eureka, CA. 29 pp.

Keter, T.S. 1995. Environmental History and Cultural Ecology of the North Fork Eel River Basin. USDA Forest Service, Pacific Southwest Region. R5-EM-TP-002. 116 pp.

Keter, T.S. 1996. Environmental and Cultural History of the Smith River Basin. MS. On file Heritage Resources, Six Rivers National Forest, Eureka, CA.

King, A.W. 1993. Considerations of scale and hierarchy. In: S. Woodley, J. Kay, and G. Francis, Eds. Ecological integrity and the management of ecosystems. Sponsored by Heritage Resources Center, University of Waterloo, and Canadian Parks Service, Ottawa, Canada. pgs. 19-45.

Klamath River Basin Fisheries Task Force. 1990. Long Range Plan For The Klamath River Basin Conservation Area Fishery Restoration Program. Prepared by the Klamath River Basin Fisheries Task Force.

Kroeber, A.L. 1925. Handbook of the Indians of California. Washington: Bureau of Ethnology, 78:898-899.

Kroeber, A.L. and E. W. Gifford. 1949. World Renewal A Cult System of Native Northwest California Anthropological Records, 13(1).

Kroeber, A.L., and S.B. Barrett. 1960. Fishing among the Indians of Northwestern California. Anthropological Records, Vol.21, No.1. University of California Press, Berkeley, CA.

Leonard, W.P., H. A. Brown, L. L. C. Jones, K. R. McAllister, and R. M. Storm. 1996. Amphibians of Washington and Oregon. Seattle Audubon Society, Seattle, WA. 168 pp.

Maharaj, V. and J. Carpenter. 1999. The Economic Impacts of Fishing, Hunting, and Wildlife Viewing on National Forest Lands. Report prepared for Wildlife, Fish, and Rare Plants, USDA Forest Service, Washington, DC. 8 pp.

Manley, P.N., G.E. Brogan, C. Cook, D. Fulmer, T.M. Jimerson, and others. 1995. Sustaining Ecosystems: A conceptual framework, v.1.0. USDA Forest Service, Pacific Southwest Region, San Francisco, CA. 216 pp.

McBain and Trush Associates, Arcata California. 1995. River Channel Morphological and Sediment Changes in the Klamath Basin, Oregon and California. Prepared for Klamath River Basin Phase 1 Reports 1995. 13 pp.

Melendy, Howard B. 1960. Orleans Bar. California Historical Society Quarterly, 39:53-58.

Millar, C.I., D.A. Delaney, R.D. Westfall, T. Atzet, M. Greenup, T.M. Jimerson. 1991. Ecological factors as indicators of genetic diversity in Port-Orford-cedar: Applications to genetic conservation. Internal competitive grants program Progress Report 1, July 1, 1991. USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA. 3 pp.

Moyle, Peter B. 2002. Inland Fishes of California. University of California Press. 446 pp.

Neitlich, P.N. and B. McCune. 1997. Hotspots for epiphytic lichen diversity in two young managed forests. Conservation Biology, 11(1):172-182.

NCRWQCB (North Coast Regional Water Quality Control Board). 1994. Water Quality Control Plan, North Coast Basin-Region 1. California Regional Water Quality Control Board, North Coast Region, Santa Rosa, California. 66 pp. +Appendices.

Noss, R.F. 1987. From plant communities to landscapes in conservation inventories: a look at the Nature Conservancy (USA). Biological Conservation, 41(1):11-37.

Omi, P.N. and E.J. Martinson. 2002. "Effect of Fuels Treatment on Wildfire Severity". Western Forest Fire Research Center, Colorado State University. Submitted to the Joint Fire Science Program Governing Board, March 25, 2002. 40 pp.

Old-Growth Definition Task Group. 1986. Interim Definitions for Old-growth Douglas-fir and Mixed Conifer Forests in the Pacific Northwest and California. USDA Forest Service Gen. Tech. Rep. PNW-447, Pacific Northwest Forest and Range Experiment Station, Portland, OR. 7 pp.

Pagel, J.E., and W. M. Jarman. 1991. Peregrine Falcons, Pesticides, and Contaminants in the Pacific Northwest. Journal of Pesticide Reform, 11:7-11.

Pfister, Stanley. Fuels Specialist, Orleans Ranger District. Personal communication. Six Rivers National Forest. February 2000.

Pierson, E.D. and G.M. Fellers. 1998. Distribution and Ecology of the Big Eared Bat, *Corynorhinus* (*Plecotus) townsendii* in California. Unpublished document. Prepared for Department of Interior, U.S. Geological Survey, Biological Resources Division, Species at Risk Program, Fiscal Year 1998. 93 pp.

Raines, M.A., and H.M. Kelsey. 1991. Sediment budget for the Grouse Creek basin, Humboldt County, CA. Bureau for Faculty Research, Western Washington University, Bellingham, WA. 110 pp. (On page H-2 of LMK WA)

Ralph, C.J., G.L. Hunt Jr., M.G. Raphael, and J.F. Piatt, Technical Editors. 1995. Ecology and conservation of the Marbled Murrelet. General Technical Report, PSW-GTR-152, Albany, CA. USDA Forest Service, Pacific Southwest Research Station. 420 pp.

Randall, J.M., M. Rejmanek, and J.C. Humber. 1998. Characteristics of the exotic flora of California. Fremontia, 26 (4):3-12.

Reid, L.M. 1998. Research and Cumulative Watershed Effects. USDA Forest Service General Technical Report PSW-GTR-141, Albany, CA, 118 pp.

Riggan, B., Local Resident. 2001. Personal Communication. Cooper Ranch, Orleans CA.

Roberts, Ruth K. 1932. Conservation as Formerly Practiced by the Indians in the Klamath River Region. California Fish and Game, 18:283-290.

Rostlund, E. 1952. Freshwater fish and fishing in native North America. University of California Publications in Geography. 9 pp.

Roth, L.F., R.D. Harvey, and J.T. Kliejunas. 1987. Port-Orford-cedar Root disease. R6 FPM PR 010 91. USDA Forest Service, Pacific Northwest Region. 11 pp.

Sanders, S.D., and M.A. Flett. 1989. Ecology of a Sierra Nevada Population of Willow Flycatchers (*Epidonax traillii*), 1986-87. Unpublished Report. Prepared for the California Department of Fish and Game, Wildlife Management Division, Nongame Bird and Mammal Section. 27 pp.

Sawyer, J.O. 1981. Ecological survey of the Adorni Candidate Research Natual Area, Humboldt County, California. Unpublished Report. On file, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA.

Schmidt, K.N., J.E. Hunter, H.B. Stauffer, S.L. Miller, C.J. Ralph, and L. Roberts. 2000. Status and Distribution of the Marbled Murrelet in Interior Northwestern California: Final Report. Unpublished document. On file, Pacific Southwest Range and Forest Experiment Station, Redwood Sciences Laboratory, Arcata, California 28 pp.

Schmidt, K.M., J.P. Menakis, C.C. Hardy, D.L. Bunnell, N. Sampson, J. Cohen, and L. Bradshaw. 2002. Development of coarse-scale spatial data for wildland fire and fuel management. General Technical Report, RMRS-GTR--87. USDA Forest Service, Rocky Mountain Research Station, Ogden, UT. 41 pp.

Scott, J.H. and E.D. Reinhardt. 2001. Assessing crown fire potential by linking models of surface and crown fire behavior. Res. Pap. RMRS-RP-29. Fort Collins, CO: U.S> Department of Agriculture, Forest Service, Rocky Mountain Research Station. 59 pp.

Shaw, Tom. Supervisory Fish Biologist, USFWS, Arcata California. Personal communication on sturgeon research, 2001.

Schirman, R. 1981. Seed production and spring seedling establishment of diffuse and spotted knapweed. Journal of Range Management, 34:45-47.

Snyder, J.O. 1931. Salmon of the Klamath River, California. California Department of Fish and Game, Fish Bulletin 34

Soto, Toz. Karuk Tribal Fisheries Biologist, Karuk Department of Natural Resources, Orleans CA. Personal communication. 2002.

SRNF (Six Rivers National Forest). 1993. Order 3 Soils Survey. Document on file, Eureka, CA.

SRNF (Six Rivers National Forest). 2002 Precipitation Records. Document on file, Eureka, CA.

SRNF (Six Rivers National Forest). 1997. Interviews Conducted in 1997 with Various Orleans and Surrounding Communities Residents and Property Owners Regarding the Lower Middle Klamath River Analysis Area. On File at Six Rivers National Forest, Eureka, CA.

Stuart, J.D., and L.A. Salazar. 2000. Fire history of White Fire Forests in the Coastal Mountains of Northwestern California. Northwest Science, Vol. 74, No. 4, pgs. 280-285.

Swezey. S.L. and R.G. Heizer. 1977. Ritual management of salmonid fish resources in California. The Journal of California Anthropology. 29 pp.

Taft, A.C., and Leo Shapovalov. 1935. A Biological Survey of Streams and Lakes in the Klamath and Shasta National Forests of California. Department of Commerce, Bureau of Fisheries, Washington DC.

Taylor, A.H. and C.N. Skinner. 1998. Fire regimes and landscape dynamics in a late-successional reserve in the Klamath Mountains, California, USA. Forest Ecology and Management, 111:285-301.

Theodoratus, D.J. 1979. Cultural/Historical Overview: Six Rivers National Forest. MS. On file, Six Rivers National Forest, Eureka, CA.

Thomas, J. W., E.D. Forsman, J.B. Lint, and others. 1990. A conservation strategy for the northern spotted owl. A report by the Interagency Scientific Committee to address the conservation of the northern spotted owl. USDA Forest Service, USDI Bureau of Land Management, USDI Fish and Wildlife Service, and National Park Service. Portland, OR. 427 pp.

Thornburgh, D.A. 1982. Succession in the mixed evergreen forests of Northwestern California. In: J.E. Means, ed. Forest succession and stand development research in the Northwest. Oregon State University, Forest Research Laboratory, Corvallis, OR. Pgs. 87-91.

Times-Standard Newspaper February 4, 1977. 930 Sixth Street Eureka California.

Times-Standard, Numerous contributors. May, 2002. Living with Fire in California's Northwest. Newspaper insert to promote fire safety. Paid for by Hoopa Tribe. 20 pp.

Trihey and Associates. 1996. In stream Flow Requirements for Tribal Trust Species in the Klamath River. Concord California. 44 pp.

Tyser, R.W. and C.H. Key. 1988. Spotted knapweed in natural area fescue grasslands: an ecological assessment. Northwest Science, 62:151-160.

USDA Forest Service. 2000. Protecting People and Sustaining Resources in Fire-Adapted Ecosystems: A Cohesive Strategy. Forest Service Management Response to the General Accounting Office Report GAO-99-65, October 13, 2000. Federal Register, November 9, 2000. Vol. 65, Number 67479-67511. 85 pp.

USDA Forest Service and US Department of the Interior, 2000, A report to the President in response to the wildfires of 2000 – Managing the impacts of wildfires on communities and the environment, September 8, 2000. 30 pp.

USDA, USDI. 2000. Management Recommendations for the Oregon Red Tree Vole *Arborimus longicaudus* (*Phenecomys longicaudus*) in the Record of Decision for the Northwest Forest Plan. Version 2.0 September 27, 2000. 25 pp.

USDI. 1995. United States Department of Interior, Office of Solicitor, Sacramento, California. Letter to the Regional Director, Bureau of Reclamation, Mid-Pacific Region, July 25, 1995. pgs. 1 – 12.

USDI National Park Service. 1992. Western Region Fire Monitoring Handbook. Western Regional Office, San Francisco, CA. 134 pp.

USFS (USDA Forest Service). 2001. Six Rivers National Forest Fire Management Plan FY 2001. Six Rivers National Forest, Pacific Southwest Region, 1330 Bayshore Way, Eureka, CA 95501. 306 pp.

USFS (USDA Forest Service). 1992. Our approach to sustaining ecological systems. USDA Forest Service, Northern Region, Missoula, MT. 210 pp.

USFS (USDA Forest Service) and BLM (USDI Bureau of Land Management). 1994. Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl and Standards and Guidelines of Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl (known as the Northwest Forest Plan (NWFP)), Portland, OR. April 13, 1994.

USFS (USDA Forest Service). 1995. Land and Resources Management Plan, Six Rivers National Forest, Pacific Southwest Region, 1330 Bayshore Way, Eureka, CA 95501.

USFS, Old Files: Orleans, #52-25. On file at the Orleans Ranger District, Orleans California.

USFWS (USDI Fish and Wildlife Service). 1986. Recovery Plan for the Pacific Bald Eagle. Portland, OR. 163 pp.

USFWS (USDI Fish and Wildlife Service). 1994. USFWS, Arcata, California. 1994. Mainstem Klamath River Fall Chinook Spawning Survey. Fiscal Year 1993. 23 pp.

USFWS (USDI Fish and Wildlife Service). 1995. USFWS, Arcata, California. 1995. Mainstem Klamath River Fall Chinook Spawning Survey. Fiscal Year 1994. 23 pp.

USFWS and Hoopa Valley Tribe. 1998. Trinity River Flow Evaluation.

USFWS (USDI Fish and Wildlife Service), U.S. Bureau of Reclamation (BOR), Hoopa Valley Tribe, and Trinity County. 1999. Trinity River Mainstem Fishery Restoration Environmental Impact Statement Report. On file, Orleans Ranger Station, Orleans, California.

USFWS. 2001. USFWS, Arcata, California. 2001. Klamath River Fisheries Assessment Program. Annual Report. 69 pp + Appendices.

Wallace, W.J. 1978. Hupa, Chilula, and Whilkut: Handbook of North American Indians, v.8, California. R.F. Heizer, Ed. Smithsonian Institution, Washington D.C. 166 pp.

Wells, H.L. 1881. History of Siskiyou County, California. D.J. Stewart & Co., Oakland CA. (reprinted 1971). 240 pp.

Western Governor's Association. 2001. A collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment: 10-Year Comprehensive Strategy. August, 2001.

Wills, R.D. 1991. Fire history and stand development of Douglas-fir/hardwood forests in Northern California. M.S. thesis. Humboldt State University, Arcata, CA. 69 pp.

Yurok Tribe. 1998. Yurok Tribe Overall Economic Development Plan. Yurok Tribe, Eureka, CA.

Yurok Tribe. 2001. Documentation of Interview of Yurok Tribal Staff for the Lower-Middle Klamath Watershed Analysis, May 10, 2002. Six Rivers National Forest, Eureka, CA.

Zielinski, W. J. and R. T. Golightly Jr. 1995. The Status of Marten in the Redwoods: Is the Humboldt Marten Extinct? pp. 115-119. In: J. LeBlanc, Ed. Conference on Coast Redwood Forest Ecology and Management, Arcata, CA. 170 pp.

Zobel, D.B., L.F. Roth, and G.L. Hawk. 1985. Ecology, pathology, and management of Port-Orford-cedar (*Chamaecyparis lawsoniana*). USDA Forest Service General Technical Report, PNW-184. Pacific Northwest Forest and Range Experiment Station, Portland, OR. 161 pp.

B. GLOSSARY OF TERMS

Aggradation – A geologic process by which streambeds and floodplains are raised in elevation by the deposition of material eroded elsewhere.

Alevin – Young fish; fry.

Allowable Sale Quantity (ASQ) – The quantity of timber that may be sold from the area of suitable land covered by the Land and Resource Management Plan for a time period specified by the plan. This quantity is usually expressed on an annual basis as the "average annual allowable sale quantity."

Anadromous – Fish that are born in freshwater, travel to the sea to grow, and return to freshwater to spawn.

Augmentation – The use of artificial production to increase harvestable numbers of fish in areas where the natural freshwater production capacity is limited, but the capacity of other salmonid habitat areas will support increased production. Also referred to as "fishery enhancement".

Basin – See Drainage Area.

Bedload – Sediment moving on or near the streambed and frequently in contact with it.

Beneficial Uses – The reason(s) why a stretch of river has been given Wild and Scenic River designation.

Bridge – A road or trail structure, including supports, erected over a depression or an obstruction, such as water, a road, a trail, or railway, and having a deck for carrying traffic or other loads.

Brood-year – Hatchlings of a given species from a single year (a cohort).

Canopy – The overhead branches and leaves of streamside vegetation.

Catchment – See Drainage Area.

Channel – A natural waterway that periodically or continuously contains moving water and has a definite bed and banks, which serve to confine the water.

Classified Roads – Roads wholly or partially within or adjacent to National Forest System lands that are determined to be needed for long-term motor vehicle access, including state county, privately owned, National Forest System, and other roads authorized by the Forest Service (36 CFR 212.1).

Clear-cut – One of several silvicultural systems designed to regenerate an even-aged stand; harvests all trees in a given contiguous area, which may be a patch, strip, or stand.

Colluvium – A deposit of loose rock debris accumulated by gravity at the base of a cliff or slope.

Competent – Not prone to landsliding.

Crowning – The movement of fire through the crowns of trees or shrubs more or less independently of the surface fire.

Confluence – Where flowing waters, such as streams, come together.

Consultation – Coordination with the U.S. Department of Fish and Wildlife or the National Marine Fisheries Service on all Forest Service programs or activities that may have an effect on species federally listed under the Endangered Species Act, or on their Critical Habitat.

Debris Jam – Accumulation of logs and other organic debris. Also called a logjam.

Dendrochronology – The study of climatic change and past events by comparing the successive annual growth rings of trees.

Deposition – In terms of hydrology, the settlement or accumulation of material out of the water column and onto the stream bed. Occurs when the energy of flowing water is unable to support the load of suspended sediment.

Depth – The vertical distance from the water surface to the streambed.

Discharge – Volume of water flowing in a given stream at a given place within a given period of time, usually expressed as cubic feet per second (cfs).

Dissolved Oxygen (DO) – The concentration of oxygen dissolved in water, expressed in mg/l or as a percent saturation, where saturation is the maximum amount of oxygen that can theoretically be dissolved in water at a given altitude and temperature.

