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Lower McCloud Watershed Analysis

Shasta-McCloud Management Unit
Shasta-Trinity National Forest

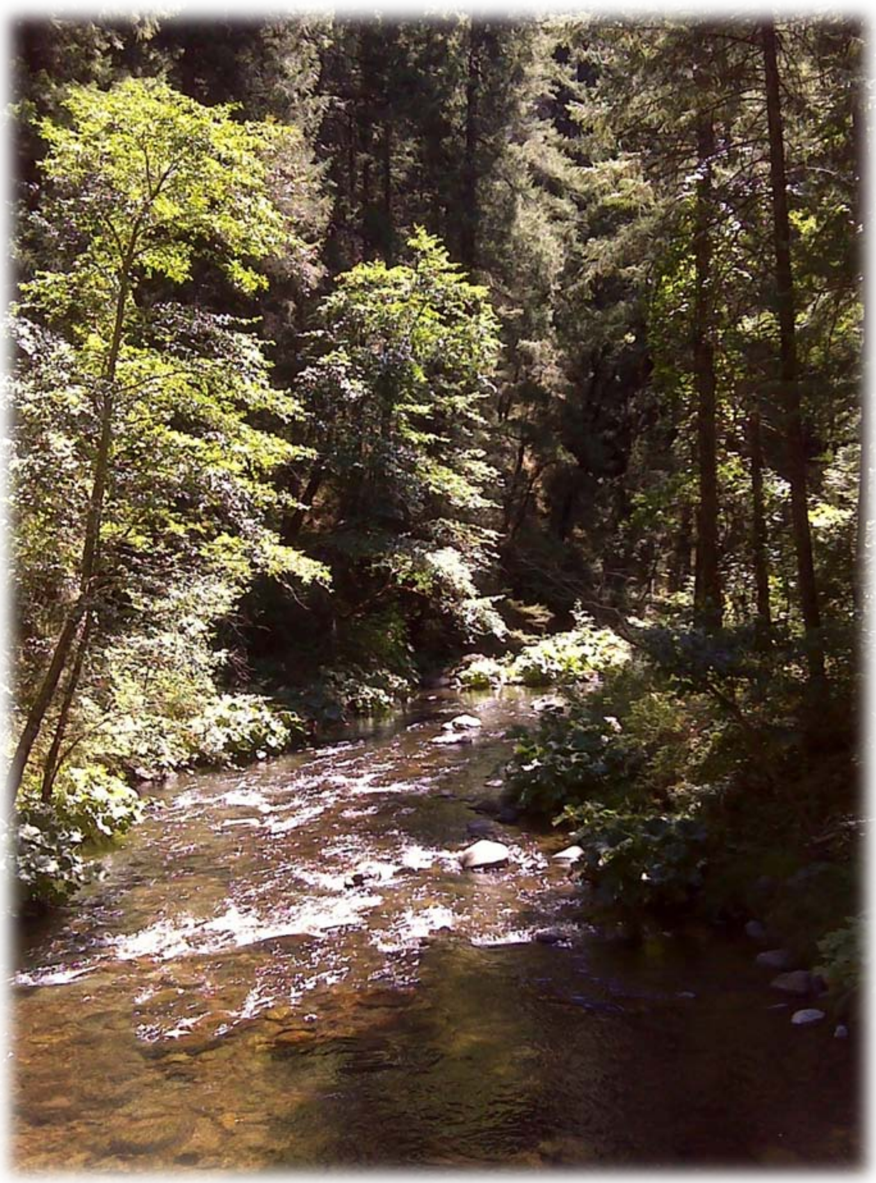

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Table of Contents

List of Tables

Introduction

About This Analysis

This watershed analysis is presented as part of the Aquatic Conservation Strategy adopted for the President's "Northwest Forest Plan" (Record of Decision [ROD] for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl, including Standards and Guidelines for Management of Habitat for late-successional and Old-Growth Related Species (USDA Forest Service and USDI Bureau of Land Management 1994).

The preparation of a watershed analysis for the Lower McCloud watershed follows direction in the Aquatic Conservation Strategy that requires watershed analysis "for roadless areas in non-key watersheds, and Riparian Reserves prior to determining how land management activities meet Aquatic Conservation Strategy objectives" (USDA Forest Service and USDI Bureau of Land Management 1994).

This document is guided by two levels of analysis:

- Core topics - provide a broad, comprehensive understanding of the watershed.

Core topics which address basic ecological conditions, processes, and interactions at work in the watershed are provided in "Ecosystem Analysis at the Watershed Scale: Federal Guide for Watershed Analysis", Version 2.2 (Regional Interagency Executive Committee and the Intergovernmental Advisory Committee 1995).

- Issues - focus the analysis on the main management questions to be addressed.

Issues are those resource problems, concerns, or other factors upon which the analysis will be focused. Some of these issues prompted initiation of the analysis. Other issues were developed from public input in response to scoping or were identified by the team during the analysis process.

Key analysis questions are developed for each issue. These questions are organized by analysis steps to help focus the analysis and to provide organization to the document while addressing the issues.

This document represents an analysis of the Lower McCloud Watershed (primarily the Mt. Shasta – Lower McCloud Lower McCloud Sub-watershed) located primarily within the McCloud River Management Area (#10) of the Shasta-Trinity National Forest (see Map 1 – Vicinity). The analysis area encompasses approximately 37,586 acres (59 square miles). Of the total acres in the analysis area, approximately 27,377 acres (77 percent) are National Forest land, and the remaining 8,209 acres (23 percent) are private landholdings. The Lower McCloud Watershed was selected for analysis to enable the Forest Service to plan long-term management of the watershed.

The purpose of this analysis is to provide district resource managers with a scientifically based understanding of the ecological processes and interactions occurring within the watershed area and how past and present activities and events interact with the physical, biological, and social environments. This information can then be used as a basis from which to make future decisions regarding the management of resources in the Lower McCloud Watershed. While this document provides management recommendations, it is not a decision document. No direct changes in the management of resources in this watershed will occur without separate documentation, public involvement, and further environmental analysis.

The Analysis Process

This analysis used the six-step process as outlined in the Federal Guide for Watershed Analysis. The six-step process includes the following:

- **Step 1: Characterization** – identifies the dominant physical, biological and human processes or features of the watershed that affect ecosystem function and conditions.
- **Step 2: Identification of Resource Issues and Key Questions** – focuses the analysis on the key elements of the ecosystem that are most relevant to the management objectives, human values or resource conditions within the watershed.
- **Step 3: Description of Current Conditions** – documents the current range, distribution and condition of the relevant ecosystem elements.
- **Step 4: Description of Reference Conditions** – documents how ecological conditions have changed over time as a result of human influence and natural disturbances.
- **Step 5: Synthesis and Interpretation of Information –** compares existing and reference conditions of specific ecosystem elements to explain significant differences, similarities or trends and their causes.
- **Step 6: Recommendations –** brings the results of the previous steps to conclusion, focusing on management recommendations that are responsive to watershed processes identified in the analysis.

The analysis also evaluates conditions in the Lower McCloud Watershed as they relate to conditions at larger scales such as the McCloud River Watershed. This analysis also discusses the importance of unique geological and biological features within the watershed with regard to paleontological records and rare flora and fauna on the west coast of the United States.

Watershed analysis is a continuous process. This document is dynamic and, as such, is intended to be revised and updated as new information becomes available.

Chapter 1: Characterization of the Watershed

The purpose of this chapter is to identify the dominant physical, biological, and human processes or features of the watershed that affect ecosystem functions or conditions. The relationship between these ecosystem elements and those occurring in the river basin or province is established. This chapter provides the watershed context for identifying elements that need to be addressed in the analysis.

The major topics covered in this chapter are:

- Location
- Watershed Setting
- Relationship to Larger-Scale Settings
- Physical, Biological and Human Features
- Land Allocations and Management Direction

Location

The Lower McCloud River Watershed is comprised of the Lower McCloud River Canyon between McCloud Reservoir and Shasta Lake. The watershed is located about 35 miles north of Redding, California and lies within Shasta County. The watershed analysis area overlies Shasta-Trinity National Forest lands and various ownerships (see Map 2 – Land Ownership).

Analysis Area Setting

The Lower McCloud River Watershed is about 67,073 acres in size, of which 44,779 acres are National Forest. The remaining 22,294 acres are comprised of various ownerships, both public and private. The public and private ownerships comprise approximately thirty-three percent of the analysis area. Large private ownerships in the analysis area can comprise one or many sections of land.

In 1896 the Central Pacific Railroad (later known as the Southern Pacific) was granted all odd-numbered sections along the McCloud River under the Pacific Railroad Acts of 1862 and 1864. Patents were finalized in 1896, forming the basis for private ownership of alternate sections throughout most of the watershed area. The Homestead Act of 1862 is responsible to a lesser degree for some private ownership in the analysis boundary. Both of these Acts pre-date the existence of the Shasta National Forest, established in 1905 (see Appendix F of this document for further information). Ownership also included Indian allotments. Eight Native American individuals held approximately 80 to 160 acres in the watershed near the Squaw Valley Creek confluence with the McCloud River (McTavish 2010).

Of the National Forest land in the analysis area, there are currently portions of three Ranger Districts overlying the Lower McCloud watershed analysis area (analysis area). Table 1-1 and Map 17-Administratve Boundaries-detail acreages percentage of analysis area, and geographic location relative to the analysis area. Most of the private land in the analysis area is located on the McCloud Ranger District. Only 67% of the land within the analysis boundary is federally owned.

Table 1-1. Summary of land ownerships in the analysis boundary

Ranger District	Acres of analysis area in federal (Forest Service) Ownership	Acres of analysis area in non-federal ownership	Percentage of analysis area in federal (Forest Service) ownership	Percentage of analysis area in non-federal ownership	Total acres
Shasta Lake (NRA)	25,619	2,513	38%	4%	45,400
McCloud	19,092	19,781	28%	23%	21,604
Mt. Shasta	69	0	1%	0%	69
Total	**44,779**	**22,294**	**67%**	**33%**	**67,073**

Watershed Setting

Watershed boundaries used in this analysis include the area drained by the McCloud River from McCloud Reservoir downstream to McCloud Bridge, where the river enters Shasta Lake. The Hawkins Creek, Claiborne Creek, and Chatterdown Creek sub-watersheds are included in the Lower McCloud River Watershed.

The majority of the watershed is characterized by a checkerboard land ownership pattern. A corridor of mostly private land follows the McCloud River. Large blocks of National Forest land occur in the Hawkins Creek drainage and along the major ridge that forms the southwest border of the watershed. The land ownership pattern for the watershed is displayed on Map 2 - Land Ownership.

Relationship to Larger Scale Setting

Many physical, biological, and human processes or features span areas much larger than a watershed. To appropriately characterize and analyze specific aspects of the watershed, the watershed needs to be placed in its logical setting with respect to these larger scales.

Three larger-scale settings need to be considered when addressing the Lower McCloud River Watershed. From smallest to largest scale they are:

- Eastern Klamath Mountains Subsection
- The Upper Sacramento Basin
- McCloud River Basin
- Late-Successional Reserve RC-335 (also known as the Iron Canyon LSR)

Eastern Klamath Mountains Subsection

The Eastern Klamath Mountains Subsection is located in the Klamath Mountains Section. The Eastern Klamath Mountains subsection has a temperate and humid climate. This subsection consists of mountains with rounded summits (USDA and USDI 1997).

Upper Sacramento Basin

The Upper Sacramento Basin drains an area of approximately 3,900 square miles. It is located north of the Keswick Dam, and includes several rivers such as the Pit River, McCloud River, and the Little or Upper Sacramento Rivers above Shasta Lake.

McCloud River Basin

The McCloud River Basin drains an area of roughly 800 square miles. Its headwaters are above Colby Meadows near Bartle. The river flows southwesterly for approximately 50 miles to its terminus at Shasta Lake (see Map 3 - McCloud River Sub-Basin).

Physical conditions and land use patterns in the McCloud River Basin are best described by dividing the basin into six sections:

1. The Upper McCloud River (above McCloud Reservoir):
    - Terrain is generally flat to gentle slopes and includes the McCloud Flats.
    - Vegetation consists of mixed-conifer and ponderosa pine forest.
    - Land use is predominantly timber management and grazing with recreation use concentrated along the river and in lava areas.
2. McCloud Reservoir:
    - Six miles of river corridor were inundated in 1965.
    - Terrain consists of a deep canyon.
    - Vegetation consists of mixed-conifer and ponderosa pine forest.
    - Land use is predominantly timber management with recreation use on/around reservoir.
3. The Lower McCloud River (between McCloud Reservoir and Shasta Lake):
    - McCloud Dam is located directly adjacent to the analysis boundary, generally regulating downstream flows.
    - Terrain consists of a deep canyon through which the river flows.
    - Vegetation is predominantly mixed-conifer and Douglas-fir forest. A large area west of the McCloud River is dominated by hardwoods and chaparral vegetation.
    - Timber management has occurred in the Hawkins Creek drainage and the upper slopes on the southeast side of the river. Most of the remainder of this portion of the river basin remains essentially unroaded.
4. The McCloud Arm of Shasta Lake:
    - Fifteen miles of river corridor were inundated in 1945.
    - Terrain consists of a deep canyon through which the river once flowed.
    - Vegetation is predominantly gray pine, knobcone pine, and chaparral.
    - High density recreation use occurs on the lake and its shoreline. Much of the remaining area is rugged, inaccessible, and essentially unroaded.
5. Upper Lower McCloud (above town of McCloud):
    - Terrain consists of a shallow canyon incised into the Mount Shasta volcano.
    - Vegetation ranges from alpine fell fields to Shasta red fir forest to mixed conifer forest.
    - Land uses consist of recreation near and above timberline, downhill ski area development below timberline, timber management elsewhere in forested areas, and small-scale residential, commercial, and industrial development in the vicinity of the town of McCloud.

6. Lower McCloud (below town of McCloud):

- Terrain consists of a narrow valley with surrounding low hills near the town of McCloud, and a deep canyon downstream from Squaw Valley.
- Vegetation is predominantly mixed-conifer and Douglas-fir forest, and also includes wet meadow (in Squaw Valley), and hardwoods and chaparral vegetation (on canyon slopes).
- Land uses include cattle grazing, a 9-hole golf course, and low-density residential development in Squaw Valley, timber management in surrounding hills, and LSR management in the canyon portion which is mostly unroaded.

Late-Successional Reserve RC-335 (Iron Canyon LSR)

The Lower McCloud River Watershed is one of six watersheds within or crossing Late-Successional Reserve (LSR) RC-335. This LSR is commonly referred to as the 'Iron Canyon LSR.' On an even larger scale, both the Lower McCloud River Watershed and LSR RC-335 need to be considered in relationship to adjacent LSRs (see Map 22 - Adjacent Late-Successional Reserves) and how linkage is provided across the landscape.

Physical Features

Dominant Physical Features

The dominant physical feature of the Lower McCloud River Watershed is the main canyon through which the river flows. Although the river flows at elevations of approximately 1500 to 2500 feet above sea level, elevations along the major ridges surrounding the watershed are roughly 4500 to 5000 feet. The highest elevation is at Grizzly Peak (elev. 6220 feet).

McCloud Reservoir is located at the upstream end of the watershed. The watershed drains into Shasta Lake at its outlet. The McCloud River is regulated by outflows from McCloud Reservoir dam. A tunnel that is part of a larger network of a hydropower system regulated by Pacific Gas and Electric (PG &E) runs through the watershed, and on to Iron Canyon Reservoir. Dominant features in the watershed are shown on Map 4 - Dominant Physical Features.

Climate

The Lower McCloud River Watershed is characterized by the highest rainfall on the Shasta-Trinity National Forests. Mean annual precipitation exceeds 70 inches throughout the watershed. The Claiborne Creek and Chatterdown Creek drainages exceed 80 inches. Most of the precipitation is from winter storms of several days' duration and moderate intensity. Approximately 90% of annual precipitation occurs from October through April. Warm, dry summers are punctuated by occasional thunderstorms.

Precipitation occurs predominantly from November through March and is likely to occur as snow or rain-on-snow during the wet season. Isolated thunderstorms are common within the area during summer months and may produce localized precipitation, primarily as rain. Precipitation amounts fall dramatically as temperatures increase during spring, summer, and early fall. Summer temperatures vary within the analysis area due to varied microclimates, but are generally warm with noticeable fluctuations.

Erosion Processes

The Lower McCloud River Watershed has a moderate to high potential for mass wasting events. This potential is proportionately higher in the steeper inner gorge areas and in response to extreme precipitation events. Under undisturbed conditions, mass movement events are relatively rare. Soils in the analysis area are shallow and stony and have slow rates of natural erosion. Given the steep slopes and high rates of precipitation, some degree of natural surface soil erosion is normal in this watershed. The threat of high intensity, stand replacing wildfire presents a potential to seriously increase hillslope erosion.

Road densities for HUC7 watersheds within the analysis area were calculated based on the Shasta-Trinity GIS library. Upper Chatterdown Creek, Upper Claiborne Creek, and Upper Hawkins Creek have road densities greater than 4 miles per square mile. These high road densities indicate probable cumulative watershed effects. Increased erosion, increased sediment to channel, and change in hydrologic response are likely cumulative effects.

Table 1-2. Road densities by HUC 7 Drainage in the analysis area

HUC 7 Name	Linear miles of road across federal ownerships	Linear miles of road across non-federal ownership.	Total Linear Miles by HUC 7	Density (mi/sq mi) per HUC 7
Ah-Di-Na	21.9	9.3	31.2	2.6
Bald Mountain Creek-Hat Mountain Creek	3.7	3.9	7.6	0.6
Bollibokka	0.6	7.3	7.9	0.6
Chiquita Creek-McCloud River	0.4	5.0	5.4	0.5
Lower Chatterdown Creek	7.4	18.0	25.5	2.5
Lower Claiborne Creek	6.9	15.4	22.3	2.5
Lower Hawkins Creek	16.3	2.6	18.9	2.1
Tuna Creek	0	5.4	5.4	1.1
Upper Chatterdown Creek	8.7	20.2	28.9	4.1
Upper Claiborne Creek	8.5	22.9	31.4	4.5
Upper Hawkins Creek	38.2	0	38	4.2
TOTALS	**113**	**110**	**223**	**2.1**

Hillslope erosion processes in the Lower McCloud River Watershed have been altered by timber harvest and road construction. Roads have had the greatest impact on the erosion processes. The majority of road related impacts are greatest south and east of the McCloud River where road densities are highest (see Map 14 - Transportation). Recurring road problems include rutting, fill slope failures, plugged culverts and drains, and minor slumps and slides. Road systems have also disrupted drainage patterns on hillslopes resulting in increased hillslope erosion and gullying.

Most land-use activities have increased the hillslope erosion processes; however, the impacts from most of these activities tend to be relatively short lived. Areas impacted by timber harvesting have re-vegetated. Roads that have not experienced use over the last decade have re-vegetated and appear to have stabilized.

The effectiveness of fire detection and suppression in the watershed may have altered the natural erosion process by decreasing hillslope erosion. Increased amounts of vegetation and slash tend to have a stabilizing effect.

While it has not been a significant problem to date, future high intensity wildfires have the potential to seriously increase hillslope erosion in the watershed Effective fire suppression has resulted in abnormally high concentrations of fuels throughout the watershed. The build-up of vegetation could result in high intensity fires which, unlike fires of lower intensity, have the potential to destabilize hillslopes by completely burning vegetation through the rooting zone. The complete loss of vegetation could destabilize the upper soil profile and increase hillslope erosion in the watershed.

Hydrology

The McCloud River is the dominant hydrologic feature in the watershed. The river drains steep, mountainous terrain between McCloud Reservoir and the McCloud Arm of Shasta Lake. Major tributaries to the McCloud River within the watershed include Hawkins, Claiborne, Chatterdown, and Squaw Valley Creek. The largest tributary to the McCloud River is Squaw Valley Creek which drains its own 5th Field Watershed.

Streamflow in the Lower McCloud River is regulated by the McCloud-Pit Hydroelectric Project at McCloud Reservoir, where water is diverted through a tunnel complex into the Pit River drainage at Iron Canyon Reservoir for the generation of electrical power.

Minimum instream flows are maintained in the Lower McCloud River to provide adequate downstream flows for fisheries habitat. During the dry season, these flows are around 200 cubic feet per second (cfs; see glossary for explanation of term) at McCloud Dam, and gradually increase to around 300 cfs where the river enters Shasta Lake about 25 miles downstream. In contrast, historic flows were around 1,000 cfs. Historically baseflows during the dry summer were supplied by several springs in the Upper McCloud River watershed which now flow into McCloud Reservoir and are diverted to Iron Canyon Reservoir.

The hydrology in Upper and Lower McCloud River is markedly different due to the dramatic shift in geology between the two watersheds. Upper McCloud River watershed is part of the High Cascades and Western Cascade terrenes while Lower McCloud River watershed lies within the Eastern Klamath belt. The upper watershed hydrology is characterized by very permeable parent material that readily captures the majority of precipitation. The groundwater eventually surfaces as springs lower in the watershed that is metered throughout the water year. Whereas the Lower McCloud River watershed has much less permeable surfaces and receives more precipitation in the form of rain, thereby generating much more runoff with a much more rapid hydrologic response. The McCloud Reservoir is located in the transition of these two distinct geologies.

The diversion of water at McCloud Reservoir does not significantly influence the larger peak flow events in the watershed. Approximately 75% of peak flows originate below the dam. (Bachman 2011). Tributaries immediately below McCloud Reservoir supply over three times more runoff during peak flows to the McCloud River than is supplied by the entire Upper

McCloud River Basin. During high-precipitation years, McCloud Reservoir usually spills for several weeks in the spring, thereby contributing even more to flows in the lower river.

Stream Channel

Stream channel morphology in the Lower McCloud River Watershed is a reflection of natural geologic and fluvial processes and, in some cases, land-use activities. Channel morphologies in the watershed are very much alike because the channels have formed in similar parent materials and climatic conditions.

Stream channels in the Lower McCloud River Watershed are broadly classified as follows:

Upland channels (swales, colluvial or bedrock channels)

- Sources areas for sediment.
- Most vulnerable to land-use impacts due to abundance and steep topography.
- Most of these channels have not been influenced by land-use impacts.

Cascade channels

- Generally exhibit perennial flows.
- Steep and dominated by boulder substrates.
- Sediment is transported through cascade channels during peak flows.
- Less influence by land-use activities than upland channels.

Step-pool channels

- Lower gradients than cascade channels.
- Characterized be a pattern of alternating steps and pools.
- Waterfalls often occur where bedrock is exposed.
- Most step-pool channels have not been impacted by land-use activities.
- Sediment delivery from upland channels can result in aggradations of smaller, low-gradient step-pool channels.

Pool-riffle or plane-bed channels

- McCloud River and lower reaches of its larger tributaries
- Majority of fisheries are found in these channels

The McCloud River lies deep within the McCloud River Canyon. The canyon bottom contains a series of terraces, the lowest of which function as floodplains. The active channel of the river has decreased in depth due to streamflow diversions at McCloud Reservoir, but in most locations has not decreased significantly in width. The canyon bottom begins to noticeably widen below the Claiborne Creek confluence. The wider canyon bottom reflects the increase in overall discharge due to input from Claiborne Creek and Squaw Valley creeks.

Water Quality

There are no streams on the Clean Water Act 303d impaired list. In general, water quality is considered high although certain parameters show variation and potential exceedance of objectives in the California State Water Quality Control Board Central Valley Basin Plan (PG&E

2009e). The quality of water in the Lower McCloud River Watershed is influenced by both natural processes and land-use activities. Beneficial uses dependent on high quality water include fish and aquatic life (including riparian vegetation), domestic drinking water for private landowners along the McCloud River, and recreation benefits associated with fishing and whitewater boating. Water quality in the Lower McCloud River Watershed is influenced by McCloud Reservoir (water temperature increases due to impoundment and reduced flows, and turbidity increases due to delta erosion during reservoir drawdown), Mud Creek debris flows and by land use practices.

The Lower McCloud River is well-known for its trophy-size trout and large trout populations, and a portion is a state designated Wild Trout Stream. Spawning runs of brown trout from Shasta Lake occur within the river each year. Water quality parameters critical to fisheries include: flow, temperature, and sediment.

The cumulative impacts of natural hillslope erosion processes, roads, and timber harvesting can potentially exert a significant influence on water quality parameters. Changes in most water quality parameters only occur during peak flow events and then quickly drop to pre-storm levels.

Turbidity in the McCloud River occasionally increases due to increases in debris activity in Mud Creek and when water levels in McCloud Reservoir drop resulting in the remobilization of accumulated sediment. This is due to continual gradual deposition of Mud Creek sediment at the delta where the river flows into the reservoir, coupled with destabilization of the delta as the reservoir level drops through the season due to water diversion for hydroelectric production. Once re-suspended, the resulting higher-density slurry of cold water and sediment flows along the bottom the reservoir to the minimum flow release at the dam where it enters the lower river. Water quality sampling conducted by PG&E during the FERC relicensing of the McCloud Pit Project indicated that turbidity was generally low throughout the McCloud Pit Project Area with the exception of Mud Creek (PG&E 2009e). In order to examine the extent of influence of Mud Creek turbidity on the McCloud River, PG&E performed a suspended sediment study document in Technical Memorandum 30 (PG&E 2009e).

Large high intensity stand replacing wildfires have the greatest potential to detrimentally influence water quality in stream channels in the watershed. A large, wildfire combined with large peak flows the following winter would increase suspended sediment, turbidity, bedload, and other parameters to potentially detrimental levels.

Biological Features

Vegetation

The dominant vegetation types in the Lower McCloud River Watershed consists of predominantly conifer stands intermixed with a small proportion of hardwoods, as well as typical vegetation expected for a montane region in the Klamath Mountains. Species composition tends to follow elevation and temperature gradients ranging from white fir forests at the highest, coldest areas in the northeast portion of the watershed to ponderosa pine/gray pine/chaparral in the lowest, hottest areas at the lower end of the watershed.

Vegetation in the Lower McCloud analysis area is distributed within the following three major categories:

- Conifer forest/woodland– 81 percent

- Hardwood forest/woodland – 15 percent
- Shrubs and chaparral – 3 percent

The remaining one percent is distributed in herbaceous and non-vegetated categories.

The landscape around High Mountain, Tombstone Mountain, Bald Mountain and Grizzly Peak is dominated by large areas of hardwood and chaparral vegetation. These areas tend to have low productivity due to geologic parent material (yielding thin rocky soils) and frequent lightening strikes.

The remainder of the watershed is highly productive due to soil quality and high rainfall. These areas have demonstrated a high capacity to recover from disturbance.

Vegetation has been modified by past timber harvest activities in Chatterdown, Claiborne, Ladybug, and Hawkins Creek drainages and on the slopes above Ah-Di-Na Campground. The remainder of the watershed is essentially unroaded and has had little modification to the naturally occurring vegetation. The western portion of the watershed, where numerous private ownerships are located is actively being managed for timber commodity production, and other resources.

The current array and pattern of vegetation is the result of several processes, including:

- Fire suppression and fires
- Soils
- Climate
- Historic Grazing
- Timber harvest

Maps and further discussion on vegetation are provided in Chapter 3.

Fire and Fuels

Fire has played a major role in shaping vegetation composition and structure in the watershed analysis area (Taylor and Skinner 1998, Skinner et al. 2006, Agee 2007). The analysis area extends through the lower- to mid-montane ecological zones and is historically characterized by frequent fires of low- to-mixed severity (Taylor and Skinner 1998, Skinner et al. 2006). Lightning, European settlers, and American Indian-ignited fires were the primary factors shaping the vegetation, creating primarily multi-aged stands (Taylor and Skinner 1998).

Stand and vegetation structures, along with severity patterns within this regime, are highly dependent on the complex combination of topography, vegetation composition, and climate (Skinner et al. 2006, Agee 2007). Generally, upper slope positions and south- and west-facing slopes burn at higher frequencies and with higher severities than lower slope positions and north- and east-facing slopes (Weatherspoon and Skinner 1995, Taylor and Skinner 1998, Jimerson and Jones 2003, Skinner et al. 2006). Spatial variation in soil productivity, in conjunction with steep gradients of elevations and aspects, controls the rates of fuel accumulation (Skinner et al. 2006). Disturbance history affects the fuel profile and is linked to patterns of fire severity on the landscape (Alexander et al. 2006, Miller et al. 2009).

Between 1924 and 1944, five fires occurred that burned over 1,000 acres with the largest occurring in 1944 and covering 4,628 acres. Since the beginning of the modern fire suppression era only a 3,085 acre fire as part of the High Complex (1999) has been recorded larger than 1,000 acres and occurred during a wide spread lightning event. The larger fires prior to World War II were followed by more than 70 years of highly successful fire suppression which allowed for vegetation development and fuels accumulation. Only nine other fires have been cataloged within the analysis area over the past 90 years greater than 10 acres in size.

As mentioned previously, the climate of the analysis area is best described as Mediterranean, characterized by wet, cool winters and dry, warm summers (Skinner 2006). Mean annual precipitation ranges from 55 to 80+ inches in the watershed and primarily occurs from November through March. Summer thunderstorms are common, and can release significant amounts of localized rain. These storms can also be dry with conditions that encourage fire ignition and spread from lightning strikes, with the summer of 2008 being the latest example of this pattern near the analysis area when a significant number of lightning strikes from a dry thunderstorm event ignited numerous fires throughout northern California.

The steep and complex landscape creates a unique interaction with fire weather and elevation during the hot, dry summers. High pressure prevails and smoke does not dissipate which often results in temperature inversions. While these inversions can lead to benign fire behavior, they can also create public health issues and concerns over high densities of smoke particulates that cover large areas and can persist for many days. When the temperature inversions are broken by high winds, fire behavior can increase significantly, resulting in large areas of high-severity fire.

Fire starts are still suppressed in the watershed. With the onset of fire suppression in the early 1900s and increased effectiveness of suppressing fires with mechanized equipment (fire engines, dozers, aircraft, etc.) in recent years, most of the fires are kept small. This has been primarily achieved through the use of aerially delivered firefighters and the use of retardant during initial attack. As a result, forest vegetation has changed from a heterogeneous pattern to a more homogeneous pattern of smaller openings in a matrix of denser forest (Skinner et al. 2006). Therefore, one of the most extensive problems related to the health of this watershed is the over-accumulation of vegetation and fuel loading due to a lack of disturbance from fire. Although severity patterns are still largely dependent on physical factors (e.g., slope position, aspect, slope percentage, elevation, etc.), the current vegetation composition and structure has created conditions that increase the likelihood of larger areas of intense and severe fire (Scott and Reinhardt 2001, Taylor and Skinner 2003, Skinner et al. 2006).

Species and Habitat

Threatened, Endangered and Sensitive (TES) Plants and Other Species of Concern

Management direction for rare vascular and nonvascular plants and fungi on the Shasta-Trinity NF is found in the Land and Resource Management Plan (LRMP) on pages 4-14 through 4-16 and pages 4-111 through 4-132. These species may include federally listed Threatened or Endangered species, Sensitive and Endemic species, watch list species, and Survey and Manage species (USDA Forest Service and USDI Bureau of Land Management 2001). Endangered and Threatened species are those listed under the Endangered Species Act of 1973. Sensitive species are those not meeting federal criteria but are listed by the Regional Forester. Forest Endemic species are those found only on the STNF and are afforded the same protection as Sensitive species. Survey and Manage species are those designated by the Northwest Forest Plan (USDA Forest Service and USDI Bureau of Land Management 2001). Watch list plant species are listed by the California Native Plant Society (CNPS) as rare but do not meet the criteria for federal or

Forest listing. These watch list plants are usually of sufficient local viability concern, however, to be considered in planning processes.

According to the Land and Resource Management Plan (LRMP p. 4-5), Forest goals for botanical species include the following:

- "Monitor and protect habitat for federally listed threatened and endangered (T&E) and candidate species. Assist in recovery efforts for T&E species. Cooperate with the State to meet objectives for State-listed species."
- "Manage habitat for sensitive plants...in a manner that will prevent any species from becoming a candidate for T&E status."

No Threatened or Endangered plants are known or suspected to occur on the Forest. Refer to the project file for a complete list of TES, Survey and Manage, and other special status vascular plant, bryophyte, lichen and fungus species of concern on the Shasta-Trinity NF.

The following Sensitive, Endemic, or Survey and Manage plant species are either documented occurrences or likely to occur in the Lower McCloud River Watershed. The analysis watershed is within the geographic range of the species and is classified as suitable habitat.

- Shasta eupatory (*Ageratina shastensis*)
- scabrid alpine tarplant (*Anisocarpus scabridus)*
- veiny arnica (*Arnica venosa*)
- Shasta clarkia (*Clarkia borealis* ssp. *borealis)*
- Butte County fritillary (*Fritillaria eastwoodiae)*
- Cantelow's lewisia (*Lewisia cantelovii*)
- Shasta snow-wreath (*Neviusia cliftonii)*
- Pacific fuzzwort (*Ptilidium californicum)*
- English Peak greenbriar (*Smilax jamesii*)

Numerous late-successional associated plants, bryophytes (mosses and liverworts), lichens, and fungi occur in the watershed due to the abundance of this type of habitat. Two Survey and Manage fungi species (*Gomphus kauffmanii* and *Spathularia flavida*) have known occurrences within the watershed analysis boundary. These species are respectively Category E (Status Undetermined) and B (Rare, Pre-Disturbance Surveys Not Practical) and both have direction to manage known sites.

There are additional CNPS watch list species occurring or having habitat within the watershed. Their listing, common name and scientific name follow:

List 2.2 (rare, threatened, or endangered in CA; common elsewhere)

- ○ trichodon moss (Trichodon cylindricus)

List 3.2 (review list)

- ○ Howell's lewisia (Lewisia cotyledon var. howellii)

List 4.2 (limited distribution)

- ○ Baker's wild hollyhock (*Iliamna bakeri*)

While these species are not listed by the USDA Forest Service Pacific Southwest Region 5 (Region 5) as sensitive, the Forest Service documents occurrences identified during botanical surveys on National Forest lands and designs project activities to reduce or avoid impacts to documented populations.

Noxious and Undesirable Weed Species

The Forest Service Manual (FSM) directs National Forests to “Determine the factors which 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” (FSM 2081.2). The following selected noxious weed species are of high concern in or near the watershed. Refer to the project file for a complete list of invasive plants on the Shasta-Trinity National Forest (STNF.)

The following noxious weed species have documented occurrences in the Lower McCloud River Watershed Analysis area.

- yellow star thistle *(Centaurea solstitialis)*
- Canada thistle *(Cirsium arvense)*
- bull thistle *(Cirsium vulgare)*
- St. John’s wort *(Hypericum perforatum)*
- perennial pea *(Lathyrus latifolius)*
- black locust *(Robinia pseudoacacia)*
- Himalayan blackberry *(Rubus armeniacus)*
- spreading hedgeparsely *(Torilis arvensis)*

The following noxious weed species have documented occurrences within five miles of the Lower McCloud River Watershed Analysis area.

- cheatgrass *(Bromus tectorum)*
- spotted knapweed *(Centaurea maculosa)*
- Maltese star-thistle *(Centaurea melitensis)*
- houndstongue *(Cynoglossum officinale)*
- Scotch broom *(Cytisus scoparius)*
- intermediate wheatgrass *(Elytrigia intermedia)*
- tall fescue *(Festuca arundinacea)*
- French broom *(Genista monospessulana)*
- Dyer’s woad *(Isatis tinctoria)*
- American pokeweed *(Phytolacca americana)*
- cutleaf blackberry *(Rubus laciniatus)*

Terrestrial Wildlife Species and Habitat

Habitat for terrestrial wildlife species associated with early-, mid- and late-seral mixed-conifer forest occurs within the Lower McCloud Watershed with the majority of the watershed comprised of mid-successional, conifer forest habitat.

In addition to mid- and late-successional, mixed conifer forest, there are a variety of other vegetative habitats including montane hardwood, oak woodland, annual and perennial grassland, and riparian corridors. Other terrestrial wildlife habitat includes limestone outcroppings and caves, though these habitats are a small percentage of the overall watershed. All of these habitats combined total approximately 18 percent of the watershed. Management of these habitat types, as described in the LRMP, involves a mix of protection, avoidance, or minimal treatment.

The watershed is made up of several land allocations whose objectives shape the overall management goals for the area, but two main allocations play a large part in the management of the species and habitats in the area: Late-Successional Reserve (LSR) and Riparian Reserve (see Map 9 – Late Successional Reserve and Roadless Area and Map 10 – Riparian Reserves). Management of LSRs involves specific actions designed to improve, promote, and protect late-successional habitat, as described in the Shasta-Trinity LRMP.

> *"Late-Successional Reserves are to be managed to protect and enhance conditions of late-successional and old-growth forest ecosystems, which serve as habitat for late-successional and old-growth related species including the northern spotted owl. These reserves are designed to maintain a functional, interacting, late-successional and old-growth forest ecosystem" (LRMP pp. 4-63, 4-70).*

Within the Shasta-Trinity National Forest-wide Late Successional Reserve Assessment (USDA Forest Service 1999), the amount of late-successional forest currently available in the LSRs, relative to each LSR, was measured as an indicator of how well the LSR was providing for late-successional associated species. LSR-335 was identified as having 25,010 acres of late-successional habitat and 47,546 acres of mid successional habitat, out of a total 76,409 acres of capable lands.

Management within Riparian Reserves is designed to maintain and restore aquatic systems, species composition, and water quality, in addition to late-successional habitats that may be present in the Reserve, as described in the Shasta-Trinity LRMP:

> *"Maintain and restore the distribution, diversity, and complexity of watershed and landscape scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted" (LRMP pp. 4-53).*

Because of this overarching goal for management of the watershed, benefits are imparted to the species associated with late-successional habitats such as the northern spotted owl, northern goshawk, American marten, Pacific fisher, as well as multiple species of mollusk, bat and amphibian.

In addition to the late-successional habitat, limestone slopes and outcroppings are also present in the watershed and contain suitable habitat for bat species, several terrestrial mollusks species, peregrine falcons and Shasta salamanders (see species list below and Map 29).

Limestone areas do not require specific management actions in order to improve, promote, or protect the habitat, other than surveys that identify areas to be flagged and avoided during management actions that would cause disturbance through habitat modification and/or ground disturbance.

Caves are also present within the watershed. The LRMP describes a cave as "any naturally occurring void, cavity, recess, or system of interconnected passages which occur beneath the surface of the earth or within a cliff or ledge and which is large enough to permit an individual to enter, whether or not the entrance is naturally formed or man-made", with guidelines for the management described as:

> ...*"Provide additional protection for caves, mines, and abandoned wooden bridges and buildings that are used as roost sites for bats"* (LRMP p. 4-53).

Multiple species are associated with caves within the Lower McCloud Watershed potentially including 15 species of bat, three of which are Forest Service Sensitive species, and five listed in the LRMP Environmental Impact Statement (EIS) as species of interest (see list, below) (USDA 1994).

Wildlife species of special concern or interest in the Lower McCloud Watershed are divided into five main categories for the purpose of this analysis. A complete list is included in Chapter 3.

- **Federally Listed Species**
- **Forest Service Sensitive Species**
- **Survey and Manage Species**
- **Game Species**
- **Neo-tropical Migratory Birds**

The Lower McCloud Watershed, in combination with the Squaw Valley Creek watershed, represents the most south-central block of late-successional habitat available for connectivity for species dependent on mature forest types as described under the Northwest Forest Plan planning area. This watershed is part of a larger landscape of habitat which enables movement of late seral associated species from further north into the Sierra Nevada mountain range to the southeast and the Klamath Mountains to the southwest.

Species of special concern or interest with recorded locations within the watershed include: northern spotted owl, northern goshawk, Pacific fisher, terrestrial mollusk species, willow flycatcher, northwestern pond turtle, foothill yellow-legged frog, Shasta salamander, and bald eagle (CNDDB 2011). There is one sighting recorded in the watershed for California wolverine on national forest land south of the McCloud Reservoir that is of unknown accuracy (CNDDB 2011). Many other species of interest have suitable habitat and the potential for occupancy in the watershed (see discussion in Chapter 3).

Designated Critical Habitat

Critical Habitat for the northern spotted owl (federally Threatened status) occurs within the Lower McCloud watershed. Critical Habitat is a legal designation identified under the Endangered Species Act, having been designated on January 15, 1992. Revised Critical Habitat was designated on August 13, 2008. Within the Lower McCloud watershed, the areas overlap each other for the most part, though acreages between the two designations are somewhat different.

Under the 1992 designation the unit is referred to as Critical Habitat Unit (CHU) CA-4. CHU CA-4 encompasses 73 percent of the federal lands within the watershed. CHU CA-4 comprises 32,624 acres (approximately 51 square miles), or 49 percent, of the watershed as a whole. The total size of the 1992 designated CHU CA-4 equals 88,958 acres, with approximately 37 percent of it (32,624 acres) located inside the analysis boundary (See Map 11 - Northern Spotted Owl Critical Habitat Unit).

Within the 2008 Critical Habitat designation, the unit is referred to as CHU-28, and comprises 39 percent of the federal lands within the watershed analysis area. CHU-28 comprises 17, 233 acres (approximately 27 square miles), or 39 percent, of the watershed analysis area as a whole. The total size of the 2008 designated CHU-28 is 110,755 acres (approximately 172 square miles), with approximately 23 percent of it (26,012 acres) located inside the analysis area boundary (See Map 11 – Northern Spotted Owl Critical Habitat Unit).

Aquatic and Riparian-dependent Species and Habitats

The construction of Shasta Dam and subsequent creation of Shasta Lake had a major impact on the surrounding natural aquatic and riparian environment. The dam eliminated the anadromous fishery resource in the Pit, McCloud, and Upper Sacramento Rivers and their tributaries, blocking salmon and steelhead (*Oncorhynchus mykiss*) access to habitat they historically occupied in the McCloud River.

Aquatic habitats in the watershed analysis area are dominated by perennial, cool water streams with adequate instream cover, dense riparian vegetation and deep pool habitats formed by bedrock and boulders. Water flow levels in the lower McCloud River are controlled by releases from McCloud Reservoir with minimum instream flows required to protect downstream aquatic resources. River temperatures below McCloud Dam generally increase in spring and summer when warmer water is released from McCloud Reservoir. However, cool water input from tributary streams maintains summer water temperatures adequate for the persistence of the high quality cold-water fishery.

The Lower McCloud River and its tributaries support a variety of aquatic and riparian species including resident and non-native trout and other fish species, freshwater mollusks and other invertebrates, amphibians and reptiles. Stream habitats in the analysis area support fluvial populations of native rainbow trout (*Oncorhynchus mykiss*) and introduced populations of brown trout (*Salmo trutta*) and brook trout (*Salvelinus fontinalis*) (see Map 12 – Stream Types and Fish Presence). Other native fish species include Sacramento sucker (*Catostomus occidentalis*) and riffle sculpin (*Cottus gulosus*). Fathead minnow (*Pimephales promelas*) and Kokanee salmon (*Oncorhynchus nerka*) have also been introduced into the watershed (Moyle 2002). In weirs operated from 1984 to 1987 about one mile upstream from Shasta Lake, Sacramento pikeminnow (*Ptychocheilus grandis*) and smallmouth bass (*Micropterus dolomieu*) were observed. Sacramento pikeminnow were also observed during surveys in 2007 to 2009 (PG&E 2009b). Lake-run Kokanee salmon, rainbow and brown trout from Shasta Reservoir also use the lower reaches of the McCloud River for spawning.

The trout fishery provides popular angling opportunities for recreationists. The portion of the river from the base of McCloud Dam to about 7.3 miles downstream is a state of California designated Wild Trout Stream and the area is well-known for its trophy-size trout. The California State Fish and Game Commission’s wild trout policy provides for the designation of “aesthetically pleasing and environmentally productive” streams and lakes to be managed exclusively for wild trout with appropriate regulations to be "largely unaffected by the angling process.” (State of California, CDFG. 2011)

Human Uses

Human use within the Lower McCloud River Watershed is moderate compared to that of other watersheds in the area. The Lower McCloud River Watershed is somewhat remotely located however there are many roads or trails within it (see Transportation System and OHV Routes section). Additionally, there are 61 miles of hiking trails present in the watershed of various conditions; with the Pacific Crest Trail (PCT) being the most notable (see Map 13– Recreation).

Approximately 33 percent of the Lower McCloud River Watershed is privately owned, with the remaining 67 percent in public (Forest Service) ownership. Many private properties in the Lower McCloud River region were deeded via land grants pursuant to the Pacific Railway Act of 1864 (13 Stat. 356). Private ownership activities or designations include nature preserves, fishing clubs, a utility company, timber companies, and ranching. Several of these private landowners, as well as other key stakeholders within the watershed, participate in a program established through the Coordinated Resource Management Plan (CRMP) developed in 1991. This plan establishes guidelines to coordinate management activities with principle landowners in the McCloud River Drainage area and public agencies that administer programs in that area (CRMP 1991).

The public lands within the watershed have unique designations relating to human use. Sixty-three percent of the public acreage is contained within a Late-Successional Reserve (LSR), 66 percent is considered Inventoried Roadless, and 33 percent is designated as Riparian Reserve (see Map 10 – Riparian Reserves). One of the management objectives within LSRs is to protect and enhance conditions of late-successional forest ecosystems by reducing the risk of large-scale disturbance, which includes major human caused impacts (USDA Forest Service 1999). The roadless designation clearly limits vehicle access by preventing the creation of new roads within these allocated portions of the watershed except under specific circumstances. Riparian Reserves have standards and guidelines which limit programmed timber harvest, and manage roads, grazing, mining and recreation to achieve objectives of the Aquatic Conservation Strategy (USDA Forest Service and USDI Bureau of Land Management 1994). See the Land Management and Allocations discussions for further information.

Additionally, several utilities cross parts of the watershed including:

- Sprint fiber optic phone line along the Hawkins Creek Road
- COTP high voltage power line near Grizzly Peak
- PG&E diversion tunnel between McCloud Reservoir and Iron Canyon Reservoir

Heritage Resources

Native Americans occupied the Lower McCloud drainage for thousands of years, and their descendants today retain an active interest in protecting their patrimonial heritage. The Lower McCloud River Watershed area appears to have been a boundary area between the Wintu and the Pit River people. The Wintu claim authority in the Ah-Di-Na area, while the Pit River people claim expertise in the Ash Camp area.

Heritage resources in the watershed tend to be concentrated along the McCloud River. Significant prehistoric sites are located at Ash Camp and at Ah-Di-Na. Ah-Di-Na also features an historic component which has been developed as a public interpretive site.

Recreation Resources

Management direction for recreation resources on the Shasta-Trinity NF is found in the Land and Resource Management Plan (LRMP) on pages 4-23 and 4-24, the Northwest Forest Plan (USDA Forest Service and USDI Bureau of Land Management 1994), as well as the CRMP.

According to the Land and Resource Management Plan (LRMP p. 4-5), Forest goals for recreation include the following:

- "Manage the Shasta-Trinity National Forest land base and resources to provide a variety of high quality outdoor recreation experiences."
- "Increase emphasis on areas of national significance such as…the Wild and Scenic Rivers System".
- "Encourage use of the Forests by the disadvantaged, physically challenged, and minorities".

Recreational activities within the watershed primarily include fishing, whitewater boating, wildlife viewing, hunting, hiking, and camping. Due to its remote location and relatively limited access, the area included in this analysis is the segment of the McCloud River least used by the general public. Some recreation use occurs at Ah-Di-Na Campground and at Ash Camp. The Pacific Crest Trail crosses the north part of the watershed. Rafting and kayaking occur along the river from Ash Camp to Shasta Lake. Several limestone caves exist in the watershed; however, they are still relatively unknown and use is fairly low.

The Lower McCloud River is well-known for its trophy-size trout and large trout populations, and is a California Department of Fish and Game (CDFG) designated Wild Trout Water. Fishing activities are strictly controlled on the river and the habitat is in excellent condition.

See the Current Conditions section for further information on these activities.

Transportation System and OHV Routes

The transportation system in the watershed totals approximately 227 miles (private and National Forest) and is displayed on Map 14 - Transportation. Current road densities on public and private lands are approximately 1.6 and 3.2 miles of road per square mile of land respectively. Roads are mostly related to past timber harvest activities and tend to be concentrated east of the McCloud River. Most of the area west of the river (with the exception of the Ah-Di-Nah campground region) has a semi-primitive and relatively unroaded character with only occasional logging roads and jeep trails. Both authorized and unauthorized (not on designated trails) off-highway vehicle (OHV) use has occurred in the watershed.

Visual Resources and Scenery

The visual quality of the Lower McCloud River Watershed is generally moderate to high within the analysis area, particularly on public lands. Vegetation is generally free of fire-scarring due to an absence of large scale (>1,000 acres) fires within the recent past. Mid-to-late seral forest is abundant as are limestone outcrops and other geologic features of note. Timber harvesting mainly on private lands has occurred, and is still occurring, in this watershed and thus has had an impact on visual quality. The allocation of 28,199 acres to a Late-Successional Reserve also continues to minimize the amount of potential timber harvest on public lands and, consequently, maintain scenic values.

A central visual draw for many recreationists is the river environment which has “unique and outstandingly remarkable features” (LRMP p. 4-121). The LRMP describes visual quality objectives (VQOs) for each management prescription to enhance scenic quality on the Forest (see Chapter 3). Additionally, broader scale VQO examples (e.g. roads and high use areas would be managed to protect the scenery within the foreground) are defined on page 2-6 in the LRMP.

Fire and Fuels as Related to Human Uses

Increased vegetation densities and fuel loading over time have led to concerns over fire behavior within and adjacent to the wildland-urban interface as well as fire effects to other resources such as recreation (see Map 15 – Wildland Urban Interface). Prescribed burning often produces smoke management issues that may decrease recreational use within the watershed. Large-scale unplanned fire events may have a larger impact to recreation as these events often occur during summer months when recreation use is typically at its highest. Air quality issues as well as the closure of roads and trails for safety concerns may also restrict recreation opportunities during and immediately following implementation of prescribed fire.

Land Ownership, Allocations and Management Direction

Management direction for the Lower McCloud Watershed is found in the Shasta-Trinity National Forests Land and Resource Management Plan (LRMP). The LRMP incorporates direction from the Northwest Forest Plan (USDA Forest Service and USDI Bureau of Land Management 1994).

Land Ownership

The Lower McCloud Watershed analysis area is comprised of various ownerships, both public and private and totals 67,073 acres. Private, non-federal ownerships account for nearly 22,294 acres, or 33% of the analysis area. Numerous ownerships in the analysis are in a ‘checkerboard’ pattern (see Map 2,-Land Ownership) common in the western US during the railroad land grant era. Forest Service ownerships account for the remaining 44,779 acres, or 67 percent of the watershed.

Frequent changing ownerships present more complexities for both access and ecological management decisions, as individual ownerships can range from several acres to many sections of land. Ownership boundaries frequently change over relatively short distances making watershed scale decisions more complex as they can involve more stakeholders who represent diverse interests. During subsequent management actions, consideration of activities on all lands needs to be addressed to better place the analysis area in context.

Land Allocations

The ROD identifies three land allocations within the Lower McCloud watershed analysis area (see Map 18 – LRMP Prescription):

- Late-Successional Reserves (LSR)
- Administratively Withdrawn Areas
- Matrix

Map 2 displays both public and private ownership within the Lower McCloud Watershed analysis area. Map 16 displays the land allocations within National Forest System lands in the analysis area, as designated in the Shasta-Trinity NF LRMP. Map 18 displays the management areas and prescriptions for National Forest System lands in the analysis area, as described in the LRMP.

Late-Successional Reserve (LSR)

Approximately 28,199 acres (42 percent) of the watershed analysis area is designated as a late-successional reserve (LSR). The Iron Canyon LSR (LSR RC-335) encompasses approximately 87,674 total acres, of which 32 percent is located in the Lower McCloud Watershed analysis area. The LSR accounts for approximately 63 percent of federal ownership in the watershed (see Map 9). Objectives for late-successional reserves as described in the LRMP are as follows:

"Late-Successional reserves are to be managed to protect and enhance conditions of late-successional and old-growth forest ecosystems, which serve as habitat for late-successional and old-growth related species including the northern spotted owl. These reserves are designed to maintain a functional, interacting, late-successional and old-growth forest ecosystem." (LRMP pp. 4-63, 4-70).

This land allocation contains a single management prescription category, with the following objectives:

Management Prescription VII – Late-Successional Reserves and Threatened, Endangered and Selected Sensitive Species: The purpose of this prescription is to provide special management for late-successional reserves and threatened and endangered species. It also includes special, selected sensitive wildlife species, which are primarily dependent on late-seral stage conditions. This prescription also emphasizes retention and enhancement of sensitive plant species, old-growth vegetation, and hardwoods. Sensitive fish and wildlife species, which are dependent on riparian areas, will be managed in accordance with the standards and guidelines in Riparian Reserves.

