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Mt. Shasta Watershed Analysis

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Shasta-Trinity National Forest



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Introduction

About This Analysis

This watershed analysis is presented as part of the Aquatic Conservation Strategy (ACS) adopted for the President’s Northwest Forest Plan (NWFP) Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl (NSO), including Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Related Species (NWFP, 1994).

The preparation of the Mt. Shasta Watershed Analysis follows direction in the ACS 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” (NWFP, 1994).

This document is guided by:

1. Core topics – provide a broad, comprehensive understanding of the watershed.
Core topics are provided in “Ecosystem Analysis at the Watershed Scale: Federal Guide for Watershed Analysis”, Version 2.2 [Guide] (Guide, 1995) to address basic ecological conditions, processes, and interactions at work in the watershed.
2. 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 on other projects in the area or were identified by the team during the analysis process. Issues are further described in Step 2.

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.

The purpose of this analysis is to provide district resource managers with an 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 about the management of resources in the Mt. Shasta 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.

Federal agencies will conduct multiple analysis iterations of watersheds as new information becomes available or as ecological conditions, management needs, or social issues change. Subsequent analysis iterations may be triggered when existing analyses do not adequately

support informed decision-making for particular issues or projects. Future iterations also may be necessary to fill critical data gaps identified during earlier analyses.

The Analysis Process

This analysis used the six-step process as outlined in the Guide. 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.

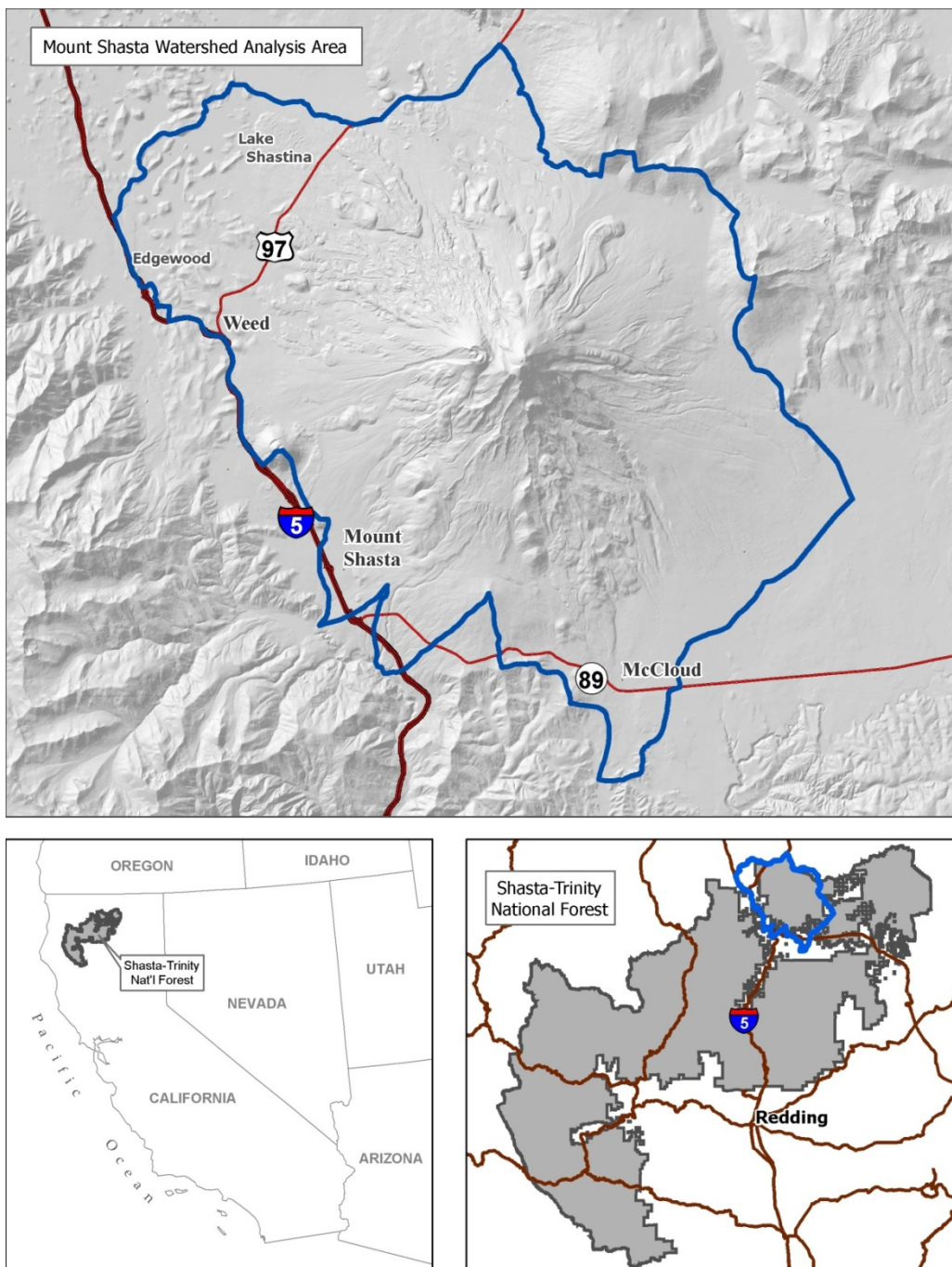
Step 6: Opportunities – brings the results of the previous steps to conclusion, focusing on management opportunities that are responsive to watershed processes identified in the analysis.

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

CHAPTER 1: Characterization of the Watershed

Location

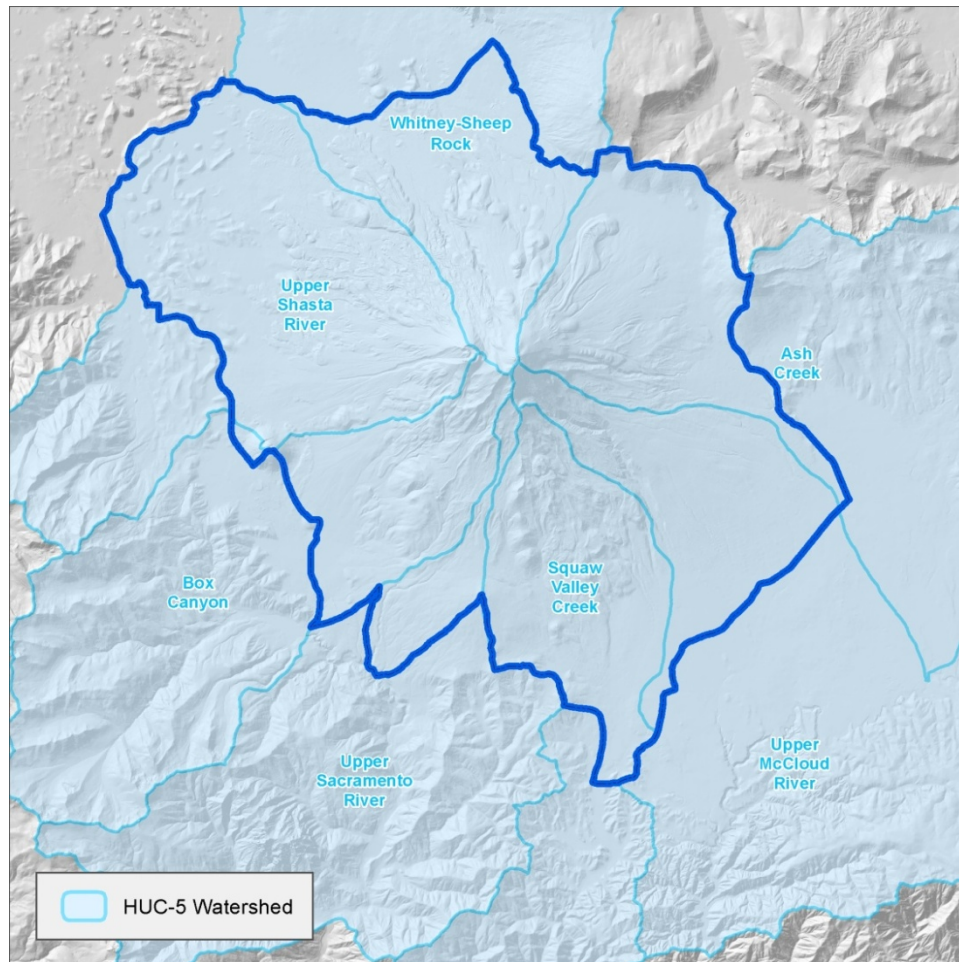
The Mount Shasta Watershed is located in Northern California about 40 miles south of the Oregon border (see Map 1-1: Mt. Shasta Watershed Vicinity Map).



Map 1-1: Mt. Shasta Watershed Vicinity Map

The Mt. Shasta Watershed incorporates the headwaters of three river systems (Shasta, Sacramento and McCloud) and the upper elevation portions of seven HUC-5 watersheds which include Whitney-Sheep Rock, Ash Creek, Upper McCloud River, Squaw Valley Creek, Upper Sacramento River, Box Canyon and Upper Shasta River watersheds (see Map 1-2: Seven HUC-5 Watersheds). The decision to analyze portions of all seven of the HUC-5 watersheds in one

ecosystem analysis was made because they all comprise the summit of Mount Shasta and have similar management issues. The entire analysis area is located with Siskiyou County.



Map 1-2: Seven HUC-5 Watersheds

Watershed Setting

The Mt. Shasta watershed is centered about Mt. Shasta, which is the largest stratovolcano in the Cascade range and a world-class landscape feature. At 14,179 feet in elevation, it towers over the adjacent terrain and due to its conical shape, creates a radial drainage pattern, with streams flowing outwardly in all directions. Some drain into the Klamath River basin to the north, and the others into the Sacramento and McCloud basins to the south. Stratovolcanoes are capable of violent explosive eruptions and many such events have occurred over the past 600,000 years at Mt. Shasta. The mountain was built through four main eruptive episodes: Sargent's Ridge, Misery Hill, Shastina, and Hotlum. About 350,000 years ago, the volcano collapsed and formed a huge debris avalanche which traveled about 25 miles to the north into Shasta Valley, forming the hills around Lake Shastina along the northeast edge of the watershed area. This debris avalanche has a volume nine times larger than the one associated with the eruption of Mount Saint Helens in 1980 and covers about 175 square miles in the Shasta Valley. After that event,

the volcano rebuilt itself to its present height in a series of eruptions, including lava flows and domes, and pyroclastic flows, with major activity ending a few thousand years ago. During that same time, glaciers carved away at the mountain, creating cirques and moraines, while debris flows traveled down the flanks forming large alluvial fans.

The watershed includes 201,073 acres, with a significant portion (88,103 acres or 44%) in private ownership. It also includes the 36,926 acre Mt. Shasta Wilderness Area, one of five wilderness areas within the Shasta-Trinity National Forest. Mt. Shasta was designated a Registered Natural Landmark by the Department of the Interior and the Heritage Conservation and Recreation Service in 1976. The watershed is roughly bounded by several main access travel routes in the region (Interstate 5 on the western edge, Highway 89 to the south, Highway 97 to the northwest and the Military Pass Road to the north and east).

The watershed also includes five rural towns (Mt. Shasta, McCloud, Weed, Edgewood and Lake Shastina) as well as several residential communities (e.g. Mt. Shasta Forest, Everitt Hill, Squaw Valley Road, etc.) that lie outside of the main town centers. While these communities influence and are influenced by the National Forest System (NFS) lands within the watershed, this Assessment does not address the activities, zoning or management of these lands. It does seek to describe the direct and indirect commercial, industrial and recreational effects on the adjacent National Forest and identify how land management activities may directly or indirectly affect these communities.

The unique volcanic history combined with past vegetation and fire activities have created a distinct landscape pattern within the watershed. Due to the broad range in elevations on Mt. Shasta (2,000-14,000 feet), several climatic bands circle the mountain, and precipitation and snow pack generally decreases with elevation. Soil development and vegetation patterns mirror the climatic bands, but are also influenced by factors such as the age of the rock, as some of the more recent lava flows are so young that they have little soil and support very sparse vegetation. With the exception of heavily modified areas (e.g. plantations, residential areas, development, etc.), habitats and vegetation types generally show a concentric pattern around the summit of Mt. Shasta for the reasons described above. The national and international significance of Mt. Shasta for recreational and spiritual pursuits, combined with the interest from local communities, draws a large number of people up into the watershed annually.

Climate

Mount Shasta lies within the Mediterranean climatic zone which extends into the Pacific inland west, from Mexico to south-central Oregon. This zone can generally be characterized as having warm, dry summers and cool, wet winters. Topography and elevation in the Mt. Shasta analysis area are highly variable and exert a large influence on most climatic variables including temperature, wind, and precipitation (distribution, intensity, amount, and form e.g. rain vs. snow).

Precipitation amounts on Mt. Shasta are highly variable with nearly all precipitation falling between October and May. Precipitation averages for Mt. Shasta, McCloud and Weed are 40, 50 and 26 inches respectively. Precipitation falls as both rain and snow at the lower elevations below 7,000 feet, while it is nearly all snow above 7,000 feet. In general, precipitation amounts increase with elevation with more than 70 inches above the 7,000 foot level. Summer thunderstorms occur infrequently but can be intense.

Each side of Mt. Shasta has a different climate that is largely created by the peak itself. The south side of the mountain (McCloud area) receives the most rainfall and winds are generally calm. In contrast, the north side of the mountain (Weed and Shastina) receives substantially less rainfall, becoming quite arid in the northern valley and is characterized by very windy conditions. The west side (Mt. Shasta City) also can be quite windy, particularly when north-south winds are funneled through the Sacramento River Canyon and northern valleys toward Yreka. The east side (Military Pass area) may or may not experience a rain-shadow effect, depending upon individual storm events. The mountain's presence frequently creates lenticular clouds above the peak on otherwise sunny days, presenting unique photographic appeal.

Geologic Processes and Hydrology

Volcanic Processes

Volcanic processes are arguably the most significant in the analysis area, since they created the existing landforms and will continue to produce eruptions in the future. However, the low frequency of events (100's to 1,000's of years between eruptions), puts them in a very different time frame relative to other important processes at Mt. Shasta which operate at intervals of years or 10's of years (fire, human activity, animal movements, landslides, and stream processes). Key volcanic processes at Mt. Shasta include: pyroclastic flows; volcanic debris flows; lava flows; domes; air fall ash; volcanic gasses; and seismicity associated with magma movement. These processes are described in Chapter 3.

Landslides

Landslides have played an important role in shaping the modern landscape, and can pose a hazard to human life and infrastructure. Simply stated, a landslide is “the movement of a mass of rock, debris, or earth down a slope” (Cruden and Varnes, 1996). For purposes of this analysis, the landslide classification scheme used by those authors was simplified into four basic types of landslides important at Mt. Shasta as defined below.

The term “**debris avalanche**” is reserved for the type of mega landslide which occurred when Mt. Shasta collapsed about 350,000 years ago, forming the huge deposit in Shasta Valley. Part of this deposit is shown on the Map 3-4: Bedrock and Surficial Deposits Map. Such landslides incorporate varying amounts of water, may occupy many square miles and travel at very high rates of speed (on the order of 100 miles per hour).

A “**debris slide**” is a shallow, rapidly moving landslide ranging from less than an acre to 10’s of acres in size. Examples occur within the inner gorges of Mud Creek, Whitney Creek, and Cascade Gulch (Map 3-6: Altered Channels, Debris Slides, and Inner Gorge Map). The debris slide in Cascade Gulch shown on the altered channel map occurred in the winter of 1996-1997, and triggered a debris flow.

A “**rock fall**” is a rapidly moving accumulation of rock debris tumbling and rolling down a steep hillslope. Rock falls are typically small in size (less than an acre), and in some cases, may involve only a few boulders.

A “**debris flow**” is a water-rich mixture of rock, soil, and other slope materials which flows downhill, usually in a confined channel. Debris flows can travel at speeds of a few miles per hour to many 10’s of miles per hour, and can modify stream channels, remove vegetation, and damage or destroy roads and structures. They can be triggered by volcanic activity, landslides, or high stream flow accompanied by a rapid influx of sediment from sheet or rill erosion. High stream flows can be caused by volcanic eruptions melting snow and ice, intense summer convective thunder storms (Whitney Creek debris flow of 1935), rapid glacial melt during extended periods of hot weather in summer (Mud Creek in the 1920’s and 1930’s), or rapid snowmelt during warm winter storms (Cascade Gulch debris flow of 1997). Other terms applied to this phenomenon include “lahar” (applied to those associated with volcanic eruptions), “mudflow” and “debris torrent”. In this document, the term “**debris flow**” is used exclusively.

Snow Avalanches

Snow avalanches occur every year on Mt. Shasta and their size, character and frequency all depend on seasonal conditions and weather conditions. Large scale avalanches that affect forest stands occur occasionally, however, small to medium size slides are more common and, while still potentially destructive to life and limb, these slides do not typically impact large swaths of forest.

Hydrology

Mt. Shasta exerts a significant influence on the distribution, type and amount of precipitation that falls throughout the analysis area. Almost all precipitation (rain and snow) that falls on the mountain above elevations of 4,000 feet percolates into the ground where it recharges aquifers that feed the numerous springs that surround the mountain, but leaving very little for surface runoff to intermittent and perennial channels. Perennial channels occur infrequently at elevations above 4,000 feet. Only two streams originating on Mt. Shasta, Mud Creek and Squaw Valley Creek flow perennially along their entire lengths. The other perennial streams are fed by springs or glacial melt and generally only persist at higher elevation on the mountain before infiltrating into the ground to recharge springs at lower elevations (e.g. Ash, Brewer, Panther, and Cold Creeks).

Stream Channels

Perennial channels that drain Mt. Shasta generally occur at higher elevations (above 5,000 feet). At lower elevations streams are spring fed and exhibit variability in flow duration, volume, channel features and flow regime. Perennial channels that persist through the watershed are limited to Mud and Squaw Valley Creeks. All of these channels are geomorphic and weather driven and many experience frequent disturbance from natural events. Debris flows, floods, and landslides all have a pronounced effect on channel morphology, flow, stability, migration, vegetation and surrounding alluvial fans. Woody debris can influence channel migration at lower elevation (e.g. Ash Creek) and windthrow and fire-related mortality are important drivers for wood recruitment to channels. Riparian habitats where they occur are often subject to frequent disturbance from debris flows and flooding. Riparian vegetation is often limited to near bank areas.

Flooding from Mt. Shasta streams is not common but can have wide reaching consequences when it does occur. Streams fed by glacial melt like Whitney, Bolam, Ash and Mud Creeks can experience large debris flows which can completely alter the channel network through channel incision or aggradation, and migration while building new alluvial fan deposits. Flooding in the non-glacially fed streams is an even rarer event but when it does occur (e.g. New Year's 1997, 2003 summer storms), it can generate debris flows with similar effects to those in streams fed by glacial melt. Volcanic activity also has the potential to trigger large debris flow and flood events.

Springs, Seeps, Wet Meadows

These occur in a wide elevational belt (2,000 – 8,000 feet) primarily around the southern and western slopes of Mt. Shasta and many were created as a result of episodic disturbance. Large riparian meadow complexes are located at the lowest elevations of the analysis area (e.g. Squaw Valley Meadow south of McCloud). The frequent disturbance regime associated with active volcanic activity over the past 10,000 years has limited the development of riparian and aquatic habitats on the mountain. Wet meadows are associated with riparian areas along perennial streams, springs, or seeps and are vulnerable to future large scale disturbance.

Vegetation

The landscape and the vegetation within the watershed are dominated by the topography of Mt. Shasta. As elevation changes, so does the vegetation. When mapped, these changes in stand type appear as circular bands around the mountain, with variation by aspect and rainfall. The vegetation bands can be seen on Map 3-8 and the seral stages of the vegetation can be seen in Map 3-9. While each layer is distinct, there is a mixing of types and species in each transition zone as you change elevation between vegetation types. A more complete discussion of each type can be found in Current Conditions, Chapter 3. It should be noted that the vegetation typing used in this watershed analysis came from Remote Sensing Application data and has its limitations. All of the vegetation typing that was done for this analysis is intended to help

characterize the landscape and should not be used as an absolute typing. More detailed analysis should be done at the subsequent project level[s].

Alpine Zone

These are the open barren slopes above the timber line including the summit of Mt. Shasta. This zone supports very sparse plant life with little to no soil development due to very slow rock weathering. Geologic processes differ above and below the timber line. The alpine zone is geologically quite young, weathering slowly, glaciers have modified the landscape, and there are minimal vegetative influences related to root support, ground cover, and evapotranspiration.

White Bark Pine Forests

These stands occupy the highest vegetation ring around the summit of Mt. Shasta below the Alpine zone (7,500 and above). It is an extremely harsh environment and soils are generally thin and of low quality. On open exposed sites whitebark pine (*Pinus albicaulis*) typically exhibits a shrub like form with a malformed trunk, while in protected areas it can have a straight trunk that extends up to 50 feet in height. The Clark's Nutcracker is known to help propagate these trees. The birds harvest the seeds and those that aren't eaten are cached underground, explaining why in many instances the trees grow in clusters. Whitebark pine, associated with the alpine dwarf shrub zone, are very short and occur in dense patches.

Red Fir and White Fir

Stands dominated by Shasta red fir (*Abies magnifica* var. *shastensis*) are located between 6,500 and 7,500 feet, just below the white bark pine. As elevation drops, red fir gives way to white fir (*Abies concolor*) between 5,000 and 6,000 feet.

Mixed Conifer

Mixed conifer covers the largest area and is generally found below 5,000 feet. It is considered a mixed series including incense cedar, sugar pine, white fir, douglas fir with a prominent ponderosa pine component. At the higher end of this series, on more moist sites the ponderosa pine is replaced by white fir as the more prominent species of the series.

Conifer Hardwood Mix

These stands are found in a very scattered and patchy nature around the west, south and east sides of the mountain. Habitat often occurs in a mosaic pattern with small, pure stands of conifers interspersed with small stands of black oak (*Quercus kelloggii*). The remaining black oak stands compete well with shrubs but not with conifers which have encroached with the exclusion of fire and forest management practices. The mixed conifer/hardwood stands generally occur on coarse, well drained, mesic soils where the extended tap root of the oaks can reach deep into water sources.

There are several aspen stands occurring between Whitney Falls and Graham Creek at elevations between 6,600 and 7,600 feet. Most stands are small, but two of the stands have approximately 200 trees each. They occur in boulder lava flows. Associated species include mountain mahogany, red fir, western white pine, whitebark pine, common juniper and willow. Aspen stands provide important habitat for cavity nesting birds such as blue birds, downy woodpeckers and sapsuckers.

Canyon live oak (*Quercus chrysolepis*) occurs on the north side of Mt. Shasta in rock outcrops and at the base of lava flows. It stays short and shrubby, growing no more than 20 feet tall. They can be fairly large at the base and do produce acorns. Oregon white oak (*Quercus oregana*) saplings have been seen in the Hotlum burn area. Within the analysis area, both species are associated with ponderosa pine, western juniper and the bitterbrush shrub type. These oaks provide nesting and roosting habitat for many bird species as well as acorns for deer and other animals.

Ponderosa Pine

The ponderosa pine forest type is found at lower elevations (3,300 to 4,200 feet) around Mt. Shasta's flanks on the southeastern side of the mountain. This area can be characterized by mudflow deposits, alluvial fans and dissected volcanic side slopes. The soils are typically deep, well drained and highly productive.

Plantations

Plantations in the Mt. Shasta watershed vary greatly in acreage and age. Mid seral age pine plantations (6" - 24" (DBH) diameter at breast height) mostly represent large shrub conversion projects dating from the 1940's to 1970's. Early seral (seedling- 6" DBH) represent plantations established in the 1980s and 1990s and tend to be smaller in size and more numerous. The seral stages are based on the Wildlife Habitat Relationship descriptions in the Shasta-Trinity Land and Resource Management Plan (LRMP page 4-15) that were updated to Regional and National standards in September 2005 by the Remote Sensing Lab.

Knobcone and Lodgepole Pine stands

The entire population of knobcone pine (*Pinus attenuata*) occurs in isolated patches in narrow regions along the Ski Park Highway, near Snowman's Hill summit and along Thimbleberry Ridge. The knobcone forest type typically occurs as homogeneous, even-aged stands following fire and is a relatively short-lived species. The lodgepole pine (*Pinus contorta*) stand is similarly confined to a small patch that occurs in the northeastern portion of the watershed in the saddle between Mt. Shasta and Whaleback at the summit of the Military Pass Road. Both pine types form open stands of similarly sized trees in association with a few other species and with a sparse understory. Many lodgepole stands are associated with meadow edges and streams, where understory consists of grasses, forbs, and sedges. Continued recruitment into the stands produces

overcrowding and slow growth which may make them susceptible to insects, and subsequently to fire.

Western Juniper

Western juniper (*Juniperus occidentalis*) stands within the Mt. Shasta watershed area are found on the north side of the mountain, generally north of Highway 97 toward Lake Shastina and provide key winter habitat for deer as well as cover, feed and nesting for birds. Generally trees are less than 130 years of age with most trees being less than 40 years of age.

Shrub Types

Three general shrub types occur within the Mt. Shasta Watershed (DF&G, 1988):

1. ***Alpine dwarf-shrub*** these habitats are typically low graminoid (grass) and forb communities with a mixture of dwarf shrubs found between 7,500 feet and 12,800 feet. The plants comprising these communities are usually less than 18 inches tall and may include the shrub Krumholtz form of whitebark pine. Coverage may reach 100% at lower elevations but becomes increasingly open as elevation increases. On mesic sites, a continuous turf contrasts with patches of bunch grasses and cushion plants on drier sites. A good example of this is Hummingbird Meadow. Pika (*Ochotona princeps*) can be found in this habitat type. May high use areas occur in this habitat type. Those associated with springs, seeps and streams are showing signs of overuse such as trampled plants, bare ground and compacted soils.
2. ***Montane chaparral*** generally occurs in mountainous terrain, from 3,000 to 7,500 feet and is the most prevalent shrub type within the Mt. Shasta watershed analysis area. Montane chaparral is characterized by evergreen species however, deciduous or partially deciduous species may also be present. Understory vegetation in the mature chaparral is largely absent. Conifer and oak trees may occur in sparse stands or as scattered individuals within the chaparral type. This is the most wide spread shrub type within the Mt. Shasta watershed analysis area.
3. ***Bitterbrush (Purshia tridentata)*** stands range from small, widely spaced shrubs to large, closely spaced shrubs with more than 90% canopy cover. In the Mt. Shasta watershed, they occur on the north side of the mountain on the lower slopes out to Lake Shastina. Bitterbrush is only occasionally found in pure stands in this area often occurring as a co-dominant with big sage (*Artemisia tridentata*), rubber rabbit brush (*Chrysothamnus nauseosus*) and curl-leaf mountain mahogany (*Cercocarpus ledifoliosus*). Bitterbrush is also associated with ponderosa pine and western juniper vegetation types. This area is important winter range for mule deer.

See Chapter 3, Table 3-9 in the Plant Species of Special Concern for species associated with these shrub types.

Dry Meadows (Sandy)

The mid to high elevations “dry-sandy meadows” around Mt. Shasta carry that descriptive designation precisely because of the soils comprising the meadow. These meadows are typified by sparse grass-forb vegetative communities with low-order productivity, reflecting quite droughty soil conditions, particularly during the short growing season. Once the soils are free of snow and warm enough for root growth or seed germination, they are already almost devoid of plant-available water. Soils are deep to moderately deep, well drained to excessively well drained, coarse sand with little or no soil profile/horizon development, within a very cold (cryptic) temperature regime. These soils are associated with lupines (*Lupinus* sp.), buckwheats (*Eriogonum* sp.), squirreltail (*Elymus elymoides*) and other early seral grasses and forbs as well as Bloomer’s goldenbrush (*Ericameria bloomer*). Due to the properties of these soils, potential for natural conifer encroachment or conversion to conifer plantations is very low. Due to the sparse fuels, the potential for high intensity wildfire in dry meadows is low.

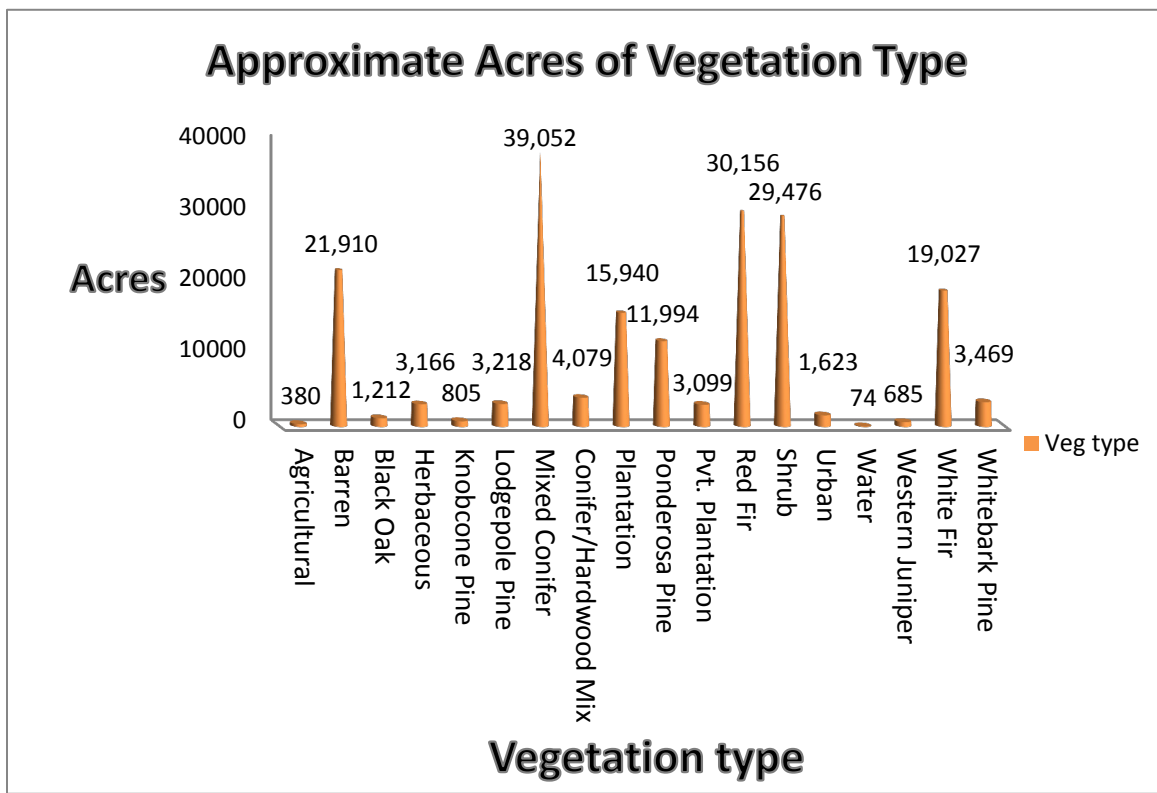


Figure 1-1: Approximate Acres of Vegetation type within the watershed

Fire and Fuels

Fire is an essential component within the watershed area as these ecosystems have developed in conjunction with fire. It is an ecosystem process that affects composition, structure and function with a continuous feedback loop affecting fuels and vegetation within the watershed analysis area (Sugihara, et al., 2006). Fire interacts with and is affected by, vegetation composition and

structure, fuel moisture, air temperature, biomass, and many other ecosystem components. These are interdependent such that changes to one, including fire, often result in significant changes to others (Sugihara, et al., 2006). Long-term alterations of fire patterns have occurred as a result of changes in climate and human interactions.

Lightning is the primary fire ignition source within the watershed and weather patterns can produce widespread thunderstorms that result in numerous fires. Hundreds of lightning fires can be ignited over short periods during these events, similar to the lightning event that occurred during the summer of 2008.

Fire behavior in the watershed is driven primarily by topography, specifically aspect, slope position and elevation. Significant differences in fire return intervals occur within the same forest type on different slope aspects. Fire return intervals lengthen with elevation, resulting in upper slopes having shorter average fire return intervals than middle and lower slopes. Natural barriers such as lava flows, breaks in vegetation and riparian zones affect landscape patterns of fire spread (Skinner and Taylor, 2006).

Topography also influences air flow throughout the watershed area. Winds generally flow up the Sacramento River canyon from south to north. Higher winds occur through the canyon as well as on the north side of Mt. Shasta. These winds cause fires to become wind-driven and result in a larger number acres burning compared to areas east of the mountain with similar fuel characteristics.

The seasonality of fires within the watershed area is mostly mid-summer through fall, which is typical of forests under the influence of long, dry summers in Mediterranean climates. Both dead and live fuels reach their lowest moisture levels at that time of year and they ignite and burn easily. There is also a temporal and spatial variation in the seasonal timing of fires indicating the influence of slope aspect, elevation, climate variation and seasonal occurrence of fire. Fires occur earlier in the season on drier pine dominated sites (south and west facing aspects) at lower elevations. Higher elevation sites along with those that are wet (north and east facing aspects) see fires occurring later in the season.

Species and Habitats

Wildlife

There are many documented occurrences of variety of terrestrial wildlife species within the watershed, however specific population information is lacking. Wildlife species of special concern or interest in the Mt. Shasta Watershed are divided into three main categories for the purpose of this analysis. This includes federally listed species, Forest Service sensitive species and other species of concern or interest. Species with recorded observations within the watershed include the northern spotted owl (NSO), northern goshawk, American marten, Pacific fisher, pika, a variety of bat species, willow flycatcher, bald eagle, mountain quail, blue grouse, black

bear, pileated woodpecker and a variety of bird species (Natural Resource Information System-NRIS). Many other species of interest have suitable habitat and the potential for occupancy in the watershed (see discussion in Chapter 3). There are historical sightings recorded in the watershed for California wolverine (NRIS), though none of the sighting can be confirmed.

Designated northern spotted owl critical habitat is located in portions of the watershed, primarily in areas to the south and east (USDI, 2008). A new rule for designating northern spotted owl critical habitat is being developed by the U.S. Fish and Wildlife Service (FWS) and is scheduled to be final in November 2012. Management within areas designated as northern spotted owl critical habitat will be defined in the new rule.

Currently there are three known NSO activity centers along the eastern side of the watershed (Forest Records). Northern spotted owl (NSO) dispersal within the watershed is dependent on the suitability and capability of habitat. Non capable habitat in the northern portion of the watershed (the shrubfields along highway 97) and areas at the higher elevations (above 7,000 feet) are barriers to NSO movement. NSOs can and do disperse through the majority of the other areas within the watershed. Breeding areas are based on the quantity, quality and location of nesting, roosting, foraging, and dispersal habitat (USDI, 2011). Additionally, Interstate 5 and highways 97 and 89 can all be barriers to NSO dispersal. Residential development, transmission lines, and barred owl presence within the watershed also can have significant impacts to NSO dispersal.

The Mt. Shasta watershed supports both summer and winter range for the Rocky Mountain mule deer and black-tailed deer (CDFG, 1985). Both subspecies of deer traditionally intermingle throughout several areas within the watershed and are managed under the McCloud Flats Deer Herd Plan. The McCloud flats deer population summer ranges are estimated to support deer from at least nine different winter ranges (CDFG, 1985). Interstate 5 and highways 97 and 89 all provide barriers to deer movement. Residential development and transmission lines with the watershed also have significant impacts on deer movement.

Late Successional Reserves

Late-Successional Reserve (LSR) and Managed Late-successional areas are key components of the Forest Plan (USDA, 1995) in providing for mature forest ecosystems including habitat for the northern spotted owl and connectivity for species health. It is important to understand the role of this watershed and the effect that management actions will have on the overall functioning of the LSRs. The forest wide LSR Assessment reveals there are critical issues that need attention within these areas including unacceptable fuel hazards and overstocked stand conditions (USDA, 1999). There are four Late Successional Reserves (LSR's) on NFS lands within the Mt. Shasta Watershed Analysis Area (USDA, 1999) (Map 3-10). This includes all or portions of the Wagon LSR (RC-362), the Mt. Shasta LSR (RC-361), Elk Flat (RC-360) and the McCloud Managed LSR (MLSA-76).

Sensitive, Endemic, Survey and Manage and Watch List Plant Species

There are seven plant species listed by Region 5 as sensitive. 13 watch list species, two endemic species and eight survey and manage fungi species are known to occur in the watershed analysis area. They occur at elevations between 3,500 feet to 12,800 feet and are associated with all vegetation types. Most are known to occur at higher elevations associated with the alpine dwarf shrub and the whitebark pine/ red fir zones. There are no species listed as threatened or endangered by the USFWS or the State of California known to occur within the analysis area. Whitebark pine is proposed for federal listing, but is not yet listed. The Federal Forest Service is treating it as a sensitive species until USFWS decides whether-or-not to formally list it. Habitats and disturbance to habitats vary by species. Some species are being impacted by too much use while others are being impacted by too little disturbance especially fire.

Public Use

Rural Areas and Private Land

Rural areas and private land can be seen scattered throughout the watershed (Map 1-1). These areas are composed of five towns (Mt. Shasta, McCloud, Weed, Edgewood, Lake Shastina), a residential area (Shasta Forest), dispersed private land (such as ranches, individual homes, agriculture) and a checkerboard ownership pattern of private timber land. Each of these entities within the watershed requires reasonable access which has created a complex road pattern. Managing landscape and resources within the watershed can be complicated due to the non-continuous nature of the NFS land.

Special Uses Sites (e.g. Electronic Sites, Target Ranges, Municipal uses)

These are generally small (5 acres or less) with small but relatively permanent infrastructure that requires road access and protection from fire. Many of the scattered sites are associated with research and data collection for features of Mt. Shasta (seismic, water, etc.). The larger sites appear as very scattered openings, while the small sites are mostly hidden or unnoticeable. While some sites include relatively permanent improvements (e.g. concrete pads, small buildings, parking areas) very few are fully cleared areas where trees and shrubs have been converted or removed. They may provide small amounts of habitat edge within the larger vegetation and are treated as Wildland Urban Interface (WUI) for protection and treatment.

Ski Park Highway and Vicinity

This includes the Mt. Shasta Board and Ski Park, the Nordic Center and the other concentrated recreation that occurs in the area between Highway 89 and the top of Gray Butte (section 4). In the winter months, outside of the town centers, it is the most heavily trafficked portion of the watershed.

Roads/Trails

Three major highways (Highway 97, Interstate 5, and Highway 89) ring the western half of the watershed and create distinct management boundaries. They provide easy all-season access to the National Forest, but also create migration barriers and constrict natural water and geomorphic movement (e.g. Whitney Creek).

The majority of trails and climbing routes (and subsequently the highest visitor use on Mt. Shasta), are along the Everitt Memorial Highway along the south side of the mountain. The Everitt Highway is plowed by the Siskiyou County Road Department in winter, and provides the easiest access into the higher elevations. Trails and climbing routes from all major trailheads begin at approximately 7,000 feet and extend up into the Mt. Shasta Wilderness Area to an elevation of 8,500-10,000 feet. User-created trails and climbing routes begin for all established trails where official Forest Service trails end. The Everitt Vista trail, Black Butte trail and the Gateway trail comprise the remaining trail system. Wintertime trails include the Nordic Center trail system, the Tri-Forest snowmobile trails, and Ron's loop Nordic trail near Sand Flat.

On the lower slopes, there are few Forest Service trails and many of the general recreation trails are user-created (un-authorized) and heavily used for hiking, mountain biking, dog walking, etc. The Mt. Shasta watershed area also includes a portion of the Forest Service Tri-Forest Snowmobile trail system on the eastern slope of the mountain.

Linear Utilities/Railroad

These include the Union Pacific Railroad that bounds the western and northern portions of the watershed and the McCloud Railway alignment which crosses the southern edge of the assessment area (see Map 5-1). Two PacifiCorp power lines (115 and 69 kV) parallel Interstate 5 and several smaller power and phone corridors form a network along the southern and western slopes of the mountain (see Map 5-1). These rights of way are maintained for the most part in early seral stages or bare soil for safety reasons. For this reason they are vulnerable to infestation by invasive weeds but may also be used as wildlife corridors by mammals. Most of these linear uses also include a low-standard single lane native surface road within or near the alignment.

Recreation, Ceremony, Metaphysical Use

Over 100,000 people visit the Mt. Shasta region every year for recreational purposes. Recreational use varies around the mountain and includes: skiing, snowshoeing, snowmobiling, sledding, camping (dispersed and developed), hiking, climbing, biking (both motorized and non-motorized) woodcutting, hunting, Christmas tree cutting, mushroom gathering, and more. Recreation use on Mt. Shasta is concentrated around roads, trails, and water. The Everett Memorial Highway is a key corridor for people to reach recreation destinations on the mountain. In addition, Mt. Shasta is considered a sacred place by both indigenous peoples and non-indigenous metaphysical spiritual seekers. Native Americans, including members of the Wintu,

Shasta, Karuk, Hupa (also “Hoopa”), Modoc, and Pit River tribes, whose aboriginal territory surrounds the mountain, use Mt. Shasta for ceremony, prayer, plant gathering, health and personal well-being. In addition to the Wilderness designation, the upper slopes of Mt. Shasta are also designated as an eligible traditional cultural property. Non-indigenous metaphysical spiritual seekers use sites on and around Mt. Shasta for meditation, prayer, ceremonies, retreats, etc.