Diurnal – Relating to or occurring in a 24-hour period; daily.

Drainage Area – Total land area draining to any point in a stream, as measured on a map, aerial photo, or other horizontal plane. Also called catchment area, watershed, and basin.

Escapement – Adult anadromous fish that elude capture and successfully return to the streams in which they hatched, in order to spawn.

Even-aged Management – The application of a combination of actions that results in the creation of stands in which trees of essentially the same age grow together.

Evolutionarily Significant Unit (ESU) – National Marine Fisheries Service definition of a distinct population segment (the smallest biological unit that will be considered to be a species under the Endangered Species Act). A population will be/is considered to be an ESU if 1) it is substantially reproductively isolated from other conspecific population units, and 2) it represents an important component in the evolutionary legacy of the species.

Exotic – Introduced into a habitat or region; not naturally occurring.

Fines – Sand, silt and clay particles, as transported by water

Fish Habitat – The aquatic environment and the immediately surrounding terrestrial environment that, when combined, afford the necessary biological and physical support systems required by fish species during various life history stages.

Flood – Any flow that exceeds the bankfull capacity of a stream or channel and flows out of the floodplain; greater than the bankfull discharge.

Forest Road – As defined in Title 23, Section 101 of the United States Code (23 U.S.C. 101), any road wholly or partly within, or adjacent to, and serving the National Forest System and which is necessary for the protection, administration, and utilization of the National Forest System and the use and development of its resources.

Forest Transportation Facility – A classified road, designated trail, or designated airfield, including bridges, culverts, parking lots, log transfer facilities, safety devices and other transportation network appurtenances under Forest Service jurisdiction that is wholly or partially within or adjacent to National Forest System lands (36 CFR 212.1).

Forest Transportation System Management – The planning, inventory, analysis, classification, record-keeping, scheduling, construction, reconstruction, maintenance, decommissioning, and other operations undertaken to achieve environmentally sound, safe, cost-effective, access for use, protection, administration, and management of National Forest System lands.

Fuel – Flammable vegetative material.

General Forest Management Area – An area of the Forest not managed for special or unique resource values, such as wilderness or botanical resources that may be managed for multiple-use, including wildlife habitat, timber production, and so forth.

Green Tree Retention – A stand management practice in which live trees, as well as snags and large downed wood, are left as biological legacies within harvest units to provide habitat components over the next management cycle.

Hatchery Fish – A fish that has spent some part of its life-cycle in an artificial environment and whose parents were spawned in an artificial environment.

Hatchery Population – A population that depends on spawning, incubation, hatching, or rearing in a hatchery or other artificial propagation facility.

Landing – A wide spot adjacent to, or at the end of a road, where felled timber (log) is brought up to the road (yarded), or stored (decked) prior to transport to a mill.

Late-Successional Reserve (LSR) – A Forest in its mature and/or old-growth stages that has been reserved to protect habitat. LSRs are one of the land allocations designated in the Northwest Forest Plan.

Mainstem – The principal, largest, or dominating stream or channel of any given area or drainage system.

Mass Wasting – A generic term for a variety of gravity-driven earth moving processes that cause such features as landslides and debris flows.

Matrix – Federal lands outside of reserves and withdrawn areas.

Mature Forest – Generally a conifer stand that has reached culmination of mean annual increment, with an average diameter breast height (dbh) of at least 21 inches and exhibiting a low degree of decadence; stands are both even-aged and uneven-aged in structure, with varying degrees of understory development, and large diameter snags and down material present.

Microtine – Belonging to the family of rodents in the genus *Microtus*, generally known as voles.

Mitigation – To moderate an effect (impact) in force or intensity; alleviate effects. In terms of fisheries, the use of artificial propagation to produce fish to replace or compensate for loss of fish or fish production capacity resulting from the permanent blockage or alteration of habitat by human activities.

Muting – Streaks of white excrement left by raptorial birds near their favorite perches.

National Forest System Road – A classified forest road under the jurisdiction of the Forest Service. The term “National Forest System roads” is synonymous with the term “forest development roads” as used in 23 U.S.C. 205.

Natural Fish – A fish that has spent essentially all of its life-cycle in the wild and whose parents spawned in the wild.

Natural Population – A population that is sustained by natural reproduction and rearing in the natural habitat.

New Road Construction – Activity that results in the addition of forest classified or temporary road miles (36 CFR 212.1).

Old-growth – Refers to old-growth forest; in general, ecosystems distinguished by old trees and related structural attributes. Old-growth encompasses the later stages of seral development that typically differ from earlier stages in a variety of characteristics, which usually include larger tree size, higher accumulations of large dead woody material, multiple canopy layers, different species composition, and different ecosystem function. The structure and function will be influenced by stand size.

Pathogen – A micororganism that causes disease, such as a bacterium or fungus.

Paleontology – The study of organisms existing in prehistoric or geologic times, as represented by the fossils of plants, animals, and other organisms.

pH – A measure of acidity and alkalinity.

Pioneer Species – Species that colonize newly created or highly disturbed habitats.

Plantation – A stand of trees resulting from planting or artificially seeding a harvested area.

Pool-riffle Ratio – The ratio of the surface area or length of pools to the surface area or length of riffles in a given stream reach, frequently expressed as the relative percentage of each category.

Priority Species – Plant species, which are currently limited in extent, and that are considered serious threats due to their deleterious ecological and economical effects.

Public Road – Any road or street under the jurisdiction of and maintained by a public authority and open to public travel (23 U.S.C. 101(a)).

Recommended Management Range (RMR) – A recommended range of environmental conditions that is expected to maintain ecosystem process and function; usually a subset of the historic range of variability.

Redd – Nest made in gravel (particularly by salmonids) consisting of a depression that is created and then covered.

Refugia – An area of suitable habitat surrounded by unsuitable habitat.

Riparian Area – The area between a stream or other body of water and the adjacent upland identified by soil characteristics and distinctive vegetation. It includes wetlands and those portions of floodplains and valley bottoms that support riparian vegetation.

Road – A motor vehicle travelway over 50 inches wide, unless designated and managed as a trail. A road may be classified, unclassified, or temporary (36 CFR 212.1).

Road Decommissioning – Activities that result in the stabilization and restoration of unneeded roads to a more natural state (36 CFR 212.1), (FSM 7703). Decommissioning includes applying various treatments, which may include one or more of the following: Re-establishing former drainage patterns, stabilizing slopes, and restoring vegetation, blocking the entrance to a road; installing water bars, removing culverts, reestablishing drainage-ways, removing unstable fills, pulling back road shoulders and scattering slash on the roadbed, completely eliminating the roadbed by restoring natural contours and slopes, or other methods designed to meet the specific conditions associated with the unneeded roads.

Road Maintenance – The ongoing upkeep of a road necessary to retain or restore the road to the approved road management objective (FSM 7712.3).

Road Reconstruction – Activity that results in improvement or realignment of an existing classified road as defined below.

Road Improvement – Activity that results in an increase of an existing road's traffic service level, expands its capacity, or changes its original design function.

Road Realignment – Activity that results in a new location of an existing road or portions of an existing road and treatment of the old roadway (36 CFR 212.1).

Roads Subject to the Highway Safety Act – National Forest System roads that are open to use by the public for standard passenger cars. This includes roads with access restricted on a seasonal basis and roads closed during extreme weather conditions or for emergencies, but that are otherwise open for general public use. These roads generally consist of operation maintenance level 3, 4, and 5 roads.

Salmonid – Fish of the family Salmonidae, including salmon, steelhead trout, etc.

Sediment – Fragmental material that originates from weathering of rocks and decomposition of organic material that is transported by, suspended in, and eventually deposited by water or air, or is accumulated in beds by other natural phenomena.

Seral Stage – A stage in the successional development of an ecosystem; an ecological stage, usually identified by vegetation types.

Silvicultural Prescription – A prescribed sequence of cultural treatments to a stand designed to meet specific management objectives, such as producing a specific wood product or creating a certain type of habitat.

Stand – A community of trees sufficiently uniform in composition, constitution, age, spatial arrangement, or condition to be distinguishable from adjacent communities and so form a silvicultural or management entity.

Standard and Guideline – A performance criterion indicating acceptable norms, specifications, or quality that actions must meet. A principle requiring a specific level of attainment; a rule to measure against.

Stochasticity – Randomness

Stock (Population)– A group of historically interbreeding salmonids of the same species of hatchery, natural, or unknown parentage that have developed a unique gene pool, which breed in approximately the same place and time, and whose progeny tend to return and breed in approximately the same place and time. They often, but not always, can be separated from another population by genotypic or demographic characteristics. This term is synonymous with population.

Structural Diversity – The diversity of forest structure, both vertical and horizontal, which provides for a variety of forest habitats, such as logs and multi-layered forest canopy, for plants and animals. Also the diversity in a forest stand that results from layering or tiering of the canopy; an increase in layering or tiering leads to an increase in structural diversity.

Substrate – The mineral and/or organic material that forms the bed of the stream.

Tailings – Material left over from a mining operation.

Temporary Roads – Roads authorized by contract, permit, lease, other written authorization, or emergency operation not intended to be a part of the forest transportation system and not necessary for long-term resource management (36 CFR 212.1).

Unclassified Roads – Roads on National Forest System lands that are not managed as part of the forest transportation system, such as unplanned roads, abandoned travelways, and off-road vehicle tracks that have not been designated and managed as a trail; and those roads that were once under permit or other authorization and were not decommissioned upon the termination of the authorization (36 CFR 212.1).

Uneven-aged Management – The application of a combination of actions needed to simultaneously maintain continuous high-forest cover, recurring regeneration of desirable species, and the orderly growth and development of trees through a range of diameter or age classes to provide a sustained yield of forest products.

Vector – A means by which a pathogen or undesirable agent can move (and have an effect), from one area to another.

Viable Population – An abundance level above which a (salmonid) population has a negligible risk of extinction.

Watershed – See Drainage Area.

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C. LIST OF ACRONYMS

ACS	Aquatic Conservation Strategy
ASQ	Allowable Sale Quantity
B.P.	Before Present
BIA	Bureau of Indian Affairs
BMP	Best Management Practices
BOR	Bureau of Reclamation
° C	Degrees Centigrade (Celsius)
CA	California
CCC	Civilian Conservation Corps
CDF	California Department of Forestry
CDFG	California Department of Fish and Game
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
CHU	Critical Habitat Unit
cu yds	Cubic Yards
dbh	Diameter at Breast Height
DDT	Dichloro-Diphenyl-Trichloroethane
DO	Dissolved Oxygen
ERFO	Emergency Repair of Federally Owned (roads)
EHR	Erosion Hazard Rating
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
° F	Degrees Farenheit
FERC	Federal Energy Regulatory Commission
FL	Flame Length
FSM	Forest Service Manual
FSH	Forest Service Handbook
FY	Fiscal Year
HRV	Historic Range of Variability
HVIR	Hoopa Valley Indian Reservation
IRR	Interim Riparian Reserve
KNF	Klamath National Forest
LMK	Lower-Middle Klamath
LRMP	Land and Resource Management Plan
LSR	Late-Successional Reserve
LWD	Large Woody Debris
mbf	Thousand board feet
mmbf	Million board feet
MIS	Management Indicator Species
NBS	National Biological Service
NEPA	National Environmental Policy Act
NF	National Forest
NFS	National Forest System
NFR	Natural Fire Rotation
NMFS	National Marine Fisheries Service
NR	Nesting and Roosting Habitat

NSO	Northern Spotted Owl
NPS	National Park Service
NWFP	Northwest Forest Plan (a.k.a Record of Decision or President's Plan)
OML	Operation Maintenance Level
POC	Port-Orford-cedar
PSW	Pacific Southwest Range and Forest Experiment Station
RM	River Mile
RMR	Recommended Management Range
RNA	Research Natural Area
ROS	Rates of Spread
RV	Recreational Vehicle
SM	Survey and Manage
SONC	Southern Oregon/Northern California
SRNF	Six Rivers National Forest
TE	Threatened and Endangered
TES	Threatened, Endangered, and Forest Service Sensitive
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USGS	United States Geological Survey
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
YIR	Yurok Indian Reservation

D. NOXIOUS WEED CONTROL PROFILES

Control Methods of Diffuse Knapweed (Centaurea diffusa)

Summary

- Manual removal of small populations of diffuse knapweed may be an effective control method.
- Revegetation of non-native plant species can suppress growth of diffuse knapweed.
- Revegetation of native plant species, which can thrive in the same conditions as diffuse knapweed, may be an effective means of control.
- Burning can be an effective means of control when used in combination with revegetation using grass.
- Grazing has not been found to be an effective method of control of diffuse knapweed populations.
- Currently no biological control has been successful at controlling diffuse knapweed populations.

Manual Control

Since diffuse knapweed reproduces entirely by seed, the key to controlling infestations is to eliminate new seed production and deplete the existing seed bank (Harris and Cranston 1979, Watson and Renney 1974). Manual removal of plants can aid in depleting new seed bases, and should occur prior to the fruiting stage for best results. Site revisits should be scheduled at least within one year of the original site visit with the intent to manually remove new diffuse knapweed occurrences.

Revegetation

Certain species can act as vegetative suppressants to diffuse knapweed. Two non-native species studied as suppressants are crested wheatgrass (*Agropryon cristatum*) and Russian wild-rye (*Elymus junceus*) (Berube and Myers 1982). However, the effects of introducing one non-native plant to suppress another should be evaluated prior to use as a method of control. Revegetation experiments based upon the use of native plants that have the ability to thrive in the same habitat conditions of diffuse knapweed should be selected for these experimental sites.

Prescribed Burns

Burning has been shown to be an effective control of diffuse knapweed with strong grass regrowth occurring on burned sites (Zimmerman 1997, Watson and Renney 1974). Within two years of burning most Diffuse knapweed rosettes were eliminated (Zimmerman 1997).

Grazing Control

Grazing is not an effective control method for diffuse knapweed. Diffuse knapweed is generally unpalatable to livestock, and the spines around the flower heads may injure the mouths and digestive tracts of grazing animals (The Nature Conservancy 2000).

Biological Control

Currently, there is no single biological control agent that effectively controls diffuse knapweed populations (The Nature Conservancy 2000).

Sources

Berube, D.E. and J.H. Myers. 1982. Suppression of knapweed invasion by crested wheatgrass in the dry interior range of British Columbia. Journal of Range Management. 35:459-461.

CDFA (California Department of Food and Agriculture). 2001. “EncycloWeedia” [Online] Available: http://pi.cdfa.ca.gov/weedinfo/CENTAURE2.htm.

Harris, P. and R. Cranston. 1979. An economic evaluation of control methods for diffuse and spotted knapweed in western Canada. Canadian Journal of Plant Science. 59:375-382.

The Nature Conservancy. 2000. “Element Stewardship Abstract for Centaurea diffusa Lamarck,” [Online] Available: http://tncweeds.ucdavis.edu/esadocs/documnts/centdif.pdf

Watson, A.K. and A.J. Renney. 1974. The biology of Canadian weeds Centaurea diffusa and C. maculosa. Canadian Journal of Plant Science. 54:687-701.

Zimmerman, J.A.C. 1997. Ecology and distribution of Centaurea diffusa Lam., Asteracea. USGS Biological Resource Division, Colorado Plateau Field Station-Flagstaff, AR. Internet 02/16/98. [Online] Available at: http://www.nbs.nau.edu/FNF/Vegetation/Exotics/diffusa/diffusa.html.

Control Methods for Spotted Knapweed (Centaurea maculosa)

Summary

- Manual control is an effective means of removing small populations spotted knapweed.
- Several plants have been used to replace knapweed species in revegetation.
- Prescribed burns are effective in controlling spotted knapweed populations when used with grass revegetation.
- Grazing is an effective means of reducing spotted knapweed.

Mechanical Control

Populations of spotted knapweed may be removed by hand pulling or digging. The entire root should be removed when this method is employed or resprouting may occur (WDNR 2002). Hand pulling must be repeated 2-4 times a year and is easiest when the plants have begun to bolt in the late spring and the soil is still moist (CDFA 2002). Proper disposal of removed plants is important to prevent spread. Piling and burning in a hot fire is a proven method of disposal. Mowing will reduce, but not eliminate, seed production, and timing is critical. A single mowing in the bud to early flower stage has been most effective, reducing seed production by greater than 75% (CDFA 2002). Mowing more mature plants will facilitate seed dispersal and is not recommended.

Revegetation

everal grasses and forbs have been used to explore the possibility of replacing knapweed species (Mauer et al. 2002). The non-native species crested wheat grass, palestine orchard grass, berber orchard grass, nangeela subterranean clover, Mt. Baker subterranean clover, and covar sheep fescue have been shown to be at least somewhat effective at replacing certain species of knapweed species (Mauer et al. 2002). Studies have shown that the greater the biomass produced by the grass, the more it reduced the number of diffuse knapweed (*Centaurea diffusa*) (Mauer et al. 2002). Those species whose growth period overlapped the growth period of spotted knapweed were most effective at competing for moisture and nutrients (Mauer et al. 2002). Native bunchgrass communities are generally very resistant to knapweed invasion.

Prescribed Burns

The use of fire has demonstrated mixed results for managing spotted knapweed. Hot prescribed burns may reduce established stands of knapweed. A follow-up of selective pulling and digging will further reduce populations. Annual burns have reduced populations by 5-90% and may be correlated with burn intensity (Morisawa 2002). Reseeding with a native species is recommended. Fire followed by vigorous grass regrowth can reduce knapweed stands. However, single, low intensity burns may actually worsen the problem since it is not hot enough to prevent resprouting and seed germination. Also, fires may disturb the area promoting colonization.

Grazing Control

Livestock will consume spotted knapweed. Sheep have been effective in reducing seed set, and in releasing grasses from competition. Spotted knapweed is palatable to sheep in late spring to early summer, and grazing has been most effective for reducing seed formation where a high density of animals grazed for a short time (Beck 1995).