Specific standards and guidelines for Late-Successional Reserves and Managed Late-Successional Areas (LRMP p. 4-44) are designed to maintain, enhance and protect these areas.

A network of reserves was established by the Northwest Forest Plan to provide old-growth forest habitat, provide for populations of species that are associated with late-successional forests, and to help ensure that late-successional species diversity would be conserved (USDA Forest Service 1999). This network consisted of Late-Successional Reserves (LSR), 100-acre core areas, and Managed Late-Successional Areas (MLSA). A set of management standards and guidelines was established for these areas and incorporated into the Shasta-Trinity National Forest's Land and Resource Management Plan (LRMP).

The management objective within LSRs is to protect and enhance conditions of late-successional forest ecosystems. Protection includes reducing the risk of large-scale disturbance, including stand-replacing fire, insect and disease epidemic, and major human caused impacts. The California Klamath Province and California Cascade Province, which both overlap the Lower McCloud Watershed, have been identified as being included in an area of "elevated risk to large-scale disturbance due to changes in the characteristics and distribution of the mixed-conifer forests resulting from past fire suppression" (USDA Forest Service 1999). Risk reduction efforts are encouraged where they are consistent with the overall recommendations in management guidelines.

Within the forest-wide assessment of the network of LSRs on the Shasta-Trinity NF (USDA Forest Service 1999), catastrophic wildfire was identified as the greatest threat to further loss and degradation of habitat for late-successional associated species. This assessment refers to fuel reduction treatments within stands of late-successional and old-growth forest habitat as essential to maintaining and protecting them. It describes low to moderate intensity fire as one of the important ecological processes essential for the development and maintenance of late-successional and old-growth forest ecosystems (USDA Forest Service and USDI Bureau of Land Management 1994).

Within the LSR Assessment (USDA Forest Service 1999), the following objectives are described to guide the development and application of treatments within LSRs:

- Protect existing late-successional habitat from threats (of habitat loss) that occur inside and outside LSRs.
- Promote the continued development of late-successional characteristics.
- Protect mid and early-successional vegetation from loss to large-scale disturbance events.
- Promote connectivity of late-successional habitat within LSRs.

As described by the Forest Plan (LRMP), the goal of wildfire suppression within LSRs is to limit the size of all fires. However, it also states “when watershed analysis, province-level planning, or Late-Successional Reserve assessments are completed, some natural fires may be allowed to burn under prescribed conditions” (LRMP p. 4-40).

Two levels of criteria were established within the LSR Assessment – the first level establishes priorities for the treatments of the LSRs within the network as a whole. The second set of criteria is developed to more specifically guide the placement of management activities within an LSR, and are to be used at the project level to identify treatment areas within and adjacent to an LSR. Objectives, criteria, and potential treatments are described to identify situations triggering further analysis, planning and implementation.

LSRs were identified that are currently at a high percent of the expected late-successional sustainable level and are at a high risk to loss by large-scale disturbance. Of the 24 LSRs analyzed on the Shasta-Trinity NF, the Iron Canyon LSR was one of the top four LSRs identified as having the greatest sustainable level of late-successional forest and that also have the highest risk.

Matrix Lands

Within the watershed analysis area, approximately 9,536 acres (14 percent) lie within the matrix land allocation (see Map 16). Three management prescriptions apply to this allocation, and all three are within the analysis area. Table 1-3 shows the acreages of each matrix prescription in the analysis area.

Table 1-3. Matrix lands for each prescription in the analysis area

Matrix Lands Prescription	Acres
III-Roaded Recreation	7,801
VI-Wildlife Habitat Management	178
VII-Commercial Wood Products Emphasis	1,556

Below is a description of the management objectives for the matrix lands:

Management Prescription III – Roaded Recreation: The purpose of this prescription is to provide for an area where there are moderate evidences of the sights and sounds of humans. Modifications are evident and may appear moderate to observers in the area but will be unnoticed or visually subordinate from sensitive travel routes. This prescription emphasizes recreational opportunities associated with developed road systems and dispersed and developed camp sites. Fish and wildlife management, which supports the recreational use of wildlife species (hunting, fishing, and viewing) is also emphasized. The emphasis of vegetation management activities will be to meet recreation, visual, and wildlife objectives while maintaining healthy and vigorous ecosystems.

Management Prescription VI – Wildlife Habitat Management: The primary purpose of this prescription is to maintain and enhance big game, small game, upland game bird and nongame habitat, thereby providing adequate hunting and viewing opportunities. Habitat management for species that are primarily dependent upon early and mid-seral stages is an important consideration. While this prescription does not emphasize those wildlife species dependent on late seral stages, habitat favorable to these species will occur within this prescription. Vegetation is manipulated to meet wildlife habitat management objectives and to maintain healthy, vigorous stands using such tools as silviculture and prescribed fire. Roaded natural recreation opportunities will be maintained.

Management Prescription VIII – Commercial Wood Products Emphasis: The purpose of this prescription is to obtain an optimum timber yield of wood fiber products from productive forest lands within the context of ecosystem management. Investments will be made in road construction, fuels management, reforestation, vegetation management, and timber stand improvement. Timber stands will be managed to obtain optimum growth and yields using cultural practices which control competing vegetation (release and weeding), obtain stocking control (thinning, and minimize mortality (pest management) within the context of the Matrix Standards and Guidelines. Rotation lengths will normally range from 70 to 140 years and average about 110 years, depending on site and species. Vegetation manipulation will provide habitat for those wildlife species primarily dependent on early and mid-seral stages.

Management prescriptions for the matrix land allocation are found in the LRMP on pages 4-64 through 4-67.

Administratively Withdrawn

Within the watershed analysis area, approximately 6,839 acres (10 percent) lie within the administratively withdrawn land allocation. Three management prescriptions apply to this allocation. In the Lower McCloud analysis area, 6,815 acres are within Management Prescription I and the remaining 24 acres are within Management Prescription X (see Map 26 – LRMP Prescription). Per the LRMP, the following describes the management objectives for the prescriptions:

Management Prescription I – Unroaded, Nonmotorized Recreation: The purpose of this prescription is to provide for semi-primitive non-motorized recreation opportunities in unroaded areas outside existing wildernesses while maintaining predominantly natural-appearing areas with only subtle modifications. Special recreational and visual values, fisheries, and riparian resources are emphasized. Also emphasized in this prescription is retention of old-growth vegetation and management of wildlife species requiring late seral stage conditions.

Management Prescription X – Special Area Management: This prescription provides for protection and management of research sod special interest areas (SIAs) and research natural areas (RNAs). In the analysis area, a unique plant area is located on Grizzly Peak, and can be viewed in the Shasta Forest GIS library.

Management Prescription XI – Heritage Resource Management: The purpose of this prescription is to protect designated cultural resource values, interpret significant archaeological and historical values for the public and encourage scientific research of these selected properties. Five cultural resources designated as Prescription XI are located in the watershed. This location of this management prescription is not disclosed to protect the resource area, but can be made available as needed.

Pages 4-45 through 4-51 of the LRMP detail the management prescriptions for Administratively Withdrawn Areas.

Roadless Designation

In the Lower McCloud analysis area, 29,705 acres are designated as inventoried roadless. All of the inventoried roadless area is on Forest Service land. Only 15,074 acres are not designated as inventoried roadless in the analysis area, and this area is predominately in the northwestern portion of the watershed. Inventoried roadless accounts for 44 percent of the total analysis area and 66 percent of Forest Service ownerships (see Map 9).

There are two individual roadless areas in the Lower McCloud watershed, the West Girard and East Girard roadless areas. The West Girard inventoried roadless area is approximately 37,490 total acres in size and is designated as 'non-wilderness'. Of this area, 12,075acres are within the Lower McCloud watershed Analysis area. The East Girard inventoried roadless area is approximately 27,875 total acres and is also designated as 'non-wilderness.' Of the total East Girard inventoried roadless area, 17,630 acres are within the analysis boundary.

The decision validating this designation was made through the second Roadless Area Rule and Evaluation (RARE II) environmental statement, from January of 1979. Compelling reasons for roadless areas being designated as non-wilderness are included in the environmental statement, but none specifically relate to any individual roadless areas. From the RARE II document, "entry into non-wilderness area and utilization of resources will be regulated by current laws, regulations, and within constraints of existing management plans." RARE II inventoried roadless areas also designated as non-wilderness need not be considered further in wilderness-related analyses.

Subsequent to RARE II, the Roadless Area Conservation final rule and Record of Decision (ROD) was adopted in 2001 (36 CFR Part 294) and is commonly referred to as the '2001 Roadless Rule' or 'Roadless Area Conservation Rule.' The 2001 Roadless Rule prohibits new road construction and reconstruction in inventoried roadless areas on National Forest System lands except under specific circumstances (see 36 CFR Part 294).

The Secretary of Agriculture authored a memo on May 28, 2009 (Secretary's Memorandum 1042-154) reserving the Secretary "decision-making authority over the construction and reconstruction of roads and the cutting sale or removal of timber in inventoried roadless areas." Future foreseeable management actions within the West Girard Roadless Area will be addressed in other portions of this document. These actions include, at a minimum, the removal of small trees in order to maintain or restore ecosystem composition and structure as well as reduce the risk of uncharacteristic wildfire effects. There may also be a need to remove small diameter trees to improve habitat for threatened, endangered, proposed or sensitive species.

Coordinated Resource Management Plan

The McCloud River System has been determined eligible for possible inclusion in the National Wild and Scenic Rivers system. In lieu of recommending Wild and Scenic River designation, the

Forest Service has taken the lead in working with adjacent private landowners and public agencies to develop a Coordinated Resource Management Plan (CRMP) for the corridor (LMP 2-6).

In July 1991, the McCloud River Coordinated Resource Management Plan (CRMP) was signed by principal landowners in the McCloud River Drainage and public agencies that administer programs in that area. The CRMP is intended to be an acceptable option to Wild and Scenic designation for the McCloud River.

Coordinated planning is a process designed to achieve compatibility between the uses being made of natural resources in a specified area. A CRMP sets forth the framework for activity planning within the CRMP boundary. This approach uses the best efforts and knowledge of everyone involved; private landowners and involved Federal, State, and local agencies.

Authority for State and Federal agencies to participate in coordinated planning is contained in existing statutes or delegations of authority. The Forest LMP contains Supplemental Management Direction to manage the Lower McCloud River under this CRMP (LRMP 4-123).

The intent of the CRMP is to coordinate large-scale resource planning. The following excerpt from the CRMP describes its objectives:

The primary objective of the CRMP is to preserve the pristine quality of the river resources described within.
The CRMP area includes significant recreation and visual resource values. Objectives for management are:

- (a)Maintenance of a predominately natural appearing area;
- (b)Provision for public use consistent with wildlife and watershed protection and the rights of private landowners.

The CRMP area includes significant vegetation resources. The objective for management is:

- (a)Vegetation use consistent with watershed, viewshed and fisheries values protection.

The portions of the McCloud River from McCloud Dam downstream to the upper boundary of the McCloud River Club has been designated by the Department of Fish and Game as a wild trout water under the California Wild Trout Program. The general fisheries management objectives of the Wild Trout Program are:

- Maintenance of wild trout populations at levels necessary to provide satisfactory recreational angling opportunities.
- Maintenance and enhancement, where appropriate, of the habitat required for optimum wild trout production.
- Preservation of the natural character of the streamside environment.

These objectives are appropriate for land management practices adopted pursuant to this management plan since they relate to the central issues of the McCloud watershed, including recreation management, timber management, wildlife management, watershed protection, and fisheries management.

The CRMP covers two general areas along the McCloud River:

- Upper River - from McCloud Reservoir upstream to Algoma Bridge.
- Lower River - from McCloud Reservoir downstream to Shasta Lake.

The Lower River section is the only area addressed in this analysis. The Upper River section is outside the analysis area.

If, for any reason, the terms of the CRMP are not followed and the Wild and Scenic River eligibility is threatened, the Forest Service will recommend the river for Federal Wild and Scenic designation (LRMP 3-23).

McCloud-Pit Hydroelectric Project

The Federal Energy Regulatory Commission (FERC) operates a hydropower project in the Lower McCloud Watershed analysis boundary. This project is FERC number 2106 (FERC No.2016) and is named the McCloud-Pit Hydroelectric Project. The project is located in the McCloud and Pit River drainages, and portions of the FERC 2106 project area are within the Lower McCloud analysis area (see Map 28 – Federal Energy Regulatory Commission). McCloud reservoir and Iron Canyon Reservoir (outside of the Lower McCloud watershed analysis boundary) are regulating storage reservoirs for the FERC 2106 project.

The FERC 2106 is completing the re-licensing process, concurrent with the, update of this watershed analysis. There are extensive technical memorandums written as a result of the re-licensing compliance requirements. These technical memorandums were used extensively by various Forest Service resource personnel during the writing of this watershed analysis, and are incorporated by reference. The technical memorandums used in this watershed analysis are listed in the references section of this document, and incorporated as electronic references.

Chapter 2: Issues and Key Questions

Identification of issues and key questions related to resources in the watershed serves to focus the watershed analysis on those key elements that are relevant to management objectives, human values and resource conditions within the watershed.

This document is guided by two levels of analysis:

♦ **core topics -** provide a broad, comprehensive understanding of the watershed.

Core topics are provided in the Federal Guide for Watershed Analysis (8/95) to address basic ecological conditions, processes, and interactions at work in the watershed. Core topics to be addressed are:

- Erosion processes
- Hydrology
- Stream Channel
- Water quality
- Vegetation
- Species and habitats
- Human uses

♦ **issues -** focus the analysis on the main management questions to be addressed.

Issues are those resource problems, concerns, or other factors upon which the analysis will be focused. Some of these issues prompted initiation of the analysis. Other issues were developed from public input in response to scoping or were identified by the team during the analysis process.

This chapter describes the major issues identified in the Lower McCloud River Watershed (watershed). Key analysis questions are developed for each issue. These questions are organized by analysis step to help focus the analysis and to provide organization to the document while addressing the issues.

The major issues identified are:

- Fire and Fuels
- Habitat Quality
- Late-Successional Reserve

Issue: Fire and Fuels

Key Questions

1. What is the current fire hazard and risk in the analysis area, including the threat to private land?
2. How might future fires affect other resources (e.g. air quality, erosion processes, human uses, soil fertility, water quality, fisheries, wildlife and botanical habitat)?
3. Under current management, what are the future trends for fire in the watershed?

4. What is the desired role of fire in the watershed?
5. What are fire and fuel management concerns within the analysis area, including fire suppression?

Issue: Habitat Quality

With late seral, late to mid seral, and mid seral conifer habitat occupying much of the federal lands within the Lower McCloud watershed (see Table 3-9 and 3-10), it is essential to develop an understanding of the factors influencing the overall condition and availability of these habitats as well as the risks to it (see Map 8 – Mid and Late Seral Habitats on Federal Lands). See Chapter 3 Species and Habitats or Vegetation sections for more details on the criteria used for assessing the seral stages within habitat types.

Late (and mid to late) seral habitat has the potential to support multiple Forest Service Sensitive and federally listed species. Other species associated with mid and early seral mixed conifer forests, limestone outcroppings and riparian habitat have the potential to occur in the watershed. These species include Forest Service Sensitive plants, amphibians, reptiles, bats, and mollusks, in addition to neotropical migratory birds and game species (see Chapter 3).

Because the Lower McCloud watershed contains federally designated Critical Habitat for the northern spotted owl (NSO), it is essential that the key elements such that constitute suitable NSO habitat are considered when assessing the overall quality of the habitat within the watershed. These key elements include nesting, roosting and foraging habitat.

Key Questions

1. How are management actions within the watershed affecting terrestrial and aquatic habitat quality?
2. Does the current condition of the watershed have a desirable mix of seral stages, age classes, and vegetation types of terrestrial habitat for wildlife species?
3. How are existing conditions influencing the potential for high-severity wildfire to impact terrestrial and aquatic habitat quality?

Issue: Late-Successional Reserve

The Iron Canyon Late-Successional Reserve (LSR RC-335) encompasses approximately 42 percent of National Forest lands within the Lower McCloud watershed analysis area. The Lower McCloud watershed is one of six watersheds within or crossing this LSR. Habitat conditions vary among these watersheds. It is important to understand the role of this watershed and the effect that management actions will have on the overall functioning of the LSR.

The STNF forest wide assessment of LSR's conducted in 1999 described the Iron Canyon LSR as containing relatively large parcels of late-successional stands with the exception of the Girard and Salt Creek drainages. Connectivity was also described as "fairly good" and that "where late-successional habitat is fragmented, connectivity is provided by mid-successional stands." The LSRA also states that *"This LSR [Iron Canyon LSR] provides for a relatively large area of late-successional habitat. Probably its most important value for late-successional species is its connectivity to the Cascades and Sierra Nevada Mountains. It is nearly surrounded by large blocks of private land and does exhibit checkerboard ownership in the southern half."* However, currently (twelve years after the LSR assessment) the patchwork network of ownership, particularly in the southern portion of the watershed, is highly fragmented, primarily as a result of timber harvest on the sections of private land amongst the national forest lands. Prior to harvest, habitat on these private lands consisted of late-successional stands that contributed to the overall connectivity of the habitat in the watershed and the LSR as a whole.

Key Questions

1. What is the current condition of the LSR in the watershed?
2. What is the desired role of fire in the LSR?
3. What is the future trend for development, maintenance and protection of late-successional habitat in the LSR?
4. How does the Iron Canyon LSR meet the criteria for prioritizing treatment areas both within the LSR network as a whole and as within individual LSRs as outlined in the forest-wide LSR Assessment?
5. What is the role of the Lower McCloud watershed in the functioning of the Iron Canyon LSR as a whole?

Items not addressed as Issues

Several items that were provided during public scoping were not included as issues in this analysis. The purpose of this section is to acknowledge these concerns.

Caves

Protection of caves in the watershed was a concern to several caving groups and individuals. Public scoping in the 1990's asked for comments on this and another adjacent watersheds - the Lower McCloud and the McCloud Arm watersheds. Most of the comments related to cave protection focused on the McCloud Arm watershed, located to the south of the analysis area, where caves are more abundant and likely to be affected by management activities. Since caves in the Lower McCloud River watershed were not a driving issue for the analysis, it was decided to address cave protection through the core topics. Opportunities exist to link cave protection in adjacent watersheds into a single management recommendation. Further studies of caves in the analysis area are recommended.

Salmon Reintroduction

Efforts are being proposed and are underway to re-introduce native salmon populations into areas of suitable habitat above a few permanent dams within California, including Shasta Dam. The lower McCloud River was one area identified as having potential suitable habitat. The future status of these experimental fish populations is unknown at this time.

In 2009 NMFS issued a biological opinion and conference opinion based on their review of the Bureau of Reclamation's proposed long-term operations of the Central Valley Project and State Water Project (CVP/SWP) in California. NMFS' final Opinion concluded that the CVP/SWP operations are likely to jeopardize the continued existence of several federally listed fish species. The Endangered Species Act requires identification of a reasonable and prudent alternative (RPA) to avoid the likelihood of jeopardy to a listed species. Thus, NMFS' opinion included studies to examine options to provide anadromous fish passage over Keswick and Shasta Dams and an Interagency Fish Passage Steering Committee was created to oversee planning and implementation of a salmon reintroduction program. Based on results of feasibility studies to assess the suitability and functionality of existing and potential anadromous fish habitat, reintroduction of listed salmonids in the Pit, McCloud, and/or upper Sacramento Rivers could begin as early as 2012 (NMFS 2009). In the short term, the Bureau of Reclamation in cooperation with NMFS, the California Department of Water Resources and other fisheries agencies are proposing to implement fish passage for adults via “trap and transport” while ongoing studies to develop and assess long-term upstream and downstream fish passage alternatives around Shasta Dam continue.

There are many uncertainties regarding the implementation of an anadromous fish reintroduction program above Shasta Dam that include both legal and financial issues. The feasibility of this endeavor is continuing to be examined by the Interagency Fish Passage Steering Committee at the time of the writing of this document.

Chapter 3: Current Conditions

Physical Features

The purpose of this chapter is to develop information relevant to the issues and key questions identified in Chapter 2. The current range, distribution, and condition of the relevant ecosystem elements are discussed.

Erosion Processes

The Lower McCloud River Watershed is located within the eastern Klamath Mountain belt of the Klamath Mountain Province. The rugged topography in the watershed has been formed over millions of years by a combination of fluvial, tectonic uplifting, and mass wasting processes. A wide variety of mass wasting features occur within the watershed including deep-seated rotational landslides, shallow debris slides and valley inner gorges. Large limestone outcrops occur on ridgetops in the vicinity of Tombstone and High Mountains and in the Willawaket and Nawtawaket drainages. Smaller limestone outcrops also occur on Van Sicklin Butte, Beetle Butte, and lower Bald Mountain Ridge, and along the McCloud River near Shasta Lake.

Land-use activities that have affected hillslope erosion processes in the Lower McCloud River Watershed include road construction, timber harvest and fire suppression. The majority of road related impacts are concentrated south and east of the McCloud River where road densities are highest (see Map 14 - Transportation). Road impacts have occurred due to a number of factors including undersized culverts, lack of maintenance, wet weather road use and winter storms. Recurring road problems include rutting, fill slope failures, plugged culverts and drains, and minor slumps and slides. Road systems have also disrupted drainage patterns on hillslopes resulting in increased hillslope erosion and gullying. Field reconnaissance indicates that most roads that have not experienced use over the past decade have begun to revegetate and stabilize. Road related impacts are greatest in the Claiborne and Ladybug Creek drainages. Other areas impacted by roads include Van Sicklin Butte, and the Hawkins and Deer Creek drainages.

The impacts of timber harvest activities are less concentrated than those of roads and are mostly limited to the eastern half of the watershed. The low erosion capacity of soils in the McCloud River Canyon tends to reduce soil erosion from ground disturbing activities. Soils in the McCloud River Canyon are shallow and stony and tend to have slower rates of natural erosion than soils in the Western Klamath Mountains west of Interstate 5. Steep slopes that have been clearcut in the Hawkins and Chatterdown Creek sub-watersheds have revegetated with brush species. Hillslopes that have been selectively cut appear to recover within a decade following treatment.

While some land-use activities have increased hillslope erosion, others may be limiting erosion. Effective fire suppression has resulted in abnormally high concentrations of fuels throughout the watershed. Over the past 50 years fire suppression has functioned as an erosion reducing mechanism by suppressing fires that could have burned appreciable amounts of vegetation in the watershed had they not been suppressed. It is important to note the benefits of fire suppression mentioned above may be offset by impacts occurring during fire suppression activities and following unplanned wildland fires resulting from fire suppression and continued build-up of fuels. Greater total available fuels generally increases combustion rates, and in some cases vegetation burn severity.

Impacts from fire suppression activities in the Butcherknife Creek drainage were apparent during the Butcher Fire in 1996. Impacts included considerable hillslope disturbance from fire lines created by heavy equipment. Considerable amounts of vegetation were removed during fire line construction and hillslopes were scoured down to mineral soil on the firelines. Erosion control work on the lines was undertaken following suppression activities. Erosion control measures were effective in mitigating hillslope erosion the following winter, but overall vegetation has been slow to recover.

High intensity wildfires have the potential to seriously increase hillslope erosion as was demonstrated in the aftermath of the Dee Fire which occurred in the Ladybug Creek drainage in 1989. The potential impacts of high intensity wildfires include total loss of ground cover, increased soil water repellence, increased overland flow, and increased soil erosion. High fuel loads can lead to high intensity wildfires that could destroy the soil organic layer resulting in increased hillslope instability. Mass wasting activity could also increase following wildfires due to increased groundwater levels and surface water concentration in the hollows of dormant unstable features.

Hydrology

The Lower McCloud River Watershed drains an area of 106 square miles between the McCloud Reservoir and the McCloud Arm of Shasta Lake. The watershed contains a twenty-four mile stretch of the McCloud River. All tributaries to the McCloud River drain mountainous terrain forested primarily by mixed conifer species. In addition to the runoff originating in the watershed, the McCloud River also receives service and groundwater from a 407 square mile area of the Upper McCloud River Basin and the 104 square mile Squaw Valley Creek Watershed. The total basin area drained by the McCloud River at Shasta Lake is approximately 617 square miles with the Lower McCloud River Watershed accounting for 17 percent of the basin area.

The Lower McCloud River Watershed is drained by a dendritic channel network. The drainage density of the watershed is approximately 6.9 miles of stream per square mile. Drainage densities are relatively uniform throughout the watershed. The watershed contains approximately 126 miles of perennial streams, 201 miles of intermittent streams and 394 miles of ephemeral streams. Ephemeral streams differ from intermittent streams in that they flow only in response to runoff producing precipitation events or rapid snowmelt. Riparian Reserves in the Lower McCloud River Watershed consist almost exclusively of stream channels and unstable areas (Maps 10 and 12).

Hydrologic features such as wetlands and wet meadows are almost completely absent from the watershed. Only one spring, south of Satin Peak, is shown on USGS topographic maps; however, many more unmapped seeps and springs occur throughout the watershed. Conversely, the Upper McCloud River watershed has a preponderance of springs that seep from a robust water supply. One large wet meadow complex, known as Little Meadows, occurs in the headwaters of Hawkins Creek. About half of the Little Meadows area is vegetated with forbs and grasses and the other half is densely vegetated with willow and mountain alder.

The hydrology of the Lower McCloud River Watershed is complex due to differences in runoff characteristics between the analysis area and the full McCloud River Basin. Also, the Pit River Hydroelectric Project water diversion has also altered base flows in the McCloud River below McCloud Reservoir. For the purposes of discussion the Lower McCloud River Watershed (analysis area) can be divided into four sub-watersheds. These sub-watersheds include Hawkins, Claiborne, Chatterdown, and the remaining Lower McCloud River Tributaries. Streamflow characteristics are similar in each of the four sub-watersheds due to similarities in climate, soils and geologic parent materials. The Upper McCloud River (above McCloud Dam) and Squaw Valley Creek (the largest of the Lower McCloud tributaries) are examined under separate watershed analyses.

An abundance of stream flow data is available for the McCloud River above Shasta Lake because of the need to monitor in stream flows below the McCloud Reservoir. Stream flow data for the Lower McCloud River and vicinity are available from six gauging stations shown in Table 3-1.

Table 3-1. Stream flow gauging stations for analysis area and vicinity

Station Name	Station Number	Period of Record
McCloud River at Baird	11369000	1911-1943
McCloud River above Shasta Lake	11368000	1946-2010
McCloud River at Ah-Di-Na	11367800	1965-2010
McCloud-Iron Canyon Diversion Tunnel	11367720	1966-2010
McCloud River below McCloud Dam (partial record)	11367760	1966-2010
McCloud River near McCloud (below Angel Creek)	11367500	1931-2010

Base Flows

Base flows in the McCloud River are completely regulated by the Pit River Hydroelectric Project. Most of the water entering the McCloud Reservoir is diverted through a tunnel to Iron Canyon Reservoir in the Pit River Watershed. From Iron Canyon Reservoir the water is again diverted to the James B. Black Powerhouse on the Pit River where it is used to generate hydroelectric power. The average base flows for the diversion tunnel and at three stations along the McCloud River are shown in Figure 1, Appendix H.

Figure 1 illustrates several important base flow characteristics for the McCloud River. First, it is apparent that almost all of the flow entering the McCloud Reservoir is diverted to Iron Canyon Reservoir. In order to provide for fisheries needs, a minimum instream flow s ranging from 40 to 50 cfs must be maintained at all times below the McCloud Reservoir Dam. Forty cfs is required from December 1 – April 30th while 50 cfs is required for the remaining months. Generally, instream flows stay well above the minimum release, rarely dropping below 100 cfs. Minimum releases from the McCloud Reservoir are also dictated by streamflow measured at the Ah-Di-Na gage located 3.9 miles below the reservoir. A minimum instream flow ranging from 160-210 cfs is required at this location in order to ensure adequate downstream flows for fisheries habitats (USGS Water Resources Data 1994). The additional runoff required to sustain the 160-210 cfs minimum requirement at Ah-Di-Na is supplied by Hawkins Creek and other smaller tributaries such as Squirrel Creek below the McCloud Reservoir.

From Figure 1 it is also apparent that average monthly base flows at Ah-Di-Na are generally only about twenty to twenty five percent of the average monthly base flows for the McCloud River above the reservoir. Average base flows for the McCloud River at Shasta Lake only exceed base flows for the McCloud River above the McCloud Reservoir in January, February and March. The decrease in average base flows is made more evident by a comparison of streamflow records prior to and after the construction of the McCloud Reservoir (Figure 2, Appendix H). Prior to the beginning of the McCloud Reservoir-Iron Canyon Diversion, the lowest daily mean flow recorded in the McCloud River at Shasta Lake from 1946-65 was 825 cfs. Since the beginning of water diversion the lowest daily mean from 1967-94 has been 292 cfs.

Minimum releases in the McCloud River below McCloud Dam and at Ah-Di-Na were set during the Federal Energy Regulatory Commission (FERC) licensing of the McCloud-Pit Hydropower Project in 1961 (table 3-2). Flows required to sustain salmonid spawning runs from Shasta Lake were used as the criteria for setting minimum flows. The needs of wild trout and bull trout were not considered during the licensing process due to the lack of public recreational fishing use that occurred on the Lower McCloud River in the early 1960s (Rode 1989). Minimum flows in the river range from 160-210 cfs during normal or wet years and 160-180 cfs during dry years. Variations in minimum flows during dry and wet years reflect annual variations in base flows in the McCloud River above McCloud Reservoir.

Table 3-2. Required minimum flow at the Ah-Di-Na stream gauging station

Period	Normal Year (CFS)	Dry Year (CFS)
January	160	160
February	160	160
March	170	170
April	170	170
May 1-15	170	160
May 16-31	200	160
June	200	160
July	200	160
August	200	160
September	210	180
October	210	180
November	210	180
December 1-15	210	180
December 16-31	170	170

Base flows in the McCloud River above the McCloud Reservoir do not fluctuate nearly as much from month to month as base flows in the McCloud River above Shasta Lake. The difference in fluctuations reflects the different hydrologic characteristics between the Upper McCloud and Lower McCloud River Watersheds. The large groundwater influence in the Upper McCloud River Basin results in relatively constant base flows throughout the year. In contrast to the Upper McCloud Basin, the majority of precipitation falling in the Lower McCloud River Watershed falls as rain and rain-on-snow, and is quickly delivered into the channel network resulting in larger, flashier peak flows and larger variations in base flows. Snowpacks on the higher ridges contribute to higher flows during late winter and early spring (as is evident in Figures 1 and 2).

Peak Flows

Peak flow events occur during the winter months when heavy rains saturate the ground and melt the snow pack in the upper elevations of the watershed. The peak flow history for the McCloud River above the McCloud Reservoir, at Ah-Di-Na and above Shasta Lake are shown in Figure 3 (Appendix H). The McCloud Reservoir-Iron Canyon Diversion does not significantly influence the larger peak flow events in the watershed, however the size of smaller peak flows occurring at less than 5-10 year intervals (often referred to as channel maintenance flows) has been reduced due to water diversions to Iron Canyon Reservoir. From Figure 3 it is apparent that the Lower McCloud River tributaries, along with Lower McCloud, supply over three times more runoff during peak flow events to the McCloud River than is supplied by the entire Upper McCloud River Basin. The disproportionate amount of runoff per unit area reflects the difference in groundwater storage between the Lower McCloud River Watershed and Upper McCloud River Basin, and substantially larger annual precipitation in the Lower McCloud Watershed.

Table 3-3. Predicted peak flows for analysis area and vicinity

	Flow (cfs) recurring at 2-100 year recurrence intervals					
Area	**2**	**5**	**10**	**25**	**50**	**100**
McCloud River near McCloud*	2,440	4,530	6,350	9,220	11,800	14,800
McCloud River at Baird*	13,600	23,800	32,000	44,100	54,300	65,600
Lower McCloud Watershed (Total)	7,450	14,580	18.950	27,620	34,110	44,120
Hawkins Creek	930	1,970	2,630	3,940	4,950	6,540
Upper River Tributaries	1,510	2,990	910	5,730	7,100	9,210
Clairborne Creek	1,260	2,500	3,250	4,720	5,840	6,480
Chatterdown Creek	1,480	2,850	3,670	5,280	6,480	8,310
Lower River Tributaries	2,270	4,280	5,500	7,950	9,750	12,500

Estimates of instantaneous peak streamflows for 2, 5, 10, 25, 50 and 100 year recurrence intervals were calculated for each of the 5 sub-watersheds in the Lower McCloud River Watershed according to Waananen and Crippen, 1977 (Table 3-3). Peak flow estimates are also shown for the Upper McCloud River and the McCloud River at Baird (Waananen and Crippen, 1977). The largest flow event measured at the McCloud River station above Shasta Lake occurred in January 1974 when the instantaneous discharge peaked at 45,500 cfs. According to the flow estimates shown in Table 3-3, the 1974 runoff event corresponds to a 100 year flood for the Lower McCloud River Watershed.

Peak and base flows in the Lower McCloud River Watershed are influenced by both natural processes and land-use activities. Water diversions have the greatest influence over base flows in the McCloud River; however, other activities may modify peak and base flows throughout the watershed. Natural processes and land-use activities that decrease vegetative cover, evapotranspiration, and infiltration generally result in increased peak and base flows. High density road networks also increase flood peaks by reducing infiltration, intercepting groundwater flow and quickly routing storm runoff to the channel network.

The affect of timber harvest and wildfire on peak flows in the watershed was studied in the Ladybug and Bones Gulch drainages as part of The McCloud River Water Quality Monitoring Project (see Water Quality for more information). Timber harvest and wildfire resulted in increased peak flows in both of the disturbed drainages. Prior to timber harvest (1986-88), the amount of runoff produced from the Ladybug drainage was about twice the amount produced by the Bald Mountain drainage. Following timber harvest and wildfire (1989-91), the runoff from the Ladybug Creek drainage was about three times as much as the Bald Mountain drainage. Peak flows in Bones Gulch also increased during the winter following timber harvest activities. Because hydrologic and geologic characteristics are relatively uniform in the Lower McCloud River Watershed it is expected that increases in peak flows in most drainages from timber harvest and wildfire will be similar to those that occurred in the Ladybug Creek and Bones Gulch drainages.

Stream Channel Morphologies

The morphology of stream channels in the Lower McCloud River Watershed is a consequence of natural geologic and fluvial processes and, in some cases, land-use activities. Channel morphologies in the watershed are very much alike because the channels have formed in similar parent materials and climatic conditions. In this section, stream channels in the Lower McCloud River Watershed are stratified into eight channel types and the dominant processes responsible for maintaining or altering these channel types are identified. Channel types were derived from the 1995 Aquatic Ecological Unit Inventory (EUI), aerial photo interpretation and field inspection.

Data pertaining to ecological, morphological and biological channel characteristics were collected at forty-seven locations in the Lower McCloud River Watershed with the majority of the sampling locations occurring in the Hawkins and Claiborne Creek sub-watersheds. The parameters of channel gradient, channel particle size, flow regime, bankfull width and active channel width were combined with site descriptions to classify stream channels into seven classes according to Montgomery and Buffington 1993, with an additional eighth class added to account for stream channels in the upper Hawkins Creek sub-basin that did not fit any of the previous seven classes (Table 3-4). Many channels within the watershed do not fit neatly into this classification system; however, the system does provide a framework for describing channel types commonly found in the watershed and the processes that influence their function and development.

Channels located in close proximity to the ridgetops or in small drainages tributary to the McCloud River are classified as swales, colluvial or bedrock channels. Together these three channel classes comprise what are hereafter referred to as upland channels. Swales and colluvial channels are source areas for sediment and are most vulnerable to land-use impacts due to their abundance and the steep topography in which they are found.

Generally, most upland channels have not been influenced by land-use activities. Natural hillslope erosion and fluvial processes control sediment delivery to these channels. Woody debris serves an important function in upland channels by storing sediment and increasing channel stability. In some portions of the watershed, such as upper Hawkins and Chatterdown sub-watersheds, timber harvest and associated road building has resulted in increased sediment delivery and transport in colluvial and bedrock channels. These impacts are not readily apparent since the majority of the sediment is carried downslope where it is deposited in low gradient reaches.

Impacts to stream channels from timber harvest activities tend to be relatively short lived, generally lasting from 1-5 years following harvest. Impacts from roads often last much longer than those of timber harvest. The road system has influenced upland channels by altering hillslope runoff pathways, increasing hillslope runoff, and increasing sediment inputs. Stream channels have been aggraded above road crossings due to plugged culverts and drains. The majority of road drainage and erosion problems are associated with roads located adjacent to and within canyon inner gorges and riparian areas. These problems are mostly noted in the southeastern part of the watershed where road densities are greatest.

Catastrophic wildfires have the potential to seriously impair upland channels by removing vegetation and destabilizing hillslopes. Increased hillslope erosion occurring during subsequent winter rains can deliver large volumes of sediment to the upland channel network. Increased runoff and hillslope erosion following vegetative loss can result in headward expansion of colluvial channels into swales. Impacts to upland channels in the Ladybug Creek drainage following the Dee Fire of 1989 illustrate the hazards that unplanned wildland fires pose to the aquatic environment. Straw bale check dams were placed in upland colluvial channels following the fire in order to trap sediment from the burned hillslopes. The check dams were completely filled with sediment during a large precipitation event the following winter.

As the drainage area increases with increased distance downstream, bedrock and colluvial channels evolve into cascade channels. Cascade channels generally exhibit perennial flow regimes. They are steep and dominated by boulder and stone substrates. The bedrock reach class also occurs periodically where bedrock is the dominant substrate. With the exception of isolated low gradient reaches, the majority of sediment derived from upland channels is transported through cascade channels during peak flows. Cascade channels have been influenced by land-use activities, although to a much lesser extent than the upland channel network above them.

As channel gradients decrease most cascade channels evolve into step-pool channels. Step-pool channels are characterized by a characteristic pattern of alternating steps and pools. Like cascade channels, step-pool channels often are interspersed with occasional bedrock reaches. The bedrock reaches often contain waterfalls which occur at exposed bedrock control points along the channel. Most step-pool channels have not been impacted by management activities. Excessive sediment delivery from upland channels has resulted in channel aggradations in some of the smaller, low gradient step-pool channels such as the lower reaches of Hornet Gulch in the Hawkins Creek sub-basin. In some cases channel aggradations has resulted in the loss of pools and the conversion of step-pool channels to plane-bed channels. Most of the larger tributaries to the McCloud River, such as Claiborne and Chatterdown Creeks, are classified as step-pool channels.

Table 3-4. Channel classes found in the Lower McCloud River watershed

Reach Class	n	Slope	Reach Type	Description
Swale (Upland)	4	Variable	Source	Occur in close proximity to ridgetops, above colluvial and bedrock channels. Do not contain channel features. Contain no evidence of annual scour. Substrate at center of swale dominated by woody debris and soil. Swales located in unstable areas serve as source areas for debris flows. Do not contain riparian vegetation unless associated with springs.
Colluvial (Upland)	9	S>.20	Source	Occur in close proximity to ridgetops. Beginning of colluvial channel denotes point of channel initiation. Upper reaches of colluvial channels ephemeral and lower reaches have intermittent streamflow on an annual basis. Channel substrate consists largely of hillslope colluvium deposited by gravitational forces rather than alluvial processes.

Reach Class	n	Slope	Reach Type	Description
Bedrock (Upland)	1	Variable	Transport	Occur in close proximity to ridgetops but can also occur at lower elevations. Identical to colluvial channel type with the exception that the dominant substrate is bedrock. Colluvial channels may be converted to bedrock channels following debris flow events. Bedrock reaches may also occur in larger, low gradient channels.
Cascade	11	.30>S>.10	Transport	High gradient channels occurring on steep mid-slopes throughout the watershed. Flow can be perennial or intermittent. Channel substrates are dominated by boulders and stones in larger perennials and cobbles and gravels in intermittents. Examples of cascade channels include the mid-elevation reaches of Mica Gulch, Centipede Creek, and Deer Creek.
Step-Pool	11	.10>S>.03	Transport	Occur in mid to lower elevations within well developed canyons and inner gorges. Flow regime is generally perennial. Channel substrates are dominated by boulders, stones and cobbles. Comprise the majority of larger tributaries to the McCloud River including lower reaches of Butcherknife and Nawtawaket Creeks and middle reaches of Claiborne, Hawkins and Chatterdown Creeks.
Plane-Bed	6	.03>S>.01	Response	Diverse channel type found in the McCloud River and portions of its major tributaries. Low gradient, perennial channels. Substrate composition is variable. Lack defined bedform patterns such as point bars and pools. Channels exhibiting plane-bed morphologies include the upper reaches of Hawkins Creek, the lower reaches Claiborne Creek and reaches of the McCloud River.
Pool-Riffle	4	.02>S.001	Response	Comprises majority of McCloud River and may also occur in lower reaches of larger tributaries such as Squaw Valley Creek. Flow regime is always perennial. Substrate types generally consist primarily of stones and boulders in riffle reaches and cobbles and gravels in pool reaches. Bedrock outcrops are common. Channel canopy cover is generally less than other channel types due to size of bankfill channel.
Alluvial Upland	1	.03>S.001	Response	Occur in flat, upland areas. Inspection of aerial photos and maps indicates that this channel type may be unique to the upper reaches of Hawkins Creek in the Little Meadows area. Channel gradients are low and flow regimes are intermittent or perennial. Substrate dominated by sand and gravels. Channels are very unstable and have been impacted by land-use activities.

**With the exception of the Alluvial Upland class, channels are typed according to Montgomery and Buffington reach level classification system (Montgomery and Buffington, 1993).*

The McCloud River and the lower reaches of its larger tributaries are classified as **pool-riffle** or **plane-bed** channels. These channels along with step-pool channels harbor the majority of the fisheries found in the watershed. Data collected during habitat surveys associated with hydropower re-licensing indicate that these channels are stable and in good health.

Large woody debris (LWD) recruitment is reduced below the McCloud Reservoir dam. Large woody debris does not play a large role in channel formation and stability in this section of the

McCloud River, although it does provide habitat for aquatic species along the streambanks. As part of the FERC relicensing for the McCloud-Pit Project, a LWD Management Plan is required (Further reference in PG&E 2009h).

Other than large flow event, coarse gravel and cobble comprise the main bedload size class (PG&E 2009g). As part of the FERC relicensing for the McCloud-Pit Project, a strategy to replace diminished coarse gravel below the dam has been developed. The delta for Star City Creek is accessible at reservoir drawdown and will provide a source for stockpiling and reintroduction into McCloud River as an attempt to mitigate depleted coarse gravel.

Pool-riffle reaches are common within the McCloud River Canyon. These reaches are characterized by alternating reaches of boulder-strewn runs and deep pools (Rode 1990). The canyon bottom contains a series of abandoned terraces, the lowest of which function as a floodplain for the river. A noticeable increase in canyon bottom width occurs below the Claiborne Creek confluence (Wales 1938). The wider canyon bottom reflects the increase in streamflow to the river from Claiborne and Squaw Valley Creeks. Reduced base flows in the McCloud River have resulted in decreased flow depths and wetted channel widths. Despite the decreased flows, historic floodplain and in-channel bed forms remain largely unmodified because the majority of peak flow runoff originates in tributaries to the McCloud River below the McCloud Reservoir.

The **alluvial upland** channel class was created for this analysis in order to describe channels in the Little Meadows area that did not fit any of the other reach classes. Alluvial upland channels have low gradients (<3%) and often have sandy beds. These channels have been impacted by timber harvest and road building activities that occurred during the 1980s. Significant channel downcutting, bank erosion and channel aggradation has occurred throughout the Little Meadows channel network. Additional impacts associated with the transportation system continue to affect channel stability in this area.

Water Quality

The quality of water in the Lower McCloud River Watershed is influenced by both natural processes and land use activities. Beneficial uses dependent on high quality water include fish and aquatic life (including riparian vegetation), domestic drinking water for private land owners along the McCloud River, and recreation benefits associated with fishing, whitewater boating and hiking. Due to the absence of lakes and wetlands most water quality concerns in the Lower McCloud River Watershed are related to the channel network.

The quality of water in the watershed was assessed by determining how natural processes and land-use activities have influenced sediment, water column and streamflow water quality parameters in the watershed (Table 3-5). Impacts from recreation activities (whitewater boating, fishing) were assumed to be negligible in comparison to other land-use practices. No grazing activity occurs in the watershed however grazing on private lands in the Squaw Valley Creek Watershed does have the potential to affect water quality in the lower McCloud River.

Pacific Gas & Electric completed water quality monitoring of waters within the McCloud-Pit Project (PG&E 2009d). The water quality parameters chemical constituents, toxicity, biostimulatory substances, and coliform bacteria were found to meet the California Central Basin Plan objectives. Dissolved oxygen was measured and within McCloud River found to remain above 7 mg/l,the basin plan standard. Within McCloud Reservoir, values varied within depth profile samples, but overall met basin plan objectives. The pH measurements occasionally reached or exceeded the range of 6.5 – 8.5. Historical data suggest these fluctuations are natural and episodic. PG&E determined that water temperature conditions support a coldwater trout fishery. However, several studies indicate that water temperatures have been modified as a result of the McCloud-Pit Project. Turbidity from sediment transport regularly affects water quality in the analysis area.

The primary source of the sediment is the Konwakiton glacier in the Mud Creek drainage upstream of the analysis area. Streamflow from Mud Creek is routed by an upstream landowner to Huckleberry Creek, which flows into the McCloud Reservoir. The maximum continuous turbidity monitoring in Mud Creek during high flow events was beyond the instrument rang of 1,062 NTU. Settling of the coarser material varies depending on the reservoir water level. As reservoir levels drawdown, the deposited material is re-suspended and migrates downstream.

The cumulative impacts of natural hillslope erosion processes, roads, and timber harvest exert a significant influence on water quality parameters. Changes in most water quality parameters only occur in response to winter precipitation. Large increases in suspended sediment and turbidity often occur during high flows. Suspended sediment and turbidity quickly drop to pre-storm levels following peak flow events. In contrast to suspended sediment and turbidity, changes in bedload concentrations following peak flows may be long lasting.

The clarity of water in the McCloud River fluctuates from excellent during most of the year to highly turbid for short periods of time during the wet season and when debris flow activity is occurring in Mud Creek. As part of FERC relicensing the McCloud-Pit Project, PG&E conducted suspended sediment monitoring in McCloud River. Results are reported in Technical Memorandum 30 (PG&E 2009e). The overall effect of water retention at the McCloud Reservoir has been to decrease turbidity and suspended sediment levels in the McCloud River for the majority of the year.

Changes in turbidity levels in the McCloud River may occur independently of high flows due to the influence of the McCloud Reservoir and Mud Creek. Turbidity in the McCloud River occasionally increases in September and October when water levels in the McCloud Reservoir drop resulting in the delivery of sediment, largely derived from Mud Creek, to the lower river (Dave Bowers, PG&E, personal communication). The naturally high turbidity levels of Mud Creek are caused by glacial runoff from the Konwakiton Glacier. Increases in turbidity occur in response to debris flows originating in Mud Creek (above McCloud Reservoir reservoir drawdown during the fall.. Higher turbidity levels also occur during valve testing or sluicing at the McCloud Dam. Impacts to the McCloud River from highly turbid flows are greatest in the reach between the dam and Hawkins Creek (Rode 1989).

The health of spawning gravels in the McCloud River was studied by Scott McBain in 1989 for the Nature Conservancy. McBain found that spawning gravels in the river contained high concentrations of dissolved oxygen. The high levels of dissolved oxygen showed that gravel deposits in the river had high permeabilities and that surface flows were mixing with the gravels. McBain concluded that the health of spawning gravels was excellent in the reaches of the river that were investigated during the duration of the study (McBain 1989).

Water temperature recorders were placed in the McCloud River and selected tributaries during the summer of 1996 in order to collect baseline data for the watershed. Water temperatures for the McCloud River below the McCloud Reservoir, at Ah-Di-Na and above Nawtawaket Creek are shown in Figure 4. The figure illustrates the steady increase in water temperature downstream of the dam and the diurnal fluctuations that occur throughout the summer. The trend of increasing temperatures is illustrated with a simple comparison of mean water temperatures at the three stations on the McCloud River during August, 1996. Mean water temperatures in the McCloud River below the dam, at Ah-Di-Na and above Nawtawaket Creek were 50.7, 52.3, and 61.4 degrees Fahrenheit respectively.

A comparison of water temperature data for Nawtawaket, Claiborne and Chatterdown Creeks for the month of August 1996 shows that water temperatures are not uniform in each tributary (Figure 5). Water temperatures in Claiborne and Chatterdown Creeks are similar while water temperatures in Nawtawaket Creek are surprisingly lower. The lower water temperatures and minimal daily fluctuations in Nawtawaket Creek may be due to limestone springs and the lack of land disturbance in the Nawtawaket Creek drainage, other groundwater influences, and shorter residence times of surface runoff in this drainage.

Water temperatures in the McCloud River below McCloud Reservoir have increased during the warm season as a result of reservoir operations. Prior to the construction of the reservoir water temperatures in the river were largely regulated by Big Springs which provided a constant flow of 45 degrees Fahrenheit water to the river. Prior to the construction of the reservoir high water temperatures in the McCloud River at Baird never exceeded 60 degrees Fahrenheit (Rode 1990). Following completion of the reservoir stream temperatures as high as 75 degrees Fahrenheit have been recorded in the lower river by the Department of Fish and Game (Rode 1990). Conversely, during the winter the water temperature at the base of McCloud Dam is now around 37 degrees Fahrenheit, whereas the pre-dam winter temperature was likely close to that of Big Springs. Lower winter water temperature would be expected to suppress biological activity in fish and invertebrates (Hesseldenz 2011).

The **McCloud River Water Quality Monitoring Project** (1986-1997) provided the Forest Service with a unique opportunity to evaluate the impacts of land-use activities on water quality in the Lower McCloud River Watershed. The study, conducted by the Nature Conservancy, used a paired watershed approach to monitor selected water quality parameters in two disturbed watersheds (Ladybug Creek and Bones Gulch) and an undisturbed watershed (Bald Mountain Creek).[1/] The goals of the project were to "establish baseline levels for water quality within the McCloud region" and "to demonstrate the project's feasibility and to promote hydrological studies as part of the normal land management decision-making process" (Bolda and Meyers, 1995). The results of the study are summarized below. For a complete description of the McCloud River Water Quality Monitoring Project refer to Bolda and Meyers, 1997.[2/]

[1/] The watersheds referred to in the study are referred to as drainages in this report in order to prevent any confusion with the Lower McCloud River Watershed.
[2/] Final report for McCloud River Water Quality Study presented in Journal of Soil and Water Conservation.

Suspended sediment, turbidity, peak flows and pH were measured in Bald Mountain, Ladybug and Bones Gulch drainages in order to examine how water quality parameters responded to disturbance activities. The percentage of each drainage impacted by each disturbance activity is shown in table3-5. The study results indicate that some water quality parameters were influenced by timber harvest activities in the Ladybug and Bones Gulch drainages.

Statistically significant differences in the concentration of suspended sediment were observed between the Ladybug and Bald Mountain drainages during storm events in 1991 following a three year period during which 32.1 percent of the Lady Bug Creek drainage was logged. The lack of a significant difference in suspended sediment concentrations between the Bones Gulch and Bald Mountain drainages suggests that suspended sediment concentrations did not increase substantially in response to the timber harvest activity that occurred in Bones Gulch.

The increase in suspended sediment concentrations in Ladybug Creek may have also been attributable to salvage activities associated with the Dee Fire which burned approximately 41 percent of the Ladybug Creek drainage in 1989. Bolda and Meyers note that:

> "although Ladybug did not show an increase in suspended sediment immediately following the fire in 1990, the added disturbance of road building and salvage logging appeared to result in an increase in the concentration of suspended sediment the following winter. Once the salvage logging activities ceased and the area was replanted, the concentration of suspended sediment returned to pre-disturbance levels (Bolda and Meyers, 1997)".

Despite the large peak flows during the winter of 1994-95 there were no statistically significant differences in suspended sediment concentrations for any of the streams. The lack of a significant difference in suspended sediment concentrations indicated that the Ladybug drainage was recovering from disturbance activities. Turbidity levels increased in all of the streams during peak flows, however no significant differences in turbidity occurred between streams during the study. The study also did not document any significant differences in pH between disturbed and undisturbed drainages following the use of ammonia-based fire retardants.

Table 3-5. Percentage of drainage impacted by management activities

Drainage	Area (acres)	Flow (cfs)	Roads	Logging	Fire
Ladybug Creek	1,375	19	3%	32%	41%
Bones Gulch	692	8	1%	7%	0%
Bald Mountain	1,030	11	0%	0%	0%

*Data from Bolda and Meyers, 1995. Flow represents average discharge from January-March, 1986-94, from the 1998 Lower McCloud River Watershed Analysis.