While all the resources define Mt. Shasta and create its unique character, the public use and population density sets it apart from all other watersheds in the Shasta McCloud Management Unit and drives much of the complexity and challenge of managing this diverse watershed.

Chapter 2: Issues and Key Questions

The purpose of this chapter is to focus the analysis on the key elements of the ecosystem that are most relevant to the management questions and objectives, human values, or resource conditions in the watershed. Watershed concerns are identified and framed within the context of issues. The Mount Shasta Watershed Analysis Interdisciplinary Team formulated issues and key questions.

All information needed to address the issues and key questions is presented within the context of the core topics. The core topics, issues and key questions address the basic ecological conditions, processes, and interactions at work in the watershed. Core topics are presented in part 2 of the Guide.

Core topics that should be covered in all watershed analyses include:

1. Erosion Processes, Hydrology, Stream Channel, Water Quality
2. Vegetation
3. Species and Habitats
4. Human Uses

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

The following issues were identified for the Mount Shasta watershed Analysis:

1. Natural Disturbance Regimes
2. Vegetation Management
3. Fire and Fuels (Fire Exclusion)
4. Habitat Quality
5. Public Use Management

Issue: Natural Disturbance Regimes (unique volcanic, landslide, debris flow hazards)

Mt. Shasta has a very active disturbance regime relative to surrounding watersheds. Natural disturbances such as debris flows and snow avalanches occur relatively frequently and can be widespread. The potential for natural disturbances to affect roads, trails and other infrastructure may be high where this infrastructure is located within active disturbance zones. The same is true of recreationists during certain times of the year. Opportunities may exist to better manage infrastructure and recreational activity to minimize impacts from natural disturbance processes.

Key Questions

1. What are the dominant natural disturbances within the watershed? How do they interact with forest management activities?
2. Are there specific locations in the watershed where concentrated human use and infrastructure is located in areas of high geologic hazard (e.g. Whitney Creek, Mud Creek)?
3. What opportunities exist to re-design or manage the constructed infrastructure as well as future modifications and additions (roads, campgrounds, facilities) to facilitate future management and be compatible with natural disturbance processes? What effects does this have on public health and safety?

Issue: Vegetation Management

Past management practices have shaped the forested stands within the watershed to what they are today. Large areas have been converted to even aged plantation and invasive plant species have been introduced during plantation development and management, logging, off road travel and illegal dumping of yard waste. As noted above, fire exclusion has changed forest structure and composition. Two Region 5 Sensitive species and one watch list species occurring within the watershed area are showing signs of either too much or too little disturbance. These include: 1) Wilken's harebell; 2) Cooke's phacelia and 3) Baker's globemallow. Wilken's harebell is showing signs of too much disturbance while Cooke's phacelia and Baker's globemallow have reduced numbers due to a lack of disturbance, especially fire. They are common throughout the Mt. Shasta Watershed especially on the southwestern and southern areas.

Key Questions

1. How and where has past management affected natural succession patterns, composition and structure and how can current and future management practices like commercial timber harvest create more stable and resilient conditions?

2. What is the desired future condition for plantations within the watershed and how can they be managed at healthy densities while maintaining Visual Quality Objectives?
3. How can hardwood diversity be protected and/or enhanced across the watershed?
4. How has past management practice influenced habitat for Wilken's harebell, Cooke's phacelia and Baker's globemallow and what steps can be taken to improve habitat in the future?
5. What management changes can be made to reduce the introduction and/or spread of invasive plant species?

Issue: Fire and Fuels (Fire Exclusion)

The exclusion of fire throughout the Mt. Shasta Watershed is a concern. Over 100 years of fire suppression has resulted in a landscape that is outside the historical range of variability and has created an increased risk. Excluding fire from the landscape for this period of time has resulted in ecosystem composition structure and function greatly altered from historical conditions. This has led to dense vegetation and accumulated fuels which create conditions that could result in uncharacteristic fire behavior. The amount of Wildland Urban Interface (WUI) within the watershed, combined with concentrated human uses, creates a situation where continued fire exclusion may allow for high intensity fires that impact firefighter and public safety.

Key Questions

1. How has the vegetation changed over time as a result of fire suppression and what is the current hazard to the watershed as a result of this change (e.g. fuel accumulation)?
2. How can natural ecosystem processes, including fire, mortality and disease, be safely returned to the entire watershed area to restore ecosystem structure and function?
3. How can human uses be managed to reduce the threat of human ignited fires and what specific management activities are needed to protect the WUI?

Issue: Habitat Quality

Mid and late seral mixed conifer and conifer/hardwood habitats have the potential to support a variety of species including the northern spotted owl in the southern and eastern portion of the watershed. There is a need to manage and protect what currently exists and to recruit additional habitat of this type for the future. Because areas in the southern and eastern portion of the Mt. Shasta Watershed contains federally designated Critical Habitat for the northern spotted owl (NSO), it is essential that the key elements that constitute suitable NSO habitat are considered when assessing the overall quality of the habitat within the watershed.

Early seral brush (bitterbrush) habitat has the potential to support early seral species including deer, mountain quail and elk particularly in the northern portion of the watershed. There is a need to manage what currently exists and continue to recruit additional habitat of this type for the future.

Key Questions

1. How has management influenced habitat for species of concern and species that depend upon a variety and diversity of habitats?
2. What management actions can be undertaken to improve habitat conditions and quality (including reducing the potential for high-severity wildfire) for species of concern and species that depend on diverse habitat types.

Issue: Public Use Management

Mt. Shasta draws many people for recreational pursuit's year round and for indigenous and non-indigenous cultural/spiritual purposes (concentrated in the summer). These include: mountain climbing, skiing/snowboarding, hiking, camping, cultural/spiritual visits, hunting, mountain biking, firewood cutting, etc. The current recreational use exceeds developed capacity and is in need of further planning and management. Unmanaged recreation has led to resource impacts specifically in ecologically sensitive sites (e.g wet meadows, riparian). Unmanaged spiritual/cultural use has proliferated and has led to illegal ornamentation (prayer flags, medicine wheels, altars, shrines, crystal arrangements, etc.) illegal placing of cremations, meadow and spring damage, and visitor conflicts. Although Forest Orders have been used to limit some use, updated and expanded management and infrastructure is needed.

Key Questions

1. Where does concentrated public use occur and how does it interact/affect: unique habitats, cultural resources, local economy, adjacent private owners and property? (map and limited description)
2. Where do we have activities that conflict with one another or with current management direction (e.g. mixed speed uses on trails, inappropriate actions within a traditional cultural property)? (map wilderness, sensitive habitats, critical habitat, legal restrictions on use)
3. What other public uses (commercial, recreational, residential) occur within the watershed, and what are the considerations of management of these uses?
4. What tools exist to improve management of recreation and cultural spiritual use on Mt. Shasta?

5. What are relevant internal/external legal designations that influence both opportunities and constraints (e.g. ownership patterns, LRMP, TCP, state water rights, CHU)? (maps with descriptive legend)

Chapter 3: Current Conditions

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.

Geologic Processes and Hydrology

Volcanic Activity

The Mt. Shasta watershed is a youthful and dynamic volcanic landscape, where eruptions have occurred once per 800 years over the last 10,000 years, and once per 600 years in the past 4,500 years (Miller, 1980) while the most recent evidence of an eruption is from about 200 years ago. Volcanic hazards at Mt. Shasta are varied and include pyroclastic flows, volcanic debris flows and floods, lava flows, growth of lava domes, air-fall of volcanic ash, and volcanic gases. These are described below:

Pyroclastic flows: Mixtures of hot gasses, rock, and ash which travel rapidly down the flank of the volcano at speeds of up to 100 miles per hour, and are capable of flowing up over low-lying hills.

Volcanic debris flows: Water-charged slurries of rock, ash, soil, and organic debris which are similar to pyroclastic flows, but generally move more slowly (from 1 to 10's of miles per hour), and are typically confined to channels. This type of debris flow is triggered by a volcanic eruption which melts snow and ice.

Lava flows: Coherent streams of molten rock that usually issue forth without major explosive eruptions, and usually move at less than walking speeds.

Domes: Masses of solid rock formed when viscous lava is erupted slowly from a vent. Dome eruptions can generate pyroclastic flows due to explosions or collapse of the sides, and as such, pose an important hazard. Shastina and Black Butte are both examples of domes which generated pyroclastic flows. Black Butte was designated as a Geologic Special Interest Area by the Forest Land and Resource Management Plan for its unique and scenic geologic features, and easy accessibility to the public, via a trail to the top.

Air Fall Ash: This consists of rock and ash fragments erupted into the atmosphere by a variety of eruption processes, which settle back to earth by falling through the air without coalescing into a pyroclastic flow. Winds can carry such ash considerable distances.

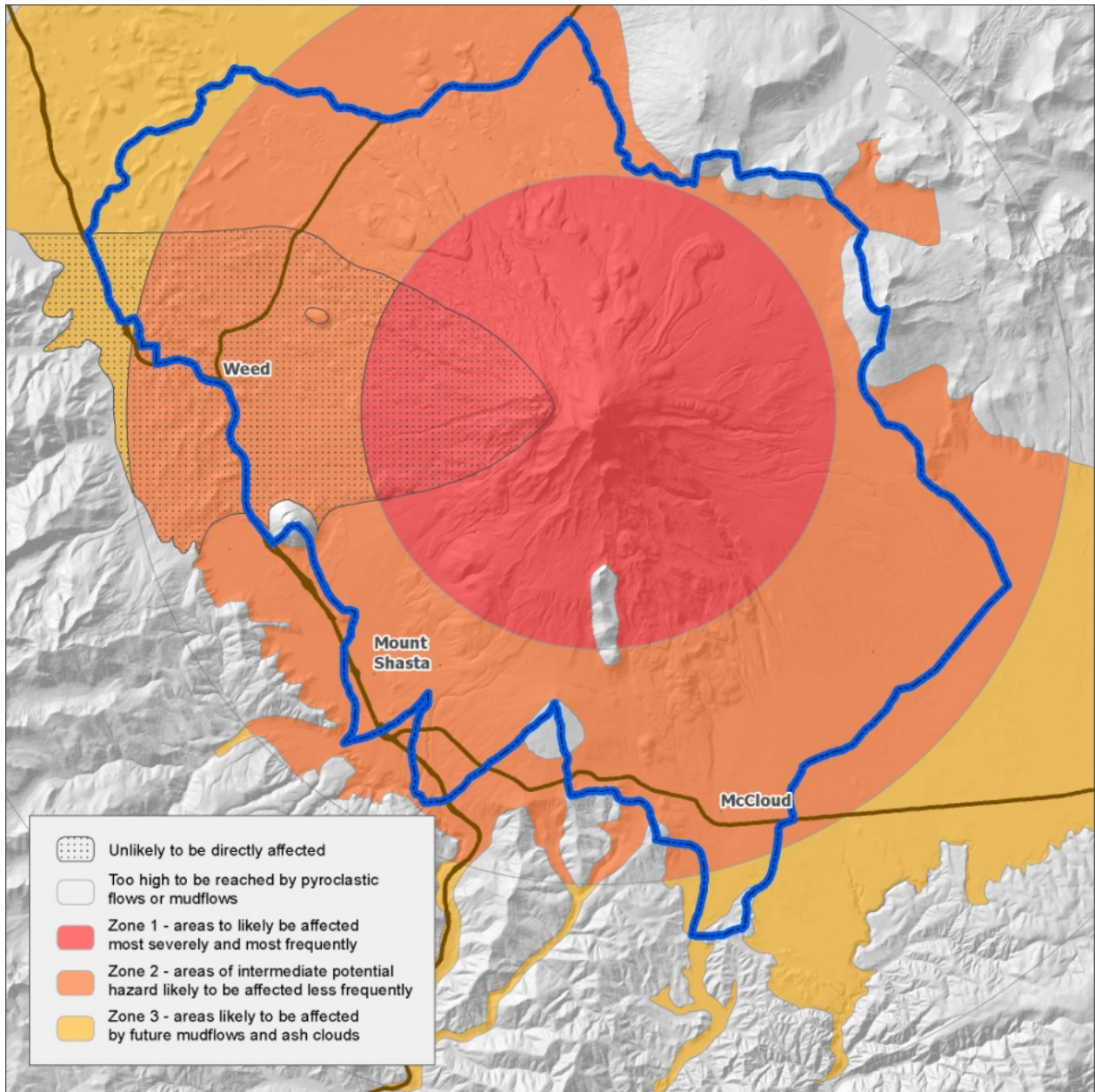
Volcanic gasses: Gasses emitted from stratovolcanoes such as Mt. Shasta typically include (in decreasing order of abundance), water steam, carbon dioxide and compounds of sulfur and chlorine, along with lesser amounts of carbon monoxide, fluorine, and boron compounds, and ammonia (Miller, 1980). Gasses such as carbon dioxide are relatively dense, and can collect in low spots, where they pose a hazard to humans and animals.

Seismicity

Seismic activity is associated with the movement of molten rock through the earth's crust. Such ground shaking can initiate landslides.

Volcanic hazards were evaluated in 1980 by C. Dan Miller (1980) of the US Geological Survey, and hazard zones are displayed on Maps 3-1 (pyroclastic and debris flows), and 3-2, (lava flows). Map 3-1 identifies 3 hazard zones as follows:

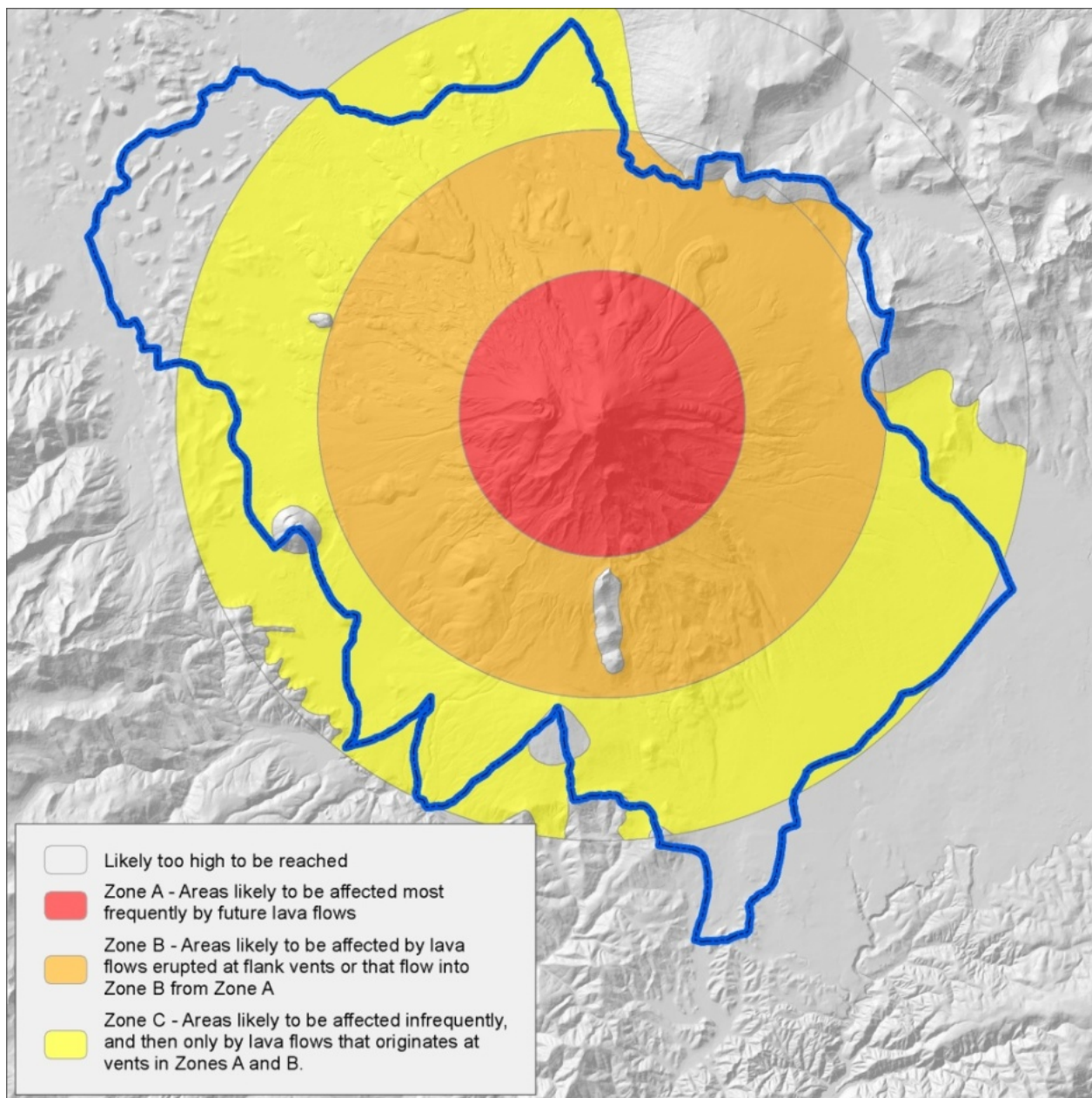
1. **Zone 1-** Areas likely to be affected most severely and most frequently by pyroclastic flows and associated ash clouds, lateral blasts, and mudflows resulting from future eruptions.
2. **Zone 2-** Areas of intermediate potential hazard likely to be affected less frequently by pyroclastic flows and associated ash clouds and mudflows from future eruptions.
3. **Zone 3-** Areas likely to be affected by future mudflow and ash clouds associated with pyroclastic flows in Zones 1 and 2. Zone 3 could also be affected by very large but infrequent, future pyroclastic flows and their associated ash clouds.



Map 3-1: Pyroclastic and Eruptive Debris Flow Hazard

Map 3-2 identifies zones of potential hazard from lava flows from future eruptions in the vicinity of Mount Shasta, California.

1. **Zone A-** Areas likely to be affected most frequently by future lava flow.
2. **Zone B-** Areas likely to be affected by lava flows erupted at flank vents or that flow into zone B from Zone A.
3. **Zone C-** Areas likely to be affected infrequently and only by lava flows originating at vents in Zones A and B.



Map 3-2 Lava Flow Hazard

Much has been learned since publication of Miller’s (1980) volcanic hazard assessment for Mt. Shasta and the US Geological Survey is in the process of reevaluating that earlier work. Field studies are in progress which will refine the current understanding of the eruptive history of the volcano over the past 10,000 years. These investigations should be completed within a few years and will lead to a new, more comprehensive volcanic hazard assessment.

Currently, the California Volcano Observatory (CalVO) is responsible for monitoring the volcano and conveying information to government agencies and the public. The observatory was

established in 2012 and replaced the Long Valley Observatory. Margaret Mangan (USGS, Menlo Park) is the Scientist in Charge. The beta version of the new CalVO website can be viewed at:

<http://volcanoes.usgs.gov/observatories/calvo/>

The US Geological Survey is currently monitoring seismicity (ground shaking) and deformation (bulging or shrinking) with seismometers and GPS instruments respectively, which are deployed around the volcano. The seismometer locations can be found on the link provided below:

http://volcanoes.usgs.gov/volcanoes/mount_shasta/mount_shasta_monitoring_4.html

In addition, the thermal springs near the summit are also monitored periodically by USGS. In the event Mt. Shasta begins to show signs of a possible eruption, CalVO will issue Volcano Alerts according to a set of established protocols. A copy of these protocols, dated 27 February 2012, was provided to the Shasta-Trinity National Forest. These will be coordinated by the Scientist in Charge (Margaret Mangan). Monthly alerts are available from CalVO summarizing results of their monitoring network:

<http://pubs.usgs.gov/fs/2006/3139/fs2006-3139.pdf>

Glaciers and Glacial Deposits

Glaciers are an active part of the Mt. Shasta landscape. They scour rock from the mountain and receive rock fall from mountain slopes above. They move continuously and transport this rock rubble down slope where it is deposited as glacial moraines or delivered to the stream system at the snout of the glacier. There are seven named glaciers (USGS 7 ½ minute maps) on Mt. Shasta: Bolam; Hotlum; Wintun; Konwakiton; Mud Creek; Watkins; and Whitney (the largest glacier in California). The moraines immediately below the glaciers are un-consolidated and easily eroded by the streams draining the glaciers.

All glaciers on Mt. Shasta retreated from 1917-1936, likely due to the low precipitation during those years. Precipitation increased after 1936 and Whitney Glacier advanced 1,500 feet from 1944-1972 (Rhodes, 1987). From 1980-1997, the western lobe advanced about 800 feet (de la Fuente and Bachmann, 1999). Google Earth time sequence images were reviewed for this Watershed Analysis and it was found that between 1993 and 2010, the narrow west lobe of the Glacier advanced about 400 feet, while the eastern lobe (the larger of the two) remained about the same (Photos 3-1 and 3-2).



Photo 3-1 (Google Earth Image)

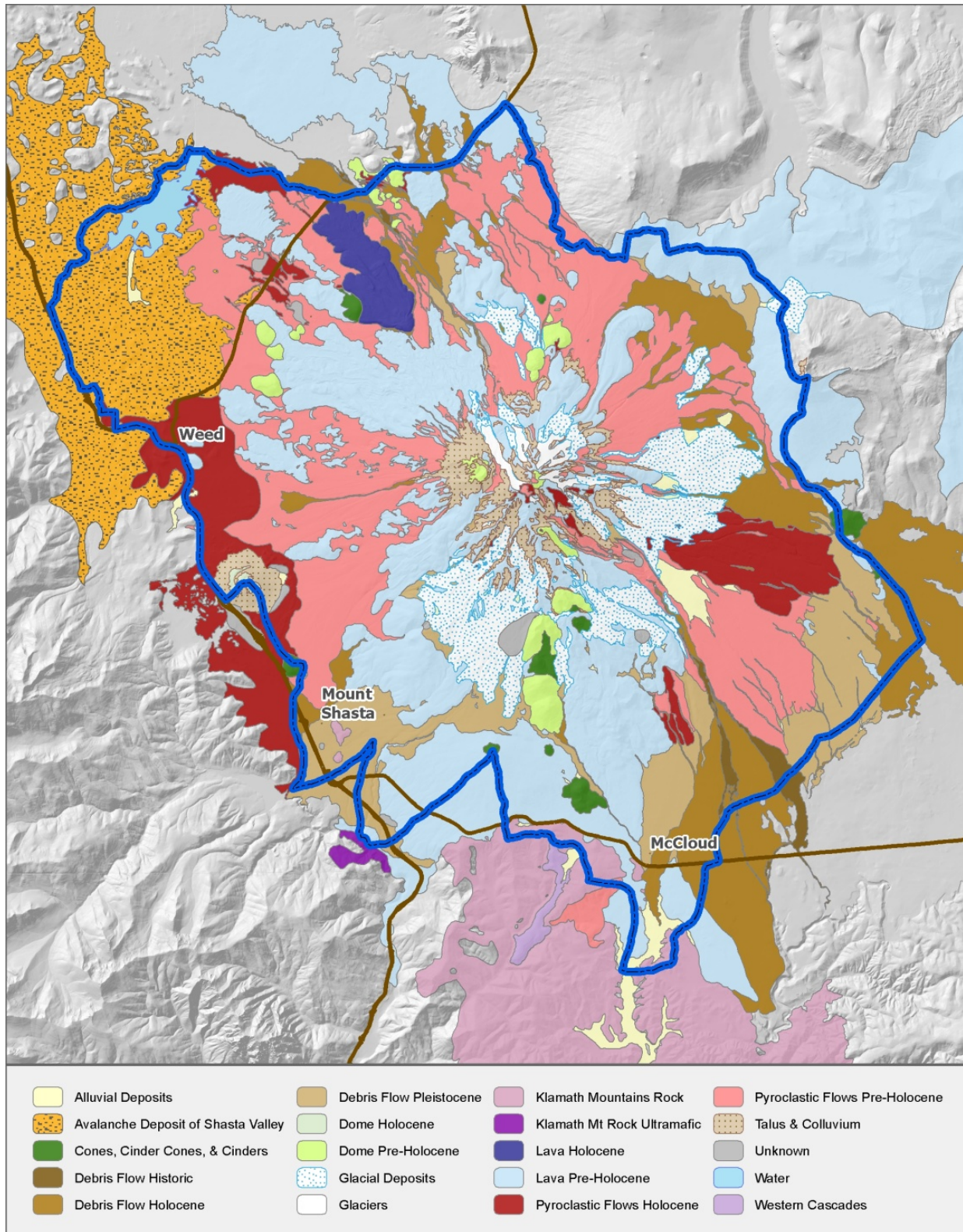


Photo 3-2 (Google Earth Image)

It should be noted that the total length of advance cannot be computed by adding the totals listed above, because there are gaps and overlaps in the time sequences presented. Historical lengthening of the glaciers has made more ice available to melt and contribute to aquifers, stream flow and debris flows. In the case of Whitney Glacier, the ice is now perched on a slope break, where it can more easily contribute ice and rock debris directly to a steeper part of the channel than it could in the 1940's.

Alluvial Fans

Alluvial fans surround the mountain and have received stream and debris flow sediment along with pyroclastic flow material for hundreds of thousands of years. They are a dynamic part of the watershed and many are active on an annual or decadal basis. Most of the alluvial fans surrounding Mt. Shasta remain active and are associated with the larger streams draining the mountain. Large historic debris flows through 1986 are listed below in Table 3-1 (Osterkamp et al., 1986). Map 3-3 (Bedrock and Surficial Deposits) shows the distribution of alluvial fans surrounding Mt. Shasta including debris flow deposits, alluvial deposits, and some pyroclastic deposits. A large part of the Mud Creek alluvial fan was designated as a Research Natural Area, (Shasta Mudflow) by the Forest Land and Resource Management Plan. This area provides the opportunity to study the secession of vegetation and also soil development following debris flows.



Map 3-3: Bedrock and Surficial Deposits

A number of roads traverse the fans and have locally intercepted the streams and diverted them to new locations. This is particularly true where the alignment runs directly down slope or slightly oblique to the downslope direction on the fan. Examples exist on the fans of Whitney Creek and Swamp Creek among others and can result in the entire flow being diverted to a new location. This condition can cause extensive damage to the road, and change hydrologic conditions downstream which can result in flooding of some areas and drying out of others. Some alluvial fans have been isolated from the active stream systems by lava flows or other obstructions and have not received sediment in recent centuries allowing them to stabilize with vegetation cover and soil development. A recent wildfire burned parts of the Whitney Creek fan around 2006 (the Hotlum Fire). More detail on the alluvial fans is contained in the streams section below.

Recent Lava Flows (barren)

Recent lava flows consist of barren rock outcrops and “fingers” formed by geologically young lava flows and include the Lava Park Flow on the northwest flank of the mountain, Military Pass flow on the north, along with some lava domes and cinder cones. These barren areas have little to no soil cover, and support scattered and hardy plant life. Over geologic time, these flows will be mantled with ash fall, wind-blown dust and soil, and other volcanic products, which facilitate soil development. One lava tube cave is known to exist within one of the younger lava flows. Recent lava flows have been subjected to very little human disturbance or fire historically due mostly to the lack of vegetation, and difficulty of road construction. An important exception is the Southern Pacific railroad which crosses the Lava Park flow.

Debris Avalanches

The current potential for a **debris avalanche** of the scale which occurred about 350,000 years ago at Mt. Shasta is not well understood. It is believed that such events usually occur in association with eruptions, but are possible without such a trigger due to gradual weakening of the rock by hydrothermal alteration. Though the probability for such an event occurring any given year may be very low, the consequences are huge, and we would benefit from refining our assessment of that potential. The new high resolution digital elevation model (DEM) could be used toward that end.

Debris Slides

Debris slides have occurred in the past 20 years within the inner gorges of the main streams draining Mt. Shasta. As such, this type of landslide should be anticipated within this setting in the future. The timing of debris slide episodes has not been systematically evaluated (winter versus summer). Other settings where debris slide potential is likely to be high include steep amphitheaters such as that at the head of Diller Canyon. A thorough assessment of debris slide

potential is not currently available. The new high resolution digital elevation model could be used toward that end.

Rock Fall

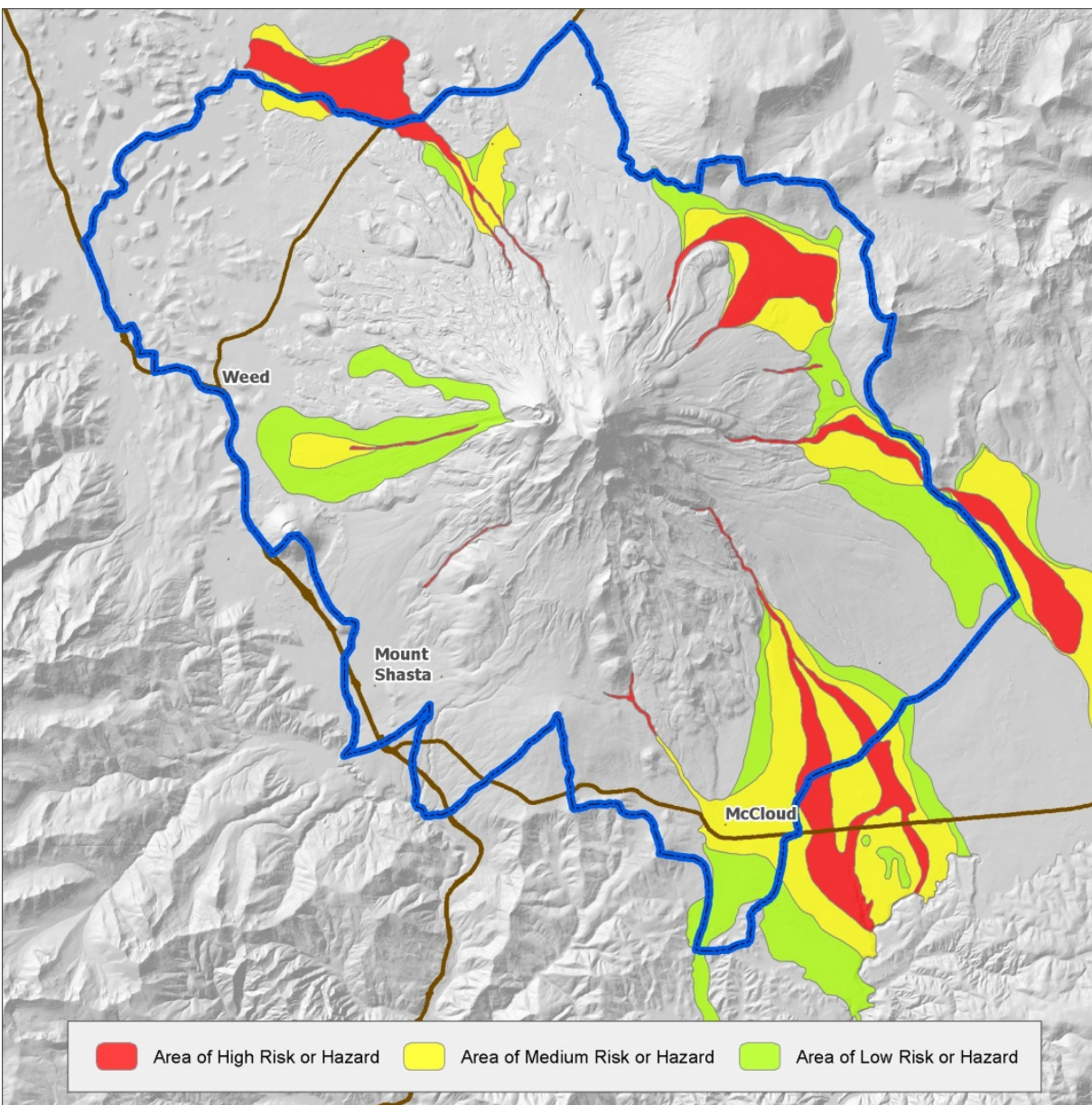
Rock fall occurs annually on Mt. Shasta and peaks in late summer and fall. Though the affected area is usually small and localized, rock fall poses a hazard to recreationists. Rock fall can be triggered by natural processes such as ravel on steep slopes, wind erosion of fine material supporting rock and seismic ground shaking, or by humans or animals walking on steep hill slopes. Rock fall potential has not been systematically analyzed, and the new high resolution digital elevation model could be used toward that end.

Debris Flows – Hazard and Risk

Debris flows are perhaps the most important type of landslide on Mt. Shasta, since they occur frequently, move relatively fast (are difficult to escape), and affect large areas. Debris flow hazards at Mt. Shasta have been addressed in detail by numerous researchers, including: (Miller (1980 and 1989); Osterkamp et al. (1986); Hupp et al. (1987); Blodgett et al. (1996); Roberts (2004); and McClung (2005). It is useful to subdivide debris flow processes at Mt. Shasta into two types: eruptive (associated with volcanic eruptions) and non-eruptive. The eruptive debris flows occur at intervals of 100's to thousands of years compared to 10's of years for the non-eruptive type. Various hazard maps have been developed, and the one by Osterkamp et al. (1986) is included in this Watershed Analysis as Map 3-5 (Non-Eruptive Debris Flow Hazard). This map was selected because it systematically covers the entire mountain and captures most of the hazardous areas identified by the other more focused maps. Furthermore, USGS is in the process of taking a fresh look at this hazard as part of its on-going reassessment of the natural hazards associated with Mt. Shasta, and will be using critical data not available to earlier researchers (high resolution Digital Elevation Model or DEM). Map 3-5 describes three hazard classes:

- **Area of High Risk or Hazard-** Indicates where debris-flow activity has occurred within the last 200 years and conditions continue to be suitable for periodic activity during the next 100 years.
- **Area of Medium Risk or Hazard-** Indicates where debris-flow activity has occurred within the last 2000 years, but renewed activity appears unlikely during the next 100 years.
- **Area of Low Risk or Hazard-** Indicates where debris-flow activity has occurred during Holocene time, but not during the past 2000 years and renewed activity appears unlikely during the next 100 years.

Areas outside these three zones were unclassified, and assumed to be of lower risk than the “Low” risk areas.



Map 3-4: Non-Eruptive Debris Flow Hazard

Since the development of the debris flow hazard zones shown on Map 3-4 in 1986, several debris flows have occurred in the analysis area, allowing a limited amount of validation or verification of these zones. The August 1997 debris flow at Whitney Creek initiated in the high hazard zone and appears to have stayed entirely within the high, moderate, and low hazard zones. It did not enter the unclassified or lowest hazard zone. In contrast, the January 1997 event in Cascade Gulch initiated in the high hazard zone, but continued further downslope on the fan into the unclassified zone. These two examples bring forth three important points:

1. **High Hazard in Stream Gorges-** Both examples initiated in deeply incised gorges on the flanks of the volcano which had been classified as high debris flow hazard zones. This observation adds credence to that classification.
2. **Lower Limit of High Hazard Zone on Fans-** Debris flows *may* extend further downslope on the fans than expected. The Cascade Gulch debris flow of January 1997 extended well below the high hazard zone delineated along the channel by the hazard map, into the unclassified zone.
3. **Stream Diversions-** Once a stream diversion occurs on a fan, predictions cannot be reliably made regarding which way it will go. Under these conditions, the concept that areas removed from the channels are less likely to experience debris flows is no longer valid. For example, the diversion which occurred at Whitney Creek below the railroad in 1997 caused the debris flow to leave the active channel network, and flow almost entirely into the low hazard zone indicated on Map 3-4. This issue could be addressed by using the new high resolution (1-meter) DEM to identify and evaluate potential diversion sites.

There are a number of factors that can trigger debris flows. These include warm temperatures (often combined with drought periods); unusually warm precipitation events occurring during the summer and fall; ongoing ravel that fills channels with rock and soil, landslides and volcanic activity. The magnitude of debris flows is strongly influenced by the snowpack on Mt. Shasta that exists at the time the debris flows are initiated. Large debris flows are less likely to occur when substantial snow cover exists on the mountain. Conversely, debris flows are more likely to occur when the snowpack is sparse or absent due to increased glacial ice exposure and the increased potential for erosion.

The ability of the snowpack to attenuate and affect debris flow processes can be ascertained by observing how debris flow prone channels respond to precipitation events throughout the year. For instance the largest winter storms almost never result in debris flows due to the ability of the snowpack to absorb vast amounts of precipitation while small summer convective storms are more capable of causing debris flows, torrents and erosion due to the absence of the snowpack. In this sense, the snowpack can be thought of as the glue that holds everything in place throughout the winter, spring and early summer months preventing debris flows and erosion during the wet winter season. The 1997 debris flow in Cascade Gulch is an exception to this association, being a prolonged warm rain-on-snow event.

Debris Flows – Channel Processes

All channels draining Mt. Shasta are vulnerable to large scale disturbances. Debris flows (see above) are the most common disturbance process affecting channels on Mt. Shasta, with as many as 10 large events occurring in any one channel over the past 200 years, the most recent occurring in Whitney Creek in 1997. While debris flows may occur in any channel, they are

more commonly associated with the larger streams that are fed by glacial melt. All of the streams fed by glacial melt have experienced regular debris flow activity over the past 500 years (Osterkamp, et al., 1986). Episodic debris flow events have resulted in the formation of large alluvial fans associated with each debris flow path. Additional debris flow events at Whitney Creek and other streams are documented in de la Fuente and Bachmann (1998), and Bachmann et al. (2004). A summary of recent debris flow activity in selected channels on Mt. Shasta is presented in Table 3-1 (Data from Osterkamp, et al., 1986).

Drainage	Debris Flow Years
Whitney Creek	1804, 1830, 1840, 1868, 1919, 1935, 1952, 1960, 1977, 1997
Bolam Creek	1800, 1845, 1897, 1935, 1955, 1973, 1997
Inconstance Creek	1881, 1918, 1939
Gravel Creek	1836, 1902, 1937, 1939, 1958, 1971
Ash Creek	1800, 1873, 1898, 1937, 1939, 1958, 1962, 1977
Panther Creek	1804, 1924, 1967
Cascade Gulch	1928, 1957
Diller Canyon	1921, 1947, 1961

Table 3-1: Debris flow history for selected drainages from 1800 to present. Data may not reflect all debris flows occurrence, particularly after 1986 (date of most recent USGS publication – Osterkamp et. al.).

It should be noted that Table 3-1 only depicts large events and that many smaller debris flows or torrents have also occurred on Mt. Shasta. The larger events depicted in Table 3-1 all resulted in substantial transport of debris from source areas high on the mountain through the inner gorge or channel network down onto the alluvial fans associated with each channel. Smaller events likely do not result in significant sediment deposition on alluvial fans and effects from these events are likely confined to the channel and near channel margins. Figure 3-1 (below) illustrates the common characteristics of debris flow paths within channels on Mt. Shasta and the key processes occurring along the debris flow paths.