Sources

Beck, K.G. 1995. “Range: Diffuse and Spotted Knapweed.” [Online] Available at: Colorado State University Cooperative Extension.

CDFA (California Department of Food and Agriculture). “EncycloWeedia.” [Online] Available at: http://pi.cdfa.ca.gov/weedinfo/CENTAURE2.htm, February 22, 2002.

Morisawa, T.L. 1999. “ Weed Notes: *Centaurea maculosa*.” [Online] Available at: http://tncweeds.ucdavis.edu/esadocs/centmacu.html

Mauer T., M.J. Russo, and M. Evans. “Element Stewardship Abstract for *Centaurea maculosa.*” [Online] Available at: http://tncweeds.ucdavis.edu/esadocs/documnts/centmac.html, March 26, 2002.

WDNR (Wisconsin Department of Natural Resources). “Spotted Knapweed.” [Online] Available at: http://dnr.state.wi.us/org/land/er/invasive/factsheets/knapweed.htm, March 26, 2002.

Control Methods for Yellow Starthistle (Centaurea solstitalis)

Summary

- Hand pulling, mowing, and grazing can be used to help control yellow starthistle, but the timing of these methods is essential.
- Prescribed burns can provide control if timed correctly.
- Re-vegetation programs using perennial grasses or legumes can be effective for management of yellow starthistle.
- Biological controls are useful in reducing seed production.

Mechanical Control

Manual removal of yellow starthistle is most effective with small patches or in maintenance programs where plants are sporadically located in the grassland system. It is important to remove the entire stem from the root system or resprouting will occur. The best time for manual removal is in late spring or early summer, after plants have bolted but before they have produced viable seed. A larger starthistle population can be controlled through physical removal by starting at the outside edge of the population and moving in. The technique requires repeated visits but ensures that no new seeds are produced, and the soil disturbance is minimized. Early summer tillage will control starthistle provided the roots are detached from the shoots. Mowing is most effective when plants are cut below the height of the lowest branches and 2-5 % of the total population of seed heads is in bloom. However, mowing before the plants reach the spiny stage encourages yellow starthistle regrowth and can result in high seed production and reduce competing vegetation, thus enhancing light penetration and increasing the starthistle problem. Even repeated mowing conducted too early will not control the starthistle and may extend its life cycle. Mowing is best employed in the later years of a long-term management program or in a lightly infested area.

Revegetation

Re-vegetation programs for yellow starthistle control generally rely on reseeding with native or high forage non-native perennial grasses (DiTomaso et al. 2000, Prather and Callihan 1991). Re-vegetation with desirable and competitive plant species can be the best long-term sustainable method of suppressing weed invasions, establishment, or dominance, while providing high forage production. Competitive grasses used in revegetation programs for *C. solstitalis* management include the non-native perennials crested wheatgrass (*Agropyron desertorum),* pubescent wheatgrass (*Thinopyrum intermedium*), sheep fescue (*Festuca ovina*), crimson clover (*Trifolium incarnatum*), alkali sacaton (*Sporobolus airoides*), and subterranean clover (*Trifolium subterraneum*). Native perennials used include big bluegrass (*Poa ampla*), thickspike wheatgrass (*Elymus lanceolatus* subsp. *Lanceolatus)*, deergrass (*Muhlenbergia rigens*), saltgrass (*Distichlis spicata*), and prairie threeawn (*Aristida spp.)*. Many perennial grasses are not very competitive at the seedling stage, and may not survive the establishment period (Prather and Callihan 1991). To overcome this disadvantage, perennials can be established in greenhouses in plugs, and then planted out in the field.

Prescribed Burns

Prescribed burns can provide control if implemented after annual plants have dried, but before yellow starthistle seed is produced. In California, burning is best performed at the end of the rainy season when flowers first appear. Yellow starthistle should be green at this time and will require desiccated vegetation to burn. Most annual vegetation other than yellow starthistle, particularly grasses, should have dried and shed their seeds by this time. Burning can also increase the recovery and density of perennial grasses (DiTomaso 2001). Burning at other times may enhance yellow starthistle survival.

Biological Control

Four insects have become established for the control of yellow starthistle in California. The hairy weevil (*Eustenopus villosus*) and false peacock fly (*Chaetorellia succinea*) are the two that have had any significant impact on reproduction (Pitcairn et al. 2000a, Pitcairn et al. 1999b). The combination of these two insects reduces seed production by 43 to 76% (Pitcarin et al. 2000a). However, this method alone is not sufficient for long-term management, but its use in combination with others increases their effectiveness.

Grazing Control

Properly timed intensive grazing by cattle, sheep or goats can reduce growth, canopy cover, survivability, and reproductive capacity of yellow starthistle (Thomsen et al. 1990, 1993). Improperly timed grazing can lead to a rapid selection for starthistle. Sheep, goats, or cattle are effective in reducing yellow starthistle seed production when grazed after plants have bolted but before spines form on the plant. Goats will eat starthistle even in the spiny stage.

Sources

Amme, D. 1991. Working with native perennial grasses. Grasslands, California Native Grass Association. 1(1).

Benefield, C.B., J.M. DiTomaso, G.B. Keyser, S.B. Orloff, K.R. Churches, D.B. Marcum, and G.A.Nader. 1999. Success of mowing to control yellow starthistle depends on timing and plant's branching form. California Agriculture. 53(2):17-21.

DiTomaso et al. 2000. Integrated approaches and control option consideration when developing a management strategy for yellow starthistle. California Agriculture 54 (6):30-36

DiTomaso, J. 2001. "Element Stewardship Abstract for (PRIVATE) Centaurea solstitialis." [Online] Available at: http://tncweeds.ucdavis.edu/esadocs/centsols.html, March 2002.

Prather, T.S. and R.H. Callihan. 1991. Interactions between a yellow starthistle community and a pubescent wheat grass community. Journal of Range Management. September 1991.

Pitcairn M.J., D.M. Woods, E.F. Van Mantgem, and R.K. Wall. 1999b. Endemic natural enemy fauna of yellow starthistle and purple starthistle in central California. pp. 83-84. D.M. Woods, Ed. In: Biological Control Program Annual Summary. 1998. California Department of Food and Agriculture, Plant Health and Pest Prevention Services, Sacramento, CA.

Pitcairn, M.J., J.M. DiTomaso, and V. Popescu. 2000a. Integrating chemical and biological control methods for control of yellow starthistle. pp. 58-61. D.M. Woods, Ed. In:

Biological Control Program Annual Summary. 1999. California Department of Food and Agriculture, Plant Health and Pest Prevention Services, Sacramento, CA.

Thomsen, C.D., W.A. Williams, and M.R. George. 1990. Managing yellow starthistle on annual range with cattle. Knapweed. 4:3-4.

Thomsen, C.D., W.A. Williams, M. Vayssiéres, F.L. Bell, and M.R. George. 1993. Controlled grazing on annual grassland decreases yellow starthistle. California Agriculture 47(6):36-40.

Control Methods of Scotch Broom (Cytisus scoparius)

Summary

- Hand pulling or use of a weed wrench is an effective control method.
- Shading plants is a useful way of reducing infestations.
- Grazing may help control scotch broom.

Mechanical Control

Hand pulling can be used to destroy seedlings and plants of scotch broom up to 1-1/2 meters tall. This is most easily done after a rain when the soil is loose, to facilitate the removal of the rooting system, which may resprout. For larger plants, the use of a weed wrench is also an effective removal tool. Cutting scotch broom to ground level at the end of the dry season can help reduce resprouting from the crown. Due to the high volume and longevity of the seeds, yearly revisits are required to remove any new sprouts or resprouts from old roots that may occur.

Prescribed Burns

Prescribed burns can eliminate above ground growth, but do not prevent resprouting from the crown and may stimulate a flush of seed germination unless the fire is hot enough to kill the seed bank. Used alone, this method will not control scotch broom populations. Subsequent burning to exhaust soil seed bank and underground food reserves, and/or revegetation with fast growing native species best follows burning. Other considerations for the use of prescribed burning include the time and cost of coordinating a burn, and the soil disturbance resulting from firebreak construction.

Revegetation

Scotch broom plants cannot tolerate heavy shade, but can tolerate minimal shade along forest canopies. Planting tall natives that can out compete scotch broom or shade young plants is effective in reducing infestation. Scotch broom stands could possibly provide a good environment for successional plants such as broadleaved shrubs or trees. These seedlings may establish sufficiently to eventually shade out scotch broom (Williams 1983).

Grazing Control

Livestock grazing as a control measure may be effective, although scotch broom is slightly toxic and unpalatable to most livestock (Mobley 1954, Long 1938). Goats appear to be the most effective grazers of scotch broom.

Sources

Long, H.C. 1938. Poisonous plants on the farm. Great Britain Man. Agric. Fish. Bulletin 75:33.

Mobley, L. 1954. Scotch broom, a menace to forest, range and agricultural land. Proceedings of the 6th Annual California Weed Conference. pp. 39-40.

Williams, P.A. 1983. Secondary succession on the Port Hills, Bank Peninsula, Canterbury, New Zealand. AZJ. Botany. 21:237-247.

Control Methods of French Broom (Genista monspessulana)

Summary

- Manual removal through the use of weed wrenches and physical labor is effective to eliminate isolated populations.
- Revegetation with native shrubs after areas are treated can minimize infestations.
- Prescribed burns appear to stimulate seed germination when not done in subsequent treatments.
- Grazing control does not appear to be an effective method of control.
- No information was available on the effects of any single biological control.

Manual Control

Manual removal of french broom is the most desirable method since this method is highly selective and permits weeds to be removed without damage to surrounding native vegetation (The Nature Conservancy, 2000). Weed wrenches are very effective tools for removing larger plants with extensive root systems. French broom is the most widespread and perhaps the most aggressive of the brooms.

Revegetation

Planting native shrubs and trees within and around broom stands can eventually help to minimize infestations by shading. French broom appears to be more tolerant of shade than scotch broom (Williams 1981). Some plant species inhibit the establishment or growth of other plants through allelopathy. Native species with such properties may be propagated in treated areas to prevent resprouting.

Prescribed Burns

Fire appears to stimulate seed germination when not done in subsequent treatments or when fire temperatures are not sufficient to render seeds unviable. Where seeds are present in the soil, a large flush of seedlings may appear on newly burned sites (CDFA 2001).

Grazing Control

Herbivores do not readily graze brooms, possible due to the bitter taste of stems and the availability of more palatable forage (Bossard 1990). Grazing by goats has been used as a control method for scotch broom (University of California Agriculture and Natural Resources 2001).

Biological Control

No information was available on the effects of insect herbivory on French broom.

Sources

Bossard, C. C. 1990. Secrets of an ecological interloper: Ecological studies on *Cytisus scoparius* (Scotch broom) in California. PhD diss., University of California Davis.

CDFA (California Department of Food and Agriculture). "EncycloWeedia." [Online] Available at: http://pi.cdfa.ca.gov/weedinfo/CYTISUSG2.html, February 22, 2001, last updated.

The Nature Conservancy. 2000. "Element Stewardship Abstract for *Cytisus scoparius* and *Genista monspessulanus.*" [Online] Available at: http://tncweeds.ucdavis.edu/esadocs/documnts/cytisco.pdf.

University of California Agriculture and Natural Resources. 2001. "Getting a Handle on Broom." Publication 8049. [Online] Available at: http://www.ceres.ca.gov/foreststeward/html/broom.html.

Williams, P. A. 1981. Aspects of the ecology of broom (*Cytisus scoparius*) in Canterbury, New Zealand. NZJ. Botany. 19:31-43.

Control Methods of Dyer's Woad (Isatis tinctoria)

Summary

- Manual control is an important and effective means of management.
- There is a lack of information on restoration and revegetation.
- There is a lack of information on the effects of fire on dyer's woad.
- Grazing may provide limited control of dyer's woad.

Mechanical Control

Hand pulling can be a very effective means of controlling dyer's woad. This method is easiest when the ground is wet and after the plant has bolted. Dyer's wood has a thick, fleshy taproot and must be removed below the crown of the plant and well down into the root (Evans 2002). Plants should be pulled twice per year: once at the beginning of May when flowers start to bloom and once two to three weeks later to eliminate any remaining plants (Kedzie-Webb et al. 2002). There is a four to six week period from the time of flowering until the seeds mature. "It is essential that the plants be removed as soon as possible after flowering to prevent the possibility of some slipping by and going to seed" (Evans 2002). Since dispersal is solely dependent on seed production it is important to carry flowering plants out of the area because they may continue to produce seeds even after they are pulled (Kedzie-Webb et al. 2002). Eradication of this weed depends on intensive and persistent efforts at monitoring from year to year as the seed bank deposited by dyer's woad may persist for some years.

Revegetation

No information was found concerning the revegetation of sites that have been infested with dyer's woad.

Prescribed Burns

No information was found concerning the effects of fire on dyer's woad when used as a control method.

Grazing Control

Sheep grazing may provide limited control of dyer's woad. Sheep readily consume top growth of dyer's woad until the flowering stage. Recent studies suggest that properly timed grazing, repeated several times per season may increase mortality and reduce reproductive performance when at least 60% of the plant is removed (Kedzie-Webb et al. 2002).

Sources

Evans, J.O. "The Importance, Distribution, and Control of Dyer's Woad (*Isatis tinctoria)*." On file, Six Rivers National Forest, 2002.

Kedzie-Webb S., R. Sheley, and S. Dewey. "Dyer's Woad: A Threat to Rangeland in Montana." [Online] Available at: http://www.montana.edu/wwwpb/pubs/mt9614.html, March 26, 2002.

Control Methods For Himalayan Blackberry (Rubus discolor)

Summary

- Hand removal of plants can be effective in controlling himalayan blackberry.
- Prescribed burns are effective in removing the above ground parts of himalayan blackberry.
- The himalayan blackberry generally out competes any fast growing natives.
- Grazing is an effective control method, especially sheep and goats.

Mechanical Control

Himalayan blackberry can be effectively controlled by hand pulling seedlings, hand hoeing smaller plants, and cutting back larger plants and digging up the roots. This work must be thorough as any piece of the roots left may resprout into a new plant. Methods using mechanical equipment to cut, chop or mow down the above ground plant can be effective as well, but multiple treatments are needed before the underground parts use up their reserve food supply, and himalayan blackberry may resprout from the root crowns in greater density.

Revegetation

In most cases himalayan blackberry must be initially removed for the establishment of other native plants. Himalayan blackberry is very fast growing and generally will out compete even fast growing native plants when they resprout from untreated root crowns. Native species that inhibit the establishment or growth through the effects of allelopathy (i.e. biochemical interference by metabolic products) may be propagated in treated areas to control re-establishment. Allelopathic noxious weeds should of course be avoided.

Prescribed Burns

Large areas of infestation may be burned to remove the above ground plants, but it will not prevent the root crowns from resprouting. Subsequent burning or other removal methods are necessary to exhaust seed banks and underground food reserves.

Grazing Control

Horses, cattle, sheep, and goats all have been proven to aid in the control of himalayan blackberry populations, with sheep and goats being the most efficient at brush removal and retarding population expansion. Goats will readily eat himalayan blackberry throughout the year, even when there is an abundant amount of pasture and other plants.

Sources

Hoshovsky, M. 1989. “Element Stewardship Abstract for *Rubus discolor”*. [Online] Available http://tncweeds.ucdavis.edu/esadocs/rubudisc.html, June 2002.

Control Methods of Spanish Broom (Spartium junceum)

Summary

- Hand pulling of spanish broom is an effective way to manage it.
- Revegetation may minimize infestations of spanish broom.
- Grazing control can be effective when implemented until seed bank is eliminated.
- Prescribed burning may in fact increase the germination rate of the seed base.
- No information was available on the effects of any single biological control.

Manual Control

Hand pulling can be used to destroy seedlings and plants of spanish broom. This method is highly selective and permits the plants to be removed without damage to surrounding native vegetation (The Nature Conservancy 2001). Hand pulling is most easily done after a rain when the soil is loose, to facilitate the removal of the rooting system, which may resprout. For larger plants, the use of a weed wrench is also an effective removal tool. Spanish broom is easily misidentified with scotch broom and sometimes french broom. Repeated mowing of these three species without root removal may lead to an extensive root system with little above ground foliage which causes manual treatment to be more difficult and time consuming.

Revegetation

Planting native shrubs and trees within and around spanish broom sites can eventually help to minimize infestations by shading out available habitat.

Grazing Control

The continued removal of the tops of seedlings and resprouts by grazing livestock prevents plant development and seed formation and also gradually weakens the underground parts. Grazing must be continued until the seed bank is eliminated, as the suppressed plants return quickly after livestock removal (The Nature Conservancy 2001).

Prescribed Burns

Spanish broom seeds will germinate readily without treatment, but scarification due to heat can increase germination of seed bank. Prescribed burns when revisited and/or reburned may be effective.

Biological Control

Erophyes spartii (gall mite) has been noted to live exclusively on spanish broom in Italy. The attack begins on the young apical shoot and causes excessive hairiness, thickening of the axis, and shortening of the internodes. The heavily infested plants go through a process of withering and may die in a few years (The Nature Conservancy 2001).

Sources

CDFA (California Department of Food and Agriculture). "EncycloWeedia." [Online] Available at: http://pi.cdfa.ca.gov/weedinfo/CYTISUSG2.html, July 30, 2002.

The Nature Conservancy. 2001. "Element Stewardship Abstract for *Spartium junceum.*" [Online] Available at: http://tncweeds.ucdavis.edu/esadocs/documnts/sparjun.pdf.