Biological Features

Vegetation

Vegetation and habitats within the Lower McCloud River Watershed are diverse, with large sweeps of forested lands, chaparral covered slopes, deep canyons, and many perennial and intermittent streams. The complex topography of the watershed allows for an array of microhabitats and a diversity of species to exist, depending upon slope, aspect, soil type, elevation and disturbance regime. Areas of high productivity soils, coupled with rainfall amounts averaging 70-80+ inches per year, allow for rapid tree growth in the absence of catastrophic disturbances. The recent history of aggressive fire suppression has resulted in the development of large areas of dense, complexly structured forests, largely replacing the early seral and open canopied fire-created habitats that dominated the watershed at the beginning of this century. These early seral forests, were in many ways, more resilient to disturbances such as fire, insects and disease due to their status as 'young forests.'

Table 3-6. Summary of regional dominance types in the analysis area

Regional Dominance Code	Alliance name	Acres in analysis area	Percentage of analysis area	Acres on public land	Acres on private land
Conifer Forest/Woodland					
MP	Mixed Conifer- Pine	30,631	46	23,275	7,356
DP	Douglas-fir Ponderosa Pine	17,234	26	9,907	7,327
DF	Pacific Douglas-fir	3,329	5	2,085	1,244
WF	White Fir	2,219	3	1,256	963
PP	Ponderosa Pine	1,127	2	390	737
PD	Gray Pine	96	<1	76	20
RF	Red fir	9	<1	8	1
Subtotal Conifer Forest/Woodland		**54,645**	**81**	**36,997**	**19,648**
Hardwood Forest/Woodland					
QK	Black Oak	5,603	8	3,255	2,348
QC	Canyon Live Oak	4,582	7	2,725	1,857
TX	Montane Mixed Hardwood	38	<1	28	10
OJ	Cottonwood-Alder	14	<1	0	14
QM	Bigleaf Maple	3	<1	3	0
Subtotal Hardwood Forest/Woodland		**10,240**	**15**	**6,011**	**4,229**
Shrubs and Chaparral					
CX	Upper Montane Mixed Chaparral	1,232	2	1,088	144
CS	Scrub Oak	473	1	408	65
CG	Greenleaf Manzanita	134	<1	87	47
CQ	Lower Montane Mixed Chaparral	106	<1	42	64
CL	Wedgeleaf Ceanothus	52	<1	40	12
Subtotal Shrubs and Chaparral		**1,997**	**3**	**1,662**	**335**
Herbaceous					
HG	Annual Grasses and Forbs	35	<1	20	15
HM	Perennial Grasses and Forbs	2	<1	0	2
Subtotal Herbaceous		**37**	**<1**	**20**	**17**
Non-vegetated/other					
BA	Barren/Rock	127	<1	85	42
W1	River/Stream/Canal	21	<1	0	21
IB	Urban-related Bare Soil	5	<1	0	5
W3	Reservoir	1	<1	0	1
Subtotal Non-vegetated/other		**154**	**<1**	**85**	**69**
Total All Alliances		**67,073**	**<1**	**44,779**	**22,294**

Vegetation on public lands is more consistently unchanged than on private lands, due to a lack of active management. Various designations, derived from the Shasta Trinity LRMP and RARE II (Roadless) limits vegetation management activities on federally owned Forest Service (federal) lands. Private lands, many of which are commercial and industrial timberlands, are utilized to supply commercial timber products to markets. Commercial timber ownerships account for just less than 12,000 acres in the analysis boundary, mostly in the south and western portions.

The vegetation assessment for this watershed analysis was done using Geographic Information Systems (GIS) data, and through field verification of GIS. Using vegetation GIS layers from 2007 (the most recent available in the Shasta National Forest GIS library) it is difficult to assess seral stages on private lands, as significant changes are visually evident from the 2010 NAIP imagery that do not appear in the attributes of the GIS vegetation layer.. These changes appear to be the result of commercial timber harvest, and while evident visually; the changes are not formally quantified in GIS layers. Seral stage quantification in the entire watershed is difficult. Public lands have been less intensively managed, and the data available from 2007 is nearly identical to the existing conditions in the field, and also visually observed on NAIP imagery.

Due to the differences between reality and the GIS data, quantification of private lands is difficult, and requires further, more detailed analysis. This analysis is recommended prior to any actionable efforts in the analysis watershed. Federal ownerships, in large part, remain unchanged. Table3-6 displays the Regional Dominance types on public and private lands.

Seral Stages

Seral stages within the watershed analysis are described as ‘early, mid, and late.’ Classification of seral stages is based on tree cover from above and overstory tree diameter classes. Overstory tree diameter is defined as the mean diameter at breast height for trees forming the uppermost canopy layer. Table 3-7 describes seral stages in relation to overstory tree diameter class.

Table 3-7. Seral stages and overstory tree diameter relationship

Seral stage	Overstory tree diameter class
Non-stocked	No tree stocking
Early	Seedlings - 9 to 0.9 inches QMD
	Saplings – 1 to 4.9 inches QMD
	Poles – 5 to 9.9 inches QMD
Mid	Small – 10 to 19.9 QMD
	Medium – 20 to 29.9
Late	Large to giant – greater than 30 inches QMD

Tree cover from above is seen from a bird’s eye view, and top story trees are those trees receiving light from above and at least one side; these are the open grown, dominant and co-dominant trees. Tree cover from above is used to further quantify seral stages, and table 3-8 displays tree cover from above and the relationship to seral stages.

Table 3-8. Seral stages tree cover from above relationship

Seral stage	Percent cover from above (approximate)
Early	Range of less than 10% to 29%

Seral stage	Percent cover from above (approximate)
Mid	Range from 30% to 59%
Late	Greater than 60%

The seral stage classification for the public lands in the watershed is described separate from the private lands. Tables 3-9 through 3-12 describe the analysis area seral stages, excluding 12,000 acres of commercial timber lands. There are 56,521 total acres described in these tables.

Table 3-9. Conifer summary for the analysis area

Overstory Tree Diameter (QMD)	Seral Stage	Conifer Tree Cover From Above (% canopy cover)					% Per Size Class
		(<10%)	(10-29.9%)	(30-59.9%)	(60-100%)	Total Acres	
Seedlings – 0 to 0.9”	Early seral	734	115	166	396	1,410	4%
Saplings – 1.0” to 4.9”		0	59	106	667	832	2%
Poles – 5.0” to 9.9”		0	3	245	2,542	2,791	8%
Small tree – 10.0” to 19.9”	Mid seral	0	24	295	5,504	5,823	16%
Medium tree – 20.0” to 29.9”		0	16	726	21,937	22,679	61%
Large tree - > 30”	Late seral	0	0	29	3,421	3,450	9%
Total acres public land (conifer)		**734**	**217**	**1,567**	**34,467**	**36,985**	**100%**

Thirty-nine acres are non-stocked (N). These do not appear in the total acres of conifer on public land displayed in the table. Total conifer forest on public land is 37,024 acres, and includes the numbers above plus the additional 39 acres that are non-stocked. The percent per size class column displays the relative percentages in each size class.

Table 3-10. Hardwood summary for the analysis area

Overstory Tree Diameter (QMD)	Seral Stage	Hardwood Tree Cover From Above (% canopy cover)					Relative % Per Size Class
		(<10%)	(10-29.9%)	(30-59.9%)	(60-100%)	Total Acres	
Seedlings – 0 to 0.9”	Early seral	0	0	0	0	0	0%
Saplings – 1.0” to 4.9”		0	1	17	100	118	2%
Poles – 5.0” to 9.9”		0	14	277	1,183	1,474	25%
Small tree – 10.0” to 19.9”	Mid seral	0	17	564	3,462	4,044	67%
Medium tree		0	5	11	359	375	6%

Overstory Tree	Seral Stage	Hardwood Tree Cover From Above (% canopy cover)					Relative % Per
– 20.0” to 29.9”							
Large tree - > 30”	Late seral	0	0	0	0	0	0%
Total public land (hardwood)		**0**	**37**	**869**	**5,104**	**6,011**	**100%**

Seral stages on private lands are not as easily quantified due to active timber management objectives on much of these lands. Within some areas, the seral stages have changed in the analysis boundary post GIS data collection (in 2007), as is visually evident in the NAIP imagery.

On private lands, seral stage quantification was not attempted for this analysis on the 12,000 acres of commercial timber lands, as harvest activities are continual and ongoing. A project specific analysis should address the seral stages on these lands, as they are likely to change on a more continual basis than other lands within the analysis boundary, barring a catastrophic event.

Table 3-11 displays a seral stage summary for conifer dominated public lands that are not managed as commercial timber lands, within the analysis boundary. Table 3-12 displays a seral stage summary for hardwood dominated public lands that are not managed as commercial timber lands, within the analysis boundary. These ownerships include private fishing clubs, conservation organizations and individual land owners. Commercial timberlands are excluded as the tree cover may have already changed, or may changed post GIS data assessment. Quantification utilizing existing data may be inaccurate, so further analysis in these areas is recommended prior to undertaking management actions on public lands. Exclusion of commercial timber lands accounts for just under 12,000 acres of private lands.

Table 3-11. Conifer summary for private, non-commercial timber land

Overstory Tree Diameter (QMD)	Seral Stage	Conifer Tree Cover From Above (% canopy cover)					% Per Size Class
		(<10%)	(10-29.9%)	(30-59.9%)	(60-100%)	Total Acres	
Seedlings – 0 to 0.9”	Early seral	0	0	3	16	19	<1%
Saplings – 1.0” to 4.9”		0	0	0	1	1	<1%
Poles – 5.0” to 9.9”		0	4	17	276	298	3%
Small tree – 10.0” to 19.9”	Mid seral	0	12	90	1,754	1,856	23%
Medium tree – 20.0” to 29.9”		0	3	80	4,893	4,976	62%
Large tree - > 30”	Late seral	0	0	0	905	905	11%
Total acres private, non commercial timber lands (conifer)		**0**	**19**	**190**	**7,845**	**8,055**	**100%**

Table 3-12. Hardwood summary for private, non-commercial land

Overstory Tree Diameter (QMD)	Seral Stage	Hardwood Tree Cover From Above (% canopy cover)					% Per Size Class
		(<10%)	(10-29.9%)	(30-59.9%)	(60-100%)	Total Acres	
Seedlings – 0 to 0.9”	Early seral	0	0	0	0	0	0%
Saplings – 1.0” to 4.9”	Early seral	0	12	8	61	81	3%
Poles – 5.0” to 9.9”	Early seral	0	9	161	303	473	19%
Small tree – 10.0” to 19.9”	Mid seral	0	17	564	1,236	1,817	74%
Medium tree – 20.0” to 29.9”	Mid seral	0	0	26	73	99	4%
Large tree - > 30”	Late seral	0	0	0	0	0	0%
Total private, non commercial land (hardwood)		**0**	**38**	**759**	**1,673**	**2,470**	**100%**

*Exclusion of non-commercial timber lands accounts for just under 12,000 acres of private lands in the analysis boundary.

Riparian Areas Vegetation

The McCloud River and its numerous tributary streams form a complex network of aquatic and riparian habitats throughout the watershed. Big-leaf maple, vine maple, willow, alder, dogwood, hazelnut, thimbleberry, blackcap raspberry, and Pacific yew are found in riparian areas, along with a diverse assemblage of rushes, sedges, ferns, and dense stands of Indian rhubarb forming the dominant herbaceous understory along perennial streams.

Early Seral Vegetation

Understory and chaparral shrub species are very diverse and are dominated by greenleaf manzanita, snowberry, serviceberry, buckbrush, deerbrush, mountain mahogany, tanoak, and Oregon ash. Redbud, buckeye, coffeeberry, Klamath plum, and mock-orange also occur throughout the watershed in second growth forest and at the lower elevations. Shrub species rarely see on the Shasta-Trinity National Forest also occur within the analysis area, such as Sierra bladdernut, hop tree, and snowdrop bush. The herbaceous understory layer is also very diverse, with dozens of wildflowers occurring commonly throughout the watershed. Several rare species which occur rarely, or not at all outside of the McCloud River Basin, occur in the watershed. These are Shasta eupatorium, rough raillardella, veiny arnica, and Howell’s cliff-maids. Shasta snow-wreath has not been located but is likely to occur in the watershed also. These species are discussed in detail under “Species of Concern”.

Vegetation diversity is also evident in the forb/grass layer, where present, with more than 60 species of wildflowers common in the watershed.

Fire Hazard

Fire hazard can be characterized by how a fire will burn or fire behavior. Fire behavior is the product of the natural environment or the unique combination of topography, weather and fuels (Countryman 1972). Topography and weather are factors on which humans have little effect. Fuels can be altered through human intervention or natural processes such as fire (rapid) and decomposition (very slow). Therefore, when assessing fire hazard, the focus can be on fuels and the associated fire behavior.

Fuels

Table 11 displays the fuel models in terms of description, acres, and percentage of each category of fuels in the watershed analysis area. These fuels models are derived from the vegetation layer and can describe fire behavior based on weather, topography, and fuels characteristics.

Table 3-13. Fuel models within the watershed analysis area

Fuel Model and Category	Description	Percent Within Analysis Area / Acres
Grass Fuel Models		
101 -- GR1	The primary carrier of fire in GR1 is sparse grass, though small amounts of fine dead fuel may be present. The grass in GR1 is generally short, either naturally or by heavy grazing, and may be sparse or discontinuous. Predicted spread rate and flame lengths are low.	1% / 670 Acres
Shrub Fuel Models		
142 -- SH2	The primary carrier of fire in SH2 is woody shrubs and shrub litter. Moderate fuel load (higher than SH1), depth about 1 foot, no grass fuel present. Spread rate is moderate; flame length moderate.	1% / 674 Acres
Timber-Understory Fuel Models		
165 - TU5	The primary carrier of fire in TU5 is heavy forest litter with a shrub or small tree understory. Spread rate is moderate; flame length high.	36% / 24,145 Acres
Timber-Litter Fuel Models		
183 -- TL3	The primary carrier of fire in TL3 is moderate load conifer litter, light load of coarse fuels. Spread rate is very low; flame length very low.	7% / 4,695 Acres
184 -- TL4	The primary carrier of fire in TL4 is moderate load of fine litter and coarse fuels. Includes small diameter downed logs. Spread rate is low; flame length low.	5% / 3,353 Acres
188 -- TL8	The primary carrier of fire in TL8 is moderate load long-needle pine litter, may include small amount of herbaceous load. Spread rate is moderate; flame length low.	10% / 6,707 Acres
189 -- TL9	The primary carrier of fire in TL9 is very high load, fluffy broadleaf litter. TL9 can also be used to represent heavy needle-drape. Spread rate is moderate; flame length moderate.	37% / 24,817 Acres
Slash-Blowdown Fuel Models		

Fuel Model and Category	Description	Percent Within Analysis Area / Acres
202 -- SB2	The primary carrier of fire in SB2 is moderate dead and down activity fuel or light blow down. Blow down is scattered, with many trees still standing. Spread rate is moderate; flame length moderate.	2% / 2,012 Acres
Descriptions based on Anderson 1982 and Scott and Burgan 2005. Fuel models derived from the California Fuels Landscape created by the Region 5 Stewardship and Fireshed Analysis Team and clipped to the analysis area in GIS.		

Fire Risk

Fire risk is defined in the Fire Management Plan as the probability of a fire start occurring over a ten year period for a given 1000-acre area. Fire risk is based on the Shasta Trinity National Forest GIS layers for fire occurrence records within the analysis area. The risk classification within the Fire Management Plan is as follows:

- Low Risk = 0 to 0.49: Less than 0.5 fires expected to occur per decade for every thousand acres in the area being analyzed
- Moderate Risk = 0.50 to 0.99: Between 0.5 and 0.99 fires expected to occur per decade for every thousand acres in the area being analyzed
- High Risk = At least one fire expected to occur per decade for every thousand acres in the area being analyzed

Within the 67,073 acre project boundary 102 fire starts occurred over a 36 year period (1971 to 2007).

Risk value, or R, is calculated using the following formula:

R = $\{(x/y)\ 10\}/z$ where:

x = fire starts = 102

y = period analyzed =36 years

z = number of acres analyzed =67,073 displayed in thousands = 67.0

Risk rating = {(102/36) 10}/67.0 = 0.42 (Low Risk).

The analysis area has a low fire risk value. Approximately seventy-six percent of ignitions are lightning caused and twenty-four percent are human caused. The majority of the human caused fires were on private land within the watershed analysis boundary. Despite numerous fire starts over recent years, there has been only one fire over 10 acres within the analysis area during this 30-year period.

Current Fire Regime Impacts to Vegetation

Vegetation patterns are influenced by disturbance history. Approximately 96 percent of the analysis area has not been affected by a fire over the past 80 years. The lack of disturbance in the analysis area has increased forest density and fuel loading with a shift to higher proportions of fire-intolerant species compared to historical periods. Therefore, there is an increased probability of passive or active crown fires throughout the watershed analysis area.

The role of fire has been significantly reduced from historical fire return intervals. Without regular disturbance patterns in place the analysis area has seen an increase in stand density and fuel loading, primarily represented by fire intolerant species which were not favored historically. This has increased the likelihood of fires to burn with uncharacteristically high intensity and severity; potentially leading to a stand replacing event throughout the watershed analysis area.

An analysis of historical fire return intervals (pre-suppression era) has been compared to contemporary fire return intervals (suppression era) for the analysis area. This analysis is known as a condition class based on departure of fire return interval. The historic fire return interval ranged from approximately 3 to 38 years with a mean of 12.75 years (Skinner 2006). The range of historic fire return intervals is largely based on a combination of biophysical values such as existing vegetative condition, topography, soil and hydrologic functions, climate and others that influence vegetation development.

The following equation is used to determine departure of fire return intervals:

{1-(reference FRI/Current FRI)} * 100

The value obtained depicts a percentage difference, and condition class is determined by the use of the Landfire National Scale (where 0-33% = Condition Class 1, 34-67% = Condition Class 2, greater than 67% = Condition Class 3).

Impacts of Fire on other Resources

Air Quality

Air quality can be evaluated in terms of visibility and the concentration of pollutants. Wildfire, residential wood and trash burning, agricultural and prescribed burning, asbestos from asbestos containing rock and road construction can create smoke or dust. Smoke and dust have the potential to affect air quality. Fire produces carbon monoxide, suspended particulate matter (PM_{10} and below) and polycyclic hydrocarbons as pollutants. The smoke produced by fires can affect visibility as well as other air pollutant standards.

Smoke- and/or dust-producing activities on National Forest lands are regulated by the Federal Clean Air Act, the Shasta-Trinity NF LRMP and the California Air Resources Board. Standards established therein are also useful in measuring the impact of wildfires on air quality.

Air quality was noticeably poor at various times in Northern California from August through October of 1987, 1999 and 2008 due to large wildfires on the Shasta Trinity, Klamath and Six Rivers National Forests. Monitoring at the community of Hoopa, California indicated that, as a result of the Big Bar Complex fires (1999), California 24-hour PM_{10} standards were exceeded on 19 days and the federal standard was exceeded on 12 days. During several days, average PM_{10} standards were greater than 420 ug/m^3 − which is considered hazardous. The smoke from the fires precipitated the first declared state of emergency in a California county due to air pollution (Herr 1999).

As fire risk and fire behavior potential in the analysis area increase, periods of poor air quality during wildfires are more likely to occur.

Erosion Processes and Soil Productivity

Fires may affect soil properties and erosion processes. Areas that burn with a moderate to high intensity often lose their duff layer. The duff layer provides protection from erosion processes, a supply of nutrients to the soil, and a natural reserve of nutrients for long-term soil productivity needs. Areas burned with high intensity also lose nitrogen by volatilization processes in the surface inch of soil. The loss of soil nutrients from fire volatilization of above- and below-ground organic material and from accelerated erosion processes impacts soil and site productivity.

Water Quality and Aquatic Species Habitat

Water quality is directly related to aquatic species habitat needs. Increased delivery of sediment to streams from upland erosion and elevated stream temperatures from loss of overstory canopy shade in the wake of high-intensity fires may reduce water quality and degrade habitat for local fish populations.

Terrestrial Wildlife Habitat

As discussed above, fire effects on vegetation also influence wildlife habitat and populations. Wildfire can potentially limit foraging resources, as well as predator protection and thermal protection for northern spotted owls. Conversely, fire can improve browse for elk, bear and other species and increase snag habitat for snag-dependent species. See the Species and Habitat discussion for a more detailed description of the inter-relationship between fire and wildlife habitat and populations.

Human Uses

Fire effects to the above resources in turn impact the recreation experience and other human uses in the analysis area. Such impacts include, but are not limited to, a degradation of visual quality near large areas of burned landscape, restrictions on motorized and non-motorized recreation (e.g. road closures, smoke issues) poor air quality during wildfire events, as well as degradation of water quality and related effects to fishing, rafting, etc.

Fire Suppression Concerns within the Analysis Area

Fire suppression capability is a major concern within the analysis area. Numerous fire starts coupled with steep terrain, limited access, dense fuels conditions and weather patterns conducive to large fire growth have created fire-suppression concerns in the past and continue to drive the concerns of managing future wildfires. These factors also may delay adequate response times to fire starts, increasing the likelihood of a fire becoming larger. Although initial attack efforts have been relatively successful to date, if a wildland fire were to exceed the capabilities of aerial suppression, ground efforts would be greatly hindered due to access constraints.

Additionally, fire and fuels management and treatments (e.g. fuels reduction treatments) are also limited on public lands and activity fuels found on private parcels may exacerbate fire suppression operations. Fire and fuels treatments are generally undertaken to reduce fire behavior potential and fire effects. Fire and fuels based treatments would increase fire suppression capabilities, increase the ability of fire to play a natural role in the ecosystem as well as decrease the risk of undesired wildland fire. Increasing capacity in the transportation system and maintaining key system components are necessary to effectively manage fire and fuels within the analysis area.

Species and Habitats

Threatened, Endangered and Sensitive (TES) Plants and Other Species of Concern

Information concerning current fire regime impacts to populations or habitat conditions of TES plants, Survey and Manage plants, and CNPS watch list plants occurring in the Lower McCloud River Watershed is moderately limited. There have been a few recent (<10 yrs) surveys for the species addressed in this report in or near the analysis area however more information is needed.

Methodology

Habitat for or occurrences of TES plants, Forest Endemic plants, and Survey and Manage plants occurring in the Lower McCloud River Watershed were assessed using Natural Resources Information Systems (NRIS) and California Natural Diversity Database (CNDDB) Element Occurrence Records, NatureServe Explorer (2009), Bureau of Land Management Plant status information (BLM 2010), results of past floristic and rare plant surveys, the California Native Plant Society (CNPS) online Inventory of Rare and Endangered Vascular Plants of California (CNPS 2011), current vegetation information (Lindstrand and Nelson 2006), and site observations (October 2010).

- **Shasta eupatory (*Ageratina shastensis*)** is a perennial subshrub classified as CNPS List 4.2 (i.e., limited distribution [watch list]; fairly endangered in California) and Forest Service Endemic. Shasta eupatory is limited to Shasta County and frequently occurs on – but is not limited to – limestone substrates (Hickman 1993) in both chaparral and lower montane coniferous forest at elevations from 1,300 to 5,900 feet (CNPS 2011). Twelve of the twenty documented populations of Shasta eupatory occur within the watershed analysis boundary and six more occur within five miles. The documented populations occur mainly on or in close proximity to limestone substrate and within the following vegetation types (Black oak, Douglas-fir – Ponderosa Pine, Mixed Conifer - Pine, Scrub Oak, and Upper Montane Mixed Chaparral and White Fir).
- **scabrid alpine tarplant (*Anisocarpus scabridus*)** is a perennial herb classified as CNPS List 1B.3 (rare, threatened, or endangered in CA and elsewhere), Forest Service Sensitive (FSS), and BLM Sensitive (BLMS). Scabrid alpine tarplant can be found on rocky, open subalpine slopes in the North Coast and southern Cascades ranges, generally between 5,500 to 7,500 feet elevation. There is one documented occurrence of scabrid alpine tarplant in the Lower McCloud River Watershed on a rock outcrop along Grizzly Peak.
- **veiny arnica (*Arnica venosa*)** is a perennial rhizomatous herb classified as CNPS List 4.2 and Forest Service Endemic. Veiny arnica typically occurs between 2,000 to 5,200 feet elevation, within coniferous or oak forests especially on ridge tops, road cuts, or within disturbed areas (Hickman 1993). There are eleven documented populations of veiny arnica within the watershed boundary, all of which occur in primarily coniferous vegetation types (e.g. Douglas-fir – Ponderosa Pine, Mixed Conifer- Pine) and some hardwood communities (e.g. Black Oak, Canyon Live Oak).
- **northern clarkia (*Clarkia borealis* ssp. *borealis*)** is an annual herb classified as CNPS List 1B.3, FSS, and BLMS. It is endemic to California, and locations are known only in Shasta and Trinity counties (CNPS 2011). Northern clarkia prefers cismontane (western slope) and foothill woodlands, chaparral, and lower montane coniferous forest habitats between the elevations of 1,300 and 4,400 feet. There are five documented population within the

watershed boundary in primarily coniferous vegetation types (e.g. Douglas-fir – Ponderosa Pine, Mixed Conifer- Pine) and some hardwood communities (e.g. Black Oak, Canyon Live Oak). These occurrences can be found along Curl Ridge and Towers roads.

- **Butte County fritillary *(Fritillaria eastwoodiae)*** is a perennial herb classified as CNPS List 3.2 (i.e., more information needed about this plant [review list]; fairly endangered in California) and FSS. Its distribution is limited to the Cascade Range, specifically Tehama, Butte and Shasta Counties (Hickman 1993). Butte County fritillary is found in chaparral and cismontane woodlands on dry benches and slopes as well as openings in lower montane coniferous forest at 164 to 4,920 feet elevation (CNPS 2011). There is one documented occurrence of Butte County fritillary within the watershed boundary along Curl Ridge Road in a Mixed Conifer- Pine vegetation type.
- **Cantelow's lewisia (*Lewisia cantelovii*)** is a perennial herb classified as CNPS List 1B.2 (rare, threatened, or endangered in CA and elsewhere), and FSS. Its distribution is limited to the Klamath Ranges, High Cascade Range, and the northern High Sierra Nevada (Hickman 1993). Cantelow's lewisia is found in mesic, granitic, sometimes serpentinite seeps in chaparral and cismontane woodlands well as lower montane coniferous forest at 2,500 to 3,500 feet elevation (CNPS 2011). There is one documented occurrence of Cantelow's lewisia within the watershed boundary south of Ladybug Creek, in a Douglas-fir – Ponderosa Pine vegetation type, on Nature Conservancy lands.
- **Shasta snow-wreath (*Neviusia cliftonii*)** is a shrub classified as CNPS List 1B.2 (i.e. rare, threatened, or endangered in CA and elsewhere), FSS and BLMS. Shasta snow-wreath is found in cismontane woodlands, lower montane coniferous forest and riparian woodlands along streamsides. This species was previously considered associated with limestone substrates (CNPS 2011, Hickman 1993); however, newer information indicates that nearly half the documented occurrences in Shasta County grow on non-limestone substrates (Lindstrand and Nelson 2006) between 984 and 1,640 feet elevation. The twenty-three documented occurrences of Shasta snow-wreath on the Forest exist outside of the watershed boundary however two occurrences are only 1.5 miles to the south of the watershed near Ellery Creek. Habitat for Shasta snow-wreath exists within the watershed analysis area.
- **Pacific fuzzwort (*Ptilidium californicum*)** is a bryophyte not yet ranked in the NatureServe or CNDDB databases. Pacific fuzzwort is a Forest and BLM sensitive species as well as a Survey and Mange List A (Rare, Pre-Disturbance Surveys Practical). Pacific fuzzwort is generally found growing at the base of large white fir trees, stumps and logs in relatively undisturbed old-growth late seral habitats above 4000 feet elevation. There are two occurrences of Pacific fuzzwort in the watershed analysis area in Little Meadows. One population occurs on a Douglas-fir and one occurs on a white fir.
- **English Peak greenbriar (*Smilax jamesii*)** is a perennial rhizomatous herb rated CNPS 1B.3, FSS and BLMS. English Peak greenbriar generally occurs along lakesides, stream banks, and riparian areas in moist montane coniferous forest between 2,900 to 7,500 feet elevation. There are four occurrences of English Peak greenbriar within the analysis area – one in Little Meadows, one on Hawkins Creek road, and two on Nature Conservancy lands near Ladybug Creek. All four populations occur within coniferous forest types (e.g. Douglas-fir – Ponderosa Pine or Mixed Conifer – Pine).

A botanically diverse assemblage of plants occurs within the watershed analysis area. The herbaceous understory layer includes several species of orchids, wild ginger, prince's pine, wintergreen, lilies, and numerous fern species. Shrub species are very diverse and are dominated by greenleaf Manzanita *(Arctostaphylos patula)*, snowberry *(Symphoricarpos* sp.*)*, serviceberry *(Amelanchier alnifolia)*, buckbrush *(Ceanothus cuneatus)*, deerbrush *(Ceanothus integerrimous)*, mountain mahogany *(Cercocarpus betuloides)*, tanoak (*Lithocarpus densiflorus)*, and Oregon ash *(Fraxinus latifolia)*. Redbud *(Cercis occidentalis)*, buckeye, coffeeberry *(Rhamnus* sp.*)*, Klamath plum *(Prunus subcordata)*, and mock-orange *(Philadelphus lewisii)* also occur throughout the watershed in second growth forest and at the lower elevations. Shrub species rarely seen elsewhere on the Shasta-Trinity National Forest also occur here, such as Sierra bladdernut, hop tree, and snowdrop bush. Overstory trees consist mainly of Douglas-fir *(Pseudotsuga menzeisii)*, ponderosa pine *(Pinus ponderosa)*, red fir *(Abies magnifica)*, white fir *(Abies concolor)*, grey pine *(Pinus sabiniana)*, black oak *(Quercus kelloggii)*, and canyon live oak *(Quecus chrysolepis)*. Additionally, a small portion (approximately 24 acres) of the Grizzly Peak botanical Special Interest Area occurs in the northeastern corner of the watershed analysis area. Grizzly Peak had been discovered in 1995 to have a large number of rare and disjunct plant species, including the Forest's only population of scabrid alpine tarplant – or 'rough raillardella' (LRMP pg. 4-125).

Approximately 81 % of the watershed is typed as coniferous, 15% is hardwood, and the rest as shrub with a negligible amount of grassland or non-forested areas. The conifer forest on public lands is largely (approximately 77%) in a mid-seral stage and about 14% is early seral and the remaining 9% is late-seral. Late-seral conditions may be particularly good habitat for plant species such as Pacific fuzzwort or English Peak greenbriar which favors shaded areas containing large diameter trees. Many mosses, lichens, and fungi occur in late-seral habitat in the watershed, but these have not been recently (< 20 years) surveyed or inventoried. Fungi were surveyed on the McCloud River Preserve, however, in the 1980's where approximately 120 species were documented (Hesseldenz 2011 personal communication). Much of the watershed is mesic and contains a high level of moisture-retaining large logs, mossy rocks, and deep shaded duff which provides excellent habitat for this assemblage of species and their symbiotic associates.

Fire suppression has also created an over-accumulation of fuels and a homogeneous array of small openings within a matrix of dense forest within the watershed. This vegetation density may not be advantageous for the perpetuation of certain rare plant species due to competition for resources (e.g. nutrients, water), space, or sunlight.

As noted in the Late-Successional Reserve and Wildlife discussions, high severity wildfire is a threat to further loss and degradation of habitat for late-successional associated species (USDA Forest Service 1999). Fuel reduction treatments, particularly through the use of low- to moderately intense prescribed fire, is encouraged to develop and maintain late-successional habitats. Plant species such as the Pacific fuzzwort, English Peak greenbriar, as well as several others may benefit from this direction.

Human disturbance within the watershed, particularly in regards to river use, may threaten these botanical species of concern. Recreationists such as anglers, boaters, hikers, or campers may inadvertently trample plants or fungi. In particular, species such as English Peak greenbriar or one of the populations of Shasta eupatory that reside within 200 feet of the McCloud River could be harmed (PG&E 2009a). Human use of the watershed, however, is moderate compared to other watersheds in the area thus threat this type of threat to botanical species of concern is therefore also moderate.

Overall habitat quality for rare plants and fungi is generally high within the federally-owned portions of the watershed. Approximately 33% of the lands within the watershed are privately owned. It is difficult to assess habitat quality on these lands as detailed information is lacking.

Much of the lands are within industrial timber ownerships therefore activities such as timber harvest may have an effect on overall habitat quality or availability for botanical species of concern.

Distribution and abundance data regarding botanical species of concern in the watershed are somewhat lacking. Further surveys and monitoring of these species and their habitat conditions are needed.

Noxious and Undesirable Weed Species

Methodology

Current habitat conditions of noxious weeds occurring in the Lower McCloud River Watershed were assessed using Natural Resources Information Systems (NRIS) Element Occurrence records, results of past floristic surveys, California Invasive Plant Council (Cal-IPC), California Department of Food and Agriculture (CDFA), and current vegetation information supplied by the Forest. Species description information (i.e. morphology, blooming period, habitat type) was taken from Hickman 1993, Bossard et al. 2000, and DiTomaso and Healy 2007. Table 3-14 explains the two main rating systems (Cal-IPC and CDFA) in California regarding noxious weeds.

Table 3-14. Noxious weed rating systems used for analysis

CDFA Rankings	Cal-IPC Rankings
A – Eradication, containment, rejection, or other holding action at the state-county level. Quarantine interceptions to be rejected or treated at any point in the state.	High – These species have severe ecological impacts on physical processes, plant and animal communities, and vegetation structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal and establishment. Most are widely distributed ecologically.
B – Eradication, containment, control or other holding action at the discretion of the commissioner.	Moderate – These species have substantial and apparent, but generally not severe, ecological impacts on physical processes, plant and animal communities, and vegetation structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal, though establishment is generally dependent upon ecological disturbance. Ecological amplitude and distribution may range from limited to widespread.
C – State endorsed holding action and eradication only when found in a nursery; action to retard spread outside of nurseries at the discretion of the commissioner; reject only when found in a cropseed for planting or at the discretion of the	Limited – These species are invasive but their ecological impacts are minor on a statewide level or there was not enough information to justify a higher score. Their reproductive biology and other attributes result in low to moderate rates of invasiveness. Ecological amplitude and distribution

CDFA Rankings	Cal-IPC Rankings
commissioner.	are generally limited, but these species may be locally persistent and problematic.

Documented Weed Infestations

Documented noxious weed surveys in the watershed have been limited although occurrence data is available from 2002, 2003, 2007, 2008 and 2009. The following select noxious weed species are documented in the Lower McCloud River Watershed and are of high concern on the Forest:

- **yellow star thistle *(Centaurea solstitialis)*** is an annual herb that is currently invading twelve million acres across California. It is rated as highly invasive by Cal-IPC and List C by CDFA and is of very high concern on the Shasta Trinity NF. There are three documented populations of yellow star thistle within the watershed boundary totaling approximately 21 acres of infestation. The largest populations are in the Ah-Di-Na and Ash Camp campgrounds. It also locally abundant in old pastures at the McCloud River Club (Hesseldenz 2011 personal communication). There are several more populations adjacent to the watershed along the perimeter of the McCloud Reservoir. This invasive plant has the ability to grow aggressively, preventing native plant species from competing for site occupancy. Over time, it may completely dominate these sites.
- **Canada thistle *(Cirsium arvense)*** is a perennial herb rated as moderately invasive by Cal-IPC and List B by CDFA. Canada thistle is common below 5,900 feet throughout California on a variety of soil types. Canada thistle invades prairies, riparian zones, and roadsides. Canada thistle is intolerant of shade and therefore colonizes well in recently burned or harvested areas where canopy shading is low. There is only one documented occurrence of Canada thistle in the watershed, however more is suspected to occur, in the hydroelectric diversion tunnel tailings along Hawkins Creek.
- **bull thistle *(Cirsium vulgare)*** is a biennial forb is considered to be moderately invasive. It is common below 6,300 feet elevation throughout California on disturbed sites, roadsides, coastal grasslands, wetlands, forest openings, or rangelands and pastures. Currently there are four documented occurrences of bull thistle in the watershed, totaling approximately 24 acres of infestation, along Hawkins Creek Road and the Ah-Di-Na Campground.
- **dyer's woad *(Isatis tinctoria)*** is a perennial or biennial herb native to Europe. It is rated moderately invasive by Cal-IPC and List B by CDFA. Dyer's woad is considered highly invasive locally (Hesseldenz 2011 personal communication) and is a highly competitive plant that occurs in rangelands, croplands, and undisturbed natural areas. No documented occurrences of dyer's woad are within the analysis area but there is one occurrence within 300 feet of the watershed boundary along the McCloud Reservoir.
- **perennial pea *(Lathyrus latifolius)*** is a perennial herb that is not yet rated by Cal-IPC or CDFA. It can be found in disturbed areas, especially roadsides below 6,200 feet elevation. Perennial pea can form dense colonies that may exclude desirable vegetation. There is one documented dispersed population of perennial pea within the watershed boundary along the Ah-Di-Na Road.
- **black locust *(Robinia pseudoacacia)*** is a deciduous tree rated as limited in its invasion by Cal-IPC. Black locust is common throughout California below 6,300 feet elevation. It

establishes mainly along roadsides, riparian areas, and disturbed woodlands. Two occurrences of black locust exist within the watershed boundary and an additional one is adjacent to the boundary at the confluence of the Lower McCloud River and Squaw Valley Creek. The two populations within the boundary occur at the Ah-Di-Nah campground (within and just downstream), and also near Claiborne Creek on the McCloud River Preserve. Black locust was historically introduced at the Ah-Di-Nah Campground as dense thickets where the species colonized previously cultivated areas, and also in stands mixed with other tree and shrub species (USDA Forest Service 1998).

- **Himalayan blackberry *(Rubus armeniacus = Rubus discolor)*** is a perennial plant rated as a highly invasive species by Cal-IPC. Himalayan blackberry is common below 5,200 feet elevation throughout California. Habitat types where it is found include wetlands and disturbed moist areas that are either manmade or natural. There are four dispersed occurrences of Himalayan blackberry documented within the watershed: one within or nearby Ah-Di-Na campground area, one along Hawkins Creek Road near Doodlebug Gulch, one at the confluence of Bald Mtn. Creek and the McCloud River, and one along Claiborne Creek on McCloud River Club property. McCloud River Club has attempted removal of this species in the past by spraying the largest populations in cabins area using Garlon herbicide with good success (USDA Forest Service 1998).
- **spreading hedgeparsely *(Torilis arvensis)*** is an annual herb rated as moderately invasive by Cal-IPC. Spreading hedgeparsely is common on roadsides and disturbed areas below 5,200 feet elevation throughout California. This species can be a problem for livestock and other grazers but may not get to densities high enough to cause serious problems. There are two occurrences of spreading hedgeparsely within the watershed: one on the McCloud River Preserve by Claiborne Creek and the other on the hydroelectric diversion tunnel tailings along Hawkins Creek.

Additional noxious weed species of either moderate concern within the watershed, or those of higher concern outside of the watershed boundary but occurring nearby include: cheatgrass *(Bromus tectorum)*, spotted knapweed *(Centaurea maculosa)*, Maltese star-thistle *(Centaurea melitensis*), houndstongue *(Cynoglossum officinale)*, Scotch broom *(Cytisus scoparius*), tall fescue *(Festuca arundinacea)*, French broom *(Genista monospessulana),* St. John's wort *(Hypericum perforatum)*, pepperweed *(Lepidium heterophyllum)*, American pokeweed *(Phytolacca americana)*, cutleaf blackberry *(Rubus laciniatus),* and common mullein *(Verbascum thapsus)*.

Although there are no currently documented populations of spotted knapweed within the watershed, three spotted knapweed plants were found at the private fishing access parking area on the west side of the river at the end of the spur road to Chatterdown Creek on the Bollibokka Club in 1999. The plants were immediately removed and had not yet gone to seed. They had probably grown from seeds inadvertently brought in by anglers (USDA Forest Service 1998). Additionally, there are no currently known documented occurrences of cutleaf blackberry within the watershed; however in 1998 it was noted as a problem species forming thickets in many locations in the Ah-Di-Na area (USDA Forest Service 1998).

In general, many noxious weeds establish or are spread within or along campgrounds, roads, trails or fuel-breaks via human or mechanical vectors. Several of these species may also colonize nearby off-road areas following a disturbance such as fire or logging (Bossard et al. 2000). This may be particularly true of species with high seed dispersal capabilities such as black locust (Landenberger et al. 2007), Canada thistle or bull thistle (Parendes and Jones 2000). It is well documented that invasive plant populations often establish or increase following fire events

(Zouhar et al. 2008). Although this risk exists for applications of low-severity fires such as prescribed burning, a high-severity, large-scale, unplanned fire event would increase a risk of invasion significantly. As noted in the Fire and Fuels discussion, moderate or high intensity fires may remove overstory trees allowing for increased light as well as reduce soil nutrients; both of which are advantageous conditions within which invasive plants may out-compete natives in colonization or spread. Similarly, the removal of overstory canopy via timber harvest may have a similar effect (Sutherland and Nelson 2010). As much of the private ownership within the watershed is managed as industrial timberlands, concerns regarding the introduction or spread of noxious weeds on these properties are present. Additionally, PGE assessments regarding the potential effects of project operations and maintenance (O&M) and project recreational use on riparian plant community composition showed a potential increase in habitat conditions for black locust (see Noxious and Undesirable Weed Species discussion) which could then displace native species or decrease habitat for botanical species of concern.

The Lower McCloud River Watershed contains approximately 227 miles of road (including designated Off Highway Vehicle (OHV) routes) and 62 miles of trail. Although recreation within the watershed is moderate compared to that of other nearby areas (e.g. Shasta Lake) there are old jeep trails and hiking trails present where noxious weeds occur or have the potential to occur and spread (Mount and Pickering, 2009). There are two campgrounds (Ah-Di-Nah and Ash Camp) within the watershed boundary that are infested with noxious weeds. Electric transmission lines exist within three miles of the watershed analysis area which also often have many noxious weed occurrences. The McCloud Reservoir – adjacent to the watershed boundary – is could also be a weed seed source.

Wind, water and wildlife also transport weeds into, out of and within the watershed. Species such as Canada and bull thistle have achenes (seeds) with a downy pappus that may be transported by wind although this is often only within a few meters of the parent plant (Bossard et al. 2000). Other species such as French broom may have their seeds dispersed via rainwash or river transport. Wildlife also distributes species such as pokeweed (*Phytolacca americana*) and Himalayan blackberry via ingestion of their fleshy fruits.

As noted in the previous section, distribution and abundance data regarding noxious weeds in the watershed are somewhat lacking. Further surveys and monitoring of these species and their habitat conditions are needed.

Current Weed Treatment Activities

Currently there are no invasive plant species removal projects within the watershed analysis area. Nearby projects consist of: 1) broom (*Cytisus scoparius, Genista monospessulana,* and *Spartium junceum*) eradication through a combination of hand cutting, pile and burn, and herbicide application in the Packer’s Bay area and 2) Dyer’s woad and yellow starthistle treatments at the McCloud Boat Ramp (begun in2005). Past attempts have been made to control these species in the watershed with little success. Plants were cut and piled, and the piles later burned. Monitoring indicated that the majority of plants re-sprouted from their base. Pokeweed removal has successfully taken place in a nearby recreation area (Bailey’s Cove) approximately 10 miles south of the watershed boundary.

Additionally, at least two private landowners in the watershed, PG&E and the McCloud River Club, manage for invasive species occurring on their property. In the case of PG&E, invasive species eradication is conducted in compliance with relicensing conditions. These control measures include manual (e.g. pulling or cutting), mechanical (e.g. mowing or discing), chemical (e.g. herbicides), and biological (e.g. insect or pathogens) strategies.

Terrestrial Wildlife Species and Habitats

Methodology

Wildlife species were divided into three main categories for the purposes of this analysis. These include the following:

- Federally listed by the U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act (1973) as threatened, endangered, proposed or candidate
- Forest Service Sensitive
- Other species of interest
    - Survey and Manage species
    - Neo-tropical migratory birds
    - Game species

Each of these categories and subcategories contain species that have a variety of habitat associations. Habitat descriptions and associations are described in more detail below. Maps included with this document display the various wildlife habitats that occur in the Lower McCloud watershed analysis area.

Current information for known locations of these wildlife species, Survey and Manage wildlife species, and species of interest occurring in the Lower McCloud watershed were assessed using district and corporate GIS data layers for species' locations. These data were compiled from past surveys, incidental sightings and known historical detections. In addition, data were gathered from the California Natural Diversity Database (CNDDB), Natural Resources Information Systems (NRIS), Forest Carnivore Surveys in the Pacific States database, and the USFWS website that provides lists of threatened, endangered, proposed or candidate species with the potential to occur in given geographic areas.

Habitat descriptions and conditions were analyzed using Existing Vegetation (EVEG) data (USDA Forest Service 2007) in conjunction with National Agriculture Imagery Program (NAIP) imagery and district vegetation GIS layers (see the project file). On-the-ground conditions were then assessed during field visits.

Federally Listed Species

Four federally listed terrestrial wildlife species are described within the USFWS list of species with the potential to occur within the watershed, based on potential habitat availability or a description of the species' historic or current range. In addition, two Candidate species were also listed as having potential to occur in the analysis area.

The analysis area is located within eight USGS quads: Yellowjacket Mountain, Tombstone Mountain, Bollibokka Mountain, Grizzly Peak, McCloud Reservoir, Hanland Peak, Shoeinhorse Mountain, and Big Bend. The following species were listed as having either their current or historic range occurring within these quads.

- Northern spotted owl (*Strix occidentalis caurina*) - Threatened
- California red-legged frog (*Rana draytonii*) - Threatened
- Vernal pool fairy shrimp (*Branchinecta lynchi*) – Threatened
- Valley elderberry longhorn beetle *(Desmocerus californicus dimorphus)* - Threatened

- Pacific fisher (*Martes pennati*) – Candidate
- Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) – Candidate

Forest Service Sensitive Species

Forest Service Sensitive terrestrial wildlife species known or expected to occur or with suitable habitat in the Lower McCloud watershed and based on either known location data or suitable habitat availability, include the following species. An asterisk [*] denotes species also categorized as Survey and Manage species.

- Late-seral mixed-conifer habitat
    - Northern goshawk (*Accipter gentilis*)
    - Pacific fisher *(Martes pennanti pacifica)* (also Candidate species)
    - American marten (*Martes americana*)
    - California wolverine (*Gulo gulo luteus*) (also Candidate species)
    - Bald eagle (*Haliaeetus leucocephalus*)
- Early/mid-seral and oak woodland habitats
    - Pallid bat *(Antrozous pallidus)*
    - Townsend's big-eared bat (*Corynorhinus townsendii*)
    - Western red bat (*Lasiurus blossevillii)*
- Cave habitat
    - Pallid bat
    - Townsend's big-eared bat
- Riparian-associated species – terrestrial
    - Northwestern pond turtle (*Emys marmorata marmorata*; formerly *Clemmys marmorata marmorata*)
    - Foothill yellow-legged frog (*Rana boylii*)
    - Cascade frog (*Rana cascade*)
    - Southern torrent salamander *(Rhyacotriton variegatus*)
    - Willow flycatcher *(Empidonax trailii*)
- Limestone-associated species
    - Shasta salamander* (*Hydromantes shastae*)

Other Species of Interest

- Bat species
    - Silver-haired bat (*Lasionycteris noctivagans*)(snags/crevices)
    - Fringed myotis (*Myotis thysanodes*) (snags)
    - Long-legged myotis (*Myotis volans*) (snags)

  - Yuma myotis *(Myotis yumanensis)*
  - Long-eared myotis (*Myotis evotis*) (snags)
- Terrestrial Mollusks
  - Shasta hesperian* (*Vespericola shasta)*
  - Tehama chaparral* (*Trilobopsis tehamana)*
  - Shasta chaparral* *(Trilobopsis roperi)*
  - Wintu sideband* (*Monadenia troglodytes wintu)*
  - Shasta sideband* *(Monadenia troglodytes troglodytes)*

Survey and Manage Species

In 1994, the USDA Forest Service and USDI Bureau of Land Management adopted standards and guidelines for the management of habitat for late-successional old growth (LSOG) forest-associated species within the range of the northern spotted owl, commonly known as the Northwest Forest Plan (NWFP). The key elements of the NWFP are the system of reserves (with focus on maintenance of late-successional habitats), the Aquatic Conservation Strategy, and various standards and guidelines affecting each of seven different land allocations. Also, mitigation measures were included for management of about 400 rare and locally restricted species, collectively known as the “Survey and Manage” program. The Survey and Manage guidelines of the NWFP record of decision (ROD) provide an adaptive-management process for managing rare and uncommon, poorly understood old-growth-forest-associated species. The adaptive-management process is based on managing species and their habitats consistent with the most current scientific information, and utilizing a comprehensive program of information gathering, analysis, and interpretation to guide management actions while providing for the likelihood of persistence for LSOG forest-associated species (Molina et al. 2003).

The Lower McCloud watershed provides habitat for seven terrestrial Survey and Manage wildlife species – six terrestrial mollusks and one amphibian. Six of these species are also managed as FS Sensitive species as described above.

- Shasta salamander (*Hydromantes shastae*)
- Siskiyou sideband (*Monadenia chaceana)*
- Shasta hesperian (*Vespericola shasta)*
- Tehama chaparral (*Trilobopsis tehamana)*
- Shasta chaparral *(Trilobopsis roperi)*
- Wintu sideband (*Monadenia troglodytes wintu)*
- Shasta sideband *(Monadenia troglodytes troglodytes)*

Game Species

Various game species are known to occur in the watershed and are generally associated with the early seral brush habitats, as these areas tend to provide the most browse, forage and hiding cover. Game species present include deer, elk, turkey, black bear, mountain quail, western gray squirrel, band-tailed pigeon, and grouse.

Neo-tropical Migratory Birds

Neo-tropical migratory birds are associated with a wide variety of habitat types within the Lower McCloud watershed, including oak woodland, mid and late seral mixed conifer, riparian, cliff and talus slopes, grassland, and chaparral/brush. These areas provide both potential breeding habitat and migration corridors for over 200 different species of birds.

Focal habitats within the watershed

Lower McCloud watershed contains multiple habitats of interest including late seral mixed conifer forest, mid seral transitional forests, hardwood forest, riparian corridors, early seral brush fields, limestone outcroppings and caves. Each habitat contains a suite of species with strong associations to particular elements of that habitat as well as a dependence upon the existence of these elements in perpetuity. Habitats within the watershed are categorized into broad groups based on the relative abundance, uniqueness or potential sensitivity to management actions within the watershed.

In addition to these habitat types, there are also categories for management of the habitat based on either LRMP land allocation, as described in the sections above, or federally designated Critical Habitat. The Lower McCloud watershed contains northern spotted owl habitat and its designated Critical Habitat (see Map 11).

Late seral mixed conifer habitat

Late seral (or late-successional) forests are generally characterized as older, multi-layered structurally complex forests with large diameter trees, high amounts of canopy cover, and decadence components such as broken-topped live trees, mistletoe, cavities, large snags, and fallen trees (USDA Forest Service 1999). These stands are relatively dense with large trees as well as a component of broad leaf trees and shrubs. Many of the larger trees contain rounded or flat tops, broken tops, conks, fire scars, and/or sparse live crowns. Crown closure is greater than 40 percent but averages 60-90 percent. Multi-storied stands are common. Some pockets of regeneration or shrubs occur within openings created by overstory tree mortality.

At one time late and mid seral stands occupying the drier sites within the watershed were more single storied but over the past 75-100 years white and red fir has established within the midstory of many of the older stands (USDA Forest Service 1999), while big leaf maple (*Acer macrophyllum*) and dogwood (Cornus sp.) tended to become established within the more moist sites. Within the understories of the more moist sites, hazelnut and a number of other shade-loving shrubs are present, along with ferns, vines, and other groundcovers. The understories of drier sites are now fairly barren in some areas. Active management in these areas is likely result in the return of more species richness and diversity within the understory due to the creation of available growing space, which allows new species to germinate.

Coniferous forest stands (mixed conifer- pine, Douglas-fir, Ponderosa pine, white fir, gray pine, and red fir) were queried within the 2007 EVEG database, using the following criteria to categorize habitat as late seral:

- Overstory Tree Diameter = QMD greater than 30”
- Conifer Tree Cover From Above (% canopy cover) = 60-100%

The category of mid seral stage for coniferous stands can capture a wide range of tree size and age class. Tables 3-9 through 3-12 differentiate between size classes as provided in the EVEG

(2007) database attributes. Mid seral stands are broken into two categories as defined by their size class. Mid seral stands with larger size class trees can be utilized by species associated more with late seral habitat, particularly if canopy closure (i.e. EVEG attribute: *Conifer Tree Cover from Above*) is relatively high. While species associated with late seral habitats tend to select for larger, older stands (i.e. >30” DBH), they will also utilize somewhat smaller size classes (i.e. Medium 20.0 to 29.9” DBH) to varying degrees depending on a variety of factors such as canopy closure, basal area, overall available habitat, proximity to water, position on the slope, levels of large woody debris, vertical structure within the stand, and the level of fragmentation within the habitat.