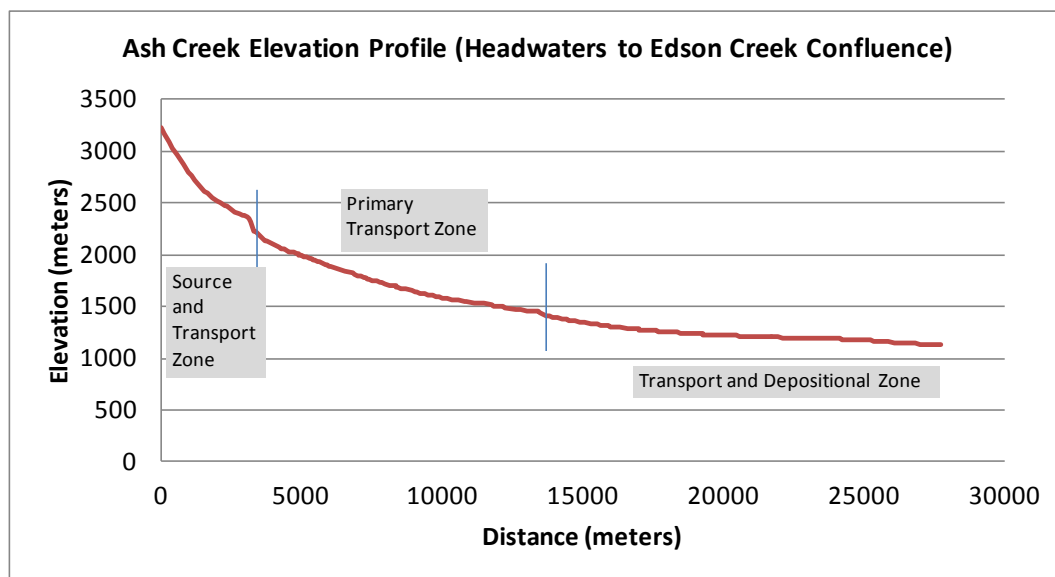
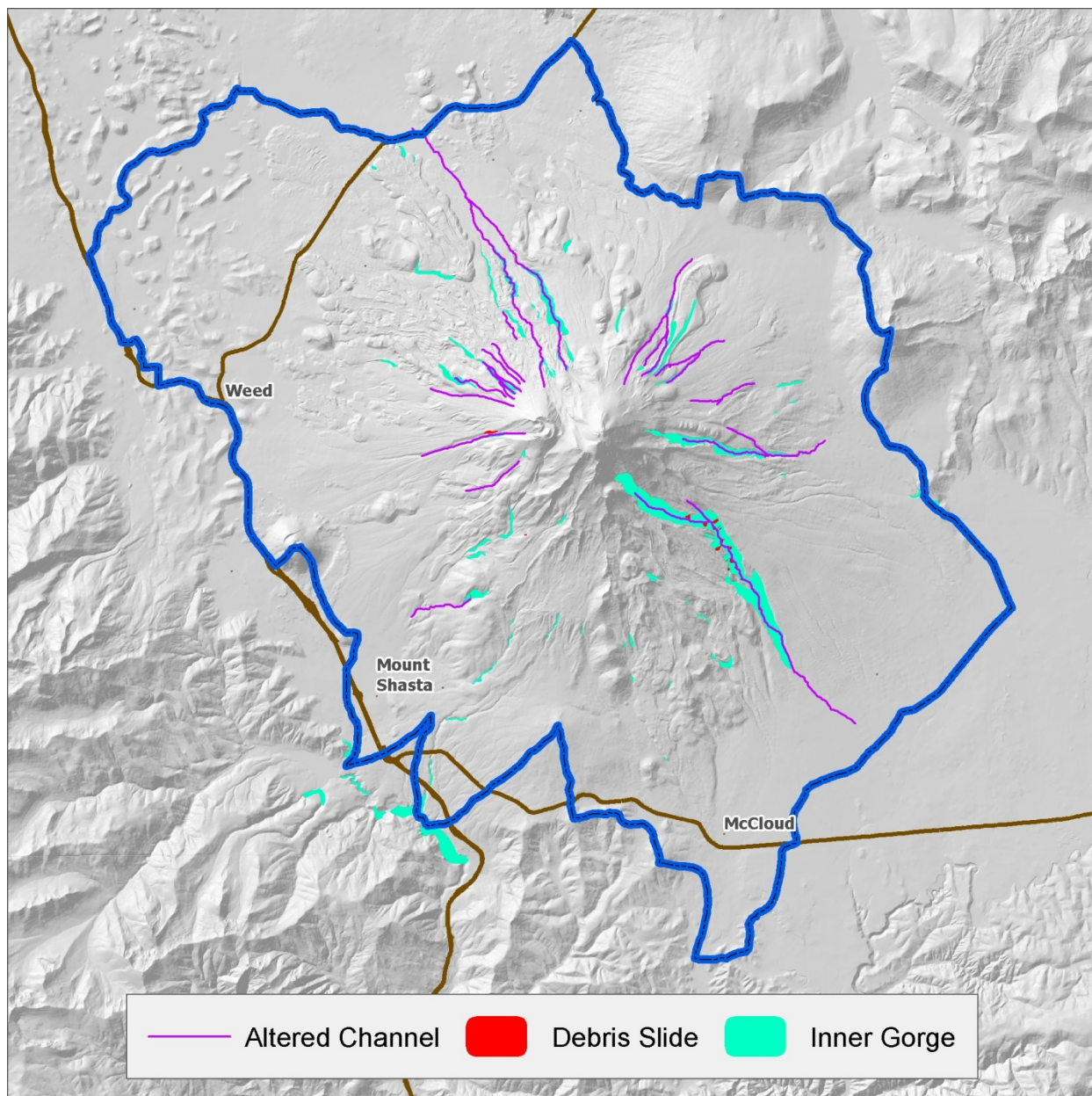


Figure 3-1: Idealized profile for Ash Creek showing dominant debris flow processes.

Debris flows occurring high on Mt. Shasta can also dramatically alter stream flow. Stream flow has been observed to increase or decrease dramatically following debris flow events. Decreases in downstream flow can occur when debris flows block upstream channels and split or divert runoff resulting in less water in the channel. Flow decreases can be severe and can result in miles of channel being completely dewatered on the lower alluvial fans (e.g. Ash Creek). Conversely, the perennial reach of Pilgrim Creek extended for several miles downstream following a small debris torrent in 1996. Perennial flows persisted for about 2.5 years in the formerly dry channel bed.

As part of the Watershed Analysis process, a rapid, reconnaissance level inventory of altered channels was conducted with Google Earth images and very limited air photo review in order to systematically identify streams with persistent scour or deposition. This condition was tracked as an indicator of possible recent debris flow activity. Map 3-5 displays streams whose channels appear barren (light colored) on Google Earth images dating from 1993 to 2009. These channels have experienced mobilization of bed material, scour, or deposition, as a result of high stream flow or debris flows in the recent past, and are referred to as “altered channels”. A discussion of how historic and more recent debris flows have affected channel morphology is presented in Chapter 4 of this analysis.



Map 3-5: Major Altered Channels, Debris Slides, Inner Gorge.

Channel altering events on the northwest flank of Mt. Shasta are easily identified on air photos for the first 10 years following disturbance, but are re-vegetated after 60 years, barring subsequent debris flow events. It follows that the altered channels shown on Map 3-5 most likely experienced large flow events less than 60 years ago. Re-vegetation rates may be different in channels on the north, east, and south sides of the mountain, and this uncertainty could be addressed by doing a more thorough historical air photo review of channel re-vegetation in those areas.

It should be noted that this rapid inventory of altered channels may have missed some streams which experienced recent channel altering events. Forest personnel have documented bed mobilization, bank erosion, and flooding/silt deposition in some streams near McCloud in association with the flood of 1997. These included Panther Creek and Squaw Valley Creek, whose channels have relatively dense over-story vegetation. This may have obscured the channel beds on the images, and consequently, they are not identified as altered channels on Map 3-5.

Landslides

Apart from volcanic processes, Mt. Shasta is highly prone to mass wasting processes such as landslides, rock fall and debris flows. The currently existing physical conditions which facilitate these processes are:

1. **Steep Slopes-** Rapid growth of the volcano (in geologic terms) has produced very steep slopes.
2. **Weak Bedrock-** Stratovolcanos, like Mt. Shasta, typically have interlayered lava, pyroclastic flows and ash, creating weak zones. Also, hot water springs chemically alter the rock into clays which weakens it.
3. **Weak Surface Materials-** A mantle of loose pyroclastic flow, glacial, ash, and talus deposits covers much of the mountain. On steep slopes these deposits can be mobilized by intense rain. Soils are predominantly sandy and cohesionless.
4. **Thick Snow Pack** – Heavy winter snowfall occurs at higher elevations, producing a deep snowpack which can melt rapidly in spring or summer.
5. **Intense Summer Precipitation-** Intense convective thunder storms are common in summer, and they produce intense, localized rainfall. When this occurs on barren rock outcrops or on melting glaciers, heavy runoff can occur and trigger debris flows.
6. **Seismic Shaking-** Ground shaking periodically affects the mountain, and can trigger rock fall or landslides. Sources of seismic shaking include magma migration beneath the mountain, movement of basin and range faults to the east, and movement of faults associated with plate junctions off the coast.

Snow Avalanches

Snow avalanches are common on Mt. Shasta and can occur as either loose snow or slab avalanches in any area where snow is deposited on slopes steeper than 33 degrees. Steeper slopes (>60 degrees) tend to shed snow continuously rather than accumulate it. Avalanches typically follow established paths, however exceptional weather conditions may result in large avalanches which can overrun their normal paths or form new ones. While avalanches occur on all slopes of

the mountain, most recorded avalanches are on the south side of the mountain (visibility and easy access improve opportunities to see and record them).

Attributes commonly associated with avalanche paths include steep, un-vegetated headwall basins with confined run-out areas, such as valley bottoms. Vegetation in these areas is often suppressed or absent depending on the frequency of avalanche activity. Above tree line, avalanche paths are generally distinguished by the shape and steepness of basins and headwalls (Haskins and Jasso, 1988). Notable snow avalanche episodes occurred in 1978, when the old ski bowl infrastructure was damaged, and in 1995, when an avalanche swept between Cascade Gulch and Diller Canyon, creating a substantial opening in the stand. This feature remains visible today (2012) from Interstate 5, and is known locally as the “Alien Footprint” (Photo 3-3).



Photo 3-3: 1995 Snow Avalanche Path (Alien Footprint)

That same year, another snow avalanche closed the road to Panther Meadow (Photos 3-4, 3-5). Approximate locations of both these avalanches are shown on Map 3-6 (Historic Snow Avalanches).

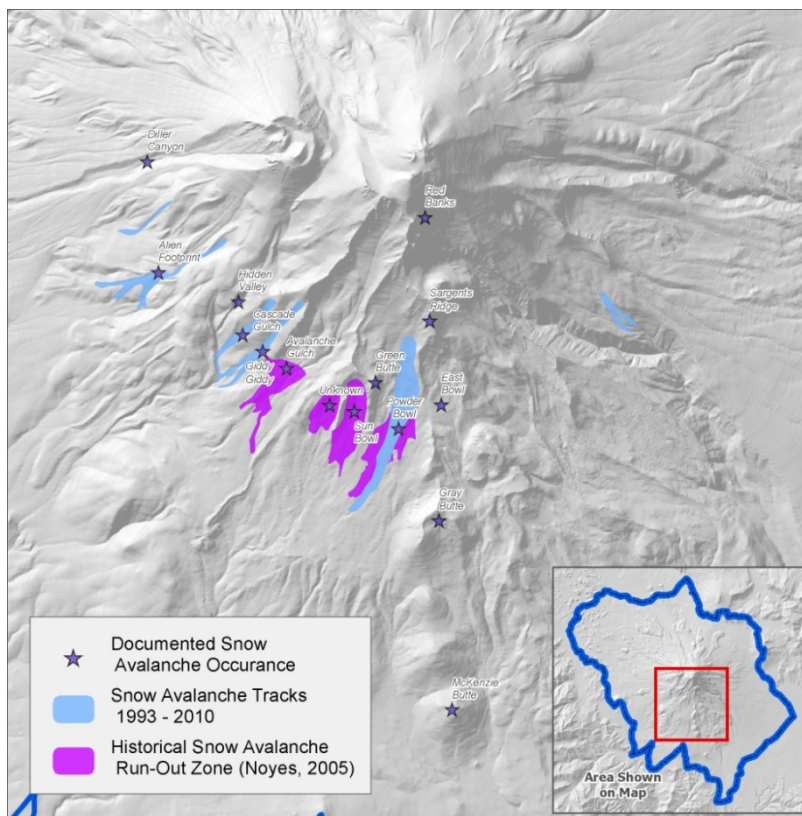


Photo 3-4: 1995 Snow Avalanche (Panther Meadow)



Photo 3-5: 1995 Snow Avalanche (Panther Meadow)

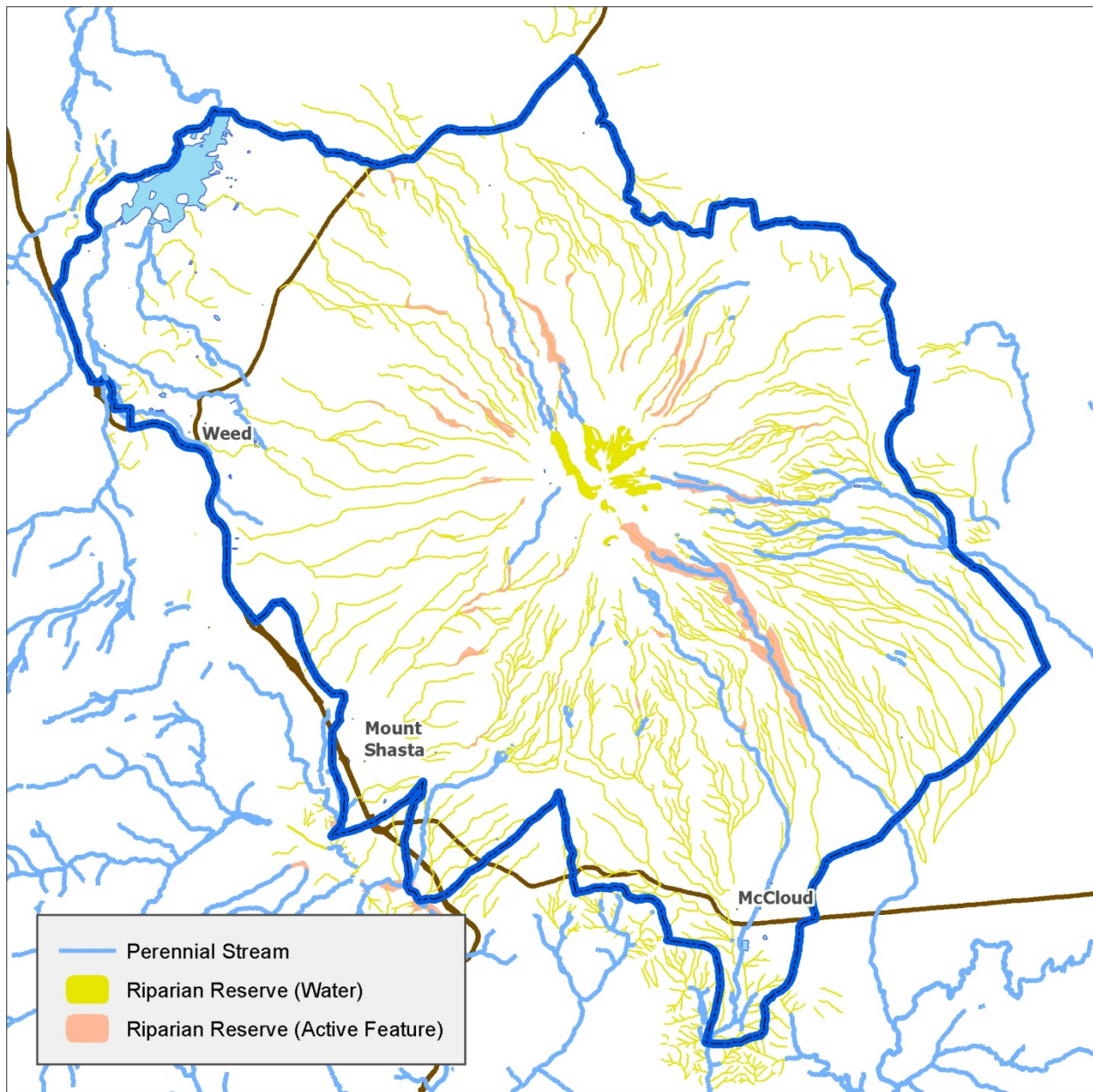
Map 3-6 provides useful information on the historic distribution of snow avalanches, and as such, identifies areas which are susceptible to avalanches in the future. However, they are not intended to serve the function of avalanche hazard maps. The avalanche hazard zones shown on the “Mt Shasta Ski Area Avalanche Hazard Zones” (Haskins and Jasso, 1988, Figure 7, page 33) captures the general area of historic avalanches, but as in the case of the non-eruptive debris flow hazard map (Map 3-4), some of the actual snow avalanche paths documented on Map 3-6, extend well below the identified hazard zones. With the historical data now available, along with the new high resolution DEM, a more refined snow avalanche hazard map can be developed.



Map 3-6: Historic Snow Avalanches

Stream Channels

The hydrology of Mt. Shasta is dominated by a groundwater flow regime; however one would not conclude this from the outward appearance of the mountain. Mt. Shasta is heavily dissected by a dense network of channels that generally begin just below the glacial zones and extend down slope in a radial drainage pattern (see Map 3-7: Riparian Reserves). Many of these channels are not currently active and were likely formed during large disturbance events associated with volcanic activity (e.g. rapid melting of snowpack/glaciers) and episodic glacial melt. These channels do not flow on an annual basis and many may not experience flow except during unusually large events.



Map 3-7: Riparian Reserves

The number of channels that exhibit surface runoff on an annual basis is much smaller than the total channel network. Almost all of the precipitation that falls on Mt. Shasta bypasses the surface channel network by infiltrating subsurface and eventually emerging as spring flow at lower elevations. The groundwater influence on Mt. Shasta is so dominant that there are only two stream channels that actually flow perennially to their confluence with larger rivers: Squaw Valley Creek and Mud Creek and both are tributaries to the McCloud River.

While surface flow hydrology on Mt. Shasta is limited, Mt. Shasta does contain several well defined drainages with perennial or intermittent stream channels (Table 3-2). The most reliable

streams from a flow perspective generally occur within the McCloud River drainage. Perennial streams are almost completely absent within the Sacramento River drainage on the southwest slopes of Mt. Shasta. The north side has numerous named streams however these are very intermittent in nature with most only flowing in response to seasonal glacial melt or large glacial melt events.

Drainage	Stream	Primary Source	Flow Regime
McCloud	Panther Creek	Springs	East and West Forks are perennial at upper elevations. Lower Panther Creek is intermittent at lower elevations. Flows into Squaw Valley Creek.
McCloud	Squaw Valley Creek	Springs	Perennial (flows into McCloud River)
McCloud	Mud Creek	Glacial Melt	Perennial (flows into McCloud River)
McCloud	Clear Creek	Glacial Melt	Perennial (flows into Mud Creek)
McCloud	Cold Creek	Glacial Melt	Perennial at upper elevations. Intermittent at lower elevations. (flows into Ash Creek)
McCloud	Ash Creek	Glacial Melt	Perennial at upper elevations. Intermittent at lower elevations. Flows into McCloud River only during unusually large events.
McCloud	Pilgrim Creek	Snowmelt	Perennial at upper elevations. Intermittent at lower elevations. No downstream connectivity.
McCloud	Brewer Creek	Snowmelt	Perennial at upper elevations. Intermittent at lower elevations. Flows into Ash Creek only during unusually large events.
McCloud	Gravel Creek	Glacial Melt	Perennial at upper elevations. Intermittent at lower elevations. No downstream connectivity.
Sacramento	Big Canyon Creek	Snowmelt	Intermittent. Flows into Sacramento River.
Shasta	Diller Canyon Creek	Snowmelt	Intermittent. No downstream connectivity.
Shasta	Whitney Creek	Glacial Melt	Intermittent. No downstream connectivity.
Shasta	Bolam Creek	Glacial Melt	Intermittent. No downstream connectivity.
Shasta	Inconstance Creek	Glacial Melt	Intermittent. No downstream connectivity.

Table 3-2: Selected stream channels on Mount Shasta; flow regimes and primary water sources.

There are many smaller perennial and intermittent channels sourced by springs, glaciers or melting snow on the mountain, but they are much less extensive than channels shown in Table 3-2. In many cases these smaller streams are unmapped and little is known about the extent of riparian habitat associated with them.

Most stream channels on Mt. Shasta experience natural disturbance resulting from debris flow activity. Many of these channels do not support extensive riparian habitat or aquatic vegetation due to the frequent disturbance impacts associated with debris flows. Debris flows can scour or remove all vegetation located within the bottom of inner gorges and near channel margins. Riparian vegetation established on or near channel margins on the lower alluvial fans can also be impacted by large debris flows which may cause the channel to migrate and abandon or bury former channel locations. The extent of debris flow impacts on riparian vegetation can be highly variable. Riparian vegetation can reestablish itself quickly along perennial streams such as Mud and upper Ash Creeks following debris flow activity but may take longer to recover within inner

gorges where significant incision has occurred on intermittent channels and on alluvial fans where channel migration has occurred.

Vegetation along these streams varies with elevation. Streambanks at higher elevations such as Panther Creek and Squaw Valley Creek experience more recreational use that tends to damage vegetation, create bare ground and compact soils. Upper elevation (above 7,000 feet) streams start out in the heather/huckleberry/sedge species associated with the alpine dwarf shrub, whitebark pine and red fir types. As elevation drops, riparian vegetation changes to a montane riparian type consisting of willow/red-stemmed dogwood/sedge or willow/alder/sedge associations. Montane riparian vegetation can also include black cottonwood, aspen, white alder and a high diversity of forbs as common associates.



Photo 3-6: Cold Creek

Streams on the east side of the mountain such as Pilgrim Creek and Cold Creek (see Photo 3-6 above), see very little disturbance from human use at higher elevations. At lower elevations vegetation may see fewer disturbances from recreationists. However, with fire suppression and other past management activities, conifer encroachment and/or upland shrub encroachment is a big issue for many streams. Streams on the east side, Cold Creek, Pilgrim Creek and Ash Creek, also have cattle from the Bartle Allotment damaging stream banks and vegetation at lower elevations (up to 6,000 feet). Much of this is considered excess use because it is outside of the allotment boundary. Grazing impacts were noted during sensitive plant surveys along Cold

Creek and Pilgrim Creek in 2011. However the biggest impacts related to human use have come from logging, planting and maintaining plantations and road building. Creeks on the north side of the mountain appear to have little to no riparian vegetation probably due to either the frequency of debris flow activity similar to Whitney Creek, or a lack of flow for long periods of time such as Bolam and Inconstance Creeks. There is a lack of information regarding riparian vegetation associated with streams on the north side of the mountain.

In contrast to the debris flow channels, some streams are not as frequently impacted by debris flow activity and exhibit well developed riparian vegetation and channel form typical of a less frequent disturbance regime. Because they have not been disturbed, these channels tend to exhibit more defined riparian and aquatic habitats along their extents. Examples of channels of this type include Squaw Valley Creek and Cold Creek above Mt. Shasta City. Both of these creeks are associated with municipal water developments, and were likely developed because of the lower potential for debris flow disturbance when compared to other potential water sources.

Squaw Valley Creek has its beginnings up in the alpine dwarf shrub type at around 9,000 feet elevation. Riparian vegetation consists of Cascade heather, alpine laurel (*Kalmia polifolia*) and huckleberry. Areas associated with springs such as Upper Southgate Meadows also have a wide variety of sedges, grasses and forbs. As elevation decreases, mid-elevation species associated with the montane riparian plant association start to come in. Tree species include black cottonwood, several willow species (*Salix* sp.), Pacific dogwood (*Cornus nuttallii*), and white alder (*Alnus rhombifolia*). Shrubs include several species of willow, mountain alder (*Alnus incana* ssp. *tenuifolia*), red-stemmed dogwood (*Cornus sericea*), bunchberry (*Cornus Canadensis*), vine maple (*Acer circinatum*), and Douglas spirea (*Spirea Douglasii*). Habitat occurs as narrow, dense stands of broadleaved, deciduous trees and shrubs near the community of McCloud. As Squaw Valley Creek flows south of McCloud other species such as California hazelnut (*Corylus cornuta* var. *californica*), cascara (*Frangula purshiana*), poison oak (*Toxicodendron diversiloba*) and deer brush (*Ceanothus integerrimus*) become common. Forb, grass and grass-like species vary with elevation and can be quite diverse. Conifer species range from whitebark pine at the upper end to ponderosa pine-Douglas fir/black oak at the lower end. Conifer encroachment on riparian vegetation is occurring along some stretches of the stream.

Springs and Seeps

Springs and seeps on Mt. Shasta generally occur as isolated small patches on the mountain in association with small wet meadows. The size and extent of spring-fed meadow systems is variable and dependent on subsurface geologic controls which affect the amount of water returned to the surface and the duration and extent of surface flows. Wet meadow habitats on Mt. Shasta are rare in part due to the frequent disturbance history associated with volcanic activity, particularly at higher elevations.

Recent work conducted for California Trout Organization has resulted in improved information on spring characteristics for springs on Mt. Shasta and in the vicinity (California Trout, 2010). Water samples were collected from 22 springs on Mt. Shasta for the purpose of determining the source area of the water and to look for similarities and differences in spring characteristics. The study found that the waters for all of the springs were sourced from elevations above 5,200 and that most of the springs had source areas above 6,000 feet. The study noted that most of the source areas for the springs were within the boundaries of the Mt. Shasta Wilderness Area. Because there is very little development within the wilderness, the potential for contamination of spring waters from human activities is low (see further discussion on wilderness management).

The spring study also employed a tritium isotope analysis process to determine the age of the water for several springs. The results revealed variability in the age of the water and groundwater residence times (Table 3-3). In general springs on the north side of Mt. Shasta exhibited longer residence times (older water) and a correspondingly higher mineral content than springs on the south side of the mountain. Spring flow was measured at selected springs as part of the study. While it is generally accepted that spring flows can vary from season to season the study results suggest that small springs located at higher elevations exhibited more fluctuation in flow than springs located at lower elevations. The study found that water quality was similar except for Soda Springs that was sampled along lower Squaw Valley Creek. The consistency in water chemistry characteristics between springs is due to a corresponding similarity in mineral content of the volcanic rocks that the spring water moves through and the relatively short residence times of ground water within these rocks. Additional high elevation springs (within Wilderness) could be included in this research to increase information about their variability and vulnerability.

Spring Name	Watershed	Spring Elevation (feet)	Source Elevation (feet)	Age (years)
Carrick Spring	Shasta River	3531	8464	>50
Mt. Shasta Big Springs (City Park)	Sacramento River	3567	8170	>50
Muir Springs	McCloud River	2983	6039	14

Table 3-3: Water Age Data for Selected Springs in Mt. Shasta Vicinity

Water Quality

The quality of water emanating from spring fed systems on Mt. Shasta is excellent. Because spring-fed channels are not susceptible to peak flow they are very stable (if undisturbed by land-use) and have good water quality. The same cannot be said for non-spring fed channels on Mt. Shasta. Water quality in the larger channels can be highly variable particularly with respect to turbidity and suspended sediment concentrations. Large runoff events often result in very turbid conditions particularly in glacial fed streams like Ash, Whitney, Gravel and Mud Creeks. Mud Creek while perennial maintains such high turbidity levels that it cannot support fish (Photos 3-7 and 3-8). Extensive studies of water quality in Mud Creek were conducted by Pacific Gas and Electric during hydropower relicensing activities for the McCloud-Pit Project. For more

information on water quality in Mud Creek refer to technical memo WR-S5 TM-30 Mud Creek Turbidity Updated July 2009 (PG&E, 2009).



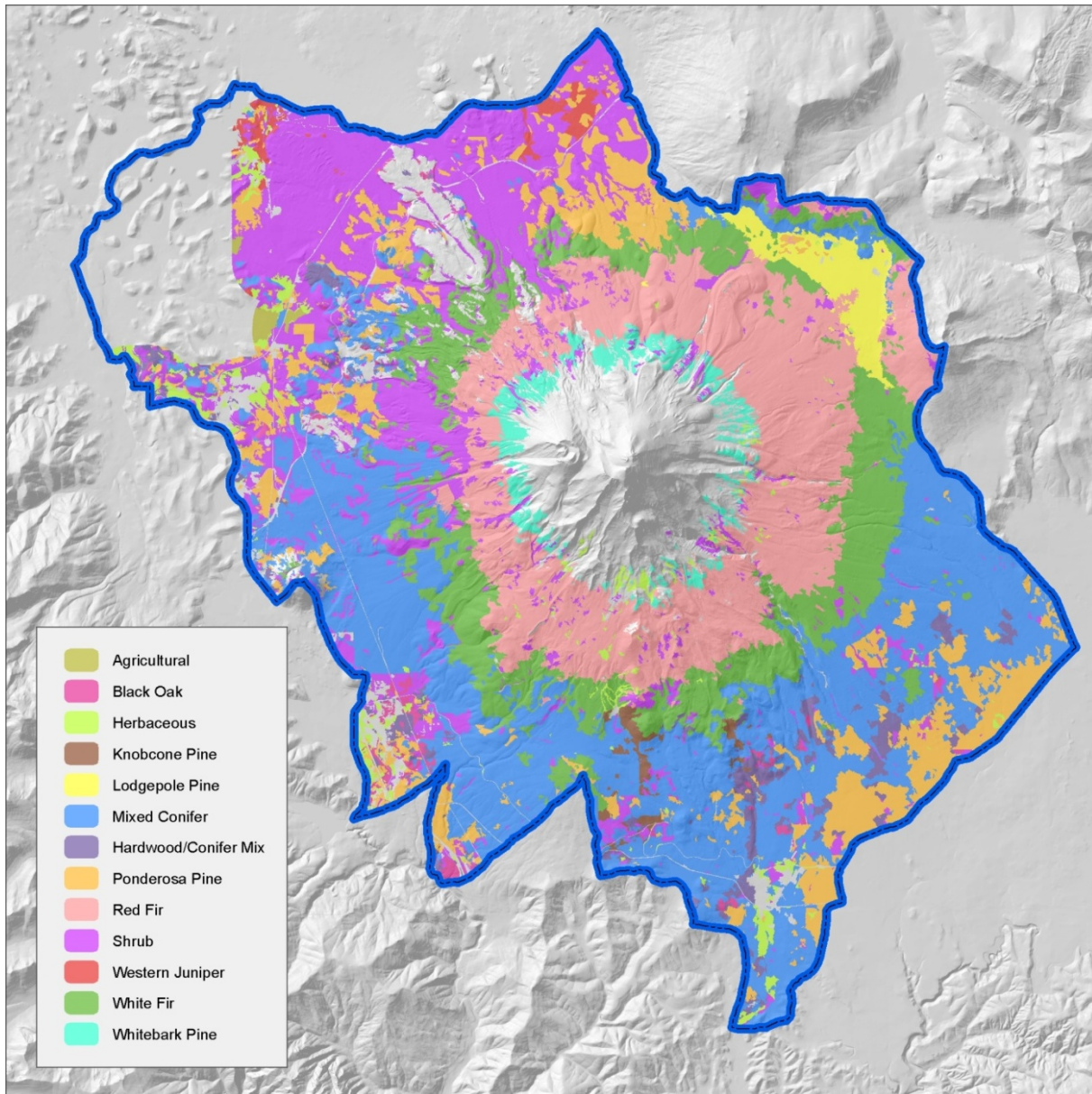
Photos 3-7 and 3-8: Koniwakiton Glacier provides sits at the headwaters of Mud Creek. Frequent slides and debris flow events can result in very turbid conditions in the creek so much so that this perennial channel does not support fish populations.

Vegetation

The current condition and general health of the vegetation within the watershed was determined using various tools such as aerial photography and personal knowledge. An additional resource that was used to help identify the potential problem spots specifically in the forested stands was the Forest Health Protection flight data (U.S. Forest Service, 2011). This flight identified mortality areas and the potential causes for that mortality. The flight also determined the species of the trees being affected by the mortality, as well as an estimate of the area being affected. More information on Forest Health Protection is available here:

<http://www.fs.fed.us/foresthealth/aviation/aerialsurvey.shtml>

As discussed in Chapter 1 the vegetation within the watershed is dominated by the topography of Mt. Shasta which can be seen in Map 3-8: “Mt. Shasta Watershed Dominant Vegetation Type” below. The vegetation typing in Map 3-8 was formed from Remote Sensing Application data and has its limitations. Again, it should be noted that all the vegetation typing that was done for this analysis is intended to help characterize the landscape and should not be used as an absolute typing.



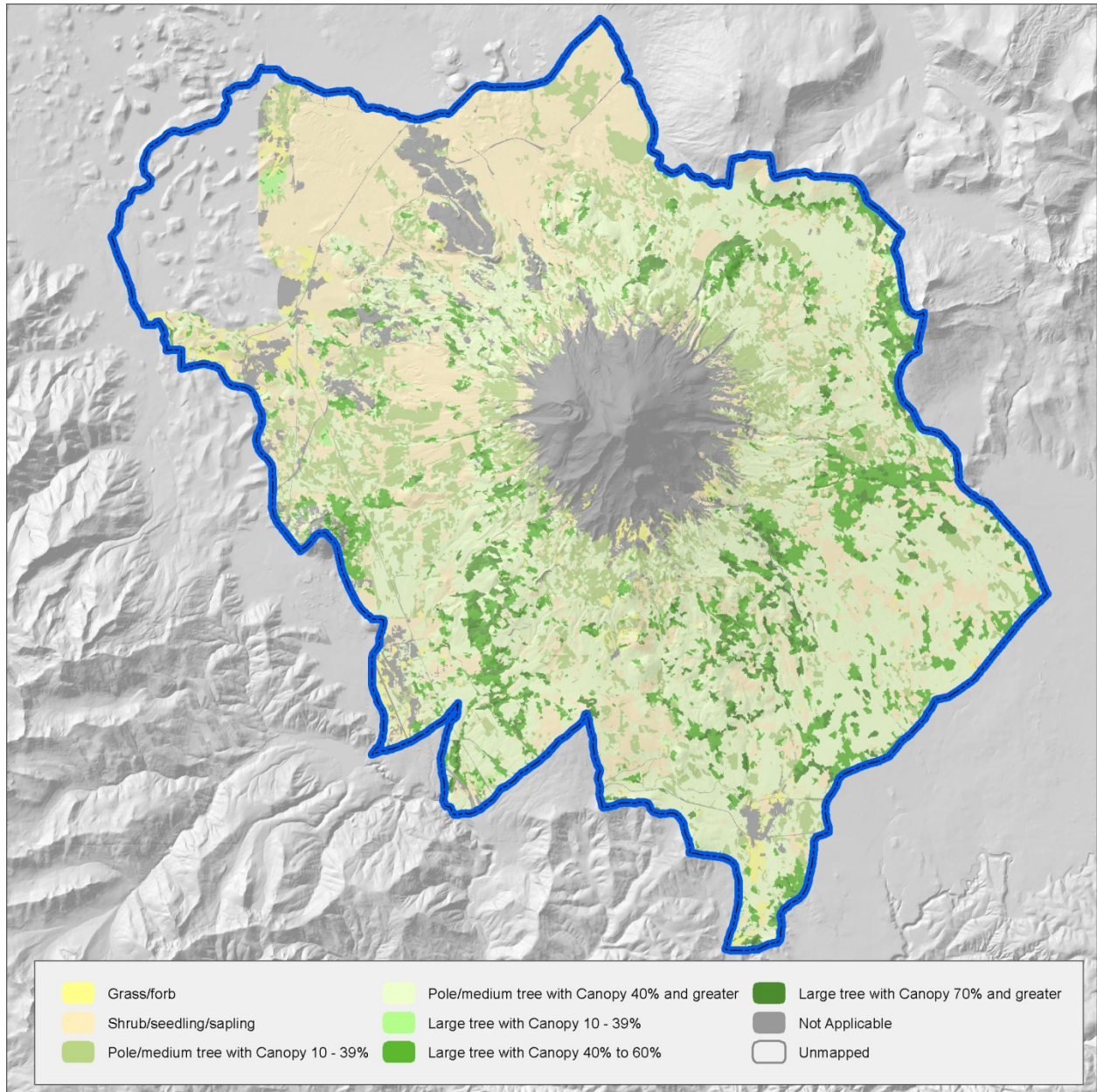
Map 3-8: Mt. Shasta Watershed Dominant Vegetation Type

Map 3-9: “Vegetation Seral Stages in the Mt. Shasta Watershed” shows the vegetation seral stages in the Mt. Shasta watershed and was also created using Remote Sensing Application data. The seral stage map depicts the overall size and canopy closure of the stands within the analysis area. The breakdowns of the sizes are depicted in the table below.

Vegetation Type	Quadratic Mean Diameter (inches)
Grass and forb	NA
Shrub/seedling/sapling	0" - 4.9"
Pole size to medium size tree	5.0" - 29.9"
Large tree and greater	≥30.0"

Table 3-4: Seral Stages

The percentage of canopy closure is determined by the percentage of ground that is covered by the overstory trees as seen from a bird’s eye view. The knowledge of the seral stages in the watershed can help managers determine where actions may be needed to either accelerate conditions to meet large tree late seral conditions, or where actions may be needed to try and maintain this conditions.



Map 3-9: Vegetation Seral Stages in the Mt. Shasta Watershed

Alpine Zone

Plant life is limited to areas providing some kind of protection from the wind and areas that hold moisture until later in the growing season. Plant life is sparse, but species diversity is higher than expected. The alpine zone on Mt. Shasta is the only place in California where you will find pumice moonwort (*Botrychium pumicola*) and Shasta sky pilot (*Polemonium pulcherrimus* var. *shastensis*). There is one known population of pumice moonwort at 9,200 feet. Shasta sky pilot is a newly described subspecies only known to occur on Mt. Shasta. There are six known sites with the elevation ranging from 9,200 to 12,800 feet. Pumice moonwort is a Region 5 sensitive species and Shasta sky pilot will be reviewed for addition to the Region 5 sensitive species list.

White bark pine

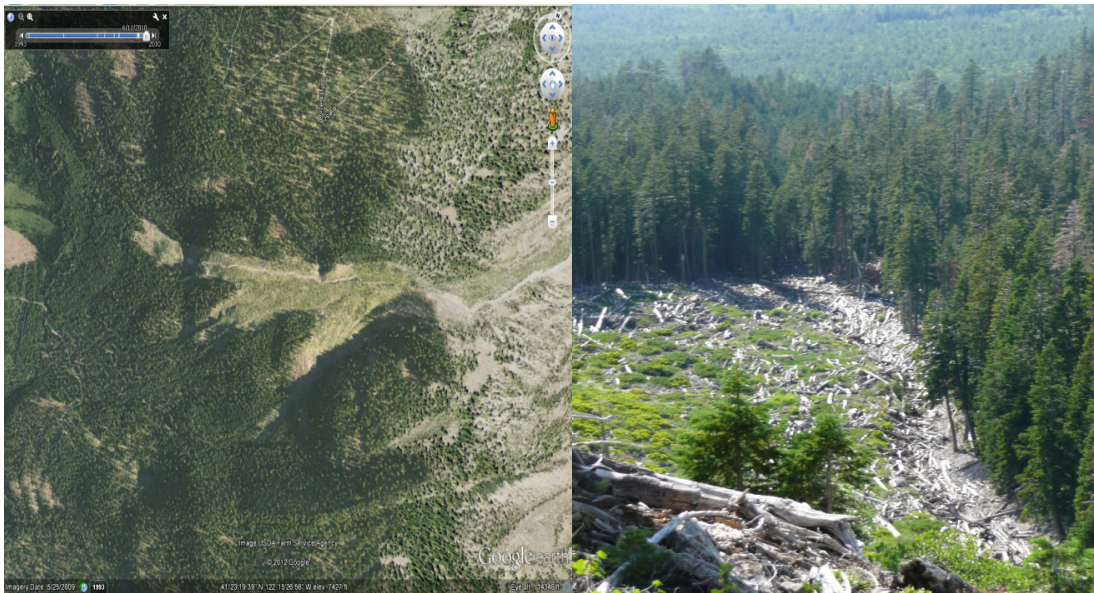
Little is known about the condition of white bark pine in part due to its high altitude and remote location. The U.S. Fish and Wildlife Service have included the white bark pine on a pending list for future designation as a Threatened and Endangered Species (TES). In addition, climate change concerns for this species are heightening. Many pure stands of white bark, particularly in the Northern Rockies, are dying, due to conditions thought to be too warm for the species along with known outbreaks of (*Cronartium ribicola*) white pine blister rust. The 2011 Forest Health Protection flights identified mortality in the some areas and attributed it to mountain pine beetle activity, but the amount of mortality was low and further investigation is warranted in subsequent project level analysis.

Red Fir, White Fir and Mixed Conifer Vegetation Types

Red fir habitats occur on frigid soils in the high mountains of Northern California and a portion of these red fir stands are located within the Mt. Shasta Wilderness Area. Heavy shade and duff tends to inhibit any under vegetation especially in dense stands. Sandy meadows and many unique habitat areas also exist in this zone (e.g. Sand Flat, Panther and South Gate Meadow). The most common understory shrubs are pine-mat manzanita (*Arctostaphylos nevadensis*) and Bloomer's goldenbush (*Ericameria bloomeri*). Sensitive plants include Wilkin's Harebell (*Campanula wilkinsiana*) and northwestern moonwort (*Botrychium pinnatum*). Shasta-Trinity Watch list species are Yosemite moonwort (*Botrychium simplex*) and sugar stick (*Allotropia virgata*). Many fungi species occur within both the red fir and white fir band including some that are identified for survey and manage in the Northwest Forest Plan.

Species specific strains of dwarf mistletoe (*Arceuthobium abietinum*) are common in true fir. Although mistletoe rarely kills trees directly, it can kill limbs and it can create large bole cankers that make the tree susceptible to breakage. The red fir type is also at elevations that are affected by snow avalanches. Large swaths of trees can be damaged or knocked down when a large avalanche event occurs, leading to high fuel loading and a fire hazard if left untreated. An example of this is the area known as the "Alien's Foot Print" on the northwest side of the

mountain. This area experienced an avalanche event that cleared a large multi-fingered path, knocking down a considerable amount of trees. See Photo 3-9 and 3-10 below.



Photos 3-9 and 3-10 Snow Avalanche damage (Google Earth Images, May 25, 2009, Photo G. Gunkel)

Many of the true fir stands are susceptible to attack by the fir engraver beetle (*Scolytus ventralis*) when overstocked stands combine with drought conditions to increase tree stress. Overstocked stands reduce the amount of nutrients and moisture available in the soil making the fir trees weak and susceptible to fir engraver attacks. These stands can be identified by bore holes and boring dust, as well as prevalent pitch streams that come from the bore holes. The fir engraver can also have nonlethal attacks which result in top kill of the fir trees. If the outbreak is epidemic, large areas of mortality can result which create fuel conditions that are prime for catastrophic wildfire. Cytospora canker (*Cytospora abietis*) frequently attacks true fir stands that have been infected with dwarf mistletoe, resulting in extensive branch kill.