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E. NOXIOUS WEED RISK ASSESSMENT

File Code: 2080 Noxious Weed Management Date: July 10, 2001
Route To:

Subject: Noxious Weed Risk Assessment

To: District Rangers, Program Managers and Project I.D. Team Leaders

It is important that we, as a Forest, increase efforts to manage noxious weeds on public lands under our jurisdiction. Benefits for keeping an area noxious weed-free include economic and ecological factors. Although many acres on Forest are infested to a degree that control seems insurmountable, we are fortunate that not all settings considered vulnerable to establishment are occupied. Many vulnerable areas are free of infestation and efforts to prevent introduction and spread are paramount.
Toward this end, the enclosed document presents a standardized method, approved for use on Six Rivers N.F., for assessing the risk of introducing or spreading noxious weeds related to proposed actions. Inventory and mapping is also discussed, as this is an important prerequisite to making an assessment. The major goal of the noxious weed risk assessment is to serve as a first step in a strategy aimed at reducing management related introduction and spread of noxious weeds on the Forest. Risk assessment is essential for implementing direction contained in Forest Service Manual 2080 - Noxious Weed Management, which requires that a risk assessment for noxious weeds to be completed for proposed actions that will result in ground disturbance.

The risk assessment uses five factors to analyze the risk of introducing or spreading weeds and it includes a list weeds that are of most concern on Six Rivers N.F. Utilizing an interdisciplinary process, a written narrative is prepared analyzing each factor in relation to the proposed action. The resulting document which forms the basis of the assessment is included as part of the NEPA documentation for the project. Analyses that result in a moderate to high risk shall include measures to mitigate the risk of introduction or spread.

Your commitment to this endeavor is critical to keeping vulnerable areas of the Forest free of infestation. If you have any questions regarding the risk assessment, please contact Forest Botanist Lisa Hoover at 707-441-3612.

/s/ S. E. Woltering

S. E. "LOU" WOLTERING
Forest Supervisor

Enclosure with file copy (hard copy only)

Author: nrg, jmcrae, 07/09/2001 1345

Noxious Weed Risk Assessment – Six Rivers National Forest

Introduction

Government agencies are beginning to give high priority to noxious weed management on public lands. Benefits for keeping an area noxious weed-free include economic and ecological factors. Economically, weed-free land has a higher appraisal value for forage for livestock, harvest game species, commercial timber growth, and recreation. Ecological factors are more difficult to quantify but are at least as important since noxious weeds degrade federally threatened, endangered, Forest Service Sensitive, and rare species habitat, visuals, watershed values (by increased erosion), productivity, and palatability and biodiversity. Noxious weeds can also increase fire risk. The cost of current treatment and prevention should be weighed against the future cost of treating a much larger infestation and future land degradation if prevention measures or control of small patches are not undertaken now.

General Noxious Weed Risk Assessment Information

Strategies for managing noxious weeds include inventory and mapping, an assessment of the potential for proposed actions to introduce or spread weeds, measures to mitigate introduction or spread, control measures, and monitoring. This document presents a standardized method, approved for use on Six Rivers National Forest for assessing the risk of introducing or spreading noxious weeds via a proposed action. Inventorying and mapping is also discussed, as this is an important prerequisite to making an assessment.

Forest Service Manual 2080 Noxious Weed Management (effective since 11/29/95) includes direction requiring a risk assessment for noxious weeds to be completed for every project. Specifically, the manual states:

2081.03 - Policy. When any ground disturbing action or activity is proposed, determine the risk of introducing or spreading noxious weeds associated with the proposed action.

1. For projects having moderate to high risk of introducing or spreading noxious weeds, the project decision document must identify noxious weed control measures that must be undertaken during project implementation.

2. Use contract and permit clauses to prevent the introduction or spread of noxious weeds by contractors and permittees. For example, where determined to be appropriate, use clauses requiring contractors or permittees to clean their equipment prior to entering National Forest System lands.

2081.2 - Prevention and Control Measures. Determine the factors that favor the establishment and spread of noxious weeds and design management practices or prescriptions to reduce the risk of infestation or spread of noxious weeds.

Inventory and Mapping

As part of project planning, give high priority to inventorying the project area and adjacent areas (particularly access roads) for noxious weeds. Any or all personnel visiting the site during project layout can do this. At a minimum, map noxious weed locations by species on quadrangle maps, estimate infestation size (acres), density of the infestation (low, medium, or high), and spread potential (low, medium, or high). Density refers to how dense the weeds are within the area mapped, varying from low, where they are sparse, to high, where the weed is the dominant species within the mapped area. Spread potential refers to the potential for the mapped weed to spread beyond the mapped area based on the susceptibility of the surrounding habitat to invasion. For example, a patch of starthistle surrounded by late-seral forest would have a low spread potential. A patch surrounded by grassland would have a high spread potential. Consult the corporate Forest Noxious Weed Database for information on noxious weed sites that are currently mapped within or adjacent to the project area.

Prevention and Early Control

Preventing an infestation of noxious weeds from becoming established is another high priority. Costs increase exponentially once an infestation has begun to spread and degrade plant communities. The most aggressive species will quickly become very expensive to control.

Prevention includes both reducing the human-assisted spread of seeds and other reproductive parts into a weed-free area, and prompt removal of the first plants that show up. It is important that treatment occurs before plants reproduce, and especially before they reproduce several generations, which may result in a locally adapted and explosive weed population (yellow starthistle, in particular, has been observed to follow this pattern).

Once a priority noxious weed (regionally determined and includes California Department of Food and Agriculture listed species) is identified in an area, eradication should be undertaken as soon as possible. In particular, hand-pulling the first plant or few plants of a noxious weed that germinate in an area is the most efficient and effective mechanism for reducing weed spread. A good inventory is essential as inventory and initial attack can often occur simultaneously.

Assessing Risk of Introduction or Spread of Noxious Weeds

The following risk assessment was developed to standardize the process for determining the risk of introducing or spreading noxious weeds associated with a proposed action. Note that inventory and mapping are essential prior to performing the risk assessment. For projects having a moderate to high risk of introducing or spreading noxious weeds, the project decision document must identify noxious weed control measures that must be undertaken during project implementation (2081.03).

Analyzing Weed Response to Proposed Action

Prepare a written narrative analyzing each factor in relation to the proposed action to derive an assessment of the level of risk. Once the level of risk for each factor has been analyzed, determine an overall level of risk for the proposed action. The factors in the table are evaluated individually as well as cumulatively. For example, if no weeds are present in the project area but weeds are adjacent and the habitat is not considered vulnerable to establishment (e.g. forest), then the overall rating would be low. If the habitat in this scenario was vulnerable (e.g. grassland) the overall rating would be moderate to high depending on how the other factors rated out. If the risk of introduction or spread is moderate to high the project decision document must identify noxious weed control measures that must be undertaken during project implementation (2081.03).

Table 54 Noxious Weed Risk Assessment.

Factors	Components	Variations	Risk
1. Known Noxious Weeds	Regionally determined or Ca. Depart. Food and Agriculture listed	None present, none adjacent	Low risk
		Weeds present, and adjacent	Moderate risk
		None present and adjacent along access routes	High risk
2. Habitat Vulnerability	Previous disturbance, plant cover, soil cover, shade, soil type, aspect/moisture	High cover, low disturbance	Low risk
		Moderate cover, disturbance	Moderate risk
		Open uninfested habitat and/or high previous disturbance	High risk
3. Non-project dependent Vectors	Existing roads and trails, traffic use, livestock/ wildlife migrations, wind patterns, drainage flow direction	No current vectors	Low risk
		Moderate current vectors	Moderate risk
		Abundant current vectors	High risk
4. Habitat Alteration Expected as a result of Project	Logging prescriptions, road construction, fuels prescriptions, change in grazing management or recreation use, intensity and extent of disturbance	Low disturbance; minimal shade and duff removal	Low risk
		Moderate disturbance, shade and duff removal	Moderate risk
		High ground disturbance, shade and duff removal	High risk
5. Increased Vectors as a result of Project Implementation	Road construction, facility construction, amount of project-related traffic	No access improvement; minimal project-related traffic	Low risk
		Temporary roads; short-term traffic increase	Moderate risk
		Road or facility construction	High risk

F. FIRE EFFECTS – VEGETATION

General Fire Effects

The presettlement composition and structure of Pacific Northwest forests were greatly influenced by fire. Fire plays a direct role in processes associated with vegetation succession, nutrient cycling, and soil structure and stability. However, fire is a dynamic process. Ecosystem response to fire will vary depending on the amounts of organic matter consumed, season of burn, time since the last burn, and the many variables associated with biotic, physical, climatic, and anthropogenic features of an ecosystem (Kauffman 1990).

In addition to genetically adapted traits (e.g. serotinous cones, sprouting from below-ground plant organs), several other factors will influence plant response to fire. Characteristics of the individual plant include age and vigor. Specific adaptations and the capacity to survive a fire often will change with age. Environmental conditions that influence survival include type of fire (surface or crown fire), fire frequency or return interval, season of burn (during the active or the dormant growing season), fuel consumption, fire intensity, physical site characteristics (slope, aspect, soil type), and associated species. The high occurrence of younger seral stages indicates that mortality of these younger, less fire tolerant trees could be higher when wildfires do occur.

It is clear that large, stand-replacing wildfires with very high to extreme fire behavior could drastically affect wildlife habitat, soils, vegetation, water quality, and channel morphology. At the same time it is important for forest managers to understand the positive role of fire in forest systems, vegetation adaptations to survival in fire regimes, and the effects of altering fire regimes on vegetation composition. Alterations of fire regime have resulted from active fire suppression in these watersheds, which historically had a much more frequent fire return interval. Fire regimes have also been altered by management activities that shortened fire return intervals (e.g. logging followed by slash burning) or lengthened fire return intervals (e.g. aggressive fire suppression). These potential fire effects need to be considered in terms of wildfires and prescribed burns. Considering the predominant tree species within the LMK watersheds, this appendix includes a brief, generalized discussion of potential fire effects.

Aggressive wildfire suppression actions, under a ground-based control strategy, could have detrimental effects, especially on unstable soils. Prescribed burning will result in some fire induced mortality, but this will mainly occur in the younger, less fire resistant seral stages or in the fire-intolerant vegetation types that would have been eliminated during more frequent fire return intervals. This substitute for the natural thinning process of light to moderate intensity wildfires would also remove some competition and could help accelerate the growth and vigor of the stronger, surviving trees. At the same time, mortality of any of the larger trees would contribute to the recruitment of snags and coarse woody debris.

Fire Effects by Species

The following is a brief, generalized discussion of potential fire effects for the predominant tree species listed for the LMK watersheds:

Canyon live oak

Above-ground foliage of canyon live oak is sensitive to fire, and this plant is generally top-killed by fires of even relatively low intensity (Green 1980). Light ground fires can seriously damage or girdle this oak, or produce fatal cambium injuries to the crown and trunk (Minnich 1977). The dead flaky outer bark is extremely flammable and can carry fire several feet up the trunk (Plumb and McDonald 1981). The bark is relatively thin and offers little protection when compared with other species of oak (Minnich 1977). The trunk appears to be sensitive to heat damage (Plumb 1980), which often extends up the trunk, far above any obvious signs of charring (Plumb and Gomez 1983).

The total effect of fire on oaks varies according to fire intensity and severity, fire behavior, season of burn, and the size of the plants. Younger plants and those with smaller stems and lower crown heights tend to be most vulnerable (Plumb 1980). Trees with crown-to-ground distances of 15-30 feet or more tend to be most resistant to damage. Larger trees have relatively little dead fuel in the crown since leaf fall occurs in early summer prior to typical fire seasons. The thicker bark of larger oaks provides some additional protection, as does the greater living biomass, which decreases overall flammability (Minnich 1980). In general slower moving, lower intensity fires more seriously damage trunks of oaks than those of higher intensity, but shorter duration (Plumb and Gomez 1983).

Crown damage is variable in oaks and the degree of damage can differ even within an individual crown. Damage may range from essentially none to total removal of the foliage. Crown survival of larger trees is somewhat variable. Trees of 12 inches dbh (diameter breast height) have survived with wounds up to 20 feet in height (Plumb 1980).

The full effect of fire on oaks may not become obvious for some time. It may be necessary to wait for at least one growing season, and preferably three, before survival can be accurately determined. Undamaged leaf crowns of seemingly girdled canyon live oaks may appear alive for as long as 8 years after a fire (Plumb and Gomez 1983).

Canyon live oak generally sprouts prolifically after fire (Minnich 1980). Even seedlings are often capable of sprouting after disturbance (Mallory 1980), and moderate to dense regrowth of sprouts is typical after fire (Plumb and Gomez 1983). Canyon live oak sprouts vigorously from the subsurface rootcrown even when the upper canopy is only partially defoliated by burning or scorching (Minnich 1980). The rootcrown itself has been described as a “basal woody mass", but does not appear to be lignotuberous (Keeley 1981). Post-fire stump-sprouting occurs where portions of the stump remains intact (Mallory 1980). Under certain circumstances, some larger trees crown sprout if only “marginally singed" (Minnich 1980). However, this appears to be somewhat unusual, with resprouting typically occurring from the base and not the crown (Minnich 1976).

Where sprouting occurs, recovery of canyon live oak is generally rapid. On many sites following lighter fires, canyon live oak frequently forms dense, virtually impenetrable stands 3 to 10 feet in height within 15 to 30 years after fire. After 30 years, canyon live oak generally grows in multi-stemmed clumps that form a closed canopy 15 to 30 feet high (Minnich 1980). Frequent fires favor shrub-like growth forms of canyon live oak that often dominate other species following several fires at fairly close intervals (Burcham 1974). Open woodlands of canyon live oak are temporarily replaced by live oak chaparral after repeated burning. However, protection from fire favors the reestablishment of oak woodlands, as oak sprouts ultimately grow tall enough to out-compete other associated plants (Mallory 1980).

A fuel management consideration is that, although the heat content of the outer bark of canyon live oak is relatively low when compared with other California oaks (*Quercus spp.*), its low density and flakiness contribute to heat buildup around the trunk (Plumb and Gomez 1983). In terms of prescribed burning, Plumb (1980) reports that “the use of prescribed fire in the management of canyon live oak does not appear to be promising" where primary goals include maintenance of oak woodlands. Trees are sufficiently sensitive to trunk girdling that even ground fires can kill the trunk surface. Prescribed fire can be used in stands of larger trees where fuel loading is low or where trunks are protected from the direct effects of heat. Repeated fires at frequent intervals can maintain shrubby canyon live oak chaparral.

Fire in California oak woodlands can create favorable, although transitory, habitat for birds such as the flicker and hairy woodpecker, which feed on insects present in the branches of fire-killed trees (Clark 1935).

Douglas-fir

Low elevation Douglas-fir forests can be included with the tanoak description below. But for higher elevation Douglas-fir the stands have a different composition and response to wildfires. In these forests, where summer moisture is quite limiting, adequate growing space for regeneration is often linked to forest disturbance, which creates sites for tree establishment as a result of overstory mortality. Historically, fire has been the most prominent disturbance in such stands. Multi-aged forests are a common result of moderate-severity fire regimes. Fire kills a portion of the canopy trees, and surviving trees often occur in patches. Many small trees are killed because of thin bark and low crowns. Some are killed immediately and others die slowly, weakened by decay that enters fire scars on stems and roots. Tree establishment occurs in the newly available growing space, and can continue for decades after fire. Such forests often have an “all-sized" diameter distribution but the age class initiation is not continuous, but rather pulsed after fire disturbance (Agee 1993). The thicker bark of older Douglas-fir trees make them much more fire resistant.

Coastal Douglas-fir is more fire resistant than many of its associates, and can survive moderately intense fires. Thick corky bark on the lower bole and roots protects the cambium from heat damage. In addition, the tall trees have their foliage concentrated on the upper bole, which makes it difficult for fire to reach the crown (Morrison and Swanson 1990). However it should be noted that trees are typically not free of lower branches up to a height of 33 feet until they are more than 100 years old (Hermann and Lavender 1990). Widely distributed as a canopy dominant in lower and middle elevation forests throughout the Pacific Northwest, Douglas-fir occupies forests with varied fire regimes. In general, the size and severity of natural fires tend to decrease, while fire frequency increases southward from western Washington to northern California (Morrison and Swanson 1990).

Crown fires commonly kill all trees over extensive areas. Hot ground fires that scorch tree crowns and char tree boles kill variable proportions of coast Douglas-fir (Agee and Huff 1980). Rapidly spreading ground fires tend to inflict more damage to Douglas-fir crowns, while slow-spreading ground fires are damaging to the bole and can kill trees through cambial heating (Peterson and Arbaugh 1989). Crown scorching from summer fires is more damaging than late summer or fall fires because more buds are killed. During late summer the buds are set and subsequent year needles are well protected (Wagener 1961). Seedlings and saplings are susceptible to and may be killed by even low-intensity ground fires (Volland and Dell 1981).

Tanoak

Tanoak is a fire-sensitive species. Above ground portions are extremely susceptible to fire mortality. The thin bark provides little insulation from radiant heat that usually kills the cambium around the base of the stem (McDonald and Tappeiner 1987). As a result, low-intensity ground fires readily top-kill tanoak seedlings and sapling-sized stems (Tappeiner and McDonald 1984), while larger, thicker barked trees occasionally survive light underburning. However, bole injuries usually result following ground fires, and vertical wounds 4 to 10 feet long are common. Many older tanoak trees may initially survive light burns, but bole wounds facilitate the entry of insects and disease, and most injured trees eventually die (Roy 1974). In virgin redwood stands in Redwood National Park, Veirs (1982) found the oldest tanoak trees occupying sites where frequent underburning by indigenous peoples reduced fuel loadings to the point where only light-intensity ground fires occurred. Crown fires kill the aerial portions of all tanoak, regardless of age or size (Roy 1974).

Tanoak is more susceptible to fire mortality when it occurs beneath a mature conifer overstory. Plants under these conditions are subject to increased stress and are less able to survive fires than when growing in a more open environment (Kauffman and Martin 1985).

Tanoak resprouts following fire via dormant buds located on an underground regenerative organ (Plumb and McDonald 1981). Carbohydrates that are stored in the burl and an extensive taproot system aid in a rapid and aggressive portburn recovery. Unless fires are particularly severe, nearly all tanoak resprout to some extent during the first postburn growing season (McDonald and Tappeiner 1987).