To properly assess habitats, a detailed field investigation is required. For the purposes of this document, GIS quantification describes what is thought to exist throughout the watershed. Project specific investigations and field review would be conducted prior to NEPA actions being developed. This assessment relies on GIS and minor field review. To complete this assessment, the and to describe the quantity of late seral habitat available within the analysis area, stands within size classes described as Medium 20.0 to 29.9” and Large >30” were grouped together. While this may provide a slight overestimation of the acres of late seral forest due to the 20.0” trees within the lower end of the size bracket, it will capture the overall availability of habitat for species associated with late seral habitat. Further field investigation is required prior to pursuing actions; this document only provides an estimate. This document is intended to guide management decisions, and displays the most basic understanding of habitats and habitat quality.

There are 26,129 acres of mid and late seral mixed conifer habitat on federal lands within the watershed, 68% of the coniferous forest on federal lands in the watershed. Tables 3-9 through 3-12 display the conifer seral stages and canopy closures for coniferous forest types in the Lower McCloud watershed analysis area on federal lands (see Map 8 and Map 25). Species associated with late seral habitat type can also use pockets or patches of other habitat types that may not consist primarily of conifer species and may have a strong hardwood presence, particularly black oaks or tanoak (referred to as montane-hardwood or montane-hardwood-conifer in the classifications). These may be secondary habitats used for foraging or as connectivity patches.

Connectivity is a measure of the extent of which the landscape pattern of the late-successional and old-growth ecosystem provides for biological and ecological flows that sustain late-successional and old-growth associated animal and plant species (Thomas et al. 1990). The ability to move across the landscape is important to the long-term persistence and viability of many wildlife species, particularly late-successional habitat associated species such as forest carnivores, spotted owls, and goshawks. The ability for movement or dispersal of these species across the landscape is provided by large blocks of late-successional habitat, particularly in LSRs, and through management objectives and various land allocations within the LSR (USDA Forest Service 1999). Those land allocations and associated management objectives include: Riparian Reserves, administrative withdrawn areas, management prescriptions, retention of old-growth fragments in Matrix lands, and 100-acre LSRs (LRMP).

Mid seral habitat

Though many species that have been identified as being closely associated with late seral forests many also use mid seral stands, as primary or secondary habitat, levels of large snags and coarse woody debris (CWD) and complex vertical structure are generally at levels less than what typically occurs in late seral forests. Use of these areas may occur due to the higher levels of canopy closure and mix of large trees amongst the generally younger stand.

Mid seral habitat adjacent to later seral stands provides for connectivity between older, late seral stands and may serve to reduce the effect of fragmentation on late seral associated species and may serve as a protective buffer against predation by barred owls and great horned owls. Late seral dependent species may also occupy mid seral habitat as “outliers” (individuals found outside established territories), where the mid seral habitat serves as a transitional habitat for species and may be important in supporting these individuals until they are able to utilize the preferred late seral habitat. Mid seral habitat often contains areas of microhabitats that consist of either openings with more early seral vegetation or patches of older, more mature habitat, and subsequently can serve a wider variety of species overall until the stand matures.

Coniferous forest stands (mixed conifer- pine, Douglas-fir, Ponderosa pine, white fir, and red fir) were queried within the 2007 EVEG attributes below, using the following criteria to categorize habitat as mid seral (see table 3-10 and 3-12):

Overstory Tree Diameter (QMD) = 10.0” to 29.9”

Conifer Tree Cover From Above (% canopy cover) = 30-59.9% and 60-100%

Refer to tables 3-9 through 3-12 for a breakdown of mid seral habitats in the watershed, which are displayed separate from late-seral. There are a minimal amount (4%) of acres categorized as mid seral that have less than 30% canopy cover, but have overstory tree diameters greater than 10” DBH. This is in sharp contrast to the vegetative condition and seral stages of the analysis area just 100 years ago, pre the fire-suppression era.

Hardwood Forest Habitat

Hardwoods occur within the watershed as both pure hardwood stands and as a component of the conifer forest. The current level of hardwood stands is shown in table 3-10 and 3-12.

Hardwood stands occur mostly within the northeastern, western and southern portions of the watershed, mainly in matrix lands and seldom within the central part of the watershed. These areas contain a mix of canyon live oak and black oak, in combination with brush species including Brewer’s oak and shrub tanoak (*Lithocarpus densiflorus*).

As described within the 1998 iteration of the Lower McCloud Watershed Analysis,

“The net acreage of hardwood stands has increased by approximately 1,000 acres over the past 50 years. Approximately 350 acres has transitioned into conifer forest types as the absence of fire has allowed shade tolerant conifers to invade some hardwood stands and inhibit the regeneration of young hardwoods. However, over 1,300 acres of brush have developed into hardwood forests over the past 50 years - also the result of fire exclusion.

Although the acreage of hardwood stands has been increasing as a result of the transition from the brush seral stage, there are few acres (<400 ac.) of suitable brushfields available to continue this trend. The brush seral stage has declined by half over the past 50 years and much of the remaining brush is on the harsher sites. The continued absence of fire in the ecosystem could result in a loss of hardwood acreage in the future as more hardwood stands are lost to conifer encroachment and few developing brush fields are available to replace them.

With past fire suppression, hardwood habitats are expected to have understory growth of seedlings and shrubs. The extent of these developing habitats though is unknown. Developing hardwood habitats can also reduce the amount of herbaceous growth usually found in the *understory, through shading out of the herbaceous growth or through competition from seedling and shrubs. In addition, acorn production may be hindered due to competition of resources by seedlings and shrubs in the understory.*

Hardwoods also function as an important component in conifer forests. Hardwood presence in conifer forests declines as overstory crown cover increases. The absence of fire and disturbance in the watershed this century has allowed conifer stands to develop and inhibit the development of hardwoods. Mature black oak is described as being intolerant of shade. If overtopped, black oak either dies outright or dies back successively each year. Short epicormic branches keep the tree alive for a time, but with continued overtopping, death is inevitable (USDA 1990). Declining black oaks are evident within dense conifer stands throughout the watershed."

Early seral coniferous

There are approximately 5,033 acres of early seral stage coniferous forest on the federal lands in the watershed (see Table 3-10), and another 1,592 acres of hardwood early seral habitat. Private lands have considerably more due to extensive harvest that has occurred in the watershed (see discussion in Vegetation section above).

Brush/browse habitat

Brush/browse habitat in the watershed is comprised of brush species such as manzanita, Brewer's oak (*Quercus garryana* var. *breweri*), deerbrush (*Ceanothus integerrimus*), and other shrub species (see Vegetation section above for more details on distribution and abundance of brush species in the watershed). The current condition of the brush/browse in the watershed is variable, depending much on soil type, aspect, slope and disturbance regime. The few areas that have burned in past wildfires contain a mosaic of new growth and older brush skeletons or young, dense pine regeneration. Many of these areas in the watershed contain older, decadent brush with much reduced palatability as browse.

Table 3-15. Brush/browse and herbaceous habitats in the analysis area

Regional Dominance	Acres in analysis area	Percentage of analysis area
	Shrubs and Chaparral	
Upper Montane Mixed Chaparral	1,232	2
Scrub Oak	473	1
Greenleaf Manzanita	134	<1
Lower Montane Mixed Chaparral	106	<1
Wedgeleaf Ceanothus	52	<1
Total Shrubs and Chaparral	**1,997 acres**	
	Herbaceous	
Annual Grasses and Forbs	35	<1
Perennial Grasses and Forbs	2	<1
Total Herbaceous	**37 acres**	

Other habitats present in the watershed

Other habitat types present in the watershed, although comprising a smaller proportion of the watershed than those discussed above, include riparian corridors, grasslands, and limestone outcrops and caves. Each of these habitat types is utilized by a particular mix of associated wildlife species. The overall availability of each of these habitat types is limited within the watershed, but the quality remains relatively high within the public lands. Private lands have had a variety of activities, some of which have degraded habitats, (e.g. timber harvest and grazing within the riparian corridors and grasslands) and impacted the vegetation and the subsequent suitability of the habitat within these areas.

Habitats such as limestone outcroppings, caves, and riparian corridors do not lend themselves to management practices such as mechanical fuels treatments or thinning as a means of protection or maintenance. These areas are less susceptible to severe fire events and tend to be more able to recuperate if impacted by fire. Also, fires tend to react less severely when they do occur, as these areas tend to be more moist and humid and less capable of carrying fire. Therefore, the general practice of avoidance during management activities and avoidance of disturbance, particularly mechanical but also from livestock, is considered sufficient for the maintenance and protection of these habitats and the species with the potential to occur within them.

Limestone caves are uniquely vulnerable to impacts from recreational caving. Traditional concerns have focused on intentional and unintentional damage to cave formations and physical disturbance of hibernating bats. Recently, however, a new threat has emerged in the form a bat fungal disease (*Geomyces destructans*), commonly called White-Nose Syndrome (WNS), which is carried from cave to cave on the dirty shoes, clothing, and caving equipment. WNS-infected bats use up their vital fat reserves during hibernation and die of starvation. WNS started in the Eastern U.S. and has not yet been documented in caves in the western U.S., but researchers fear that it is only a matter of time.

Critical Habitat (NSO)

The intent of critical habitat for the northern spotted owl is to provide the physical and biological features that were the basis for determining the habitat to be critical. Those physical or biological features are referred to as ‘Primary Constituent Elements’ and include, but are not limited to:

- Space for individual and population growth, and for normal behavior;
- Food, water, air, light, minerals, or other nutritional or physiological requirements;
- Cover or shelter;
- Sites for breeding, reproduction, and rearing of offspring,
- Habitat that is protected from disturbance and/or representative of the historic, geographical, and ecological distributions of a species

The Primary Constituent Elements for northern spotted owl critical habitat include:

- Forests which provide nesting, roosting, or foraging habitat, including stands which currently provide foraging habitat for resident spotted owls, even if the stand may not currently provide nesting conditions.

- Forest stands with adequate tree size and canopy cover to provide some protection from avian predators and at least minimal foraging opportunities. It is important to note some dispersal habitat may not provide nesting, roosting, or foraging habitat, though nesting, roosting, and foraging habitat will provide for dispersal.
- Lands that have the potential to produce nesting, roosting, foraging, or dispersal habitat sometime in the future, though not currently in such a habitat condition;

Critical habitat within the Lower McCloud watershed includes portions of Critical Habitat Unit (CHU) #CA-4/CHU 28 (Eastern Klamath Mountains) Subunit 77, which was seen by the Interagency Scientific Committee (ISC) as the best opportunity to create a large habitat conservation area in the Shasta-McCloud subprovince (see Map 11). This CHU is one of the keys to maintaining the viability of the subprovince and providing a source population, and is considered in the LSR Assessment as one of the most important CHUs to protect in the subprovince. It is also a vital area for providing linkage and an opportunity for genetic interchange between the northern and California subspecies (USDA Forest Service 1999).

Terrestrial Wildlife Species within the Watershed

McCloud-Pit Relicensing Project (FERC Project No. 2106) – Updates to the Current Condition within the Analysis Area

McCloud-Pit Relicensing Project (FERC Project No. 2106) for PG&E submitted the "The McCloud-Pit Project (project) Supplement to the Pre-Application Document (PAD) and Revised Study Plan", dated October 17, 2007, that identified issues associated with special-status raptors for which "the existing, relevant, and reasonably available information is insufficient to analyze potential project effects on these species". Specifically, the issues identified consisted of the potential effect(s) of project operations and maintenance and recreational use on special-status raptor species. Study Description WL-S1, Assess Special-Status Raptor Use in the Project Area, was designed to address these issues; and included surveys for bald eagle, peregrine falcon, northern spotted owl, and northern goshawk, and an evaluation of transmission line-avian interactions. The goal of this study was to develop the information necessary to supplement existing data to describe and analyze these issues. The specific information to be obtained from Study Description WL-S1 included the distribution of suitable habitat for special-status raptor species potentially occurring in the project area (i.e. the area affected by the relicensing of the McCloud-Pit Project), and an analysis of potential project-related effects on these species.

In conjunction with the Special Status Raptor assessment, an evaluation of avian interactions with transmission and distribution lines was performed. The evaluation included a review of bird-caused outages and electrocutions occurring in the relicensing project area and examined the configuration of the electric conductors, insulators, transmission lines, and ground wires on distribution poles and transmission structures. The goal of the evaluation was to determine if the specified PG&E facilities comply with current recommended standards to prevent bird electrocution and was performed as part of Study Description WL-S1, Assess Special-Status Raptor Use in the Project Area, in the FERC-approved Revised Relicensing Study Plan (PG&E 2008a).

Issues associated with special status fish and aquatic resources were also identified. One of the issues identified was the potential effect(s) of the FERC relicensing project operations and maintenance, and project-related recreation use on special-status amphibian and aquatic reptile species. Surveys for special status amphibians and reptiles near the McCloud Reservoir and stream reaches affected by the relicensing were identified. Study Description FA-S2, *Surveys of Special-Status Amphibians and Aquatic Reptiles near Project Reservoirs and Project-affected Stream Reaches I,* was designed to address these issues, and included surveys for Shasta salamander, tailed frog, southern torrent salamander, foothill yellow-legged frog, California red-legged frog, Cascades frog, and northwestern pond turtle (PG&E 2009).

Surveys for terrestrial mollusks of species concern were also conducted during the McCloud-Pit FERC relicensing effort. Individual Forest Service Sensitive mollusks were detected above the McCloud Reservoir along Star City Creek and Tarantula Gulch, but the majority of the detections were along the Lower McCloud River.

As a result of these studies and their associated surveys, known locations of species of special concern can be updated for the current condition portion of the watershed analysis. More information regarding the details of the FERC relicensing surveys can be found within the individual species specific Technical Memorandums.

In summary, terrestrial wildlife surveys were conducted between 2007-2010 for FERC relicensing of the McCloud-Pit hydroelectric project for the following groups of species:

- **Special Status Raptors** (bald eagle, northern spotted owl, northern goshawk, peregrine falcon)
- **Special Status Amphibians and Reptiles** (Shasta salamander, tailed frog, southern torrent salamander, foothill yellow-legged frog, California red-legged frog, Cascades frog, and northwestern pond turtle)
- **Special Status Terrestrial Mollusks** (Shasta Hesperian, Tehama chaparral, Shasta chaparral, Wintu sideband, Shasta sideband)
- **Evaluation of avian interactions with transmission and distribution lines**

It is important to note that the entire watershed or even the entire Lower McCloud River were *not* surveyed for the FERC relicensing project for all species, but only areas that were considered affected by the hydroelectric power project and recreational activities associated with the facilities. Surveys were based on the use of the habitat within the river corridor or adjacent to the reservoir by the individual species and were not consistent between species (i.e. yellow-legged frogs, bald eagles, and northern spotted owl surveys had very different survey/study areas), none of which included the entire watershed. Results of these survey efforts will be given within individual species descriptions below.

Federally Listed

Northern spotted owl

The northern spotted owl (NSO) is a medium-sized owl that inhabits conifer forests of the Pacific Northwest, including northwestern California (Forsman et al. 1984). These owls occupy large home ranges (>3,000 acres). Because this species exhibits strong affinities for mature and old-growth forests and can incorporate large tracts of these forests into its home range, mature and old-growth coniferous forest has been considered equivalent to northern spotted owl habitat (Franklin et al. 2000).

Northern spotted owls are strongly associated with late seral coniferous forests. Suitable habitat for the species on the Shasta Trinity NF is described as multi-layered, multi-species coniferous forest stands with >60 percent total canopy cover for nesting/roosting, a minimum of 40 percent canopy cover for foraging; large (>18"dbh) overstory trees, large amounts of down woody debris, presence of trees with defects or other signs of decadence in the stand (USDI 2011a). This forest type is a subset of suitable habitat and may vary due to climatic gradients across the range (USDI 2011a).

Determinations of suitability also consider size of stand and adjacency to other habitat types, which owls can utilize. Forested stands with reduced acreage due to past land management activities or natural occurrences such as wildfire can create limiting habitat attributes essential to individual owl viability. Wildfire can potentially limit foraging resources, as well as predator protection and thermal protection. These foraging resources include prey abundance and essential cover for protection during foraging endeavors; and can both be depreciated or lost when intense wildfire moves through a forested stand.

Currently there are five known NSO activity centers in Lower McCloud Watershed: ST-202, ST-205, ST-206, and ST-212 , as indicated in the STNF NRIS database as of 2011 (table 3-15). Suitable habitat exists scattered within the watershed in the form of late seral mixed coniferous forest, as described in the tables and discussion of late seral habitat above.

Table 3-15. Northern spotted owl activity centers in the analysis area in 2011*

NSO Activity Center ID	Year established	Year last visited	Site Status	Last Known Reproductive Status
ST – 201	1989	1997	Inactive	Unknown
ST – 202	1989	2004	Inactive	Unknown
ST – 205	1989	1997	Inactive	Unknown
ST – 206	1989	2004	Inactive	Nesting
ST – 212	1989	2004	Active	Non-nesting pair

**Information in the table above was obtained from the STNF Forest GIS layer “NRIS – Wildlife February 2011”*

In conjunction with the McCloud-Pit Relicensing Project, a one-year, six-visit northern spotted owl survey was conducted in the NSO Study Area between April and August 2008. Within the Lower McCloud watershed, the NSO Study Area consisted of suitable NSO habitat within a 1.3-mi buffer distance of the McCloud Reservoir (PG&E 2008d). The initial four visits were conducted between April 15 and June 30 2008, while the last two visits were conducted between July 1 and August 4, 2008, meeting the requirements of the USFWS Northern Spotted Owl Survey Protocol (1993) for a one-year survey.

From the FERC relicensing surveys conducted, two northern spotted owl detections occurred, both adjacent to the McCloud Reservoir survey area. No active pairs or nests were found, nor were any activity centers determined. It is important to note that the entire watershed was not surveyed for the FERC relicensing project, but only areas that were considered to be affected by the hydroelectric power project and recreational activities associated with the facilities.

As described within the Northern Spotted Owl Technical Memorandum TM-53 (Public)

"...both northern spotted owl detections occurred in the upper Mink Creek drainage, east of Van Sicklin Butte, and were outside of the 1.3 mi survey buffer around the Project Boundary. These detections occurred on July 9 and 30, 2008, and consisted of a single female owl. Follow-up surveys were conducted the morning following each detection. On July 10, 2008, the owl was relocated during the follow-up visit and presented three mice. The owl consumed two of the mice and cached the third mouse. A female northern spotted owl was also relocated during the follow-up visit on July 31, 2008 and again presented three mice. The owl consumed one mouse and cached the remaining two mice. No other northern spotted owls nor any other owl signs were observed during either follow-up survey. According to the owl protocol, the status determination for this northern spotted owl is "single owl, status unknown," since detections must occur during three of the survey visits to make a "resident single" status determination. However, based on this survey information and review of recent historical data showing that northern spotted owls have previously been detected in this general area, resident single status can be inferred (personal communication, D. Derby, Wildlife Biologist, Shasta-Trinity National Forest, and L. Lindstrand III, Wildlife Biologist, North State Resources, Redding, CA, January 31, 2008). In either case, the detections and follow-up surveys were beyond the point where breeding status (minus observation of a pair with young) can be confirmed (June 1)" (PG&E 2008d).

In addition to the NSO detections, a single barred owl detection was made during the NSO survey effort. As the Technical Memorandum describes

"...one barred owl detection occurred in the vicinity of call station 46 in the Flatwoods/Pit 6 Dam survey area west of the 1.3 mi survey buffer around the Project Boundary, in an area known as Reynolds Basin. The barred owl detection occurred on July 1, 2008, and consisted of two birds. ....A follow-up survey was conducted on July 8, 2008, to relocate the birds and, if present, determine how to proceed with the northern spotted owl surveys in that area. A barred owl pair was found during the follow-up visit. No nest was found nor was any reproductive status determined, though at a minimum, it was determined that the pair roosted at the location and likely occupied the forest stand in the area detected. For the remaining spotted owl survey visits in that area, we omitted the call station near the barred owl location to avoid potentially calling-in a northern spotted owl into the barred owl location..... No northern spotted owl detections occurred during the surveys in this area; however, the presence of barred owls is known to reduce response rates of northern spotted owls (Crozier et al. 2006)" (PG&E 2008).

Vernal Pool Fairy Shrimp

The vernal pool fairy shrimp is a federally listed crustacean endemic to California and Oregon vernal pools. It inhabits small vernal pools with cool water (10ºC) of moderate alkalinity and conductivity that are less than 1m deep. Vernal pools are defined as temporary wetlands that form in depressions of unplowed grasslands over a hardpan clay layer. Pools fill with winter rains and evaporate over time, lasting anywhere from a few weeks to a few months (Gallagher 1996). As a result, this species completes its life cycle in a matter of weeks.

The current distribution of the vernal pool fairy shrimp is limited to Oregon and California. Populations are found in Southern Oregon's Agate Desert and in California's Central Valley and coastal mountains. Just three occurrences are also found in Southern California. Relative to other fairy shrimp, this species has a relatively large distribution; however, it is uncommon within its range. Historic data are nonexistent since it was first described in 1990. Its distribution or abundance may have been much greater in the past, since vernal pools are currently an endangered habitat. California's Central Valley has lost 75 percent of its vernal pool habitat and Oregon's Agate Desert has lost 90 percent (Gallagher 1996).

The presence of a hardpan layer in the Lower McCloud watershed is unknown at this time. There have been no surveys conducted in the area for either vernal pools or vernal pool fairy shrimp. If management actions are proposed for this area, an assessment of the potential for vernal pools would help to provide locations to be avoided during ground disturbing activities.

California red-legged frog

The historic range for the California red-legged frog includes Shasta and Siskiyou County but the current range described by the USFWS shows no occurrences within the watershed or these counties. Siskiyou and Shasta County, including the Lower McCloud watershed, were included in the original designation of critical habitat for the California red-legged frog. However, critical habitat for this species was revised and became effective as of April 16, 2010. The newly revised designated critical habitat no longer includes Shasta and Siskiyou County within the designation. In the declaration within the federal register, the USFWS stated that the areas removed from the 2001 designated critical habitat did not contain essential habitat features or were not essential to the conservation of the species. Therefore, while the current designation does not include all areas where red legged frogs have occurred, is does “more precisely map the essential physical and biological features that occur within the geographical area occupied by the California red-legged frog at the time of listing, and includes those areas containing the most suitable habitat for use by the frog”(USDI 2010a).

The California red-legged frog is the largest native frog in the western United States. It is endemic to California and Baja California, Mexico, at elevations ranging from sea level to approximately 5,000 feet. It uses a variety of areas, including aquatic, riparian, and upland habitats, but certain habitat features are critical; the most important feature being a pond, a slow-flowing stream reach or a deep pool within a stream that contains vegetation to which an egg mass can be attached. In addition, these areas must hold water long enough for tadpoles to complete their metamorphosis into juvenile frogs that can survive outside of water (USDI 2010a). This habitat type does exist in the watershed, though there are no known occurrences of this species in the area and it is outside of the current range of this species.

Surveys were conducted for California red-legged frogs during the FERC relicensing efforts throughout the Lower McCloud watershed along the Lower McCloud River and its substantial tributaries. No individuals of this species were detected.

Valley elderberry longhorn beetle

Valley elderberry longhorn beetle is endemic to the upland riparian areas of the Central Valley of California (Linsley and Chemsak 1972). The range of valley elderberry longhorn beetle extends from Shasta County in the north to Fresno County in the south. It is mostly concentrated at elevations below 3,000 feet in the watersheds of the American, San Joaquin, and Sacramento Rivers. Valley elderberry longhorn beetle habitat is steadily declining with the elimination of upland riparian habitat throughout its historical range. Less than 1% of the original upland riparian habitat remains, mostly distributed in small, isolated fragments (Collinge et al. 2001).

Habitat for valley elderberry longhorn beetle consists of elderberry shrubs (*Sambucus* sp.) occurring in upland riparian forests or elderberry savannas adjacent to riparian vegetation, most commonly within alluvial plains (Talley et al 2007). In Collinge et al. (2001) valley elderberry longhorn beetle exit holes were consistently found to occur in clumps of elderberry bushes rather than in isolated bushes, in elderberry branches 2-4 inches in diameter, and in branches less than 3 feet above the ground. Collinge et al. (2001) also found that plants in isolated drainages are less likely to support valley elderberry longhorn beetle populations than plants with connectivity to other habitat.

Valley elderberry longhorn beetle are a specialized herbivore that feeds exclusively on two species of elderberry plants: blue elderberry (*Sambucus mexicana*) and red elderberry (*Sambucus racemosa var. microbotrys*) and does not seem to select one species over the other (Barr 1991). The larval form is a nonlethal parasite on red and blue elderberry shrubs, while the adult form is also a pollinator of red and blue elderberry shrubs.

Urban and agricultural development, aggregate mining, and flood control practices (e.g., damming and channel maintenance) have damaged or eliminated a large percentage of the upland riparian forests that once occurred in California, reducing and fragmenting the available habitat for valley elderberry longhorn beetle (Barr 1991). The greatest threats to the persistence of valley elderberry longhorn beetle are habitat loss and fragmentation, flood management, pesticide and herbicide use, and exotic species invasion (USDI 1984; USDI 2006).

The valley elderberry longhorn beetle was proposed as a threatened subspecies with critical habitat on August 10, 1978 (43 FR 35636). A rule re-proposing critical habitat was issued on May 2, 1980 (45 FR 29373), to comply with amendments made to the Endangered Species Act. A final rule listing the beetle as threatened and designating critical habitat was published in the Federal Register on August 8, 1980 (45 FR 52803). A final recovery plan was approved for the beetle on June 28, 1984 (USDI 1984). On September 26, 2006 a 5-year review was completed by the USFWS in which information was compiled that prompted a proposal to de-list the valley elderberry longhorn beetle. The 5-year review found “substantial scientific or commercial information indicating that delisting the valley elderberry longhorn beetle may be warranted” (USDI 2011). The USFWS is currently conducting a ‘12-month finding’, and will determine from this whether a petition to de-list action is warranted. The primary rationale for the recommendation to delist the valley elderberry longhorn beetle was that the number of known occupied localities had increased from less than 10 at the time of listing in 1980 to more than 190 in 2006. Loss of riparian habitat slowed throughout the Central Valley, and there were a number of programs and regulatory mechanisms in existence to protect habitat (USDI 2011). The decision on whether to de-list the valley elderberry longhorn beetle will not be made until after the finalization of this iteration of the Lower McCloud watershed analysis. The USFWS deadline for submission of current scientific information as it pertains to the petition to de-list is October 12, 2011. After this time, an additional 12 months is projected for a decision to be made.

Species-specific surveys were not conducted for the valley elderberry longhorn beetle during the McCloud-Pit FERC relicensing effort, though special status plants were inventoried and elderberry was detected in several locations within the watershed. While the presence of its larval host plant, elderberry, alone does not indicate the presence of valley elderberry longhorn beetle or its habitat, it can be used as an indicator of the potential for an area to provide suitable habitat (Talley et al 2006). Depending on habitat type, the environmental characteristics most strongly associated with beetle presence were host plant availability, topography and proximity to habitat edge, in addition to presence and higher density of larger, more mature plants (Talley et al 2006).

Forest Service Sensitive

Bald Eagle

The bald eagle was listed in 1967 under legislation that preceded the Endangered Species Act, and was officially listed as Endangered when the Act was signed into law in 1973. The bald eagle was listed as Endangered in the lower 48 states of the United States because of a severe decline in numbers. This decline was primarily attributed to the use of certain pesticides that caused reproductive dysfunction and eggshell thinning. Habitat loss and disturbance at nest and roost sites were also major factors. Eagle populations have rebounded since the banning of DDT and the increased protection for nesting and winter roosting habitat. The bald eagle was removed from the Endangered Species List by the USFWS on July 9, 2007 and is now managed as a FS Sensitive Species. Viability of this species on the Forest is expected to be provided through implementation of the National Bald Eagle Management Guidelines (USDI 2007) the Bald and Golden Eagle Protection Act, the Migratory Bird Treaty Act and implementation of LRMP standards and guides for bald eagles.

Nesting territories are generally associated with lakes, reservoirs, rivers or large streams. Nest trees are generally large-limbed, mature overstory conifers (generally pine) located within close proximity (2 miles or less) to large bodies of water that provide fish and waterfowl for foraging. Bald eagles have a very high fidelity to their established nests. A pair will remain in the same nest area year after year if left undisturbed. Bald eagles are known to occur in the watershed and have been seen along the Lower McCloud River during spring and summer months. Habitat for nesting and foraging exists along Lower McCloud River. Records within the CNDDB database indicate that four nest sites have occurred historically along the Lower McCloud River from the Reservoir to the beginning of the McCloud Arm of Shasta Lake.

All known bald eagle territories along the Lower McCloud River have been monitored by PG&E since the mid-1980s. New sites are added to the monitoring list as they are identified and monitoring results are submitted to California Dept. of Fish and Game and the USFS annually. In relation to the McCloud-Pit Relicensing surveys, winter bald eagle surveys were conducted on December 18, 2006, January 8, 2007, and February 13, 2007. The second year of winter surveys was initiated on December 10, 2007. A total of six adult eagle sightings were made along the McCloud River in December 2006. Potential prey for bald eagles was also noted during the winter helicopter surveys.

Surveys were also conducted on March 29, May 14, and June 18, 2007. Two new bald eagle nests were discovered along the Lower McCloud River, one near the confluence with Chatterdown Creek and the other upstream of McCloud Bridge near Shasta Lake. The former apparently failed during incubation, while the latter successfully raised one young (PG&E 2008).

The second year of winter surveys was conducted on December 10, 2007, January 23, 2008, and February 14, 2008. A maximum of six adult eagles were found distributed along the mainstem of the McCloud River, downstream of McCloud Dam during the first year’s surveys (survey dated December 18, 2006), while a maximum of five adults and one subadult were found there during the second year (survey dated January 23, 2008)(PG&E 2008).

Northern Goshawk

Northern goshawks can be found in middle and higher elevation mature coniferous forests; usually with little understory vegetation and flat or moderately sloping terrain. Moderate and high quality habitats contain abundant large snags and large logs for prey habitat and plucking posts (Squires and Reynolds 1997). Goshawks generally breed in mature coniferous, mixed, and deciduous forest habitats. Suitable nesting habitat contains large trees for nesting, a closed canopy for protection and thermal cover, and open spaces allowing maneuverability below the canopy (Squires and Reynolds 1997). Territories associated with large contiguous forest patches are more consistently occupied compared to highly fragmented stands.

On the Shasta-Trinity NF, goshawk habitat consists of mid- and late-successional mixed conifer forest with scattered harvested and natural openings. Foraging habitat is variable and includes mid- and late-successional forest, natural and man-made openings, and forest edges. There are no known northern goshawk territories described in either the Forest GIS layer or CNDDB for the Lower McCloud watershed, though suitable nesting and foraging habitat exists throughout the area and nests are likely present in the late seral and mid seral habitat described in the tables above.

As a result of the McCloud-Pit Relicensing effort, goshawk surveys were conducted in suitable habitat within the Lower McCloud watershed, but only within suitable habitat within a 0.5 mile buffer around the Ah-Di-Na campground and the McCloud Reservoir. Large areas of the watershed were not surveyed with this effort, as they did not fall within the defined boundaries of the FERC relicensing project area. Therefore, within the remaining suitable habitat of the watershed, potential exists for goshawk nesting, though to what extent the watershed is being used by goshawks is unknown.

During the FERC relicensing surveys conducted on 7/12/2007and 8/9/2007, three separate detections were made approximately 0.5 miles south of the USFS Ah-Di-Na Campground. No active nests were found during the associated follow-up surveys, although a suspected activity center was located near these detections.

Pacific Fisher

The fisher is a forest carnivore that occupies late seral stage habitat in mature, late successional and old growth mixed conifer stands with a home range that can be very large (up to 11,000 acres in low quality habitat) (CDFG 2010). In the western mountains, fishers prefer late-successional forests (especially for resting and denning) and occur most frequently where these forests have the fewest non-forested openings. Historically, trapping for fur reduced fisher populations.

Drainage bottoms are generally used more often for resting compared to ridge-tops and mid-slope locations possibly due to increased access to water, increased prey abundance, larger trees, and denser canopy cover (Yeager 2005). Riparian areas provide concentrations of rest site elements, such as broken-top trees, snags, and coarse woody debris. Whether for prey availability, water access, riparian vegetation or microhabitat conditions, fisher may selectively use rest sites within 500 feet of water, and rarely farther than 1,100 feet from water. Fisher tend to use large live trees with cavities, particularly oak species, and logs for rest structures.

Populations of fisher currently occur in the North Coast Ranges of California and the Klamath-Siskiyou Mountains of northern California and southern Oregon. Additionally, surveys and sightings in California place fisher throughout much of the Sierra Nevada range. There at least 6 sightings of fisher throughout the Lower McCloud watershed listed within the CNDDB database (CNDDB 2011) and Forest GIS layers. Habitat for fisher exists in the watershed and based on the recorded sightings and the juxtaposition of additional sightings, it is likely that the area presently supports a fisher population, though the size and distribution of which is currently unknown.

Forest carnivores were not surveyed during the McCloud-Pit FERC relicensing effort, as they were not considered to be affected by the hydroelectric project's activities.

American Marten

American marten tend to use high elevation (generally >5,000 feet), multi-storied, late-successional mixed conifer forests with moderate to dense canopy closure. Preferred habitat consists of a dense overstory exceeding 70 percent with an average minimum tree size >24"dbh and sufficient understory particularly larger quantities of slash, rotten logs and stumps to provide hiding cover and denning areas. In most studies of habitat use, martens were found to prefer late-successional stands of mesic coniferous forest, especially those with complex physical structure near the ground (Buskirk and Powell 1994). This complex physical structure near the ground addresses three important life needs of martens: it provides protection from predators, access to the subnivean space where most prey are captured in winter, and protective thermal microenvironments, especially in winter (Buskirk and Powell 1994).

Therefore, martens are most limited to the narrowest range of habitats within their home ranges during the winter months. Martens gain access to subnivean spaces created by coarse woody debris at lower snow depths, and by lower branches of live trees in deep snow (Corn and Raphael 1992). In general, these subnivean access points have higher volumes of coarse woody debris, more log layers, and fewer logs in advanced stages of decay.Removal of coarse (large) woody debris from forests or interfering with processes that make it available in suitable sizes and stages of decay by removing standing trees and snags may indirectly affect martens by reducing habitat quality.

Martens generally occupy stands that are located within ¼ mile from water with forest openings less than one acre in size. They are most abundant in forested areas adjacent to meadows or riparian corridors, but use travel ways comprised of closed canopy forests to move between foraging areas. Martens generally avoid habitats that lack overhead cover, and tend to avoid crossing large openings (> 300 yards), especially in winter. However, when they do use or cross these areas, they tend to focus on coarse (large) woody debris, low growing branches, or patches of shrub.

Marten sightings have been documented in the Shasta-McCloud Management Unit. Private land surveys were completed in 1990-1995 on the McCloud Flats (east of the watershed) and in the Sacramento River Canyon area, (west of the watershed) (Criss and Kerns 1990). Marten were documented at the higher elevations, 4,000 feet and above. In 2002-2003 surveys were conducted on the Shasta-McCloud Management Unit along routes within the Pilgrim Creek Snowmobile Park (North State Resources 2003). Marten were detected at various camera locations at the higher elevations (4,000-7,000 feet) during three survey periods. No sightings for marten were recorded in the CNDDB database or Forest GIS layer in the vicinity of the Lower McCloud watershed.

Forest carnivores were not surveyed during the McCloud-Pit FERC relicensing effort, as they were not considered to be affected by the hydroelectric project's activities.

California wolverine

Wolverines are generally considered a solitary species, with adults associating only during the breeding season. The species occurs at low densities and is highly secretive, making estimation of population trends difficult (Banci 1994). Wolverine home ranges are generally extremely large, with adult ranges up to 350 square miles (Banci 1994). The current range in the contiguous United States is believed to include Idaho, Montana, Oregon, Washington, Wyoming, and California (Banci 1994). Wolverines are highly dependent upon mature, late-successional conifer forests for survival in winter, and generally move downslope in winter into heavier timber where food is available (Zeiner et al. 1990). They also use red fir, subalpine conifer, alpine dwarf-shrub, lodgepole, wet meadow, Jeffrey pine and montane riparian habitats.

Historical trapping reduced populations in various parts of the United States range, including California. Limiting factors for this species include habitat fragmentation and human disturbance, which have prevented population recovery since the days of trapping.

Wolverines naturally occur in low densities (Zeiner et al. 1990). They are difficult and expensive to study and are rarely observed, so a lack of sightings does not necessarily mean that wolverines are not present. There have been few surveys of wolverines in the contiguous United States that were designed to estimate population size at even a local scale. Only one wolverine has been officially recorded in the entire state of California in the last 20 years, despite hundreds of days of forest carnivore surveys across northern California (Moriarty 2008).

CNDDB records reflect one wolverine sighting with an unknown date and an unknown level of accuracy, south of the McCloud Reservoir. No confirmed sightings are recorded for the watershed. Important habitat elements specific to wolverine are not present in the watershed, making the likelihood of occurrence in the area very low. The checkerboard ownership of the watershed and subsequent fragmentation, combined with the current level of roads and human use in the area, offset the otherwise suitable aspects of the late seral forest present in the watershed and very likely precludes occupancy by wolverine.

FS Sensitive Bats

A wide range of habitats are required by the various bat species present in the watershed. The FS Sensitive Townsend’s big-eared bat, pallid bat and western red bat can utilize multiple different habitats in a given day. Suitable habitat for each of these species occurs in the watershed.

Pallid bats are usually found in low to middle elevation habitats below 6,000 feet. Varieties of habitats are used, including grasslands, shrublands, woodlands, and coniferous forests. Pallid bats most often occur in open, dry habitats that contain rocky areas for roosting. They are a yearlong resident in most of their range and hibernate in winter near their summer roost. Day roosts may vary but are commonly found in rock crevices, tree hollows, mines, caves and a variety of human-made structures. Tree roosting has been documented in large conifer snags, inside basal hollows of redwoods and giant sequoias, and bole cavities in oaks (Pierson and Rainey 2007). Cavities in broken branches of black oak are very important and there is a strong association with black oak for roosting. The site must protect bats from high temperatures, as this species is intolerant of roosts in excess of 104 degrees Fahrenheit. Night roosts are usually more open sites and may include open buildings, porches, mines, caves, and under bridges (Pierson and Rainey 2007). Pallid bats are very sensitive to roost site disturbance. Townsend’s big-eared bats are distributed broadly throughout western North America. They also occur in two disjunct, isolated populations in the central and eastern United States. In the West, this species’ range extends from the Pacific coast north to southern British Columbia, south to central and southern

Mexico and the Baja Peninsula (Gruver 2006). This species is found throughout California from low desert to mid-elevation montane habitats. The roost sites for this species are cavernous sites associated with caves, mines and buildings. It also roosts in hollow trees and certain types of bridges. The Townsend's big-eared bat has been documented in the Sacramento watershed and a roost is known to exist in a cave to the northeast of the Pit Arm watershed.

Western red bats are locally common in some areas of California; occurring from Shasta County to the Mexican border, west of the Sierra Nevada/Cascade crest and deserts (Zeiner et al. 1990). Red bat winter range includes western lowlands and coastal regions south of San Francisco Bay. The western red bat is typically solitary, roosting primarily in the foliage of trees or shrubs (Bolster 2005). Day roosts are commonly in edge habitats adjacent to streams or open fields, in orchards, and sometimes in urban areas. Red bats require water and there may be an association with intact riparian habitat, particularly willows, cottonwoods, and sycamores. In 1997, the Shasta-Trinity NF began surveys in areas where proposed activities could affect potential roost sites, though none were conducted directly within the Lower McCloud watershed. During the course of a six year survey period (June through September 2005-2010) with over 80 nights of bat mist net monitoring at the Trout Creek watershed area, two red bats were found. Both bats were captured in late August during migration.

Bat surveys were conducted from 2007-2008 in suitable habitat within the Lower McCloud watershed during the FERC relicensing effort. Reconnaissance surveys were conducted in June and August of 2007 and in February and July of 2008 to identify potential bat roost sites. Where potential bat roosts were identified, mist netting capture surveys were conducted using harp traps. Fifteen bat species were identified with these surveys, three of which were FS Sensitive species; western red bats, Townsend's big eared bats, and pallid bats were captured and identified.

In addition, winter hibernacula surveys were conducted in winter 2008 within structures identified as potential hibernation habitat during the reconnaissance survey effort. Hibernacula surveys consisted of visual observation and habitat structure surveys. A winter emergence survey was also conducted near a known colony of various bat species located near the McCloud Reservoir, though a roost inspection was not conducted due to a lack of accessibility.

All three of the FS Sensitive bat species were determined to be present in the Lower McCloud watershed, though the current distribution and abundance of each is unknown. Further surveys in the watershed, apart from the FERC relicensing effort, would help to identify roost sites not associated with PG&E structures or areas affected by the reservoir, and contribute to knowledge regarding populations and distribution of bats species in the watershed.

Terrestrial Riparian-Associated Wildlife Species

Northwestern pond turtle

Northwestern pond turtles are associated with permanent or nearly permanent water from sea level to 6,000 feet in elevation. Western pond turtles (species *Emys marmorata*- formerly known as *Clemmys marmorata;* Spinks et al. 2003) can be found in the United States from Washington to Baja, California, though the subspecies, the northwestern pond turtle, is only found in Washington through northern California, including some aquatic habitats on the Shasta-Trinity NF and the Lower McCloud watershed.

Northwestern pond turtles prefer the quiet stretches of moving water on ponds, lakes, major rivers and streams. Important habitat elements such as partially submerged logs, rocks, mats of floating vegetation, or open mud banks, are used as basking sites and refuge from predators. Nest sites generally occur within ¼ mile of water sources, and are usually characterized as open areas dominated by grasses and herbaceous annuals with a southern exposure (Holland 1991).Causes of population decline include habitat loss and alteration (both aquatic sites used for feeding and basking, and nest sites), population fragmentation, predation on young, especially by raccoons and introduced predators (e.g. bullfrog), and commercial harvest for the pet trade.

Data records from the district and CNDDB include sightings within the watershed with multiple sightings along the Lower McCloud River and its tributaries. Presence/absence surveys for northwestern pond turtles were conducted for the FERC relicensing effort for two consecutive years (2007-2008) in the areas surrounding the McCloud Reservoir and the Lower McCloud River in both lentic and lotic habitats. No pond turtles were observed either year within the Reservoir itself, but four detections were made along the Lower McCloud River and its tributaries. Overall, 4.9 mi of the Lower McCloud River (20.4% of the total length of 24 mi) and 3.6 mi of the perennial tributaries to the Lower McCloud River were surveyed (PG&E 2009 TM-09 FA-S2).

Habitat exists for this species throughout the watershed, and the area apparently supports a population of northwestern pond turtles based on the juxtaposition of sightings, abundant habitat, and the current sightings of individuals in the watershed, though the size and distribution of which is currently unknown.

Foothill yellow-legged frog

Historic distributions of this species ranged through most Pacific drainages west of the Sierra/Cascade Crest, from southern Oregon to southern California. Current distribution and abundance of this species has been reduced drastically in the southern portion of its range but it still occurs throughout coastal drainages in the northern portion of its range. This species is closely associated with permanent bodies of still water and are typically found at elevations below 1,800 feet. Breeding occurs in the spring, in shallow, slow flowing water with pebble and cobble substrate, preferably with shaded riffles and pools. It is also known to occasionally use moderately vegetated backwaters, isolated pools, and slow moving rivers with mud substrates.

The foothill yellow-legged frog is at risk due to various anthropogenic and environmental threats throughout its range. Among some of the larger rivers in California, predation from introduced bullfrogs has been implicated as a cause of their decline. In addition, increased sediment loads in breeding streams have a potential to reduce survival of eggs.

Data records from the district and CNDDB include four sightings within the watershed along the Lower McCloud River and its tributaries. Presence/absence surveys were conducted for the FERC relicensing effort for two consecutive years (2007-2008) in both the areas surrounding the McCloud Reservoir and the McCloud River in both lentic and lotic habitats.

As described within the PG&E Technical Memorandum (PG&E 2009 TM-09 FA-S2) *"No amphibian egg masses were observed and very few larvae were observed. One FYLF adult and15 young-of-year were observed at survey Sites 119 and 140; all but one of these observations were made at Site 140. Sites 119 and 140 comprise approximately 5 percent of the total surveyed area (including tributaries on the Lower McCloud River), and only 2 percent of* *the total length of the Lower McCloud River (not including tributaries). Relative abundance for[FYLF] observed in the Lower McCloud River was very low."*

The total stream length surveyed was approximately 20 percent of the Lower McCloud River (4.8 of 24 total mi) not including the tributary survey lengths. Approximately 3.6 mi of tributaries to the Lower McCloud River were also surveyed in 2007. Maps of each survey Site are available within the Technical Memorandum (TM-09 FA-S2) for Special Status Amphibians and Reptiles Updated February 2009.

General potential limiting factors were identified for each life stage of the foothill yellow-legged frog in the reptile and amphibian analysis within the PG&E Technical Memorandum, and included water temperature, water depth, water velocity, substrate size, predation by native and non-native species, diatom and algae availability, canopy cover, and tributary proximity.

Cascade frog

The Cascade frog is a montane species found in the Olympic Peninsula, Washington, and in the Cascade Range of Oregon, Washington, and northern California (Blaustein et al.1995). Populations appear to be declining throughout the range. Reasons for this decline are not well understood, but locally populations have been impacted by predation from introduced, non-native aquatic species.

Habitat for this species includes montane meadows, marshes, ponds, small bodies of water, ephemeral pools, potholes without vegetation, and along small creeks. They are typically found at elevations above 2,500 feet and are closely restricted to water.

Data records from the district and CNDDB indicate no sightings within the watershed. Habitat areas specifically suitable for Cascades frog were not identified and species specific presence/absence surveys were not conducted for the FERC relicensing effort because, as described within the Technical Memorandum, *"Although Cascades frogs have been reported using riverine habitat as low as 400 m (1,300 ft) elevation, populations in the vicinity of Lassen Volcanic National Park were historically most abundant at elevations between 1,450 m (4,800 ft) and 2,480 m (8,100 ft) (Lannoo 2005). All sites surveyed in the Lower McCloud River...were well below those elevations (all sites surveyed were below 915 m [3,000 ft]). No Cascades frogs were observed during surveys for other special-status species"* (PG&E 2009).

Southern torrent salamander

This species occurs from northwestern California to the Coast Range of Oregon in mid to low elevations. Habitat elements considered critical for survival include riparian vegetation, cool water present year round, and stream shade and water present for all stages of their life cycle. They are often associated with cold mountain streams, springs, and/or seepages that are well shaded and are no more than a few feet from free-running water. Declines of torrent salamanders have been attributed to increased amounts of sediments and increased water temperatures as a result of timber harvesting within their preferred habitat. Changes in forest canopies and the hydrology of seeps and streams can have negative impacts to southern torrent salamanders.

Management of Riparian Reserves through the Aquatic Conservation Strategy is expected to provide for or minimize impacts to aquatic and riparian associated species, including this species.

While systematic surveys specific to this species have not been conducted by STNF personnel within the watershed, personnel responsible for past stream and wetland surveys have looked for this species. According to district records and CNDDB database, no detections have been made directly within the Lower McCloud watershed. In addition, herpetofauna surveys conducted for the FERC relicensing surveys targeted southern torrent salamanders as a focal species for survey, but had no detections within the watershed.

Willow Flycatcher

The willow flycatcher is a common migratory species that breeds in a variety of riparian shrub habitat from Maine to British Columbia and as far south as southern Arizona and California (Sedgwick 2000). In general, the willow flycatcher prefers moist, shrubby areas, often with standing or running water. In northern California, they are strongly tied to thickets of willows, whether along streams in broad valleys, in canyon bottoms, around mountain side seepages, or at the margins of ponds and lakes. Willow flycatchers have been detected in 1995, along Hawkins Creek approximately 1.25 miles downstream from Little Meadows (alluvial upland habitat) and about 0.25 to 0.50 miles south of the McCloud River Club, along the McCloud River (USDA 1998). Little Meadows, though not surveyed, is also suspected to have willow flycatchers.

No surveys were conducted for this species during the FERC relicensing effort. While riparian habitat was mapped with the FERC surveys, it was not evaluated in the context of willow flycatcher habitat so the suitability of the willow vegetation for this species is unknown. Overall, wherever suitable habitat occurs, the willow flycatcher has the potential to occur in the watershed.

Limestone Associated Wildlife Species

Shasta salamander

The Shasta salamander is listed as both a FS Sensitive species and a Survey and Manage species. It primarily inhabits isolated limestone formations near Shasta Lake and surrounding area, though recent surveys have confirmed that it may also inhabit non-limestone habitats near the McCloud Reservoir. Currently, there are 61 known sites representing 16 to 17 population centers, most of which are on national forest land surrounding Shasta Lake (Naumann and Olson 2004). Habitat includes moist limestone fissures and caves, volcanic and other rock outcroppings, and under woody debris and duff in mixed pine-hardwood stands found near moist caves, rock cracks, and cliff faces (Gorman and Camp 1953).

A survey protocol and management plan has been developed for this species on the Shasta-Trinity NF. It is regularly surveyed for as part of the assessment process prior to ground disturbing activities. Primary threats listed in California Department of Fish and Game (CDFG) Non-game Species Assessments include increased recreation around Shasta Lake, limestone quarrying, and raising of lake water levels. Recreational caving can also threaten populations in caves, since they are often out in the open and can easily be stepped on. In addition, timber harvest can cause a loss of habitat and possible direct mortality, due to moisture loss via canopy reduction and ground disturbance. Highways can act as barriers to dispersal, and rock quarries can remove or disrupt habitat.

Habitat exists for the Shasta salamander in pockets of limestone rock outcrops and caves scattered throughout the watershed. Several limestone outcroppings do occur within the watershed, but these are usually located above 3000', are drier sites and not forested. Caves are also present which may have salamander populations. There are significant limestone outcrops in Mink/Squirrel drainage, on Van Sicklin Butte, in Bones Gulch, on Beetle Butte, on Bald Mountain Ridge, at the headwaters of Oak Creek (Tombstone Mountain and Tater Hill), on

High Mountain, and in Nawtawaket and Wittawaket drainages. Nawtawaket Creek is fed by a large limestone spring, and there are small limestone springs in Bones Gulch, on Beetle Butte, and on Bald Mountain Ridge. Other sites may occur, but could not be detected at this level of analysis using aerial photos, geological maps and soils maps. Their presence will be determined at the project level.

Species specific surveys were conducted for Shasta salamanders as part of the FERC relicensing effort, but were concentrated along the perimeter of the McCloud Reservoir and one location at the confluence of Lower McCloud River and Hawkins Creek. Other than these two areas, no other part of the Lower McCloud watershed received specific surveys, although additional habitat exists in the watershed for this species. Shasta salamanders were found at two of the survey sites: McCloud Reservoir and Fenders Flat/Pit 7Afterbay Dam (not within the Lower McCloud watershed). Shasta salamanders were found in limestone and non-limestone habitats at the McCloud Reservoir survey site. Surveys began December 11, 2007 and were completed on May 9, 2008 and met all protocol survey requirements, including appropriate weather conditions, and required level-of-effort search time. A total of eight adults and 2 juveniles were detected during the surveys that included the McCloud Reservoir sites. Additional habitat exists within the watershed that was not included in this survey effort, but it is likely that additional Shasta salamanders exist where suitable habitat elements exist in nearby locations.

The McCloud Reservoir Shasta salamander sites all represent northern extensions of the known species range. Specifically, these sites represent between approximately 1.5 to 3 mile extensions from the nearest previously known Shasta salamander location in the Centipede Creek drainage. These sites are also among the highest known elevations reported for Shasta salamander occurrences (PG&E 2009 TM-49 FS-S2; Lindstrand 2008).

Terrestrial Mollusks

- Shasta hesperian* (*Vespericola shasta)*
- Tehama chaparral* (*Trilobopsis tehamana)*
- Shasta chaparral* *(Trilobopsis roperi)*
- Wintu sideband* (*Monadenia troglodytes wintu)*
- Shasta sideband* *(Monadenia troglodytes troglodytes)*

The Shasta hesperian snail is endemic to the Klamath Province, primarily in the vicinity of Shasta Lake, up to 2,700 feet elevation. It has been found in moist bottom lands, such as riparian zones, springs, seeps, marshes, and in the mouths of caves (Kelley et al. 1999).

The Tehama chaparral snail is an endemic species of Tehama, Butte, and Siskiyou Counties. This species is usually associated with rocky talus, but has also been found under leaf litter and woody debris on the ground within 300 feet of limestone outcrops (Kelley et al. 1999).