Sensitive plants within the white fir zone include Wilkin's Harebell (*Campanula wilkinsiana*) and Grape Fern (*Botrychium pinnatum*). Musk thistle populations (invasive weeds) are known to occur as high as 5,600 feet in the vicinity of Dillard Canyon. The eastern area of this zone also includes portions of the Bartle grazing allotment near Pilgrim Creek and Cold Creek which has created some disturbance to streambanks with associated habitat and plant loss, including habitat for Wilken's harebell.

Many of the mixed conifer stands within the watershed have high stocking levels where competition for water and nutrients is high and vulnerability to insect and disease infestations is increased. Pine species within this mix such as ponderosa pine are susceptible to western pine beetle (*Dendroctonus brevicomis*) and many of the pine components in these stands are dying due to their inability to withstand these attacks. Under normal conditions and stocking levels, the

pine trees natural defense to exude pitch out of the insect holes is sufficient to limit infestation and mortality. Photo 3-11 shows an area of mixed conifer with pockets of mortality in the ponderosa pine.



Photo 3-11: Western Pine Beetle Mortality (Flight Data, August 2011)

Conifer Hardwood Mixed

These are mixed stands with a larger component of hardwoods, predominantly black oak (*Quercus kelloggii*). Historically black oaks were found extensively throughout the lower elevations of this watershed in the mixed conifer and ponderosa pine type. Past management practices have allowed shade tolerant species such as white fir and incense cedar to encroach, causing many of the black oaks stands to shrink dramatically as competition increases. The current condition of the aspen stands on the north side of the mountain is likely optimal. They are surrounded by conifers, but surrounding lava should discourage encroachment by conifers. These larger stands are estimated at approximately 200 trees and photos indicate that some young trees are present (see Photo 3-12).



Photo 3-12: Aspen Stand on North Side of Mt. Shasta

The Hotlum Fire in 2006 burned and/or damaged some of the canyon live oak on the north side of the mountain. Some may have been harvested for firewood, but many are left and they are doing well. These oaks are not in danger of encroachment by conifer or juniper. These trees begin to appear near the Big Springs/Lake Shastina turn-off and can be found at the lower elevations where there are rock outcrops or lava flows. The biggest threat to these stands is wildfire and possibly firewood cutting.

Ponderosa Pine (non-plantation)

Currently many of the ponderosa pine stands on the Shasta McCloud Management Unit are experiencing high amounts of mortality due to one or more pest or pathogen. When densely stocked, ponderosa pine stands are subject to frequent attacks by the red turpentine beetle (*Dendroctonus valens*) and the western pine beetle (*Dendroctonus brevicomis*), which can result in significant mortality. Dense stand conditions can also contribute to the spread of black stain root disease (*Leptographium wageneri*), mistletoe, and western gull rust (*Endocronartium harknessii*) where they exist. Photo 3-13, from 2011 Forest Health Protection flight data, shows ponderosa pine mortality in pine stands.



Photo 3-13: Ponderosa Pine Mortality (Flight Data, August 2011)

Plantations

There are approximately 19,000 acres of plantations within the watershed (16% or 3,100 acres under private ownership). Approximately 54% or 10,300 acres are considered early seral and 46% or 8,700 acres in mid seral stage (see Photos 3-14 and 3-15). Although ponderosa pine was the most common plantation species planted prior to the 1980's, regeneration practices in the 1980's began to change. Residual trees of varied types were included and a mix of species was planted to promote species diversity into the otherwise monotypic plantations. Younger plantations generally have very open understory conditions due to site preparation and plantation maintenance practices including pre-commercial thinning and mastication of competing shrubs with mechanical equipment. Dense shrub understories are more common in older plantations that were previously converted from shrub fields, due to the shrubs natural ability to re-establish. Shrub mastication is also done as a fire protection measure to reduce ladder fuels which helps create defensible space during wildfire events.

Many of these plantations were shrub conversions, with the remainder established in poorly stocked conifer/shrub mixes. Where shrub cover was heavy, a common site-preparation practice was to machine pile topsoil and shrubs into windrows, usually burn the windrows, and plant conifer seedlings between the windrows. This practice was done to remove the root burls of sprouting species and remove the upper seed bank in the soil to inhibit rapid regrowth of the shrub species. The practice was very effective in establishing plantations with good survival, but long-term productivity of these sites has been impacted to varying degrees by the topsoil displacement (Atzet et al., 1989; Powers, 1990; Powers et al., 1990). This site-preparation

practice was eventually considered harmful, and soil protection standards were enacted in the early 1990's specifically to address such practices with respect to soil quality management. Plantations continue to be fairly productive, but not as productive on a stand basis as they would have been with intact soils and appropriate shrub species control management. Many of these plantations are reaching an age and condition (dense stocking, dense shrub understory, very common insect problems impacting forest health) that they are in need of thinning and fuels reduction projects, and these projects should be conducted with specific consideration regarding past soil displacement, cumulative impacts, and potential restoration needs.



Photo 3-14: Early-seral plantation Archives 2010; Photo 3-15: Mid-seral plantation (Archives 2010)

Knobcone and Lodgepole Stands

Knobcone pine stands within the watershed are decadent, impacted by dwarf mistletoe, and exhibit high mortality and heavy fuel loads. As a result, the potential for catastrophic wildfire in this vegetation type is very high with large amounts of both standing snags and downed logs. Dwarf mistletoe from these stands has spread to surrounding ponderosa pine increasing the combined fuel load and increasing mortality. The lodgepole pine stands are frequently infested with western gall rust (*Arceuthobium americanum*) and lodgepole pine dwarf mistletoe. Both gall rust and lodgepole pine dwarf mistletoe have been known to attack ponderosa pine as an alternate host.

Western juniper

Western juniper represents the northwestern portion of the pinyon and juniper region in the Intermountain West. In the Mt. Shasta area, the native range for western juniper is known to extend west of the Cascades as far as Mount Ashland in southern Oregon and south into Trinity County. Western juniper is a long-lived, sometimes slow growing tree species, the oldest is known to be 1,600 years old. However, old-growth represents only a small portion of the population throughout most of its range with the exception of the Mazama Ecological Province

in Central Oregon. Western Juniper communities may be separated into pre-settlement (old-growth) and post-settlement communities (e.g. after 1870) (Miller, 2005). There are three types of stands within the analysis area:

- 1) juniper savannah (<10% juniper) are characterized by widely scattered single trees growing among rock outcrops and perennial grasslands;
- 2) juniper/shrublands (10% juniper+/-) growing with bitterbrush, curly leaf mountain mahogany, rabbit brush and big sagebrush and
- 3) juniper woodlands (>30% juniper) can be very dense and will have few understory plants or shrubs Juniper woodlands. Generally trees are less than 130 years of age with most trees being less than 40 years of age.



Photos 3-16: Dense juniper woodland (phase 3) and 3-17: Open juniper woodland (phase 2)



Photo 3-18: Shrub/juniper woodland (phase 1)

Juniper stands within the analysis area are in the transition stage between Phase I and Phase II (early transition). Woodland transition directly affects plant community structure, composition, seed pools, wildlife habitat and ecological processes including hydrology and nutrient cycles

(Miller, 2005). Juniper stands have seen little to no management treatment and a lack of fire which has allowed the species to expand into areas where it once did not exist. Much of this habitat type is located on the private lands in the northwest region of the watershed.

Presently there are 685 acres classified as juniper woodland (> 10% juniper) within the Mt. Shasta watershed. The biggest concentrations are between Highway 97 and Lake Shastina and between Bolam Road and Military Pass Road. Other mapped areas are scattered and small, however walking through these other areas one can spot numerous young trees one to three feet tall.

Juniper seed establishment frequently occurs under shrubs and there is no evidence to suggest that competition from associated shrubs or herbs limits the success of western juniper seedling establishment. As western juniper begins to dominate a site, shrubs begin to decrease. This has an impact on ladder fuels, ground and shrub nesting birds, seed pools and structural complexity of the plant community (Miller, 2005). According to Miller there is no data suggesting there are juniper-obligate species or species that require dense, closed western juniper woodlands. Maintaining low densities of western juniper on portions of the landscape increases the abundance, diversity, and richness of avian and small mammal populations in the shrub-steppe and as western juniper increases, wildlife abundance, species richness and diversity decline (Miller, 2005).

Shrub Types

Alpine dwarf-shrub type

These are high elevation plants that occur in shallow soils with short growing seasons. The current condition for much of this shrub type has not changed since pre-settlement times (see photo 3-19). Currently, human use is heavy in some areas of this shrub type and where heavy use occurs; there is damage to plants and soils. All trails (included user-created) above 7,500 feet pass through this type and many are located in sensitive areas. Mountain heather/huckleberry communities can take hundreds of years to grow back. Pikas (*Ochotona princeps*) are associated with this shrub type. They rely on the shrubs, forbs and grasses to provide forage. Some of the species they are known to use are: Newberry's knotweed (*Aconogonon newberryi*); fireweed (*Chamerion angustifolium*); prickly or shaggy hawkweed (*Hieracium horridum*); mountain heather (*Phyllodoce empetrifomis*; ocean spray (*Holodiscus discolor* and *Holodiscus microphyllus*); coyote mint (*Monardella odoratissima*) and snowbush (*Ceanothus velutinus*). The alpine zone on Mt. Shasta is the only place in California where you will find pumice moonwort (*Botrychium pumicola*) and Shasta sky pilot (*Polemonium pulcherrimus* var. *shastensis*). Wilken's harebell (*Campanula wilkinsiana*) is known to occur on Forest Service land and private property associated with springs, seeps and streams within this shrub type.



Photo 3-19: Alpine dwarf shrub looking downhill from Green Butte Springs area

Montane chaparral

The most abundant species in this shrub type include green-leaf manzanita (*Arctostaphylos patula*), snowbush (*Ceanothus velutinus*), whitethorn (*Ceanothus cordulatus*), pinemat manzanita (*Arctostaphylos nevadensis*), shrub chinquapin (*Chrysolepis sempervirens*), bitter cherry (*Prunus emarginata*), and choke cherry (*Prunus virginiana* var. *demissa*). They occur in dense stands between 3,000 and 7,500 feet elevation and many stands are decadent, meaning they are old with crown decadence (dead branches) over >25%. Historically, these stands were created and maintained by a frequent fire regime and with European settlement, many fires were human caused. While early logging removed trees and turned some once forested areas into shrub fields, thousands of acres of chaparral were also converted to pine plantations. The plantations along Everitt Memorial Highway and Highway 89 are good examples of these conversions. Fire suppression has created dense shrub conditions and the potential for high intensity wildfire in the montane brush type is now high. This brush type continues to be important for deer foraging, hiding cover, and fawning. Quail depend on brush fields for hiding cover. Spotted Towhee and other ground nesting bird species can also be found in this habitat type. Manzanita berries, wild plums, chokecherry, serviceberry etc. are very important forage plants for bear, deer, coyotes, foxes, birds and most prey species such as rodents. Maintaining a mosaic of age classes is important for this shrub type.

Bitterbrush (Purshia tridentate)

Currently most bitterbrush stands within the watershed, with the exception of 3,000 acres burned in the Hotlum Fire in 2006, are decadent. Like the montane type, these stands were created and maintained by a frequent fire regime. Bitterbrush areas may have grown due to fire and grazing activities (Young, Clements, 2002). Early conversions from shrub to ponderosa pine reduced

many acres of bitterbrush. Although many of these plantations failed at the lower elevations, rubber rabbitbrush and cheatgrass has repopulated these disturbed sites instead of bitterbrush, sagebrush or curly leaf mahogany. Surveys after the Hotlum Fire showed that bitterbrush and sagebrush regenerated mostly from seed. Green-leaf manzanita may also be extending its range down into the bitterbrush type. Since this stand type is important winter range for mule deer, maintaining this stand in a healthy state is very important. Bitterbrush is important forage in the fall while sagebrush is important forage during the winter (Young, Clements, 2002). Restoration should be undertaken carefully. Interactions between shrubs, grasses (especially cheatgrass) and junipers are important to consider as well as predation by rodents on seedlings. When restoring, it is important to maintain a mosaic of all age classes. One sensitive species, Cooke's phacelia (*Phacelia cookei*) and one watch list species, Baker's globemallow (*Iliamna bakeri*) are known to occur within this vegetation type.



Photos 3-20: Bitterbrush germinated from seed after fire in 2006 and 3-21: Decadent bitterbrush stand



Photo 3-22: Sagebrush germinated from seed after fire in 2006

Dry Meadow (Sandy)

Dry meadows and the plants that inhabit them are fragile and sensitive to disturbance. The lupines, knotweeds, grasses and small forbs that grow in these habitats are easily damaged or killed by foot traffic, vehicles and activities related to disperse camping and other recreational activities. Conifer encroachment into these meadows is minimal due to the poor soils and high elevation. These soils are readily eroded by run-off from melting snow or thunderstorms in steeper zone, however many of these areas such as Sand Flat and Red Fir Flat are, as their names imply, flat so erosion isn't a concern. These meadows can be found within the red fir/whitebark pine and dwarf alpine shrub associations.



Photo 3-23: Dry Meadow at Sand Flat

Fire and Fuels

The Mt. Shasta region has experienced nearly 100 years of fire suppression resulting in a vegetation structure and composition that is vastly altered from historical conditions. The restricted size and frequency of fires across the landscape has resulted in increased stand density, a shift from fire-tolerant to fire-intolerant species, and reduced structural diversity throughout the region and watershed area. As a result, severe wildfires have increased throughout the Cascade Range, especially in the low and mid elevation forests. If full fire suppression continues, severe fires may escalate in less fire-prone, higher-elevation area as fuel loads and stand density increase (Skinner and Taylor, 2006).

Currently, all wildland fires within the watershed analysis area receive a full suppression response, although Shasta-Trinity National Forest fire planning efforts are continuing to incorporate national fire management policies to manage fires under a full range of strategies. Planned ignitions within the watershed analysis area are currently utilized to reduce fuel loading following harvest activities.

Fire Regime

Fire regime groups are used to describe the historical frequency and severity under which fires burned. The classification is based on the role fire would play across a landscape in the absence of human intervention. The five class system was developed based on the average number of years between fires (fire frequency) in conjunction with severity (amount of dominant vegetation replaced) of the fire on the dominant over-story vegetation (NWCG). The five classes are as follows.

I – 0-35 year frequency and low (surface fires mostly) to mixed severity (less than 75% of the dominant vegetation replaced).

II – 0-35 year frequency and high (stand replacement) severity (greater than 75% of the dominant overstory vegetation replaced).

III – 35-100+ year frequency and mixed severity (less than 75% of the dominant overstory vegetation replaced).

IV – 35-100+ year frequency and high (stand replacement) severity (greater than 75% of the dominant overstory vegetation replaced).

V – 200+ year frequency and high (stand replacement) severity.

The fire regimes within the watershed analysis area and the area that they cover is represented in table 3-5 below.

Fire Regime	Acres	Percent
Non- Burnable	28,179	15
I	90,024	48
II	10,254	5
III	31,742	17
IV	29,166	15
Total	189,365*	100

Table 3-5: Fire regimes within the Mount Shasta WA.
*** Does not include unmapped acres**

Fire Return Interval Departure (FRID)

Fire return interval departure is used to assess the amount of departure from the natural regime. This is calculated using the natural fire regime, and fire history records. Fire return interval departure is divided into three classes based on low (FRID 1), moderate (FRID 2), and high (FRID 3) departure from the natural (historic) fire regime (NWCG).

Currently 53% of the watershed is classified as a high departure. These areas have missed several fire return intervals and the risk of losing key ecosystem components is high. Some 16% of the watershed area is at a moderate fire return interval departure. These areas have missed one or more return intervals and the risk of losing key ecosystem components is moderate. Only 13 %

of the watershed area displays a low fire return interval departure. These areas are within the natural range of fire occurrence and the risk of losing key ecosystem components is low. Within the watershed 3% of the area has seen fire return intervals more frequent than historical ranges, while 15% of the watershed is unburnable (e.g. rock, ice, open debris flows, etc.).

Fire Hazard

One of the primary measures utilized for assessing fire hazard or fire behavior is flame length. Flame length is an indicator of how hot or severe a fire can become. The hazard analysis provides an evaluation of where vegetation may be problematic in a wildfire situation. Flame lengths are categorized in the Fire Management Plan and Appendix B of the Fire Line Handbook as follows:

Low – Flame lengths 0 to 4 feet. Persons using hand tools can generally attack fires at the head or flanks of fires.

Moderate – Flame lengths 4 to 8 feet. Fires are too intense for direct attack on the head of the fire by persons using hand tools. Equipment such as dozers, engines and retardant aircraft can be effective.

High – Flame lengths greater than 8 feet. Fires may present serious control problems such as torching, crowning, and spotting. Control efforts at the head of the fire will probably be ineffective.

For the watershed analysis, modeling results from 90th percentile weather conditions are reported. Fires occurring at 90th percentile weather conditions have demonstrated significant fire behavior and large fire growth. Only 10% of the days throughout the year exhibit more extreme fire weather than what was used for this analysis. Modeling completed under this standard shows the potential for fire behavior during the more extreme weather conditions.

Flame Lengths	Acres	Percent Total Area
Low 0-4 ft.	148773	75%
Moderate 4-8 ft.	26265	13%
High > 8 ft.	23554	12%
Total	198592	100

Table 3-6: Fire behavior potential based on flame lengths utilizing 90th percentile weather within the Mount Shasta WA.

Fire Risk

Fire risk is defined in the Fire Management Plan as the probability of a fire start occurring over a 10 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:

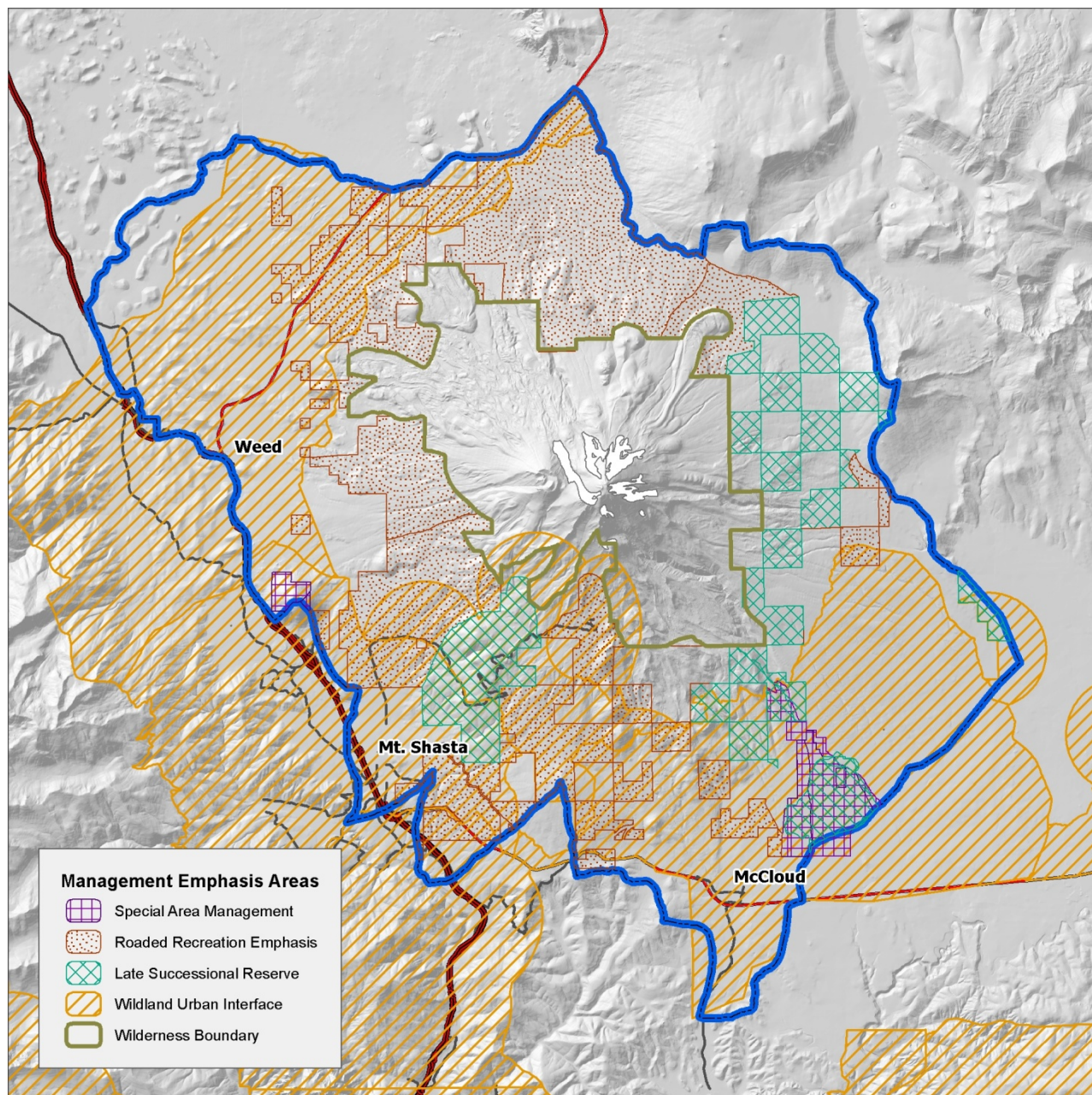
- Low Risk = Less than 0.5 fires expected to occur per decade for every 1000 acres being analyzed.
- Moderate Risk = Between 0.5 and 0.99 fires expected to occur per decade for every 1000 acres in the area being analyzed.
- High Risk = At least one fire expected to occur per decade for every 1000 acres in the area being analyzed.

Currently 61% of the watershed area is at low risk with 22% at moderate risk and 17% at a high risk rating.

Wildland Urban Interface (WUI)

Wildland urban interface is an area where structures and other human development meet or intermingle with undeveloped wildland (National Fire Plan 2000). Within the Mt. Shasta Watershed there are numerous communities (e.g. Weed, Mount Shasta, McCloud), powerlines, highways, communication towers, recreation facilities and other infrastructure. The WUI accounts for 77,946 acres or 67% of the NFS lands within the watershed area.

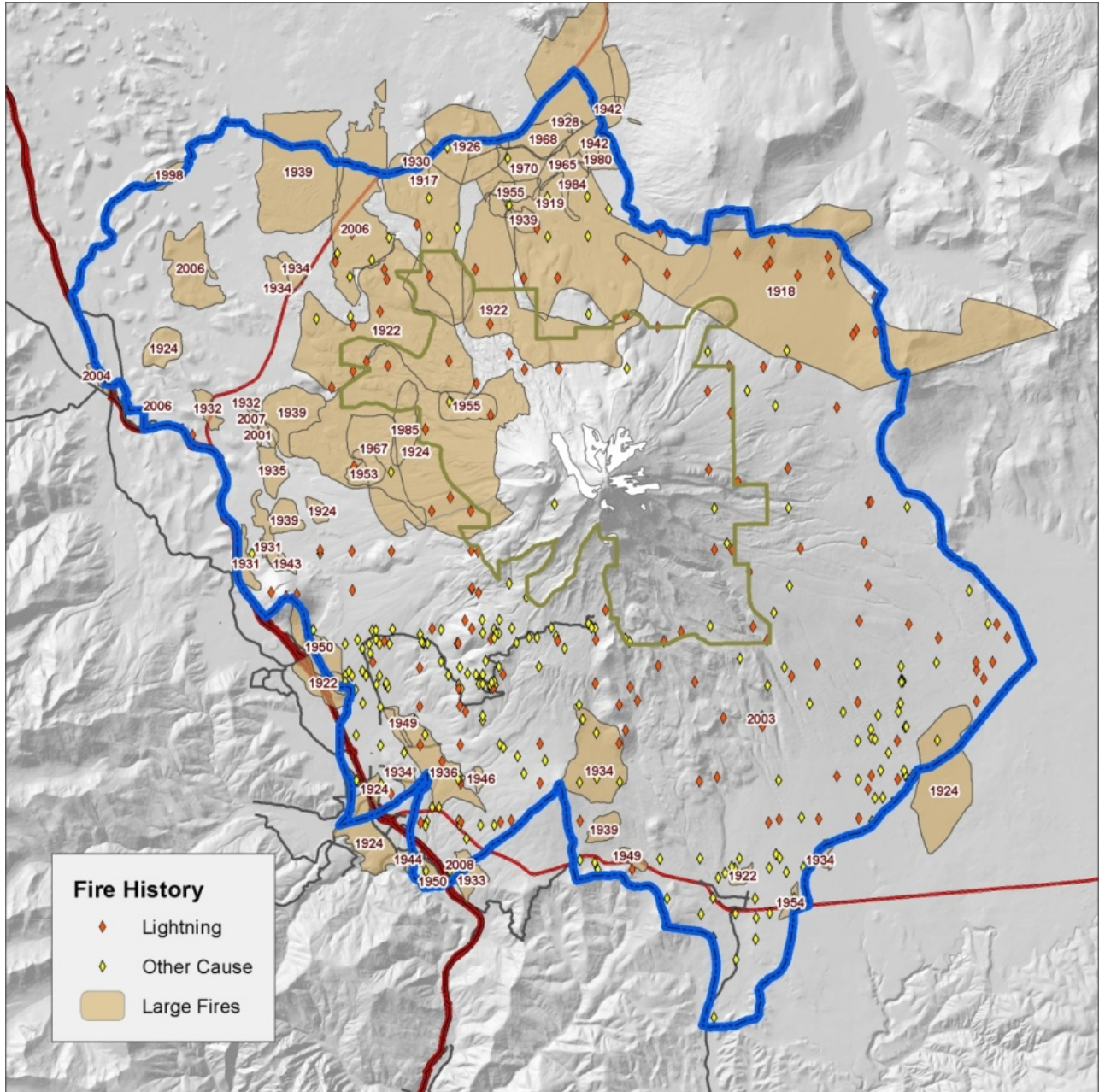
The Fire Management Plan outlines objectives for treatments within the WUI. The primary goal for these treatments is to establish an environment where firefighters can safely manage a wildfire while protecting infrastructure. See map 3-10 for the location of these areas within the analysis area.



Map 3-10: Management Emphasis Areas

Wildfires

Since the year 1917, a total of 253 fires have burned 75,484 acres within the watershed area. The largest of these burned 12,869 acres in 1924; the cause was unknown. Additional fires may have occurred, as early fire tracking records are likely to be incomplete. Human starts account for 76% of the fires within the watershed area while lightning started 16% of the fires and 8% had an unknown cause. The human starts are concentrated along the Everett Memorial Highway area and to a lesser extent around the town of McCloud (See Map 3-11 below).



Map 3-11: Mt. Shasta Fire History

Multiple agencies respond to wildland fires within the analysis area including the California Department of Forestry and Fire (CalFire), Bureau of Land Management (BLM), city and volunteer fire departments among others.

Species and Habitats

The Mt. Shasta watershed contains habitat for one wildlife species listed as Federally Threatened, 12 Forest Service Sensitive Species (USDA, 2007), and two game species of concern. These species and their status are listed in Table 3-7 and discussed in the following sections.

Wildlife Species of Concern	Status
Northern Spotted Owl	Federally Threatened
Northern Goshawk	Forest Service Sensitive
Willow Flycatcher	Forest Service Sensitive
Bald Eagle	Forest Service Sensitive
California Wolverine	Forest Service Sensitive
Pacific Fisher	Forest Service Sensitive
American Marten	Forest Service Sensitive
Pallid Bat	Forest Service Sensitive
Townsend's Big Eared Bat	Forest Service Sensitive
Western Red Bat	Forest Service Sensitive
Northwestern Pond Turtle	Forest Service Sensitive
Cascades Frog	Forest Service Sensitive
Foothill Yellow-Legged Frog	Forest Service Sensitive
Mule Deer	Game
Elk	Game

Table 3-7: Wildlife Species of Concern within the Mt. Shasta Watershed

Federally Threatened Species

Northern Spotted Owl (NSO)

The northern spotted owl (*Strix occidentalis caurina*) is a medium-sized owl that inhabits conifer forests of the Pacific Northwest, including northwestern California (Forsman, 1984) and has been listed as a threatened species by the U.S. Fish and Wildlife Service (FWS).

Northern spotted owls are strongly associated with late seral coniferous forests and suitable habitat for the species on the Shasta-Trinity is described as multi-layered, multi-species coniferous forest stands with >60 % total canopy cover for nesting/roosting, a minimum of 40 % 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, 2011).



Photo 3-24: Northern spotted owl

The Shasta-McCloud area is near the southern edge of the range for the NSO (*Strix occidentalis caurina*) and the northern boundary for the California spotted owl (*Strix occidentalis occidentalis*). This area was identified as an area of concern between the two species in the 1992 final rule for Critical Habitat (USDI, Fish and Wildlife. 1992, Federal Register).

Suitable habitat is scattered throughout the watershed but does not exist in the shrub lands in the northern portion of the watershed or in the high elevation white fir, red fir and alpine habitats. A majority of the habitat at the lower elevations is not currently considered suitable NSO habitat due to the prevalence of homogeneous ponderosa pine stands that have limited species diversity, lack tree age classes which provide vertical structure, and tend to contain more open canopy within the stands. These areas may provide a dispersal function that links the two subspecies of owl. Currently there are four NSO activity centers (USDA, 2011) in the eastern and southern portions of the watershed (see Table 3-8 below).

NSO Activity Center ID	Year last visited	Last year owl was detected	Status in year last detected
ST – 211	2011	2006	Single
ST – 213	2011	2003	Night Response
ST – 214	2010	1993	Single
ST – 215	2011	2003	Single

Table 3-8: Northern spotted owl activity centers in the Mt. Shasta Watershed as of 2011

Barred owls are recognized as a significant threat to the recovery of the NSO (USDI 2011). Barred owls have only been detected in the far eastern portion of the watershed near Elk Flat (Forest Records).

Northern Spotted Owl Critical Habitat

Spotted owl habitat preference was identified in 1989 (USDI, 1989) and critical habitat was originally proposed within the Federal Register on May 6, 1991 (56 FR 20816-21016) (USDI, 1991). A Final Rule was published on January 15, 1992 (57 FR 1796-1838) (USDI, 1992). This rule was superseded by a new rule published on August 13, 2008 which became effective on September 12, 2008 (USDI, 2008). A portion of the watershed on National Forest System land occurs in NSO critical habitat unit 29 (Shasta/McCloud Unit) (USDI, 2008). Following the 2008 rule, numerical subunits were designated to help locate areas on the ground. All or portions of subunits 64, 65, 70 & 72 are within the Mt. Shasta watershed area (USDI, 2008). A new rule for NSO critical habitat is currently being developed by the FWS and is scheduled to be final in November 2012. It is unknown if significant changes in NSO critical habitat designations will occur with the final revised rule.

The 2008 designation of critical habitat for the NSO (USDI, Revised Designation of NSO Habitat, 2008) addresses the primary constituent elements (PCEs) which are used to identify the

known physical and biological features essential to the conservation of the NSO. The PCEs are summarized below.

1. “Forest types that support the northern spotted owl across its geographic range.” In the southern portion of its range, specifically in the watershed area, this includes mixed conifer and fir forests.
2. “Nesting, roosting, foraging habitat. Forest types described in the paragraph above that contain habitat types to meet the home range needs of territorial pairs of northern spotted owls throughout the year or that are habitat capable of developing one or more of these habitat types.”
 - a. “Nesting habitat is essential to provide structural features for nesting, protection from adverse weather conditions, and cover to reduce predation risks. It includes moderate to high canopy closure (60-80%); a multilayered, multi species canopy with large (generally greater than 30 inches (in), 76 centimeter (cm) diameter at breast height (dbh)) overstory trees; a high incidence of large trees with various deformities (e.g. large cavities, broken tops, mistletoe infections, and other platforms); large snags, large accumulations of fallen trees and other woody debris on the ground; and sufficient open space below the canopy for northern spotted owls to fly.”
 - b. “Roosting habitat is essential to provide thermoregulation, shelter, and cover to reduce predation risk while resting or foraging. It differs from nesting habitat in that it need not contain those specific structural features used for nesting (such as cavities, broken tops, and mistletoe platforms), but does contain moderate to high canopy closure (60-80%); a multi-layered, multi-species canopy; large accumulations of fallen trees and other woody debris on the ground; and open space below the canopy for northern spotted owls to fly.” Nesting/roosting habitat within the watershed area is limited.
 - c. “Foraging habitat is essential to provide a food supply for survival and reproduction. It contains some roosting habitat attributes, but can consist of more open and fragmented forests or, especially in the southern portion of the range where some younger stands may have high prey abundance and structural attributes similar to those of older forests, such as moderate tree density, sub canopy perches at multiple levels, multilayered vegetation, or residential older trees.” The majority of the watershed that is in mixed conifer is described as foraging habitat.
 - d. Dispersal habitat “are essential to the dispersal of juvenile and non-territorial northern spotted owls, or that are habitat-capable of developing one or both of

these components.” Furthermore “dispersal habitat is essential to maintaining stable populations by filling territorial vacancies when resident spotted owls die or leave their territories; and to providing adequate gene flow across the range of the species.” In the watershed area, dispersal habitat is generally defined as homogeneous ponderosa pine stands, young plantations or forest stands of sparse canopy closure with little structure.

Northern spotted owl movement within the watershed is dependent on the suitability and capability of habitat. Non capable habitat in the northern portion of the watershed (the brush fields along highway 97) and areas at the higher elevations (above 7,000 feet) are barriers to owl movement. Owls can and do disperse throughout the majority of the other areas within the watershed. Owl breeding areas are based on the quantity, quality and location of nesting, roosting, foraging, and dispersal habitat (USDI, 2011).

Additionally, Interstate 5 and highways 97 and 89 all can be barriers to owl movement. Residential development, transmission lines, barred owl presence within the watershed also can have significant impacts to owl movement.

Forest Service Sensitive Species

Northern Goshawk

The northern goshawk is a large forest raptor occupying boreal and temperate forests throughout the Holarctic (Squires and Reynolds, 1997). Although goshawks nest in a variety of habitat types-from willow stands to massive old growth forests of the Pacific Northwest, they seem to prefer mature forests with large trees and open understories (Squires and Reynolds, 1997). Goshawks in northern California prefer mature and old-growth conifer forests that have relatively dense canopy closures, have usually little understory, and are in close proximity to riparian corridors (Zeiner et al, 1990). Openings may increase nest access, serve as travel corridors (Speiser and Bosakowski, 1987), support open country prey (Shuster, 1980) or reduce flight barriers to fledglings (Hall, 1993).

Random acoustic surveys using taped goshawk vocalizations in potentially suitable nesting habitat have been conducted in various areas within the eastern portion of the watershed (Forest Records). Seven known goshawk territories (ST-205, ST-222, ST-229, ST-231, ST-243, ST-248 and ST-252) occur within the watershed. Visits to the nest core areas occur in most years (Forest Records).

Willow Flycatcher

The willow flycatcher is a common migratory species that breeds in a variety of usually shrubby, often wet 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; e.g., in California “strikingly restricted 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 (Grinnell and Miller, 1944).” Cottonwood clumps may also be important. Surveys for willow flycatchers have not been conducted in the watershed but are recommended.

Bald Eagle

The bald eagle is the only eagle unique to North America. On August 9, 2007 the U.S. Fish and Wildlife Service (FWS) removed the bald eagle from the threatened and endangered species list. The bald eagle is protected by the Migratory Bird Treaty Act and the Bald Eagle and Golden Eagle Protection Act (USDI, 2010, 2010a). The nearest suitable habitat and territory is located at Lake Siskiyou southwest of the watershed. Bald eagles have been seen flying within the watershed.

Pacific Fisher

Pacific fisher is a forest carnivore that is the largest member of the genus *Martes*. Populations of fisher currently occur in the North Coast ranges of California and the Klamath-Siskiyou mountains of northern California (native fisher) and southern Oregon (reintroduced fisher). Additionally, surveys and sightings in California also place fisher throughout much of the Sierra Nevada range. The Klamath region population, which includes areas within the watershed, may be the largest population remaining in the western United States (Carroll, 1999). The Pacific fisher most often occurs between 2,000 - 5,000 feet in the Klamath Province.

In 2002-2003 the Shasta-McCloud Management Unit camera stations were used to survey areas in the eastern portion of the watershed along the routes within the Pilgrim Creek Snowmobile Park (North State Resources, 2002, 2003). One fisher was detected at a camera station located at the 4,000 ft. elevation within the watershed. Sightings of fisher have also occurred in other areas in the southern portion of the watershed. The majority of the watershed is above the altitudinal distribution of the Pacific fisher.

American Marten

There are two subspecies of American marten in California, *Martes americana humboldtensis* and *Martes americana sierrae* (Zielinski et al., 2001). Both subspecies are, for the most part, geographically distinct from one another. The exception is in Trinity and Siskiyou counties where their distributions potentially overlap (Zielinski et al., 2001). The American marten is associated with late-seral coniferous forest characterized by closed canopies, large trees, and abundant standing and downed woody material (Zielinski et al., 2001). Of particular importance is the quantity of downed debris on the forest floor as it provides protection from predators,

access to the subnivean (under snow) environment for hunting and resting, and thermal protection from heat and cold (Ruggiero and Aubrey, 2004).

On the Shasta-Trinity National Forest, the American marten is associated with higher elevation (greater than 4,000 feet) late successional old growth true fir stands and to a lesser extent lower elevation conifer forest similar to fisher habitat. Suitable habitat consists of various mixed conifer types with at least 40 percent crown canopy closure with large trees and snags. Small clearings, meadows, and riparian areas provide foraging habitat. Absence of roads is preferred. Suitable habitat is available within the watershed. The majority of the watershed at the higher elevations is within the altitudinal distribution of the American marten.

In 2002-2003 the Shasta-McCloud Management Unit camera stations were used to survey areas in the eastern portion of the watershed along the routes within the Pilgrim Creek Snowmobile Park (North State Resources, 2002, 2003). Marten were detected at various camera stations located at the higher elevations (4,000 -7,000) during the four survey periods. Additionally there are numerous observations of marten at the higher elevations within the watershed.

Wolverine

In California, wolverine once occurred throughout the Sierra Nevada, Cascades, Klamath, and northern Coast ranges in forests in alpine, boreal forest and mixed forest vegetation types (Schempf and White, 1977). Wolverines predominately use coniferous forest, but their significant use of non-forest alpine habitats distinguishes them from the fisher and marten (Banci 1994). In north coastal areas, wolverines were observed in Douglas-fir and mixed conifer habitats, and probably use red fir, lodgepole, wet meadow, and montane riparian habitats. Most sightings in this region range from 1600 to 4800 feet elevation, according to California Department of Fish and game records from 2005.

Wolverines appear to select areas that are free from significant human disturbance, especially during the denning period from late winter through early spring. Deep snow is required for successful wolverine reproduction because female wolverines dig elaborate dens in the snow for their offspring (USDI, 2010b). These den structures are thought to protect wolverine kits from predators as well as harsh alpine winters. Wolverines that occur in forested areas use dense forest cover for travel and resting, especially in the winter.

In California over the last 20 years, numerous surveys using remote cameras at several locations, including the Shasta-Trinity National Forest, have detected only one wolverine on the Tahoe National Forest (Moriary, 2008). There are unconfirmed wolverine sightings in the watershed. Wilderness areas, such as the Mount Shasta Wilderness, may provide the large secluded areas this species requires.

Pallid Bat

Pallid bat is a locally common year-long resident of low elevations in California (Zeiner et al., 1990). It occurs throughout California except for the high elevation Sierra Nevada from Shasta to Kern counties, and the northwestern corner of the state from Del Norte and western Siskiyou counties to northern Mendocino County. It is most common in open, dry habitats with rocky areas for roosting, though a wide variety of habitats are used: grasslands, shrublands, woodlands, and forests. There have not been any Forest Service bat surveys conducted within the Mt. Shasta watershed.

Townsend's Big-eared Bat

This species occurs in the western and southeastern United States and in southern British Columbia with isolated populations on the Southern Plains and southward to Mexico. It is found throughout California from low desert to mid elevation montane habitats (Zeiner et al., 1990). The roost sites for this species are cavernous sites associated with caves, mines, and buildings. It also roosts in hollow trees, bridge and in some instance bird boxes.

A Townsend's big-eared bat colony is known to exist in a cave located on the McCloud Ranger District several miles east of the watershed. There have not been any Forest Service bat surveys conducted within the Mt. Shasta watershed.

Western Red Bat

Zeiner wrote that 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. There have not been any Forest Service bat surveys conducted within the Mt. Shasta watershed.

Northwestern Pond Turtle

The Northwestern pond turtle occurs in a variety of habitat types associated with permanent or nearly permanent water (Holland, 1991) and they are often concentrated in low flow regions of rivers and creeks, such as side channels and backwater areas. Habitat suitability is limited. Most of the watershed is above the elevation where pond turtles commonly occur. In addition, the general lack of aquatic habitats with permanent water within the watershed further limits the availability of pond turtle habitat. There have not been any Forest Service reptile surveys conducted in the watershed.