Sites that are particularly prone to the rapid development of a dense tanoak understory are those where the preburn vegetation consists of low conifer stocking combined with high tanoak densities. Fires aimed at suppressing the tanoak understory can be expected to be most effective when conducted in 30 to 75 year old conifer stands (Tappeiner and McDonald 1984).

White fir

The typically thin bark of white fir provides little insulation for the cambium during mild underburns until it reaches diameters greater than 8 inches. Smaller trees are either killed directly or weakened and later die from secondary infection of insects or disease (Atzet and Wheeler 1982). The bark of old white fir trees tends to be moderately thick. Their shallow roots show a tendency towards root char as a common way of killing. This may be the cause of the large amounts of white fir snags along the northeast corner of the Analysis Area.

Sapling and pole-sized white fir have thin bark that provides little insulation for the cambium, and shallow roots that are susceptible to soil heating. Because of its shade tolerance, white fir is slow to self-prune lower branches. These low-growing branches, which have slender twigs and finely divided foliage, easily ignite from burning undergrowth, and provide a fuel ladder to the upper crown. Consequently, even low intensity surface fires often kill young white fir. Larger trees are more fire resistant. Mortality results from crown scorch, girdled stems from cambial heating, or root damage from soil heating. Trees damaged or weakened by fire are susceptible to attack by insects and disease. Fire wounds in contact with the ground provide an entry point for decay fungi. Fire-weakened trees that are attacked by insects can be killed within a few years.

Following stand-replacing fires, white fir reestablishes via wind-dispersed seed. Exposed mineral soil seedbeds created by fire favor seedling establishment. However seedling establishment and survival in sunny locations is often poor. Seedlings establish quickly after fire if a canopy remains, but may take several years to establish if the canopy has been removed.

Because sapling and pole-sized white fir are sensitive to even low-intensity fires, prescribed fire can be used as a thinning tool. In mixed conifer forests where white fir dominates the understory due to years of fire suppression, prescribed low-intensity surface fires will kill large numbers of white fir. This reduces the hazard of white fir providing a fuel ladder to ignite the crown of overstory trees and also restores tree species composition closer to that of pristine conditions. When fire prescriptions cannot ensure that young white fir will not ignite the crown of overstory trees, cutting all trees under a certain size before burning reduces this fire hazard.

Underburning before timber harvesting with the shelterwood method in mixed conifer forests can be used to aid natural regeneration. The combination of cutting and burning can remove all advanced regeneration, thus sanitizing the site of heart rot, which is present in many 5-6 inch diameter white fir. Following harvest seedling establishment of all conifers was abundant (Mohr and Petersen 1984). In some locations preharvest underburning is not recommended because it stimulates dormant shrub seeds to germinate and, thus, promotes the growth of shrubby vegetation that restricts the establishment and growth of conifers (Weatherspoon 1985).

White oak

Historically, Oregon white oak was subjected to a fire regime of low-severity surface fires occurring every few years. A study in the Oregon white oak woodlands of Humboldt Redwoods State Park revealed a history of fire every 7.5 to 13.3 years during the presettlement era (Stuart 1987). Frequent fire resulted in the open savannas typical of presettlement times in the Willamette Valley, Oregon, and the bald hills of California. Dead woody fuels were scant, but flashy fuels (grasses) were abundant and dry early in summer. The fire spread rate was moderated by the gentle topography typical of this cover type. Fire seldom spread into adjacent coniferous forests.

Oregon white oak has adapted to low- to moderate-severity fire by sprouting from the bole, root crown, and roots. Sprouts of this species grow far more rapidly than do seedlings. Young trees not subjected to periodic top-kill by fire followed by sprouting often do not attain sexual maturity before they succumb to herbivory (Sugihara and Reed 1987). Initial establishment of seedlings is somewhat dependent on fire also. Although this species does not require a bare mineral seedbed, seedling recruitment is greatly enhanced when the litter layer has been removed by fire (Arno and Hammerly 1977).

Crown fire generally kills this species. Moderate-severity surface fire rarely kills large trees, but smaller oaks may be killed or suffer severe cambium damage (Burns and Honkala 1990). Low severity surface fire rarely harms mature trees, but seedlings and saplings are commonly top-killed.

Most researchers report vigorous sprouting of top-killed Oregon white oak, although at least one researcher (Griffin 1980) has classified this species as a weak sprouter. Sugihara and Reed (1987) report more vigorous sprouting in 40-year-old than in 70-year-old oaks. Studies conducted on young, even-aged stands show good postfire recovery of these trees.

Fire appears to be the dominant controlling factor involved in converting invading coniferous forests back to Oregon white oak woodland. If a conifer forest is the objective, managers can simply allow young invading conifers to grow. In order to halt conifer establishment and facilitate oak regeneration, a minimum frequency of prescribed burning every 5 years is recommended. Ideally prescribed fire should be set annually. When existing conifers are 10 feet or more in height, oak woodlands can be restored by the removal of conifers with cutting or girdling. A program of prescribed burning is then necessary for long-term maintenance (Sugihara and Reed 1987).

Exotics / Rare Plants

Exotic plants can displace native plants and alter or transform their habitat. Many aggressive exotic species are opportunistic invaders of openings, including those caused by fire or mechanical soil disturbance. Fires or machinery used in burning create openings that can provide opportunities for the spread of exotic plant species from external seed sources or from a latent on-site seed bank. Exotic grass species, which are fire-conducting, have been known to alter fire regimes by increasing fire frequency and, consequently, the composition of plant and animal communities adapted to less frequent fires. Also, rare plants or Survey and Manage species could benefit or be negatively impacted from burning.

Sources

Agee, J.K. and M.H. Huff. 1980. First year ecological effects of the Hoh Fire, Olympic Mountains, Washington. In: R.E. Martin, D.A. Edmonds, J.B. Harrington, and others, Eds. Proceedings of the 6th conference on fire and forest meteorology, April 22-24, 1980, Seattle, WA. Society of American Foresters. pgs. 175-181. Bethesda, MD.

Agee, J.K. 1993. Fire ecology of Pacific Northwest forests. Island Press. Washington, D.C. 493 pp.

Arno, Stephen F., and Ramona P. Hammerly. 1977. Northwest Trees. Seattle WA: The Mountaineers. 222 pp.

Atzet, T. and D.L. Wheeler. 1982. Historical and ecological perspectives on fire activity in the Klamath Geological Province of the Rogue River and Siskiyou National Forests. USDA, Forest Service, Pacific Northwest Region, Portland, OR. p. 16.

Burcham, L.T. 1974. Fire and chaparral before European settlement. In: Rosenthal, Murray, ed. Symposium on living with the chaparral: Proceedings; 1973 March 30-31; Riverside, CA. The Sierra Club, San Francisco, CA: pgs. 101-120

Burns, Russell M., and Barbara H. Honkala, tech. coords. 1990. Silvics of North America. Vol 2. Hardwoods Agric. Handb. 654. Washington, DC: U.S. Department of Agriculture, Forest Service. 877 pp.

Clark, Harold W. 1935. Fire and bird populations. Condor. 37:16-18.

Green, Lisle R. 1980. Prescribed burning in California oak management. In: Plumb, Timothy R., technical coordinator. Proceedings of the symposium on the ecology, management, and utilization of California oaks; June 24-26, 1979; Claremont, CA. Gen. Tech. Rep.

PSW-44. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Forest and Range Experiment Station: pgs. 136-142.

Griffin, James R. 1980. Sprouting in fire-damaged valley oaks, Chews Ridge, California. In: Plumb, Timothy R., technical coordinator. Proceedings of the symposium on the ecology, management, and utilization of California oaks; 1979 June 26-28; Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: pgs. 216-219.

Hermann, R.K. and D.P. Lavender. 1990. *Pseudotsuga menziesii* (Mirb.) Franco Douglas-fir. In: R.M. Burns, B.H. Honkala, Technical coordinators. Silvics of North America. Volume 1. Conifers. Agric. Handbook. p.654. USDA Forest Service, Washington, DC. pgs. 527-540.

Kaufman, J.B. 1990. Ecological relationships of vegetation and fire in Pacific Northwest forests. In: Walstad, J., et al. (eds.), Natural and prescribed fire in Pacific Northwest forests. pgs. 39-52.

Kauffman, J.B. and R.E. Martin. 1985. Shrub and hardwood response to prescribed burning with varying season, weather, and fuel moisture. In: Proceedings of the 8th conference on fire and forest meteorology, April 29-May 2, 1985. Detroit, MI. Society of American Foresters. Bethesda, MD. pgs. 279-286.

Keeley, Jon E. 1981. Reproductive cycles and fire regimes. In: Mooney, H.A., Bonnicksen, T.M., Christensen, N.L., [and others], technical coordinators. Fire regimes and ecosystem properties: Proceedings of the conference; December 11-15, 1978; Honolulu, HI. Gen. Tech. Rep. WO-26. Washington, DC: U.S. Department of Agriculture, Forest Service. pgs. 231-277

Mallory, James I. 1980. Canyon live oak. In: Eyre, F. H., ed. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters: pgs. 125-126.

McDonald, P.M. and J.C. Tappeiner II. 1987. Silviculture, ecology, and management of tanoak in northern California. In: T.R. Plumb, N.H. Pillsbury, Technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources, November 12-14, 1986, San Luis Obispo, CA. General Technical Report, PSW-100. USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA. pgs. 64-70.

Minnich, Richard A. 1976. Vegetation of the San Bernardino Mountains. In: Latting, June, ed. Symposium proceedings: plant communities of southern California; 1974 May 4; Fullerton, CA. Special Publication No. Berkeley, CA: California Native Plant Society: pgs. 99-124.

Minnich, Richard A. 1977. The geography of fire and big-cone Douglas-fir, Coulter pine and western conifer forests in the east transverse ranges, southern California. In: Mooney, Harold A.; Conrad, Eugene, technical coordinators. Proc. of the symp. on the environmental consequences of fire and fuel management in Mediterranean ecosystems; 1977 August 1-5; Palo Alto, CA. Gen. Tech. Rep. WO-3. Washington, DC: U.S. Department of Agriculture, Forest Service: pgs. 443-450.

Minnich, Richard A. 1980. Wildfire and the geographic relationships between canyon live oak, Coulter pine, and bigcone Douglas-fir forests. In: Plumb, Timothy R., technical coordinator. Proceedings of the symposium on the ecology, management and utilization of California oaks; 1979 June 26-28; Claremont, CA. Gen. Tech. Rep. PNW-44. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: pgs. 55-61.

Mohr, F. and G.J. Petersen. 1984. Underburning on white fir sites to induce natural regeneration and sanitation. Fire Management Notes. 45(2):17-20.

Morrison, P.H. and F.J. Swanson. 1990. Fire history and pattern in a Cascade Range landscape. General Technical Report, PNW-GTR-254. USDA Forest Service, Pacific Northwest Research Station, Portland, OR. 77 pp.

Peterson, D.L. and M.J. Arbaugh. 1989. Estimating postfire survival of Douglas-fir in the Cascade range. Canadian Journal of Forest Research. 19:530-533.

Plumb, Tim R. 1980. Response of oaks to fire. In: Plumb, Timothy R., technical coordinator. Proceedings of the symposium on the ecology, management, and utilization of California oaks; 1979 June 26-28; Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: pgs. 202-215.

Plumb, Timothy R.; Gomez, Anthony P. 1983. Five southern California oaks: identification and postfire management. Gen. Tech. Rep. PSW-71. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 56 pp.

Plumb, T.R. and P.M. McDonald. 1981. Oak management in California. General Technical Report, PSW-54. USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA. 11 pp.

Roy, D.R. 1974. Lithocarpus densiflorus (Hook. & Arn.) Rehd. Tanoak. In: C.S. Schopmeyer, Technical Coordinator. Seeds of woody plants in the United States. Agriculture Handbook No. 450. USDA Forest Service, Washington, DC. pgs. 512 514.

Stuart, John D. 1987. Fire history of an old-growth forest of Sequoia sempervirens (taxodiaceae) forest in Humboldt Redwoods State Park, California. Madrono. 34(2):128-141.

Sugihara, Neil G., and Lois J. Reed. 1987. Prescribed fire for restoration and maintenance of Bald Hills oak woodlands. In: Plumb, Timothy R.; Pillsbury, Norman H., technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources;1986 November 12-14; San Luis Obispo, CA. General Technical Report PSW-100. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: pgs. 446-451.

Tappeiner, J.C., and P.M. McDonald. 1984. Development of tanoak understories in conifer stands. Canadian Journal of Forest Research. 14:271-277.

Veirs, S.D. Jr. 1982. Coast redwood forest: stand dynamics, successional status, and the role of fire. In: J.E. Means, Ed. Forest succession and stand development research in the Northwest: Proceedings of the symposium, March 26, 1981, Corvallis, OR. Oregon State University, Forest Research Laboratory, Corvallis, OR. pgs. 119-141.

Volland, L.A. and J.D. Dell. 1981. Fire effects on Pacific Northwest forest and range vegetation. USDA Forest Service, Pacific Northwest Region, Range Management and Aviation and Fire Management, Portland, OR. 23 pp.

Wagener, W.M. 1961. Past fire incidence in Sierra Nevada Forests, Journal of Forestry 59(10): pgs. 739-748.

Weatherspoon, C.P. 1985. Preharvest burning for shrub control in a white fir stand: preliminary observations. In: Proceedings of the 6th annual forest vegetation management conference, November 1-2, 1984, Redding, CA. Forest Vegetation Management Conference, Redding, CA. pgs. 71-88.

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G. FUEL TREATMENTS

Fuelbreaks

Fuelbreak construction includes those activities necessary to permanently modify a strip of heavy, hazardous fuels with dense stand characteristics to a lighter, more open fuel type along a strategically located ridge, natural land feature, or road. “Compartmentalized landscape units of reduced fuel allow safe access for fire suppression crews and provide strategic locations for efficient fire suppression. Stands are manipulated to reduce continuity of canopies, boles are pruned on residual trees and significant quantities of understory fuels are removed” (USFS and BLM 1994, B-7). Fuelbreak construction would entail manipulation of live vegetation by thinning young conifers, limbing larger trees and cutting brush. This activity may be done by manual and/or mechanical means, with prescribed burning as a key component in removing the fine fuels that carry a ground fire and the ladder fuels (e.g. low branches and shrubs) that can carry the fire into the crown. Jackpot fuels (i.e. concentrations of natural or activity fuels) that increase the chance of high intensities, spotting, and torching are also reduced or eliminated during the construction of a fuelbreak. As was shown by the existing fuelbreaks within the Megram Fire, reducing canopy cover and snags also decreases the chance of a crown fire continuing throughout a stand and spotting into an adjoining drainage. Snags left within a fuelbreak could hamper suppression effectiveness. Therefore, if snags are left within the fuelbreak and a wildfire occurs within or downslope from the fuelbreak, all snags that could present safety or spotting problems would be cut down in a control suppression strategy.

This strip of land on which the vegetation has been modified to a lower fuel loading and more open canopy is used for the purposes of:

- breaking up expanses of continuous heavy fuels into smaller blocks that are more manageable from a fire suppression standpoint
- providing safer access to suppression forces during fire control operations
- providing a prepared line and anchor points from which fire suppression forces can backfire to remove hazardous fuels ahead of an oncoming wildfire
- minimizing adverse resource impacts of control strategies and the need for intensive rehabilitation efforts in the event of a large, intense wildfire (e.g. wide dozer firelines)
- providing the infrastructure necessary for adjacent, large area, landscape level prescribed burns to be implemented

Shaded fuelbreaks could also be used to help isolate high-risk areas where understory burning is not desired or practical (e.g. plantations, adjacent to communities, Botanical Areas). In addition, fuelbreaks allow fire control forces to conduct backfiring operations even with the bulk of forces deployed elsewhere (Agee et al. 2000). Individual examples of this occurred during the Megram Fire (Hostler, personal communication 2000).

Fuelbreaks often include “safety islands” (strategic areas where personnel and their equipment can be located safely if a fire is spreading all around them) and improved sources of water. Because of environmental dynamics and the long-term use and strategic nature of fuelbreaks a maintenance and reburn schedule is necessary to keep fuel loading and canopy closure at required standards. “Indefinite maintenance of the fuelbreak in low fuel condition is essential. In the Klamath sub-region, the occurrence of sprouting hardwoods with substantial regrowth potential (Tappeiner et al. 1984) suggests maintenance intervals of a decade or less for fuelbreaks" (Agee and Edmonds 1992). Subsequent treatments should be relatively easy and much less costly because the majority of ladder fuels and jackpots have already been eliminated. Under low to moderate weather conditions, future wildfires would respond in a similar fashion to a prescribed burn, with resulting low to moderate fire severity.

Prescribed Burning

Prescribed fire is any fire ignited by management actions to meet specific objectives, and it includes understory burning (or underburning), pile burning, and jackpot burning. Regarding LSRs in the Klamath Province: "Underburning can be used to reduce fuel loading and some vertical fuel continuity. Wildfires in stands that are managed using underburning are generally less severe, and fire suppression is aided. To increase effectiveness, underburning should be implemented over large areas" (USFS and BLM 1994, B-7).

Understory burning involves the application of prescribed fire to natural or management produced (e.g. thinnings) fuels under an overstory canopy to reduce fuel loading and some vertical fuel continuity. Conditions of weather, fuel moisture, soil moisture, and staffing are chosen that will allow the confinement of the fire to a predetermined area. At the same time prescriptions are designed to produce fire intensities and rates of spread required to accomplish certain planned benefits to one or more objectives of hazard reduction, silviculture, wildlife management, grazing, etc. Since underburning is an area treatment that eventually reduces total dead fuel loads and vertical fuel continuity (Agee and Edmonds 1992), "wildfires entering such stands under most conditions have less severe overstory scorch and allow direct control of the fire. To be effective, underburning must be implemented over wide areas…Underburn sites can be keyed into fuelbreaks to expand fuel-reduced areas. The underburning need not be done at historic return intervals. Monitoring of burned areas where owls exist should be done to determine what effects underburning has, and how long they last."