The Shasta chaparral snail is an endemic species of Shasta County. It is found within 100 meters of lightly to deeply shaded limestone rockslides, draws, or caves with a cover of shrubs or oak and is strongly associated with Shasta Lake.

The Shasta sideband and Wintu sideband are both strongly associated with Shasta Lake. Habitat for both species includes limestone areas, including caves, talus slopes, and other rocky areas that can be open, brush-covered, or associated with pine-oak woodlands.

Multiple protocol surveys have been conducted throughout the Shasta-Trinity NF, and the Mount Shasta McCloud Management Unit, since the designation of these species within the Northwest Forest Plan. These species are known to occur in various, specific locations within suitable habitat on the Forest. Most recently surveys were conducted for the FERC relicensing effort

FERC surveys for special status mollusk species included suitable habitat within a 16 ft. wide band around the McCloud Reservoir and along 15 miles of the Lower McCloud River downstream from the Reservoir until one mile south of the confluence with Squaw Valley Creek. The 9 miles of the Lower McCloud River from Shasta Lake to within one mile downstream of the confluence with Squaw Valley Creek were excluded from the surveys. Surveys around the reservoir focused on spring areas or the mouths of tributaries that support riparian areas independent of fluctuating water levels. Surveys were also conducted in limestone outcrops within 328 feet of riparian zones in the survey areas and 656 feet of PG&E facilities and associated roads.

Two terrestrial mollusk species - the Shasta chaparral snail (*Trilobopsis roperi*) and the Shasta Hesperian snail (*Vespericola shasta*) - were found during surveys conducted in the spring of 2007 and the fall of 2008. *Trilobopsis roperi* was found in restricted habitats along cliffs at the Pit 6 and Pit 7 facilities sites and near tributary inflows to Pit 6 and Pit 7 reservoirs. *Vespericola shasta* was found in diverse wet or moist habitats in 26 of the 32 sites surveyed. Location specific data is available within the Terrestrial Mollusk Report (PG&E 2008 TM-70).

Game Species

The herd of colombian black-tailed deer that occupy the watershed is designated as the McCloud Flats deer herd by CDFG. The Weaverville deer herd utilizes the area to the west and south of the watershed, and the Cow Creek deer herd is to the east and south (see Map 21 – CDF&G Deer Range).

A management plan for the McCloud Flats Deer Herd was established in 1983 by the California Dept. of Fish and Game, Region I in cooperation with U.S. Forest Service, U.S. Bureau of Land Management and the National Park Service. This plan indicated the population trends, suitable fawning habitat, and management for critical winter and summer range. There is a small amount of designated critical winter range in the southern portion of the watershed and directly to the north of the watershed. There is no other designated fawning ground, fall holding areas, or critical summer range for deer within the watershed (CDFG 1983 and GIS layers from CDFG). There is also long strip of critical winter range west of the I-5 highway, approximately 8 miles west of the Lower McCloud watershed (see Map 21 - CDF&G Deer Range) .

Concerns regarding the resident and seasonal deer populations include the loss of early seral habitat, the loss of herbaceous and young shrub layer in the understory, and the loss of mast producing hardwoods. The exclusion of fire has impacted the deer habitat in the watershed through conifer encroachment upon herbaceous openings as well as a reduction in the availability and quality of palatable browse. Fire exclusion has also allowed the understory of forested conifer and oak habitats to mature, to be shaded out and to be replaced by shade tolerant species. Late summer forage important for resident deer is reduced with this change in vegetation. Fire suppression has also allowed hardwoods within mixed hardwood/conifer habitats to be overgrown and shaded out. This is suspected to occur once the conifers reach >60 percent canopy. The mast produced by these hardwoods is reduced or eliminated, causing a reduction in an important food source for deer and other game species. Specific areas where these changes have occurred are unknown, though they are suspected to occur throughout the watershed (USDA Forest Service 1998).

Fifty-one Rocky Mountain elk were introduced to the area in 1911 from Yellowstone National Park into the Squaw Creek drainage (south of the Lower McCloud watershed). Consequently, herds of over 80 animals now range over the eastern portion of the Whiskeytown Shasta-Trinity National Recreation Area (NRA) during all seasons, though they tend to extend into the higher elevations to the north and east of Shasta Lake.

Elk are known to occupy the watershed, with sightings in the southern and eastern portions of the watershed (CNDDB 2011). Little, though, is known about the habitat's capability for elk and the overall extent to which elk are using the watershed.

Black Bears

Black bears are common within the watershed during all seasons. They forage on a diversity of grasses, berries, forbs, browse, insects, and carrion. Road density and disturbance play a major role in habitat use and distribution of black bear. The fragmentation caused by the checkerboard ownership and relatively high level of roads, particularly on private lands, may create less favorable habitat conditions than some of the adjacent watersheds (i.e. Squaw Valley Creek to the west).

Within hardwood stands, herbaceous forage and acorn production are important to many wildlife species, especially game species such as squirrels, turkey, bear, elk and deer. Any reduction in herbaceous growth and in the acorn crop, then, would have negative impacts, especially if these habitat elements are a limiting factor to a species. It is known which species utilize these habitat elements, but it is not known if these elements are limiting to these same species within the watershed.

Aquatic and Riparian Dependent Species

Aquatic and Riparian-Dependent Species of Concern

Currently, there are no federally listed threatened or endangered fish species within the analysis area. However, prior to the construction of Shasta Dam, endangered Sacramento River winter-run Chinook salmon *(Oncorhynchus tshawytscha),* threatened Central Valley spring-run Chinook salmon (0. *tshawytscha)* and threatened Central Valley steelhead (*0. Mykiss*) occupied the lower McCloud River. The feasibility of re-introducing native salmon populations into the lower McCloud River is currently being examined; see Chapter 2, under *Items Not Addressed as Issues.*

Other aquatic species of concern include Forest Service Region 5 sensitive species and survey and manage mollusk species. Sensitive and Survey and Manage aquatic species known to occur or that may occur within the analysis area are listed in table 3-16.

Table 3-16. Aquatic species of concern in the analysis area

Common Name	Scientific Name	Type	Known Locations
R5 Regional Forester Sensitive Species			
Hardhead minnow	*Mylopharodon conocephalus*	fish	McCloud River and Shasta Lake
Nugget pebblesnail	*Fluminicola seminalis*	snail	McCloud River and its tributaries

Common Name	Scientific Name	Type	Known Locations
Survey and Manage Species			
Potem pebblesnail	*Fluminicola n*. sp 14	snail	Upper Shasta and Pit River Basin

Forest Service Sensitive Species

Hardhead - Hardhead minnows are typically found in relatively undisturbed low-elevation streams. They are omnivores that forage on drifting invertebrates and aquatic plant material, and on zooplankton in reservoirs. This species prefers moderate velocity water and are mostly observed in runs or pools in stream systems or associated with surface waters in reservoirs. Hardhead migrate to tributaries in April and May and spawn by broadcasting eggs over gravel riffles or runs. Hardhead usually occur with Sacramento pike minnow and Sacramento sucker. They are documented as present in Lake Shasta in small numbers (Moyle 2002).

Surveys for hardhead were completed in the Lower McCloud River in 2007 for the McCloud-Pit Project FERC relicensing. Both snorkeling and electrofishing methods were used at two locations: below Tuna Falls (river mile 6.0) and upstream of Shasta Lake (river mile 1.9). Hardhead were not found during these surveys although the availability of suitable habitat was identified (PG&E 2009).

Nugget Pebblesnail - The nugget pebblesnail prefers cool, clear, flowing water and gravel-cobble substrates. It is typically found in larger creeks and rivers, and prefers well-oxygenated streams and stable gravel-boulder substrates, but also occurs on soft, mud substrates in large springs (Frest and Johannes, 1999). Presently, this species occurs in the Pit and McCloud River basins, and is known from only two sites on the Shasta-Trinity NF (Furnish and Monthey 1998).

An aquatic mollusk study was completed in 2007 for the McCloud-Pit Project FERC relicensing. The lower McCloud River and vicinity streams, springs and seeps were included in the surveys. The study inventoried all mollusk species found and assessed suitable habitat for all mollusk species potentially occurring in the area. Nugget pebblesnails were found in the McCloud River at the confluence of Chatterdown Creek (PG&E 2008f).

Survey-and-manage Species

Potem Pebblesnail - The Potem pebblesnail is associated with cold-spring complexes in the Upper Shasta and Pit River systems and has been found on National Forest System lands during surveys (Furnish and Monthey 1998). It occurs in muddy to silty substrate in small cold springs and spring runs. Sites are often shaded (Frest and Johannes, 1999). This species is considered a spring snail, meaning it prefers small, perennial, coldwater spring habitats.

The potem pebblesnail has not been documented in the Lower McCloud watershed but is included here as potentially occurring in the area. Spring and seep habitats in the analysis area were surveyed for the presence of mollusk species in 2007 for the McCloud-Pit Project FERC relicensing along the proposed McCloud transmission line. No aquatic mollusk species of concern were found during this effort (PG&E 2008f). Further survey efforts would be required to determine the presence or absence of this species from other isolated spring habitats.

Other Non Special Status Aquatic Species

Fish Species

The Lower McCloud River is known as a premier trout stream with an abundance of large rainbow and brown trout occurring throughout the lower river. This river has the largest known adfluvial run of trout from Shasta Lake. The Department of Fish and Game once estimated that trout abundance was approximately 8,500 fish per river mile (Lower McCloud Watershed Analysis 1998; Rode, per comm.). In fish species surveys completed during 2007 to 2009 for the McCloud-Pit project FERC relicensing, trout comprised over 70% of the fish species composition above Tuna Falls, with rainbow trout numerically dominant (PG&E 2009c). The abundance of l)arge fish in this river is not only a function of the excellent habitat quality, but also due to the extremely limited take that is permitted from this area as much of the lower river is in private ownership. The native and introduced fish species most commonly found in analysis area streams are shown in table 3-17. Additional fish species that occur in Shasta Lake may also be periodically found in the lowest reach of the McCloud River as influenced by lake level and condition fluctuations.

Table 3-17. Non special status fish species in the analysis area

Common Name	Scientific Name
Native Species	
Rainbow Trout	*Oncorhynchus mykiss*
Sacramento Sucker	*Catostomus occidentalis*
Riffle Sculpin	*Cottus gulosus*
Sacramento Pikeminnow	*Ptychocheilus grandis*
Introduced Species	
Brown Trout	*Salmo trutta*
Brook Trout	*Salvelinus fontinalis*
Kokanee Salmon	*Oncorhynchus nerka*
Smallmouth Bass	*Micropterus dolomieu*

Aquatic Mollusk Species

Freshwater mollusks are an important component of the aquatic ecosystem and can be very beneficial in maintaining water quality and contributing to balanced food webs (Furnish 2007). A aquatic mollusk survey was completed in the lower McCloud watershed and vicinity for the McCloud-Pit Project FERC relicensing. Survey was limited to a few locations and was not spread out across the analysis watershed. Field data collection took place during the summer and fall of 2007 and all of the species observed were native to California. A total of eight species were identified in this limited survey of watershed, seven of these are not considered special status species. Those found are displayed in table 3-18. The remaining species, nugget pebblesnail, is a Region 5 Forest Service Sensitive species and is discussed previously.

Table 3-18. Non special status mollusk species identified in FERC 2106 relicensing surveys

Common Name	Scientific Name
Mussels and Clams (Bivalves)	
Western Pearlshell Mussel	*Margaritifera falcata*
Tiny Peaclam	*Pisidium insigne*
Striated Fingernail Clam	*Sphaerium striatinum*

Common Name	Scientific Name
Snails (Gastropods)	
Black Juga	*Juga nigrina*
Kneecap Lanx	*Lanx patelloides*
Button Sprite	*Menetus opercularis*
Tadpole physa	*Physella gyrina*

Fish-bearing Streams

The Lower McCloud River drainage has been designated as a focal watershed in the draft Forest aquatic habitats strategy. Within the watershed, there are approximately 106 miles of fish bearing streams. There are 16 named fish-bearing streams tributary to the McCloud River, these are shown in table 3-19. Trout species dominate these streams. The largest and most significant are Claiborne, Hawkins , and Chatterdown Creeks. Squaw Valley Creek, which is the largest tributary to the Lower McCloud River, falls outside of this analysis area. The other tributaries are of varying importance to fish with the smaller streams providing fish habitat only within the lower reaches. Some of the smaller streams, as well as the upper portions of the larger streams, become intermittent during low flow conditions and provide habitat on a seasonal basis (USDA 1998) other un-named perennial streams including smaller spring-fed streams and intermittent stream channels may provide habitat for aquatic species during parts of the year.

Table 3-19. Fish-bearing streams and miles of suitable habitat

Stream Name	Miles of Habitat
McCloud River	24.8
Hawkins Creek	16.4
Squirrel Creek	2.6
Ladybug Creek	3.8
Fitzhugh Creek	1.0
Bald Mountain Creek	1.6
Claiborne Creek	17.2
Hat Mountain Creek	2.2
Oak Creek	4.1
Chiquito Creek	1.8
Tuna Creek	3.2
Chatterdown Creek	17.8
Big Grey Creek	0.5
Little Bolliboka Creek	1.2
Big Bolliboka Creek	1.3
Whittawaket Creek	1.6
Natawaket Creek	4.8

The mainstem Lower McCloud River and its major tributaries are providing adequate habitat conditions for most aquatic and riparian associated species. Management of Riparian Reserves through the Aquatic Conservation Strategy is expected to provide for or minimize impacts to aquatic and riparian dependent species.

Aquatic and Riparian Habitats

Optimal aquatic and riparian habitats and standard thresholds adequate to assess their conditions are difficult to describe in terms of specific habitat parameters. One set of criteria cannot fit all streams nor all species. Aquatic habitat requirements vary from intermittent standing water with varied amounts of vegetation and vegetation type to permanent, cool water, with instream cover and surrounding dense riparian vegetation. One of the most difficult aspects is how to scale habitat parameters to the size of a stream and to the geologic morphology of its watershed. Pools in smaller streams tend to be shallower than pools in larger streams. Streams in a watershed having large areas of decomposed granitic soils generally have a higher percentage of fines in substrates than streams within watersheds composed mostly of competent bedrock.

Cool, clear, flowing water with high levels of dissolved oxygen, a variety of pool habitats, deposited gravel in pool tailouts, intact riparian areas with vegetative and topographic shade, and woody debris are important habitat parameters to maintain for healthy aquatic populations. The Lower McCloud River and some of the tributaries are examples of properly functioning stream systems where flows, stream substrates and the delivery of large wood are in dynamic equilibrium. This has resulted in the formation and maintenance of habitat features, such as deep pools and runs that are critical to the production of large and mature trout populations. The number of large trout in the river is indicative of a relatively healthy watershed and a stream system that is properly functioning. The smaller tributaries are also functioning well but are limited for fish habitat because of their small size and steeper gradients. These streams, though not as important for fish habitat, are critical to the maintenance of proper water quality and sediment delivery (USDA 1998). Maintaining or improving these habitat conditions in perennial streams within the analysis area would continue to provide high quality habitat, critical for maintaining populations of desired fish species. Localized cold spring complexes and spring-fed cold, clear waters with low amounts of fine sediments are critical for maintaining populations of other sensitive and survey and manage mollusk species.

The McCloud River and the lower reaches of its larger tributaries are classified as pool-riffle or plane-bed channels. Pool-riffle reaches are common within the McCloud River Canyon. These reaches are characterized by alternating reaches of boulder-strewn runs and deep pools (Rode, 1990). These channels along with step-pool channels harbor the majority of the fisheries found in the watershed. Due to the absence of baseline data it is difficult to determine if these channels have been impacted by management activities, however data collected during the 1995 Ecological Unit Inventory indicate that channels are generally stable and in good health and have not been significantly influenced by land-use activities occurring in the watershed.

Benthic macroinvertebrate sampling was conducted by PG&E in the Lower McCloud River during 2007 and 2008. These results were compared to similar macroinvertebrate data collected by the Nature Conservancy on the McCloud River Preserve from 1999 to 2008. While overall metrics values of the most recent sampling efforts were somewhat below both previous samples and reference samples, the metrics generally indicated good aquatic habitat conditions and good water quality conditions (PG&E 2009f).

Macroinvertebrate data was also collected and analyzed in Lady Bug and Bald Mountain Creeks in 1985, 1986 & 1988 (Mangum, 1985, 86, 88). Bald Mountain Creek is an undisturbed sub-basin while the Lady Bug Creek sub-basin underwent timber harvest and road building in 1986. Analysis of data indicates that macroinvertebrate diversity and the biotic condition in Lady Bug Creek did not deteriorate as a result of management activities during the three years of monitoring and that there was rapid recovery from any impacts (USDA 1998).

Although overall aquatic habitat conditions are properly functioning in the analysis area, the presence and function of McCloud Dam and Reservoir have unavoidable negative affects to aquatic habitat in the mainstem lower McCloud River. These include increased pulsed turbidity, a loss of large woody debris downstream of the dam and a loss of gravel recruitment downstream of the dam.

The clarity of water in the McCloud River fluctuates from excellent during most of the year to highly turbid for short periods of time during the wet season (due natural erosion and road runoff) and summer months (due to Mud Creek sediment mobilization). Mud Creek, a tributary to McCloud Reservoir receives large amounts of fine volcanic sediment from the Konwakiton glacier on Mount Shasta. This sediment is delivered directly into McCloud Reservoir in pulsed events and its movement through the system is further affected by McCloud reservoir operations, becoming re-suspended when reservoir levels are drawn down. The sediment plume is released into the lower McCloud River where turbidity levels become high enough to alter fish behavior and impair angling conditions. Typical turbidity spikes last four to eight days (FERC 2011).

McCloud Dam limits the available gravel in the lower McCloud River by trapping coarse sediment that would normally be delivered downstream. Coarse sediment reduction amounts decrease as distance from the dam increases, ranging from about a 94% reduction at the Hawkins Creek confluence to about a 78% reduction at the Squaw Valley Creek confluence. These amounts highlight the importance of coarse sediment inputs from major tributaries such as Hawkins Creek, Ladybug Creek, Claiborne Creek and Squaw Valley Creek to offset the lack of substrate inputs from the upper watershed. The reach with the highest potential to have degraded substrate and the highest reduction of mobile sediments is about three to five miles downstream of the dam. With no coarse sediments supplied from the upper watershed to replace mobilized substrate, optimal spawning habitat is reduced (FERC 2011).

The health of spawning gravels in the McCloud River was studied by Scott McBain in 1989 for the Nature Conservancy. McBain found that spawning gravels in the river contained high concentrations of dissolved oxygen. The high levels of dissolved oxygen showed that gravel deposits in the river had high permeabilities and that surface flows were mixing with the gravels. McBain concluded that the health of spawning gravels was excellent in the reaches of the river that were investigated during the duration of the study (McBain 1989).

In an effort to protect and maintain functioning aquatic habitats, manage existing erosion and minimize future erosion and sediment delivery to stream channels, PG&E has proposed to prepare an Erosion and Sediment Monitoring and Control Plan to determine and develop effective erosion control procedures during the term of their new McCloud-Pit Project license.

Similar to coarse sediments being trapped by McCloud Dam, large woody debris (LWD) is also blocked from moving downstream. Typically LWD is blocked by the dam structure and then removed from site to protect the dam facilities. The large stream width and high stream power of the lower McCloud River limits the role LWD can play in influencing channel morphology or sediment storage. However, large wood is essential to the creation and maintenance of fish habitat and provides habitat structure for all aquatic species. Large wood serves not only as cover, but acts as flow deflectors and can result in the formation of long-term deep water habitats. These habitats are important to maintaining the long term persistence of large fish populations. PG&E is proposing to complete a Large Woody Debris Management Plan, which would facilitate the placement of LWD downstream of the dam providing a more natural movement of large wood through the McCloud River system (FERC 2011).

Human Uses

Heritage Resources

There are 25 currently recorded archaeological sites on federal land within the Lower McCloud Watershed. Most of the area within the watershed has not been surveyed for archaeological resources, and the potential is very high for additional sites. Most of the known sites were documented in the 1970s and 1980s, and have not had their records updated since then. . All of the sites along the McCloud River located below the McCloud Dam to the confluence of Squaw Valley Creek have been recently revisited and their site records updated for the McCloud-Pit FERC project. Two new sites were recorded on federal land near the confluence with Claiborne Creek. The site records indicate that many of the sites have been affected by logging and recreation inside the watershed. Old logging activities, including skid roads, landings, and clear-cuts were cited as creating heavy disturbances in many sites. Forest service system roads, jeep trails, logging roads, and dirt two-tracks transect at least twelve of the sites, and trails bisect another five. Modern camping was also noted as a major disturbance on some of the site records (including the three recently updated sites, listed above). Looting of archaeological resources was noted on some records as the result of this access to sites. Although logging hasn't occurred inside the watershed recently, recreational use has undoubtedly continued to impact archaeological sites located within the boundary.

There are 18 prehistoric sites, two historic sites, and five multi-component sites (with both an historic and prehistoric component) located on federal land within the McCloud River Watershed. They are all located directly adjacent to rivers and streams, with the exception of two prehistoric sites located on ridge tops above water.

The prehistoric sites within the watershed provide evidence for hunting areas, short-term camps, and habitation/village sites. Most of the prehistoric habitation sites indicate late period prehistoric use within the last 1,500 years, however, one site dates to 7,000 years ago.

Some of the prehistoric use locations were also used historically as campsites. In addition to campsites, historic use of the watershed is evidenced by cabin and structure remains, trash dumps, a livestock corral, an early Forest Service campground along an old trail, and an historic fire lookout.

Recreation Resources

Methodology for analysis

Current human use in the watershed was assessed via reviewing photos (historic vs. current), CRMP documents, McCloud-Pit FERC relicensing technical memorandums (2008c, 2008d, 2008f), and the Shasta-Trinity LRMP (e.g. Visual Quality Objectives, Visual Resource Management standards, Recreation Opportunity Spectrum guidelines, and direction for Nosoni, McCloud River, Pit, Shasta NRA, and Slate-Delta management areas). GIS queries were also performed using all relevant layers from the Forest GIS Library (2010). Discussions with Forest personnel and other local experts were also critical to this assessment.

Discussion of Recreation Resources

The Lower McCloud River Watershed has varied recreation opportunities. Although recreational use is generally moderate compared to that of other watersheds in the area, there are several notable stakeholder groups actively involved with recreation issues: the partnerships created under the Coordinated Resource Management Plan (collectively referred to as “the McCloud CRMP Group”), the Mount Shasta Trail Association, the River Exchange, commercial outfitter guides, and private anglers. As stated previously, the CRMP focuses on coordinating management activities with principle landowners and public agencies in the McCloud River drainage area. The Mt. Shasta Trail Association partners with the Forest Service in designing, constructing, maintaining and using trails in the area. The River Exchange is a volunteer group which focuses on promoting healthy watersheds in the area.

Many of the recreational activities within the watershed center on the McCloud River. Known for its “unique and outstandingly remarkable features” (LRMP p. 4-121) the Lower McCloud River has been found eligible for Wild and Scenic River status. In lieu of officially recommending this designation; however, the Forest Service works with adjacent private landowners under the CRMP regarding the river corridor. A primary objective of the CRMP is to retain the characteristics of the river which made it eligible for wild and scenic river consideration (LRMP p. 2-6). Should the requirements of the CRMP not be fulfilled, the Forest Service could pursue recommendation for the Lower McCloud River for Wild and Scenic River status (USDA Forest Service 1994).

Ownership along and management of the Lower McCloud River are of key importance when discussing use of the river, particularly from a recreational standpoint. For further discussions on river use related to other resources see the Aquatic and Hydrology discussions within this document. Once the McCloud River leaves National Forest land below Ah-Di-Na, it flows for approximately 20 miles across mostly private land. Public land along this stretch of river is limited to only 1.5 miles of National Forest riverfront at four locations. There is also some public access however – with some restrictions – through the privately owned McCloud River Preserve. As noted previously, various landowners and stakeholders are active in recreational aspects of the Lower McCloud River.

River-based Recreation

Fishing

The Lower McCloud River is a popular spot for anglers’ pursuing large, wild trout (see Aquatic discussion). Fishing mainly centers around rainbow trout however brown trout fishing does occur during late fall. Protective angling regulations limit take to only 2 fish per day. Approximately 7.3 miles of the Lower McCloud River – from McCloud Reservoir to just south of the confluence with Bald Mountain Creek – is designated as a California Department of Fish and Game (DFG) Wild Trout Water. This designation means, among other things, that it is open to public angling, is able to support “wild trout populations of sufficient magnitude to provide satisfactory trout catches” and that the trout are of wild or semi-wild strains (CDFG 2011).

Anecdotal evidence indicates there are currently over 3000 fishing-related visits annually to the upper section alone of the McCloud River (Smith 2011 personal communication). Density of anglers, and frequencies of visits, varies both seasonally and geographically. Based on a study done by PG&E, the highest use occurs in May and June, and from mid-September to October, however many anglers fish the entire summer (PG&E 2008f). Use may also fluctuate based on flows (e.g. waders prefer lower-flows while boat-based angling can tolerate higher flows) which is affected by the precipitation as well as upstream dam releases.

Access trails to fishing locations are limited on public lands however many ‘informal trails’ have been documented within the watershed (PG&E 2008f). The McCloud River Preserve has a well-developed trail system and also a 10-angler limit to prevent overcrowding. Trespassing issues on private lands were noted as a concern in the past (USDA Forest Service 1998) however they are not currently seen as a major problem (Hesseldenz 2011 personal communication). An increase in demand for fishing opportunities, and related access (e.g. trails, shoreline access, and parking) is expected to occur throughout the next 40 years (PG&E 2008e). PG&E currently plans to upgrade some trails and campgrounds (see further discussion) which should improve public access opportunities for fishing.

Whitewater Boating

Whitewater boating on the Lower McCloud River consists of rafting and kayaking. Rafting is practical for only a couple weeks each spring during heavier releases from McCloud Reservoir. Kayaks can operate during lower flows and can negotiate the river at any time during the year. Class I -V rapids are present along the 24 mile stretch of river within the watershed and are used by non-commercial whitewater boaters only (PG&E 2008e). To date, all applications for commercial use permits to conduct rafting operations on the Lower McCloud River have been denied as the river has been found to be unsuitable or inappropriate for commercial rafting (USDA Forest Service 1998). Non-commercial whitewater boating has been identified by the CRMP as an appropriate recreational use of the Lower McCloud River if conducted in a “sensitive and proper manner”; however, the plan also stresses the need for further education of the boating public regarding resource, ownership and safety issues (USDA Forest Service 1998).

There are few camping spots along the stretch of river within the analysis boundary and boaters typically use it for day paddle only. Boaters putting in at the launch area below Ah-Di-Na Campground, quickly leave National Forest land and enter a 19 mile stretch of river through mostly private ownership. This 19 mile stretch crosses four corners of National Forest land totaling 1.7 miles. Three of these corners have minor river frontage of less than 1800 feet. One stretch of river continues for 11.6 miles entirely on private ownership (USDA Forest Service 1998). PG&E currently plans to upgrade some trails and campgrounds (see further discussion) which should improve public access opportunities for whitewater boating.

Trails and Campgrounds

Officially recognized as recreation facilities, but commonly thought of as part of the transportation system, there are approximately 62 miles of National Forest System Trails (NFST) within the watershed analysis boundary. These trails include: the Hat Mountain Trail (and spur), the McCloud-Claiborne Trail, the McCloud River Trail, the Pacific Crest Trail (PCT), and the Tuna Creek Trail. There is also a small spur trail, called the ‘Tank’ trail, which connects the McCloud River trail to a tributary of the river’s main stem.

Approximately 17 miles of the PCT bisects the northern portion of the watershed from east to west and it also includes a major bridge crossing over the McCloud River at Ash Camp. The PCT may be accessed within the watershed via FS roads 38N53 (Ah-Di-Nah Road), 38N11 (Hawkins Creek Road) or the 38N36 (Bald Mountain Road) and it is the most heavily-used trail within the watershed. The McCloud River Trail is approximately 19 miles in length, follows the west side of the river, and extends from Ladybug Creek to the southern terminus of the watershed boundary – just north of the McCloud Bridge Guard Station. This trail is administratively used only and is generally not accessible to the public. The McCloud-Claiborne Trail is approximately 14.5 miles and follows the east side of the river – across from the McCloud River Trail – although this trail has been roaded over for much of its length (Naser 2011 personal communication). The Hat Mountain, Tuna Creek, and Tank trails are unmaintained and difficult to locate. The majority of trail users are anglers, boaters, and backpackers, with some use by equestrian groups and hunters. See the Heritage Resources section and Map 13 - Recreation for further information regarding trails in the analysis area.

There are also many user-created or ‘informal’ trails within the watershed – mainly from campgrounds and other trails down to the McCloud River. There are currently plans in place to upgrade one of these trails (from the PCT bridge abutment across from Ash Camp down to Ah-Di-Nah) however other trails may also need to be looked at. Opportunities for new trails have been identified within the Unroaded Non-Motorized Recreation management prescription (see Map 18 - Management Areas and Prescriptions).

The CRMP outlines consensual agreements between public agencies and private landowners for development of access to trail systems, dispersed recreation and public facilities. Supplemental Management Direction of Management Area 10 highlights the need to develop trail access to and along the McCloud, as well as to emphasize the dispersed recreational use of the Pacific Crest Trail systems (LRMP p. 4-123).

There are two developed NFS campgrounds within the watershed boundary: Ah-Di-Nah and Ash Camp, both accessible from Forest Road 11 (see Map 13 - Recreation). The Ah-Di-Nah campground is also accessible from Forest Road 38N53 which is described as a very rough, rocky, narrow road (PG&E 2008e). This campground receives moderate use, primarily from anglers, and contains approximately 18 campsites, water and restroom facilities managed and maintained to minimum standards . The Ash Camp campground has no defined campsites or much in the way of amenities and therefore receives light use. Both sites have user-created or ‘informal’ paths down to the McCloud River and Ash Camp also has informal paths down to Hawkins Creek as well as Pacific Crest Trail access.

There are also three dispersed campsites near Ah-Di-Nah and two dispersed camp sites near Ash Camp. The sites near Ah-Di-Nah are as follows: one near the entrance to Ah-Di-Na Campground near Forest Road 38N53, and two on the Lower McCloud River off Forest Road 38N53 near The Nature Conservancy’s McCloud River Preserve. The sites near Ash Camp include one on Hawkins Creek at Hawkins Creek Tunnel that is accessible via the PG&E Project road and one on the PG&E spoil pile area on Hawkins Creek that is just north of Hawkins Creek Tunnel (PG&E 2008e).

The settlement agreement (2010) between PG&E and the USFS in relation to the FERC relicensing process include the redesign, reconstruction, and development of the Ash Camp and Ah-Di-Nah campgrounds (e.g. picnic tables, fire rings, toilets, parking spaces). Additionally, trails and associated signs will be developed that lead from the campgrounds to the Lower McCloud River trailhead and that accommodate fishing and car-top boating access.

Recreation Opportunity Spectrum (ROS)

The recreation opportunity spectrum (ROS) is a system that inventories National Forest lands for a variety of existing and potential recreation opportunities based on the size, distance from roads, and degree of development of a given area (LRMP p. 3-15). Supply (i.e. the quantity of recreation facilities or settings available for visitor use) is assessed along with demand for various types of recreation. The three recreation settings, or classes, pertinent to the Lower McCloud River Watershed are: Semi-primitive non-motorized (SPNM), Semi-primitive motorized (SPM), and Roaded Natural (RN) (table 3-20 and Map 13-Recreation). Semi-primitive settings include wild and scenic rivers, large lakes, and backcountry areas. Some of these areas are managed for motorized travel (e.g. boat or off-highway vehicle). Other areas are managed for non-motorized travel (e.g. foot, horseback, mountain bike, raft, and kayak). Roaded natural areas allow for motorized use but practices are supposed to 'harmonize with the natural environment' (USDA Forest Service 1994). For complete definitions of ROS classes refer to the Project File.

Table 3-20. Summary of recreation opportunity spectrum classes in the analysis area

ROS Code	Recreation Opportunity Spectrum (ROS) Name	Acres	Percent of Designated Area	Percent of Watershed Analysis Area
RN	Roaded Natural	18,137	34%	27%
SPM	Semi-Primitive Motorized	33,780	63%	50%
SPNM	Semi-Primitive Non-Motorized	13,236	3%	2%
Total		53,243	100%	79%

Unroaded Non-Motorized Recreation

As discussed in Chapter 1 (Land Allocations and Management Direction discussion) the Shasta-Trinity LRMP describes various management prescriptions developed through Forest planning process. Of the various prescriptions directly relating to recreation, only the Unroaded Non-Motorized Recreation (Prescription 1) occurs within the watershed analysis boundary. Prescription 1is described as follows:

"The purpose of this prescription is to provide for semi-primitive non-motorized recreation opportunities in unroaded areas outside existing Wilderness while maintaining predominantly natural-appearing areas with only subtle modifications. Also emphasized in this prescription is retention of old-growth vegetation and management of wildlife species requiring late seral stage conditions" (LRMP p. 4-45).

Approximately 6,814 acres, or 10 percent of the watershed, is allocated for unroaded non-motorized recreation. This area occurs in the southwestern portion of the watershed (see Map 13 - Recreation). During the original 1998 analysis, two areas were identified where Prescription I boundaries could be moved to the edge of the viewshed:

- The boundary along east side of McCloud River south of Claiborne Creek could be moved upslope to the ridgetop.
- The boundary through Nawtawaket Creek drainage could be moved south to the ridgetop.

See chapters 5 and 6 Land Allocation Adjustment discussions for further information.

Transportation System and OHV Routes

The Lower McCloud River Watershed contains approximately 227 miles of road; 139 miles of which occur on Forest Service lands. Road densities in the watershed are relatively low; 1.6 and 3.2 miles of road per square mile for federal and private lands respectively. Roads in the watershed were mainly constructed in support of timber sale activities, dam and pipeline construction, as well as power line construction and maintenance. New road construction may occur in conjunction with timber harvest activities on private lands within the watershed however information on this is limited.

Data on operational maintenance were taken from the Shasta-Trinity NF GIS library.

Table 3-21. Roads in the analysis area by jurisdiction and operational maintenance level

Jurisdiction	1 – Basic Custodial Care (Closed)	2 – High Clearance Vehicles	3 – Suitable for Passenger Cars	4 – Moderate Degree of User Comfort	None - Private	Total
FS – Forest Service	17.28	113.01	7.69	0.65	0.00	138.63
P – Private	0.88	38.10	0.00	0.00	49.00	87.98
Total	18.16	151.11	7.69	0.65	49.00	226.63

Only five percent of the mileage of NFS roads is suitable for passenger car travel. The vast majority of road miles (see table 3-21) are labeled for high clearance vehicles. One of the most popular jeep trails within the watershed runs from Skunk Hill near McCloud Reservoir the top of Bald Mountain. This trail runs along the ridge of the adjacent Squaw Valley Creek watershed for 8.5 miles and accessible mostly by OHV or four wheel drive vehicles, but the road is now gated at Skunk Hill. Unauthorized OHV use occurs often – primarily on Level 1 (closed) roads – but is limited in due to some of the steep terrain in the watershed (Bonivert 2011 personal communication). Recently, prohibition of motorized travel of unauthorized routes and cross-country travel has been established by Federal Regulation under the Forest's Motorized Travel Management (MTM) Record of Decision (USDA Forest Service 2010).

The heaviest use of the road system occurs in the spring, summer, and fall when public and commercial use is at its peak. The Hawkins Creek Road (FA-11) is a tie-through route between Big Bend and McCloud but is usually closed in winter due to snow. Lower elevation roads in the south end of the watershed, such as the Curl Ridge Road (35N18) and the Fender Ferry Road (34N17), are essentially open year-round. Roads in this watershed access a variety of seasonal recreational uses including hunting, fishing, dispersed camping, and off-highway vehicle use.

Several private inholdings have restricted road access across National Forest system lands but are not open to public vehicle traffic. Right-of-way agreements between private landowners and the Forest Service exist for select roads within the watershed. The checkerboard ownership pattern and co-op cost share agreements tend to limit road management options. Some physical road closure methods have been used in the past and results have been mixed. The remote nature of the area has also resulted in low maintenance of gates and barricades and an increased risk of vandalism. Additionally, the road system also includes several low standard "flatcar" bridges. Examples include crossings over Caliborne and Chatterdown Creek. While these bridges provide haul and tie-through routes on private timberland, they are not up to standard for Forest Service use and cost share agreements do not include these structures.

Caves

Several limestone caves are known to exist in the watershed; however, they are still relatively unknown by the public and use is fairly low. Information regarding caves within the watershed, especially within the checkerboard ownership (public and private) portion, is limited. This is due to the area's remoteness and limited access, inhibiting exploration of the landscape for caves (J. Wolfe, President, Shasta Area Grotto; personal communication 1997). Where access has allowed exploration, three caves have been identified as having significance to wildlife, archaeology or caving groups. These locations can be found within the watershed project file as they are sensitive data. Although human use of the caves is minimal, damage or vandalism to this resource is of concern. See the Physical Sciences section for a more detailed discussion of cave resources.

Mining Resources

There are no active mining claims within the watershed. Mineral records indicate a number of prospects are located within the watershed however only two mines of are note within the watershed boundary. The Keane site – just upstream from Pine Flat on the former Bollibokka Club - was an inactive copper mine that was developed in the 1920's. The other site is a small mine just upstream from the mouth of Squaw Valley Creek on McCloud River Club property (Hesseldenz 2011 personal communication).

Visual Resources and Scenery

The LRMP, the National Forest Management Act (NFMA), and the Travel Management Rule all contain management direction for visual resources and scenery. The LRMP sets visual quality objectives (VQOs) which establish minimum acceptable thresholds for landscape alterations from an otherwise natural-appearing forest landscape. Roads and trails create linear alterations in landscapes that can be mitigated through sound design. Roads may present uncharacteristic line qualities in forest landscapes if left unmitigated. Landscapes with a dense canopy cover and/or sloping terrain have the capability of masking these linear alterations; sparsely covered landscapes have less capability.

Scenic values are moderate to high in the watershed. Trails and roads within the watershed are not easily viewed from a distance due to copious vegetation cover as well as steep hillsides. The natural integrity of the area, thus, is relatively uninterrupted by roads and visual impairments, allowing for a more scenic setting. The old-growth vegetation, the stream corridors, and the associated plant and wildlife species all contribute to this watershed's high visual quality.

The visual character of the Nosoni Management Area, however, was noted in the LMP to be affected by management practices on the National Forest but also by the presence of checkerboard pattern of private lands interspersed through this area. Generally the private lands are more intensively managed (LRMP pg. 4-129). Patch clearcuts on public and private lands within and outside the analysis area have altered background visual resources, as viewed from within the analysis area. The most noticeable clearcuts that may be visible from within the analysis area are located in Ladybug Creek, Claiborne Creek, and Chatterdown Creek drainages on the southeast side of the McCloud River (Hesseldenz 2011 personal communication).

Habitat Quality and Human Uses

As noted in the Biological Features discussions, human uses such as recreation, mining, road-building or maintenance, timber harvest, or hydroelectric projects may have an effect on the quality of species' habitat within the watershed. Several of these aforementioned activities have created areas (open canopy, bare soil substrates, etc.) where noxious weeds occur. Additionally, road building is directly associated with erosion and may decrease aquatic or riparian habitat quality. See individual resource discussions for further information.

Late-Successional Reserve and Human Uses

Dispersed recreational uses, which are emphasized for the Lower McCloud River Watershed, are considered generally consistent with the objectives of Late-Successional Reserves (USDA Forest

Service and USDI Bureau of Land Management 2001). For specific information regarding the Iron Canyon LSR see Chapter 1.

Fire Effects on Human Uses

As mentioned in the Fire and Fuels discussion, fire effects to several resources may impact the recreation experience and other human uses in the analysis area. Such impacts include, but are not limited to, a degradation of visual quality near large areas of burned landscape, restrictions on motorized and non-motorized recreation (e.g. trail or road closures), poor air quality during wildfire events, as well as degradation of water quality and related effects to fishing, rafting, etc

Chapter 4: Reference Conditions

The purpose of this chapter is to explain how ecological conditions have changed over time as a result of human influence and natural disturbances. A reference is developed for later comparison with the current conditions over the period that the system evolved and with key management objectives.

This chapter begins with a historic overview which summarizes the natural processes and land-use activities in the watershed. The remainder of the chapter follows the six core topics that have been presented previously.

The major headings in this chapter are:

- Historical Overview
- Physical Features
- Biological Features
- Human Uses
- Pre-1900: During this period, significant Anglo-American influences were absent. Although native peoples used and managed the area, the ecosystem was functioning under essentially natural conditions during this time.
- 1900-1945: During this period, human influences began to affect natural processes in the watershed. The area began to experience increased effects from settlement, mining, wildfire suppression, timber harvest, and road construction activities. Water from the Upper McCloud River began to be diverted to the lumber mill in the town of McCloud, with the overflow water adding to the base flow of Lower McCloud.
- 1945-present: This period began with the completion of Shasta Dam and the subsequent creation of Shasta Lake in 1945, thereby blocking prolific historic anadromous fish runs up the McCloud River and Lower McCloud. Major human influence on watershed ecosystem processes has been documented during this time period.

Historical Overview

Land-Use Activities

Heritage Resources

Native Americans have traditionally occupied the Lower McCloud Watershed. Ethnographies and place name data indicate that the Winnemem Wintu Tribe were the primary early inhabitants of the watershed. However place names indicate that people from the Pit River Tribe had knowledge and used the McCloud River near its upper stretches such as Hawkins Creek, and Star City Creek. Currently there are no tribal lands within the watershed area. However the Pit River and Winnemem Wintu Tribes retain a strong interest in the area and wish to be consulted prior to any projects that may impact known cultural resources.

The physical presence of Native Americans in the watershed is demonstrated by the concentration of prehistoric sites located on the terraces along the river and along the major ridges. Not only have sites been recorded on federal lands, but a number of sites have been recorded on land owned by the Nature Conservancy, McCloud River Club, and Bollibokka Club. Two archaeological sites, have been evaluated and determined eligible for the National Register of Historic Places. One site with both prehistoric and historic resources has also been developed as an interpretive area for the visiting public.

Mining

Mining activity in the watershed has been minor. Gold mining was reported in the Hawkins Creek drainage in the 1850's. A copper mine – the Keane site – was located southwest of Hat Mountain near Pine Flat from 1896-1919, and another copper mine was located near the mouth of Squaw Valley Creek.

Recreation

Recreation use of the watershed centers on use of the McCloud River. Significant dates include:

- 1896 – Central Pacific Railroad is granted odd-numbered sections along the river under the Pacific Railroad Acts of 1862 and 1864.
- 1896 – Ah-Di-Na is purchased from the Central Pacific Railroad by William R. Whittier and developed into a private sport-fishing and hunting resort.
- 1900 – McCloud River Club land is purchased from Central Pacific Railroad.
- 1921 – Bolliboka Club land is purchased from previous owners.
- 1958 – Lands at Ah-Di-Na are purchased by the Hearst Corporation.
- 1965 – Creation of McCloud Reservoir provides a recreational attraction in the area.
- 1965 – Forest Service acquires lands at Ah-Di-Na from the Hearst Corporation and establishes a public campground and fishing access.
- 1974 – McCloud River Club donates 2330 acres of their land to the Nature Conservancy which forms the McCloud River Preserve.
- 1975 – Construction of the Pacific Crest Trail begins.

Federal Timber Harvest

Although some logging occurred on private land as early as 1958, timber harvest activities on National Forest land did not start until 1966. The first timber sales removed overstory trees in the Mica Gulch and Hawkins Creek areas. Regeneration harvest began in 1976 with the Hornet Sale. Timber sale history on National Forest land is summarized in table 4.1.

Table 4-1. Historic harvest volumes and timber sales within the analysis boundary

Sale Name	Volume (mmbf)	Sold	Closed
Mica Gulch	15.4	1966	1969
Hawkins	24.5	1972	1976
Hornet	4.3	1976	1981
Mica II	3.3	1978	1986
Deer-Mica	15.0	1984	1986
Ah Di Na	1.7	1984	1986
Horse Ridge	8.0	1986	1989
Beetle Dee	16.6	1986	1992
Hawkins II	9.6	1987	1990
Satin Peak	4.6	1987	1989
Dee Fire Salvage	1.1	1990	1992
Total	104.1		

The Forest Service Activity Tracing System (FACTS) database shows harvest and required site preparation and reforestation treatments as summarized in table 4-2. The only harvest treatment listed is clear cutting, except for 2 acres that received an overstory removal treatment in 1989. All of the timber harvest activity on federal lands was prior to the Northwest Forest Plan implementation and dramatically subsided after 1991. Harvesting, particularly clear cutting, continues today on private lands, specifically on ownerships that are private timber companies.

Table 4-2. Summary of harvest activities within the analysis boundary

Year	Acres
1974	15
1975	38
1980	61
1983	35
1985	349
1986	82
1987	57
1988	87
1989	557
1990	774
1991	47
TOTAL (1974 – 1991)	**2,102**

Road Construction

Access in the Lower McCloud River Watershed was fairly limited prior to 1966. Access into the area increased rapidly in the late 1960's with the development of road systems for timber sales. Significant events in the development of the transportation system in the watershed are as follows:

- 1902 - trail from Salt Creek
- 1914 - first wagon roads in place.
- 1916 - forest map shows trails on Curl Ridge, Claiborne Creek, Hawkins Creek and along the McCloud River
- 1916 - Forest map shows an auto road to the McCloud River Club via Lower McCloud.
- 1930's - CCCs construct Fender Ferry Road accessing south end of watershed.
- 1950's - road constructed to private land near Ah Di Na
- 1960's - Hawkins Creek Road constructed
- 1978 - Rare II temporarily stops development of unroaded areas on USFS
- 1980's - period of accelerated road building in support of timber harvest activities on both National Forest and private land.
- 1996 - latest road construction accesses private land in the Hat Mountain/North Fork Chatterdown Creek area.

Reservoirs/Diversion

- 1945 - construction of Shasta Dam is completed
- passage of anadromous fish is blocked
- wildlife migration is affected
- 1965 - construction of dam at McCloud Reservoir is completed
- water is diverted to Iron Canyon Reservoir.
- base flows and peak flows on the Lower McCloud River are affected.

Grazing

The extent of grazing in the watershed prior to 1900 is uncertain. As valley lands became more settled, grazing of sheep and cattle moved into the foothill and mountain areas. Controlled grazing began in 1905 with establishment of the National Forest. Records for the period 1917-21 show three grazing allotments in the area. Grazing in the watershed ended by 1950.

Mining

Mining activity in the watershed has been minor. Gold mining was reported in the Hawkins Creek drainage in the 1850's. A copper mine was located southwest of Hat Mountain from 1896-1919.

Recreation

Recreation use of the watershed centers on the private clubs along the McCloud River. Significant dates are:

- 1896 - Central Pacific Railroad is granted odd-numbered sections along the river under the Pacific Railroad Acts of 1862 and 1864.

- 1896 - Ah-Di-Na is purchased from the Central Pacific Railroad by William R. Whittier and developed into a private sport-fishing and hunting resort.
- 1900 - McCloud River Club land is purchased from Central Pacific Railroad.
- 1921 - Bolliboka Club land is purchased from previous owners.
- 1958 - lands at Ah-Di-Na are purchased by the Hearst Corporation.
- 1965 - creation of McCloud Reservoir provides a recreational attraction in the area.
- 1965 - the Forest Service acquires lands at Ah-Di-Na from the Hearst Corporation and establishes a public campground and fishing access.
- 1974 - the McCloud River Club donates 2330 acres of their land to the Nature Conservancy which forms the McCloud River Preserve.
- 1975 - the Pacific Crest Trail is constructed.

Natural Processes

Eruptions/Mudflows

Mount Shasta has erupted 13 times in the last 10,000 years. Repeated eruptions and mudflows affect water quality and channel morphology. The last major mudflow occurred on Mud Creek in 1924. Sediment from this mudflow entered the McCloud River and was observed entering San Francisco Bay.

Peak Flows

Peak flows greater than 20,000 cfs occur on the Lower McCloud River at approximately 10 year intervals. In 2004, the maximum flow was recorded at 19,800 cfs. Flood events have been recorded in 1955, 1964, 1971, 1974, and 1997.

Erosion Processes

Mass wasting processes continue to erode the Klamath Mountains. Mass wasting features predominate the Lower McCloud River Watershed .

Climate

Climate in the area is characterized by alternating colder/wetter periods and warmer/dryer periods. Climate fluctuations affect watershed erosion processes, peak flows, and fire regimes.

Klamath Mountain Uplift

The Klamath Mountains continue to be uplifted. This uplift process is continually being offset by the erosion process.

Physical Features

Geology, Geomorphology, and Erosion Processes

Geology, Geomorphology, and Erosion Processes

<u>Pre-1900</u>

The Lower McCloud River Watershed has been formed by natural processes occurring over time scales of hundreds of thousands or millions of years. The most recent period of mountain uplift began in the early to mid-Pleistocene, approximately 1.7-1.5 million years before present (BP)., and continues today. During the past 150 years land-use activities occurring within the watershed have influenced the rates, frequency, magnitudes and areas of occurrence of natural processes. The interactions between natural processes and land-use activities are complex. Some land-use activities, such as road building and fire suppression, have significantly altered natural processes throughout the entire watershed while others have had little to no effect. Very little information is available concerning reference conditions for natural processes prior to European settlement. In order to understand how land-use activities affected natural processes it is necessary to identify the dominant natural processes that occurred in the watershed prior to European settlement and then determine the effects of land-use activities on each natural process.

The current topography of the Lower McCloud River Watershed has been created almost exclusively by a combination of tectonic uplift, mass wasting and fluvial and surface erosion processes. The influence of these processes has been continuous from the beginning of the Klamath Mountain uplift. The extensive role that mass wasting has played in forming the present day watershed is evident from the Geomorphic Features Map (Map 24). Mass wasting features occur over most of the watershed area. Common mass wasting features that are widespread throughout the watershed include debris slides and multiple rotational/translational landslides. Map 17 displays the current mass wasting features found in the watershed. The distribution of mass wasting features across the watershed has not changed appreciably as a result of land-use activities. Therefore, this map is believed to reflect the approximate distribution of mass wasting features found in the watershed prior to European Settlement as well as current conditions.

The Klamath Mountains are still being uplifted; however, the rate of uplift has been offset by the continuing effects of erosion processes. Erosion rates in the watershed have varied considerably over time in response to long term changes in climatic patterns. The last major period of erosional activity occurred during the Pleistocene Epoch, 100,000 to 2 million years BP. The climate during this period was wetter than it is today. Most of the slides depicted on the Geomorphic Features Map (Map 24) occurred during this epoch. Many of these slides were several million cubic yards in size and significantly altered the topography of the Lower McCloud Watershed during the Pleistocene.

During the Holocene Epoch (100,000 years BP), the climate has generally been drier than the Pleistocene. The decrease in landslide size during this epoch appears to reflect dryer conditions in the Lower McCloud Watershed. Landslides occurring during this period have been much smaller (~100,000 cubic yards) than those that occurred during the Pleistocene. The smaller slides may indicate a trend of decreasing mass wasting activity from the end of the Pleistocene to present.

In the past 200 years, mass wasting activity is believed to have been greatest following large unplanned wildland fires such as those that occurred in the late 1800s. Aerial photography from 1944 and historical information taken from regional newspapers in the early 1900s indicate that wildfires played a significant role in controlling vegetation patterns. The 1944 aerial photography indicates that much of the Lower McCloud River Watershed was covered in early seral vegetation as a result of frequent wildfires, some of which burned through the entire southern portion of the watershed on the late 1800s (see Vegetation section later in this chapter for more information). These large fires probably aggravated mass wasting processes during the following winters by removing vegetation and destroying root systems on burned hillslopes.

1900-1945

Between 1900 and 1945 land-use activities introduced by European settlers began to influence natural erosion processes in watershed. The earliest activities to occur in the watershed included fur trapping, mining and trail construction (see Historic Overview section for more information). These activities probably affected erosion processes; however, the extent and duration of these activities was so limited that their relative influence on the watershed during this time period is believed to have been insignificant.

Grazing activity occurring in the Chatterdown and Claiborne Creek sub-watersheds may have affected erosion processes. Direct impacts from cattle and sheep have not been documented; however, grazing activities occurring during the early 1900s probably affected erosion processes in areas where frequent burning occurred. Historical records indicate that many of the fires that occurred in the watershed were grazing related (Cranfield, 1984). Some of these fires were accidental while others probably occurred during efforts to improve forage. The influence of grazing activities on erosion processes ended with the exclusion of cattle and sheep from the watershed following the completion of Shasta Dam in 1945. No impacts from grazing are evident in the watershed today.