Cascades Frog

Cascade frog inhabits high altitude ponds, lakes, and streams within open coniferous forest from Washington to northern California (Briggs, 1987). While limited in area, suitable habitat occurs

within the watershed, however no Forest Service amphibian surveys have been conducted within the Mt. Shasta watershed.

Foothill Yellow-Legged Frog

Foothill yellow-legged frogs use a variety of aquatic habitat types (depending on their life stage and the time of year) including: pools, riffles, and runs in rivers and their smaller tributary streams. Forest records have no observations within or near the watershed. The watershed is near the eastern boundary of the known range for this species (Zeiner et al., 1990) and is above the elevation where foothill yellow-legged frogs commonly occur. There have not been any Forest Service amphibian surveys conducted in the watershed.

Game Species of Interest

McCloud Flats Deer Herd

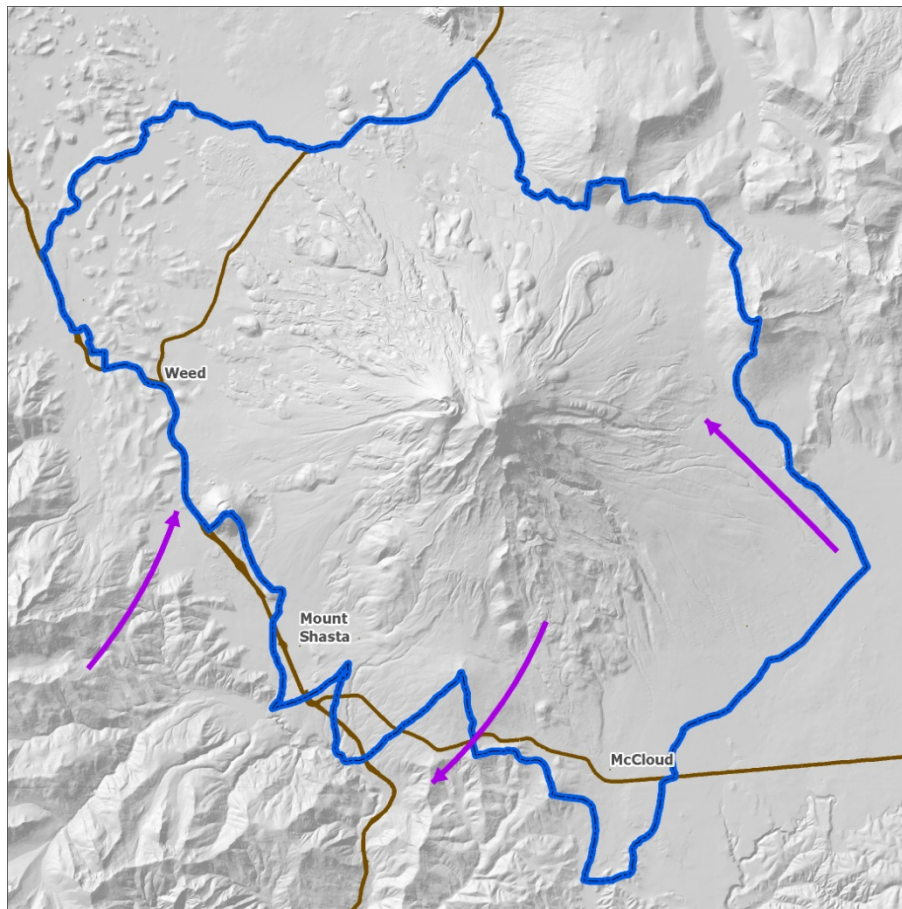
A management plan for the McCloud Flats Deer Herd was established in 1967 (CDFG, 1967) and updated in 1985 (CDFG, 1985) by the California Dept. of Fish and Game, Region I in cooperation with U.S. Forest Service, U.S. Bureau of Land Management and the National Park Service. This plan outlined population trends, suitable fawning habitat, and management for critical winter and summer range. Critical winter range for deer was established in the northern portion the watershed.



Photo 3-25: Deer

Several areas throughout the watershed are considered summer range. In the fall, deer summering within the Mt. Shasta watershed move in several directions to their winter range (CDFG, 1967, Map No.1). Some populations move south from the watershed to winter within the Shasta-Lake Ranger District, and other populations move west towards the coast. The deer that reside in the watershed move north to winter within the northern portion of the watershed near Highway 97 and the Military Pass road. In the spring the deer come from all directions to

again summer throughout the watershed. Map 3-12 shows the migration of deer across the Mt. Shasta watershed.



Map 3-12: Deer Migration in the Mt. Shasta Watershed

Deer movement within the watershed is dependent on the location of water sources. Areas in the northern and eastern areas of the watershed have limited water availability. The quality and quantity of vegetation also affects deer movement.

Concern exists for resident and seasonal deer populations, including the loss of early seral habitat, the loss of herbaceous and young shrub layer in the understory, and the loss of mast (e.g. acorns) producing hardwoods causing a reduction in an important food source for deer. The exclusion of fire has caused the habitat to shift from a mosaic of early seral habitat, to mostly mid seral habitat. This shift encroaches upon herbaceous openings as well as limits the amount of palatable browse. Fire exclusion has also allowed the understory of forested conifer and oak habitats in the eastern and southern portions of the watershed and shrubs in the northern portion of the watershed 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. Surveys for deer are lacking within the watershed.

American Elk

Elk occur west of the Cascade crest, Sierra foothills, and coast range from Oregon to Baja California from sea level to approximately 7,000 feet, although they are rare over 4,800 feet. Elk concentrate in riparian timber edge habitats near meadows.

Similar to the deer herd, elk migrate from lower elevation areas near Shasta Lake into the watershed for summer range. Elk utilize areas within the watershed, though currently elk densities are relatively low. Elk herds in northern California have been increasing over the past few decades, and it appears that they continue to increase. Despite less than ideal habitat conditions, elk herds may continue to increase. Many of the factors limiting deer herds, primarily declining habitat quality due to exclusion of fire and vegetation management practices, are also limiting elk. Surveys for elk in the watershed are lacking.

Late Successional Reserve

There are four Late Successional Reserves (LSR's) on NFS lands within the Mt. Shasta Watershed Analysis Area (USDA, 1999) (See Map 3-10). This includes all or portions of (please note that the acres, percentages and miles are for the entire LSRs and not broken down based on the watershed boundary:

Wagon LSR (RC-362)

Total Acres (Shasta-Trinity NF)	4,922
Acres Capable of Supporting Late-successional Habitat	4,484
Acres Currently Supporting Late-successional Habitat	989
Acres of Early-Successional Habitat	984
Acres of Riparian Reserve	40
Suitable Owl Habitat as a Percent of Capable Owl Habitat	74%
Miles of Road	20.4
Road Density	2.7
Private Land	16

Mt. Shasta LSR (RC-361) (10,358 acres within the Mt. Shasta Watershed)

Total Acres (Shasta-Trinity NF)	14,504
Acres Capable of Supporting Late-successional Habitat	12,598
Acres Currently Supporting Late-successional Habitat	786
Acres of Early-Successional Habitat	5,267
Acres of Riparian Reserve	1,138
Suitable Owl Habitat as a Percent of Capable Owl Habitat	52%
Miles of Road	120
Road Density	3.1
Private Land	10,850

Elk Flat (RC-360) (532 acres within the Mt. Shasta Watershed)

Total Acres (Shasta-Trinity NF)	3,056
Acres Capable of Supporting Late-successional Habitat	2,836
Acres Currently Supporting Late-successional Habitat	1,306
Acres of Early-Successional Habitat	681
Acres of Riparian Reserve	266
Suitable Owl Habitat as a Percent of Capable Owl Habitat	67%
Miles of Road	21.7
Road Density	3.9
Private Land	443

McCloud Managed LSR (MLSA-76) (2,108 acres within the Mt. Shasta Watershed)

Total Acres (Shasta-Trinity NF)	2,596
Acres Capable of Supporting Late-successional Habitat	2,565
Acres Currently Supporting Late-successional Habitat	0
Acres of Early-Successional Habitat	673
Acres of Riparian Reserve	80
Suitable Owl Habitat as a Percent of Capable Owl Habitat	71%
Miles of Road	9.2
Road Density	2.3
Private Land	81

Plant Species of Concern and Their Habitats

There are three categories of plant species of concern within the Mt. Shasta watershed analysis area:

- 1.) Sensitive species are those species identified by a Regional Forester for which population viability is a concern as evidenced by:
 - a) Significant current or predicted downward trends in population numbers or density;
 - b) Significant current or predictable downward trends in habitat capability that would reduce a species' existing distribution.
- 2.) Survey and manage bryophyte, fungi, lichen and vascular plant species listed in the *Settlement Agreement, Conservation Northwest v. Sherman, No. 08-1067-JCC* dated 07/06/2011.
- 3.) Watch list species or (NFMA list) are plants that do not meet all of the criteria to be included on the Regional Forester's Sensitive List, but are of sufficient concern that we need to consider them in the planning process. Endemic species are treated like sensitive species. See Table 3-9 below, Plant Species of Concern.

Plant Species of Concern Scientific Name	Common Name	Habitat	Vegetation Association within the watershed
Trees			
<i>Pinus albicaulus</i> : Sensitive (proposed for federal listing; not yet listed) Common above 8,000 ft.	Whitebark pine	High elevation near tree line; shrub form up to at least 10,000 ft.	Whitebark pine/alpine dwarf shrub
Vascular Forbs			
<i>Allotropa virgate</i> : Watch list Within watershed; 2NFS and 3 pvt.*	Sugar stick	In the Cascades: associated with red fir and lodgepole pine at elevations between 6,000 and 9,800 ft.	Red fir/lodgepole pine
<i>Arnica viscosa</i> : Endemic Fairly common at and above subalpine elevations	Mt. Shasta arnica	Open, rock subalpine to alpine; elevation 6,500 to 8,200 ft.	Red fir/whitebark pine/alpine dwarf shrub
<i>Asarum marmoratum</i> Watch List Within watershed: 1 ownership unknown	Marbled wild ginger	Lower montane coniferous forest	Mixed conifer/hardwoods
<i>Balsamorhiza lanata</i> Watch list Within watershed: 3 pvt.	Woolly balsamroot	Rocky, volcanic; cismontane woodland	Ponderosa pine, western juniper/bitterbrush
<i>Botrychium pinnatum</i> Sensitive Within watershed; 1 pvt. and 1 NFS	Northwestern moonwort	Moist fields, shrubby slopes branch of Squaw Valley Ck. and Cold Ck. Elevation 5,400 to 6,600 ft.	Red fir/White fir
<i>Botrychium pumicola</i> : Sensitive	Pumice moonwort	Open volcanic soils; Mt. Shasta– Diller Canyon; Elev. 8,900 to 9,200 ft.	Alpine Dwarf Shrub
<i>Botrychium simplex</i> : Watch List Within watershed: 4 NFS	Yosemite moonwort	Moist meadows and springs elevation 5,100 to 8,000 ft.	Red fir/Pine
<i>Campanula wilkinsiana</i> : Sensitive Within watershed: >16 On NFS 15	Wilken's harebell	Streams, springs and seeps from 5,000 to 8,800 ft.	Alpine Dwarf Shrub/Red fir/whitebark pine/mixed conifer
<i>Chaenactis suffrutescens</i> Sensitive Within watershed: possibly 1 ownership unknown	Shasta chaenactis	Serpentinite; often roadsides, sometimes ridges, streambanks and openings	Mixed conifer/hardwood
<i>Cordylanthus tenuis</i> ssp. <i>palescens</i> Within watershed: 4 pvt. Populations showing on NFS are not palescens (Wilson et al, 2011)	Pallid bird's beak	Lightly disturbed openings in ponderosa pine; gravelly, volcanic soils; only occurs near Black Butte and the city of Weed, CA.	Ponderosa pine
<i>Erigeron nivalis</i> : Watch list Within watershed: 1NFS	Snow fleabane	Volcanic, alpine boulder and rock field, meadow and seeps and subalpine coniferous forest. Elev. 8,800 to 9,500 ft.	Whitebark pine/Dwarf alpine shrub

Plant Species of Concern Scientific Name	Common Name	Habitat	Vegetation Association within the watershed
<i>Eriogonum pyrolifolium</i> var. <i>pyrolifolium</i> Watch list Within watershed: fairly common at higher elevations both NFS and pvt.	Pryrola-leaved buckwheat	Alpine and subalpine boulder and rock field (sandy or gravelly pumice);	Alpine dwarf shrub, whitebark pine, red fir
<i>Geum aleppicum</i> Watch list Within watershed: 2 ownership unknown	Aleppo avens	Great basin scrub; lower montane coniferous forest; meadows and seeps	Mixed conifer/hardwoods
<i>Hulsea nana</i> Watch list Within watershed: 2 NFS	Little hulsea	Rocky or gravelly volcanic soils; alpine boulder and rock field; subalpine coniferous forest	Alpine dwarf shrub, whitebark pine, red fir
<i>Hymenoxys lemmonii</i> Within watershed: 1NFS; 2 pvt.	Alkali hymenoxys	Great basin scrub; lower montane coniferous forest; meadows and seeps	Bitterbrush, western juniper
<i>Iliamna bakeri</i> : Watch list Within watershed: 3NFS	Baker's globemallow Mountain hollyhock	Mountain slopes; juniper woodland, lava beds; elevation 3,280 to 8,200 ft.	Juniper woodland/pine plantations, bitterbrush
<i>Orthocarpus pachystachyus</i> Watch list Within watershed: 1 historical (1800s) somewhere on the north side of the mountain	Shasta orthocarpus	Great basin scrub; meadows and seeps; valley and foothill grasslands	Bitterbrush; western juniper, grasslands
<i>Polemonium pulcherrimum</i> var. <i>shastensis</i> : Endemic Within watershed: 6 NFS	Shasta sky pilot	Alpine; elevation 9,200 to 12,800 ft.	Alpine dwarf shrub
<i>Scutellaria galericulata</i> Watch list Within watershed: 1 pvt. or city; Historical 1894, Sisson; may have been misidentified	Marsh skullcap	Lower montane coniferous forest; meadows and seeps; marshes and swamps	Mixed conifer/hardwoods, ponderosa pine
<i>Silene suksdorfii</i> : Watch list Within watershed: 1 NFS	Cascade alpine campion	Rocky slopes; Cascade range (Mt. Shasta, Mt. Lassen); elevation 7,900 to 10,200 ft.	Red fir/whitebark pine/Dwarf alpine shrub
<i>Viburnum edule</i> Watch list Within watershed: 1 pvt.	Squashberry	Meadows and seeps; riparian scrub; occurs south of McCloud, CA	Lower montane riparian scrub;
Bryophytes			
<i>Meesia triquetra</i> Sensitive Within watershed: 1 pvt. or city	Three-ranked hump moss	Bogs and fens; meadows and seeps, subalpine coniferous forest, upper montane coniferous forest; reported in Mt. Shasta, CA	Mixed conifer/hardwood; lower montane wetlands
<i>Meesia uliginosa</i> Sensitive Within watershed: 1 pvt. or city	Broad-nerved hump moss	Bogs and fens; meadows and seeps, subalpine coniferous forest, upper montane coniferous forest; reported in Mt. Shasta, CA	Mixed conifer/hardwood; lower montane wetlands

Plant Species of Concern Scientific Name	Common Name	Habitat	Vegetation Association within the watershed
<i>Ptilidium californicum</i> : Sensitive, survey & manage Bryophyte Within watershed: 6 NFS	Pacific fuzzwort	Grows on trees, logs and stumps usually on white fir; elevation 3,900 to 6,200 ft. (Mt. Shasta/McCloud Unit)	Red fir/white fir transition zone/mixed conifer
Fungi (Survey & Manage)			
<i>Arcangeliella crassa</i> : Category B Within watershed; 1 NFS	Gastroid milk cap	Forms sporocarps below soil surface; assoc. with various <i>Pinaceae</i> sp. in mixed forests containing white fir, red fir, lodgepole, Jeffrey and ponderosa pines between 6,500 and 7,200 ft.	Red fir/mixed conifer
<i>Arcangeliella lactarioides</i> : Category B Within watershed; 2 NFS	Gastroid milk cap	Forms sporocarps below soil surface; assoc. with various <i>Pinaceae</i> sp.; particularly red fir and ponderosa pine above 5,200 ft. Bunny Flat,	Red fir/mixed conifer
<i>Bondarzewia mesenterica</i> (<i>B. montana</i>): Category B Within watershed; 3 NFS		Under conifers, usually near stumps or trunks at higher elevations btwn 5,800 and 7,200 ft. (Mt. Shasta)	Red fir/white fir/ mixed conifer
<i>Collybia bakerensis</i> : Category F Within watershed; 1 NFS		On fallen conifer logs soon after snow melt. The one population occurs near Bunny Flat; also occurs at lower elev. outside of the assessment area	Red fir/white fir
<i>Cortinarius magnivelatus</i> : Category B Within watershed; 2 NFS		Forms sporocarps beneath soil surface under mountain conifers (esp. fir and pine) usually buried in duff	Mixed conifer/ponderosa pine
<i>Cortinarius vessucisporus</i> : Category B Within watershed; 2 NFS; 1 pvt.		Forms sporocarps beneath soil surface assoc. with the roots of red fir above 6,600 ft. to 11,000 ft. Occurs near Cascade Gulch, Horse Camp and Mud Creek Glacier	Red fir/whitebark pine/alpine dwarf shrub
<i>Gastroboletus subalpinus</i> : Category B Within watershed; 5 NFS		Forms sporocarps beneath soil surface under mountain conifers; assoc. with red fir, whitebark pine, lodgepole pine and mountain hemlock	Red fir/whitebark pine/mixed conifer/lodgepole pine
<i>Gomphus bonarii</i> ** Category B Within watershed; 4 NFS Common on McCloud Flats		Partly hidden in deep humus under firs and pines mid elevation	Red fir/ white fir/mixed conifer

* NFS = located on National Forest System lands; pvt = located on private property

** “Many species delimited on morphological grounds proved to be phenotypic variants of a few well-supported genetic species. According to the genetic data, *G. bonarii* and *G. floccosus*, and all their forms and subspecies are phenotypes of only one genotype (Figures 2.2 and 2.4). Hence, the previously known species *G. bonarii* and *G. floccosus* and their variants are here synonymized, with priority for the name *Turbinellus floccosus*. *Turbinellus* also contain the newly recombined species *T. flabellatus*, *T. fujisanensis*, *T. kauffmanii* and *T. stereoides*.” (Gianchini, 2004). It is still listed in the Settlement Agreement, *Conversation Northwest v. Sherman*, No. 08-1067-JCC dated 07/06/12.

Table 3-9: Plant Species of Concern

Several other species appeared on the map from CNDDDB (California Natural Diversity Data Base) dated 05/07/12. Some are known to occur outside of the watershed in the Klamath Range or Shasta Valley. Others were errors of location or identification.

Two sensitive species (Wilken's harebell and Cooke's phacelia) and one watch list species (Baker's globemallow) are known to be negatively affected by human activities or lack of management.

Wilken's harebell grows along streams, spring and seeps from 5,000 feet up to 8,800 feet. All but the Cold Creek Springs population show signs of trampling or other types of human disturbance, mainly trail creation. All known populations on NFS land were surveyed in 2011. The Cold Creek and Pilgrim Creek populations between 5,000 and 6,000 feet are being trampled by cattle from the Bartle Allotment, although the area is outside of the Bartle Allotment boundary. This has been an ongoing concern for many years. Other populations are in areas receiving heavy use from climbers, hikers and other recreationists.

Populations of Cooke's phacelia require disturbance such as fire or mechanical disturbance that removes shrubs and other competing vegetation. They are generally found along roads and the railroad right-of-way where there is bare ground from soil disturbance. Since this species was first mapped in the late 1970's and early 1980's, numbers have dropped dramatically. Surveys conducted in 2011 found fewer than 10,000 plants on the Shasta-Trinity while original counts were around 100,000 plants for all populations. Two populations have not been relocated in recent years. Although surveys for the Whitney Creek population were conducted in 2011, no plants were found and the population is presumed to have been extirpated by the Whitney debris flow in 1997. No evidence of the second population was found near the intersection of Highway 97 and 42N84.

The Bolam Fuelbreak Project proposes to construct a fuelbreak for 150 feet on the southwest side of the Military Pass Road, and for 150 feet on both sides of the Bolam Road. Although populations known to occur in the upper Bolam Road area were absent in 2011 survey, we expect that this treatment project will provide suitable habitat for the known seed bank in the area and monitoring is planned post treatment. The known population at the intersection of Highway 97 and Bolam Road is doing fairly well. The Military Pass Road has the most populations and they are found scattered within the first four miles heading south along both sides of the road.

Baker's globemallow is especially adapted to fire and needs disturbance that creates sunny openings. Large populations have been known to sprout immediately after large fires, diminishing after several years as other vegetation comes back. It is believed that seed remain viable for at least 100 years. Management to improve habitat for this species will need to include fire. This is an herbaceous shrub with beautiful pink flowers. They are a favorite of native bees, deer and other grazing and browsing animals. Seeds are eaten by birds and rodents. Currently

there are populations in the Graham plantations on the north side of the mountain above the railroad tracks. These populations were discovered during a check of these plantations and appear to be thriving while the trees are small. Another population on the north side, closer to Highway 97, has not been relocated during recent surveys. There are also scattered plants in the plantations off of Everitt Memorial highway. These populations are not thriving because they are being shaded out by pine trees. One population is suffering under competition from invasive species.

Invasive Species

Invasive weed species are associated with human caused disturbance such as plantation development and management, logging, dumping of yard waste, vehicles, escaped horticulture species and wildfire. Invasive species are most common on the south and southwest sides near the town of Mt. Shasta where shrub stands were converted to pine plantations beginning as early as 1948. Musk thistle (*Carduus nutans*) is the most common invasive species and is “A” rated (treatment required) by the State of California, Department of Food and Agriculture. There are also small populations of Scotch broom (*Cytisus scoparius*), yellow starthistle (*Centaurea solstitialis*) and dyer’s woad (*Isatis tinctoria*). These are all species requiring treatment in a wildland setting. Musk thistle is found at the highest elevation (5,400 feet elevation in Diller Canyon). Cheatgrass is found to varying degrees at lower and mid elevations throughout the area.

Musk thistle, Scotch broom, and perennial sweetpea are known to occur on both private and NFS lands near the town of McCloud. The rest of the eastern side of the watershed is relatively free of high priority weed species. Commonly found on the east side are low priority weed species such as bull thistle (*Cirsium vulgare*), common mullein (*Verbascum thapsis*) and Klamath weed (*Hypericum perforatum*).

The north side of the mountain has several populations of yellow starthistle, some associated with railroad maintenance and others with plantation development and management. There are four small populations of musk thistle in the Hotlum area associated with railroad maintenance and vehicles. These may have been exacerbated by the Hotlum fire in February of 2006. By 2008, there was a noticeable increase in cheatgrass. Except for yellow starthistle populations known to occur in the Graham Plantations (T43N, R4W, Section 2), all known weed populations occur in the area of the Hotlum Fire between Hotlum Road on the west, the railroad tracks on the north, Forest Road 42N84 on the east and Highway 97 on the north.

Wet Meadow Habitats

Springs on Mt. Shasta often support small wet meadow habitats. Because they are small, have scenic value and contain water, wet meadows can be exposed to concentrated human use. The greatest amount of human use occurs in springs, seeps and wet meadows located on the south

side of the mountain. These include Panther Meadows, Hummingbird Spring, Saint Germain Meadow and South Gate Meadows. Almost all of the use within these meadows occurs when they are snow free from about July through October and access to all of the springs occurs when the Everitt Memorial Highway gate at Bunny Flat is opened, usually in late spring or early summer (June/July).

Riparian communities typical of springs and seeps that support wet meadows are determined by elevation:

- High elevation communities consist of wet to seasonally wet meadows surrounded by mountain heather, alpine laurel, dwarf huckleberry (*Vaccinium caespitosum*) and thin-leaf huckleberry (*V. membranaceum*). Conifers associated with these communities are Shasta red fir, whitebark pine and mountain hemlock (*Tsuga mertensiana*). Meadow species are a diverse mix of high elevation forbs, sedges, rushes and grasses. High elevation springs and meadows are delicate ecosystems that do not recover quickly once disturbed due to the short growing season. Most of these meadows are showing the signs of unmanaged human activities such as damaged plants and bare and compacted soil. Many of these springs have also had water diversions as well as trails and old roads made through them that have changed or continue to change the hydrology.
- Mid-elevation meadows such as McGinnis and Bear Springs are slightly more resilient as the growing season is longer and soils more developed. Mid-elevation communities occur within the lower elevations of the red fir type, white fir and mixed conifer types. Shrub species can vary from the red fir type to the mixed conifer type and may include western blueberry (*Vaccinium uliginosum* ssp. *occidentale*), Douglas spirea, wood rose (*Rosa gymnocarpa* var. *gymnocarpa*), and creeping snowberry (*Symphoricarpos mollis*). Meadow species are a diverse mix of forbs, sedges, rushes and grasses. Bear and McGinnis Springs as well as most other springs, are associated with water diversions that may alter their hydrology.
- Low elevation springs and meadows like the meadows south of the town of McCloud are surrounded by mixed conifer and mixed conifer hardwood vegetation types. Conifers include big leaf maple (*Acer macrophyllum*), white alder, incense cedar, ponderosa pine, Douglas fir, Pacific dogwood, black oak, aspen and black cottonwood. Associated shrubs include vine maple (*Acer circinatum*), American dogwood, California hazelnut (*Corylus cornuta* var. *californica*), elderberry (*Sambucus mexicana*) and willow species. Meadow species can be diverse, however, these meadows are privately owned and many are used as pasture, home sites, golf courses etc. It may be assumed that the species diversity may be less than now than it was prior to European settlement in the area. Invasive species have been brought in with development. Water from springs have been diverted to supply water to home sites and businesses and to supply water for livestock.

Impacts to wet meadow habitats are usually associated with trampling of vegetation and from users that venture off of the established trail system(s) where they exist. The potential for impacts is greatest during spring melt when visitors will often leave established trails to avoid traversing remaining snowpack areas on the trail(s). Some visitors will walk the 2.5 miles from Bunny Flat to Panther Meadows prior to the gate being opened and trails being visible. If off-trail use is not controlled when ground conditions are close to saturation in the early spring, considerable trampling and denudation of meadow vegetation can occur. Off trail use also occurs during the summer when visitors will leave established trails to get closer to meadow streams and springs. Frequent off trail use has resulted in the creation of additional foot trails in the meadows. Often when new trails become worn and muddy they in turn become undesirable to walk on which results in the creation of more trails.

Panther Meadows: Panther Meadows is actually a series of small stringer meadows that originate to the east of the Ski Bowl parking area and run downslope and covers about 10 acres. The meadows are spring fed and form the headwaters of Panther Creek which usually flows perennially through the meadows prior to becoming intermittent in the vicinity of the Mt. Shasta Board and Ski Park. Panther Meadows is by far the most heavily visited meadow on the mountain and has a long history of both human use and restoration activity. Based on photographic evidence concentrated human use and associated resource impacts did not begin in the Panther Meadows area until access improvements were made to the Everitt Memorial Highway resulting in increased visitors to the meadows (see photos 3-26 and 3-27). The Forest Service has implemented many restoration projects in Panther Meadows including vegetation restoration, signage encouraging visitors to stay on established trails, trail relocation projects and voluntary wet meadow closures. Additional restoration is recommended in the mid and lower portions.



Photos 3-26 and 3-27: Panther Meadows Spring in 1967 and in 1994.

South Gate Meadows: South Gate Meadows is accessed via trailheads originating within or near Panther Meadows and the Upper Ski Bowl parking lot. These meadows require a longer hike and experiences less use, however impacts including off trail use and denudation of vegetation are occurring due to the absence of active management (see photo 3-28). Restoration

efforts have yet to occur in South Gate Meadows where camping and day use has increased steadily over the past decade. Trail relocation and restoration is recommended for this wet meadow.

Hummingbird Spring: Hummingbird spring is a very small meadow located along the user trail to South Gate Meadows. This area experiences heavy through traffic from hikers heading to South Gate Meadows, many of which wander off trail through the meadow as they head toward their destination. Restoration to this spring has occurred in the past and positive effects have been seen, but impacts to vegetation continue to occur from foot traffic along the spring and the stream. Additional trail relocation and restoration are recommended (See Photo 3-29).



Photos 3-28 and 3-29: South Gate Meadows and Hummingbird Spring (date unknown).

Saint Germain Meadow: Saint Germain meadow is a small riparian area near the wilderness boundary in the Old Ski Bowl. This meadow is very small, but popular with local groups and a user trail has begun to develop to this meadow. Damage to the actual wet meadow area is minimal at this point, but the potential for impacts is increasing commensurately with increased use. The potential for impacts is mitigated slightly by the rocky nature of the area (e.g. the user trails are very rocky and there is less vegetation than at other wet meadow locations). A faint user trail can be found along the wilderness boundary. Trail designation is recommended.

Clear Creek Meadows: The Clear Creek route on the East side of the mountain hosts a spring fed stream and small meadow area that attracts many hikers and climbers. Clear Creek Meadows is located at an elevation of 8,500 feet and does not receive as much use as other meadows on the south side of the mountain. The climbing route that passes by the meadows is only accessed via a 4-wheel drive road followed by a strenuous hike up to the meadows. Despite the limited use some impacts to the spring (stream bank erosion and destruction of flora) have occurred as a result of camping and day use. The majority of the stream channel and meadow areas are in good condition.

Other springs, seeps and wet meadows on the mountain see much less use. Many of the problems associated with the wet areas, springs and seeps mentioned above are not a problem at the other wet areas on the mountain as snow, accessibility and/or lack of human presence keep them protected. Refer to the Alpine Zone narrative for additional information on impacts to aquatic and riparian resources.

In addition to recreation impacts other management factors are also influencing the spring and wet meadow habitats. In the absence of fire, wet meadows are generally moving towards later seral stages due to conifer encroachment. Periods of high precipitation and high water tables tend to halt or reverse conifer encroachment, at least temporarily; but there has been a noticeable long-term decrease in wet meadow habitat for the last several decades. When wet meadows are in a moist condition, the potential for intense wildfire is low within the meadow itself. However, dry conditions in late summer can result in a rapid fire spread through dry grass vegetation. Conifer encroachment is occurring in some wet meadow habitats (e.g. Mud Creek, Cold Creek meadows) and often provides vertical fuel-ladders that can create crown fires in the adjacent forest.

Many springs on Mt. Shasta have been partially developed for water supplies. Some springs such as McBride Springs at McBride Springs Campground have been developed for recreation purposes. Springs within the Old Ski Bowl still contain remnants of old water developments that need to be fully decommissioned. Springs are the municipal water source for the communities of McCloud (Upper and Lower Elk and Intake), Mt. Shasta (Cold Springs), Weed (Beaughton Spring) and Dunsmuir (Near Mossbrae).

Public Uses

The Mt. Shasta Watershed is the most heavily populated watershed in the Shasta-McCloud Management Unit. At the lower elevations within the watershed, human use is heaviest within and immediately adjacent to the towns and communities that ring the mountain (Mt. Shasta, McCloud, Weed, Edgewood, and Lake Shastina) which can be seen on Map 1-1. In addition to the purely municipal use (residential, schools, businesses, etc.), use occurs in the NFS urban interface directly adjacent to these communities. These uses include running, hiking, mountain biking, OHV use, skiing, snowshoeing, snowmobiling, etc. In addition, illegal uses such as dumping, occupancy trespass, and illegal residency are higher in this zone.

Populated Areas (Rural)

This includes the towns of Mt. Shasta, McCloud, Weed, Edgewood and Lake Shastina, but also the small communities that sit within mostly undeveloped natural areas (e.g. Mt. Shasta Forest, Squaw Valley Creek Road, Everitt Memorial Highway). They represent a combined population of approximately 10,000 to 15,000 people living in or along the border of the watershed. While still rural by state standards, these towns represent a strong influence on the watershed as they provide for municipal, industrial, commercial and recreational use and serve as the gateway for

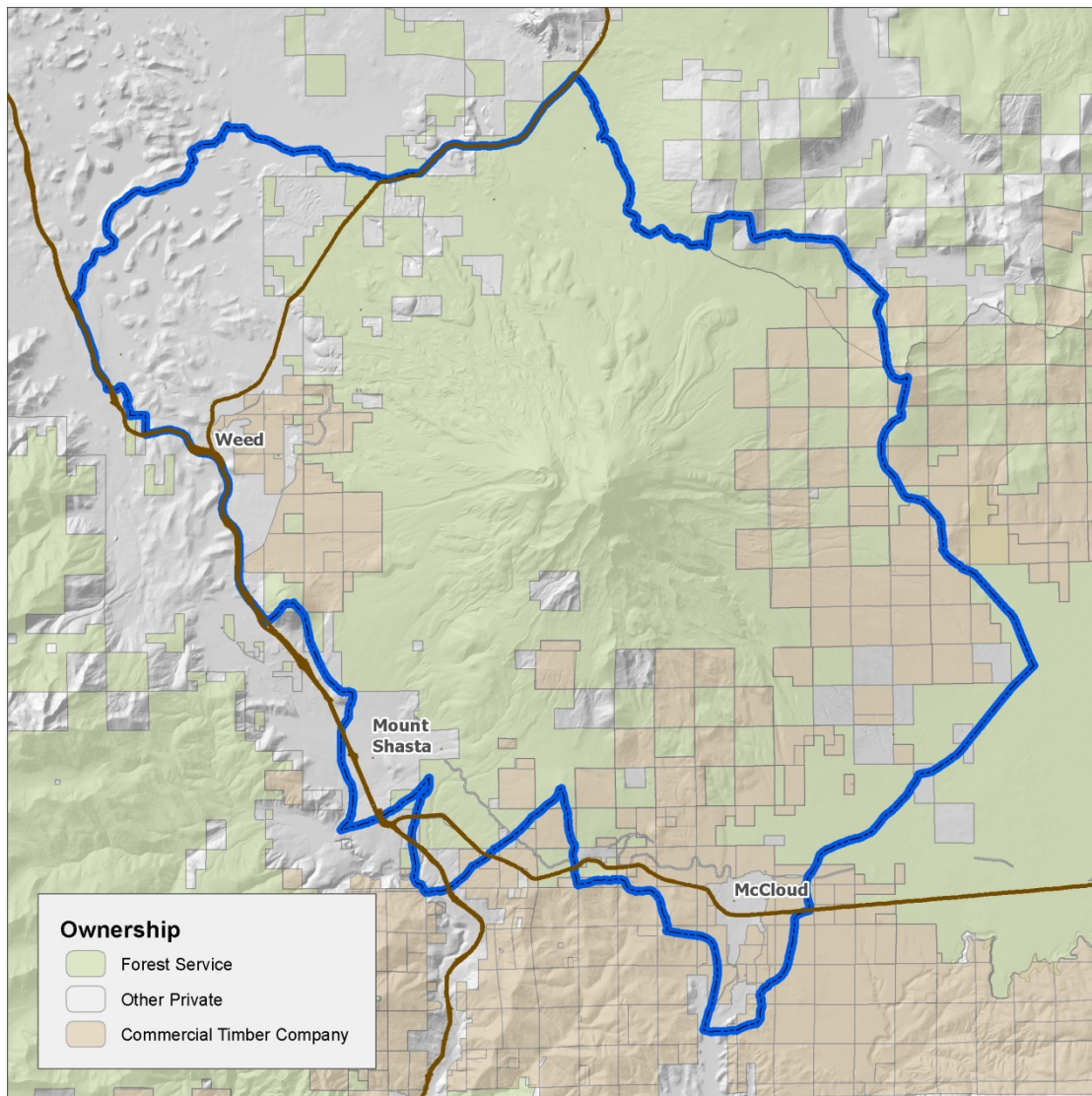
many of the National Forest visitors. The Forest Service works with local Fire Safe Councils to identify and treat high fuel hazard areas in this Wildland Urban Interface (WUI).

Private Industrial Timberlands

These are typically large (up to 640 acres) parcels in a checkerboard pattern concentrated in the eastern and southern portions of the watershed. As remnants of the railroad land grants, these are primarily managed for private timber production for several large timber management companies (Sierra Pacific Industries, Timber Products Company and Roseburg Forest Products or their affiliates). There are other private timberland owners within the watershed, but their amounts are far less than those listed above. Private timber land accounts for approximately 25% of the total area within the watershed boundary and can be viewed below on Map 3-16. Many of these lands are bordered by National Forest System lands and can indirectly affect some of the practices that are conducted on those lands. Addressing these issues is timely at the project level prior to project implementation.

Private Lands – Dispersed (ranches, individual homes, agricultural)

There are several other private land areas scattered within the watershed that are not associated with industrial timberland and can be viewed as “other private” on Map 3-17 (Land Ownership) below. These areas include private homes found on plots of land, agricultural or livestock ranches, a vacation resort, and two golf courses (Mt. Shasta Resort and Golf Course, and Lake Shastina Golf Course).



Map 3-13: Land Ownership

Roads

There are 895 miles of state, county, city and Forest Service roads within the watershed area (see Map 5-1). Road densities are concentrated in the local communities and spread out to facilitate access to the outlying areas. Traffic levels are concentrated on primary arterial routes (I-5, Highway 89, Highway 97, Pilgrim Cr Road, Military Pass, Everitt Memorial Highway) and collector and local roads facilitate direct access to the majority of areas in the watersheds, traveling around the mountain. Interstate-5, and Highway's 89 and 97 are high-volume routes for through- traffic in the north state and most of the residential population within the watershed lives within the communities located along one of these routes.

A network of smaller roads (system, non-system, cost share and private roads) connects the major highway system to both the National Forest and to private inholdings within the

watershed. The Transportation system meets a variety of needs for timber management, fuel treatments, access to private inholdings, fire control, utility management, special uses, recreation and access to recreational sites. Harvesting of special forest products, including greenery, firewood, mushrooms and plants are among the other opportunities facilitated by the transportation system. When poorly managed, these smaller native surface roads can divert water, provide seedbed for noxious weeds and fragment habitat.

Roads under Forest Service jurisdiction are typically managed and maintained according to their assigned Maintenance Level (see chart below). Many of the main roads are maintained with support from cost-share partners with private inholdings only accessible through the National Forest. While Cost share and cooperative agreements with private partners do provide a mutual benefit, it also limits administrative control. Roads over private inholdings may be gated and not open to all traffic. This is a major consideration for road management on the east side of Mt. Shasta where private inholdings create a complete checkerboard ownership pattern where access to forest service lands can only be obtained through an access agreement.

Road Maintenance Levels	
Maintenance Level 5	Roads that provide a high degree of user comfort and convenience. Normally double lane paved facilities, or aggregate surface with dust abatement. This is the highest standard of maintenance. There are no Maintenance Level 5 roads on the forest.
Maintenance Level 4	Roads that provide a moderate degree of user comfort and convenience at moderate speeds. Most are double lane aggregate surfaced. Some may be single lane. Some may be chip sealed or treated for dust abatement.
Maintenance Level 3	Roads open and maintained for travel by a prudent driver in a standard passenger car. User comfort and convenience are lower priorities. Typically these roads are lower speed, single lane with turnouts. Some may be fully surfaced with aggregate base or native material.
Maintenance Level 2	Roads open for use by high-clearance vehicles. Passenger car traffic is allowed but discouraged. Use by the public is unrestricted. Traffic is normally minor; consisting of a combination of administrative, permitted, dispersed recreation, or other specialized use. Non-traffic generated maintenance is minimal. Typically these roads have a native surface.
Maintenance Level 1	These roads are closed year-round, but some intermittent use may be authorized. When closed, they must be physically closed with barricades, berms, gates, or other closure devices. When closed to vehicular traffic, they may be suitable and used for non-motorized uses, with custodial maintenance.

Table 3-10: Road Maintenance Levels

Road surface drainage presents the most common concern as a sediment source within the watersheds. Native and aggregate surfaced low-standard roads typically contribute more sediment than a paved surface road. Sediment deposits increase for road surfaces where conditions have deteriorated. The majority of the roads under forest service jurisdiction within the Mt. Shasta watersheds are native and aggregate surfaced.

The Mt. Shasta watershed has many stream and drainage crossings with associated structures which present a significant concern. Typically, crossings are appropriately sized and adequate

but the active landscape features present certain challenges that make long term planning difficult. Sediment deposits can accumulate rapidly at stream crossings, requiring constant maintenance and creating at-risk conditions for most stream crossing structures, such as culverts. A failing stream crossing can quickly deteriorate during a single storm event and produce large amounts of sediment. A sediment source inventory is needed to fully assess the current condition of stream crossings within the Mt. Shasta watershed. The USGS 1-meter Digital Elevation Model developed in 2011 is an excellent tool to aid in this inventory.