Large area burns should be the norm (both for economic and ecological efficiency), but at the same time underburning includes some inherent risks. Burning large areas will involve some Riparian Reserves. Large areas may burn in mosaics with varying fire intensity and severity. While this may mimic natural underburning, there are risks associated with retaining coarse woody debris and preserving remaining trees and snags. The likelihood for reburning, spotting, and the killing of some trees is increased as is the possibility for a prescribed burn to escape the planned burn area. The mortality of standing trees would primarily involve younger, thinner barked, or fire intolerant tree species, which, in turn, can contribute to future snags and coarse woody debris. But it is anticipated that by prescribed burning under appropriate weather conditions, subsequent detrimental wildfire effects may be reduced by decreasing the amount of available fuel and breaking up the fuel ladder. To prevent further resource damage, it would be important to remove as much excess heavy, dead fuel material and ladder fuels as possible before understory burning was undertaken. Piling and burning created fuels and burning natural concentrations of fuels (jackpots) would also be important in this removal effort.

Fire Suppression

Beyond fuel treatments that strategically address hazard reduction throughout the landscape, certain other strategies can help improve overall suppression effectiveness. Wildland fire use is the management of naturally ignited wildland fires to accomplish specific prestated resource management objectives in predefined geographic areas outlined in FMPs (NPS et al. 1998). As designated in the Six Rivers National Forest Late-Successional Reserve Assessment (LSRA, Six Rivers NF. 1999) the entire LSR complex was designated as a candidate for wildland fire use. The Wildland Fire Implementation Process will be used real-time to determine where wildland fires in the LSR would help to achieve resource benefits. Wildland fire use should be considered under the right weather and staffing parameters as a way to reduce the long term hazard for this area. This strategy should especially be considered in areas that have already been designated as good candidates for large area understory burns.

Other suppression strategies that should be considered for use under the right weather and staffing parameters include the Minimum Impact Suppression Tactics (MIST) that were developed in Region 1 primarily for use in wilderness areas, proposed wilderness, or other lands with similar land management objectives (USFS 2001). The intention of these tactics was to reduce fire suppression or holding impacts on resources while insuring the actions taken were timely and effective. These low impact tactics for suppression, logistics, aviation, hazardous materials, rehabilitation, and demobilization should be considered throughout the Analysis Area and carried out, if at all possible, in the LSR, wilderness, and any other areas with significant resource concerns (e.g. near landslide areas), except during extreme burning periods when the need to aggressively suppress the wildfire overrides the resource concern. These low impact suppression actions may result in an increase in the amount of time spent watching, rather than disturbing, a dying fire to insure it does not rise again. They may also involve additional rehabilitation measures on the site that were not previously carried out.

Of special importance to this area is cooperative wildland fire management between the Forest Service and federally recognized tribes as indicated in the Memorandum of Understanding between federally recognized tribes sited within the SRNF and the USDA Forest Service: "Such cooperation will benefit natural resources, the parties, and the public, and will provide a foundation for formal and informal consultation on a government-to-government basis and, more specifically, will assure that Tribal concerns are effectively addressed by those managing incidents within areas of concern, and to do so in manners which, at a minimum, do not compromise firefighting safety and effectiveness, and which demonstrate a high regard for cost efficiency." On extended attack fires, tribal representatives will participate in both planning and implementation levels of the Incident Management Organization, and interact with all relevant resources.

Considering the risk and hazard within the Analysis Area, pre-attack planning should also be addressed and pursued to determine the need and placement of water sources, helispots, communication links, etc. It is known that access to water sources is deficient in the Analysis Area, and need to be developed. Pre-attack planning could also incorporate areas of special tribal management consideration regarding cultural or spiritual sites or attributes.

Mechanical and Manual Methods

Mechanical fuel treatments involve the removal or rearrangement of excess or undesirable live and dead fuels through the use of mechanized equipment. Using mechanical methods to rearrange or reduce the fuel profile can mitigate the risks of fire escaping during prescribed fires (and so is often used as a preliminary treatment before prescribed burning) or becoming a crown fire during a wildfire. These fuel treatments can be used for salvage harvesting, thinning, machine piling, crushing, and chipping. Mechanically treated material may be piled on site to be burned later, or physically removed from the site.

The mechanized equipment can include wheeled skidders, crawler-tractors, cable yarders, or specially designed vehicles (e.g. excavators) with attached implements (e.g. disks and blades). Two Missoula Technology and Development Center publications on understory biomass reduction methods (Windell and Bradshaw 2000a, Windell and Bradshaw 2000b) give a general overview of available mechanized equipment. More equipment continues to be developed as the need for fuel treatments increases across the western United States.

In most locations mechanical operations can be carried out under a much wider set of weather conditions than prescribed burning, and may reduce or eliminate air quality concerns. However, mechanical operations may not be feasible or desirable on some sites due to other management objectives (e.g. soil stability, visual quality), site limitations (e.g. access, steep slopes), or costs (Karsky 1993).

Manual fuel treatments can also be used on small scales to remove or rearrange excess or undesirable fuels. Manual fuel treatments include the use of hand-operated power tools and hand tools to cut, clear or prune herbaceous and woody species, and are often employed along roads or within shaded fuelbreaks. Manual treatments may be considered stand-alone treatments or may be followed by burning debris piles or prescribed burning the treatment site.

References

Agee, J.K. and R.L. Edmonds. 1992. Forest protection guidelines for the Northern Spotted Owl. Appendix F of Recovery Plan for the Northern Spotted Owl - Draft. pgs. 419-480

Agee, J.K., B. Bahro, M.A. Finney, P.N. Omi, D.B. Sapsis, C.N. Skinner, J. W. van Wagtendonk, and C.P. Weatherspoon. 2000. The use of shaded fuelbreaks in landscape fire management. Forest Ecology and Management 127:55-66

Hostler, Clarence. 2000. Hydrologist formerly with the Six Rivers National Forest. Personal Communication.

Karsky, D. 1993. Site preparation equipment for steep slopes. Technical Report, 9324-2804-MTDC. USDA Forest Service, Missoula Technology and Development Center, Missoula, MT. p. 91.

Six Rivers National Forest. 1999. Forest-wide Late-Successional Reserve Assessment (LSRA). v. 1.0. April 1999. Document on file, Six Rivers NF, Eureka, CA.

NPS (National Park Service), USDA Forest Service, Bureau of Indian Affairs, U.S. Fish and Wildlife Service, and the Bureau of Land Managment. 1998. Wildland and Prescribed Fire Management Policy – Implementation Procedures Reference Guide. 81pp.

Tappeiner, J.C., T.B. Harrington, and J.D. Walstad. 1984. Predicting recovery of tanoak (Lithocarpus densiflorus) and Pacific madrone (Arbutus menzeisii) after cutting or burning. Weed Science. 32:413-417.

USFS (USDA Forest Service) and BLM (USDI Bureau of Land Management). 1994. Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl and Standards and Guidelines of Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl (known as the Northwest Forest Plan (NWFP)), Portland, OR. April 13, 1994.

USFS (USDA Forest Service). 2001. Six Rivers National Forest Fire Management Plan FY 2001. Six Rivers National Forest, Pacific Southwest Region, 1330 Bayshore Way, Eureka, CA 95501. 306 pp.

Windell, K. and S. Bradshaw. 2000a. Understory biomass reduction methods and equipment. Technical Report, 0051-2828-MTDC. USDA, Forest Service, Missoula Technology and Development Center, Missoula, MT. p. 32.

Windell, K. and S. Bradshaw. 2000b. Understory biomass reduction methods and equipment catalog. Technical Report, 0051-2826-MTDC. USDA Forest Service, Missoula Technology and Development Center, Missoula, MT. p. 156.

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H. ESTIMATING LANDSLIDE VOLUMES & SEDIMENT DELIVERY

Raines and Kelsey (1991) developed a sediment budget for the Grouse Creek watershed in the nearby South Fork Trinity Basin. A part of their study involved an inventory of active landslides similar to that done for the LMK Analysis Area, including both the measurement and estimation of sediment delivery from these mass wasting features. They developed a mathematical relationship of the form $V = yA^x$ for shallow, rapid landslides where V is estimated volume delivered and A is the slide's area. The coefficient y and exponent x were estimated from statistical regression of field-collected data.

The Six Rivers National Forest has continued to collect and analyze landslide data on about 350,000 acres, including field data relating area to volume across the variety of geologic and geomorphic terranes of the Forest. From these data as well as theoretical considerations, we have progressively refined or calibrated the equation coefficients to reflect variation in slide geometry on different geologic/geomorphic sites.

In Grouse Creek, Raines and Kelsey (1991) found the best fit for their data using y = 0.821 and x = 1.134 as an average across all geologic and geomorphic units. Our subsequent data indicates that slides tend to be consistently deeper in some geologic units than in others, especially in old landslide deposits, and also vary according to slope position. Therefore, we have adjusted the coefficients upward or downward for the LMK Analysis Area data as shown in the following table. Values are generally higher for weaker geologic units or for the deeper regolith expected in lower slope positions (where the majority of slides occur anyway).

Table 55 Calibrated Coefficients for Estimating Volume of Sediment Delivery of Landslides for Various Geology.

	Upper/Middle		Lower/Streamside	
Geology	**y**	**x**	**y**	**x**
wht, Mzgb	0.55	1.06	0.65	1.08
Jgv, Jum, Mzum	0.65	1.08	0.70	1.09
Jgs, rct	0.70	1.09	0.75	1.10
sfm	0.75	1.10	0.85	1.12
Qls in wht, Mzgb	0.65	1.08	0.70	1.09
Qls in Jgv, Jum, Mzum	0.75	1.10	0.85	1.12
Qls in Jgs, rct	0.85	1.12	0.90	1.13
Qls in sfm	0.85	1.12	0.95	1.14

- wht = Western Hayfork Terrane
- Mzgb = Mesozoic gabbro
- Jgv = Galice metavolcanic
- Jum & Mzum = ultramafic rocks
- Jgs = Galice metasedimentary
- rct = Rattlesnake Creek Terrane
- sfm = South Fk Mtn schist
- Qls = Quaternary landslide deposits

These coefficients were applied in calculating an estimated volume of all shallow debris slides or avalanches (the majority of mapped features), but they were further adjusted for other types of slide features – slightly lower for rockfalls and slightly higher for debris flows and deep-seated slides. This was primarily on a theoretical basis that the latter features would tend to be deeper for a given area than the former types of slides.

There was no time budgeted for field-checking of area-to-volume relationships in the LMK Analysis Area prior to completing this watershed analysis. It is anticipated that watershed specialists will collect some data as projects are developed and NEPA analysis is done in different parts of this area.

Sources

Raines, M.A., and H.M. Kelsey. 1991. Sediment budget for the Grouse Creek basin, Humboldt County, CA. Bureau for Faculty Research, Western Washington University, Bellingham, WA. 110 pp.

I. MANAGEMENT INDICATOR SPECIES

Under the National Forest Management Act (NFMA), the USFS is directed to "provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives" (P.L. 94-588, Sec 6 (g) (3) (B)). The 1982 regulations implementing NFMA require that: "Fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area" (36 CFR 219.19). MIS is a concept used by the agency to serve as a barometer for species viability at the Forest level. Population changes of MIS are believed to indicate the effects of management activities.

The Six Rivers National Forest (SRNF) Land and Resource Management Plan (LRMP) uses MIS to assess potential effects of project activities on the various habitats and habitat assemblages with which these species are associated. Forty-one Forest fish and wildlife species have been selected as MIS or assemblages for a variety of habitats that are potentially affected by resource management activities on the SRNF. Table 56 lists the MIS and assemblages occurring on the SRNF, and those known or thought to occur within the LMK Analysis Area based on habitat suitability, survey results, or incidental sighting records. Habitat suitability evaluations were made using the California Wildlife Habitat Relationships System, Version 8.0 software, developed by the California Department of Fish and Game (CDFG).

Species Information

Individual Species

Northern Spotted Owl

Species information is listed under the Terrestrial Wildlife Species section of Chapter 3.

Pileated Woodpecker

Suitable and optimal pileated woodpecker habitat is similar to conditions preferred by the northern spotted owl and the fisher. Pileated woodpeckers prefer multi-storied mature and late-mature successional conifer forests with moderate to dense canopy closure, and abundant snags and down logs. This species forages primarily in dead wood; therefore, both standing snag and down log densities are important indicators of habitat quality.

Suitable habitat for the pileated woodpecker exists within the Analysis Area. No project-specific surveys for the pileated woodpecker have occurred to date within the Analysis Area. However, the species has been recorded, associated with the Orleans Breeding Bird Survey (BBS) Route (CAL-167); an average of less than 1.0 observations have been recorded per route since route initiation. The SRNF Wildlife Sighting Record Database contains approximately 31 sighting records for the LMK Analysis Area. An evaluation of habitat conditions utilizing the California Wildlife Habitat Relationship Model displayed approximately 15,205 acres of high quality habitat within the Analysis Area.

Table 56 MIS Species and Habitat Assemblages within the LMK Analysis Area.

MIS Species and Habitat Assemblages	Present	Suitable Habitat Present
Individual Species		
Northern Spotted Owl	Yes	Yes
Pileated woodpecker	Yes	Yes
Black Bear	Yes	Yes
American marten	Yes	Yes
Fisher	Yes	Yes
Black-tailed deer	Yes	Yes
Bog/Seep/Spring/Wet Meadow Assemblage		
Southern Torrent Salamander	Yes	Yes
Marsh/ Lake/ Pond/ Assemblage		
California red-legged frog	No	No
Western pond turtle	Yes	Yes
Wood duck	Yes	Yes
River/Stream/Creek Assemblage		
Cutthroat trout	No	No
Steelhead/rainbow trout	Yes	Yes
Tailed frog	Suspected	Yes
Summer steelhead		
Common merganser	Yes	Yes
Ruffed grouse	Yes	Yes
Winter wren	Yes	Yes
American dipper	Yes	Yes
Yellow-breasted chat	Yes	Yes
Tanoak/Madrone Assemblage		
Hammond's Flycatcher	Yes	Yes
Western Tanager	Yes	Yes
Black-headed grosbeak	Yes	Yes
Snag Assemblage		
Flammulated Owl	Yes	Yes
Western screech owl	Yes	Yes
Red-breasted sapsucker	Yes	Yes
Downy woodpecker	Yes	Yes
Hairy woodpecker	Yes	Yes
White-headed woodpecker	Yes	Yes
Vaux's swift	Yes	Yes
Brown creeper	Yes	Yes
Western bluebird	Yes	Yes
Douglas squirrel	Yes	Yes
Down Woody Debris Assemblage		
Arboreal salamander	Suspected	Yes
Clouded salamander	Suspected	Yes
Blue grouse	Yes	Yes
Dusky-footed wood rat	Yes	Yes
Western fence lizard	Yes	Yes
Black Oak/White Oak Assemblage		
Acorn woodpecker	Yes	Yes
Scrub jay	Yes	Yes
Lazuli bunting	Yes	Yes
Western gray squirrel	Yes	Yes

Black Bear

The black bear is a widespread, common to uncommon resident occurring from sea level to high mountain regions. The black bear occurs in dense, mature stands of forest habitats, and feeds in a variety of habitats including brushy stands of forest, valley foothill riparian, and wet meadow. This species requires large trees and various cavities and hollows in trees, snags, stumps, logs, uprooted trees, talus slopes, or in the earth for denning. These habitat elements must be in mature, dense vegetation, and on sheltered slopes for adequate denning.

The black bear was selected as an MIS because of its habitat association with mid and late–successional stages of all forest vegetation types, meadow types, and its large down log requirements. CDFG monitors black bear populations within northwestern California. CDFG estimates the population in 2001 to be approximately 17,000 to 23,000 animals and reports the population to be increasing, which is reflected in the increase of bear tags being issued in recent years. The northern portion of California is continually noted by CDFG as supporting the highest density of bears of any area within the western United States.

Suitable habitat for the black bear exists within the LMK Analysis Area. There are 4 sightings listed within the Forest Wildlife Database recorded for this species within the Analysis Area, although bears are known to be quite common. No systematic surveys for the black bear have occurred to date within the LMK Analysis Area. An evaluation of habitat conditions utilizing the California Wildlife Habitat Relationship Model displayed approximately 15,023 acres of high quality habitat within the LMK Analysis Area.

American Marten

Species information is listed under the Terrestrial Wildlife Species section of Chapter 3.

Fisher

Species information is listed under the Terrestrial Wildlife Species section of Chapter 3.

Black-tailed Deer

CDFG monitors black-tailed deer populations in the LMK Analysis Area. The Blacktail deer population on the SRNF is estimated at 17,000 (USFS 1995, III-58). Approximately 12,799 acres is designated as a Key Deer Herd Area for the Hoopa sub-unit of the Redwood Creek Deer Herd within the Analysis Area. Objectives of this habitat management area are outlined in the Deer Herd Management Plans in the LRMP (USFS 1995, IV-102). The herd has an estimated population of 1,700 animals (4.3 deer/sq. mi) (USFS 1995, III-59).

Suitable habitat for the black-tailed deer exists within the Analysis Area. An evaluation of habitat conditions utilizing the California Wildlife Habitat Relationship Model displayed approximately 22,318 acres of high quality habitat within the Analysis Area.

Bog/Seep/Spring/Wet Meadow Assemblage

Southern Torrent Salamander

This species is found from near sea level to 4820 feet in elevation (Welsh and Lind 1996). Preferred habitat is described as cold, permanent seeps and small streams with a rocky substrate (Jennings and Hayes 1994). Welsh and Lind (1996) found that this species is associated with cold, clear headwater to low-order streams with loose, coarse substrates in humid forest habitats of large conifers, abundant moss, and greater than 80% canopy cover. These conditions are mostly found within late-seral stage forests. According to Welsh and Lind (1996) suitable habitat has the following characteristics: (1) conifer dominated forests associated that have mature to old-growth structural attributes, with 15-130 conifers per acre greater than 21 inches dbh, 72-100% canopy closure, low numbers of cut stumps, low percent cover of grass, and high percent cover of moss, (2) seep or other shallow, slow flowing habitats, that have cold, clear water in first to third order streams, with 15-46% of the substrate in cobble, a mix of coarse substrates (cobble, pebble, and gravel), 3-47% substrate cementedness, and sand and fine organic particles present, and 3) water temperature from 43.7-59.0 °F.