1945-present

Over the past 100 years fire suppression activities have decreased the size and frequency of fires in the watershed. Fire suppression occurring in watershed in the early 1900s was relatively ineffective due to access difficulties associated with the remoteness of the watershed. The employment of aircraft in 1945 greatly increased the effectiveness of fire suppression efforts. The reduction in fires has in turn reduced the amount of ground disturbed by wildfires. Effective fire suppression is believed to have reduced erosion and the size of landslides by reducing the amount of ground disturbed by wildfire. More research and monitoring effort are needed to determine if the relationship between fire suppression and decreased incidence of mass wasting activity is valid.

Road construction and timber harvest activities are not believed to have influenced erosion processes in the watershed until the mid-1960s. From approximately 1965 to present, timber harvest and road construction activities have affected erosion processes east of the McCloud River. Actual mass wasting activity occurring as a result of timber harvest practices has been documented in the Deer Creek area of the Hawkins Creek sub-basin. Due to the lack of intensive surveys it is not known how many slides have occurred as a direct result of harvest activities. Surface erosion from poorly constructed roads, non-maintained roads and disturbed hillslopes has increased over the past 30 years. The lack of an observed increase in mass wasting activity may be partly due to the relatively brief period in which road construction and timber harvest activities have occurred in the watershed.

Table 4-3. Impacts of land-use activities on erosion processes

Land-Use Activity	Impacts to Erosion Processes	Affected Area
Fire Suppression	Reduced erosion and frequency and size of landslides by reducing the amount of land disturbed by wildfire	Entire watershed
Timber Harvest	Some incidences of increased mass wasting activity ih Hawkins Creek area, possible impacts to other areas.	Hawkins, Claiborne and Chatterdown Creek sub-watersheds
Road Construction	Increased surface erosion in heavily roaded areas	Hawkins, Claiborne, Chatterdown sub-watersheds and areas west of McCloud River above Ah-Di-Na
Reservoirs/Diversions	No impacts to hillslopes	None
Grazing	Impacts associated with burning of allotments to maintain range forage. Impacts to riparian areas that were heavily grazed (extent of impacts unknown)	Claiborne and Chatterdown Creek sub-watersheds
Mining	Minimal to no effect	Mining activity minimal in watershed. Small areas in vicinity of Hat Mountain were affected
Recreation	No impacts	None

Hydrology

Pre-1900

Natural processes that controlled peak and base flows in the Lower McCloud River Watershed prior to European settlement have not changed from reference to current conditions. Peak and base flows within the watershed were controlled by the prevailing climate, or more specifically variations in annual precipitation. Variations in the amounts and distribution of vegetation within the watershed also affected peak and base flows. Wetter periods brought increased rainfall which reduced wildfire activity and stimulated vegetative growth. Increases in evapotranspiration probably partially offset increases in base flows during these wetter periods. Conversely, dryer periods resulted in lower flows that were offset by decreased evapotranspiration following unplanned wildland fires.

Changes in precipitation and evapotranspiration affected peak and base flows in tributary streams to the McCloud River but had a lesser effect on base flows in the river itself. Base flows to the McCloud River were largely regulated by groundwater inputs from Big Springs above the present day location of McCloud Reservoir. In his McCloud River Investigation conducted in 1938, Wales noted that discharge into the McCloud River from Big Springs was approximately 450 cfsor approximately half of the minimum flow recorded at the town of Baird (now beneath Shasta Lake) (Wales 1938). Measurements made by the U.S. Geological Survey in August 1981 indicate that the discharge from Big Springs was 615 cfs, much larger than that estimated by Wales (Poeschel, et al. 1986). This constant supply of cold, clean water kept base flows high in the McCloud River during dryer periods prior to the creation of McCloud Reservoir.

The effects of groundwater flows from Big Springs on the McCloud River is best summarized by Mike Rode. The following paragraph is from Rode's 1990 report on the status of the Bull Trout in the McCloud River.

"About 56 km (35 mi.) above Shasta Lake is Lower Falls which, prior to the construction of Shasta Dam, was a barrier to the upstream migration of anadromous fish. About 2.1 and 2.9 km (1.3 and 1.8 mi.), respectively, below Lower Falls, Muir (Little) and Big Springs increase the summer flow of the McCloud River from roughly 1 m^3/s (40 cfs) to about 23 m^3/s (800 cfs). About 0.8 km (0.5 mi.) above Wyntoon, a third spring source further augments river flows. This spring water inflow transforms the McCloud into a large, very clear, cold river with summer temperatures seldom exceeding 7.8 degrees Celsius (46 degrees Fahrenheit) until the river reaches McCloud Reservoir." (Rode 1990)

<u>1900-1945</u>

Between 1900 and 1945 peak and base flows within the Lower McCloud River Watershed were not affected significantly by land-use activities. The scope of logging, road construction and mining activities was very limited and fire suppression activities were still only partially effective at controlling wildfires. Controlled burns undertaken by grazing permittees to enhance range forage may have affected water flows. Peak and base flows in the Chatterdown and Claiborne Creek sub-watersheds may have increased for short periods of time following fires set by the grazing permittees.

1945-present

Hydrologic conditions in the McCloud River Drainage were dramatically altered following the completion of Shasta Dam. Shasta Dam was the cornerstone of the Central Valley Project designed to provide irrigation water to farms, conserve winter runoff, maintain navigation on the Sacramento River and to reduce the threat of flooding in the Central Valley (Cranfield,1984). Approximately 13 miles of the McCloud River below the Lower McCloud River Watershed was inundated during the creation of Shasta Lake.

Hydrologic conditions in the Lower McCloud River Watershed did not change significantly until the McCloud Dam was completed in 1965. The McCloud Dam was one component of the McCloud-Pit Project which was implemented for the purpose of hydroelectric power generation. Phase I of the project resulted in the creation of McCloud Reservoir and Iron Canyon Reservoirs and the construction of two large diversion tunnels (McCloud Reservoir to Iron Canyon and Iron Canyon to Pit 5 Power House). Monthly base flows in the McCloud River below McCloud Reservoir decreased by approximately 1000 cfs as a result of the diversion project (Fig. 2). Phase II of the project was never completed but would have drastically altered hydrologic conditions in the remainder of the McCloud River between McCloud Reservoir and Shasta Lake. While the Pit River Hydroelectric Project decreased base flows in the McCloud River it should be noted that none of the other tributaries to the McCloud River were affected by the project.

Table 4-4. Impacts of land-use activities on hydrologic processes

Land-Use Activity	Impacts to Hydrologic Processes	Affected Area
Fire Supression	Affects runoff and water yield due to increased vegetative cover and increased evapotranspiration. Undetermined effect on peak and base flows (both should decrease).	Entire watershed
Timber Harvest	Increases runoff due to influence over vegetation and evapotranspiration.	Hawkins, Claiborne and Chatterdown Creek sub-watersheds
Road Construction	Increased peak flows during winter rains when road system intercepts groundwater flow. Affects timing of flood peaks by altering the pathways and rates of water movement through the channel network.	Hawkins, Claiborne, Chatterdown sub-watersheds and areas west of McCloud River above Ah-Di-Na.
Reservoirs/Diversions	Large decrease in base flows to the Mccloud River from McCloud Reservoir	McCloud River from McCloud Reservoir to Shasta Lake
Grazing	Possible increases in base and peak flows following buning to enhance range forage.	Claiborne and Chatterdown Creek sub-watersehds
Mining	No impacts	None
Recreation	No impacts	None

Beginning in 1945 the effectiveness in fire suppression increased and the natural fire regime in the watershed was altered. No data on the impacts of increased vegetation cover on evapotranspiration and water yield is available during this period; however, it is likely that water yield decreased as a result of increased evapotranspiration throughout the watershed. These decreases were probably offset in some areas by timber harvest activities which were observed to increase water yield in disturbed drainages (see Ch. 3).

Beginning in the mid-1960s timber harvest and road construction began to influence hydrologic processes in the watershed east of the McCloud River by increasing water yields from disturbed drainages. Increases in water yield were limited mainly to Hawkins, Claiborne and Chatterdown Creek sub-watersheds. The cause and effect relationship between timber harvest and water yield was verified in the Nature Conservancy Water Quality Study (see Ch. 3). Increases in water yield in Bones Gulch and Ladybug Creek were limited to the first year following timber harvest and wildfire disturbance. Increases in water yield from timber harvest activities were probably partially offset by increased evapotranspiration in areas where wildfire activity was suppressed.

Stream Channel Morphologies

Pre-1900

Channel morphologies in the Lower McCloud River have been formed primarily by fluvial erosion processes and mass wasting activity. Prior to European settlement channel morphologies were controlled by peak flows and hillslope erosion processes. Frequent fires and mass wasting activity affected channel development and influenced channel stability. Swales, colluvial, bedrock and cascade channels located in upland areas that were burned frequently probably exhibited unstable characteristics as a result of the high sediment inputs and the lack of large woody debris needed for channel stabilization. These upland channel types probably hosted aquatic and terrestrial plant and wildlife species adapted to frequently burned, early seral habitats rather than those adapted to the forested riparian areas found throughout the watershed today.

The channel morphologies of step-pool and pool-riffle channels like Hawkins, Claiborne and Chatterdown Creeks were probably similar to those found in the watershed today. Because impacts from burning appear to have affected midslopes and ridgetops more than inner gorge areas it is believed that the larger channel types such as step-pool and pool-riffle channels probably were not impacted appreciably by wildfires or mass wasting activity. Gravel and fine sediment probably accumulated in step-pool and pool-riffle channels following large wildfires and floods, however the sediment deposited during these events was probably flushed from the channel network during smaller bankfull flows occurring over the following years. Large woody debris probably played a significant role in controlling the morphologies of smaller step-pool channels; however, most large wood was probably flushed through the larger step-pool and pool-riffle channels.

1900-1945

Little information is available concerning the effects of land-use activities on channel morphologies in the Lower McCloud River Watershed between 1900 and 1945. Stream channel disturbance was very limited due to the limited level of human use that occurred in watershed during this period. Some stream channels may have been impacted by land-use activities such as road construction and mining; however, these impacts were probably insignificant due to the small area in which they occurred. Stream channels and riparian areas were probably impacted by grazing activities in the Chatterdown and Claiborne Creek sub-watersheds; however, the degree to which grazing activities affected stream channels and riparian areas is unknown. Today no signs of long-term stream channel degradation from grazing are visible in the Claiborne and Chatterdown Creek sub-watersheds.

1945-present

Some land-use activities occurring over the past 47 years have affected the morphology and stability of stream channels in the watershed. Perhaps the most widespread impacts to stream channels have occurred as a result of the successful exclusion of fire from areas that burned frequently prior to the onset of effective fire suppression techniques. A comparison of 1944, 1975 and 1995 aerial photos (see discussion on Vegetation in this chapter) shows that early to mid seral stands have developed into mid to late seral stands largely due to the exclusion of fire. The effects of this vegetative conversion on channel morphology are not readily apparent; however, the trend to older, mature stands has reduced sediment inputs to upland and cascade channels.

The exclusion of fire affected channel stabilities indirectly by influencing vegetation in close proximity to streams. The shift in vegetation from younger to older stands is believed to have affected upland and cascade channels in several ways. The establishment of mid to late seral vegetation has resulted in reduced soil erosion. The delivery of sediment to upland stream channels has decreased with increased vegetative cover. The potential for coarse woody debris recruitment to upland channel types located near the ridgetops and cascade channel types located on the midslopes has also increased. Increased levels of woody debris recruitment will eventually lead to changes in the morphologies and stability of colluvial, bedrock and cascade channel types. Fire suppression activities are also believed to have influenced channel stability by increasing evapotranspiration and lowering runoff peaks throughout the watershed.

Timber harvest and associated road construction activities did not begin to impact channel morphologies in the Lower McCloud River Watershed until the early 1970s. Impacts from these activities occurred mainly in the Hawkins, Claiborne and Chatterdown Creek drainages. Impacts were greatest in upland channels located within close proximity to ridgetops. Step-pool and cascade channel types were also impacted in areas where roads were constructed within stream inner gorges. Impacts were generally limited to channels located within or below clearcut areas rather than areas where selective cuts had occurred. The impacts associated with timber harvest activities were relatively small and were mainly limited to increased sedimentation in upland channels.

Roads impacted the morphology of upland channels throughout the watershed. Impacts were generally concentrated at stream crossings and in areas where roads were constructed within or adjacent to stream inner gorges and on unstable hillslopes. Common impacts to upland stream channels from roads included channel aggradation above plugged or partially plugged culverts, channel degradation below stream crossings, and gullying along poorly drained road systems. Impacts to step-pool and pool-riffle channels were mostly in the form of increased sediment inputs which led to increased deposition in pools and loss of fish habitat. Unlike the impacts from timber harvest activities which were of short duration, impacts from roads were chronic, especially on road systems that were not maintained.

Changes in the flow regime as a result of the McCloud Reservoir diversion had little effect on channel types in the McCloud River below the McCloud Dam. Overall the influence of the diversion on channel morphologies only appears to have affected a small reach of the McCloud River below the dam. The quantity of spawning gravels and cobbles has been reduced in this reach.

Table 4-5. Impacts of land-use activities on stream channel morphologies

Land-Use Activity	Impacts to Stream Channel Morphologies	Affected Area
Fire Suppression	Potential for increased large woody debris inputs to stream channels located in watersheds where fire suppression has been effective. Possible increased channel stability due to reduction in mass wasting activity	Swale, colluvial, bedrock and cascade channel types would show most significant changes in stability and woody debris concentrations. Overall decreases in sediment inputs to all channel types.
Timber Harvest	Some impacts to upland channel types in Little Meadows. Some impacts to swales, colluvial and bedrock channels located in close proximity to or within harvest units.	Hawkins, Claiborne and Chatterdown Creek sub-basins. Impacts are restricted to areas where harvest activities have occurred. Impacts greatest in and below clear cuts.
Road Construction	Impacts to smaller bedrock, colluvial and upland channel types. Impacts to larger channel types occur in areas where roads parallel stream channels in steep inner gorges.	Hawkins, Claiborne, Chatterdown sub-watershed and areas west of McCloud River above Ah-Di-Na.
Reservoirs/Diversions	Loss of fine sediment and bedload inputs to McCloud River from McCloud Dam to Hawkins Creek confluence. Lower summer base flows have decreased size of active channel and affected riparian vegetation. Aggradation of bedload at Shasta Lake.	McCloud River from McCloud Reservoir to Shasta Lake.
Grazing	Impacts to riparian area from early 1900-1949, Bank erosion and overgrazing of riparian areas may have occurred.	Chatterdown Creek sub-watershed and to a lesser extent, Claiborne Creek sub-watershed.
Mining	Minimal impacts associated with early placer mining attempts during mid-1800's.	No impacts from any mining activities have been documented.
Recreation	No impacts.	None.

Reservoirs and diversions have affected channel morphologies in the McCloud River below the McCloud Dam. Due to the lack of pre-reservoir data, no measurable impacts were noted; however, changes in channel habitat types have occurred. The quantity of spawning gravels and cobbles in the McCloud River has decreased below the dam. It is likely that channel aggradation also occurred in the McCloud River Arm of Shasta Lake; however, channel aggradation in the Lower McCloud River Watershed did not occur because Shasta Lake was not full during the majority of peak flow events. Overall the influence of the diversion on channel morphologies only appears to affect a small reach of the McCloud River below the dam. None of the tributaries to the McCloud River in the watershed are impacted by the Pit River Hydroelectric Project

Water Quality

Pre-1900

With the exception of the McCloud River, reference conditions for water quality in the Lower McCloud River Watershed are believed to be similar to current conditions, with the greatest changes taking place over the last 50 years. The quality of water in the streams tributary to the McCloud River has always been very good. Natural processes that affected water quality in the tributary streams prior to European settlement included climate, fire, peak flows, mass wasting, Mud Creek debris flow and and possibly volcanic eruptions from Mount Shasta. Impacts to water quality only occurred for short periods of time during winter high flows when concentrations of suspended sediments increased. Water quality in all of the tributary streams was probably excellent between high flows and during the summer and fall when base flow conditions prevailed.

The quality in the McCloud River, while very good, was affected by natural processes originating in the Upper McCloud River basin that were not present in the Lower McCloud Watershed. These processes caused water quality in the McCloud River to differ significantly from that of the tributary streams. Levels of suspended sediments in the McCloud River were higher than in the tributary streams due to the influence of Mud Creek. Mud Creek and Lower McCloud are the only perennial streams draining Mount Shasta that actually flow perennially into the McCloud River. Numerous debris flows occurring at approximately 75 year intervals significantly elevated concentrations of suspended sediments in the river.

Water temperature in the McCloud River was greatly influenced by Big Springs due to the large volume of groundwater that entered the river at this location. The water temperature at Big Springs is approximately 7 degrees Celsius. The low water temperatures kept the McCloud River very cold and also controlled the distribution and types of aquatic species found along the lower river.

<u>1900-1945</u>

Little to no information concerning the effects of land-use activities on water quality in tributaries to the McCloud River is available for the early 1900s. Historical accounts of the watershed from Wales indicate that the quality of water in the tributaries was very good during this period (Wales 1938). Water quality was likely impacted by mining and grazing activities, however the extents of the impacts are not well understood. No other land-use activities have significantly influenced water quality in the Lower McCloud Watershed (see Table 4-4).

The large debris flows originating on Mount Shasta during the mid-1920s impacted water quality in the McCloud River. The largest debris flows from Mud Creek occurred during the mid-1920s. During the largest of these events in 1924 it was estimated that approximately 10,000,000 cubic yards of glacial debris were deposited in a ten mile stretch of Mud Creek and an unknown amount of this material entered the McCloud River (Wales 1938). During the peak of the debris flow it is estimated that the solid content of sediment in the McCloud River was approximately 68 percent (Cranfield 1984). The large quantities of sediment deposited and suspended in the river significantly degraded habitat for aquatic species that lived in and along the river. During the height of the flows much of river bed was covered by a layer of fine sediment which degraded the quality of spawning gravels. The poor clarity of the water during the flows also hindered the ability of fish to feed on aquatic insects (Cranfield 1984).

A total of nine debris flow events have occurred in Mud Creek from 1900 to 1985 (Blodgett et al. 1996). In the interim periods between these flows, water quality in the McCloud River was much improved; however, it should be noted that the concentrations of suspended sediments in the river from Mud Creek were still high. Concentrations of suspended sediments were diluted by the large quantities of water that entered the river at Big Springs upstream of the Mud Creek confluence.

<u>1945-present</u>

Water quality in the tributaries to the McCloud River was affected by the increased amount of land-use activity that occurred throughout the eastern half of the watershed. The majority of impacts were associated with increased instream sedimentation in areas where timber harvest and road building activities occurred. Impacts to water quality from timber harvest and road construction were mostly non-apparent while these activities were taking place unless the activities occurred in close proximity to perennial streams. Impacts from these activities did not manifest themselves until the following winter during winter runoff events. Impacts from timber harvest appeared to be relatively short lived and mostly in the form of increased hillslope erosion and turbidity during winter runoff events. The McCloud River Water Quality Monitoring Project showed that increased levels of turbidity did occur in drainages that were impacted by timber harvest activities and wildfires. The amount of sediment originating from disturbed areas decreased within 1-5 years of harvest activity. Impacts to water quality from the road system were more chronic and ultimately appear to be more significant than those of timber harvesting.

Fire suppression activities actually operated to decrease fine sediment inputs to streams and improve water quality over the last 50 years. The suppression of wildfire throughout the watershed resulted in reduced amounts of hillslope erosion and increased hillslope stabilization. Increased canopy cover over upland stream channels also influence water quality throughout the watershed by lowering water temperatures.

Water quality in the McCloud River was altered following the completion of McCloud Reservoir and the onset of water diversion from the McCloud River for the Pit River Hydroelectric project. Prior to the construction of McCloud Reservoir, streamflow in the McCloud River had higher levels of turbidity due to the influence of Mud Creek. Turbidity levels in the McCloud River decreased when sediments from Mud Creek were cut off from the lower river by McCloud Reservoir. The decreased concentrations of fine sediments in the lower river improved water quality accept during short periods in the fall when reservoir levels in McCloud Reservoir were low. Lower water levels in McCloud Reservoir affect the concentration of sediments at the outflow and occasionally result in the transfer of sediment laden runoff downstream. Turbidity levels below the dam have also been observed to increase following large runoff events as sediment settles in McCloud Reservoir.

Table 4-6. Impacts of land-use activities to water quality

Land-Use Activity	Impacts to Water Quality	Affected Area
Fire Suppression	Improved water quality as a result of more canopy cover, decreased stream temperatures, increased channel stability, decreased sedimentation.	Entire watershed, however changes in vegetation have been greatest in southern tributaries to the McCloud River including Chatterdown Creek.
Timber Harvest	Increased turbidity immediately following harvest activities.	Hawkins, Claiborne and Chatterdown Creek sub-watersheds.
Road Construction	Increased turbidity during winter storms, increased sedimentation resulting from surface runoff from roads.	Hawkins, Claiborne, Chatterdown sub-watersheds and areas west of McCloud River above Ah-Di-Na.

Land-Use Activity	Impacts to Water Quality	Affected Area
Reservoirs/Diversions	Decreased turbidity in McCloud River following completion of McCloud Dam due to loss of sediments from Mud Creek. Increased levels of turbidity for short periods in spring and fall in response to reservoir drawdown and Mud Creek inflows. Increased water temperatures in the McCloud River	McCloud River from McCloud Reservoir to Shasta Lake.
Grazing	Increased sedimentation, bank erosion in overgrazed riparian areas. Increased erosion from burning activities.	Chatterdown Creek sub-watershed, and to a lesser extent Claiborne Creek sub-basin.
Mining	Minimal to no effect. Water quality was probably disturbed during placer mining activities in the mid-1800s but no data is available to confirm this.	Mining activity minimal in watershed. Small areas in vicinity of Hat Mountain were affected.
Recreation	No Impacts	None

The effect of McCloud Reservoir on water temperature in the lower river was opposite of what one would expect. Normally, reservoirs lower downstream water temperatures. Water temperatures in the McCloud River, prior to the completion of McCloud Reservoir, were much colder than those found in the tributary streams due to the influence of Big Springs. The temperature of water emanating from Big Springs is approximately 44-45 degrees Fahrenheit. Temperature data collected on the McCloud River above Hawkins Creek in 1996 indicate that the water temperature of the river remained above 50 degrees Fahrenheit throughout the summer and fall. The higher water temperatures have influenced the distributions and types of aquatic species found throughout the lower river (see Fisheries).

Biological Features

Vegetation

Overview

Large ecosystems maintained by surface fire, such as ponderosa pine and drier mixed conifer types, are a result of primary and secondary succession. These regimes contain persistent successional plant species that generally are shade intolerant and have developed adaptations to survive fire and maintain a constant or fluctuating population in response to disturbance. In the absence of fire beyond the normal return interval, these fire adapted species are replaced by late-successional species that are predominantly shade tolerant, thus the development of fuel ladders that alter fire behavior.

Pre-1900

Mixed conifer forests contain a variety of vegetation species that have a variety of responses to disturbance from fire. Such forest types make up one of the more complex regimes to describe a natural fire response. Native Americans and lightning were both sources of fire disturbance in mixed conifer and ponderosa pine forests. Native Americans burned such forests regularly as indicated from recorded accounts (Lewis 1973). Research on fire modeling based on long term climatic data, including lightning frequency, suggests that much of early fire history can be explained by lightning occurrence alone (Van Wagtendonk 1972). Anecdotal information recorded in 1934 notes a conversation with an old-timer that lived in the Mount Shasta region since 1852 who stated that “he never knew of Indians firing the country off because they already had plenty of game to hunt” (Shrader 1995). It appears likely that Native American influence as an ignition source ended by the late 1800’s.

Pre-settlement fire histories in mixed conifer forests show a pattern of lengthening of fire return intervals with increasing elevation. The intensity of these fires was generally low due to fire frequency which kept residual fuel loading down and eliminated the vertical fuel ladder component. Historically, fires were more likely to be to surface fires. Typical return fire intervals for this fire regime were likely at 8-30 years depending on geographical features.

The pre-settlement pattern of vegetation within the watershed appears to have been formed by fairly frequent fires, which periodically burned off chaparral covered ridges and hillslopes, leaving large timber essentially confined to canyon bottoms or moist north slope areas.

Large fires are known to have occurred in the watershed in 1872 and 1898. The 1898 fire appears to have burned a major part of the watershed.

<u>1900-1945</u>

Human influences have affected the natural disturbance patterns, thus altering the fire regime. What was once a short return interval, low intensity regime has developed into one of moderate to high intensity at infrequent intervals. Fire return intervals have been calculated using dendrochronology in a similar watershed with much the same regime characteristics which shows the current return interval at 17-36 years. This is verified by recorded fire history that shows the last significant fires occurred within this settlement period between the years of 1872 and 1920. Many of the human caused fires were possibly from grazing activities.

With the advent of a highly structured suppression influence starting in the early 1900’s we can now see very long intervals between fires that are generally large and stand replacement events.

<u>1945-present</u>

The 50 year period from 1944 to 1995 shows a dramatic development of vegetation in the watershed. Tree size, crown cover, and stand structures increased rapidly during this period. This rapid development of vegetation is attributed to high soil productivity, high rainfall, and fire exclusion. Land allocations have tended to exclude less productive ground from the LSR; therefore, the tables below show faster development of late seral conditions within the LSR portion of the watershed than in the entire watershed.

The development of vegetation and habitat conditions in the Lower McCloud River Watershed was determined by observations from aerial photographs. The following sets of aerial photographs were used:

- 1944 - earliest available photo flight
- 1975 - photo flight used for Geographic Information System (GIS) database
- 1995 - most recent photo flight

Results of these observations are displayed in the following tables, charts and maps. This data is taken directly from the 1998 Lower McCloud Watershed analysis.

Table 4-7. Vegetation and habitat development from 1944 to 1995

Seral stage	Acres			Percent		
	1944	1975	1995	1944	1975	1995
Non-forested	128	128	128	0.3	0.3	0.3
Brush	3,833	1,9	1,857	8.5	4.4	4.1
Hardwood	5,863	6,879	6,847	13.0	15.2	15.2
Early seral-planatation	0	0	2,184	0.0	0.0	4.8
Eary seral-open canopied (<40%)	1,563	210	84	3.5	0.5	0.2
Early seral-closed canopy (>40%)	509	17	26	1.1	0.0	0.1
Mid seral-open canopy (<40%)	24,517	14,079	8,397	54.3	31.2	18.6
Mid seral-closed canopy (>40%)	7,772	9,583	10,022	17.2	21.2	22.2
Late seral-closed canopy (>40%)	936	12,262	15,576	2.1	27.2	34.5
Totals	45,120	45,120	45,120	100.0	100.0	100.0

Table 4-8. Vegetation and habitat development within the LSR portion only from 1944 to 1995

Seral stage	Acres			Percent		
	1944	1975	1995	1944	1975	1995
Non-forested	48	48	48	0.2	0.2	0.2
Brush	1,314	883	788	4.6	3.1	2.7
Hardwood	1,553	1,533	1,533	5.4	5.3	5.3
Early seral-planatation	0	0	1,545	0.0	0.0	5.4
Early seral-open canopied (<40%)	1,292	190	58	4.5	0.7	0.2
Early seral-closed canopy (>40%)	452	9	26	1.6	0.0	0.1

Seral stage	Acres			Percent		
	1944	1975	1995	1944	1975	1995
Mid seral-open canopy (<40%)	16,576	7,489	4,231	57.8	26.1	14.8
Mid seral-closed canopy (>40%)	6,697	7,727	6,756	23.4	27.0	23.6
Late seral-closed canopy (>40%)	739	10,793	13,635	2.6	37.6	47.4
Totals	28,672	28,672	28,672	100.0	100.0	100.0

Vegetation conditions observed in 1944 photos are consistent with conditions that would be expected on a landscape recovering from fires 50 years ago. Upper slopes had a scattered conifer overstory over a brush and sapling understory. Stringers of larger trees and heavier stocking were observed along major streams and draws. These conditions are believed to be the result of the large fires documented in newspaper accounts in 1872 and 1898.

The 1944 aerial photography was also used to track the development of current late successional stands over the last 50 years. Table 4-7 describes the 1944 condition of stands that had developed into late seral conditions in 1995. This table shows that mid seral open canopy conditions in 1944 were the major source of current late successional habitat. Approximately 55% of the acreage of current late successional stands developed from such conditions. The table also shows that mid seral closed canopy conditions in 1944 were also significant as the source of approximately 38% of the acreage of current late successional stands.

In the analysis area, hardwood species show a trajectory of decline from historic levels. Hardwood species require sunlight to survive. As deciduous trees, hardwoods must add photosynthetic capacity (leaves) annually. Conifer species, in contrast, retain needles. A conifer can begin photosynthetic activity much earlier in the year than a hardwood species as it has its needles (leaves, photosynthetic capacity) in tact. Hardwood species must have sunlight to grow and maintain viability when in conifer stands. Historically, frequent fires maintained open canopy conditions for hardwood species. Lack of fire in the last 100 years in the fire suppression era has shown a decline to hardwood species in stands lacking an active fire regime. The hardwood component is important to all species of wildlife.

In addition to providing the greatest acreage of current late successional conditions, mid seral open canopy stands in 1944 also developed the best characteristics for late successional habitat 50 years later. Mid seral open canopy stands in 1944 had a scattered overstory of mature trees over an understory of brush and conifer saplings. Over the next several decades, these stands developed into multi-layered conifer stands with scattered large overstory trees over a pole and young sawtimber stand. The brush layer declined as canopy cover increased. Stands that developed from mid seral closed canopy conditions showed less development of vertical stand structure. Mid seral, closed canopy stands developed at a slower rate due to higher levels of competition and less dominance by individual tress. The result was the development of single-layered stands with little vertical structure.

From 1995 to 2011, there have been moderate changes to the watershed, specifically on private timber company lands (just under 12,000 acres, or 18% of the analysis area). Thorough research and documentation of related harvest and other activities should be gathered prior to any analysis that would propose to manipulate vegetation. Forest land classification is important to understand in context of the larger Iron Canyon LSR, as there are many forest dependent species currently utilizing the analysis area to meet their forage and cover requirements. Recent management actives are likely creating early seral conditions in a landscape that been experiencing rapid forest succession. This new habitat niche is likely to impact wildlife, possibly fecundity rates.

Fire and Fuels

Pre-1900

C. Hart Merriam, Chief of the Division of Biological Survey in 1898, wrote "of the hundreds of persons who visit the Pacific slope in California every summer to see the mountains, few see more than the immediate foreground and a haze of smoke which even the strongest glass is unable to penetrate". Few forested regions have experienced fires as frequently and with such high variability in fire severity as those in the Klamath Mountains (Taylor and Skinner 1998). With frequent fire, fuel accumulations over most of the area were maintained at low levels. This frequent regime produced low-to-moderate fire severity. Within the analysis area, fire scar studies show that fire was a frequent process (Skinner 2006).

A study of fire scar analysis to understand fire history was done in the Squaw Creek drainage near the analysis area (Skinner 2006). The study showed a fire return interval (FRI) of 3 to 38 years, with a mean FRI of 12.75 years. Additional research shows that lower elevation mixed conifer forests of the Klamath Mountains historically burned every 5 to 19 years, with riparian areas burning with somewhat less frequencies (Fry and Stephens 2006, Taylor and Skinner 1998, 2003).

Studies of historical fire regimes also show that vegetation and topography strongly influence the fire regime. Frequent fires and fire-scarred trees that have survived previous fires suggest that the fire regime was characterized by low-to-moderate severities (Taylor and Skinner 1998, Skinner et al. 2006). Studies also show that upper slope positions, ridge tops, and south and west facing aspects burned at higher severities than lower slope positions and north and east aspects (Taylor and Skinner 1998, Alexander et al. 2006).

Prior to the establishment of the Shasta-Trinity NF (originally the "Shasta National Forest"), suppression concerns were primarily focused on keeping wildfires from spreading to homes and improvements. These efforts typically did not result in successful wildfire suppression. In some cases, human-caused fires or wildfires were allowed to burn for many reasons.

1900-1945

Fire suppression efforts were instituted after the establishment of the National Forest system. Since the onset of fire suppression in the early 1900s, and with the increased effectiveness of mechanized suppression techniques (fire engines, dozers, aircraft, etc.) in recent years, most fires within the watershed have been kept small. This has been primarily achieved through the use of aerially delivered firefighters and the use of retardant during initial attack. Several fires ranging in size from 1,000 to 5,000 acres occurred during this period.

1945-present

With successful fire suppression, fuels and vegetation density have increased and fires have the potential to become more intense and difficult to control. Suppression concerns have primarily been focused around homes and improvements (i.e. wildland urban interface). Concerns over fire effects to resources (e.g. wildlife habitat, soils, human uses, hydrology, air quality, etc.) have increased through time. Management actions on private land parcels within the watershed have caused a number of ignitions during this time period and residual fuel loading from these activities has the potential to exacerbate fire behavior,

Species and Habitat

Threatened, Endangered and Sensitive (TES) Plants and Other Species of Concern

There is little information pertaining to the historical occurrence and distribution of sensitive plants within the watershed. Although the CNDDB and NRIS databases have entries of plant occurrences within the watershed dating as early as 1976 (e.g. Shasta eupatory), this does not indicate whether these species existed in the watershed prior to those records. These data simply tell us the first known and documented locations of the selected rare plants.

Habitat for species with limestone affinities, such as Shasta eupatory, exists in limited quantities (approximately 1900 acres) mainly in the southern portion of the watershed. It should be noted, however, that affinity does not equal endemism therefore it is possible Shasta eupatory could be found on other substrates within the watershed. Several caves in the watershed may contain suitable habitat for rare lichen, fungi, or bryophyte species. Habitat for several other species may have been somewhat altered or reduced by events or activities within the watershed such as grazing, high-severity fire, fuels accumulation from fire suppression, timber harvest, road construction, and recreational use such as hiking or OHV use.

Noxious and Undesirable Weed Species

Most of California’s invasive plants originated from the Mediterranean Basin and began establishing as early as the 1730s – initially along the coasts and then spreading inland (Zouhar et al. 2008). Activities such as clear cut logging, prescribed or wild fire, grazing, and road building and maintenance have all been shown to increase the abundance of noxious weeds in the Northwest California Bioregion. Noxious weeds have competitive advantages (e.g. rapid growth rates and prolific seed crops, seeds that spread easily by wind, water and wildlife, etc.) that often allow them to colonize a site more quickly and effectively than native plants. Logging, wildfires, and grazing often expose bare mineral soils which may then be colonized by invasive plants due to a reduction in competition for space and resources.

As discussed in the Fire and Fuels section, the watershed has experienced a reduction in the frequency and extent of fire during the era of widespread fire suppression (1900-1945 and 1945-present). Although the buildup of fuels from active fire suppression created some shaded environments where light-loving invasive plants have a difficult time establishing (Keeley 2006), this accumulated fuel load also increased potential wildfire severity. Although there have been many fire starts in the watershed, only nine small or medium (10-1,000 acres) wildfires and two large (> 1,000 acres) wildfires have occurred in the watershed since the onset of fire suppression. These fires resulted in the creation of new habitat for several invasive plants that may capitalize on open, bare substrates.

Historically, non-native weeds may have been introduced as early as the 1800's by fur trappers entering the watershed from other bioregions. The introduction or spread of weeds may have also increased due to livestock grazing which began in the area prior to 1877 (Guilford-Kardell 1994). The building of roads and larger trails by Anglo-American private landowners in the watershed may also have increased weed establishment during the same time period. OHV use, via authorized and unauthorized routes, has existed in the watershed for over 50 years and has also likely increased the introduction and spread of noxious weeds along these routes. As noted in the previous chapter, several non-native plant species have become established in the area around Ah-Di-Na Campground. These species are believed to have originated from the Ah-Di-Na homestead around the turn of the century. Fruit trees that were planted at the Ah-Di-Na homestead also remain today (USDA Forest Service 1998).

There is little specific information pertaining to the historical occurrence and distribution of noxious weeds in the watershed. Some information may be gleaned, however, by reviewing these species' distributions at a broader scale. The following is a general description of noxious weed introduction and occurrence in California:

- **yellow star thistle (*Centaurea solstitialis*)** is native to southern Europe and western Eurasia. This species was introduced to California in 1850, possibly as a contaminant in seed grain, and spread rapidly (DiTomaso and Healy, 2007). Beginning in the late 1950s, it expanded its range within the state at an exponential rate, increasing from 1.2 to 12 million acres (Cal-IPC 2010).
- **Canada thistle (*Cirsium arvense*)** is native to southeastern Europe and was introduced to North America in the seventeenth century as a contaminant in crop seed (Bossard et al. 2000). There is no information regarding the vector for introduction of Canada thistle in the watershed.
- **bull thistle (*Cirsium vulgare*)** is native to Europe, western Asia and North Africa. Bull thistle likely came to the U.S. as a contaminant on ships in seed supplies or ballast. By 1925 it had been reported in several areas of California including the Klamath region (Bossard et al. 2000).
- **dyer's woad (*Isatis tinctoria*)** is native to Europe and was introduced by some of the first immigrants to the Plymouth Colony in the early 1600s (Zouhar 2009). It was intentionally introduced to this region in the 1980s as a commercial crop by the Marlahan family in Scott Valley (this the local common name "Marlahan mustard," but it turned out to not be a viable commercial endeavor. The species quickly escaped cultivation, however, and has been rapidly spreading throughout the region ever since (Hesseldenz 2011 personal communication).
- **perennial pea (*Lathyrus latifolius*)** is native to Europe. It has been planted as a garden ornamental and has escaped cultivation in many areas of California (DiTomaso and Healy, 2007).
- **black locust (*Robinia pseudoacacia*)** is native to the United States though the extent of its original range was thought to be east of the Rocky Mountains. It has been widely planted and frequently escapes cultivation (Stone 2009). Black locust was planted at the Ah-Di-Na homestead (less than two miles from the watershed boundary) approximately 100 years ago and has had a major impact within and around Ah-Di-Na Campground and various areas downstream within the riparian corridor (USDA Forest Service 1998).
- **Himalayan blackberry (*Rubus armeniacus*)** is native to western Europe and was introduced to the U.S. as a cultivated crop. By 1945 Himalayan blackberry had become naturalized along the west coast of California (Bossard et al. 2000). It may have been

intentionally planted at Ah-Di-Na and/or the McCloud River Club in the early 1900s (Hesseldenz 2011 personal communication).

- **spreading hedgeparseley (*Torilis arvensis*)** is native to the Mediterranean region and was introduced as an ornamental in the mid 1800s. By the 1930s was being prolifically planted along highways in southern California. By 1949 Spanish broom had spread northward to Marin County (Bossard et al. 2000).

Terrestrial Wildlife Species and Habitat

Prior to settlement in the mid 1800s, the transportation system consisted of trails associated with hunting, fishing, trading and other activities of the native inhabitants. Some early explorers and trappers passed through this watershed in the early 1800s (Henery 2008). The gradual extirpation of large carnivores such as the grizzly bear and gray wolf began as settlers moved into the area. Trapping and overhunting resulted in population-level declines of other furbearer species such as fisher, marten, wolverine, beaver and river otter.

Wildlife species that were restricted to special habitats (cavity nesters, bats) may have existed in greater numbers due to large expanses of habitat or the absence of the land use practices of the Europeans who were to follow. Large expanses of late-successional habitat prior to mechanized timber harvest practices offered habitat for species associated with this habitat type, though the landscape was most likely more open due to more frequent fire and subsequent lack of heavy fuels in the understories.

In the late 1800s, livestock grazing and homesteading began to change the native landscape. Attempts to extirpate wildlife species populations that were considered threats, such as the grizzly bear and wolf, continued. Elk were also extirpated, possibly due to overhunting as occurred with elk in the Trinity Alps (Henery 2008); however, elk were successfully reintroduced in 1911.

Changes to habitat most likely affected other species historical populations and distributions. A major contributor to the change in habitat was fire suppression. Fire suppression practices caused a decrease in populations of deer and other species that utilize early seral habitats. Conversely, fire suppression most likely contributed at least in part to an expansion of the distribution of many species that utilized late-successional patches found in the watershed (e.g. northern spotted owl, northern goshawk). Distribution and abundance of these species has also been influenced by multiple other factors including timber harvest of their original, occupied habitats, conversion of these habitats to other land uses, and changes to stand structure and overall juxtaposition of late seral habitats.

In addition, increased human activity through construction of roads and timber harvest most likely contributed to a movement out of the general area or decline in habitat use for some species due to disturbance and exposure. Species that may have proliferated in the human-altered environments are expected to be more common today than before European settlement (Henery 2008).

Late-Successional Mixed Conifer Habitat

<u>Pre-1900</u>

Perhaps the largest scale influence to vegetation within the watershed prior to 1900 was recurrent wildfire. Typical fire severity and return intervals are discussed within the Fire and Fuels section of this watershed analysis and the impacts of these intervals are discussed in the Vegetation section.

Late-successional habitat was closely associated with major rivers and their tributaries. The remaining landscape consisted of more open forested habitats with early seral shrub or herbaceous understories, hardwood/conifer, oak woodland and chaparral habitats. Because of the open nature of much of the landscape, late successional species would have been associated with the stream courses and adjacent forested stands.

<u>1900-1945</u>

Settlement in the areas surrounding the Lower McCloud River, as well as the introduction of fire suppression techniques initiated habitat changes in habitats visible today. In the beginning, very small quantities of timber were likely harvested as a result of settlement, rather than marketing, as the watershed was not as accessible as much of the surrounding forested land. As fire suppression became more efficient, less of the land was maintained in an early-seral stage.

<u>1945-present</u>

Though fire suppression may have improved conditions for some species of wildlife, habitat may have become less suitable for other species as a result of an increase in dead/down wood, dense understories, increased canopy closure and the subsequent decline of shade-intolerant species. Excessive buildup of dead/down wood on the forest floor can inhibit visibility and accessibility of prey species for some avian predators. Dense understory regeneration by shade-tolerant species has the potential to obstruct movement of avian predators and decrease the overall species composition. Increased canopy would have led to a decline of oaks and other shade-intolerant species in the understory and subsequent decrease in structural diversity and palatable forage (such as mast and herbaceous vegetation) important to many wildlife species. However, the same increase in canopy closure and downed wood (and snags) would have also resulted in improved habitat conditions for species associated with late seral conditions such as fisher, marten, northern spotted owl, and goshawk.

With the increase in timber harvest in the 1960s, fragmentation of much of the late-successional habitat in the surrounding watersheds, in addition to the private lands within the watershed, increased, resulting in a reduction of habitat quality and overall suitability for species associated with these habitats. Some clearcut areas could have mimicked natural openings of early seral habitat, but at the cost of fragmentation. Harvest units were, and continue to be, much larger than natural openings and different in overall composition, particularly with their tendency toward single-aged monocultures and dense stocking. This fragmentation impacted the late-successional species occurring there, though to what extent is not known, as no surveys were conducted before harvest activities at that time. These differences could have significant long-term management implications and effects on fire behavior.

With the increasing harvest on private lands and subsequent fragmentation of larger amounts of older forests, a greater significance is then placed on the protection and promotion of larger blocks of late-successional habitat remaining in the watershed.

Early-Seral Brush / Browse Habitat

<u>Pre-1900</u>

Open chaparral and oak woodlands played a large role in supporting deer, small mammals (that served as both seed dispersers and prey for larger predators), and a wide variety of open habitat/early seral-dependent wildlife species. Hardwood and brush species grew more in the southern half of the watershed with patchy distribution elsewhere. Naturally occurring disturbances such as fire would have maintained forage in the form of herbaceous vegetation found amongst the chaparral and open forest understories. As the chaparral recovered, sprouting chaparral provided succulent, palatable forage. In undisturbed areas, mature chaparral produced berries and dense cover.

Oak woodlands supported hardwood-associated species such as the gray squirrel, band-tailed pigeon, acorn woodpecker, pallid bat, deer, turkey and black bear. Wildfires often burned relatively cool and kept the hardwood understory relatively open, stimulated acorn production and vegetative growth, and maintained shrublands in a mosaic of seral conditions.

1900-1945

Settlement was primarily in the northern portion of the watershed and fire suppression efforts were still developing. Habitat changes incurred from grazing and other human-caused disturbances continued. Wolf and grizzly bears were on the verge of complete extirpation, and dramatic declines in furbearing species and elk continued.

1945-present

As fires were suppressed, chaparral became more decadent with time. Browsers were negatively affected as the browse became unpalatable and new growth became out of reach. In addition, as the brush became decadent, a smaller amount of habitat was available for small- to medium-sized mammals, as branches near ground level matured or died. Other species which fed on berries or used shrubs as cover (e.g. bears, birds and deer) benefited from the maturing browse (USDA Forest Servcie1998).

Within the oak woodlands, fire suppression reduced the amount of browse available in the understory in the form of mast, herbaceous growth or early-seral shrubs. Herbaceous growth may have been hindered since understory growth of shrubs and oak seedlings, usually tempered by frequent fire, would out-compete the herbaceous plants. Following this, shrub species in the understory would have matured and become unpalatable as browse (USDA Forest Service 1998).

Aquatic and Riparian Habitat

Pre-1900

Large runs of Chinook salmon and steelhead ascended the McCloud River up to Lower Falls, about six miles above present McCloud Reservoir. The mainstem McCloud was estimated to support over 25,000 redds with additional populations utilizing the larger tributaries such as Squaw Valley Creek, Star City, Claiborne and Caluchi Creeks (Yoshiyama et al. 2001). Coho salmon (*Oncorhynchus kisutch*) were also present but in much smaller numbers. Bull trout (*Salvelinus confluentis*) and rainbow trout, as well as Sacramento sucker (*Catostomus occidentalis*) and riffle sculpin, were common year-round river inhabitants (Moyle 2002). Native fish assemblages within the McCloud River were used by local Native Americans as an important source of food and cultural significance. Early European settlers who began to inhabit the area in the mid to late 1800s also relied on the fishery as an important food source.

Stream processes were likely functioning to provide excellent fish habitat. Bedload movement and large woody debris were in balance with channel functions and most likely provided an abundance of deep pools and runs. Under these conditions, large fish would have been common. Based on information compiled by Cranfield (1984), stream systems were healthy enough to continue to support large and consistent salmon runs despite periodic mud flows into the McCloud River. Other aquatic species most likely recovered from the mud flows as tributaries probably served as reserves which would repopulate the river. As with the river, the riparian habitats and tributaries most likely underwent periodic changes, with associated aquatic species fully adapted to these changes (Lower McCloud Watershed Analysis). Early human presence had little impact on the river and surrounding watersheds or on local fish populations, as human land alterations were small in scope and were associated primarily with homesteading and Native American use.

The gold rush of the mid-1800s attracted thousands of people to Shasta County and the upper Sacramento River basin. These miners and settlers capitalized on the fishery resources, for both personal and commercial consumption. The abundant runs of Chinook salmon were most impacted by these ventures. By the late 1800s, diminishing runs of salmon were noticeable in the Sacramento River. Thus McCloud River salmon populations were also diminishing due to a variety of increasing downstream impacts including fish canneries, logging, railroad construction, mining and smelting operations, and growing communities.

The McCloud River fishery gained considerable fame in the 1860s and 1870s for the prolific size of its salmon and steelhead runs, and the large size, beauty, and tenacity of its rainbow trout. In response, the U.S. Fish Commission established an egg-taking station at Baird on the lower McCloud River in 1872. During the early years of its operation, Baird Station was taking spawn from most all spring run salmon returning to the McCloud River to use for establishing salmon populations in the eastern part of the United States. From 1884 to 1887 Baird Station was closed due to a diminished salmon population but in response to the large declines in Sacramento River salmon populations, Baird Station was re-opened in 1888 to help maintain Sacramento River salmon runs. The egg station continued operation until 1935 at which time McCloud River salmon runs were significantly depleted (Yoshiyama et al. 2001). The site is now under Shasta Lake.

Wildland fires occurred regularly within the McCloud River drainage. They were part of the natural basin ecology and due to their recurrent nature, most likely helped maintain channel processes through the contribution of large woody material and coarse and fine sediment.

<u>1900-1945</u>

Changes to fish populations and aquatic habitat that began taking place in the late 1800s continued through the early 1900s. These changes were associated with fish hatcheries, fish canneries and commercial fishing, grazing, mining, timber harvest, and recreation. Logging operations were active along portions of the McCloud River to supply timbers to mining companies and railroad construction (Brown 1915).

Copper smelting was extensive in the early 1900s a few miles downstream from the mouth of the McCloud River. Smelting fumes destroyed large areas of forested vegetation and created a large fire hazard. High erosion rates from areas with no vegetation delivered large amounts of sediment to stream systems in the upper Sacramento River Basin. Erosion had become enough of a concern that control efforts were initiated in the 1920s and 1930s through reforestation programs (CDF 2005).

Cattle grazing occurred unregulated throughout the watershed with the east and southern portion of the watershed ‘deteriorating’ as a result of grazing (Lower McCloud Watershed Analysis 1998; Cranfield 1984). The deterioration could have referred to direct impacts on the riparian habitat or to indirect impacts, such as laying bare upland herbaceous habitat. In addition, cattle most likely competed with other grazers and browsers which were already being impacted by reduced forage habitat in the uplands. The north and western portion of the watershed received less use as many natural deterrents made grazing difficult to impossible. Burning in support of grazing was common and served to compound other impacts associated with grazing. Those effects would have included the loss of riparian vegetation, increased sedimentation, loss of bank stability, and changes in water quality. By 1907 the Forest Service began reducing the number of cattle grazing on National Forest lands and implemented stricter grazing regulations (Lower McCloud Watershed Analysis 1998).

In 1924-35 mud flows from Mud Creek entered the upper McCloud River resulted in extreme turbidity levels downstream. This reportedly occurred several times since then and had resulted in high turbidity levels throughout the summers for a number of years. The effects of this elevated turbidity and deposition of fine silts would have resulted in some pool filling and a reduction in benthic invertebrate productivity. The effects on fish are unknown, but it is presumed impacts were short term in nature (Lower McCloud Watershed Analysis 1998).

All these activities contributed to destruction of riparian vegetation, erosion of streambanks and accelerated sediment delivery to the Sacramento River system. These changes in stream morphology likely resulted in degraded aquatic habitat conditions and added to further declines in anadromous fish populations. At the same time, the development of fish hatcheries in Shasta County and the widespread practice of introducing non-native game fish to western waterways resulted in the introduction of other non-native fish species such as brown trout and brook trout.

1945-present

The completion of Shasta Dam in 1945 blocked the historic runs of salmon and steelhead from accessing the upper Sacramento River system including the McCloud River. The elimination of anadromous fish runs changed the ecology of the area by removing an important human food source, altering the fish community structure, genetically isolating rainbow trout, and disrupting the flow of nutrients that large runs of anadromous fish contribute to the natural food web. The dam resulted in simplifying and destabilizing the native fish community as it effectively blocked upstream and downstream migration patterns.

The creation of Shasta Lake converted stream environments into a lake environment. Fish populations that required stream habitats experienced habitat reduction, which caused local population levels to sharply decrease. The formation of a warm water lake fishery adversely affected native fish populations even more. Introduced warm water lake species such as bass and catfish moved into the McCloud Arm of Shasta Lake and further upstream into the lower reaches of the McCloud River. Non-native brown trout are now abundant in the analysis area. These introduced species often out-compete and prey on native species, further reducing their numbers.

The depletion of salmon runs, which served as a major food source for native bull trout, and the introduction of non-native trout species, which brought hybridization, competition, and predation to the bull trout population all contributed to this species' dwindling numbers (Moyle 2002).

By 1965 the construction of McCloud Dam blocked bull trout in the lower reaches of the McCloud River from swimming upstream to spawn and flooded 6 miles of prime bull trout habitat. Additionally, brook trout, which are known to hybridize with bull trout creating sterile offspring were introduced to the reservoir. McCloud Reservoir diverts about 80 percent of McCloud River flows to the Pit River for hydroelectric production. As a result, the McCloud River downstream from the reservoir has significantly reduced flow levels, disrupted sediment regimes and raised water temperatures, all contributing to the final demise of the bull trout population in the McCloud River. This impoundment, along with Shasta Dam, has permanently altered aquatic habitats in the analysis area.

More recently, recreation, probably more than any other single activity, has had the greatest impact on the river. The McCloud River Club, Ah-Di-Na Club and the Bolliboka Club have had major influences on the conservation of the fishery and the preservation of habitat within the river. In order to protect their recreational interests, these clubs took an active part in the area's management and have been successful in maintaining an excellent river fishery.

Human Uses

Heritage Resources

Pre-1900

The Wintu and Achumawi (Pit River) Native Americans Tribes are known to have used the Lower McCloud River Watershed area prior to Euro-American discovery. Although the Okwanuchu are also rumored to have occupied this territory, the term "Okwanuchu" was a Shasta word meaning "South People" and it is uncertain whether this was actually a tribal entity (Powers 1955).

Native American occupation of the watershed can be found in the linguistic evidence from an ethnographic inventory containing traditional Pit River and Wintu place names, habitation sites, religious/mythological areas, and resource use areas within the watershed (Theodoratus 1985). Terraces lining the McCloud River also contain abundant evidence of prehistoric and historic Native American use. The presence of house pits, midden, and Gunther type projectile points at many of the prehistoric sites indicate occupation during the late prehistoric period within the last 1,500 years. Artifacts located at one of the prehistoric village site along the McCloud River indicate a date of 7,000 years before present.