Roads that exist in riparian areas, especially parallel or within stream beds, present a significant stream diversion potential. The design and construction of these roads for early logging activities most likely did not consider the stream location, long term effects or rehabilitation and typically results in an entrenched road that intercepts, carries and diverts stream flows. These roads also may also ascend directly up a slope at a continuous grade, intercepting runoff even when not located directly in a drainage corridor.

Trails

There are very few trails within the watershed area, mostly concentrated within the southwest area along the Everitt Memorial Highway. Use on these trails is heavy when they are snow-free and nearly half of these are user-created.

- Black Butte Trail
- John Everitt Vista Point Trail
- Sand Flat to Horse Camp Trail
- Bunny Flat to Horse Camp Trail
- Horse Camp to Hidden Valley Trail (User created)
- Spring Hill (private) to Helen Lake Trail (User created)
- Green Butte Trail (User created)
- Old Ski Bowl Trails (User created, numerous roads)
- South Gate Meadows Trail (User created)
- Panther Meadows Trails
- Gray Butte Trail

All Others:

- Northgate Trail
- Brewer Creek Trail
- Clear Creek Trail

Most Forest Service maintained trails within the watershed are in good condition. Annual maintenance is usually completed by mid-summer, however limited staffing (trail crew/wilderness rangers) does delay completion in some years of intensified blow down and storms. Many user created trails exist within the assessment area. Portions of these user trails may be maintained by Forest Service wilderness rangers where they occur in suitable and durable

locations while repair and naturalization efforts are made to close poorly located or duplicate user trails. On all user trails, the Forest Service wilderness rangers use short segments of bamboo with a red flag to help keep climbers/hikers on the “trail” and prevent additional user created trails. The loose sandy soil type on Mt. Shasta does not lend itself well to trail stability, durability or longevity.

In addition to the designated trails, there are many climbing routes that lead further up the mountain and variations to each of them (there is no formal trail to the summit). Routes are a recommended direction of travel for climbers (usually over snow). In some years, low annual snowfall will create dry conditions on the mountain and user trails are visible. With the exception of the Clear Creek route, all Forest Service and user created trails terminate around the 10,000 to 11,000 foot elevation. The Clear Creek route hosts many user trails above this elevation due to its low angle terrain and loose rock/scree composition. The heaviest climbing season is in spring and early summer, usually April through June/July. Snow cover and stable avalanche conditions create good climbing conditions. As the snow melts, rock fall increases and travel over loose, steep terrain becomes difficult and more dangerous, however climbers attempt to climb Mt. Shasta all year long.

Bunny Flat (6,950 feet): This is the most popular and heavily used trailhead on the mountain and only 1.75 miles from the parking lot to the Sierra Club Cabin (Horse Camp) on Sierra Club Foundation lands. This is the traditional John Muir climbing route to Lake Helen and the summit and includes access to the Avalanche Gulch, West Face, Casaval Ridge, Green Butte/Sargents Ridge and Shastina summit routes. There are additional hiking/climbing trails into Hidden Valley. The Forest Service, in partnership with the Sierra Club Foundation, has cooperated in trail work including the main trail to Horse Camp. Avalanche Gulch and points beyond are in good shape. An additional trail leads from Horse Camp to Hidden Valley, and is used by day hikers and climbers accessing the West Face route. This trail is maintained annually and the trail is in moderate condition, although portions of the trail are difficult to follow. Much of the trail has seen a slow widening and damage to water bars. It is common to find over 150 cars at the parking lot and along the road (see Photo 3-30).



Photo 3-30: Bunny Flat Parking Area

Old Ski Bowl (7,200 ft.): Located at the end of the Everitt Memorial Highway and outside the wilderness area, previous development (Ski Shasta) and heavy use has created many user-created trails and old roads. This area is only open in the summer and fall months when the gate at Bunny Flat is open. During winter, the Everitt Memorial Highway and the Ski Bowl area are very popular for both snowmobilers and skiers. This is the parking area and access route for Panther Meadows, Gray Butte and South Gate Meadows. A user created mountain bike trail begins in the Old Ski Bowl and can be traveled all the way to Mt. Shasta City. While the user trail into South Gate Meadows is generally in good condition, minimizing alternate trails and damage is an ongoing challenge. In cooperation with the Mt. Shasta Bioregional Association, local Native American tribes and various organizations and schools, trails in the upper Panther Meadows area have been reconstructed in conjunction with meadow rehabilitation and are in very good condition. Additional improvements are needed in lower Panther Meadows where the Gray Butte trail crosses a very wet area of the meadow.

Northgate Trailhead (7,000 ft.): This trailhead provides access to the Whitney, Bolam and Hotlum Glaciers and the Hotlam/Bolam ridge climbing routes to the summit. A Forest Service trail extends to roughly 8,500 feet where a user created trail continues. This trailhead is closed during winter months due to snow. The north side of the mountain lies in the rain shadow and receives much less snow and more wind for much of the winter. The Forest Service trail is in very good shape and aside from annual trees clearing, does not require much maintenance. A section of trail was rerouted several years ago in an effort to relocate the trail away from the creek drainage with positive results.

Brewer Creek Trailhead (7,280 ft.): This trailhead lies on the northeast side of the mountain and requires higher clearance vehicles to access. Use of this trail has increased over the last few

years due to people taking advantage of late season skiing and climbing that can be accomplished with relative ease. This trailhead provides access to the Hotlam/Wintun Ridge route. The Forest Service trail is in good condition and extends up into the Wilderness to about 8,500 feet where a user trail continues. Due to the flat trail design however, much of the lower trail is rarely used as most climbers find the multitude of switchbacks a nuisance and choose to head directly upslope following the numerous snow “fingers” which extend down the mountain. These late season snow patches can often make the trail hard to find when descending off the mountain.

Clear Creek Trail (6,520 ft): The Clear Creek climbing route is the easiest route on the mountain, and there is a user trail that extends nearly all the way to the summit. Most people camp in this area due to the water access, and a user trail extends to Clear Creek springs from the end of the Forest Service trail at 8,500 feet. Portions of the lower trail follow an old road. The Forest Service trail is in good shape, although steep in some areas. This side of the mountain hosts some of the most beautiful vistas which generate user trails off the main trail to reach viewing areas.

Whitney Falls: Portions of the trail have been partially destroyed due to recent debris flows and to date no repairs have been conducted. Other trails are overgrown and no longer in use, while some roads have converted to trails due to lack of travel and clearing of brush.

Linear Utilities/Railroad

In addition to two large transmission lines (PacifiCorp’s 69kV and 115kV) that follow the western boundary of the watershed (see Map 5-1), there is a network of smaller utilities (power, phone, fiber optic) that provide service to residential and commercial users scattered within the watershed. They can be viewed on the Treatment along these corridors to remove hazard trees, replace poles, upgrade equipment and brush access roads is ongoing. The native surface road system that serves this infrastructure generally has not had adequate maintenance, and many are eroded and in poor shape. Because the roads often closely follow the pole alignment of the utility right-of-way, many are poorly aligned (straight up and down the slope) such that water drains down the surfaces providing a sediment source for waterways. These roads are also used by recreationalists (hunting, OHV, woodcutting, etc.) for general access into the forested areas.

On the southern slopes, power has been extended relatively high on the mountain to serve the Mt. Shasta Board and Ski Park and the two USFS Communication Sites (Gray Butte and Ski Bowl). Historically this line also served the Mt. Shasta Ski Area (Ski Shasta).

While the eastern portion of the McCloud Railway (east of McCloud) is in transition to a rail trail, the western portion (McCloud to Mt. Shasta) is currently still intact and operating. Both the tracks and the road system would benefit from maintenance and upkeep (see Map 5-1).

Portions of the Union Pacific (U.P.) Railroad lie with the western and northern portion of the watershed and this line is heavily used and actively maintained. The road system is native surface and mostly within the private right-of-way (generally 200 feet). The U.P. system includes some railroad bridges that cross large canyons on the west (Hotlum) and northern (Whitney/Bolam) sides of the mountain, allowing the railroad to avoid some impacts from water and debris flows off the slopes of the mountain.

Arguably, the most significant impact of the railroad system is the checkerboard ownership pattern created when alternate one-mile sections of reserved public domain were granted to the railroads beginning in the 1860's. Areas where these land grants stretched 30 miles to either side of the track alignment, land management was significantly affected. Fraudulent survey of the property lines was not uncommon creating trespass, and land disputes where land lines may be found to be up to ¼ mile in error. Road systems cross in and out of multiple ownerships creating the need for Cost Share road agreements, and these alternating sections require thousands of miles of property boundary location, marking and management. Large scale land exchanges and small tract act purchases have resolved some of these challenges, but much of the watershed outside of the wilderness boundary still includes a distinct checkerboard pattern creating the need for an assortment of private agreements to allow access, occupancy and use.

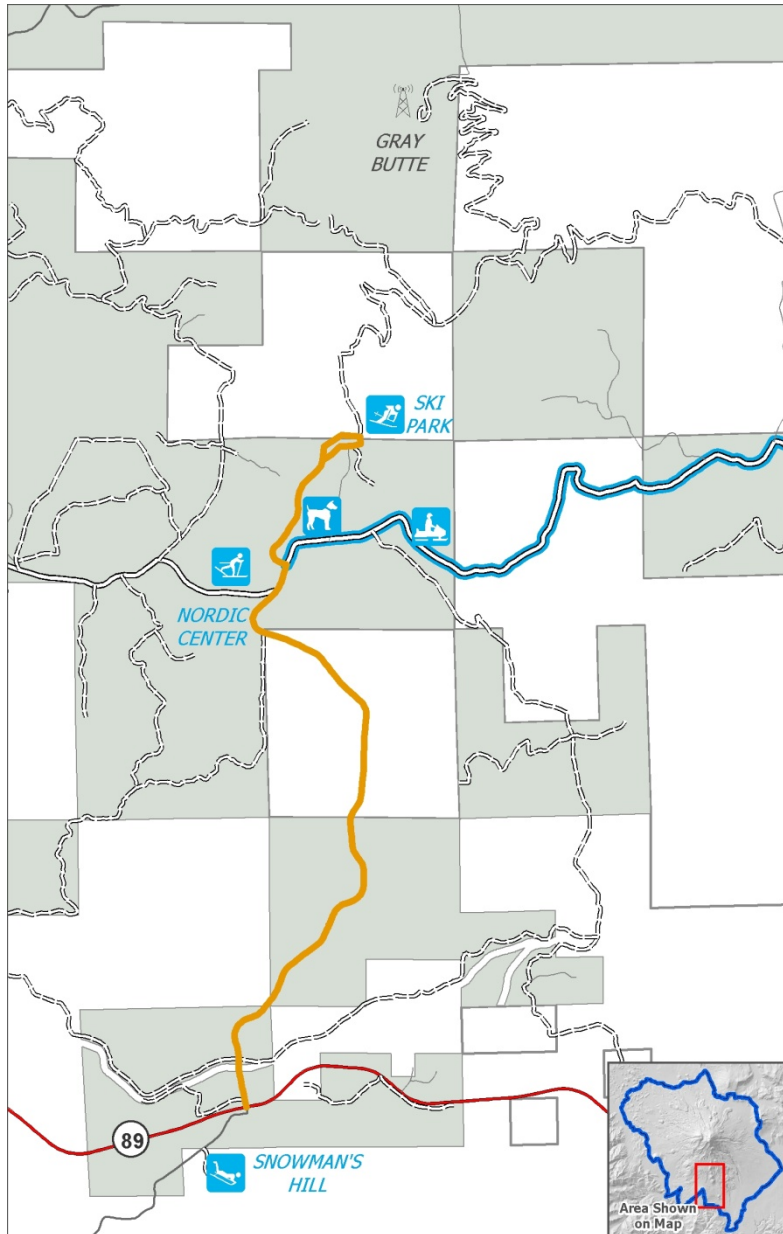
Special Uses Sites

These are typically small (<1 acre) developments along or near roads that are authorized under easement, lease or special use permit to private corporations, government agencies, or individuals. Uses include commercial sites like electronic sites for communication uses (radio, cell phones, television, etc.), municipal uses (community water development, roads, and liquid waste), private uses including roads and waterlines serving private property, and research uses (monitoring for seismic, weather, water, and botanical resources). While the sites are typically small and non-disturbing uses, they do typically require access by road, adding to need for some of the road network.

Ski Park Highway and Vicinity

The Mt. Shasta Board and Ski Park is a private ski area located primarily in section 9 (T.40N., R.3W, MDBM) in the southern portion of the watershed. Some portions of the support facilities (parking, access road, maintenance yard, leach fields) are located on the adjacent National Forest System lands under special use permit. While use is primarily winter-based, they do host summer events and provide some limited services for daily visitors (lift rides, restaurant). Access is from Highway 89 along the "Ski Park Highway" (Forest Road 40N88), and is a Cost Share road shared with the Forest Service and two additional land management companies. This is also the sole public access route to the USFS Gray Butte Communication Site and provides access to the private parcels located north and west of Signal Butte.

The Ski Park Highway also provides winter access to the Mt. Shasta Nordic Center on NFS lands just south of the Ski Park, and snowmobile use along the McKenzie Butte Road (Forest Road 40N31) between Mt. Shasta and McCloud and to the Tri-Forest Snowmobile Park on Pilgrim Creek Road. An informal but popular sledding site is located at Snowman’s Hill at the intersection of the Ski Park Highway and Highway 89 and wintertime traffic in this area is heavy during the ski/snow season. Tourism associated with the Mt. Shasta Board and Ski Park provides employment for local residents, tax income for Siskiyou County, and a significant source of revenue for local hotels/motels, restaurants, and outdoor gear stores.



Map 3-14: Ski Park Highway Corridor

Recreation

As elevation increases, use concentrates along roads and routes that lead up the mountain to destination locations including campgrounds, parking areas, trailheads, meadows, and vista points. The Everett Memorial Highway is a 14-mile two-lane paved road that terminates near 8,000 feet at the parking area of the previous Mt. Shasta Ski Area (Ski Shasta). As Mt. Shasta becomes more well-known, international visitors and tour bus traffic has increased along Everitt Memorial Highway. The traffic counter on this route currently averages 100,000 visitors annually (estimate 3.5 people per vehicle, see Figure 3-2).

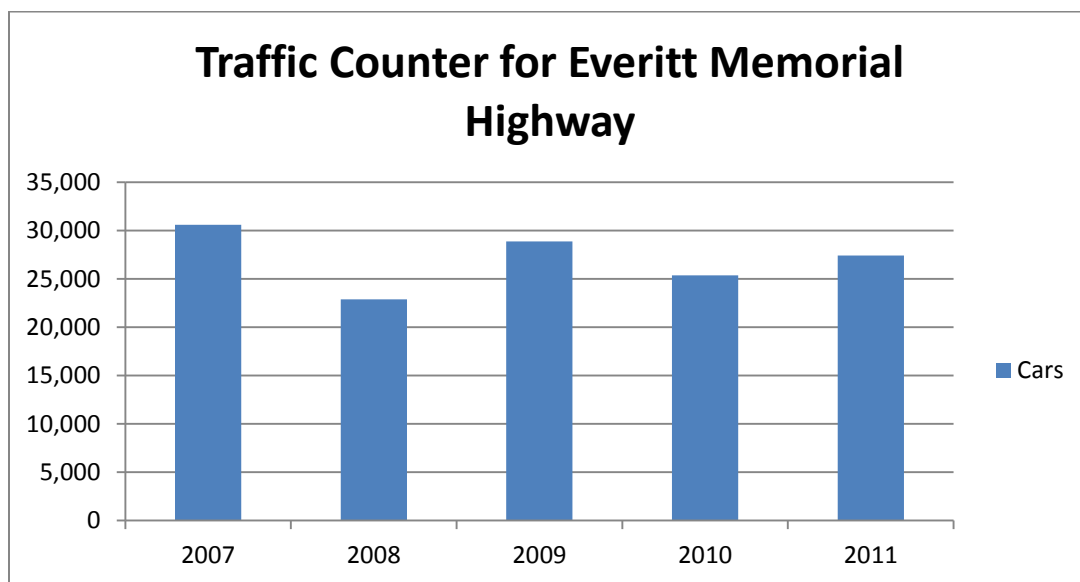
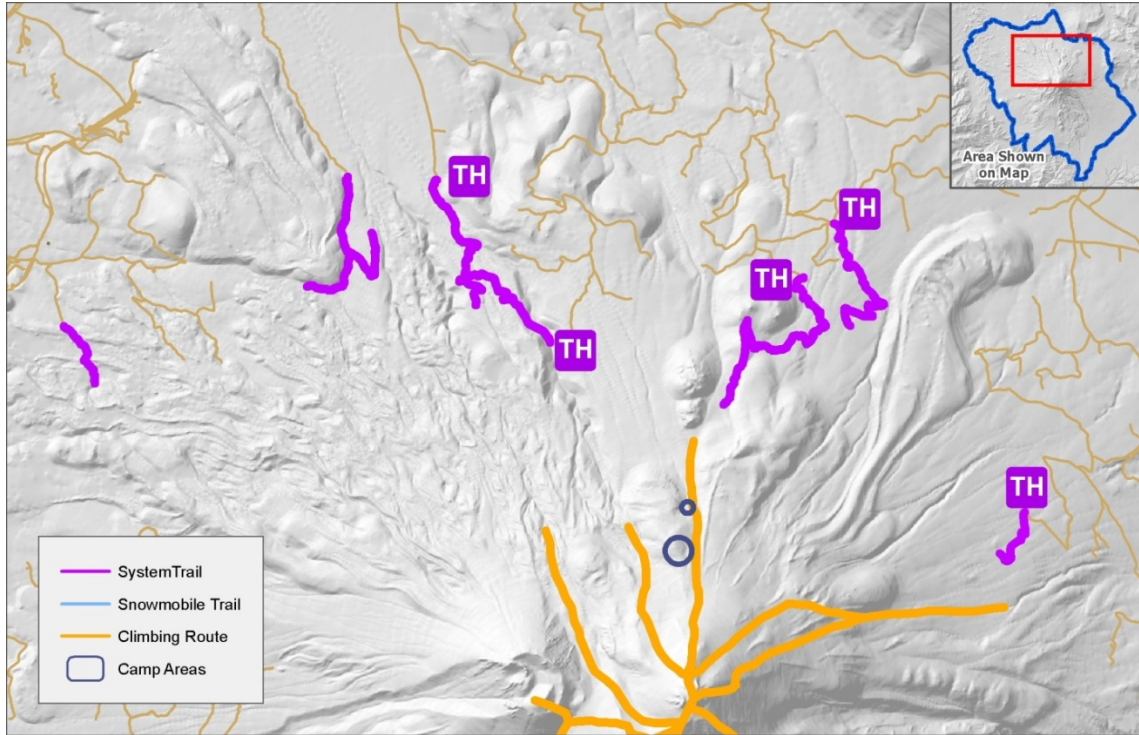
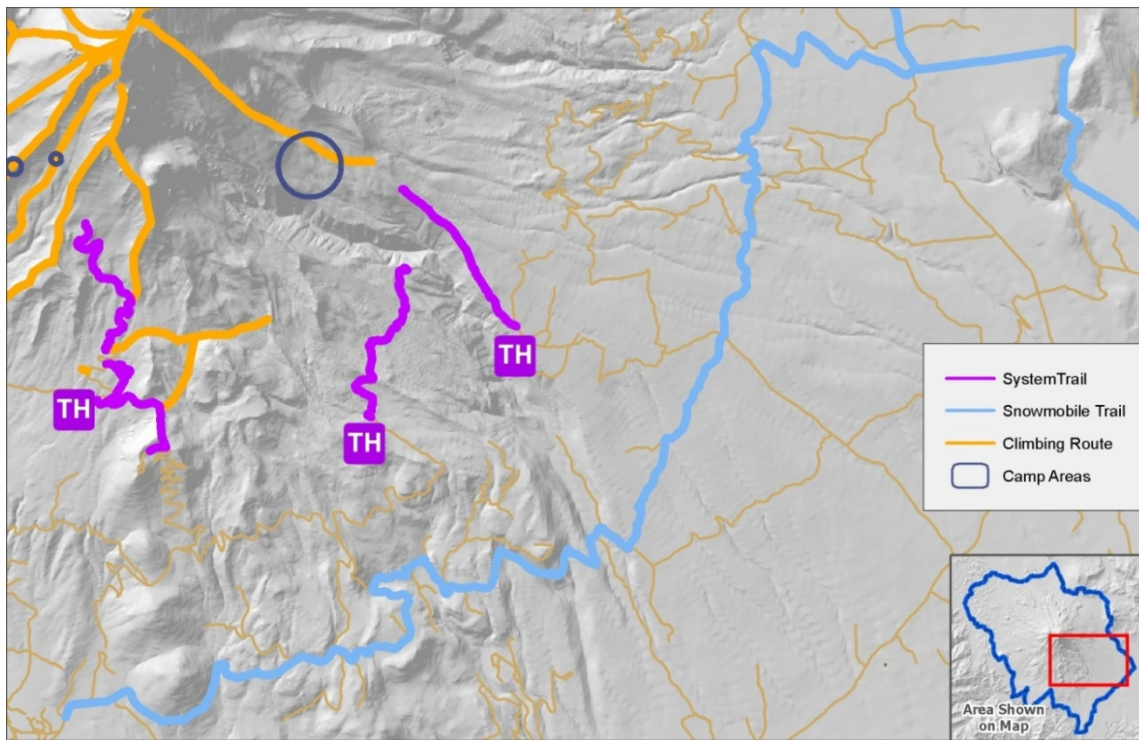


Figure 3-2: Everitt Memorial Highway Traffic Counter from 2007-2011

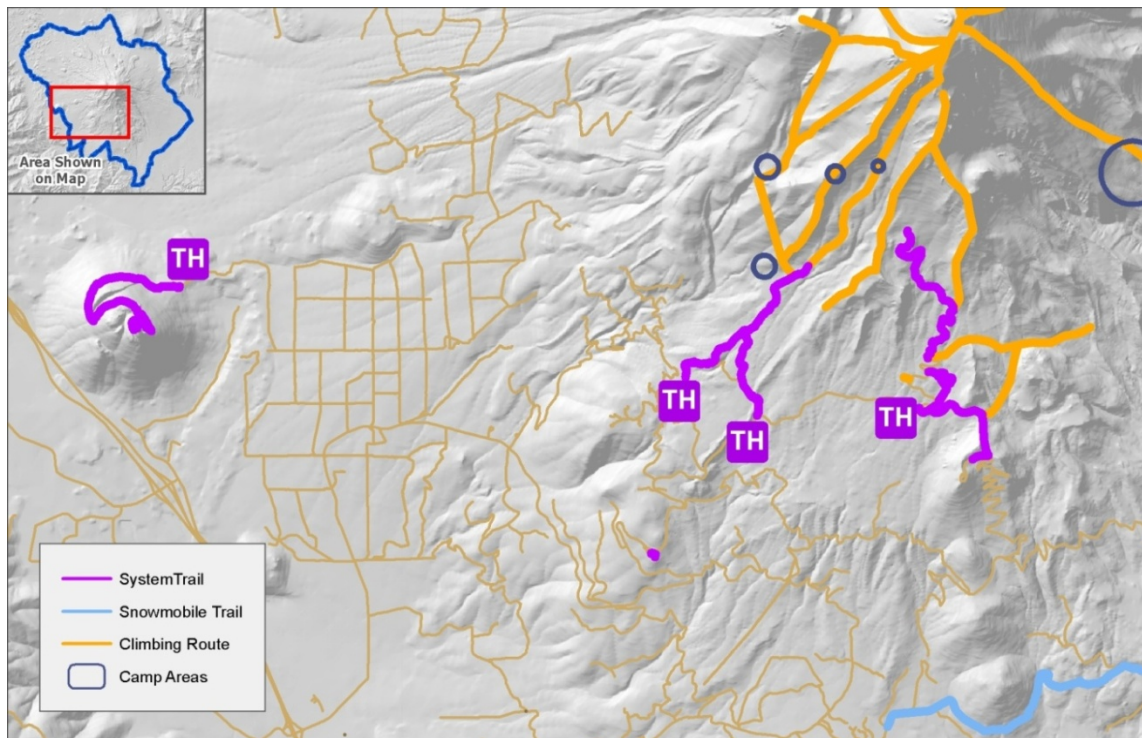
Recreational use varies by season but can include skiing, snowshoeing, snowmobiling, sledding, camping, hiking, climbing, biking (both motorized and non-motorized) woodcutting, hunting, and Christmas tree cutting among others. Most use is concentrated along roads and/or water. Wilderness use peaks in May and June when mountain climbing conditions are the best, while camping use peaks in July and August when multiple recreation events, Native American ceremonies, large group uses and the August full moon combine to fill both developed and dispersed sites along the Everitt corridor. Mt. Shasta was a gathering location for the Harmonic Convergence in 1987 and was visited by the Dalai Lama in 1989. Both events drew large crowds (estimated 3,000 to 5,000) to the Ski Bowl area. The world-wide observance of the end of the Mayan Calendar in 2012 is expected to be another large event.



Map 3-15: North Mt. Shasta Trails and Climbing Routes



Map 3-16: Southeast Mt. Shasta Trails and Climbing Routes



Map 3-17: Southwest Mt. Shasta Trails and Climbing Routes

Alpine Zone Recreation

The alpine zone on Mt. Shasta spans 9,000 feet to the top (14,179 feet). Terrain in this zone consists of glaciers, snow, rock and some flora up to about 10,500 feet. The alpine zone is used primarily by climbers and day hikers. Most use is on snow during the winter, spring and early summer months and concentrated in the Avalanche Gulch region, however use occurs all year long. The routes climbers use can be seen on Maps 3-15, 3-16, and 3-17 above. The commonly used camping areas can be seen on these maps as well which are used by climbers summiting Mt. Shasta.

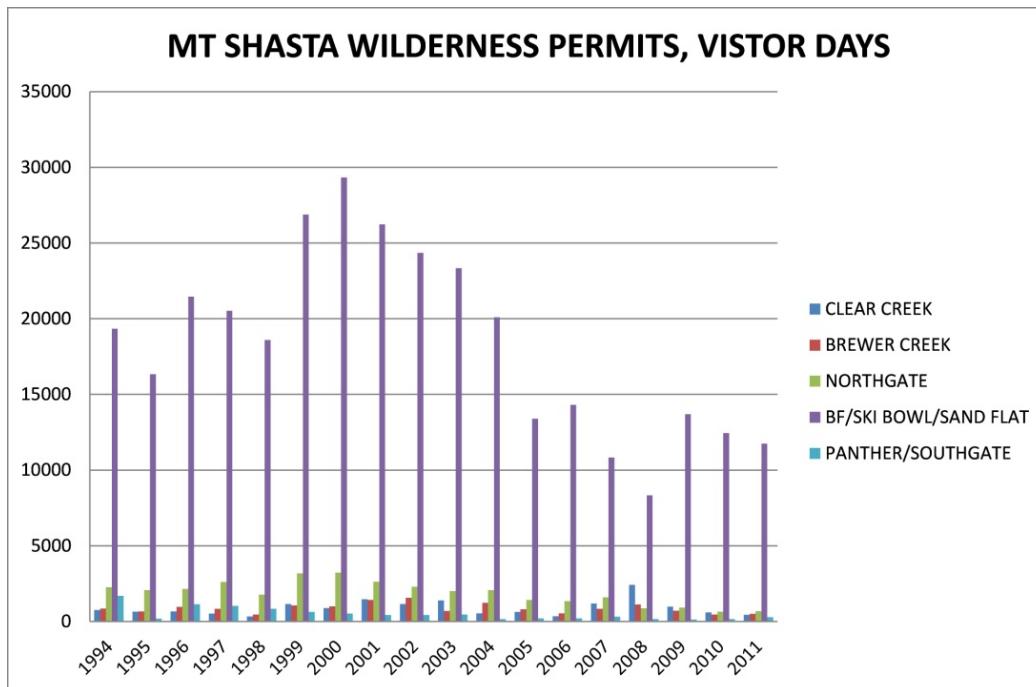


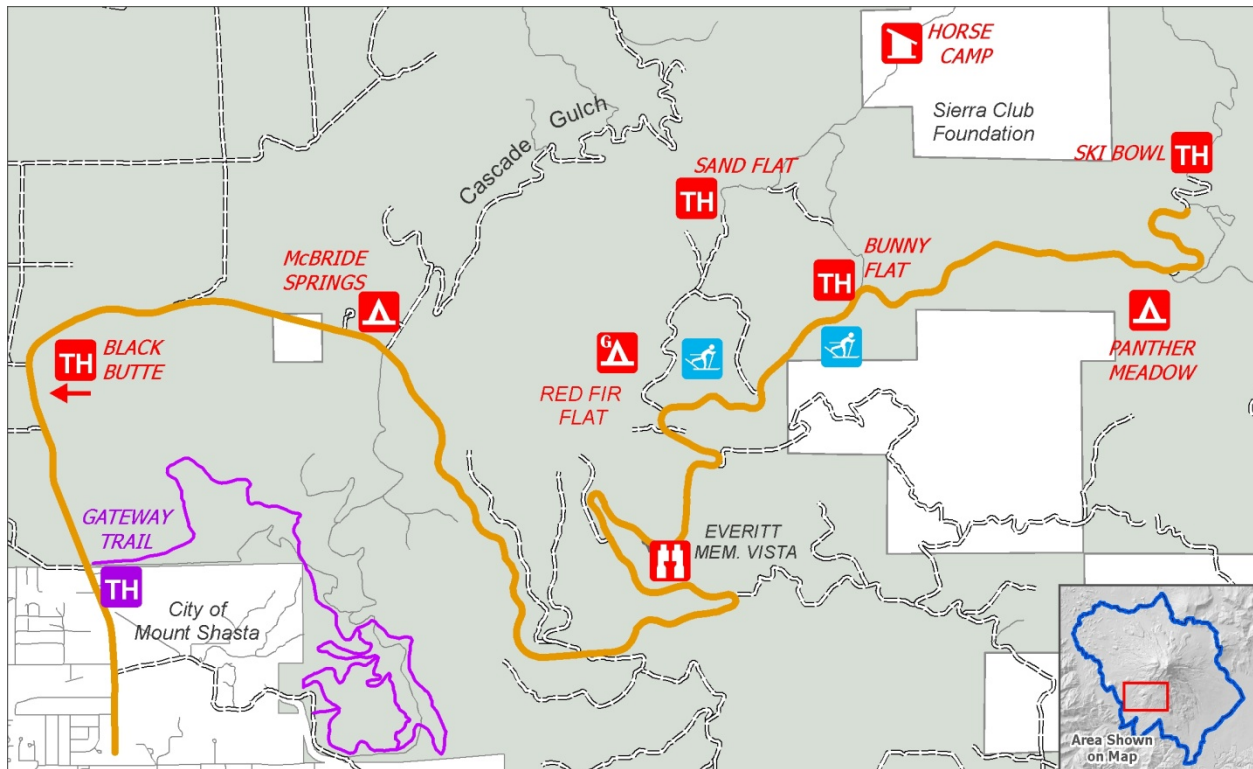
Figure 3-3: Wilderness Use

The Forest Service currently operates an Avalanche Center during winter months which provides free avalanche education and transceiver clinics to the public, institutions, clubs and grade schools in an effort to promote safety and save lives. Additionally, the Avalanche Center issues avalanche danger forecasts several days a week, and avalanche watches and warnings are issued in conjunction with the National Weather Service when avalanche danger has reached or is expected reach high/extreme levels.

In the summer and fall, climber numbers drop while day hiker and tourist use increases. While erosion is not a concern when snow covers the zone, as the snow melts, user trails show and erosion is a problem in some areas, specifically the south side trails/routes where use is the highest. High elevation riparian areas see annual damage from climbers/hikers seeking water and/or a resting point. Grasses and plants near edges of streams/springs see damage from aggressive tread of climbing/skiing boots. Camping/meditating near these areas also contributes to accelerated erosion and destruction of soil and plants. Areas that host flora that do well in dry soil also see damage annually from campers (Lake Helen, Hidden Valley, etc.) The alpine zone away from riparian areas is very durable, however loose scree/talus show user trails easily and create safety hazards for users. User created trails are an on-going problem as just a couple tracks in the scree can lead to more use by climbers. Forest Service management practices are to block and restore these “rogue” use trails back to the natural looking environment.

McBride Springs and Panther Meadows (11 and 16 campsites respectively) are the only two developed campgrounds located in the watershed area (see map 3-18 below). They are only open seasonally (May through September) and are typically at or over capacity when open.

The Bunny Flat and Ski Bowl Parking areas are full to overflowing on during the summer season (see photo 3-30, above). There are limited sanitation facilities (Sierra Club, Bunny Flat, Panther Meadows, Red Fir Flat, Everett Memorial Vista Point, and McBride Springs) and one developed potable water source (McBride) along the Everett corridor and these see very heavy use (see Map 3-18 below). Due to the heavy use and direct impacts to the sensitive resources at the higher elevations, a Forest Order is in place for a portion of the Panther Meadows area and the area within the Wilderness boundary is subject to the Forest Order for Wilderness use. An update of these documents is in progress to reflect the increased and diverse use now occurring.



Map 3-18: The Everett Memorial Highway Corridor with Recreation Destinations

At the lower elevations, mountain bike use is heavy along authorized and unauthorized routes through the lower plantations. Users construct trails and features (e.g. jumps) and “gravity” routes down the mountain. The road and trail to Black Butte is also open and a popular destination for day hiking.

Wintertime traffic is concentrated along the Everett Memorial Highway (see Map 3-18 above) and the Ski Park Highway corridor where Siskiyou County and the Mt. Shasta Board and Ski Park provide snow removal. The upper gate is closed at Bunny Flat on the Everett Memorial Highway, and the Bunny Flat parking lot is often full to overflowing on weekend days. Pursuits include backcountry skiing, sledding, snowshoeing, snowmobiles and general sightseeing. This is also an access point for the Sierra Club Foundation property 1.5 miles above the parking area and within the Mt. Shasta Wilderness Area. The County also plows small parking areas at Upper

and Lower Sand Flat road for additional skiing and snowshoeing into the Sand Flat/Jack Flat area. A cross country ski trail is marked in this area (Ron's Loop). An additional parking area is also maintained near Cascade Gulch (below the lower gate) which is a popular location for sledding and the end of a popular ski route (McBride) that begins at the Sierra Club hut. Congestion occurs at the limited number of clear parking areas along the Everett Memorial Highway and at Bunny Flat.

Native American Religious/Cultural Use

Mt. Shasta is considered a sacred place by indigenous Native Americans whose aboriginal territory surrounds the mountain. Mt. Shasta is a major visual point for the Hupa (also "Hoopa"), Karuk, Modoc, Pit River, Shasta and Wintu Indian peoples of northern California and, as such, the mountain peak is used today as both a spiritual and geographical locator (Theodoratus, 1991). In general, there are no casual or strictly recreational visits by Indian people. Rather, places on Mt. Shasta are used by local tribal people for traditional ceremonies, some of which have been held annually for over 30 years. Places on Mt. Shasta are also used by individuals from the local Tribes for prayer, plant gathering, health and personal well-being. Because of its historic and current importance to indigenous people, areas of Mt. Shasta (generally above tree line) were designated as a traditional cultural place and was determined eligible for the National Register of Historic Places in 1994.

Non-indigenous Metaphysical Use

Mt. Shasta is a center for non-indigenous metaphysical use as well. In 1987, Mt. Shasta gained national and international significance as a pilgrimage site during the "Harmonic Convergence" (related to the Mayan Calendar), when it was identified as one of two "power spots" where one could observe an alignment of planets, and harmony with peoples and the environment (Zanger 1992:103). Non-indigenous people visiting the mountain are represented by organized groups, such as followers of the Ascended Master religious movement (known also as "I-Am" or Saint Germain). Most are loosely characterized as individuals and groups who adhere to "New Age" or metaphysical spiritual practices, as evidenced by rock stacks, prayer flags, mandalas, shrines, offerings, etc. Since 1987 there has been a proliferation of illegal commercial spiritual activities such as guided vision quests and ceremonies, and illegal related activities such as the placing of cremations on Mt. Shasta.

Commercial/Municipal

This includes timber harvest, brush mastication, and road and facility maintenance. Botanical and wildlife surveys are also ongoing as well as habitat restoration activities. Some logging occurs in this watershed both on NFS and private lands. Residential use continues on the Pilgrim Creek road (42N13), Widow Springs Road (41N13), and the connecting network of roads.

In addition to municipal spring development, the watershed includes small municipal water developments (e.g. Mt. Shasta Board and Ski Park, Bear Springs Water Company) and a multitude of small wells and systems for residential use. Portions of the community leach field systems as well as the leach fields for Mt. Shasta Board and Ski Park and some County residents fall within the boundary.

Illegal

A substantial amount of the illegal dumping on the unit also occurs in the zone surrounding the toe of the mountain along the network of native surface roads. Illegal dumping is especially high in the Hotlum region which is often accessible throughout the year, and a tall layer of brush obscures users from the highway. This is also a popular area for legal target shooting and many of the illegal dump sites double as unofficial target ranges as abandoned appliances and furniture are used as targets. Illegal residency also occurs in areas within the watershed near roads and communities. While much of the use is legitimately dispersed recreational camping, a portion of this use extends well beyond the 30-day limit and by individual living illegally on public and private land.



Photos 3-33 and 3-34: Illegal Dumping in Hotlum Area

Research

National Forest lands in the vicinity of Mt. Shasta have a long and continuing history of pioneering forestry research. Beyond protection, no active management should occur without approval by the Pacific Southwest Research Station in Redding, California.

Possibly the most important silviculturally is the **S.B. Show Plantation** near Pilgrim Creek (T40N, R1W, NE ¼ Sec. 8 MDM) which was established in 1919 and 1920 by S. Bouvier Show and is likely the oldest successful ponderosa pine plantation in California and perhaps the world. Show, a district forester (and later Regional Forester for the California Region) charged with reforestation of National Forest lands in the vicinity of the McCloud Flats, tried unsuccessfully

to plant rocky lava flows where harvested trees had been growing. Show cleared and planted a rabbitbrush flat which had an outstanding survival success. His success was a turning point in developing a reforestation program for California. In 1972, Region 5 established an un-replicated series of one acre plots as part of a study of commercial thinning. The plots were thinned to 40, 55, and 70% of basal area which is normal for stands of that age and site quality. Subsequent measurements have been made by the PSW Research Station to examine stocking effects on stand growth and susceptibility to insects and disease. The Show Plantation has been a popular showpiece for visiting land managers, scientists, and the public. The entire plantation is about 18 acres and serves as an important example of what can be accomplished with appropriate silviculture.

A natural stand of ponderosa pine near **Edson Creek** is a companion to the S.B. Show Plantation study plots, and is located in T40N, R1W, SW ¼ Sec. 2 MDM. The stand regenerated following a wildfire and is about 125 years old as of this writing. Un-replicated one acre plots were thinned in 1972 by Region 5 to 40, 55, and 70% of normal basal area as part of an administrative study of commercial thinning operations. Subsequent measurements have been taken by the PSW Research Station. Neither Show nor Edson Creek plots have been re-thinned, although the District has thinned surrounding areas.

The Shasta Mudflow Research Natural Area in the Mud Creek drainage near McCloud (T40N, R2W MDM, portions of 13 sections) was established in 1971. This unique area includes a dated series of layered mudflows formed during periodic melting of the Konwakiton Glacier and outwash of volcanic ash that overflowed Mud Creek. Five broad flows (A-E) have been approximately dated, the most recent occurring in 1924-1931 (Flow A), and the oldest (Flow E) occurring about 1,000 years earlier. Dickson and Crocker established the importance of this site in a series of 1953 papers that continues to draw the attention of many scientists. The site demonstrates Hans Jenny's 1941 concept that soil forms through interactions of climate (cl), organisms (o), parent material (p), relief (r), and time (t), and that this could be expressed mathematically if most factors were held constant and one was allowed to vary. In the case of the Shasta Mudflow RNA, the equation can be expressed as:

$$S = f(\text{time})_{cl, o, p, r.}$$

This concept is simple in theory but difficult to demonstrate in nature, and the Shasta Mudflow chronosequence is a significant example of where this can be done. The site also has been the focus of forest entomological and disease studies.

The Spring Hill Plantation study (T40N R4E, NW ¼ of Section 4 MDM) marks some of the earliest herbicide trials in western forestry and perhaps the oldest designed study of how shrub control affects the long-term development of young forests. In 1961 the site supported dense thickets of manzanita, snowbrush, Sierra plum and bitter cherry that established following

logging and subsequent wildfires in the late 19th century. Thirty acres were cleared with a bulldozer in 1961 which meant that shrubs and an estimated 4 to 6 inches of topsoil were pushed into windrows. The cleared bays between windrows were planted the following year with ponderosa pine, which lead to survival of the trees, but tree growth was stunted from brush reinvasion and from “L-rooting” occurring during machine planting. Following planting, Jay Bentley and coworkers of the California Forest and Range Experiment Station (now the PSW Research Station) conducted formulation, rate, and timing trials with herbicides to test their effectiveness at controlling shrubs. Treatments were applied to rectangular plots each about 0.2 acres, sandwiched in the cleared bays between windrows. Bentley’s trials were completed in 1964 leaving plots with varying densities of shrubs. In 1966 Philip McDonald of the PSW Station chose four plots in each of four shrub density categories and monitored vegetative changes periodically for the next 3 decades. McDonald’s work established one of the earliest experiments in the West of how vegetation control influences plantation development, and led to many papers and presentations. With McDonald’s retirement, half of the treatment replications were obliterated when windrows were flattened and re-spread by the District, however, half still remain. They serve as remarkable demonstrations of the long-term effects of shrub competition on forest development.