Within the Analysis Area habitat for this species exists in association with riparian habitats adjacent to springs, seeps, and intermittent and perennial stream courses. The SRNF Wildlife Sighting Record Database contains 3 sighting records for the Analysis Area. An evaluation of habitat conditions utilizing the California Wildlife Habitat Relationship Model showed approximately 318 acres of moderate to high quality habitat within the Analysis Area.

Marsh/Lake/Pond Assemblage

California Red-legged Frog

The LMK Analysis Area is outside of the species range for the California red-legged frog. No further discussion of the California red-legged frog is warranted within this document.

Western Pond Turtle

Species information is listed under the Terrestrial Wildlife Species section of Chapter 3.

Wood Duck

The wood duck is an uncommon yearlong resident, occurring mainly in the central valley and in the Coast Ranges of central California. Preferred habitats include lakes, ponds, and slow moving riverine habitats bordered by deciduous trees (willows, cottonwoods, and oaks). The species utilize cavities in trees for nesting, often preferring abandoned pileated woodpecker cavities as well as nest boxes.

Suitable habitat for the wood duck is occurs within the Analysis Area primarily within the slower moving reaches of the Klamath River and tributaries as well as several ponds in the northwestern portion (Twin Lakes & Dry Lake). There are 8 sightings listed within the Forest Wildlife Database recorded for this species within the Analysis Area. The species has not been recorded, associated with the Orleans BBS Route (CAL-167). No systematic surveys for the wood duck have occurred to date within the Analysis Area.

River/Stream/Creek Assemblage

Cutthroat Trout

The LMK Analysis Area is outside the species range for the cutthroat trout. No further discussion of the cutthroat trout is warranted within this document.

Steelhead/Rainbow Trout

Species information is listed under the Water Quality and Fisheries section of Chapter 3.

Tailed Frog

The tailed frog is often considered uncommon, but has been shown by experienced observers to be quite common in suitable habitats. Presently, this species is known only from Del Norte, Humboldt, Siskiyou, Trinity, Shasta, Tehama, and Mendocino Counties (Bury 1968). Salt (1952) suggested a southern limit to the range as far south as central Sonoma County. The tailed frog occurs within montane hardwood-conifer, redwood, Douglas-fir, and ponderosa pine habitats from sea level to 6500 feet in elevation.

Adults forage primarily terrestrially along stream banks but occasionally feed underwater. Adults seek cover primarily under submerged rocks and logs within the stream or occasionally under similar objects close to the stream. Individuals have also been found in crevices in spray-drenched cliff walls near waterfalls. Most California populations occur in areas that receive more than 100 cm (40 inches) of rainfall annually and distribution may be limited by the required presence of permanent streams (Bury 1968). This species is restricted to perennial montane streams in steep-walled valleys with dense vegetation.

Suitable habitat for this species does exist within perennial drainages associated with cascades within the LMK Analysis Area. The SRNF Wildlife Sighting Record Database contains 4 sighting records for the Orleans Ranger District. However, no sighting records occur within the Analysis Area. No systematic surveys for the tailed frog have occurred to date within the Analysis Area although its presence is suspected based on suitable habitat.

Common Merganser

The common merganser is considered a locally common breeder on lakes, ponds, and large streams of the Coast, Klamath, Cascade, and Sierra Nevada ranges. The species utilize deciduous riparian woodland associated with streams, rivers, and lakes for breeding. The common merganser nests primarily within cavities, however, it is known to nest within root masses and down woody debris.

Suitable habitat for the common merganser is not limited within the Analysis Area and occurs throughout the majority of the Klamath River reaches and tributaries as well as several ponds in the northwestern portion (Twin Lakes & Dry Lake). There are 2 sightings listed within the Forest Wildlife Database recorded for this species within the Analysis Area. In addition, the species has been recorded, associated with the Orleans BBS Route (CAL-167); an average of 2.67 observations have been recorded per route since route initiation. No systematic surveys for the common merganser have occurred to date within the Analysis Area.

Ruffed Grouse

The ruffed grouse is an uncommon, local resident of valley foothill riparian and surrounding conifer forests at low to middle elevations in northwestern California. Yocum (1978) reported distribution in recent decades from extreme northern Del Norte County south to extreme southern Humboldt County and westward to northern Trinity County. The ruffed grouse utilizes a variety of habitats, specifically riparian stands with young and old deciduous trees mixed with brushy areas interspersed that contain herbaceous inclusions. The species is noted to utilize conifer stands for cover. The species requires deciduous hardwood species for meeting feeding requirements. These species include aspen, alder, and willow, specifically the buds and catkin.

As noted by CDFG, ruffed grouse populations within northern California remain consistently stable, which is reflected in the stability of the hunter harvest bag limit regulations over the last 5-8 years. No systematic surveys for this species have been conducted within the LMK Analysis Area. Suitable habitat for this species exists, and is associated with the intermittent and perennial drainages within the Analysis Area. In addition, the species has been recorded, associated with the Orleans BBS Route (CAL-167); one observation has been recorded since route initiation. The SRNF Wildlife Sighting Record Database contains 39 sighting records for the Analysis Area. No systematic surveys for the ruffed grouse have occurred to date within the Analysis Area. An evaluation of habitat conditions utilizing the California Wildlife Habitat Relationship Model showed approximately 387 acres of moderate to high quality habitat within the Analysis Area.

Winter Wren

The winter wren is an uncommon resident in dense, mature conifer, hardwood-conifer, and riparian forests of the humid coastal belt from the Oregon border to northern San Luis Obispo County. The species prefers low, tangled vegetation with logs and other downed woody debris that provide cover. Habitat preferences include dense, mature forests combined with dense riparian vegetation near streams. The species is noted as nesting within existing cavities and within recesses associated with logs, stumps, and root tangles.

No systematic surveys for this species have been conducted within the LMK Analysis Area. However, the species has been recorded, associated with the Orleans BBS Route (CAL-167) (Orleans RD); detections have been recorded since route initiation. Specifically, the average detection rate associated with the Orleans BBS Route is 1.0 per route per annum. The SRNF Wildlife Sighting Record Database does not contain any sighting records for the LMK Analysis Area. An evaluation of habitat conditions utilizing the California Wildlife Habitat Relationship Model displayed approximately 387 acres of moderate to high quality habitat within the Analysis Area.

American Dipper

This species is an uncommon to common resident on clear, fast-flowing streams and rivers in montane regions throughout California. It is common in the Cascade and Sierra Nevada ranges, occupying riverine habitats up to 11,600 feet in elevation. The species breeds from March into August, with peak activity from May into July. In general, the species is confined to clear, clean streams and rivers with rocky shores and bottoms in montane habitat. The species forages on aquatic insects and larvae, small fish, snails, tadpoles, and occasionally flying insects. In addition, the American Dipper is noted for gleaning rocks in streams, on shore, and under water in seeking small fish, insects, and tadpoles. The nest structure is often a domed nest of grasses, mosses, and leaves usually within 3-6 feet of stream surface in a location inaccessible to mammals. The nest may be on a crevice in rocks, behind waterfalls, within stumps or logs, in banks, and bridges or other human-made structure.

No systematic surveys for this species have been conducted within the Analysis Area. However, the species has been recorded, associated with the Orleans BBS Route (CAL-167) (Orleans RD); detections have been recorded since route initiation. Specifically, the average detection rate associated with the Orleans BBS Route is 1.0 per route per annum. The SRNF

Wildlife Sighting Record Database contains one sighting record for the LMK Analysis Area. Suitable habitat for this species is not limited within the analysis area and occurs throughout the majority of the reaches of the Klamath River and tributaries.

Yellow-breasted Chat

The yellow-breasted chat is an uncommon summer resident and migrant in coastal California and in the foothills of the Sierra Nevada. It is uncommon along the coast of northern California, and occurs locally south of Mendocino County (McCaskie et. al. 1979). In migration the species may be found in lower elevation mountains within riparian habitat that is associated with thickets of willows and other brushy vegetation near watercourses, which provide cover. Habitat preferences include riparian communities associated with open forest vegetation typical of young pole stands that contain a dense brush component.

No systematic surveys for this species have been conducted within the LMK Analysis Area. The species has been associated with the Orleans BBS Route (CAL-167) (Orleans RD), and has been recorded since route initiation. Specifically, the average detection rate associated with the Orleans BBS Route is 8.0 per route per annum. The SRNF Wildlife Sighting Record Database contains one sighting record for the Analysis Area. Suitable habitat for this species is not limited within the Analysis Area and occurs throughout the majority of the reaches of the Klamath River and tributaries.

Tan Oak/Madrone Assemblage

Hammond’s Flycatcher

The Hammonds flycatcher is a common summer resident in dense coniferous forests at about 4000-8000 ft from the Cascade Range south along the western slope of the Sierra Nevada to Kern County. Preferred nesting habitats include mixed conifer and red fir. The species also may nest in denser Jeffrey and ponderosa pine habitats, and in Douglas-fir habitat in the mountains of the northern California coast down to about 2000 ft. Common spring (mid-April to early May) and uncommon fall (September to early October) transients are found in all wooded habitats from sea level to timberline throughout interior and southern coastal California. This species frequents older forests, which provide well-shaded nesting and roosting sites, singing posts, and foraging perches. Nests are most commonly found in deeply shaded foliage underneath the dense canopy of older forests.

This species has been recorded, associated with the Orleans BBS Route (CAL-167) (Orleans RD); one observation has been recorded since route initiation. The SRNF Wildlife Sighting Record Database contains one sighting record for the Analysis Area. No systematic surveys for this species have been conducted within the Analysis Area. Habitat conditions present within the LMK Analysis Area for the Hammond's flycatcher are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 34,463 acres of moderate to high quality habitat exists within the Analysis Area.

Western Tanager

The western tanager is a common breeding resident of montane forests throughout most of California, including the coastal ranges. This species is common and widespread in its migration in foothills and lowlands. For breeding, this species prefers moderately open, mature, coniferous forests with associated hardwoods, but also frequents edges of denser stands. It is probably most common in mixed conifer and montane hardwood-conifer habitats, but also nests in montane hardwood habitat, including stands dominated by live oaks. They occur widely in other wooded habitats during migration, when in winter they prefer groves of exotic trees, especially flowering eucalyptus. This species breeds in the Coast Range, usually avoiding the fog belt (Grinnell and Miller 1944, McCaskie et al. 1979, Garrett and Dunn 1981).

This species has been recorded, associated with the Orleans BBS Route (CAL-167), with an average detection rate of 30.0 per route per annum. The SRNF Wildlife Sighting Record Database contains one sighting record for the Analysis Area. No systematic surveys for this species have been conducted within the Analysis Area.

Habitat conditions present within the LMK Analysis Area for the western tanager are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 34,463 acres of moderate to high quality habitat exists within the Analysis Area.

Black-headed Grosbeak

The black-headed grosbeak is a common summer resident and transient. This species is a common breeder throughout most of California, excluding higher mountains, Great Basin, and southern deserts. This species frequents valley foothill hardwood, valley foothill hardwood-conifer, valley foothill riparian, and montane riparian habitats. It is less common in other wooded habitats of lower montane elevations, and is often near water and areas where deciduous oaks are numerous. It is rare and irregular in California from October to late March (Grinnell and Miller 1944, McCaskie et al. 1979, Garrett and Dunn 1981). This species builds nests in shrubs or trees, often beside streams or other water, but may be located away from water in open woodland, orchards, or near edges of denser woodland. The black-headed grosbeak occurs in open woodlands and near edges of denser stands, and favors habitats with deciduous trees, especially oaks, and a diversity of plant life.

This species has been recorded, associated with the Orleans BBS Route (CAL-167) (Orleans RD), with an average detection rate of 7.0 per route per annum since route initiation. The SRNF Wildlife Sighting Record Database contains one sighting record for the Analysis Area. No systematic surveys for this species have been conducted within the Analysis Area.

Habitat conditions present within the Analysis Area for the black-headed grosbeak are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 34,463 acres of moderate to high quality habitat exists within the Analysis Area.

Snag Assemblage

Flammulated Owl

Flammulated owls are an uncommon summer resident locally in a variety of coniferous habitats from ponderosa pine to red fir forests. The species breeds within the north coast of California, and Klamath Ranges, Sierra Nevada, and within suitable habitat in mountains in southern California. The species is found within montane regions from 6,000 to 10,000 ft in elevation. Flammulated owls roost close to the trunks of fir or pine trees, and may also occasionally use cavities in trees or snags for cover (Zeiner et al. 1990). Males utilize territorial “song posts”, which are mostly associated with mature, open stands of mixed ponderosa pine and Douglas-fir (Reynolds and Linkart 1987). They prefer habitat types with low to intermediate canopy closure.

Habitat conditions within the LMK Analysis Area for the flammulated owl are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 27,799 acres of moderate to high quality habitat exists within the Analysis Area. High quality habitat is associated with old-growth ponderosa pine forests, mixed with California black oak and Douglas-fir combined with fairly open canopies. No surveys to protocol have been conducted for the flammulated owl within the Analysis Area.

This species has not been recorded, associated with the Orleans BBS Route (CAL-167) (Orleans RD). The SRNF Wildlife Sighting Record Database contains approximately six sighting records for the Analysis Area. No systematic surveys for this species have been conducted within the LMK Analysis Area.

Western Screech Owl

The western screech owl is an uncommon to common, yearlong resident of open, pinyon juniper, riparian, redwood, and mixed conifer habitats. The species occurs throughout the length of California to 8,000 feet in elevation with the exception of the central and western portions of the Mojave Desert (Garret and Dunn 1981). Western screech owls are secondary cavity nesters, and typically utilize abandoned woodpecker cavities, as well as hollow trees, logs, and stumps, for nesting. The species utilizes a variety of habitats from coniferous to oak-woodland forest communities in combination with openings, meadows, and riparian areas.

Habitat conditions present within the Analysis Area for the western screech owl are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 48,119 acres of moderate to high quality habitat exists within the Analysis Area. No surveys have been conducted for the western screech owl within the Analysis Area. The SRNF Wildlife Sighting Record Database contains approximately 19 sighting records for the Analysis Area. This species has not been recorded, associated with the Orleans BBS Route (CAL-167) (Orleans RD).

Red-breasted Sapsucker

This species is an uncommon to fairly common, yearlong or summer resident in open wooded mountainous regions of California. Occurs from the Oregon border south in the Coast Range, along the coast to Marin County, and along both the eastern and western slopes of the Cascade Range and Sierra Nevada south to Kern County (Grinnell and Miller 1944, Zeiner et al. 1990). Like other sapsuckers and woodpeckers, the red-breasted sapsucker requires tree cavities for nesting and roosting. The species is an important cavity excavator, providing nest and roost cavities for a community of secondary cavity nesters. Snags and hardwood availability are habitat variables of special consideration for these sapsuckers (Airola 1980). The species prefers nesting habitat within montane riparian habitats (aspen), montane hardwood-conifer, mixed conifer, and red fir, especially near meadows, clearings, lakes, and slow moving streams.

Habitat conditions present within the LMK Analysis Area for the red-breasted sapsucker are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 48,506 acres of moderate to high quality habitat exists within the Analysis Area. No systematic surveys have been conducted for the red-breasted sapsucker within the Analysis Area. The species has been recorded, associated with the

Orleans BBS Route (CAL-903) (Mad River RD); two observations have been recorded since route initiation. The SRNF Wildlife Sighting Record Database contains one sighting record for the Analysis Area.

Downy Woodpecker

This species is a common, yearlong resident of riparian deciduous and associated hardwood and conifer habitats. It occurs throughout the state of California with the exception of the southern California desert regions, and is typically found below 5900 feet in elevation. The species is closely associated with riparian softwoods, and also utilizes hardwood and conifer in proximity to riparian habitats. The downy woodpecker exhibits a preference for aspen communities adjacent to riparian conifer/deciduous habitats.

Habitat conditions present within the LMK Analysis Area for the downy woodpecker are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 48,578 acres of low to moderate quality habitat exists within the Analysis Area. No surveys have been conducted for the downy woodpecker within the LMK Analysis Area. The SRNF Wildlife Sighting Record Database does not contain any sighting records for the LMK Analysis Area. The species has not been recorded on the Orleans BBS Route (CAL-167) (Orleans RD) since route initiation.

Hairy Woodpecker

This species is a fairly common, permanent resident of mixed conifer and riparian deciduous habitats from sea level to 9,000 feet in elevation. The species occurs throughout the state of California, but is scarce to absent in portions of coastal central California, the Central Valley, Salinas Valley, Mojave, and the Great Basin. Specific habitat includes relatively open or patchy stands of conifers with adjacent riparian habitats and abundant snags. The hairy woodpecker is a primary cavity excavator and develops cavities within the interior of snags and or dead branches.

Habitat conditions present within the LMK Analysis Area for the hairy woodpecker are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 49,497 acres of low to moderate quality habitat exists within the Analysis Area. No surveys have been conducted for the hairy woodpecker within the Analysis Area. The SRNF Wildlife Sighting Record Database does not contain any sighting records within the watersheds. The species has also been recorded associated with the Orleans BBS Route (CAL-167) (Orleans RD); detections have been recorded since route initiation, and, specifically, the average detection rate is 1.0 per route per annum.

White-headed Woodpecker

This species is a common yearlong resident of montane coniferous forests up to lodgepole pine and red fir habitats. It occurs in the Sierra Nevada, Cascade, Klamath, Transverse and Peninsular ranges, and Warner Mountains. Occasionally found at lower elevations along the north coast and interior areas (McCaskie et al. 1979). The species forages on live, mature conifers with deeply creviced and scaly bark (Raphael and White 1984) and also on snags and pine and fire cones. The white-headed woodpecker prefers semi-open areas with large mature trees that provide 40-70% canopy closure. Cavities are excavated in large snags or stumps with a minimal diameter of 2 feet.