Euro-American intrusion into the watershed probably occurred about 1830. Fur trappers and miners were among the first to enter the area (Conner 1941). Settlers began entering the watershed as early as 1860 (Conner 1941). In 1896, the Central Pacific Railroad was granted lands along the McCloud River under the Pacific Railroad Acts of 1862 and 1864.

Recreation use of the McCloud River began as early as the 1870's. The sport fishing potential of the McCloud River was recognized during this period and a fishing resort was established at "Horseshoe Bend" (now Hearst) on the upper river, thus introducing wealthy sportsmen to the river. This period saw development of the private ownership pattern along the river and the establishment of private sport-fishing clubs. In 1896, Central Pacific Railroad acquired land along the McCloud River under the Pacific Railroad Acts of 1862 and 1864. Ah-Di-Na was purchased from Central Pacific Railroad by William R. Whittier in 1896 and developed into a private sport-fishing and hunting resort. It also operated as a self-sufficient ranch for many years.

The McCloud River Pioneer newspaper has vague references to early mines in the watershed starting in 1890. Locations such as Grizzly Peak and Hawkins Creek are mentioned. The mines were thought to have gold and silver-bearing ore. An 1892 excerpt states that "No positively rich mine has yet been struck in the McCloud and Pit divide but plenty of 'float' indicates mineral". There was also copper mining in the watershed. There were apparently three copper mines near Hat Mountain, Pine Flat, and the mouth of Squaw Valley Creek.

1900-1945

As valley lands became settled, grazing of sheep and cattle moved into the hills and mountains. It is unknown if grazing occurred within the watershed prior to 1900, but by 1905 there were cattle grazing on Squaw Creek, the Pit River, and the McCloud River. This area was heavily burned periodically to maintain accessibility for grazing (Cransfield 1984).

The watershed area was divided into three range allotments:

1) McCloud Allotment – generally the Claiborne Creek and several smaller adjacent drainages

2) North Fork Allotment – generally the Chatterdown Creek drainage and over into Squaw Creek

3) High Mountain Allotment – west side of McCloud River

Historic use of the watershed intensified with the establishment of the Shasta National Forest in 1905. The 1916 Shasta National Forest Map shows the development of trails, phone lines, and fire lookouts. This map depicts a network of trails through the Lower McCloud Watershed. There is a major "trail passable by pack outfits" parallel to Squaw Creek and branching from there to other areas, and another "trail passable by pack outfits" from Curl Ranger Station stretching northward to and along Claiborne Creek. There are also paths described as "trails or routes passable for foot travel only) along and between other drainages throughout the watershed. Phone lines extend along some of the trails. Early Forest Service structures also appear on the 1916 Forest map, indicating a rather heavy presence in this area. There is a lookout on Grizzly Peak, the Curl Ranger Station, and the Cold Springs Ranger Station. Ogborne Mine appears on the 1916 Forest map as well, along with Rinckles Resort (on private land) and individual structures with associated names (Curl and Whittier). The map also provides direction toward the abundant deer and bear to be found in specific locations, and an area labeled simply "Good Camp" (currently on private land).

Following the purchase and use of Ah-Di-Na before the turn of the century, private sport-fishing clubs continued into the 20th century. In 1900, the McCloud River Club land was acquired from the Central Pacific Railroad by George W. Scott and William M. VanArsdale, then owners of the McCloud River Lumber Company. They established a private fishing club. A small cabin and trail bridge across the river were constructed by the Forest Service on the McCloud River Club property below Hat Mountain Creek. In circa 1900 a wagon road and later auto was eventually built to access the McCloud River Club.

In 1921, the Bolliboka Club land was purchased from owners who presumably obtained railroad land in the early 1900's. A trail bridge across the river was constructed by the Forest Service on Bolliboka Club property above Chatterdown Creek for seasonal use in fire suppression. New trails were built by the private land owners for fishing or hunting access (e.g. Tuna Creek Trail, portions of the McCloud River Trail).

There was essentially no development of publically available recreational facilities on National Forest land during this period. There was also no documented occurrences of whitewater boating. The area designated as Unroaded Non-motorized Recreation remained essentially unroaded during these periods.

<u>1945-present</u>

This period includes several events that had major impacts on the watershed.

In the 1930's lands at Ah-Di-Na that were purchased by William Randolph Hearst for recreation use, connected to his estate at Wyntoon by a trail along the McCloud River. After his death, road construction and logging were initiated by the Hearst Corporation in 1958. The Forest Service acquired lands at Ah-Di-Na from the Hearst Corporation in 1965 and shortly afterward established a public campground.

In 1945, the construction of Shasta Dam was completed and Shasta Lake was formed. This blocked the annual upriver migrations of anadromous fish, and blocked animal migrations such as deer. The inundation of the lake also hastened the end of stock grazing within the watershed as it made access more difficult (Cransfield 1984).

In 1965, the McCloud Dam was constructed and water was diverted to hydroelectric plants on the Pit River. The diversion of water drastically altered base flows in the river below the dam. The McCloud Reservoir provided a recreational attraction and the 1969 donation provided access to the area. The period from 1966 to 1992 saw considerable timber harvest in the watershed with 104 million board feet removed. Timber harvest was accompanied by extensive development of road systems through much of the area.

In the early 1970’s, the McCloud River Club donated 2330 acres of land to the Nature Conservancy, which formed the McCloud River Preserve. Whitewater boating on the Lower McCloud River began during this period. Conservancy staff observed kayakers on the river in the 1970’s. The earliest documented rafting of the river appears to been several trips in the spring of 1982, made possible by high flows from El Nino conditions during the previous winter (USDA Forest Service 1998). Lands at Ah-Di-Na were purchased by the Hearst Corporation and road construction and logging began in 1958. These activities provided road access to Ah-Di-Na. Construction of McCloud Dam and creation of the reservoir in 1965 provided a recreational attraction as well as access to the area. Logging on National Forest land in the watershed began in 1966 and further increased access into the area. In 1965, the Forest Service acquired lands at Ah-Di-Na from the Hearst Corporation and shortly afterward established a public campground, providing public fishing access o the river.

With the creation of McCloud Reservoir, the Forest Service began developing recreational facilities. On the east side of McCloud Reservoir, the Star City “Campground” evolved from a day-use only requirement imposed by deed restriction into an overnight campground receiving high usage. In 1996, Star City was closed to overnight camping to comply with the deed restrictions. This resulted in a shortage of camping facilities in the McCloud Reservoir and Lower McCloud River area. As noted previously, however, Star City will soon be re-opened and will be officially designated and managed as a campground via the McCloud-Pit Relicensing Project agreement. With the 1996 closure of the Star City site to overnight camping, increased pressure was placed on Ash Camp. Overflow from Ash Camp has been accommodated on the large flat created by tunnel tailings where the diversion pipe crosses Hawkins Creek. This location is still undeveloped and lacking in large shrubs and trees however plans are also underway to improve Ash Camp facilities and trails. From 1975 through the mid-1980s, the Pacific Crest Trail was constructed through the area - passing through Grizzly Peak, Ash Camp, and Ah-Di-Na.

During this period (mainly 1979-1982) groups such as the currently named ‘Shasta Area Grotto’ caving group began forming and becoming active in recreational cave explorations. Currently, cave use is closely monitored by the Forest Service in conjunction with local spelunking groups and overall recreational use of caves is limited.

Transportation System and OHV Routes

<u>Pre-1900</u>

During this period only historic trails existed in the watershed. These were used by Native Americans until the late 1800's when Anglo-Americans began establishing presence within the watershed. As noted previously, some roads were built in the watershed by private landowners who had been deeded properties pursuant to the Pacific Railway Act of 1862.

1900-1945

Pack trails are shown on Curl Ridge, Claiborne Creek, Hat Mountain, Hawkins Creek, Bald Mountain, and along the McCloud River. Some roads within the watershed were constructed during this time to aid in Forest Service activities such as grazing, and fire suppression activities. An auto road connected the McCloud River Club via Squaw Valley Creek. Many of these routes have had little or no maintenance and remain suitable for high clearance vehicles only. Some of these roads and trails were used to access recreation opportunities such as fishing.

1945-present

The watershed continued to remain essentially unroaded in the early part of this period. The Bollibokka Club (now Westlands and Arrillaga) constructed a one-mile access road to its main clubhouse in the 1960's, and extended this road five miles further to Tuna Creek for logging purposes in 1974. This road was further extended to Pine Flat in the 1990's to access a new cabin (Hesseldenz 2011 personal communication). Eventually several private roads were built for access and activities such as timber harvest.

In the late 1970's, the majority of the Lower McCloud River Watershed was identified during the Roadless Area Review and Evaluation (RARE II) process as potential new wilderness. RARE II established the West Girard and East Girard Roadless Areas (see Map 9 – Late Successional Reserves and Roadless Areas). The 2001 Roadless Rule' strengthened this situation by prohibiting new road construction and reconstruction in inventoried roadless areas on National Forest System lands except under specific circumstances. See Chapter 1 Roadless Designation discussion for further information.

Currently, several private inholdings have restricted road access across National Forest system lands but are not open to public vehicle traffic. A few roads within the watershed have maintenance and cost-share agreements between public and private owners – see Chapter 3 for further discussion.

Visual Resources and Scenery

Visual and scenic quality likely transitioned from very high during Native American occupancy to a more moderate-to-high quality today. Activities such as timber harvest have historically altered the visual quality within the watershed. The development of roads for various purposes has also decreased some of the visual value although many are not visible from a distance. As of 1994, however, the foreground along the McCloud River was labeled as Variety Class A (i.e. Distinctive – unusual or outstanding visual quality) but timber harvest was also visible in some places (USDA Forest Service 1994).

Because the watershed experienced relatively frequent fires before the onset of the modern fire suppression era (see Fire and Fuels discussion) there was likely more prevalent fire scarring of vegetation. Over the past 80 years, however, approximately 99 percent of the analysis area has not been affected by a fire thus reducing visual impacts of fire but also increasing the visual changes of dense vegetation.

Chapter 5: Synthesis and Interpretation

The purpose of this chapter is to compare existing and reference conditions of specific ecosystem elements and to explain significant differences, similarities, or trends and their causes. The interaction of physical, biological, and social processes is identified. The capability of the system to achieve key management plan objectives is also evaluated.

This chapter is organized by addressing the issues and core topics listed in Chapter 2. Additional topics that emerged during the analysis are included in this section.

Issues addressed in this chapter are:

- Fire and Fuels
- Habitat Quality
- Late Successional Reserve

Core Topics addressed in this chapter are:

- Physical Features
- Geomorphology and Erosional Processes
- Hydrology
- Stream Channel
- Water Quality
- Biological Features
- Vegetation
- Species and Habitats
- Human Uses

Issue 1: Fire and Fuels

Key Questions

1. What is the current fire hazard and risk in the analysis area, including the threat to private land?
2. How might future fires affect other resources (e.g. air quality, erosion processes, human uses, soil fertility, water quality, fisheries, wildlife and botanical habitat)?
3. Under current management, what are the future trends for fire in the watershed?
4. What is the desired role of fire in the watershed?
5. What are fire and fuel management concerns within the analysis area, including fire suppression?

Present Condition

The analysis of fire return interval departure shows that much of the analysis area is in condition class 3 (see Chapter 3). This indicates that a majority of the landscape has departed at least 66% from historic conditions and has missed approximately four or more fire return intervals when compared to historic occurrences. This brings a high risk of losing key ecosystem components, vegetation attributes and an increase in potential fire size, fire intensity and fire severity. Many of the private parcels of land within the analysis area have been heavily managed for timber production resulting in a mix of areas with either minimal vegetation, logging slash or early seral state vegetation (such as brush and saplings).

Conclusions that can be drawn from this analysis are:

- There are large areas of dense vegetation and high fuel loading above what is characteristic of historic conditions.
- There is a low fire start occurrence (fire risk) in the analysis area and the primary source of ignition (~76%) is lightning.
- Over 64,390 acres or 96 percent of the analysis area has not experienced fire over the past 80 years.
- High intensity, stand replacing fire is the leading threat to other resources (i.e. wildlife habitat, air quality, soil stability, recreation, hydrology, air quality, etc) and private lands.
- Air quality is at risk in proportion to fire risk and the potential for high to extreme fire behavior.
- The likelihood of successful initial attack, especially during multiple start events, is greatly diminished by the factors mentioned above.

Causal Mechanism(s)

- Fire exclusion and other past land use management (e.g. lack of vegetation management on public lands, residual fuel loading on private industrial timber lands, etc.) have exacerbated the current problematic conditions.

- Site quality and productivity allow for fire intolerant species to thrive in the absence of disturbance and promote increases in fuel loading beyond historic levels.

- A reduced amount of human ignitions compared to nearby watersheds, which often occur at unpredictable times and in unfavorable locations with respect to fire behavior, occur within the watershed.

Trends

- Through time, vegetation density and fuel loading has increased and will continue to do so without interruption by disturbance or management action. This has, in part, led to an increased likelihood of uncharacteristic fire behavior, fire intensity and fire severity in reference to historic conditions.

- There has been and continues to be a low fire start occurrence in the analysis area (an average of ~1 fire start per year) with approximately 76% being naturally occurring ignitions and 24% being generated from human caused sources.

- Forest vegetation has changed from a heterogeneous pattern of mostly fire tolerant species to a more homogeneous pattern of smaller openings in a matrix of denser vegetation with increasing populations of fire intolerant species.

- Air quality is expected to be similar to that of recent years. Activities on NFS lands are guided by provisions of the Federal Clean Air Act, the Shasta-Trinity LRMP and the California Air Resources Board to minimize adverse effects to air quality. Periods of poor air quality are likely to occur during high-intensity fires; however, smoke particulates are expected to be less than before 1900.

Influences and Relationships

- Numerous fire starts coupled with steep terrain, limited access, dense fuel conditions and weather patterns conducive to large fire growth have caused difficulties in past fire suppression efforts (e.g. High Complex, 1999). These conditions are a concern for land managers attempting to manage future wildfires within the analysis area.

- Vegetation type, disturbance history, soil type, fuels, topography and weather play a vital role in fire severity patterns on the landscape.

- Fire severity patterns on the landscape influence physical and biological resources (e.g. human uses, water quality, botanical resources and terrestrial and aquatic wildlife).

Conclusions

- There is a need to reduce fire risk and fire hazard in the analysis area.

- There is a need to protect communities at risk and infrastructure both within and adjacent to the analysis area.

- There is a need to provide for the management of fire within the analysis area to protect life, property and improvements as well as providing for the function of fire in the ecosystems.

Issue 2: Habitat Quality

Key Questions

1. How are management actions within the watershed affecting terrestrial and aquatic habitat quality?
2. Does the current condition of the watershed have a desirable mix of seral stages, age classes, and vegetation types of terrestrial habitat for wildlife species?
3. How are existing conditions influencing the potential for high-severity wildfire to impact terrestrial and aquatic habitat quality?

Present Condition

- Late and mid successional habitat exists in the watershed and provides habitat for multiple FS Sensitive species and the northern spotted owl.
- The patchwork network of ownership of the watershed has created a highly fragmented landscape within the central and eastern portions of the watershed, primarily as a result of timber harvest and road building on the sections of private land amongst the national forest lands. Prior to harvest, habitat on these private lands consisted of late-successional stands that contributed to the overall connectivity of the habitat in the watershed.
- The quantity of late-successional habitat in the watershed has been reduced as compared to levels present when the last watershed assessment was written in 1998.
- Many of the areas of chaparral are being encroached by young dense conifers causing a loss of heterogeneity, and thus a loss of habitat richness, within the watershed analysis area. In some of these areas, the natural progression of seral stages has been hindered by the lack of fire that would otherwise contribute to the stimulation of new growth and the reduction in older, decadent brush within the understory.
- Good quality riparian habitat exists throughout the drainages and tributaries and along the Lower McCloud River within the watershed.
- In some mid and late seral conifer stands within the watershed, fire suppression has resulted in a relatively dense middle story, which reduces maneuverability for predatory birds such as spotted owls and goshawks. A dense middle story can also result in reduced sunlight to the forest floor, which is essential for the production of an herbaceous vegetative layer important for sustaining prey species and plant diversity.
- Limestone caves in the area, and the bats that may occur within them, may be at some risk from recreational cavers, though to what extent is still unknown. It is possible that White-nose Syndrome (WNS) will appear in western caves and precautions may need to be made to proactively protect the caves known to be utilized by bats.
- With the FERC relicensing effort (discussion in Chapters 1 and 3), multiple surveys were conducted in areas affected by the PG&E hydroelectric project and associated facilities and roads from 2007-2009. However, these surveys were conducted, in general, on a small subset of the watershed and were not a comprehensive survey of habitats within the watershed.

Causal Mechanism(s)

- Lack of low to moderate intensity fire
- Land use activities (i.e. timber harvest and road building)
- Natural processes
- As a result of a lack of fire, many late seral stands are experiencing an encroachment of young dense conifers amongst large, widely spaced conifers and a subsequent loss of a broadleaf middle story. In some areas this is resulting in a loss of optimal habitat structure for old-growth and late seral habitat associated species

Trends

- The shade tolerant, young conifer midstory, where present within these older stands, will continue to develop, competing with the larger overstory trees for water, soil nutrients, and sunlight, which may cause the overstory trees to become stressed and eventually die.
- Late seral stands on federal lands will continue to mature, accruing large snags and downed logs as natural processes take place. Subsequently, fuels will continue to accumulate over time, increasing the vulnerability of the habitat to high intensity, stand replacing fire.
- Without low to moderate intensity fire, stands containing early seral brush/browse species will continue to become decadent, decreasing the palatability of the forage and increasing the risk of high intensity fire in areas containing dense woody debris and extensive brush skeletons; thus leading to a loss of important forage habitat (for species such as deer, elk, and prey species).
- Timber harvest and road construction on private lands are likely to continue at current levels, perpetuating habitat fragmentation throughout the checkerboard ownership in the watershed.
- Habitat fragmentation is a primary threat to multiple species of concern with either known occurrences or potential habitat within the watershed (i.e. fisher, marten, northwestern pond turtle, goshawk, northern spotted owl)
- Transfer of WNS fungus by recreationalists into caves within the watershed may affect the caves and the cave associated species in the future if the disease moves to caves in the western United States.

Influences and Relationships

- Within the last watershed analysis (1998), private timber practices and wildfire were not considered to be problematic. As was stated within Chap.5 of that document:
- Fragmentation is not inhibiting the functioning of this LSR.
- “Dispersal in the LSR will be provided by current and developing late-successional habitat.”

- Timber harvest on private lands is reducing the amount of available late and mid successional conifer habitat and increasing fragmentation within the watershed both through the use of regeneration harvest and relatively high levels of road construction.
- A lack of low to moderate intensity fire in the watershed has had many interconnected impacts on the habitat and species within the watershed.
- Stand structure has changed to the point of having extensive horizontal and vertical fuel ladders, making the watershed vulnerable to stand replacing, high intensity fire.
- Without the gradual introduction of fire back into the system, in the event of a high intensity wildfire, different types of change may take place:
    - A landscape level disturbance that results in the loss of encroaching conifers, from within primarily oak woodland or chaparral, would potentially return the area to a more natural condition.
    - However, in late seral stands that are filled in by dense, young conifers, a landscape-level disturbance event could be catastrophic to the desired goal of retaining and restoring late seral and old-growth habitat.
- Less intense wildfire can be beneficial in terms of hollowing-out trees and logs, producing charcoal which helps hold soil nutrients, killing conifer seedlings and saplings that would otherwise continue to grow and shade out important understory species, and rejuvenating fire-tolerant herbaceous and browse species, as well as the fuels related issues described in the Fire and Fuels section above.

Conclusions

- There is a need to reduce fire hazard in the watershed. Risk reduction efforts are encouraged where they are consistent with the overall recommendations in the management guidelines of the LRMP.
- Circumstances have changed since the 1998 Lower McCloud Watershed Analysis was written. Fragmentation within the watershed has increased markedly, placing an increased level of importance on the maintenance and promotion of high quality habitat on the national forest lands in the watershed.
- On the ground habitat verification and species specific surveys in areas *not* included in the FERC relicensing effort would help to identify areas that are currently being used by species of special concern. These areas could then be prioritized for either management actions and/or protection.
- Data regarding the caves in the watershed is incomplete in so far as comprehensive and current account of what species of bat are using the caves and the role the caves play in the bats' lifecycle.

- Data are also needed to determine to what extent these caves are being used by recreational cavers and what precautions are necessary to protect against the spread of WNS.

Issue 3: Late-Successional Reserve

Key Questions

1. What is the current condition of the LSR in the watershed?
2. What is the desired role of fire in the LSR?
3. What is the future trend for development, maintenance and protection of late-successional habitat in the LSR?
4. How does the Iron Canyon LSR meet the criteria for prioritizing treatment areas both within the LSR network as a whole and as within individual LSRs as outlined in the forest-wide LSR Assessment?
5. What is the role of the Lower McCloud Watershed in the functioning of the Iron Canyon LSR as a whole?

Present Condition

- Fragmentation is described within the first iteration of the Lower McCloud watershed analysis as a concern for NSO dispersal outside the watershed, but the watershed itself, and the Iron Canyon LSR, is described as not compromised as a result of fragmentation.
- In the thirteen years since the first iteration of the watershed analysis (written in 1998), the watershed has undergone relatively high levels of habitat modification, primarily from land use activities on private land, particularly within the central and eastern portions of the watershed.
- With the increasing harvest and fragmentation of larger amounts of older forests, a greater significance is placed on the protection and promotion of larger blocks of contiguous late-successional habitat (i.e. Late-Successional Reserves, Riparian Reserves, and NSO Critical Habitat) on national forest lands.
- Current levels of fragmentation, specifically on the patchwork network of private land within the central and eastern portions of the watershed, may be inhibiting the function of this watershed in its overall role within the Iron Canyon LSR. Within the 1999 LSRA, this watershed was described as an integral part of the connectivity of the LSR, primarily based on the large blocks of late successional habitat and relatively high connectivity. Currently, these characteristics are considerably reduced, with the expectation that this will likely continue into the foreseeable future.

Present Condition

- At the time of the last iteration of the Lower McCloud watershed analysis (1998), the watershed was described as the largest contributor of late-successional habitat and as containing most of the late-successional habitat and known owl activity centers in LSR RC-335. Late-successional habitat in the LSR has become considerably more fragmented, with substantially fewer blocks of contiguous habitat since this was written.
- The Iron Canyon LSR encompasses approximately 87,674 total acres, with 28, 199 acres, or 42%, of federal ownerships within the Lower McCloud watershed.

- The Iron Canyon LSR, including Lower McCloud watershed, was identified within the LSRA as an area of elevated risk to large-scale disturbance due to changes in the characteristics and distribution of the mixed-conifer forests resulting from past fire suppression.
- The Lower McCloud watershed is one of six watersheds within or crossing the Iron Canyon LSR.
- Seventy-seven percent of the acreage within the Iron Canyon LSR (68, 639 acres) was identified as at risk of high mortality (e.g. stand-replacing) in the event of an unplanned wildfire.

Causal Mechanism(s)

- Lack of low to moderate intensity fire
- Land use activities (i.e. timber harvest and road building) on private lands
- Natural processes

Trends

- Late seral habitat on federal and non-commercial timber lands will continue to provide connectivity within the Iron Canyon LSR itself and within the network of LSRs as a whole, though the quality of the habitat will be influenced by the lack of connectivity resulting from the patchwork ownership.
- Mid seral habitat within the LSR will continue to develop into later seral stage habitat and will eventually contribute somewhat towards replacement of late-successional habitat lost to land management practices on private lands or wildfire.
- High severity, high intensity wildfire has been identified as one of the greatest threats to further loss and degradation of habitat for late-successional associated species within the network of LSRs.

Influences and Relationships

- Of the 24 LSRs analyzed on the Shasta-Trinity NF, the Iron Canyon LSR was one of the top four LSRs identified as having the greatest sustainable level of late-successional forest and that also has the highest risk.
- Management objectives for LSRs involve specific actions designed to improve, promote, and protect late-successional forest ecosystems. Protection includes reducing the risk of large-scale disturbance, including stand-replacing fire, insect and disease epidemic, and major human caused impacts.

Conclusions

- Fragmentation within the portion of the Iron Canyon LSR that lies within the Lower McCloud watershed has increased markedly, placing an increased level of importance on the maintenance and promotion of high quality habitat on the national forest lands in the watershed.

- In order to close the gap between what the current trends are and what the management objectives for the area are, more data is needed to more thoroughly evaluate current on the ground conditions and the effect that the current levels of fragmentation are having on the quality of the late successional habitat in the LSR and the watershed as a whole.
- Where ground conditions are known, a plan for achieving management goals that includes a return to more historic fire return intervals should be established for the long term sustainability of the LSR as a whole.
- There is a need to reduce fire hazard in the watershed. Risk reduction efforts are encouraged where they are consistent with the overall recommendations in the management guidelines of the LRMP.

Erosion Processes

Core Questions

1. What are the natural and human causes of changes between historical and current erosion processes in the watershed?
2. What are the influences and relationships between erosion processes and other ecosystem processes (e.g., vegetation, woody debris recruitment)?

Present Condition

- Dormant and active mass wasting features are present in the watershed.
- Road related erosion is occurring in the watershed however the full extent is unknown.

Causal Mechanism(s)

- Fire suppression activities have decreased the number of acres burned in the watershed. The decrease in ground disturbance by wildfire is believed to have led to decreased soil erosion and mass wasting activity.
- Road systems provide additional sediment sources to streams.

Trends

- Fire suppression has reduced the potential for hillslope erosion and mass wasting activity.
- Current short term trends in hillslope stability and mass wasting activity could be reversed in the event of stand replacing wildfires.
- The short time period over which mass wasting processes have been studied and land-use activities have occurred (<50 years) precludes predictions of long term trends in mass wasting processes.

Influences and Relationships

- High intensity stand replacing wildfire could destroy the soil organic layer resulting in increased slope instability.
- High intensity stand replacing wildfire increases the potential for mass wasting and hillslope erosion.
- Roads increase hillslope erosion and gullying by disrupting drainage patterns.
- LSRs encourage development of vegetation conditions that improve slope stability and reduce hillslope erosion.
- Peak flow events increase the hillslope erosion process.

- Hillslope erosion processes influence water quality.
- Hillslope erosion can deliver large volumes of sediment to the upland channel network.
- Sediment loads from erosion processes can result in a loss of spawning habitat.

Conclusions

- No definitive conclusion can be made regarding the effects of land-use activities on mass wasting processes due to the short time period (<50 years) during which land-use activities have occurred in the watershed. Longer time periods and more intensive studies will be necessary to determine how land-use activities affect mass wasting processes.
- There is a need to inventory roads for erosion concerns and implement actions to reduce road-related erosion in areas where there is a potential to affect water quality and aquatic and riparian habitats.
- There is a need to develop a transportation system that is compatible with Late Successional and Riparian Reserve objectives and meets the access needs of private land owners.

Hydrology

Core Questions

1. What are the natural and human causes of change between historical and current hydrologic conditions?
2. What are the influences and relationships between hydrologic processes and other ecosystem processes (e.g., sediment delivery, fish migration)?

Present Condition

- Peak and baseflows in tributaries to the McCloud River are not believed to have changed appreciably from reference to current conditions.
- Baseflows and peak flows occurring at less than 5-10 year intervals in the McCloud River have been reduced due to water diversions from Lake McCloud.

Causal Mechanism(s)

- Diversion of water from Lake McCloud to Iron Canyon Reservoir

Trends

- Trends in base and peak flows are static but will be changing depending on the outcomes of the relicensing process for the McCloud-Pit Project.
- The occurrence of high intensity stand replacing fire could increase base and peak flows.

Influences and Relationships

- Peak flows are affected by high intensity stand replacing wildfire, high road densities, and timber harvest activities.
- In the absence of disturbance, LSRs allow for the development of vegetation conditions that reduce peak flows.
- Peak flow events result in increased hillslope erosion.
- Reduced baseflows linked to the McCloud-Pit Hydropower Project have resulted in decreased flow depths and wetted channel widths in the McCloud River.
- Peak flows are important to the downstream transport of gravel and large woody material.
- Higher flows improve the quality of whitewater boating in the McCloud River.
- Lower baseflows in the McCloud River improve the quality of fishing by providing better conditions for wading.

- Decreased water releases and reservoir impoundment have resulted in higher water temperatures downstream of McCloud Dam.

- McCloud Reservoir alters the supply of coarse sediment and bedload transport below the dam.

Conclusions

- Peak and base flows in tributaries to the McCloud River are functioning within the range of natural variability.

Stream Channel

Core Questions

1. What are the natural and human causes of change between historical and current species distribution and habitat quality for species of concern in the watershed?
2. What are the influences and relationships of species and their habitats with other ecosystem processes in the watershed?

Present Condition

- The stability of upland stream channel types has increased in areas where fire has been effectively suppressed.
- Upland channels have been impacted by increases in fine sediments in heavily roaded areas.
- Larger streams have been impacted by sediment sources from roads located within and adjacent to inner gorges.

Causal Mechanism(s)

- Fire suppression.
- Roads.
- Timber harvest.
- McCloud-Pit Project

Trends

- The stability of upland channels continues to increase in areas where fire has been excluded.
- Poorly maintained roads continue to be chronic sediment sources to streams.
- Reduced baseflows linked to the McCloud-Pit Hydroelectric have resulted in decreased flow depths and wetted channel widths in the McCloud River.
- Substrate and LWD recruitment is altered below the McCloud Reservoir dam.

Influences and Relationships

- Hillslope erosion following catastrophic wildfire can deliver large volumes of sediment to the upland channel network.
- High intensity stand replacing wildfire destroys large woody debris in riparian areas and removes the source of future large woody debris.

- When stream channels are destabilized by high intensity stand replacing wildfire, riffles tend to elongate resulting in a loss of pools and deep water habitat.
- High intensity stand replacing wildfire removes riparian vegetation which is critical to bank stability.
- Increased sediment loads following large wildfires cab result in a temporary loss of spawning habitat.
- Road building can increase sediment delivery to the channel network.
- Poorly designed road crossings can result in aggradation of stream channels.
- LSRs encourage development of vegetation conditions that improve slope and bank stability.
- LSRs provide an ample source for the long-term recruitment of large woody debris in Riparian Reserves.
- Reduced baseflows linked to the McCloud-Pit Hydroelectric Project have resulted in decreased flow depths and wetted channel widths in the McCloud River.
- The stream channel characteristics of the McCloud River can affect the quality of whitewater boating.
- The formation and maintenance of habitat features, such as deep pools and runs are, critical to the production of large and mature trout.
- Spawning gravels below McCloud Reservoir dam have been depleted.

Conclusions

- Fire suppression has decreased sediment inputs and increased channel stability in areas where fire has been excluded.
- Upland channel types have been impacted by roads. There is a need to conducts sediment source inventories to determine how roads are impacting aquatic and riparian habitats.
- There is a need to manage for the accumulation of fuels in areas where fire has been excluded. Fire must be reintroduced in the watershed in order to prevent the continued build up of fuels in fire prone areas and to reduce the risk of high intensity stand replacing fires.
- Coarse sediment replacement in McCloud from Star City Creek delta will be implemented on an experimental basis and should be evaluated for effectiveness (dependent on completion of relicensing process).

Water Quality

Core Questions

1. What are the natural and human causes of change between historical and current water quality conditions?
2. What are the influences and relationships between water quality and other ecosystem processes in the watershed (e.g., mass wasting, fish habitat, stream reach vulnerability)?

Present Condition

- Mean summer water temperatures in the McCloud River above Shasta Lake have increased by 5.5 degrees Celsius from pre-reservoir temperatures (Rode 1990; USDA Forest Service 1998).
- Turbidity levels in the McCloud River are lower than pre-reservoir conditions.
- With the exception of Ladybug and Bald Mountain Creeks, little to no water quality data is available for tributaries to the McCloud River.

Causal Mechanism(s)

- McCloud Reservoir Dam
- Iron Canyon Diversion

Trends

- There is a risk of increased sedimentation should high intensity stand replacing fire occur.

Influences and Relationships

- Hillslope erosion following catastrophic wildfire can deliver large volumes of sediment to the upland channel network.
- Large fires result in the formation of ash which can increase the pH of streams.
- High intensity stand replacing wildfire removes riparian vegetation which is critical to maintaining cooler water temperatures.
- Increased sediment loads following large wildfires results in a temporary loss of spawning habitat.
- Road building can increase sediment delivery to the channel network.
- Timber harvest can increase sedimentation and reduce canopy cover over streams.

- LSRs and Riparian Reserves provide greater crown cover that reduces water temperatures.
- Water quality affects aquatic and riparian dependent wildlife species and fisheries.

Conclusions

- Summer water temperatures have increased in the McCloud River and winter water temperatures and decreased.
- More water quality data is needed to assess water quality conditions in tributaries to the McCloud River.
- Water quality is likely affected by poor road drainages in HUC7 drainages (Upper Hawkins Creek, Upper Claiborne Creek, and Upper Chatterdown Creek.

Vegetation

Core Questions

1. What are the natural and human causes of change between historical and current vegetative conditions?
2. What are the influences and relationships between vegetation and seral patterns and other ecosystem processes in the watershed?

Present Condition

- Aggressive fire suppression over the last decade, coupled with highly productive soils has resulted in:
- Skewed distribution of seral stages, due to lack of an active fire regeime.
- Departure from historic vegetation species composition, with conifer species becoming locally dominant due to an abrupt change (100 years) in the major disturbance regime, wildland fires.
- Understory plant community changes.
- The loss of early seral habitat through fire exclusion and natural succession has been partially offset by the establishment of plantations on public and private lands.

Causal Mechanism(s)

- Fire exclusion
- Site productivity
- High precipitation
- Commercial tree harvest

Trends

- Early seral habitat acres will continue to be inadequate
- Hardwood forest habitats remain stable, but declining over time in the absence of natural disturbance regimes of frequent low intensity fires.
- Mid to late seral conifer habitats are expected to increase slowly increase over time on public lands without active management
- Mid to late seral conifer habitats may show an overall decrease on commercial timber lands, as recent harvests show clear-cutting of these stands to be occurring. These lands account for approximately 18% of the analysis area.

Influences and Relationships

- There is a potential for conversion large acreages of mid and late-successional forest to high intensity, high severity wildfire to early seral habitats.
- High intensity wildfire removes riparian vegetation which is critical to maintaining cooler water temperatures, increasing stream biotic potential, and maintaining bank stability.
- High site productivity and high precipitation make the watershed suitable for supporting large acreages of late-successional forest.
- Fire exclusion has allowed large acreages of late-successional forest to develop.
- Forest stand history has allowed the development of multi-layered stand structures.
- The LSR land allocation emphasizes the development of late-successional forest in the watershed rather than early seral stages.
- LSRs encourage development of vegetation conditions that improve slope stability and reduce hillslope erosion.
- LSRs encourage development of vegetation conditions that reduce peak flows.
- LSRs and Riparian Reserves provide greater crown cover that reduces water temperatures.

Conclusions

- The vegetation condition in the watershed influences wildlife habitat, fuel loads and structure, slope stability

Species and Habitat

Core Questions

1. What are the natural and human causes of change between historical and current species distribution and habitat quality for species of concern in the watershed?
2. What are the influences and relationships of species and their habitats with other ecosystem processes in the watershed?

Threatened, Endangered and Sensitive (TES) Plants and Other Species of Concern

Present Condition

Populations of sensitive plants are known to occur within the watershed analysis area. Rare plant habitat is present however it may be declining and there is unexplored habitat for several sensitive plants throughout the watershed. Some existing habitat may be threatened by potential very high-severity wildfires. Other habitat, however, may benefit from fire. Human disturbance within the watershed currently plays a minor role in the threats to these botanical species of concern. Although a few surveys for rare species have occurred in the area, a comprehensive inventory for rare plant, fungi, lichens, and bryophytes is lacking.

Causal Mechanism(s)

- Rare plant habitat is imperiled by fuels accumulation from fire suppression. Many rare species rely on forest openings and may be limited in reproductive capabilities due to a dense overstory condition.
- The mechanisms behind rare species' responses to various fire frequencies, intensities, or severities are not well documented. Some generalizations, however, have been observed:
- Species with deep rhizomes, such as English greenbriar, or bulbs, such as Butte County frittilary, may persist or flourish after prescribed fire or wildfire. For example, a 2006 study (USDA Forest Service) showed Butte County fritillary as having "no apparent change in population'' after a spring underburn was implemented.
- Species which have evolved with low- to moderate intensity fire may benefit from similar conditions created by prescribed burns.
- Late successional associated plant species (e.g. Pacific fuzzwort) may be negatively impacted by a high severity stand-replacing fire due to loss of necessary large-diameter trees, adequate shading, etc.
- Past and present human-caused disturbances such as road and trail construction, timber harvest, and some mining may have contributed to a lack of rare plant habitat. Competition from noxious weeds may be displacing rare plant species.

- Access to the watershed for recreation (hiking, OHV, camping, etc.) is somewhat limited (see Human Uses sections) therefore direct impacts such as trampling or poaching of species on public lands is not of major concern at this time.

Trends

- The risk of very high-severity fire – and thus its potential negative impacts to rare plant populations and suitable rare plant habitat – has increased with fire exclusion and in the absence of treatment of accumulated fuels.
- The risk of negative impacts to rare species from human disturbance within the watershed is not markedly increasing however it may increase as recreation within the area increases.

Influences and Relationships

- High-severity wildfire can extirpate rare plant populations and result in temporary loss of rare plant habitat. Continued accumulation of untreated fuels in the watershed will increase the risk of high-severity fire.
- Reduced sunlight in the absence of disturbance results in habitat loss for some rare plant species.
- Although recreation use in the analysis area is relatively low, human activities such as OHV use, hiking, driving, and camping may threaten rare plant populations and habitat through direct trampling, soil compaction and/or introduction and spread of noxious weeds.
- Competition from noxious weeds may displace rare plants.
- Protection measures that maintain the viability of rare plant populations during Forest activities increase the likelihood of their survival.

Conclusions

- Appropriate management of fuels to maintain or enhance habitat conditions for known rare plant occurrences will likely promote stable or increased population numbers of these plant occurrences within the watershed.
- Properly managed human activities within the watershed analysis area (e.g., OHV use, camping, hiking, and fishing) will continue to have little negative impacts to rare plants.
- Surveys for sensitive plant, lichen, fungus, and bryophyte species are needed in the majority of the watershed.

Noxious Weeds

Present Condition

Several noxious weed species have established in the watershed and may possibly increase in abundance and distribution. These documented weeds occur primarily along the Hawkins Creek Road, and at the Ah-Di-Nah and Ash Camp campgrounds within the watershed analysis area as well as along the perimeter of the McCloud Reservoir adjacent to the analysis boundary. No known weed populations are known to be directly competing with native rare plant species however they are competing with native vegetation.

- Particular weed species of concern include: black locust, Himalayan blackberry, yellow star thistles, perennial pea and spreading hedgeparsely.
- Black locust and Himalayan blackberry are infesting campgrounds and scattered locations within the riparian zones but have not yet encroached into conifer stands.
- Yellow star-thistle is established at Ah-Di-Na and other historic sites along the river. Yellow star-thistle is competing aggressively against native herbaceous vegetation. This species deposits allelopathic compounds in the soil which prevents germination of other plants.
- Other invasive plant species, such as Scotch broom, dyer’s woad, and gypsy flower, have not yet been found within the analysis area, but currently exist upstream and are likely to eventually reach the analysis area.

Causal Mechanism(s)

- Causal agents for the introduction of specific individual noxious weed populations in the watershed are unknown. Several species, however, may have been introduced through animal dispersal, road building, grazing, logging, or other human activities (camping, vehicle use, and hiking) within the watershed analysis area. In particular, establishment of the Ah-Di-Na homestead, the McCloud River Club, and the Bollibokka Club may have been a vehicle for intentional and unintentional weed seed introduction.
- Species such as black locust may have spread along the McCloud River via transport of seeds from high flows.
- Additionally, wildfires in the watershed analysis area created openings in the forest canopy where invasive species may have established; however, without surveys this information is unknown.

Trends

- Non-native species exist in the watershed. These species’ populations will continue to increase if no or insufficient weed-removal plans are implemented. In particular:

- Black locust is expected to continue colonizing additional sites along the river floodplain between Ah-Di-Na and Shasta Lake.
- Himalayan blackberry is expected to continue colonizing additional riparian areas along the river and tributary streams between McCloud Dam and Shasta Lake
- Yellow star-thistle and other noxious weeds are likely to continue spreading along roads wherever there is disturbed soil.
- Existing native riparian vegetation along the Lower McCloud River is likely to be displaced wherever black locust and/or Himalayan blackberry become established.
- Insufficient funding does not permit a systematic program to effectively deal with invasive species removal presently.

Influences and Relationships

- Species such as Himalayan blackberry, yellow star thistle, or black locust may outcompete and thus diminish available browse for wildlife.
- High-severity wildfires increase the risk of introduction and spread of noxious weeds.
- Human activities such as road maintenance, OHV use, hiking, passenger car use, and camping act as vectors for the spread of noxious weeds.
- Removal of non-native vegetation may have temporary impacts around recreation sites, such as Ah-Di-Na Campground, until native vegetation recovers.

Conclusions

- Black locust, yellow star thistle, Himalayan blackberry, perennial pea, spreading hedgeparsely and thistles are likely to spread in the watershed analysis area and will continue to compete with native species if active weed management is not implemented.
- Black locust occurring in riparian areas may spread in this ecotype, displacing native riparian vegetation. New populations may expand at existing campgrounds (e.g. Ah-Di-Nah) or establish at other sites (e.g. Ash Camp) but likely will not encroach into sufficiently dense (i.e. shaded) conifer stands.
- Other nearby invasive plant species will likely establish within the watershed.

Terrestrial Wildlife Species and Habitat

Present Condition

- Habitat for late seral species such as the northern spotted owl, goshawk, marten and fisher currently exists in the watershed and is of variable quality, depending on factors such as position on the slope, aspect, site productivity and last occurrence of a disturbance mechanism (e.g. fire, wind event, landslides, or flooding).

- Habitat for species associated with limestone, caves and rock outcroppings (such as Shasta salamanders, bats, and mollusks) exists in the watershed - though to what extent is not completely known.

- Current habitat quality and species distribution has changed from historic conditions due to a general change in stand structure due, at least in part, to a lack of low to moderate intensity fire and the subsequent growth of a dense conifer mid-story, a more tightly closed overstory and an accumulation of large amounts of dead and down woody debris in the form of either logs or brush skeletons.

- Surveys for federally listed and FS Sensitive species were conducted within portions of the Lower McCloud watershed during the FERC relicensing effort (2007-2009), though these were not a comprehensive survey of all suitable habitat within the watershed for any of the species of concern. Areas surveyed were in association with the PG&E facilities such as the Lower McCloud Reservoir, portions of the Lower McCloud River and many of its tributaries, campgrounds, and some associated roads. It should not be assumed that the area has had complete surveys for all species of concern. Each species for which a survey was conducted had its own individualized survey area, which did not necessarily overlap with other survey areas. Surveys were not completed for FS Sensitive species that were deemed to be unaffected by the relicensing, such as marten and fisher, or in unaffected areas containing suitable habitat for species such as northern spotted owl or goshawk. However, some species received very thorough surveys, such as terrestrial mollusks, bald eagles and Shasta salamanders.

- There are both known locations and unconfirmed sightings for federally listed and candidate species within the watershed; five northern spotted owl activity centers; multiple confirmed sightings of Pacific fishers; and one unconfirmed sighting of a wolverine.

- There are both known locations and sightings of Forest Service Sensitive species within the watershed; two known bald eagle nests and multiple sightings; confirmed Shasta salamander detections; confirmed northwestern pond turtle sightings; willow flycatcher sightings; confirmed locations for multiple FS Sensitive (and Survey & Manage status) terrestrial mollusks.

- The Lower McCloud watershed includes portions of Critical Habitat Unit (CHU) #CA-4/CHU 28 (Eastern Klamath Mountains) Subunit 77 for the northern spotted owl, which was seen by the Interagency Scientific Committee (ISC) as the best opportunity to create a large habitat conservation area in the Shasta-McCloud sub-province.
- Limestone caves in the area, and more specifically the bats that may occur within these caves, may be at some risk from recreational cavers, though to what extent is still unknown. It is possible that White-nose Syndrome (WNS) will appear in western caves and precautions may need to be made to proactively protect the caves known to be utilized by bats.

Causal Mechanism(s)

- Lack of low to moderate intensity fire
- Land use activities (i.e. timber harvest and road building) on private land
- Natural processes

Trends

- Private lands are likely to continue timber harvest and road construction at current levels, perpetuating habitat fragmentation throughout the checkerboard ownership in the watershed.
- Habitat fragmentation is a primary threat to multiple species of concern with either known occurrences or potential habitat within the watershed.
- As natural processes take place, late seral stands will continue to mature, and large snags and downed logs will accumulate, causing an increase in habitat for species associated with large woody debris, such as forest carnivores (fisher, marten, etc.) and prey species (wood rats, rodents species, etc.).
- Subsequently, fuels will continue to accumulate over time, increasing the vulnerability of the habitat to high intensity, stand replacing fire and the potential loss of large blocks of late seral habitat.
- Stands containing early seral brush/browse species will continue to become decadent, decreasing the palatability of the forage and increasing the risk of high intensity fire in areas containing dense woody debris and extensive brush skeletons, leading to a subsequent loss of important forage habitat (for species such as deer, elk, and prey species).

Influences and Relationships

- Circumstances have changed since the 1998 Lower McCloud Watershed Analysis was written. Fragmentation within the watershed has increased markedly, placing an increased level of importance on the maintenance and promotion of high quality habitat on the national forest lands in the watershed.

- The Critical Habitat Unit (CHU) is one of the keys to maintaining the viability of the sub-province and providing a source population for northern spotted owls, and is considered in the LSR Assessment as one of the most important CHUs to protect in the sub-province.
- The CHU is a vital area for providing linkage and connectivity, and an opportunity for genetic interchange between the northern and California subspecies.

Conclusions

- Due to the increased level of importance placed on the Critical Habitat Unit within which the Lower McCloud watershed occurs, management should focus on activities that are compatible with the objectives of enhancement, protection, and promotion of the high value habitat present within the watershed.
- While relatively extensive surveys have been conducted for some species within the watershed, large portions of the watershed (those areas unaffected by the FERC relicensing) remain unsurveyed. Additional surveys would provide managers information for making site specific recommendations geared toward the enhancement, protection, and promotion of species specific habitats.

Aquatic and Riparian Species

Present Condition

- The construction of Shasta Dam and creation of Shasta Lake blocked federally listed anadromous salmon and steelhead from their historic range in the McCloud River. The Bureau of Reclamation and other federal and state agencies are examining the possibility of re-introducing Sacramento River spring run and winter run Chinook salmon into historically occupied habitats above Shasta Dam.
- Shasta and McCloud Dams contributed to the demise of bull trout in the McCloud River.
- Aquatic mollusks that are either listed on the Regional Forester’s October 15, 2007 Sensitive species list or listed as Survey and Manage Species under the Northwest Forest Plan occur in the analysis area.
- The lower McCloud River and its perennial tributaries provide consistent year-round flows fed by cold water from Mount Shasta snow melt and natural springs. Stream habitats are generally properly functioning with cool water refugia, functioning riparian areas, adequate instream cover, and a variety of pool habitats. However, the conditions of specific aquatic habitat parameters are affected by the operation of McCloud Dam and reservoir.
- Stream habitats are dominated by both native and introduced trout species that provide popular sport-fishing opportunities for trophy sized trout. These trout species utilize the lower McCloud River for all phases of their life cycle.

Causal Mechanism(s)

- Construction of Shasta Dam and the subsequent creation of Shasta Lake – as well as construction of McCloud Dam – has fundamentally altered aquatic habitats and aquatic species communities in the McCloud River.
- Current and historic natural and human-caused disturbances that have had the most influence on habitat conditions within Riparian Reserves are fires, floods, grazing and timber harvest. With little timber harvest and grazing activity, and relatively low road densities, the current greatest threat to the function of Riparian Reserves in the analysis area is high intensity fire. Fire suppression has led to increased upland stand densities, which has contributed to less frequent but higher severity fires across the landscape. These high-severity upland fires have burned through Riparian Reserves with similar intensity.

Trends

- Current fish populations within streams are expected to remain stable. Aquatic and riparian-dependent species habitat will fluctuate in response to future disturbances such as fires and floods.

- Aquatic mollusk species of concern are expected to remain stable as long as their perennial spring habitats remain undisturbed.

Influences and Relationships

- Localized cold spring complexes and spring-fed cold, clear waters with low amounts of fine sediments are critical for maintaining populations of sensitive and survey and manage aquatic mollusk species.

- Successful recovery efforts for aquatic species of concern will conserve and restore the long-term dynamics of watersheds, rather than just habitat attributes. Meeting any given management imposed habitat standard may or may not reflect the health of a stream or spring system. Maintenance of critical stream processes, such as the flow regime; sediment, woody material delivery, and riparian vegetation are more likely to result in the successful conservation of aquatic and riparian-dependent species. Riparian Reserve designations and the Aquatic Conservation Strategy were designed to protect these critical stream processes.

- Fire impacts to vegetation within Riparian Reserves can be highly variable and are dependent on a wide variety of factors including fire intensity and behavior, fire weather, vegetation type, vegetation density and age, topographic factors (e.g. slope, aspect, and elevation), and local soil moisture conditions. Riparian Reserves at the greatest risk of loss from high and moderate burn intensities are upland ephemeral and intermittent stream drainages. Fires in upland areas generally burn swales and ephemeral and intermittent stream channels at the same intensities as the adjacent hillslopes because of dry summer conditions that deplete moisture and create favorable conditions for fire (Skinner 1997). Being of higher gradient, they also contribute to a chimney effect of fire being drawn up ravines. Generally large perennial channels burn at low intensity and have little hardwood and conifer mortality.

Conclusions

- Additional survey information for aquatic species of concern is needed to accurately plan for future projects proposed in the analysis area.

- Carefully planned vegetation management treatments will move Riparian Reserves towards desired conditions as well as benefit multiple species.

- Within the lower McCloud River Watershed, effects of a potential future high severity wildland fire on Riparian Reserves would markedly decrease the functioning of riparian and stream habitats within the Reserves.
- Vegetation treatments within Riparian Reserves, including prescribed fire, may be appropriate to protect them from future high intensity wildfire.
- Reduction of heavy fuel loads within the watershed would help attain Aquatic Conservation Strategy objectives by:
- Protecting riparian habitat and by providing for better long-term growth and persistence of functioning vegetation communities in Riparian Reserves.
- Reducing the potential and of high erosion rates that result from widespread high intensity wildfires by returning the area to a more natural fire regime.
- Allowing for unplanned ignitions to play their natural role in the ecosystem.

Human Uses

Core Questions

1. What are the causes of change between historical and current human uses?
2. What are the influences and relationships between human uses and other ecosystem processes in the watershed?

Heritage Resources

Present Condition

There are at least 25 known cultural resources (sites) within the Lower McCloud Watershed boundary and there are likely additional resources that have not yet been identified. Most of the sites within the watershed have been susceptible to damage and destruction from human uses including road construction and maintenance, logging and modern camping, casual artifact collecting and intentional looting Details about the current conditions of the sites along the McCloud River have been reported during the McCloud-Pit FERC relicensing project. The current conditions for the remainder of the sites in the analysis boundary are not known since they have not been visited or assessed for impacts recently. There are two sites within the watershed that are eligible for the National Register of Historic Places Causal Mechanisms

- Human uses including road building, logging and recreational access

Trends

- Proposed or future road construction or maintenance, logging, or increased recreational access will continue to impact sites over time.

Influences and Relationships

- Continued or improved recreational access to the watershed will increase negative impacts to cultural resources through vandalism and theft of desirable artifacts.
- Management activities such as logging and road construction have the potential to disturb or destroy known and unknown cultural resources.

Conclusions

- All sites should be formally visited to update the site records and document impacts that may have occurred since the sites were originally recorded.
- Adequate survey for cultural resources within the entire watershed boundary should be conducted to ensure an accurate inventory and to document previously unknown sites.

Recreation

Present Condition

- As large areas with dense vegetation and fuel loading conducive to large fire growth and extreme fire behavior increase in the analysis area, the risk of adverse effects to recreation resources (e.g., scenery and access) also increases.
- Unmanaged recreation activities (e.g. illegal campfires) in the watershed could pose risks to other resources and increase the risk of human-caused fire starts. Improvements to managed recreation sites are underway.
- The arrangement of existing parcels of public land along the river below Ah-Di-Na does not provide adequate river access for recreation in desirable locations.
- There is concern that the limited amount of public land along the lower river cannot withstand the impacts of heavy recreational use such as fishing or whitewater boating.
- Ash Camp overflow camping is currently being accommodated on the terrace where the diversion tunnel crosses Hawkins Creek.
- The Unroaded Non-Motorized Recreation area (Prescription I) is underutilized.
- Opportunities for additional trails have been identified within the Unroaded Non-Motorized Recreation management prescription.