One of four unique **Understory Fuel Reduction Study Sites** was established by the PSW Research Station in 2003 near Black Butte (T41N R4E, SE ¼ of Section 28, NE ¼ Sec. 33, MDM). It was established in a 1976 open plantation of ponderosa pine with a dense understory of woody ladder fuels of manzanita and snowbrush shrubs (ladder fuels averaging 19 tons per acre). The purpose of the experiment is to see how alternatives in dealing with understory ladder fuels affect carbon sequestration, forest health, and susceptibility to wildfire. Shrub treatments consist of a Control, Manual Removal, Mastication, Mastication plus Rototilling, and a fifth treatment of “Mastication plus Best Management Practices” not yet determined as of this writing. Each treatment is applied to ½-acre plots, and each is replicated four times in a randomized-block design.

CHAPTER 4: Reference Conditions

The purpose of this chapter is to explain how ecological conditions have changed over time due to 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 summarizes the natural processes and land-use activities in the watershed following the five core topics:

1. Geologic Process and Hydrology
2. Vegetation
3. Fire and Fuels

4. Species and Habitats
5. Public Uses

Discussions of physical features, biological features and human uses can generally be segregated into two distinct periods, as follows:

- Pre-European Settlement: During this period, significant Anglo-American influences were absent. Although native peoples used the area, the ecosystem was functioning under essentially natural conditions during this time.
- Post-European Settlement: 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.

Geologic Processes and Hydrology

The geologic processes that are active on Mt. Shasta are described in Chapter 3, and for the most part are very similar to reference conditions. For example, the time frames under which volcanic processes operate are well beyond the time frames used in this analysis for addressing ecosystem processes (pre and post European Settlement periods). This chapter describes trends for geologic and hydrologic processes in response to natural and human factors.

Pre-European Settlement

Geologic and hydrologic resources in the Mt. Shasta Watershed have likely been in a constant state of adjustment in response to what was and continues to be a very active disturbance regime. The influence of past volcanic activity and glaciations has undoubtedly resulted in major changes to the landscape features in the distant past. Over the past 10,000 years the dominant disturbance processes effecting channels have been debris flows, landslides and runoff events triggered by rainfall at high elevations. Channel adjustments to debris flows were likely similar to those that have occurred in the recent past and include channel incision along steeper reaches within inner gorges and channel abandonment/migration on alluvial fans. The magnitude of channel alterations were directly related to the size of the debris flow and it is likely that the largest events completely altered the locations of channels on developing alluvial fans.

Stream channels on Mt. Shasta were not affected by any human use activities prior to European settlement, but were likely frequently impacted by the natural disturbance processes noted previously. Mapping of historic debris flows by the USGS suggests that many of the channels that were active from 1900 to present also experienced frequent debris flow activity from 1500-1900. Debris flows appear to have been frequent occurrences in the Whitney, Bolam, Mud Creek, Ash Creek, Gravel Creek and Inconstance Creek drainages prior to 1900 (Osterkamp, et al., 1986). Research conducted by Osterkamp, et al. also indicates that all streams fed by glacial melt have experienced multiple debris flows in the past 500 years. Large debris flows occur on Mt. Shasta at a rate of roughly four per century and smaller debris flows may be 10-20 times

more numerous. Osterkamp's research also notes that no significant debris flows have occurred in stream channels that are not fed by glacial melt in recent centuries.

Post European Settlement

The development of communities and associated infrastructure in the Mt. Shasta Watershed resulted in modifications to the channels caused by the construction of railroads, roads, wetland drainage projects and other activities. A comprehensive discussion of the effects of infrastructure development on stream channels and erosion processes on private lands and communities surrounding Mt. Shasta is beyond the scope of this analysis, however it is worth noting that the impacts arising from infrastructure to stream channels in the watershed often paled in significance to the impacts that the natural erosion and stream channel processes had on the infrastructure itself. Many early roads and railroads were constructed in the watershed because at that time few perennial streams were observed to occur on Mt. Shasta. The constructed roads and railroads were not designed to accommodate the magnitude of the natural disturbance processes. Road failures at stream crossings were likely common and would have occurred in response to summer storms and debris flow activity.

Trends in non-eruptive debris flow and channel processes are described below by referencing historically significant debris flow and flood events occurring on Mt. Shasta over the past 100 years.

The Mud Creek Debris Flow (1924-1931)

The largest debris flow event to occur in the past 100 years was the Mud Creek debris flow that occurred in the 1920s. The Mud Creek debris flows were triggered by the rapid melting of the Koniwakiton Glacier. The debris flows transported large quantities of sediment down Mud Creek where they were deposited onto the Mud Creek alluvial fan (Kavanaugh Flats), into the McCloud River and ultimately into the lower Sacramento River. The largest debris flows occurred in 1924 (7,000,000 cubic yards), 1926 (1,300,000 cu. yds.), and 1931 (18,000,000 cu. yds.) impacted the railroad, roads and the water system for the community of McCloud (Wilson and Egenhoff, 1976). Water quality in the McCloud River was impacted by the debris flows and of the total material moved, it is estimated that between 1,000,000 and 3,000,000 cubic yards of sediment flowed into the McCloud River in 1924 followed by an additional 700,000, and 1,000,000 cubic yards in 1925, and 1931, respectively (Wilson and Egenhoff, 1976). During this period the government made several attempts to divert the debris flows from the railroad and other infrastructure. Some of these efforts were effective in the short term but were ultimately not successful in controlling the debris flows.



Photo 4-1: Mud Creek Debris Flow, courtesy McCloud Fly Fishing Club.

The Whitney/Graham Creek Debris Flows (1935)

On August 28, 1935, a large debris flow occurred on Graham Creek, on the NW side of Mt. Shasta, which damaged the Southern Pacific Railroad (Melhase, 1935). An even larger event occurred at the same time in Whitney Creek, taking out an entire segment of the same railroad. At an elevation of 4,900 feet on the broad alluvial fan, Graham Creek gets very close to Whitney Creek, and it is possible that they may have been temporarily connected during the 1935 event. In Graham Creek, an altered channel segment, about 4,500 feet long, was identified, beginning at the falls at elevation of 7,600 feet and extending down to about 6,600 feet (Map 3-5). This altered channel is visible from 1993 through 2009. However, below 6,600 feet, Graham Creek shows no evidence of recent alteration on 1993 and newer imagery. In fact, the channel is mostly obscured by vegetation on the newer imagery. Examination of 1944 air photos (DDD-66-37 through 66-41) taken on August, 23, 1944, show that Graham Creek was altered all the way down to the railroad, and the age of vegetation in the photos indicates that it was established after the event.

The Whitney/Bolam Debris Flow (1997)

On August 20, 1997, a debris flow occurred in Whitney Creek, causing it to take a new course after it crossed the Southern Pacific Railroad and bury highway 97 near the Lava Park lava flow (de la Fuente and Bachmann 1998). After the event, the stream returned to its pre-1997 channel, where it has stayed for the most part, and has not reoccupied the new channel which formed in 1997. An earlier 1997 debris flow occurred around January 1, 1997 in Cascade Gulch. This event damaged Everett Memorial Highway, and deposited debris on the fan downstream. Both of these altered channels (Whitney Creek and Cascade Gulch) remain clearly visible on 2009 Google

Earth images, though there has been some encroachment of brush and trees. Areas where the streams overflowed and deposited light colored sediment on the surface of the fan are still identifiable on the 2009 image, but with some difficulty.

Unlike the 1997 New Year's Flood, this debris flow was triggered by unusually heavy summer rains during the glacial melt season (de la Fuente, et al., 1999) and in contrast to this event, Whitney Creek did not experience any flooding or debris flow activity during the 1997 Flood. The difference in the Whitney Creek channel's response between the 1997 Whitney-Bolam debris flow and the 1997 New Year's Flood illustrates that there is a strong influence in the timing of precipitation and the amount of snowpack on flooding and debris flow processes on Mt. Shasta.

New Year's Day Flood (1997)

The 1997 flood was a very large rain-on-snow event that occurred in response to almost continuous precipitation that began on December 25th, 1996 and continued through January 2nd, 1997. Winter frontal storms rarely cause problems on Mt. Shasta because most of the precipitation falls as snow or rainfall from the storms, and is absorbed by the deep snowpack which does not contribute to runoff. In the case of the 1997 flood, snow levels were very high and the capacity of the snowpack to absorb rainfall was exceeded. As a result, this unusual event triggered one large debris flow in a tributary in Cascade Gulch above Mount Shasta City and several smaller streams that rarely ever flow experienced unusual flooding events. The most notable of the latter was Panther Creek which flooded and deposited sediment over portions of the community of McCloud. Flooding also occurred along portions of Squaw Valley Creek resulting in damage to roads in McCloud. Big Canyon Creek experienced flooding in response to the failure of a diversion ditch that had been designed to route Big Canyon Creek around a railroad crossing. While these impacts were large, it is worth noting that few other problems were documented on the mid to upper slopes of Mt. Shasta as a result of the 1997 Flood.

Summer Storm of 2003

On July 23rd, 2003 a summer thunderstorm produced 14 small debris flow events on the south and east flanks of Mt. Shasta. The storm melted some of the remaining snowpack above 8,000 feet in elevation which contributed to the debris flow activity. Impacts from the storm included: numerous plugged culverts and channel infilling on roads associated with Ash and Squaw Valley Creeks; plugging and subsequent road prism erosion on Brewer Creek; and increased turbidity in the McCloud River extending down to Shasta Lake as a result of debris flow activity in Mud Creek. Small debris flows also occurred in Gravel, Pilgrim, Cold, and Mud Creeks as well as several unnamed streams. While the storm was localized, the impacts to the transportation infrastructure on the south and east flanks of Mt. Shasta were extensive.

The development of roads and other infrastructure on Mt. Shasta may impact stream channels, yet it has had very little effect on water quality, channel morphology and runoff processes. The water quality in most streams flowing off Mt. Shasta is fair to poor owing to high natural background turbidity levels. It is unlikely that the development of road infrastructure has decreased water quality outside of the range of natural variability.

Vegetation

Pre-1900

In the summer of 1898, a biological survey was conducted under the guidance of C. Hart Merriam at several locations within the Mt. Shasta Watershed Analysis area (Merriam, 1899). The results of the surveys were documented in the North American Fauna No. 16, and are used here to provide reference conditions for vegetation and wildlife conditions in this watershed. The itinerary of the 1898 surveys included a variety of life zones located in and around: Wagon Camp, Panther Creek, South Gate, Squaw Creek, Mud Creek Canyon, Cold Creek, Ash Creek Canyon, Brewer Creek Canyon, Clear Creek, Inconstance Creek, North Gate, Whitney Creek, Bolam Creek, Shastina, Diller Canyon, Sisson (now Mt. Shasta City), McCloud, Little Shasta Valley and completely around the lower slopes of the mountain within the yellow pine belt. The surveys began on July 15 and extended to September 24th. The primarily forested habitats include: ponderosa pine, open plains of the Shasta Valley, gray pine, Douglas fir, incense cedar, sugar pine, white fir, knobcone pine, black oak and other deciduous trees, Shasta fir, mountain white pine, lodgepole pine, white bark pine and black alpine hemlock.

Stand types over time have seen little to no change over the past 100+ years. The stand types and species compositions are elevational in nature as one proceeds up the mountain. Changes in management strategies since the pre-1900's have had the greatest effects on species composition as well as on species distribution. Most of these changes have occurred at the lower elevations in the stands that are warmer and have historically had fewer shade tolerant species, due in part to frequent fire occurrence and early harvest practices that targeted high valued species such as ponderosa pine and sugar pine. Timber belts in the higher elevations, typically white fir and red fir, have had fewer fire occurrences, and their species composition is dominated by these shade tolerant species. The white bark pine belt, which makes up the highest reaching extent of trees, has very few if any other trees existing in this belt, and it is here that the fewest changes have occurred since the late 1800's.

Whitebark pine, as it is described in the North American Fauna No. 16, pushes its way over steep and barren slopes to the extreme upper limit of tree growth. At certain altitudes the slanting trunks, only 4 or 5 feet in height, serve as pillars to support the flattened tops which form a canopy of intertwined and matted branches. These dwarf groves offer attractive shelters from wind and storm and can be used as such in some cases. Just below tree line on the north side of Shasta, between North Gate and Shastina, is an extensive gently sloping pumice plain that is

thickly spotted with rather large mats of pines averaging 2 to 4 feet in height. This area is about a 1.5 miles across and contains hundreds of acres of the dwarf flattened pines. This area as defined in the North American Fauna No. 16 is probably the largest continuous area of whitebark pine on Shasta. Photo 4-2 was recently taken of a whitebark pine. As seen, the conditions have not changed from the description above and comparatively with Photo 4-3 below.



Photo 4-2: Whitebark Pine at timberline on Mt. Shasta, California, Don Bain's 360o panoramas



Photo 4-3: Whitebark Pine Tree, Mt. Shasta, Carlton Watkins, circa 1870, Mount Shasta Companion

Red fir is lower in elevation than the whitebark pine belt. As a rule, the red fir stops abruptly where the whitebark pine begins. This belt was described as a forest of tall stately trees, dark, somber and free from underbrush with beds of the low mountain manzanita interspersed in areas which afford a pleasing relief from the uniform dark brown of the surface carpet, usually a shallow layer of fir needles mixed with decayed cones and wood. These dense stands are also interspersed with open areas of brush. Photo 4-4 below shows current conditions today which appear similar to how it was described in 1898.



Photo 4-4: Shasta Red Fir Stand, Don Bain's 360° virtual Tour

The **white fir** type is found in lower elevations below the red fir type. The condition of this type has not changed much from its historic condition. The stands have historically had dense canopies with small understory trees coming in. Based on the shade tolerance of the species, it has always been able to handle higher densities than its shade intolerant neighbors found lower in elevation. This is evident based on Photo 4-5 (dated 1899) at Wagon camp and the current Photo 4-6 taken near Castle Lake.

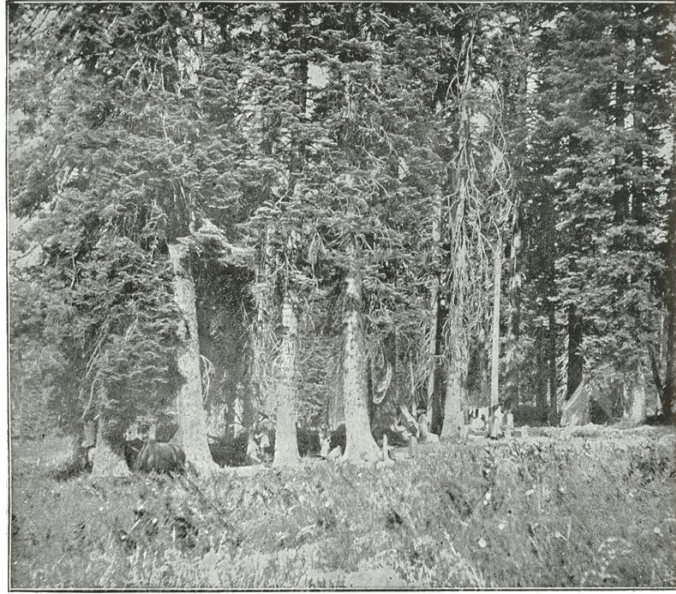


Photo 4-5: White Fir near Wagon Camp C. Hart Merriam, 1899, Courtesy of the COS Library



Photo 4-6: White Fir Stand near Castle Lake, 2010

The **mixed conifer** type is the type that has seen the biggest changes over time, many of these changes being human caused. The species that are found in the mixed type are ponderosa pine, white fir, incense cedar, Douglas-fir, sugar pine, lodgepole pine and knobcone pine. The composition and density of this layer has changed because fire suppression has kept large scale wildfires under control and harvest activities have been reduced in recent decades. Under frequent fire regimes the more fire resistant species such as ponderosa pine, sugar pine, Douglas-fir, lodgepole pine and knobcone pine would survive the more frequent less severe fires, while the white fir and incense cedar would die. This would naturally keep the stands thinned out and

create a mix that was more fire resistant (see Photo 4-7). Between the logging practices that harvested the higher valued fire resistant species and fire suppression, the stands have developed into dense stands of shade tolerant fire susceptible species.

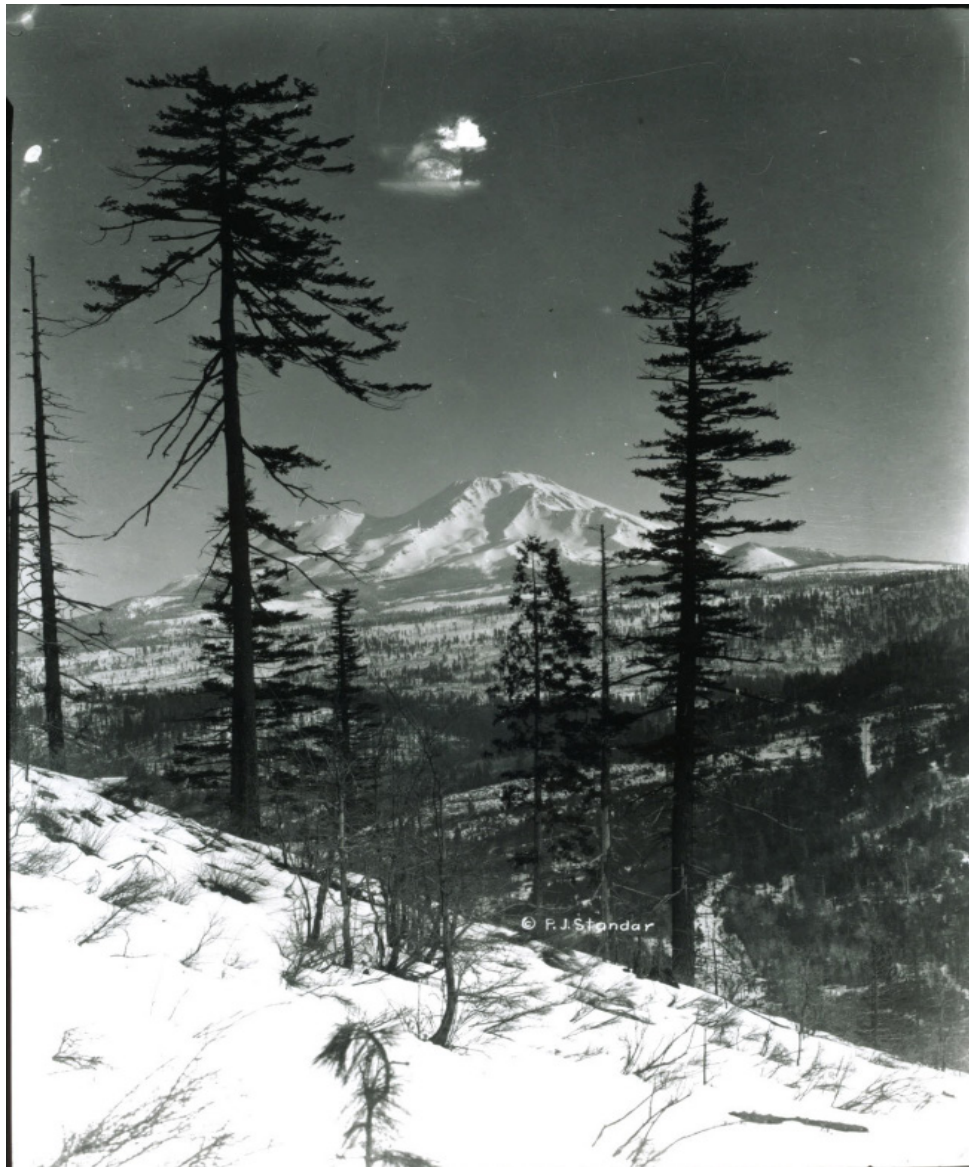


Photo 4-7: Photo from Mt. Bradley, from John Signor’s Collection late 1800-1920

Historically the mixed conifer type had many large openings of brush due in part to the frequency and severity of fires. As referenced in the North American Fauna No. 16,

“The south and west open pine forests are interrupted by extensive parks, which from a distance appear to be meadows of waving grass. A nearer view shows this to be an illusion, the broad fields of green being in reality impenetrable thickets of chaparral (see Photo 4-7). A chaparral of unyielding manzanita and buck brush.”



Photo 4-8: Mt. Shasta Brush Fields, Mt. Shasta Ranger District Archives



Photo 4-9: Post Treatment Brush Fields, Mt. Shasta Ranger District Archives

The **hardwood forest woodland** is found predominantly in the south and western side of the watershed. The stands are small and are found below the white fir type. Prior to active fire suppression in the early 1900's, fire frequency helped shape these stands. The predominant species of hardwood found in this type is California black oak. This oak is able to survive low intensity ground fires and is known to be a vigorous sprouter if top killed.



Photo 4-10: Hardwood Forest Woodland; SMMU Project File 2010

The **mixed conifer/hardwood forests** are predominantly various conifer species (Douglas-fir, ponderosa pine, white fir, incense cedar, sugar pine, lodgepole pine and knobcone pine) with a California black oak component. Other hardwoods that may be found in smaller amounts are: aspen, cottonwood and canyon live oak. Fire played an important role in maintaining these stands by excluding conifer encroachment. Frequent low intensity fires would remove the small conifer understory and help initiate the black oak sprouting. With the exclusion of fire over the past one hundred years, hardwood species have slowly been out competed by the conifers. Without low intensity, high frequency fires many of these stands are starting to look like Photo 4-11 below.



Photo 4-11: Mixed Conifer Hardwood; SMMU Project File 2010

Ponderosa pine (non-plantation) stands experienced more frequent low intensity high frequency fires prior to the 1900's than in recent decades. The higher frequency of fires in the ponderosa pine stands created a more open mosaic structure, which was a typical environment for these pines. Currently, fire suppression has increased stand density and in some places, increased the understory growth of more shade tolerant species such as white fir and incense cedar. An increase in stand density has also increased the likelihood of insect and disease outbreaks as well.

Plantations are found on both NFS and private lands within the watershed area. Though many of the plantations were planted as ponderosa pine, not all of them remain pure ponderosa pine. With an increased awareness of the importance of having species diversity in stands, more and more plantations have been planted with a mix of conifer species. In addition, many plantations when established left residual trees (typically white fir and incense cedar) that became seed sources adding to the mixture of species. This helped to create the patchy diversity in the plantations that you can often find today. Photo 4-12 shows a relatively recent plantation that shows a mixture of Douglas-fir and ponderosa pine. This plantation is just outside the watershed analysis area along Pilgrim Creek Road.



Photo 4-12: Mixed Species Plantation, SMMU Project File 2010

Many of the **knobcone** stands have been converted to plantations. Knobcone is a relatively short-lived species whose snags don't remain standing for very long. For this reason the wildlife value is low. Conversion of knobcone to other species such as ponderosa pine or mixed conifer reduces the fuel loads while increasing future habitat with improved snag recruitment.

The **lodgepole pine** stands have not experienced much change since Merriam's 1899 depiction. He called this lodgepole pine area northeast of the mountain "a dark, somber forest with very little noticeable vegetation except scattered patches of dwarf manzanita in dry woods". Photo 4-13 depicts these conditions of the lodgepole stands even today.



Photo 4-13: Lodgepole Stand, off Military Pass Road, Don Bain's 360° virtual tour

During the past 130 years, **western juniper** has been expanding within its geographic range at unprecedented rates compared to any other time period. Prior to European settlement, the spread of western juniper was controlled by fire and most western juniper trees were typically confined to rocky ridges, low sagebrush (*Artemisia arbuscula*) flats and pumice soils where fine fuels were too low in abundance to carry fire. Most stands were sparse and savanna-like (< 10% tree canopy cover). In the assessment area, juniper was associated with perennial bunch grasses such as Idaho fescue (*Festuca idahoensis*), blue bunch wheatgrass (*Elymus spicatus* [Pseudoroegneria]), Thurber's needlegrass (*Stipa thurberiana*), squirreltail (*Elymus elymoides*), and Ross's sedge (*Carex rossii*). These bunch grasses carried fire very well and helped to maintain very open stands. Stands having > 10% juniper cover would have been rare. Shrubs associated with western juniper would have been bitterbrush/ big sage/curly-leaf mountain mahogany shrub types. It may have also been associated with the lower edges of the ponderosa pine type in some areas.

Post Settlement (1850- 1950)

Limited evidence suggests western juniper began increasing its range following the end of the Little Ice Age in 1850. However, its rapid increase in abundance and expansion since the late 1800's has been largely attributed to anthropogenic factors such as season long, excessive grazing (Miller, 2005 and Young, Clements, 2002).

According to *History of Siskiyou County, California* by Harry L. Wells (1881), ranching was already underway by the mid-1850s. By the 1870's the open range lands at the base of Mt. Shasta toward Shasta Valley were seeing season long grazing and large numbers of livestock, primarily sheep and cattle. This reduced fine fuels reducing fire frequencies making it possible for juniper to expand. Logging by the Weed Lumber Company removed large pines leaving only shrub fields. This also created a favorable habitat for juniper expansion. With fire suppression,

the major element to control juniper, burning fewer acres more juniper were left standing. Western juniper has continued to expand even after grazing was dramatically reduced on Federal Forest Service Lands.

Dry Meadows (Sandy)

Dry meadows such as Sand Flat and those above tree line may have been in better condition than it is in today. Although meadow size would have been approximately the same, damage to the fragile vegetation may have decreased due to human manipulation as use increased over time. The first person to climb Mt. Shasta was Capt. J.D. Pierce, a merchant from Yreka. He ascended the peak alone in 1854. Soon after, he made the climb again with a party of 13 men (Wells, 1881). From that day onward, recreational use such as camping, hiking, climbing and spiritual quests only increased. As use increased so did the number of trails, roads and camping places. These open areas were good places to put these trails, roads, and parking areas. Camping areas were along the meadow edges in the trees. In the watershed analysis area, these meadows generally occur in the red fir zone up into the whitebark pine zone including the alpine dwarf shrub habitat type.

Fire and Fuels

Fires

Fire was a common occurrence in the watershed prior to the establishment of the Forest Reserves in 1905 (Skinner and Taylor, 2006). Native people in the watershed area utilized fire to promote food production, make baskets, improve hunting conditions, gather food, and for ceremonial purposes. Regular lightning storms along with the widespread use of fire by native people promoted frequent surface fires of mostly low to moderate severity. The frequency of these fires decreased as elevation increased (Skinner and Taylor). The frequency and size of fires in the watershed area would also have been influenced by debris flows and volcanic materials on Mt. Shasta.

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). Merriam also describes the south and west slopes of Mt. Shasta as an open pine forest interrupted by extensive parks of brush (Merriam, 1899). These openings in the pine canopy are likely the result of fires. Research shows that lower elevation mixed conifer forests of the Klamath Mountains historically burned every 12 to 19 years. These frequent, mixed-severity fires killed some overstory trees, initiated recruitment, and thinned or killed understory stems. The resulting forest structure consisted of multi-aged stands. New trees established where a portion of the canopy was killed by more severe fires (Taylor and Skinner, 1998).

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. 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).

Prior to the establishment of 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.

Since 1900

The earliest records of fire suppression in the watershed area occurred in 1887 for fires burning along the railroad lines near what is now Mt. Shasta City (Skinner and Taylor, 1998). Fire suppression efforts were instituted after the establishment of the National Forest System. Since the onset of fire suppression in the early 1900's, and with the increased effectiveness of mechanized suppression techniques (fire engines, dozers, aircraft, etc.) in recent years, total area burned by fires has been greatly reduced compared to historic levels (Skinner and Taylor, 1998). Average fire return intervals in the Klamath Mountains have increased to over 20 years (Skinner and Taylor, 1998).

With successful fire suppression, fuels and vegetation density 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). Under the current fire suppression strategy, fire as an ecosystem process has been dramatically reduced. This has resulted in the development of a more homogeneous landscape pattern. Concerns over fire effects to resources (e.g. wildlife habitat, soils, human uses, hydrology, air quality, etc.) have increased through time.

Species and Habitats

Wildlife

Early survey results recorded 68 mammals and 136 birds occurring on Mt. Shasta and in the surrounding vicinity (Merriam, 1899). The survey noted mountain sheep (big horn sheep, see Figure 4-1), elk and grizzly bear, although these have since been exterminated or driven away.



Figure 4-1: From Sudden and Solitary, Miesse and Peterson 2008:171. Engraving from an article by John Muir in Scribner's Monthly (May 1881). This is from one of Muir's Shasta trips when he found a herd of hardy bighorn sheep sharing his strategy for sheltering from a storm.

Deer were noted as common on Mt. Shasta and the Sierra-Cascade system while antelope were common in the Shasta Valley but are now rarely seen. The survey mentioned that the wolverine has been killed in the near vicinity and probably occurs on Shasta, although no positive records of wolverine exist. The mountain red fox was recorded as common on the upper slopes above timberline. Of particular note were several records of pikas occurring at the 8,000 to 10,000 foot level.

Four owl species were recorded including the great horned, burrowing, California pigmy and California screech owl. Both the great horned and screech owls were heard hooting. The survey makes no mention of either the barred owl or northern spotted owl.

Sensitive Plant Species

There is little information regarding habitats for special plant species. Merriam mentions Wilken's harebell in the *North American Fauna No. 16* dated 1899. It was described by Greene in 1899. One may assume that prior to European settlement; habitat for this species was not affected by human disturbances. However, they may have been affected by an occasional natural disturbance such as debris flows, mud flows, avalanches etc. and possibly by volcanic activity.

Cooke's phacelia was described by L. R. Hecknard, L. Constance and R. Ornduff in June of 1969. This plant is an annual and seems to prefer disturbed sandy areas such as roadbeds and roadsides. One might assume that prior to Europeans coming to the area; Cooke's phacelia habitat was maintained by fire, wind and possibly by summer thunderstorms washing sandy soils down from higher elevations or debris flows providing new bare soil for plants to colonize.

Populations could also be destroyed by debris flows or volcanic activity. There would have been trails used by Native Americans and wildlife and later, Europeans, These trails would also provide habitat for this species. Once settlement began and ranching and grazing were introduced to the area, livestock trails and excessive grazing provided habitat. Unfortunately, ranching and grazing also introduced invasive species especially cheatgrass to the area. Cooke's phacelia does not compete well with cheatgrass. In the 1970s and 1980s preparation for planting pine plantations provided the disturbance necessary to provide habitat especially along Military Pass Road. Plantations only provided habitat for a short period of time so in the late 1980s, special ground disturbing projects were done in the Military Pass area to provide habitat. The Klamath National Forest and the Shasta-Trinity National Forest had an agreement to take turns grading their respective sides of the Military Pass Road to maintain some habitat along the road. Unfortunately, without fire, shrubs came in colonized the bare ground next to the road. This plant spreads seeds by drying up and rolling along the ground when the wind blows. If there are shrubs, or other plants creating barriers to this travel, new areas are not colonized. Numbers of plants have dropped dramatically since large populations were counted in the 1980s.

Baker's globemallow populations would have ebbed and flowed with the natural fire regime. This plant was first described by W.L. Jepson in 1925. This is an early seral species and would have been plentiful after a fire for several years then as shrubs and other plants recovered; they would have disappeared until the next fire. Once fire suppression came to be the norm, most populations disappeared entirely. Other types of disturbances came along in the 1970's through the 1990s mainly plantation creation and maintenance and power line construction. Somehow these disturbances provided what was needed for the seeds to germinate. In 1940, Wm. Bridge Cooke collected a specimen from along the Everitt Memorial Highway. In 1941, Carl B. Wolf found this plant growing along Highway 97 10 miles northeast of Weed, California. These two populations are no longer visible. A population found by L. R. Hecknard with L Constance and R. Ornduff in 1969 is also not visible. The seeds are waiting for another fire.

Springs, Seeps, Wet Meadow Habitats

Pre-European Settlement

Very little information is available concerning the condition of springs, seeps and wet meadow habitats prior to European settlement. Based on the relatively frequent eruptive history on Mt. Shasta it is likely that many of the wet meadow systems are relatively young. Most of the present day summit areas of Mt. Shasta were formed in the relatively recent geologic past less than 10,000 years ago, so it is likely that springs, seeps and wet meadows located on the mountain slopes began to form around this time. The relatively young landscape and the frequent disturbances from volcanic activity explain the limited presence of wet meadow habitats and surface flow hydrology on the mountain. Wet meadow soils and vegetation have had very little time to develop due to the frequent disturbance regime. The extent of Native American uses occurring at springs and wet meadows in the watershed is unknown however it is likely that

these areas were visited regularly and that higher levels of use were associated with meadows and springs located at lower elevations. No impacts to springs and wet meadows have been documented prior to European settlement of the Mt. Shasta area.

Settlement of the Mt. Shasta area began after 1850. The first effects to springs and wet meadow habitats likely occurred on the lower slopes of the mountain in the areas now occupied by McCloud, Mount Shasta City and Weed and were associated with the development of water sources for human uses. The degree of habitat alteration is not known, however significant modification of natural drainages did occur in order to drain wetland areas and facilitate settlement and community growth. A complete analysis of modifications to springs, wet meadows and channels on private lands is beyond the scope of this analysis. Just a few examples of modifications occurring in the lower watershed include substantial water diversions to facilitate community growth, establishment of log ponds associated with all mill locations with associated diversions, draining of wetlands in Sisson Valley, and development of springs for domestic uses.

Impacts to springs and wet meadow habitats on public lands in the late-1850's and early 1900's were initially very light based on historical records. Limited road access on the mountain made for limited human use and spring developments through the early 1900's. Road access on the south side of the mountain had improved by 1930 with the establishment of the Mt. Shasta Snowline Road (later Everitt Memorial Highway) which provided vehicle access to Panther Meadows as well as other higher elevation wet meadows. Despite the improved access, impacts to the meadows and springs remained relatively light for decades. Establishment of facilities like McBride Springs Campground in the 1940's (Recreation Plan, 1944), and the Mount Shasta Ski Bowl in 1959, resulted in spring water developments that probably impacted vegetation and flows, but there is little documentation on impacts from these developments.

Even after the development of the Mt. Shasta Ski Bowl ski area, impacts to springs and wet meadows remained light through the 1960's and 70's. Photos of the spring at Panther Meadows taken in 1967 reveal that even at this later date, meadow vegetation appears to have not been affected by humans. Forest Service records indicate that significant degradation of meadow resources were first documented in 1987 at the time of the Harmonic Convergence which brought large numbers of visitors to Mt. Shasta and concentrated use in the meadows. Recreation use at the springs increased steadily afterwards and recreation use at springs and wet meadows gradually expanded outward to other meadows (e.g. Hummingbird, South Gate).

The Forest Service and partner organizations have implemented many restoration projects at Panther Meadows which have resulted in restoration of habitat and reduction of impacts to the meadow, however constant oversight is required to maintain restoration areas and prevent further habitat degradation. While other springs and wet meadows have been affected by human uses the impacts are generally localized or very light when compared to Panther and South Gate Meadows.

Public Uses

Humans- Native Americans

Native Americans inhabited the watershed as evidenced from the presence of recorded prehistoric sites on National Forest System lands. Approximately 10 relatively small archaeological sites are located on the forested mid-slopes around Mt. Shasta, mostly on the southeast side. However, their influence on the landscape appears to be only slight, judging from the small size of sites and paucity of artifacts. However, use of fire for hunting deer, improving the yields of wild tobacco and other wild seed, and for catching grasshoppers for food were common practices among the Shasta Indians on the north side of Mt. Shasta (Cassidy, 2008) and may have created openings or a more open forest. No time period for their occupation has been established.

In contrast to Mt. Shasta’s mid-slopes, abundant archaeological sites have been recorded in the lush valleys and spring areas in the cities and towns of Weed, Mt. Shasta, and McCloud, although archaeological investigations of these sites are sparse. Surrounding areas, such as the Sacramento River Canyon, have documented prehistoric populations beginning around 5300 B.P. (before the present) (Basgall and Hildebrandt 1989).

In the late 1800’s ethnographies noted the presence of four Tribes whose aboriginal territories surrounded Mt. Shasta; these included the Wintu (note various spellings include Wintun and Winton), Shasta, Modoc, and Pit River Tribes (see Figure 4-2).

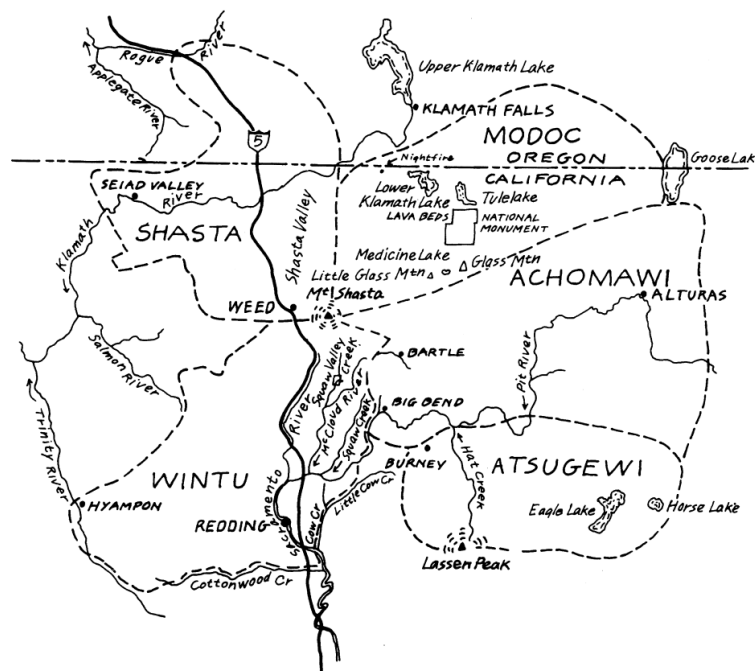


Figure 4-2: Tribes around Mt. Shasta (Achumawi were also known as the Pit River Tribes)

The date of transition from Native Americans living in aboriginal villages to living among European/white settlements is estimated to have occurred between 1860-1870. During the 1841 Wilkes Expedition (United States Exploring Expedition), it was noted in journals that the Mt. Shasta Region was populated entirely by indigenous people (see Figure 4-3). The Kelsey Census of 1900-1907 lists approximately 22 Wintoon and 7 Pit River people living in Sisson, and another 13 Wintoon in Dunsmuir.



Figure 4-3: Alfred Thomas Agate, Shasta Peak, originally from 1841 sketch. Agate had two Shasta Indians pose, dressed in deer skins. They were standing due west of Shasta in the foothills (Miesse and Peterson 2008)

Mt. Shasta's historic importance to Native Americans as a sacred Mountain has its foundation in the many traditional/mythological stories, songs, and native words describing Mt. Shasta (Theodoratus 1991, La Pena lithograph). Mt. Shasta figures prominently in the mythology of all tribes that lived around it, as well as several from whose territories the Mountain could be seen (Karuk, Klamath, Hupa (also Hoopa), and Yana for example). Several of the mythological places correspond to natural features on Mt. Shasta and form a cultural landscape; meadows and springs held particular importance as well.



Figure 4-4: Frank LaPena, Wintu artist. 2001. We Are All Sacred.

Humans- Fires

Prior to the Central Pacific Railroad reaching Mt. Shasta in 1886, the results of wildfires were observed on Mt. Shasta by W. H. Brewer in 1862 and Josiah Dwight Whitney in 1865. Whitney notes that after July, the incessant fires in the surrounding forest fill the air with smoke and take away all distinctness from the distant view.

Humans – Europeans

Although the Mt. Shasta region was part of Mexican territory prior to 1840, it was relatively unexplored and not yet settled by Europeans/emigrants. Early trappers from the Hudson’s Bay Company (based in Vancouver Washington) merely passed through the area in the 1830’s in their search for beaver. It was not until the United States Exploring Expedition (often called the Wilkes Expedition) was sent to explore this “terra incognita” that Mt. Shasta became a destination for early scientific explorations. The 1841 Wilkes Expedition included surveyors, artists, botanists, and naturalists who were sent to explore, map, inventory and depict the unexplored northern California Sacramento Valley and mountains. These explorations were followed by the early geologic surveys of Mt. Shasta, precursors of the United State Geological Survey (Josiah Whitney and William Brewer in 1862, Clarence King in 1864 and 1870 (see Photo 4-15 below), Major Powell in 1879, etc). These explorations largely focused on the geology and glaciers of Mt. Shasta.