Habitat conditions present within the LMK Analysis Area for the white-headed woodpecker are limited as shown by the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 1,682 acres of low quality habitat exists within the LMK Analysis Area. No systematic surveys have been conducted for the white-headed woodpecker within the Analysis Area. The SRNF Wildlife Sighting Record Database does not contain any sighting records for the Analysis Area. The species has not been recorded, associated with the Orleans BBS Route (CAL-167) (Mad River RD); no detections have been recorded since route initiation.

Vaux's Swift

Vaux's swifts are summer breeding residents of northern California. They breed fairly commonly in the Coast Ranges from Sonoma County in the north and very locally south to Santa Cruz County. The species prefers redwood and Douglas-fir habitats with nest sites in hollow trees and snags (Baldwin and Hunter 1963). They are fairly common migrants throughout most of California in April-May and August-September. Vaux's swift occur in spring and summer, although not necessarily as breeders, on the SRNF (Timossi 1990). Timossi (1990) indicates that a wide variety of tree sizes and cover classes are used for reproduction, feeding, and cover, however, Baldwin and Zaczkowski (1963) found nests in stubs in areas with continuous canopy. Because forest edges, meadows, burned areas, and special features like streams, rivers, ponds, and lakes are used for foraging, habitat fragmentation would appear to have little effect on these swifts.

Vaux's swifts are likely to be sensitive to activities that limit the availability of snags and stubs for nesting and roosting. Habitat characteristics that can be maintained through management include the retention and enhancement of stream and meadow habitat for foraging areas as well as large snags.

Habitat conditions present within the LMK Analysis Area for the Vaux's swift are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 48,184 acres of low to moderate quality habitat exists within the Analysis Area. No surveys have been conducted for the Vaux's swift within the Analysis Area. The SRNF Wildlife Sighting Record Database contains no sighting records for the LMK watersheds. The species has been recorded, associated with the Orleans BBS Route (CAL-167) (Orleans RD); approximately 13 observations have been recorded since route initiation.

Brown Creeper

The brown creeper is a common to uncommon resident in montane habitats throughout the state of California, and in coastal conifer habitats south to San Luis Obispo County. It is a rare transient in southern deserts and on the Channel Islands in fall and winter. The species prefers habitats containing dense, mature stands of conifers, but is also found in hardwood and hardwood-conifer habitats, especially in winter (Grinnell and Miller 1944, Garrett and Dunn 1981). Hardwoods and riparian deciduous trees are also used as a source of cover primarily during winter. Nests are typically constructed behind loose bark and rarely within cavities, and are found usually within old-growth incense cedar, coastal redwood, pine, fir, or snags.

Habitat conditions present within the LMK analysis area for the brown creeper are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 27,779 acres of moderate to high quality habitat exists within the Analysis Area. No surveys have been conducted for the brown creeper within the Analysis Area. The SRNF Wildlife Sighting Record Database contains no sighting records for the LMK watersheds. The species has been recorded, associated with the Orleans BBS Route (CAL-167) (Orleans RD); detections have been recorded since route initiation, and the average detection rate is 3.00 per route per annum.

Western Bluebird

These birds are fairly-common, to common, year-round residents throughout much of California, excluding the higher mountains and eastern deserts. The western bluebird breeds in open woodland of oaks, riparian deciduous trees, or conifers with herbaceous understory. Optimal habitats include sparse to open canopied, mature, valley foothill and montane hardwood and hardwood-conifer communities. It is uncommon in habitats without adjacent forest cover. The availability of snags frequently limits population density (Ross 1933, Raphael and White 1978, Ehrlich 1988). The species typically nests within vacant woodpecker cavities within snags and stumps, and will occasionally use nests of the cliff swallow.

Habitat conditions present within the LMK Analysis Area for the western bluebird are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 142 acres of moderate quality habitat exists within the Analysis Area. No surveys have been conducted for the western bluebird within the LMK Analysis Area. The SRNF Wildlife Sighting Record Database does not contain any sighting records for the Analysis Area. The species has not been recorded, associated with the Orleans BBS Route (CAL-167) (Orleans RD), since route initiation.

Douglas Squirrel

This squirrel is a common, yearlong resident of conifer, hardwood conifer, and riparian habitats of the Sierra Nevada, Cascade, Klamath, North Coast, and Warner ranges. The Douglas squirrel occurs in California from sea level to 11,000 feet in elevation. Douglas squirrels are omnivorous and eat primarily conifer seeds and fungi as well as, occasionally, arthropods, bird eggs, and nestlings. Mature trees with substantial crown closure provide cover for this species. The species generally avoids forested habitats with considerable shrub understory. Reproductive activity occurs within mature conifer stands and nests are usually located within vacant cavities with live green trees and snags. However, the Douglas squirrel is known to utilize rock cavities and nests of vegetative material located in the upper canopy.

Habitat conditions present within the LMK Analysis Area for the Douglas squirrel are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 15,360 acres of high quality habitat exists within the Analysis Area. No systematic surveys have been conducted for the Douglas squirrel within the LMK Analysis Area. The SRNF Wildlife Sighting Record Database contains 2 sighting records for the Analysis Area.

Downed Woody Material Assemblage

Arboreal Salamander

The arboreal salamander is found in the Coast Ranges from northern Humboldt County south to Mexico border. This species is only found on the surface during moist periods, when it can be located without difficultly. The arboreal salamander occurs primarily in valley-foothill hardwood, valley-foothill hardwood-conifer, and mixed conifer habitats. However, it is also found within Douglas-fir to redwood habitat types. Additionally, the species may be found in chaparral of southern California. Moisture requirements are usually met by fall, winter, and spring rainfall. During dry periods, this salamander retreats to moist, natural, or human made refuges including rodent burrows, seepages, rock fissures, mine shafts, caves, spring boxes, water tanks, and wells.

Habitat conditions present within the LMK Analysis Area for the arboreal salamander are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 6,782 acres of moderate quality habitat exists within the Analysis Area. Surveys for terrestrial mollusks were conducted within and adjacent to the LMK Analysis Area in 1998 to 2001 and no incidental detections for the arboreal salamander were recorded. The SRNF Wildlife Sighting Record Database does not contain any sighting records for the Analysis Area, but their presence is suspected based on suitable habitat.

Clouded Salamander

The clouded salamander is found in the humid coastal forests of northern California from the Oregon border to central Mendocino County. Habitats utilized include Douglas-fir, redwood, red fir, and valley-foothill riparian communities. This species is not commonly observed in dry periods, and probably aestivates during these periods. The species is usually found under logs and beneath the bark of snags or logs. They have also been observed utilizing talus piles and moist rock crevices (Behler and King 1979). The clouded salamander is most abundant in dense old-growth forest but also occur at the borders of clearings (Stebbins 1985). Dry seasons are spent aestivating deep under logs and moist rock crevices.

Habitat conditions present within the LMK Analysis Area for the clouded salamander are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 15,360 acres of moderate quality habitat exists within the Analysis Area. Surveys for terrestrial mollusk species were conducted within and adjacent to the Analysis Area in 1998 to 2001 and no incidental detections of the clouded salamander were recorded. The SRNF Wildlife Sighting Record Database does not contain any sighting records for the Analysis Area, but their presence is suspected based on suitable habitat.

Blue Grouse

The blue grouse is an uncommon to common permanent resident at middle to high elevations. It occurs in open, medium to mature stands of fir, Douglas-fir, and other conifer habitats, interspersed with medium to large openings and available water. The species inhabits the North Coast Ranges in northwestern California, and the Klamath, Sierra Nevada, and portions of the Warner, White, and Tehachapi Mountains. The blue grouse utilizes firs and other conifers with dense canopy closure for cover. The primary food items include conifer needles (especially fir and Douglas-fir), fruits, flowers, seeds, insects, land snails, and spiders. The species primarily nests on the ground, usually associated with brushy areas adjacent to downed logs or under low tree branches or shrub cover.

As noted by CDFG, blue grouse populations within northern California remain consistently stable, which is reflected in the stability of the hunter harvest bag limit regulations over the last 5-8 years. No systematic surveys for this species have been conducted within the Analysis Area. The species has not been recorded, associated with the Orleans BBS Route (CAL-167) (Orleans RD). Habitat conditions present within the Analysis Area for the blue grouse are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 5,920 acres of moderate quality habitat exists within the LMK Analysis Area. The SRNF Wildlife Sighting Record Database contains 37 sighting records for the Analysis Area.

Dusky-footed Woodrat

The dusky-footed woodrat is common in California. It is found throughout the Coast Ranges, and in the northern interior (central Siskiyou County, Modoc County, Lassen County, and Shasta County). The species is also widespread along the entire western slope of the Sierra Nevada, mostly below 7,000 feet. The dusky-footed woodrat is abundant in forest habitats of moderate canopy closure and moderate to dense understory. Food items include a variety of woody plants and fungi, flowers, grasses, and acorns. Nest sites are constructed of sticks, grasses, and leaves at the base of trees, shrubs, or, often, hills.

Habitat conditions present within the LMK Analysis Area for the dusky-footed woodrat are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 34,757 acres of moderate quality habitat exists within the Analysis Area. No surveys have been conducted for the dusky-footed woodrat within the Analysis Area. The SRNF Wildlife Sighting Record Database does not contain any sighting records for the Analysis Area.

Western Fence Lizard

The western fence lizard is probably California’s most common reptile. This adaptable lizard is found throughout California except in true desert, where it is restricted to riparian and high mountain locations. The species ranges in elevation from sea level to 10,000 feet. Western fence lizards utilize a variety of habitats from valley-hardwood, grasslands, coniferous, hardwood, and alpine communities. Cover for this species includes tree trunks, woodpiles, wooden fences, rock piles, crevices, burrows, and accumulations of coarse woody debris. Eggs are usually laid within damp, friable, well-aerated soil, in pits dug by females.

Habitat conditions present within the LMK Analysis Area for the western fence lizard are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 15,360 acres of moderate quality habitat exists within the Analysis Area. The SRNF Wildlife Sighting Record Database does not contain any sighting records for the Analysis Area.

Black Oak/White Oak Assemblage

Acorn Woodpecker

The acorn woodpecker breeds from western North America to northern South America. In California, acorn woodpeckers range from sea level to over 6,000 feet in elevation, which are the limits of oak distribution. It is present within the western Sierra Nevada foothills, Coast Ranges, Klamath Range, and in the eastern Sierra Nevada from Modoc County (Ziener, Laudenslayer, Jr., Mayer and White, 1990). Acorn woodpeckers are most commonly found in oak savannah, oak woodland, and montane forest with oaks. Hurley, Robertson, Brougher, and Palmer (1981) state that the prime habitat type includes primarily the black oak-woodland community of pole/medium tree stage or larger tree stage with less than 40% canopy closure. Additionally, suitable stand structures are 1 to 2 acres of large oak-pine surrounded by open canopied oak or oak-conifer stands. The species excavates nesting cavities in winter and spring within live trees and snags.

Habitat conditions present within the LMK Analysis Area for the acorn woodpecker are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 411 acres of low to moderate quality habitat exists within the Analysis Area. No surveys have been conducted for the acorn woodpecker within the Analysis Area. The SRNF Wildlife Sighting Record Database contains 3 sighting record for the Analysis Area. The species has been recorded, associated with the Orleans BBS Route (CAL-167) (Orleans RD); detections have been recorded since route initiation, and, specifically, the average detection rate is 1.00 per route per annum.

Scrub Jay

The current subspecies of the western scrub jay within the SRNF is *Apheloocoma californica californica*, which utilize areas west of the Cascades and the Sierra Nevada from Washington to Baja California. The species is a common resident and breeder within scrub and open mixed woodland that contain oaks. The jay constructs its nest relatively low to the ground in a small tree or shrub, usually within oak woodland habitat. The western scrub jay prefers early successional habitat including shrubby habitats combined with dense undergrowth. There is a strong correlation between the occurrence of oaks, and the species is probably one of the best avian oak dispersers in California.

Habitat conditions present within the LMK Analysis Area for the western scrub jay are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 411 acres of moderate quality habitat exists within the Analysis Area. No surveys have been conducted for the western scrub jay within the LMK Analysis Area. However, the species has been recorded, associated with the Orleans BBS Route (CAL-167) (Orleans RD); detections have been recorded since route initiation, and, specifically, the average detection rate is 2.00 per route per annum. The SRNF Wildlife Sighting Record Database does not contain any sighting records for the LMK watersheds.

Lazuli Bunting

This species is a common summer (April into September) visitor throughout most of California, except in higher mountains and southern deserts. It breeds in open chaparral habitats and brushy understories of open wooded habitats, especially valley foothill riparian. The species also breeds often on hillsides near streams and streams. Within arid habitats, the species is restricted to riparian habitats. Nests are usually constructed within dense thickets of shrubs, vines, small trees, or tall grasses.

Habitat conditions present within the LMK Analysis Area for the Lazuli bunting are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 781 acres of low to moderate quality habitat exists within the Analysis Area. No surveys have been conducted for the Lazuli bunting within the Analysis Area. However, the species has been recorded, associated with the Orleans BBS Route (CAL-167) (Orleans RD); detections have been recorded since route initiation, and, specifically, the average detection rate is 15.0 per route per annum. The SRNF Wildlife Sighting Record Database does not contain any sighting records for the LMK watersheds.

Western Gray Squirrel

This squirrel is fairly common in mature stands of most conifer, hardwood, and mixed hardwood-conifer habitats in the Klamath, Cascade, Transverse, Peninsular, and Sierra Nevada Ranges (Ingles 1965). The species uses mature trees for cover, and requires cavities in trees and snags for nests. Typically, the western gray squirrel utilizes abandoned woodpecker cavities, or constructs nests on tree branches composed of shredded bark, grass, mosses, or lichens. The squirrel is highly associated with conifer and oak habitats. Oak mast and hypogenous fungi are vital components of their diet, however, pine nuts, forbs, grasses, and leaves are also consumed.

Habitat conditions present within the LMK Analysis Area for the western gray squirrel are classified utilizing the habitat classification database found within the California Wildlife Habitat Relationship System. Approximately 27,799 acres of moderate quality habitat exists within the Analysis Area. No surveys have been conducted for the western gray squirrel within the Analysis Area. The SRNF Wildlife Sighting Record Database does not contain any sighting records for the Analysis Area. However, the species is regarded as relatively common throughout the SRNF as noted by personal observations.

Sources

Airola, D.A., Ed. 1980. California Wildlife Habitat Relationship Program:Northeast Interior Zone, Volume III. Birds. USDA Forest Service, Lassen National Forest, Susanville, CA. pp. 509.

Baldwin, P.H. and W.F. Hunter. 1963. Nesting and nest visitors of the Vaux's swift in Montana. Auk. 80:81-85.

Baldwin, P.H. and N.K. Zaczkowski. 1963. Breeding biology of the Vaux's swift. Condor. 65:400-406.

Behler, J. L. and F.W. King. 1979. The Audubon Society field guide to North American reptiles and amphibians. Alfred Knopf, New York. pp. 743.

Bury, R.B. 1968. The distribution of *Ascaphus truei* in California. Herpetologica. 24:39-46.

Garrett, K. and J. Dunn. 1981. Birds of southern California. Los Angeles Audubon Society. p. 408.

Grinnell, J. and A.H. Miller. 1944. The Distribution of birds of California. Pacific Coast Avifauna. 27:608.

Hurley, J.F., S.R. Robertson, S.R. Brougher, and A.M. Palmer. 1981. Wildlife habitat capability models and habitat quality criteria for the western Sierra Nevada. USDA Forest Service, Stanislaus National Forest, Sonora, CA. p. 56.

Ingles, L.G. 1965. Mammals of the Pacific States. Stanford University Press, Stanford, CA. p. 506.

Jennings, M.R. and M.P. Hayes. 1994. Amphibian and reptile species of special concern in California. Final report submitted to the California Department of Fish and Game, Rancho Cordova, California.

McCaskie, G., P. De Benedictis, R. Erickson, and J. Morlan. 1979. Birds of northern California, an annotated field list. 2nd ed. Golden Gate Audubon Society, Berkeley, CA. pp. 84.

Raphael, M.G. and M. White. 1978. Avian utilization of snags in northern California coniferous forest. USDA Forest Service, Region 5, San Francisco, CA. Progress Report.

Raphael, M.G. and M. White. 1984. Use of snags by cavity-nesting birds in the Sierra Nevada. Wild. Monogr. 86:66.

Reynolds, R.T. and B.D. Linkart. 1987. The Nesting Biology of Flammulated Owls in Colorado. pp. 239-248. In: R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre, Eds. Biology and Conservation of Northern Forest Owls. USDA Forest Service General Technical Report, RM-142.

Ross, R.C. 1933. Western bluebird nesting in wall tile. Condor. 35:73-74.

Salt, G.S. 1952. The bell toad, *Ascaphus truei,* in Mendocino County, California. Copeia. 1952:193-194.

Stebbins, R.C. 1985. A field guide to western reptiles and amphibians. 2nd ed., Revised. Houghton Mifflin, Boston, MA. pp. 336.

USFS (USDA Forest Service). 1995. Six Rivers National Forest land and resource management plan. Pacific Southwest Region, San Francisco, CA.

Welsh, H.H. Jr. and A.J. Lind. 1996. Habitat correlates of the southern torrent salamander (*Rhyacotriton variegatus*) in northwestern California. Journal of Herpetology. 30:385-398.

Yocum, C.F. 1978. Status of the Oregon ruffed grouse in northwestern California. California Department of Fish and Game. 64:124-127.

Zeiner, D.C., W.F. Laudenslayer Jr., K.E. Mayer, and M. White. 1990. California statewide wildlife habitat relationships system. California's wildlife, 3 volumes. California Department of Fish and Game, Sacramento, CA.