Causal Mechanism(s)

- Fire suppression.
- Unauthorized OHV routes expose upland areas to direct and indirect resource impacts. Current closure orders have not eliminated this concern.
- Past road and trail construction opened the watershed to increased recreational use.
- Popularity of recreational activities such as fishing, camping, and whitewater boating are increasing.
- Construction of McCloud Reservoir created a nearby recreational attraction.
- Most of the land along the McCloud River is privately owned.
- Unmanaged use of the Star City site..
- There is a lack of trail access to the Unroaded Non-Motorized Recreation area.

Trends

- Unmanaged recreation use in the watershed could increase the potential for human-caused fire starts.
- River use is expected to increase as the popularity of fishing and whitewater boating increases.
- OHV and pedestrian traffic are expected to increase.
- Use of the Unroaded Non-Motorized Recreation Area is expected to remain unchanged.

Influences and Relationships

- Increased OHV traffic has the potential to impact the integrity of the watershed by creating new routes on the landscape, creating ruts that channel water downslope, impacting soil, and spreading noxious weeds. In addition, if unauthorized routes increased, particularly in sparsely covered landscapes, can adversely affect the forest's visual resources and rare plant populations and habitat.
- Unmanaged recreation use increases the likelihood of human-ignited fires (e.g. escaped campfires, fireworks, etc.). Human caused fire starts along streams at the base of slopes may result in hotter and more damaging fires than fire starts along ridge tops. Major wildfires have the potential to affect access to and the quality of recreational activities.
- Providing opportunities for well-managed recreation decreases potential negative impacts to the watershed.
- Widespread high intensity wildfires may burn large areas of vegetation, thus potentially exposing caves to increased exploration and resource damage; major wildfires also impact visual resources.
- Impacts to air quality from major wildfires are of concern for their effect on human uses. Prescribed fires may also impact air quality; however, these impacts are managed to reduce adverse effects.
- Land ownership patterns affect the quality of the recreational experience.

Conclusions

- Increased recreational use of the watershed may increase soil erosion, human-caused fire starts, and noxious weeds infestations, thereby adversely affecting water quality, heritage, visual resources, rare plant populations and habitat, and special features such as caves.
- Managing recreation and recreation sites within the watershed will decrease potential negative impacts or hazards to the landscape from these activities.

- Major wildfires have the potential for adverse impacts to recreation, visual resources and other human uses in the watershed. As the risk of major wildfires increases with continued fuels accumulation, the risk of impacts to human uses from fires also increases.

- River access on public land need to be managed to accommodate recreationists.

- There is a need to provide additional camping sites in the northeast portion of the watershed - consistent with objectives of the LSR – and around the Ash Camp area.

- The Unroaded Non-motorized Recreation Area (Prescription I) is currently underutilized due to a lack of trails. Opportunities exist to develop a trail system in this area.

Chapter 6: Recommendations

The purpose of this step is to bring the results of the previous steps to conclusion, focusing on management recommendations that are responsive to watershed processes identified in the analysis. By documenting logical flow through the analysis, issues and key questions (from step 2) are linked with step 5 synthesis and interpretation of ecosystem understandings (from steps 1, 3, and 4). Monitoring activities are identified that are responsive to the issues and key questions. Data gaps and limitations of the analysis are also documented.

Recommendations included in this chapter are:

Fire and Fuels

Recommendations

- Fire management activities including hand/mechanical fuel reduction treatments, the use of prescribed fire and utilizing unplanned fires for resource benefit are needed to:

    - reduce the severity of fire effects and fire behavior in the analysis area,

    - to meet land management objectives,

    - to restore fire processes where compatible with other resource needs

- Fuel reduction treatments should focus on areas where high resource values are subject to high hazard and risk. The future outcome would be a return of fire to the forest ecosystem which would be achieved by limiting intensity of fire that occurs in the area by reducing fuels, reintroducing fire into the ecosystem, and restoring the ecosystem to a pre-suppression condition in which fire would be consistent with low/moderate-intensity fires that were common historically whether the ignitions are planned or unplanned

- Employ a collaborative landscape approach with adjacent landowners and agencies to reduce fire hazard and fire risk to values identified in the analysis area. The majority of this approach would be prescribed burning and managing unplanned fire for resource benefit; however, thinning, mechanical treatments, and other fuels and vegetation treatments may be considered. Focus on fuel reduction treatments that alter the fuel profile so that it is consistent with policy and land management direction and more closely resembling historic conditions.

- Use natural and management created fuel-breaks in future wildfire suppression and fuels treatment activities in the analysis area. These fuel-breaks can be maintained and used with little additional investment and will increase the safety and effectiveness of fire management activities.
- Ensure there is access during fire season and periods of project implementation. Ensure roads and infrastructure (i.e. bridges) are accessible for necessary fire equipment (i.e. fire engines, crew hauls, dozers, etc.) and that gated access is passable for those that respond to fires.
- Encourage all land owners within and adjacent to the analysis area to use defensible space precautions around structures.
- Manage vegetation to reduce the potential for adverse impacts to air quality from future wildfires. Maintain air quality values to meet or exceed applicable standards and regulations during fuel reduction treatment activities.
- Incorporate lessons learned from past fires and land management actions into future fire management planning.

Habitat Quality

Recommendations

- Utilize active, silvicultural density management tools such as prescribed fire and thinning to improve habitat quality.
- Consider physiographic (e.g. soils, slope, aspect, elevation) as well as biotic (e.g. species composition, stand structure) features when predicting habitat quality outcomes from prescribed fire or other vegetation management activities. Plant communities are largely controlled by site quality and vegetation response differs by physiographic conditions.
- Consider the amount of fragmentation in the watershed when proposing management activities, such that additional fragmentation does not result from actions on national forest lands.
- Consider management actions that may reduce fragmentation in the watershed where possible, in an effort to somewhat offset the current trend toward increased fragmentation on private commercial timber land.

Late-Successional Reserve

Recommendations

- Consider the amount and extent of fragmentation in the LSR when proposing management activities, such that additional fragmentation does not result within the LSR from actions on national forest lands.

- Prepare the watershed for the reintroduction of fire while targeting the ultimate outcome of restoring forest ecosystems that are both: 1) resilient to high severity fire and 2) will provide optimal habitat conditions for species associated with late seral stage conditions.
- Due to the increased level of importance placed on the Critical Habitat Unit and the LSR within which the Lower McCloud watershed occurs, management should focus on activities that are compatible with the objectives of enhancement, protection, and promotion of the late successional habitat present within the watershed analysis area.

Other Resource Recommendations

Cave Resources

- Identify locations of caves and abandoned mines within the analysis area.
- Consult with local Grottos associated with the National Speleological Society on the locations and mapped extents of known caves, and develop site specific mitigations as needed to address cave resources.
- Conduct reconnaissance level field inventories of karst areas prior to implementing ground and vegetation disturbing activities.
- Use low-intensity prescribed fires in the vicinity of cave entrances. Pre-treat fuels when necessary, by removing from the site by hand or other prescriptive means.

Rare Plants and Noxious Weeds

- Explore opportunities to conduct studies on rare plant and noxious weeds within the watershed, particularly in response to vegetation management and fuels treatments.
- Conduct a rare plant survey of the analysis area, including limestone outcrops.
- Identify and assess populations of late-successional associated species of vascular plants, fungi, bryophytes, and lichens.
- Determine the extent and viability of the particular following sensitive plants that are known to occur in or very near to the watershed:
    - Shasta eupatory
    - scabrid alpine tarplant
    - veiny arnica
    - northern Clarkia
    - Butte County fritillary
    - Cantelow’s lewisia
    - Shasta snow-wreath
    - Pacific fuzzwort
    - English Peak greenbriar
- Update this watershed analysis with new information gleaned from surveys or monitoring regarding the location, abundance, or occurrences of species of concern.

Recreation Opportunities

- Evaluate the development of an additional campground along Hawkins Creek at the diversion tunnel.
- Monitor use of improved trail and campground facilities after PG&E upgrades existing conditions.
- Pursue opportunities to develop hiking trails within Prescription I.
- Make ridgetop jeep trails in all land allocations except Prescription I available for OHV use wherever such use is compatible with other resource values and management objectives.
- Maintain current policy of not permitting commercial rafting.

Water Resources

- Conduct a road sediment source inventory to identify sediment sources.
- Develop and implement actions to mitigate sediment sources.

Wildlife

- Re-establish and expand past northern spotted owl surveys in an effort to determine to what extent the barred owl has impacted the area and whether known NSO activity centers have been affected, and to evaluate impacts from the current levels of fragmentation
- Data on the caves in the watershed is incomplete in so far as a comprehensive and current account of what species of bat use the caves and the role the caves play in the bats' lifecycle
- Data are also needed to determine to what extent these caves are being used by recreational cavers and what precautions are necessary to protect against the spread of WNS.
- Site-specific and species specific surveys for federally listed or candidate species and Forest Service Sensitive species and their potential habitats are needed within the watershed in order to assess priorities for management actions or protections and to evaluate impacts from the current levels of fragmentation.
    - Examples of such surveys are:
        - Willow flycatcher surveys on the large patches of willows in the northern portion of the watershed, potentially in collaboration with the private land owners that also have suitable willow habitat. Some older survey information exists in the forest databases, but no current presence/absence or abundance and distribution information is available.
        - Goshawk surveys in suitable mid and late seral habitat
        - Forest carnivore surveys in areas where past surveys have not been conducted.

- There is a need to map additional limestone habitats that have had only anecdotal location information.

Research, Survey, and Monitoring Needs

Recommendations

- Research, surveys, and monitoring should be conducted whenever feasible in order to:
    - Inform sound management decisions, and to
    - Increase opportunities for implementing projects without undue restraint

Fire and Fuels

- Attempts to engage intra-government and academic research entities to identify and conduct studies evaluating the interaction of fire on particular species (see Species and Habitat section Chapter 3) would aid land manager's ability to conduct fuel reduction treatments and restore the role of fire to the landscape.
- Develop a monitoring strategy for the analysis area that is inclusive of fire management goals and is flexible, quantitative and integrated with other disciplines to allow for a comprehensive approach to managing the analysis area.

Heritage Resources

- Conduct survey within the watershed boundary to inventory and document all cultural resources possible.
- Monitor documented sites to assess the current conditions and update the site records.
- Install interpretive signs for public education at historic sites with interpretive potential.

Rationale / Objective

- Section 106 of the National Historic Preservation Act (NHPA) requires consideration of the effects of Federal undertakings on historic properties, which is possible only after cultural resources are properly inventoried and documented.
- The Shasta-Trinity National Forests "Land and Resource Management Plan" (LRMP) for the McCloud River Management Area (MA #10) outlines these protection measures: stabilization, fencing, monitoring, and limiting public use.
- The LRMP for MA #10 also outlines interpretation of archaeological sites in areas where visitors are already directed.
- The Prescription XI Heritage Resource Management objective is "to protect designated cultural resource values, interpret significant archaeological and historical values for the public, and encourage scientific research for these selected properties."
- The LRMP for MA #10 also places special emphasis on a thematic study of sites indicative of Native American and early settler use along the McCloud River and outlines interpretation of archaeological sites in areas where visitors are already directed.

The Monitoring Action Plan for Heritage Resources includes the investigation of disturbances of Native American religious/sacred and Native American traditional resources areas, checking the adequacy of site protection measures, and determining thoroughness of field identification of sites.

Appendix A – Glossary

The following terms are taken from Schwarz et al. 1976, Merriam Webster Dictionary (http://www.merriam-webster.com/), or the Oregon Department of Fish and Wildlife.

Abiotic: The nonliving, material (as opposed to conceptual) components of the environment such as air, rocks, soil (in general), water, coal, peat, plant litter, etc.

Airshed: 1. A region with common sources and problems of air pollution; it may coincide with a watershed or be a part of a large urban agglomeration. 2. The air encompassing a specific geographic region.

Alluvial: Pertaining to material that is transported and deposited by running water.

Anadromous fish: Those species of fish which mature in the sea, and migrate into streams to spawn. Salmon, steelhead, and shad are examples.

Aspect: The compass direction that the slope of a land surface faces toward (e.g. north, northwest, south).

Background: The distant part of a scene, landscape, etc.

Bedrock: 1. The more or less solid rock either on or beneath the surface of the earth. It may be soft or hard and have a smooth or irregular surface. 2. Any in place, solid rock exposed at the surface of the earth or overlain by unconsolidated material.

Biomass: The total quantity (at a given time) of living organisms of one or more species per unit of space (species biomass), or of all the species in a biotic community (community biomass).

Biota: The plants and animals of an area, taken collectively.

Biotic: All the natural living organisms in a planning area and their life processes. The term "biotic" in land use planning contexts is most commonly used as a resource classification category which subdivides the natural resources and properties into either the biota and living characteristics or the abiotic (non-living) entities and characteristics.

Blowdown: Also called "windthrow". Generally used when referring to trees uprooted by the wind.

Browse: That part of the current leaf and twig growth of shrubs, woody vines and trees available for animal consumption.

Brush: 1. A growth of shrubs or small trees usually of a type undesirable to livestock or timber management. 2. A collective term that refers to stands of vegetation dominated by shrubby, woody plants or low growing trees – regardless of whether some of the components are cropped.

Bulk density: The mass or weight of oven-dry soil per unit of bulk volume, including air space.

Carnivore: An organism (plant or animal) that feeds on animal substances.

Carrion: The bodies of dead animals, usually found in nature in the process of decay; not "fresh meat".

Clearcutting: 1. Removal of virtually all of the trees, large or small, in a stand in one cutting operation. 2. The term "clearcutting" is also loosely applied to any type of cutting in which all the merchantable timber is cut and all trees that cannot be utilized profitably are left.

Climax vegetation: 1.The group of plant species which is the culminating stage in plant succession for a given set of environmental conditions. 2. A relatively stable type of vegetation in equilibrium with its environment and with good self perpetuating reproduction of the dominant plant species.

Colluvium: Mixed deposits of soil material and rock fragments accumulated near the base of steep slopes through soil creep, landslides, and local surface runoff.

Crown: The upper part of a tree or other woody plant carrying the main branch system and foliage above a more or less clean stem(s).

Cubic feet per second (c.f.s. or ft^3/s): The amount of water, measured in cubic feet, which flows by a point in a channel (or is discharged from a discharge point).

Diameter at breast height (DBH): The diameter of a tree measured four feet, six inches from the ground level. "Ground level" can follow two conventions; either the highest point of the ground touching the stem, or the mean of the highest and lowest points.

Dissolved oxygen: 1. The oxygen dissolved and freely available in water. 2. The oxygen dissolved in water, waste water, or other liquid and usually expressed in milligrams per liter, parts per million, or percent of saturation.

Dissolved Organic Carbon (DOC): The thousands of dissolved compounds found in water that derives from organic materials (such as decomposed plant matter).

Edge habitats: The transition zone between two different habitat types.

Endangered species: 1. An endangered species, or subspecies, of animal or plant is one whose prospects of survival and reproduction are in immediate jeopardy. 2. Any species which is in danger of extinction throughout all or a significant portion of its range.

Endemic species: A species whose natural occurrence is confined to a certain region and whose distribution s relatively limited.

Fauna: The animal life of an area, "animal" being used in a broad sense to include birds, fish, reptiles, insects, mollusks, crustaceans, etc., in addition to mammals.

Flora: 1. The plant life of an area. 2. The sum total of the kinds of plants in an area at one time.

Fluvial: 1. Of or pertaining to streams and flowing waters. 2. Growing or living in streams. 3. Produced by stream action, as a fluvial plain.

Forage: All browse and nonwoody plants that are available to livestock or game animals and used for grazing or harvested for feeding.

Forb: Any herbaceous plant other than true grasses, sedges, and rushes. Also may be any non grass like plant having little or no woody material on it.

Foreground: That part of a scene, landscape, etc. which is nearest to the viewer.

Fuel-break: A natural or artificial barrier usually created by the removal of vegetation and used to prevent or retard the spread of fire. Also may be called a “fire break”.

Game species: Any species of wildlife for which seasons and bag limits have been prescribed, and which are normally restricted to possession by sportspersons under state laws and regulations.

Geomorphology: A science that deals with the relief features of the earth or of another celestial body (as the moon) and seeks a genetic interpretation of them.

Groundwater: Water within the earth that supplies wells and springs. Specifically, water in the zone of saturation where all openings in soils and rocks are filled – the upper surface of which forms the water table.

Heterogeneous: Differing in kind; having qualities which are significantly not uniform throughout; possessed of different characteristics; opposed to homogeneous.

Homogeneous: Of the same kind or nature; consisting of similar parts or of elements of a like nature; having qualities which are significantly uniform throughout; opposed to heterogeneous.

Hydrologic Unit system: A standardized watershed classification system developed by USGS in the mid 1970s. Hydrologic Unit Codes (HUCs) describe the various scales of the units. On the Shasta-Trinity NF these are delineated into eight levels (ranging from largest to smallest): Region, Subregion, Basin, Subbasin, Watershed, Subwatershed, Drainage, and Subdrainage.

Karst: A terrain with distinctive landforms and hydrology created from the dissolution of soluble rocks, principally limestone and dolomite.

Mass wasting: A general term for any of the variety of processes by which large masses of earth material are moved downslope by gravitational forces – either slowly or quickly.

Mesic: Refers to environmental conditions that have medium moisture supplies rather than hydric (wet) or xeric (dry) conditions.

Microclimate: The essentially uniform local climate of a usually small site or habitat.

Mineral soil: A soil consisting predominantly of, and having its properties determined predominantly by inorganic matter. Usually contains less than 20 percent organic matter.

Noxious plants: Also known as “noxious weeds” or “invasive plants”. Typically non-native plants that have been introduced into an area without the insect predators or plant pathogens that help keep them in check in their native habitats.

Peak flow: The maximum volume of flow attained at a given point in a stream during a runoff event. Also known as “peak discharge”.

Percolation: The downward movement of water within soil, especially the downward flow of water in saturated or nearly saturated soil.

Perennial stream: Streams that flow throughout the year and from source to mouth.

Polycyclic hydrocarbons: Any of a class of hydrocarbon molecules that have multiple carbon rings, and that include carcinogenic substances and environmental pollutants.

Prescribed burn: The planned burning of a forest, stand, prairie, or slash pile with the intent to confine the burning to a predetermined area.

Riparian: 1. In loose usage, referring to the land bordering a stream, lake or tidewater. 2. Of, pertaining to, or situated on the banks of a river (though by common usage extended to include any stream, irrespective of size).

Runoff: 1. The total stream discharge of water, including both surface and subsurface flow, usually expressed in acre feet.

Sensitive species: Generally refers to any naturally-reproducing fish, wildlife or plant species which are facing one or more threats to their populations and/or habitats. Implementation of appropriate conservation measures to address the threats may prevent them from declining to the point of qualifying for threatened or endangered status.

Seral: A biotic community which is developmental, transitory stage in an ecologic succession.

Silviculture: Generally, the science and art of cultivating (i.e. growing and tending) forest crops, based on knowledge of silvics (growth and development of trees).

Slash: The residue left on the ground after timber cutting and/or accumulating there as a result of storm, fire or other damage. It includes unutilized logs, uprooted stumps, broken or uprooted stems, branches, twigs, leaves, bark and chips.

Snag: 1. A standing dead tree from which the leaves and most of the branches have falled. 2. A standing section of the stem of a tree broken off at a height of 20 or more feet above the ground.

Stand: An aggregation of trees or other growth occupying a specific area and sufficiently uniform in composition (species), age arrangement, and condition as to be distinguishable from the forest or other growth on adjoining areas.

Succession: 1. An orderly process of biotic community development that involves changes in species, structure and community processes with time; it is reasonably directional and, therefore, predictable.

Surface erosion: Erosion which removes materials from the surface of the land as distinguished from gully or channel erosion. The two main types of surface erosion are sheet erosion and rill erosion.

Suspended particulate matter: Sum of all microscopic solid and liquid particles, of human and natural origin, that remain suspended in a medium such as air for some time. These particles vary greatly in size, composition, and origin, and may be harmful.

Swale: A low-lying or depressed and often wet stretch of land.

Threatened species: Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range and which has been designated in the Federal Register by the Secretary of Interior as a threatened species. This includes species categorized as rare, very rare, or depleted.

Topography: The configuration of a surface including a relief, elevation and the position of its natural and man-made features.

Turbidity: Defined as the capacity of materials suspended in water to scatter light. It is measured in arbitrary Jackson turbidity units (JTU). Highly turbid water is often called “muddy”, although all manner of suspended particles contribute to turbidity.

Watershed: The total area above a given point on a stream that contributes water to the flow at that point.

Wildfire: A free-burning fire. Any fire other than a controlled burn or a prescribed burn, occurring on wildland.

Wildland Urban Interface (WUI): The area where houses or dwellings meet or intermingle with undeveloped wildland vegetation.

Xeric: Refers to a habitat characterized by dry conditions rather than mesic (moderate)

Appendix B − References

Note: The following references are cited within the main document. For further references used, but not cited, refer to the project file.

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Appendix C – Map Listing

Maps are available in Adobe Acrobat, filed separately from the main document.

List of Maps

Map 26: Fire Risk

Map 27: Fire Hazard

Map 28: Federal Energy Regulatory Commission

Map 29: Limestone Bearing Rock Units

Map 30: Bedrock

Appendix D – Wildlife Habitat Descriptions

This appendix provides a brief description of wildlife habitats requirements for wildlife species that occur or potentially could occur within the analysis boundary. In parenthesis is the status of certain wildlife species in 2011, when this watershed analysis was completed.

American Marten (Forest Service Sensitive, California Species of Special Concern)

Suitable habitat consists of various mixed conifer forests types under 4000' elevation, with more than forty percent crown closure with large trees and snags. Martens use tree cavities, snags, stumps, logs, burrows, caves, and rocky crevices for cover and den sites. Habitat with limited human use is important. Small clearings, meadows, and riparian areas provide forage habitat. This species is mostly carnivorous taking small mammals and birds, but insects, fruit and fish are also consumed. See Pacific fisher for preferred road densities (LMP Appendix G).

California Red-legged Frog (Federally Threatened)

This subspecies of red-legged frog (*Rana draytonii*) occurs from sea level to elevations of about 1,500 meters (5,200 feet). It has been extirpated from 70 percent of its former range and now is found primarily in coastal drainages of central California, from Marin County, California, south to northern Baja California, Mexico. Potential threats to the species include elimination or degradation of habitat from land development and land use activities and habitat invasion by non-native aquatic species.

The California red-legged frog requires a variety of habitat elements with aquatic breeding areas embedded within a matrix of riparian and upland dispersal habitats. Breeding sites of the California red-legged frog are in aquatic habitats including pools and backwaters within streams and creeks, ponds, marshes, springs, sag ponds, dune ponds and lagoons (USFWS 2002). It inhabits cool, deep, still to slow moving water such as lakes, ponds, ditches, or slow streams (Zeiner et al. 1990). Associated dense shrubby or emergent vegetation is required, and well vegetated terrestrial areas within the riparian corridor may provide important sheltering habitat during the winter (Davidson, 1994).

Foothill Yellow-legged Frog (Forest Service Sensitive)

This species requires shallow, flowing water, apparently preferring small to moderate-sized streams with at least some cobble-sized substrate. They are infrequent or absent in habitats where introduced species are present (e.g., various fishes and bullfrogs).

Northern Goshawk (Forest Service Sensitive, Federal & California Species of concern)

Suitable habitat for goshawks is described as late seral, dense coniferous, riparian or upland forests near early seral openings. Prey is medium to large birds or small mammals. According to the LMP, 'preferred' nest stand structure is 4b, 4c, and 5 conifer habitats with 60% of the nest stand containing a habitat mosaic with >60% canopy closure, 20% brush or small trees, and two or more 1/10 acre openings. The remaining 40% is dense mature forest with no openings and greater than 60% canopy closure. Forage stands also contain a 60% habitat mosaic with the remaining 40% having younger stands and openings.

Northern Spotted owl (Federally Threatened)

Suitable nesting habitat is typically conifer or mixed conifer and hardwood forest, a total of 70% or greater crown closure with an overstory of 40% or more crown closure and large diameter tress, and two or more layered stands providing the remaining canopy closure. A multi-layered canopy that simultaneously provides cover while allowing for easy flying passage is preferred. Spotted owls nest in cavities that form in decadent or broken topped trees and snags. Their prey base of small mammals depends on the presence of snags and large down woody material.

Pacific Fisher (Federal Candidate, Forest Service Sensitive)

Suitable habitat for fishers consists of large areas of mature dense forest stands below 6000', with snags and canopy closure greater than fifty percent. Fishers use cavities in large trees, snags, logs (>30" DBH), rock areas and brush piles for cover and den sites. This species is largely carnivorous taking small mammals and birds. Riparian habitats are used as travel corridors and key habitat. Preferred road densities are <1 mi./mi.2, with 1-2 mi./mi.2 acceptable for maintaining moderate habitat (LMP Appendix G).

Northwestern Pond Turtle (Forest Service Sensitive, Federal species of Concern)

This species is found in a variety of habitat types associated with permanent or nearly permanent water (Holland, 1991; Zeiner, 1988). These turtles are often concentrated in low flow regions of rivers and creeks, such as side channels and backwater areas. They prefer creeks that have deep, still water and sunny banks. Hatchlings are small and require shallow edgewater areas with minimal currents. This species depends on basking to regulate their body temperature. Basking sites include logs and other woody material, rocks, emergent vegetation, overhanging vegetation that touches the water, and sloping banks. Studies conducted on the main stem of the Trinity River indicate this turtle prefers slow moving water (e.g., pools) where basking sites exist (Wilson et al., 1992).

Pallid Bat (Forest Service Sensitive)

This species is a year-round resident from low to high elevations. It selects a variety of day roosts including rock outcrops, mines, caves, hollow trees, buildings and bridges. Food items are primarily large ground-dwelling arthropods but also include large moths. Foraging occurs in and among vegetation as well as on the ground surface.

Peregrine Falcon (Delisted from Federally Endangered List)

Peregrine falcons were once federally listed as endangered but were delisted in 1999. After delisting, Peregrines were managed as FS Sensitive species until 2004, when they were no longer listed on the Regional Foresters Sensitive Species list. They are considered species of interest, but no longer have specific Standards and Guides described within the LRMP, other than those used for general protection of raptor species. Peregrines have relatively strict nesting requirements: vertical cliff habitat with large potholes or ledges that are inaccessible to land predators and are preferentially located near habitat that has a high avian prey population. Peregrines are known to forage near and occasionally within forested habitat types; however, it is not considered a crucial habitat for any stage of their life history.

Shasta Salamander (Forest Service Sensitive, Survey & Manage Species, Federal Species of Concern, California Threatened)

Suitable habitat for Shasta salamander is described as limestone caves or outcroppings which provide a cool, moist microclimate during the summer months, occurring below 3000 feet. They are most common where there is a light cover of oak among the limestones, though they do occur where digger pine-chaparral to sheltered canyons of Douglas-fir occur. This forested habitat also provides moist, cool microclimates, where salamanders can be found on the forest floor or under dead/down material. Salamanders are not known to use this type of habitat more than 50' from a limestone outcrop. Preferred habitat is usually found on north and east facing sides of outcrops below the 2000 foot elevation. (Bogener, D. and P. Brouha. 1979.)

Townsend's Big-eared Bat (Forest Service Sensitive)

This species is a year-round resident from low desert to high mountain habitats. It is a cavern dwelling species that uses mines, caves and buildings. It is one of the bat species most dependent on mines and caves in California. Food items are primarily small moths. Foraging occurs near vegetation and other surfaces, and prey is probably gleaned from these surfaces.

Willow Flycatcher (Forest Service Sensitive)

The willow flycatcher tends to nest in large clumps of willows separated by openings (Zeiner et al., 1990). Willow flycatchers have been detected in more linear willow habitat (some alder) along the main stem of the Trinity River; however, no nest sites were located (Wilson et al., 1992). See Chapter 3 for additional information.

Snag Cavity Dwellers

General nest tree habitat requirements for primary excavator species are snags with signs of heart rot, firm sapwood, over 50% of the bark remaining (i.e., decay class 2 or 3), and 15” dbh or greater. Some species, like the pileated woodpecker, are able to excavate in firmer wood (decay class 1), whereas others, like the pygmy nuthatch, require softer wood (decay class 4). Forest habitat requirements vary from open canopy (western bluebird) to moderate and dense canopy habitat (house wren and flammulated owl). Snag density needs vary from 1.5 to 4.0 snags per acre, with the majority of snags in the 15-24" dbh size range. Species needing >24" dbh snags include marten, fisher, northern spotted owl, pileated woodpecker and, on occasion, northern goshawk. Recruitment required to maintain this snag density over time is approximately 3 green trees to one hard snag. Forage requirements are insect infested trees or logs, seeds, flying insects, terrestrial insects, or small mammals. Snags are also used by snag and non-snag dependent species for communication, courtship, food storage, thermal regulation, denning, cover, and perches.

Bark Cavity Dwellers

Some species nest or roost primarily under the bark, such as the brown creeper and long-legged bat. Only the snag tree requirements for bats are discussed here. Bats roost under the bark of snags, within snags, under wooden bridges, within caves, in tree foliage, and other similar areas. Suitable snags have been described as hollow snags or snags with peeling bark of 1" thickness or greater, located where it can be warmed by solar radiation, and standing 20+ feet tall. During the summer, bats may use a variety of roost sites, moving from one site to another depending on the time of day and temperature of the roost. Maternity roosts are very sensitive to disturbance during the summer months and hibernaculums during the winter. Eleven species of bats are suspected to occur within the watershed, with a few species not utilizing snags. No bat roost sites have been detected within the watershed. Formal surveys for bat roost sites have not been conducted and their snag requirements are unknown.

Appendix E – Management Direction

Management direction for the Lower McCloud River Watershed is provided by the Shasta-Trinity National Forests Land and Resource Management Plan (LMP) which incorporates direction from the Record of Decision (ROD) for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl.

Land Allocation

The ROD identifies four land allocations within the Lower McCloud River Watershed (see Map 8 in the Watershed Analysis):

- Late-Successional Reserve (LSR)
- Late-Successional Reserves are identified with an objective to protect and enhance conditions of late-successional and old-growth forest ecosystems, which serve as habitat for late-successional and old-growth forest related species including the northern spotted owl. Limited stand management is permitted, subject to review by the Regional Ecosystem Office (ROD A-4).
- Riparian Reserve (RR)
- Riparian Reserves provide an area along streams, wetlands, ponds, lakes, and unstable and potentially unstable areas where riparian-dependent resources receive primary emphasis. Riparian Reserves are important to the terrestrial ecosystem as well, serving, for example, as dispersal habitat for certain terrestrial species (ROD A-5).
- Administratively Withdrawn Areas
- Administratively Withdrawn Areas are identified in current Forest and District Plans or draft plan preferred alternatives and include recreation and visual areas, back country, and other areas where management emphasis precludes scheduled timber harvest (ROD A-4).
- Matrix
- The matrix consists of those federal lands outside the three categories of designated areas listed above (ROD A-5).

Management Prescriptions

Management Prescriptions apply a management theme to specific types of land. Within the general framework of the Forest Standards and Guidelines, they identify specific activities that are to be emphasized or permitted on that land and their associated standards and guidelines.

The LMP identifies eight Management Prescriptions in the Lower McCloud River Watershed area (see Map 9 in the Watershed Analysis):

- I Unroaded Non-Motorized Recreation
    - The purpose of this prescription is to provide for semi-primitive non-motorized recreation opportunities in unroaded areas outside existing Wildernesses while

maintaining predominantly natural-appearing areas with only subtle modifications (LMP 4-45).
    - This prescription emphasizes special recreational and visual values, fisheries, and riparian resources (LMP 4-45).
    - This prescription applies to the Administratively Withdrawn Areas land allocation.
- III Roaded Recreation
    - The purpose of this prescription is to provide for an area where there are moderate evidences of the sights and sounds of humans (LMP 4-64).
    - This prescription emphasizes recreational opportunities associated with developed road systems and dispersed and developed campsites (LMP 4-64).
    - This prescription applies to the Matrix land allocation.
- VI Wildlife Habitat Management
    - The primary purpose of this prescription is to maintain and enhance big game, small game, upland bird game and non-game habitat (LMP 4-66).
    - While this prescription does not emphasize those wildlife species dependent on late seral stages, habitat favorable to these species will occur within this prescription (LMP 4-66).
    - This prescription applies to the Matrix land allocation.
- VII LSRs and Threatened, Endangered, and Selected Sensitive Species
    - The purpose of this prescription is to provide special management for LSRs and Threatened and Endangered species (LMP 4-43).
    - This prescription emphasizes retention and enhancement of sensitive plant species, old-growth vegetation, and hardwoods (LMP 4-43).
    - This prescription applies to the Late-Successional Reserve land allocation.
- VIII Commercial Wood Products Emphasis
    - The purpose of this prescription is to obtain optimum timber yield of wood fiber products from productive forest lands within the context of ecosystem management (LMP 4-67).
    - Timber stands will be managed to obtain optimum growth and yields using cultural practices which control competing vegetation, obtain stocking control, and minimize mortality (LMP 4-67).
    - This prescription applies to the Matrix land allocation.
- IX Riparian Management
    - The purpose of this prescription is to maintain or enhance riparian areas, wildlife and fisheries habitat, and water quality by emphasizing streamside and wetland management (LMP 4-59).
    - Multiple resource uses and activities will occur in support of, and to the extent that they do not adversely affect the maintenance of riparian area dependent resources (e.g., fish, wildlife, water quality) (LMP 4-59).
    - This prescription applies to the Riparian Reserve land allocation and is unmapped in the LMP.

- X Special Area Management
    - This prescription provides for protection and management of special interest areas and research natural areas (LMP 4-49).
    - Grizzly Peak is designated as a botanical Special Interest Area (LMP 4-125).
    - This prescription applies to the Administratively Withdrawn Areas land allocation.
- XI Heritage Resource Management
    - The primary theme of this prescription is to protect designated cultural resource values, interpret significant archaeological and historical values for the public, and encourage scientific research of these selected properties (LMP 4-50).
    - This area is unmapped and applies to all land allocations.

Management Areas

Supplemental management direction for specific units of land is provided in the LMP under Management Area Direction (LMP - Chapter 4 - Section G). A management area is a contiguous unit of land with separate, distinct management direction in response to localized issues and resource opportunities.

The LMP identifies three Management Areas in the Lower McCloud River Watershed area (see Map 9 in the Watershed Analysis). Supplemental management direction that applies to the Lower McCloud River Watershed is summarized as follows:

- National Recreation Area (NRA) - Shasta Unit (#8) (LMP-4-115)
    - Search for additional populations of Shasta snow-wreath. Avoid disturbance pending completion of a conservation strategy.
    - Construct no additional permanent roads on the Shasta Unit for timber harvest. Existing roads may be relocated to improve esthetics.
    - Administer the NRA according to specific direction provided in the Management Plan for the Shasta Unit.
    - Treat slash from timber harvest activities to meet adopted VQOs or fire hazard reduction objectives, whichever are the most restrictive standards. Natural fuel manipulation for fire hazard reduction will be done to maximize protection of forest investments and interface areas.
    - Plan no regulated timber harvest in the Shasta Unit. Unregulated harvest will occur to maintain a healthy, diverse, esthetic, residual stand.
    - Maintain or improve habitat for wildlife, including self-sustaining populations of ospreys, bald eagles, and Shasta salamanders. Improve habitat for harvest wildlife species.
- McCloud River (#10) (LMP-4-123)
    - Conduct a thematic study of the archaeological sites representing the Native American uses of the McCloud River. Emphasize sites that are being disturbed by dispersed recreation activities such as Ash Camp and Ah-Di-Na.
    - Interpret archaeological sites along the McCloud River in areas where visitors are already being directed.

  - Emphasize fuel management strategies that will reduce risk and hazard from wildfires adjacent to the California-Oregon Transmission Project (COPT) power line corridor.
  - To enhance forest health, develop a natural fire program to reinstate fire into the ecosystem.
  - Cooperate with the DFG in developing a Wild Trout Management Plan for the Lower McCloud River.
  - Where the opportunity arises, acquire public access along the McCloud River and Squaw Valley Creek.
  - Continue to develop trail access to and along Squaw Valley Creek and the McCloud River.
  - Emphasize the dispersed recreational use of the Tom Dow, Tom Neal, and the Pacific Crest Trail Systems.
  - Complete trailheads at Squaw Valley Creek and Ash Camp.
  - Evaluate whitewater boating opportunities.
  - In cooperation with private landowners, PG&E, and the DFG manage the Upper and Lower McCloud River and Squaw Valley Creek under a Coordinated Resource Management Plan (CRMP) to protect the unique and outstandingly remarkable features of the river environment.
  - Maintain or improve selected habitats for black bear, spotted owls, deer, elk, and turkey.
- Nosoni (#12) (LMP-4-131)
  - Cooperate with the DFG in developing a Wild Trout Management Plan for the Lower McCloud River.
  - Continue to work with the Nature Conservancy, the DFG, and the McCloud River Club to manage the recreation fishery in the McCloud River.
  - Reduce naturally occurring fuels to protect forest investments and interface areas from losses due to wildfire.
  - Provide low development and dispersed recreation facilities and emphasize hunting, fishing, and hiking opportunities.
  - Develop and implement a program to manage and use hardwoods for energy, fiber, and wildlife habitat.
  - Observe the following special management direction in the McCloud River corridor:

    Timber access:

    a. Minimize new road construction and attempt to locate new roads away from stream courses.
    b. Minimize stream crossings.
    c. Design logging systems for maximum resource protection.
- In cooperation with private landowners, PG&E, and the DFG manage the Upper and Lower McCloud River and Squaw Valley Creek under a Coordinated Resource Management Plan (CRMP) to protect the unique and outstandingly remarkable features of the river environment.
- Maintain or improve selected habitats for deer, elk, turkey, bear, bald eagle, northern spotted owls, and Shasta salamander.

- Continue to work with interest groups such as the Rocky Mountain Elk Foundation, Wild Turkey Federation, and Quail Unlimited to improve wildlife habitat.
- During project level planning identify cultural and historical values. Manage significant sites under Management Prescription XI.

The above Supplemental Management Direction consists only of those excerpts from the LMP that apply to the Lower McCloud River Watershed. Refer to the LMP (Chapter 4 - Section G) for a complete list of supplemental management direction.

Coordinated Resource Management Plan

The McCloud River System has been determined eligible for possible inclusion in the National Wild and Scenic Rivers system. In lieu of recommending Wild and Scenic River designation, the Forest Service has taken the lead in working with adjacent private landowners and public agencies to develop a Coordinated Resource Management Plan (CRMP) for the corridor (LMP 2-6).

In July 1991, the McCloud River Coordinated Resource Management Plan (CRMP) was signed by principal landowners in the McCloud River Drainage and public agencies that administer programs in that area. The CRMP is intended to be an acceptable option to Wild and Scenic designation for the McCloud River.

Coordinated planning is a process designed to achieve compatibility between the uses being made of natural resources in a specified area. A CRMP sets forth the framework for activity planning within the CRMP boundary. This approach uses the best efforts and knowledge of everyone involved; private landowners and involved Federal, State, and local agencies.

Authority for State and Federal agencies to participate in coordinated planning is contained in existing statutes or delegations of authority. The Forest LMP contains Supplemental Management Direction to manage the Lower McCloud River under this CRMP (LMP 4-123).

The intent of the CRMP is to coordinate large-scale resource planning. The following excerpt from the CRMP describes its objectives:

The primary objective of the CRMP is to preserve the pristine quality of the river resources described within.

The CRMP area includes significant recreation and visual resource values. Objectives for management are:

> *(a) maintenance of a predominately natural appearing area;*
>
> *(b) provision for public use consistent with wildlife and watershed protection and the rights of private landowners.*

The CRMP area includes significant vegetation resources. The objective for management is:

> *(a) vegetation use consistent with watershed, viewshed and fisheries values protection.*

Portions of the McCloud River have been designated by the Department of Fish and Game as wild trout waters under the California Wild Trout Program. The general fisheries management objectives of the Wild Trout Program are:

A. Maintenance of wild trout populations at levels necessary to provide satisfactory recreational angling opportunities.

B. Maintenance and enhancement, where appropriate, of the habitat required for optimum wild trout production.

C. Preservation of the natural character of the streamside environment.

These objectives are appropriate for land management practices adopted pursuant to this management plan since they relate to the central issues of the McCloud watershed, including recreation management, timber management, wildlife management, watershed protection, and fisheries management.

If, for any reason, the terms of the CRMP are not followed and the Wild and Scenic River eligibility is threatened, the Forest Service will recommend the river for Federal Wild and Scenic designation (LMP 3-23).

Appendix F – History of the Lower McCloud River Watershed

Pre-1900: Terraces which line the McCloud River contain abundant evidence of Native American use, dating 5000 years or more into the past. At least three different ethno-linguistic groups of Native Americans are known to have used the Lower McCloud River Watershed area in the years prior to the coming of the Anglo-Americans. The Okwanuchu, linguistically related to the Shasta of the Shasta Valley, may have been the earliest inhabitants of the McCloud River. Developing an intimate knowledge of the land, they easily met all their physical needs from its varied resources. They practiced an annual pattern of traveling to the higher elevations of the McCloud River drainage in the summer, including trips to the Medicine Lake Highlands to obtain obsidian at the Grasshopper Flat or Lost Iron Wells obsidian source, and to the lower elevations in the winter. They left behind tangible evidence of their passing in obsidian spear points, net-weights, and grinding stones at such places as Ah-Di-Na and Ash Camp.

Within the last 1000 years or so, two other groups began encroaching on Okwanuchu territory. The Wintu moved northward up the McCloud River corridor and the Achumawi (Pit River people) advanced westward from their home on the middle Pit River. Both groups may have been attracted by the particularly rich anadromous fisheries on the McCloud River, which in turn were products of the constant cold water supply. These groups intermarried with the Okwanuchu who eventually ceased to exist as a separate group. This new culture developed a much more intensive fishing-based economy than had been present before. Permanent, year-round villages were established, and fish and acorns collected in abundance and stored for year-round use.

Names and details of 32 Native American villages on the McCloud within the watershed, collected in the 1880s, are believed to reflect the time period just prior to 1850. Those on the south are Wintu, and north of Claiborne Creek are Okwanuchu, Pit River, or a mixture of two or all three groups. A list of 67 Native American placenames recorded within the watershed area in the early 20th century includes 54 with Wintu names, 10 with Pit River names, and three places with names in both languages. No Okwanuchu placenames survived with the possible exception of Ah-Di-Na. Many of the placenames are translated into words for natural features, plants, and animals. References include limestone formations, riffles and eddies in the river, tributary creeks, salmon and suckers, bears, grizzlies, deerlicks, panthers, mountain quail, buzzards, fleas, 'black" manzanita, live oak, "sourbush", acorns, tobacco, and "red paint." Other names mention Indian villages and trails.

The latter part of the 19th century saw the earliest penetrations into the watershed area by Anglo-Americans, but numbers apparently were minimal and the effect to the environment slight. The earliest Anglo-Americans in the general area were fur trappers. In 1829, Hudson's Bay trapper Alexander McLeod "wintered" on the upper McCloud at or near Dead Horse Summit which was named for his ill-advised camp. The McCloud was first called the McLeod River after his expedition. Although numerous trappers from the Hudson's Bay base at Fort Vancouver trapped the Sacramento and Pit rivers between 1828 and 1840, when the fur trade declined, there is no record of any who traversed the length of the McCloud River.

Gold brought miners into the watershed area in the 1850s with some mining reported in the Hawkins Creek drainage. Legend has it that a miner named Hawkins and a group of other miners found a gold mine somewhere between Bartle and Ash Camp on the northwest foot of Grizzly Peak. They found so much gold that they buried some. Hawkins became greedy and killed the others. Hawkins Creek was supposedly named for this incident by Justin Sisson in 1882 while searching for the Lost Hawkins Mine.

Settlement followed, although all recorded settlement dating to the late 19th century was located to the north or south of the watershed. The river became known as the McCloud in the early 1850's, probably for Ross McCloud who explored the entire river in the 1850's and attempted to establish a pack trail through the area. He later abandoned this route in favor of the Sacramento River.

Although there was some economic and social interaction between the Native Americans and Anglo-Americans, conflicts began almost immediately with thievery and murders committed on both sides. Actual violence appears to have diminished in the 1870's.

The rich fisheries of the McCloud River were recognized nationally and in 1872 the first California fish hatchery was established by Livingston Stone at Baird for the U.S. Fish Commission for the purpose of collecting and shipping salmon eggs. Greens Creek Fish Hatchery, four miles above Baird, was also established in 1872 to collect trout eggs. The eggs were shipped throughout the country and the world (both hatchery locations are now inundated within Shasta Lake). The sport fishing potential of the McCloud was recognized at least as early as the 1870's. Justin Sisson, who had a hotel in Berryvale (later called Sisson and Mt. Shasta), had a fishing resort at the "Horseshoe Bend" (now Hearst) on the McCloud where he took his guests, including John Muir, thus introducing wealthy sportsmen to the McCloud.

Government Land Office (GLO) surveyors surveyed the lands within the analysis area between 1870 and 1882, making sections available for distribution in the form of homesteads, Indian allotments, and grants to schools and railroad companies. There is, however, no record of any successful homesteading within the watershed during this time period. Access was by foot trail, and trails followed both sides of the McCloud.

As valley lands became more settled, grazing of sheep and cattle were moved into the hills and mountains. It is unknown, however, if grazing was conducted within the analysis area prior to 1900.

1890-1945: The GLO surveys of the 1870's and 1880's made large tracts of federal land available for distribution. Sections 16 and 36 in each township were allotted to schools. The Homestead Act of 1862, under which a citizen could claim 160 acres of Federally-owned land, stimulated filing on lands in the McCloud River area but there is no record of patented homestead entries within the analysis area prior to the 1920's. A total of seven parcels of 80 and 160 acres in the Hamilton Bend area (T37N, R3W, Sec. 22, 26, and 28; now McCloud River Club) each were assigned as patented Indian trust lands in 1893.

In 1896 the Central Pacific Railroad (later known as the Southern Pacific) was granted all odd-numbered sections along the McCloud River under the Pacific Railroad Acts of 1862 and 1864. Patents were finalized in 1896, forming the basis for private ownership of alternate sections throughout most of the watershed area.

Ah-Di-Na was purchased from the Central Pacific Railroad by William R. Whittier in 1896 to develop into a private sport-fishing and hunting resort. It also operated as a self-sufficient ranch for many years. In 1900 the McCloud River Club land was acquired from the Central Pacific Railroad by George W. Scott and William M VanArsdale who founded the fly fishing club (Scott and VanArsdale originated the McCloud River Railroad and Lumber Company the same year).

The nucleus of the Bollibokka Club lands was purchased in 1921 from previous owners who presumably obtained railroad land in the early 1900s. Although the large flats at Ah-Di-Na and the mouth of Claiborne Creek were developed and ranched, the overall effect to the watershed was minimal during this period.

Although there was extensive copper mining on Squaw Creek and the Sacramento River during the early 20th century, very little occurred in the McCloud drainage. Claims located on the north side of Hirz Mountain (T35N, R3W, Sections 5, 6, 7, and 8) were sporadically mined for iron ore between 1903 and 1944, and a nearby claim (Sections 7 and 8) was worked in 1957 to 1963 (now owned by the Southern Pacific Land Company). There apparently was at least one copper mine within the analysis area. The Keane copper mine was located about one mile southwest of Hat Mountain in Section 4, T36N, R3W, and contained seven adits 20' to 135' in length. A second reference, apparently to the same mine, gives the location as about four miles downriver of the McCloud River Club, "Abe Morgans place”, which became a copper mining camp.

The Shasta National Forest was established in 1905 with headquarters in Sisson (Mt. Shasta). With the exception of the Hawkins Creek drainage, the Lower McCloud River Watershed lay within the Squaw Creek District, which became the Redding District in 1938. Hawkins Creek was then, as later, part of the McCloud District. The Forest Service during its earliest years was primarily concerned with controlling grazing and the prevention of fires. A lookout station at Grizzly Peak is shown on the 1916 Forest map (the current lookout building was constructed in 1953 and is not considered historically significant). The lookout building at North Fork Mountain on Curl Ridge was constructed or reconstructed in 1935, probably by the CCCs (this building no longer exists). The 1916 map also shows a series of trails and a phone line called the Henderson Phone Line which traveled from McCloud and Squaw Valley Creek to cross the McCloud near Ash Camp and along Hawkins Creek to connect with Big Bend and points beyond. Pack trails are shown on Curl Ridge, Claiborne Creek, and Hawkins Creek and along the McCloud. An auto road connected the McCloud River Club via Squaw Valley Creek.

With its formation, the Squaw Creek District assumed management of stock grazing on Forest Service lands. A grazing atlas stored on the Shasta Lake District contains a considerable amount of information on grazing as well as vegetation patterns for the years 1917 through 1921. The Lower McCloud River Watershed area during those years was divided into three allotments. The McCloud allotment included the Claiborne Creek drainage and several smaller drainages with a total of 7,667 acres of federal land and 10,219 acres of private land. This allotment had not previously been open to grazing because it was considered too rough. It was opened in 1918 because of the war and because the private sections had been opened to sheep. The carrying capacity of the federal and private lands was each estimated at 3000 sheep and 200 head of cattle. Forage is described as consisting of "blue brush, short black oak, and other palatable brush such as bitter cherry, hazel, water maple and quite a lot of bunch grass on the ridges”. Mountain lions, coyotes and bears were reported as quite numerous. Permittees in 1919 ran a total of 3700 sheep; in 1920, 1500 sheep are reported, and in 1921, 1400 sheep. Because the McCloud River Club controlled the mouth of Claiborne Creek, stock was driven in by way of Curl Ridge from DeLamar on Squaw Creek. Curl Ridge became known as the “cattle highway”.

The North Fork allotment which included the drainage of Chatterdown Creek extended across Curl Ridge into Squaw Creek. Both sheep and cattle were grazed on this allotment. That portion of the District on the west side of the McCloud River was part of the High Mountain allotment, which apparently was administered by the Sacramento or Mt. Shasta District.

Between 1933 and 1940, the Civilian Conservation Corps (CCCs) established camps in the old fish hatchery at Baird, at Stouts Meadows, and just north of McCloud but none are recorded within the analysis area. The enrollees at McCloud devoted much of their time to working on the Mud Creek Dam and ditch.

1945-1965: The construction of Shasta Dam, begun in 1938 and completed in 1945, prevented the annual upriver migrations of anadromous fish as well as blocking animal migrations such as deer herds. The inundation of the lake also hastened the end of stock grazing within the watershed area as it made access much more difficult.

In addition to structures at Ah-Di-Na, the McCloud River Club and Bollibokka Club, the 1945 U.S.G.S. quadrangle shows structures at Ash Camp on the north side of Hawkins Creek, at Pine Flat on the east side of the river, "Wyatt" on the north side of the mouth of Chatterdown Creek, and "McAphee Flat", on the west side of the river just south of the mouth of Nawtawakit Creek (the latter three now all part of the Bollibokka Club Land Company). In 1945 all were connected by a system of trails along the river, generally on both banks. Numerous trails also connected to the ridge tops, and a "tractor way" followed the length of Curl Ridge.

In 1955 the newly organized Shasta-Trinity National Forests incorporated the Shasta National Forest, and the Redding District became the Shasta Lake District. District maps show many trails but very few roads into the Lower McCloud River Watershed; three exceptions were to the McCloud River Club by way of Squaw Valley Creek, to Grizzly Peak via Mushroom Rock and Star City Meadows, and upper Hawkins Creek via Smith Flat (now in Iron Canyon Reservoir).

The lands at Ah-Di-Na were purchased by the Hearst Corporation, and road construction and logging began in 1958.

1965-present: The past three decades have seen an increase of human use within the watershed area. Pacific Gas and Electric Company's construction of the McCloud Reservoir, which drastically changed the water levels of the river, provided a recreational attraction as well as access into the area. The purpose of the reservoir was to divert water to the Pit River hydroelectric plants by way of the Iron Canyon Reservoir.

The initiation of logging on public lands and the continuation of logging on private lands also increased access into the area. The Forest Service in 1965 acquired lands at Ah-Di-Na from the Hearst Corporation and shortly afterward established a public campground, providing public fishing access to the river. The 1966 Mica Gulch Timber Sale was the first timber sale on federal lands within the analysis area. In 1974, the McCloud River Club donated 2330 acres of their land to the Nature Conservancy, which formed the McCloud River Preserve, allowing limited public access.

In 1975, the Pacific Crest Trail was constructed through the watershed area via Ah-Di-Na and Ash Camp.

Appendix H-Figures