United States Geological Exploration of the Fortieth Parallel (King)
Plate 66: Mount Shasta. California. n.d. (Photo by C. E. Watkins)

Photo 4-15: United States Geological Exploration of the Fortieth Parallel (King); Plate 66: Mt. Shasta. California. No Date. (Photo by C. E. Watkins)

An early wagon road/emigrant trail was established in the northeast portion of the watershed in 1855 (Cassidy, 1997). Today known as the Military Pass Road, it linked the Pit River County more directly with Yreka via the east side of Mt. Shasta. Its earliest use was also as an emigrant route. When Indian skirmishes became common on the road, the military became involved in escorting emigrants along the road, hence the name "Military Pass road". Eventually it became the main route used by the military between Fort Jones and Fort Crook. The Military Pass road was also used as a freight road to ship supplies from paddle wheelers at Red Bluff north to the gold mining regions near Yreka. The effects of this route to the landscape, from the route itself and its use by teams of oxen and horses, has largely been masked by subsequent railroad logging.

The explorers were followed by early settlers in the 1860's and 1870's. They altered the flat lands surrounding the mountain and carved out ranches, cultivated strawberries (Berryvale/Sisson), grazed milk cows (McCloud- Conner Ranch), and herded cattle and sheep (Weed/Shasta Valley). Many small private sawmills sprang up following the settlers. According to local resident and historian Donna Brooks, (Brooks, 1981) there was said to be 52 sawmills built between Shasta Springs and Weed.



Figure 4-5: Mt. Shasta from Sisson's Tavern. Oil painting by William Keith 1878

But it was not until 1886 when the Central Pacific reached Sisson, that large scale lumbering began and effects to the landscape on a larger scale occurred. The railroad needed wood for its initial construction and on-going operations; they needed cord wood for steam engines, wood for ties, bridges and tunnel timber, trestles and other countless structures. The Dunsmuir News of September 26, 1896 reports that “When S.P. built through to Oregon there was a splendid body of sugar pine timber extending from a couple of miles north of here [Dunsmuir] to Black Butte summit. That timber has been all cut out”. In 1899, C. Hart Merriam, reports “During the past ten years the county about Shasta, particularly on the west and south, has been repeatedly devastated by forest fires. Here, as elsewhere, lumbermen and fires have destroyed the greater part of the timber on the lower slopes and adjacent plain.”



Photo 4-16: Post 1949 Photo of the Shasta Daylight from SP archives

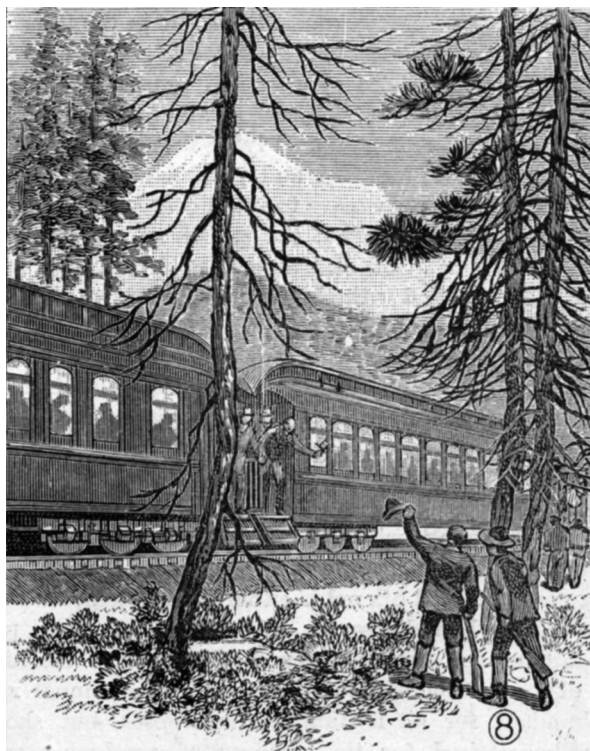


Figure 4-6: First train via Mt. Shasta from SF to Portland. In Frank Leslie's Illustrated Newspaper dated December 24, 1887. Based on photos by HC. Tibbits

Succeeding the railroad, the final major historic event which affected the landscape around Mt. Shasta was the creation of the Shasta National Forest in 1905 from the remaining public domain lands. These lands with a multiple use mandate (e.g. recreation, timber use, grazing), changed the landscape over time.



Photo 4-17: The Shasta National Forest Headquarters in Mt. Shasta, California

Populated Rural

The City of Mt. Shasta is perhaps the oldest of the communities in the watershed. Early settlers came in the 1850's and settled in the large meadows and timbered areas which later became Old Stage Road. They established homesteads, small farms, saw mills and eventually stage stations and hotels; this area was first known as Strawberry Valley and then later Berryvale. With the coming of the Central Pacific Railroad in 1886 the town grew around the railroad route and was incorporated in 1905 as Sisson. It was renamed Mount Shasta in 1924.

The town of McCloud and City of Weed were first established as lumber company towns, built by mill owners.



Photo 4-18: View of Mt. Shasta from McCloud, California; McCloud River Railway website, 1920's?

The town of McCloud was built by the McCloud River Lumber Company in 1897 to house and provide services for the families of millworkers. The company owned the buildings until 1963, when the mill was sold to U.S. Plywood and the houses were sold to individuals living in them. The company built a standard gauge railroad from Mt. Shasta to McCloud over the southeast slope of Mt. Shasta on steep terrain with loose rocky volcanic soil. Krieger (1984:10) notes that in the Big Canyon area the company elected to use large fills. These were made using the heavy lava rock on the mountain's slopes which were carried by hydraulic force. Water for the hydraulic monitors was found in springs on the mountain and flumed for several miles.

The City of Weed was also a company town. Abner Weed bought the Siskiyou Lumber and Mercantile Company and 280 acres in 1900 in the area that became the City of Weed. Originally his logging operations were confined to the relatively level areas in the valley and lower slopes of Mount Shasta within a few miles of his mill site (Shoup et al., 1981). Beginning in 1902 the Weed Lumber Company started building a standard gauge logging railroad east of the mill onto today's Shasta-Trinity National Forest.



Photo 4-19: Mt. Shasta from the Weed Lumber Company Mill. COS Collection

Based on the location of the Weed Lumber Company mainline railroad grade originally built at the base of Mt. Shasta’s northern slopes and logging spur grades branching out on the mid-slopes, it is surmised that by circa 1908 the yellow pine was nearly all cut down. A 1908 Forest Service report (Smith, 1908) commented on the impact to the land (which also expanded onto the Goosenest District of today’s Klamath National Forest).

“...logging has left very few seed trees and an unusually a large amount of slash and waster. The original stand had under it very little reproduction, but was open enough to allow a fairly dense brush growth... Under the present management and system of logging it seems certain that the logged area will become a non-producing brush covered tract of little value for grazing or any other purpose. ”

CHAPTER 5: Interpretations

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 step discusses each issue within the context of each applicable core topic. Additional issues and topics are also addressed here if they are deemed important for guiding future management direction for the watershed, or will result in a management opportunity.

Issues addressed in this chapter are:

- Natural Disturbance Regimes (unique volcanic, landslide, debris flow hazards)
- Vegetation Management

- Fire Exclusion
- Habitat Quality
- Human Use Management

Natural Disturbance Regimes (unique volcanic, landslide, debris flow hazards)

Topic 1: Active Disturbance Regime

Present Condition

Frequent disturbance processes occurring in relatively short time frames (e.g. 10's to 100's of years) include debris slides, rock fall, debris flows, and other erosion events triggered by summer storms or unusually warm winter events, and snow avalanches. These processes have occurred repeatedly over the past 100 years. Though volcanic hazards are ever present, disturbances associated with volcanic activity occur less frequently (e.g. > 500 year intervals).

Causal Mechanisms

- Precipitation (summer and winter storms). Summer storms generally have the potential to cause more disturbance than all but the largest winter storms (e.g. January 1997 Flood).
- Glaciers (largest debris flow potential associated with streams fed by glacial melt).
- Orographic influence on precipitation.
- Lack of vegetative cover at higher elevations.
- Snowpack and snow cover at time of precipitation events (more erosion occurs when snow cover is absent).
- Topography (naturally steep slopes).
- Air temperature (warmer temperatures can increase debris flow activity).
- Drought (debris flow activity increases during drought periods).
- Seismic activity.

Trends

- Trends for the active disturbance regime have been relatively constant over the past 200 years, but debris flows initiated by glacial melt are likely to change in frequency if the glaciers continue to grow.
- Debris flows and other disturbance processes are likely to continue to occur at a similar frequency as the past 200 years. We have no data indicating the trend will be up or down.
- Climate change may alter the frequency of some disturbance events in the next 100 years but the trend is unknown.

Influences and Relationships

- Debris flows and episodic runoff events govern channel development and influence stream channel migration, incision and aggradation.
- The amount of vegetative cover within inner gorges is dictated by elevation and the magnitude and frequency of debris flows and floods.
- Debris flows and other active disturbance processes can impact infrastructure on both public and private lands.
- Impacts to the transportation system are expected to be greatest where roads and trails overlap areas of active disturbance (e.g. inner gorges, stream crossings, avalanche paths).
- Snow avalanches pose a hazard to human life and safety, and two fatalities have been documented since 1973.

Conclusions

- There is a need to continue to monitor glacier growth and recession to improve our understanding of debris flows processes and to better forecast the magnitude and frequency of future debris flows.
- There is a need to identify channels that are susceptible to disturbance (e.g. channel migration) in order to inform future management.
- There is a need to inventory all Forest infrastructure on Mount Shasta and determine which sites are susceptible to impacts from active disturbance processes. All proposed recreation developments need to consider the potential for impacts from active disturbance processes.
- There is a need to better define historic debris flow activity on Mouth Shasta by use of historical air photos back to 1944.
- There is a need to continue to monitor and systematically map snow avalanches on Mount Shasta to provide for public health and safety.
- There is a need to employ recent technology (e.g. LiDAR imagery) to identify areas susceptible to disturbance on Mount Shasta.

Topic 2: Active Disturbance Regime

Present Condition

Volcanic activity including pyroclastic flows, lava flows, lava dome formation, volcanic gasses, and airfall ash occurs at time frames of hundreds to thousands of years. Seismicity may occur at shorter time frames.

Causal Mechanisms

- Volcanic processes occur in response to subduction and melting of tectonic plates, which generates magma. When magma rises toward the surface it creates various types of eruptions, and commonly triggers seismic activity.

Trends

- Trends for future volcanic activity are likely to continue at rates similar to those of the past few thousand years. However, eruptions over the past 10,000 years have been clustered in time. It may be possible to refine our predictive ability for the next few hundred years by better understanding the eruptive history over the past 10,000 years.

Influences and Relationships

- Volcanic processes are natural, and interact with weather and climate, as when winds blow volcanic ash, and when heavy snowpack is melted by a volcanic eruption. They also interact with landslide processes, as for example at Mount Saint Helens, when a large landslide unroofed the volcano, and facilitated the ensuing lateral blast on the flank. There are no known associations between volcanic processes and human activity.

Conclusions

- There is a need to better understand the eruptive history of Mount Shasta to better define the likelihood and magnitude of future eruptions.
- There is a need to continue to monitor indicators of volcanic activity (seismicity, deformation, hot spring characteristics).
- There is a need to employ recent technology (e.g. LiDAR imagery) to better analyze the stability of the Mount Shasta Volcano, and the potential influence zones of volcanically initiated debris flows.

Topic 3: Geologic Hazards and Management of Human Uses on Public Lands

Present Condition

Disturbance processes on Mount Shasta can occur relatively frequently and in many different locations. Many landforms on Mount Shasta (e.g. alluvial fans, inner gorges) were formed in the recent past by debris flows and much of the present mountain has been shaped by volcanic processes occurring within the past 10,000 years. Some infrastructure on Mount Shasta is located in areas that can experience frequent disturbance. Recreation sites located in close proximity to debris flow channels (e.g. Bolam/Whitney Trailhead) are vulnerable to future disturbance. Debris flows have the potential to interact with the transportation system (e.g. channel migration/road capture, road failure, gullying). Many roads are susceptible to future impacts from debris flows. Some roads have been poorly designed and may be vulnerable to stream capture (particularly roads that parallel channels prone to debris flows). Many roads, including portions of the major highways, are located on alluvial fans with a long history of

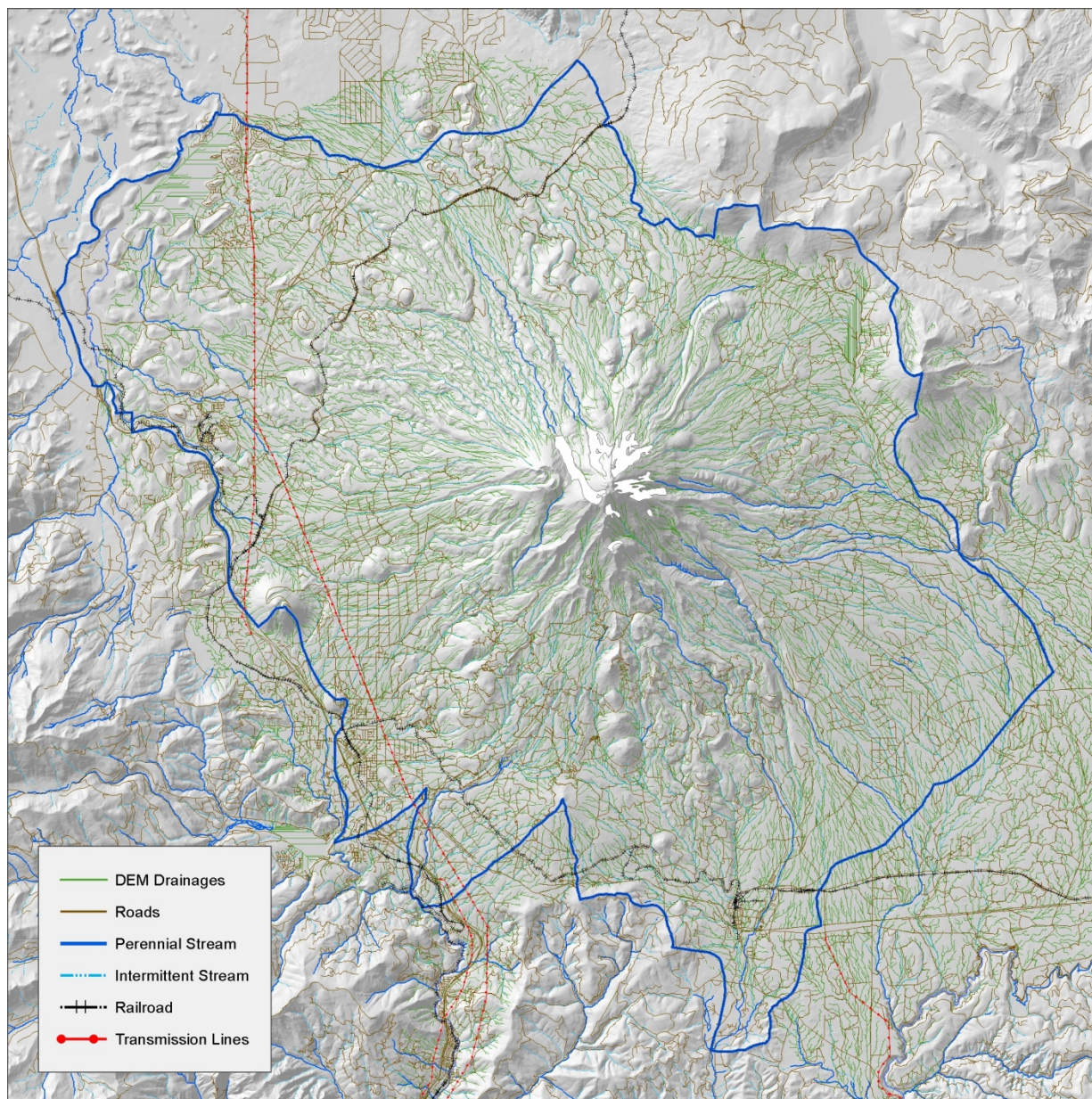
channel migration as a natural process. Concentrated human use also occurs in areas that are prone to active disturbance (e.g. Avalanche Gulch).

Natural hazards are an important issue for recreationists at Mount Shasta, and there have been at least 31 fatalities since 1961 due to a variety of causes, including exposure, illness, snow avalanche, and rock fall (Table 1). There were two fatalities related to snow avalanches, one to rock fall, nine each to exposure and illness, and six to other, or unknown causes. The figures in Table 1 were compiled by Nick Meyers from District files, in May, 2012, and involved determining the cause, date, location, etc. for each fatality. It should be noted that this compilation was done in the very short time period available for the WA, and it likely contains some errors. However, the numbers are useful for describing the magnitude of the issue at hand. There was also a considerable amount of data in the files on injuries, but insufficient time was available to summarize this information.

Additional valuable information could be gleaned by further analyzing historical data on injuries experienced by recreationists. This would allow better focus on key hazards which might possibly be reduced by modifying our current management practices.

Mt. Shasta Watershed Analysis – May 2012

FATALITIES RECORDED AT MOUNT SHASTA 1961-2011														
Year	Total	Rockfall	Exposure	Falling	Illness	Snow	Av.	Other	Unknown	Location	Date	Sex	Age	Note
Year	Fatal.	Fatality	Fatality	Fatality	Fatality	Fatality	Fatality	Fatality	Fatality	Location	Date	Sex	Age	Note
2012	0	0	0	0	0	0	0	0	0					
2011	1	0	1	0	0			0	0	Old Ski Bowl	11/12/2011	M	20	Meditation disorient
2011	1	0	1	0	0			0	0	Clr. Cr.	6/29/2011	F	50	Possible high alt. sid
2011	1	0	0	0	1			0	0	Av. Gl.	7/8/2011	M	50	Older than 50, heart s
2010	1	0	0	0	1			0	0	Sum.Plat.	4/1/2010	M	26	High alt. sickness
2010	1	1	0	0	0			0	0	West Face	7/4/2010	F	56	
2009	1	0	0	0	1			0	0	Horse Can	6/4/2009	M	53	
2008	1	0	0	1	0			0	0	Av. Gl.	11/28/2008	F	33	
2007	0	0	0	0	0			0	0					
2006	0	0	0	0	0			0	0					
2005	0	0	0	0	0			0	0					
2004	1	0	0	1	0			0	0	Casaval Rg	3/16/2004	M	21	
2003	0	0	0	0	0			0	0					
2002	0	0	0	0	0			0	0					
2001	0	0	0	0	0			0	0					
2000	1	0	0	1	0			0	0	Hotlam-Bc	9/23/2000	M	36	
2000	1	0	1	0	0			0	0	Cascade G	4/14/2000	M	38	With other 2000 fatal
2000	1	0	0	1	0			0	0	Cascade G	4/14/2000	M	45	With other 2000 fatal
1999	1	0	0	0	0			0	1	Aval. Gl.	5/22/1999	M	69	Never Found
1999	1				1					Hotlam-Bc	9/12/1999	M	32	
1998	0	0	0	0	0			0	2					Conflicting Notes, or
1997	1	0	1	0	0			0		Aval. Gl. V	8/25/1997	M	43	
1996	0	0	0	0	0			0	0					
1995	1	0	1	0	0			0		Bolam		M	53	
1994	1	0	1	0	0			0		Konwakit?		M	35	Never found
1993	1	0	0	0	1			0		?		M	25	
1992	0	0	0	0	0			0	0					
1991	0													
1990	0													
1989	0													
1988	0													
1987	0													
1986	0													
1985	0													
1984	1			1						?	9/29/1984	M	38	Never found
1983	1					1				Green But	4/2/1983	M	28	
1982	0													
1981	1			1						Ski Bowl	7/30/1981	M	12	
1981	1				1					?	5/24/1981	M	?	
1980	0													
1979	0													
1978	1							1		?	9/8/1978	F	?	Disappeared climbin
1978	1							1		Whitney S	9/2/1978	F		Hanglider
1977	1		1							?	9/15/1977	M	55	found 7-7-78
1977	1		1							Whitney S	2/20/1977	F	45	
1976	0													
1975	1		1							Ski Bowl	3/25/2012	M	20	
1974	0													
1973	1					1				Aval. Gl.	11/19/1973	M	23	
1972	1			1						Aval. Gl.	3/19/1972	M	48	
1971	0													
1970	0													
1969	0													
1968	0													
1967	0													
1966	0													
1965	1			1						Hotlum	10/10/1965	M	28	
1964	0													
1963	1			1						Cascade G	8/21/1963	M	20	
1962	0													
1961	1							1		Aval. Gl.	12/28/1961	M	?	Glissading
Totals	31	1	9	9	6	2	3	3						
Year	Total	Rockfall	Exposure	Falling	Illness	Snow	Av.	Other	Unknown	Location	Date	Sex	Age	Note



Map 5-1: DEM Generated Streams and Transportation/Utility Corridors

Causal Mechanisms

- Natural disturbances are frequent and widespread on Mount Shasta. Some hazardous areas have been identified, such as for debris flows, but others have not been systematically analyzed, so it is not possible to completely anticipate locations likely to be affected by future disturbance processes, especially roads and trails.
- Some early infrastructure development on Mount Shasta occurred without consideration of natural disturbance processes and areas of high geomorphic disturbance. The sources of disturbances (e.g. glacial melt, debris slides, rock fall, debris flows) often are far removed upslope of infrastructure, and in some cases were not recognized.

- Concentrated use areas (e.g. climbing routes) are located in areas of high snow (?) avalanche hazard.

Trends

- There is a growing awareness of the threats that natural disturbance processes on Mount Shasta pose to infrastructure, and the need to reduce risk from future disturbance events.

Influences and Relationships

- Disturbance impacts to roads can affect all management and human use activities on Mount Shasta on public and private lands.
- Public health and safety can be affected by disturbance processes.
- Disturbance processes can dramatically alter vegetation and fuels in active disturbance zones (e.g. avalanche paths, inner gorges, alluvial fans).
- Disturbance processes have the potential to impact access to private lands and communities.

Conclusions

- There is a need to complete an inventory and hazard assessment for all infrastructure on Mount Shasta. All known sites on National Forest lands should be evaluated.
- There is a need to develop site specific recommendations to reduce hazard and risk, including the relocation of infrastructure outside of active geomorphic areas where appropriate. There is a need to identify opportunities to redesign existing transportation infrastructure (roads, trails, parking areas) to accommodate disturbance events. Map 5-1, “DEM Generated Streams and Transportation/Utility Corridors” displays intersections of the stream network and infrastructure. This map incorporates the existing National Hydrography Data Set (NHD) stream networks for perennial and intermittent streams, and also a more complete channel network of ephemeral streams derived from the new high-resolution Digital Elevation Model data. These are labeled “DEM Drainages” on the map. There is a need to use this new terrain and channel data in analyzing hazards to infrastructure as well as to human life.
- There is a need to consider the natural disturbance regime when completing Travel Analysis Plans on Mount Shasta.
- There is a need to develop public awareness of geologic hazards through educational programs and strategically placed signs (such as in areas prone to rock fall and debris flows) in order to provide for public safety.
- There is a need to systematically map, digitize, and characterize historical debris flow on air photos as far back as 1944, and similarly map and characterize future debris flows.
- There is a need to continue avalanche forecasting on Mount Shasta in order to provide for public safety.

- There is a need to map all significant snow avalanches which occur in the future, and systematically record data in an electronic data base
- There is a need to compile and digitize historical data in District files on injuries to recreationists, and analyze this information for patterns which might suggest changes in current management.
- Areas known to experience concentrated human use (e.g. Panther Meadows, Lake Helen, Ski Bowl, Bunny Flat, etc.) should be evaluated for potential hazards to human life and safety.

Vegetation Management

Topic 1: Conifer and Hardwood Management

Present Condition

- There are stands in the red fir, white fir and mixed conifer types that have higher densities than what are considered healthy which are leading to increased mortality and creating conditions that are at risk of catastrophic wildfire.
- The high densities of (non-plantation) ponderosa pine stands are creating conditions that are susceptible to black stain root disease as well as western pine beetle attacks.
- The hardwoods are being out competed in the conifer/hardwood mix stands as well as in the hardwood stands.
- The lodgepole pine stands are in an over mature condition and are experiencing outbreaks of western gull rust. The knobcone pine stands are also in an over mature state. These stands are seeing an increase in the fuel loads due to the mortality and mixed with the underbrush, are at higher risk for catastrophic wildfire.
- Many of the plantations lack heterogeneity and are in need of continued maintenance to remain healthy and viable.

Causal Mechanisms

- Past and present management practices have led to the current condition of many of the stands. Approximately 100 years of fire suppression have led to increased understory growth which creates ladder fuels which can help a ground fire become a crown fire if the conditions are right.

Trends

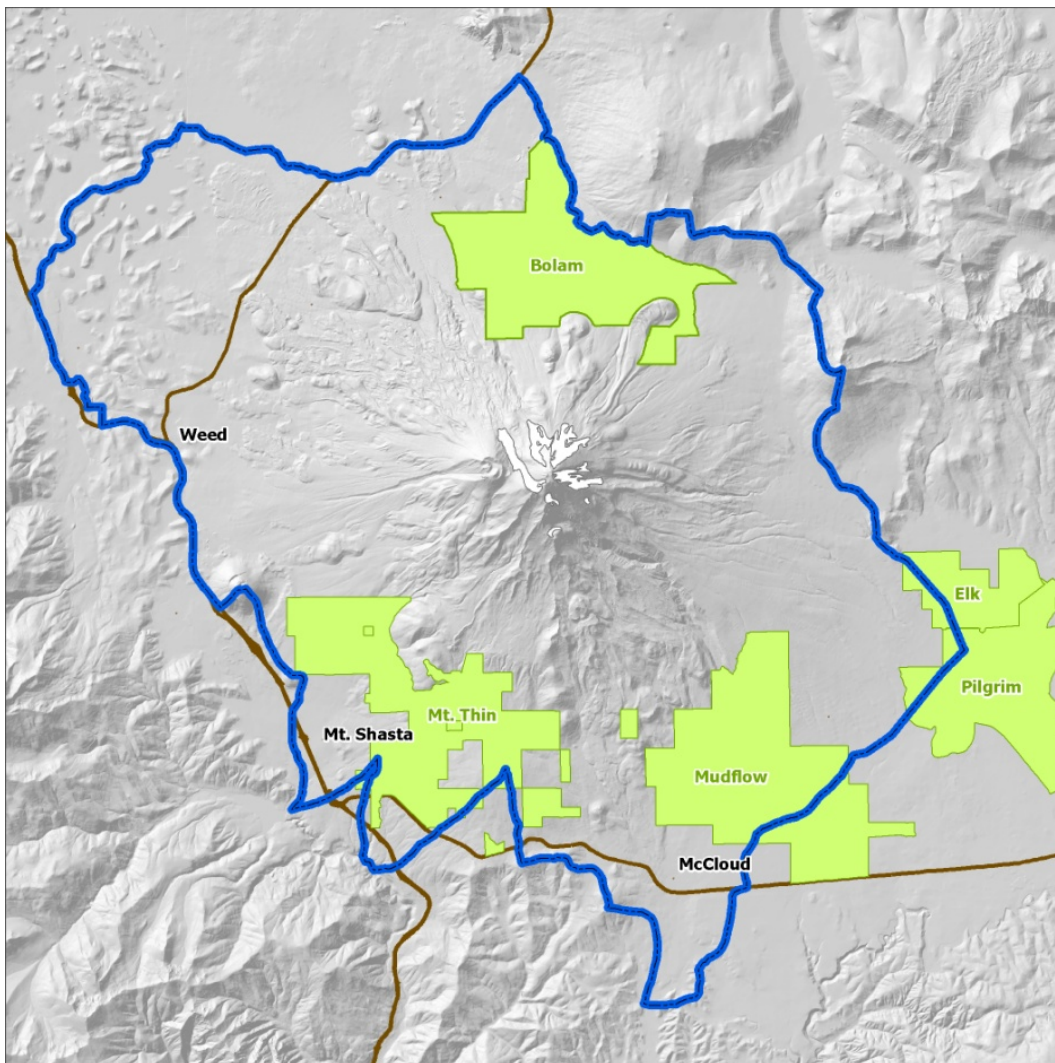
- The trends appear to be an increase in mortality in all the overstocked stands, as well as an increase in the chance for insect and disease outbreaks. Overstocked stands will also lead to an increase in the opportunity for catastrophic wildfire due to increased ladder fuels and which can eventually become increased fuel loads. The hardwood stands will continue to be out competed and will continue to see their numbers decline.

Influences and Relationships

- The relationship of high stand densities and their adverse influence on stand health lends itself to the need to manage many of the stands within the watershed.
- Lower stand densities provide for increased water and nutrients for residual trees, which provides for greater resistance to insect attacks and disease.
- Lower stand densities also allow for increased sunlight to reach the understory trees such as black oak and aspen. This decrease in conifer competition helps to increase the success of the hardwoods and leads to a healthier stand diversity.
- Healthy stand densities also have a relationship with decreased fuel loads. With healthy stands there is a decreased chance of catastrophic mortality caused by insect and disease outbreaks.

Conclusions

- Maintain stand densities at levels that promote health and help prevent the chance of catastrophic wildfires in the red fir, white fir and mixed conifer stands.
- Manage the (non-plantation) ponderosa pine stands at density levels that protect them from catastrophic disease and insect outbreaks. Incorporate diversity into the stands whenever necessary to prevent continued outbreaks of disease and insect attacks.
- Where hardwood species naturally occur and are being outcompeted by the conifers, manage the conifers to promote the hardwood species.
- Manage the dead and dying diseased lodgepole pine stands to promote a more healthy and vigorous condition. Incorporate diversity whenever possible to create conditions that are resistant to epidemic insect and disease outbreaks. Treat the knobcone pine stands to reduce fuel loads and incorporate diversity whenever possible to create healthy and vigorous stands into the future. Map X below shows the ongoing vegetation management projects within the Mt. Shasta watershed boundary. Make note that the polygons representing the treatment areas are the boundaries of the actual treatment areas but rather they are the environmentally assessed areas and the treatment happens inside but may not take up the whole polygon area.



Map 5-2: Vegetation Management Areas inside Mt. Shasta Watershed

- Past management practices have favored conifer establishment over hardwoods and other vegetation types with a resulting lack of habitat for hardwood dependent species.
- Extensive disturbance activities associated with shrub field conversions (site preparation) included creating windrows, terracing and up to six years of tilling. Tilling was done to keep competing understory plants including shrubs and grasses at a minimum. These activities reduced species diversity in the understory. Understory species that came back tended to less desirable for wildlife like Bloomer’s goldenbush (*Ericameria bloomeri*), rubber rabbitbrush (*Chrysothamnus nauseosus*) and cheatgrass (*Bromus tectorum*) and needlegrasses (*Stipa* sp.). They also resulted in the introduction of invasive species.
- In some instances in the Bolam/Hotlum area, bitterbrush/big sage habitat as well as some of the best natural bunchgrass habitat was destroyed in order to create ponderosa pine plantations. Many of these have failed have converted to predominantly rubber rabbitbrush or manzanita.

Topic 2: Three Plant Species of Concern and Their Habitat

Present Condition

- Wilken's harebell (Region 5 Sensitive): All known populations on the Shasta side of the Shasta-Trinity National Forest occur within the Mt. Shasta WA area along streams, seeps and springs. Present condition for populations on private land is not known. Populations in areas of high human use are being affected by trampling. Many of the higher elevation hiking trails go through their habitat. Populations between 5,000 and 6,000 feet are being affected by cattle grazing outside of the Bartle Allotment boundary.
- Baker's globemallow (Watch list; CNPS List 4): This species is losing habitat due to a lack of disturbance. It is an early seral species requiring fire for seed germination. Some populations on the north side of the mountain have responded to mechanical soil treatments such as tilling in plantations. These populations are doing well for now, but will continue to need some kind of disturbance. They will also decline as trees get older and fill in reducing the amount of sunlight available to the plant. Other small populations on both the south side and north side have disappeared.
- Cooke's phacelia (Region 5 Sensitive and Mt. Shasta endemic): This is an early seral species requiring bare ground for seed germination. Its numbers have declined from 100,000 to 10,000 in 2011. Lack of fire has created dense stands of shrubs along the roads where it is found. The plantations that were planted in the 1970s and 1980s have grown to the point where sunlight no longer hits the ground and the needle duff is quite thick. The only disturbance the habitat has received in recent years has been road maintenance. Two populations on the Shasta-Trinity have not been located.

Casual Mechanism(s)

Wilken's harebell:

- poor placement of user created trails and
- excess cattle grazing

Baker's globemallow and Cooke's phacelia:

- Lack fire
- Past and current vegetation management
- Natural processes

Trends

Wilken's harebell:

- As use increases, degradation of plants and their habitat will continue to increase

Baker's globemallow and Cooke's phacelia:

- Habitat and plant numbers will continue to be reduced by a lack of fire or some other type of soil disturbance.

- Cooke's phacelia may be headed for the endangered species list.

Influences and Relationships

Wilken's harebell: Habitat disturbance is directly influenced by poor placement of user created trails in high use areas and excess cattle grazing.

Baker's globemallow and Cooke's phacelia: Reductions in habitat and number of plants has been influenced by changes in the fire regime,

Conclusions

Wilken's harebell: management should focus on improving habitat by removing trails on National Forest Service land out of habitat and in the case of Green Butte; infrastructure from the old ski bowl that has changed the water flow from the spring should be removed to improve hydrologic function also improving habitat.

Baker's globemallow and Cooke's phacelia: management should focus on reintroducing fire and other ground disturbing activities that create open areas to improve habitat for these two species.

Fire and Fuels

Topic 1: Fire Exclusion

Present Condition

A large portion of the landscape has missed several fire return intervals and the risk of losing key ecosystem components is high. Over half of the watershed analysis area has a high departure from historic fire return intervals. There is a potential for larger fire size, fire intensity and fire severity. The Wildland Urban Interface is a significant portion of this watershed. Firefighter and public safety is a priority. Concentrated human use occurs within the watershed.

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 high risk of fire start occurrence across 61% of the watershed analysis area.
- Humans are the primary ignition source.
- Approximately 25% of the area is likely to have a fire that fire firefighters will not be able to direct attack using hand tools. Equipment may be necessary.
- Air quality is at risk in proportion to fire risk and high fire behavior potential.
- Ecosystem composition, structure and function vary greatly from historical condition due to the suppression of fires over the last century.

Causal Mechanisms

- Fire exclusion has led to an increase in fuel loadings beyond historic levels.

- Fire exclusion has led to increased stand densities and reduced forest health. This results in increased populations of insects and diseases.
- High public use of the analysis area has led to more human ignitions than natural.

Trends

- Through time, vegetation density and fuel loading has increased and will continue to do so without interruption by disturbance or management action.
- There has been and continues to be a larger number of fires started by human than lightning.
- Forest vegetation has changed from a heterogeneous pattern of mostly fire tolerant species to a more homogeneous pattern of denser vegetation with increased fire intolerant species.

Influences and Relationships

- Fire severity patterns on the landscape influence physical and biological resources (e.g. wildlife, water quality, human uses and natural resources).
- Vegetation type, disturbance history, soil type, fuels, topography and weather play a vital role in fire severity patterns on the landscape.
- Fire frequency influences vegetation, soil nutrient availability, insect populations and susceptibility to disease.
- Concentrated human uses lead to concentrated human fire starts.

Conclusions

- There is a need to:
 - manage fire within the analysis area to protect life, property and improvements
 - manage fire within the analysis area to restore fire adapted ecosystems
 - manage vegetation within the analysis area to restore ecosystem health
 - protect the Wildland Urban Interface from uncharacteristic wildfire
 - communicate with the public and other agencies regarding our activities
 - coordinate our management activities with other agencies and organizations

Habitat Quality

Topic 1: Wildlife Species and Habitat

Present Condition

- Current habitat quality and species distribution has changed from historic conditions due to past railroad logging and a lack of low to moderate intensity fire. These practices

within the mixed conifer type created growth of a dense mid-story, a more tightly closed over-story and an accumulation of large amounts of dead and down woody debris. In the northern portion of the watershed fire suppression resulted in decadent brush fields that lack in nutritious vegetative growth.

- Habitat for late seral species such as the northern spotted owl, goshawk, marten and fisher currently exists in the southern and eastern portion of the watershed and is of variable quality
- Habitat for early seral species such as deer currently exists in the northern portion of the watershed and is of low quality
- Surveys for federally listed, FS Sensitive species or species of concern have not been conducted within the majority of the watershed, with the exception of specific areas for northern spotted owls and northern goshawks.
- At least one lava tube cave is known to exist within the analysis area. This cave may provide bat habitat.
- There are both known locations and unconfirmed sightings for federally listed and candidate species within the watershed; four northern spotted owl activity centers; at least one confirmed fisher and several unconfirmed sightings of wolverine.

Causal Mechanism(s)

- Lack of low to moderate intensity fire
- Past and current vegetation management
- Natural processes

Trends

- As natural processes take place, mid and 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 mid and late seral habitat.
- Stands containing early seral brush/browse species will continue to become decadent, decreasing the palatability of 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

- Past timber harvest has influenced the relationships of species and their habitats in the watershed on both private and public lands within the watershed.

- Fire suppression has influenced the quality of habitat for both early and late seral species.
- NSO critical habitat is a vital area for providing linkage and connectivity, and an opportunity for genetic interchange between the northern and California subspecies.

Conclusions

- Management should focus on activities that are compatible with the objectives of enhancement, protection, and promotion of high value habitat within the watershed.
- A lack of comprehensive surveys in the watershed prevents managers from providing site specific recommendations geared toward the enhancement or protection of a specific species and its associated habitats.

Public Use Management

Topic 1: Concentrated Recreation Use

Present Condition

Concentrated human use occurs in four key areas of the watershed during most if not all seasons of the year: Everett Memorial Highway; the community interfaces on the lower slopes (also the Wildland Urban Interface); Ski Park Highway/Highway 89 Corridor; Highway 97; and the Military Pass Road (including the Snowmobile Park and access along the Pilgrim Creek Road). General examples of impacts and issues associated with concentrated use for the key areas are cited below.

- **Everett Memorial Highway.** Everitt Memorial Highway provides the most popular access to Mount Shasta's climbing routes and the high country. Numerous areas have experienced impacts from concentrated use emanating from the highway including the following:
 - Panther, South Gate, Hummingbird, and St. Germain Meadows
 - Vegetation trampling affecting sensitive plants and other vegetation
 - Spring impacts including compaction, denudation, sedimentation
 - Increased impacts from visitor use during snowmelt season
 - Sanitation impacts (human and dog)
 - Unauthorized trails and improvement needs on existing trails
 - Illegal commercial uses for guided spiritual activities
 - Offerings and structures: rock stacks, shells, sage, crystals, circles etc.
 - Leaving of cremations
 - Nudity, unleashed dogs –wildlife disturbance
 - Significant Native American cultural values and contemporary use
 - User created dams/diversions

- Panther Meadows Campground (developed site)
 - Vector impacts to Panther Meadows
 - Infrastructure vandalism
 - Impacts to sensitive plants
 - Vector for impacts to stream banks south of the campground (Panther Creek).
 - Unleashed dogs – sanitation and wildlife disturbance
 - Site capacity often exceeded
 - Illegal activities
- Avalanche Gulch/Lake Helen
 - Located on primary climbing route (>80% of climbers ascend this route)
 - Route crosses Sierra Club Foundation Property (private)
 - Illegal feeding of wildlife
 - Poor sanitation and trash from concentrated use
 - Often over capacity for wilderness value of solitude
- Bunny Flat
 - Highly-concentrated use in winter (primary winter access to high country)
 - High diversity of user groups including skiers, snowmobilers, bus tours, sledders, sightseers, hikers, climbers, etc.
 - No developed campsites, no developed water source or garbage collection
 - Limited signing (climbing/hiking routes, information, interpretation, Horse Camp regulations, safety, USFS regulations, etc.)
 - Camping area access roads not authorized
 - Access point for Sierra Club Horse Camp
 - Cooperative agreement with Siskiyou County for road maintenance (including snow plowing)
- Ski Bowl
 - Concentrated vehicle parking; site often full or at capacity
 - No developed trailhead or trail system for users
 - Overnight camping/no facilities (sanitation, water, garbage, etc.)
 - Access routes to both Green Butte and South Gate Meadow which pass through sensitive plant populations and riparian areas

- Impacts to springs from old ski area infrastructure
- Debris from old ski area infrastructure, including remains of the parking area currently used as informal recreation site
- Illegal commercial uses, group use, tour bus destination
- Sand Flat/Red Fir Flat
 - Concentrated dispersed camping and use; escaped camp fires
 - Only reservation recreation site within the watershed
 - Only marked Nordic trail (USFS) within the watershed
 - Popular sites for large group uses (weddings, events, reunions, etc)
 - Year-round use with limited parking or pull-outs
 - Limited sanitation facilities; no water or garbage
 - Off-road use, unauthorized routes, bike trails
 - Illegal ceremonies
- McBride Campground
 - Undersized for the amount of demand
 - Water diversions along creek
 - Vegetation and soil impacts around spring head
- Plantations
 - Overflow dispersed camping and illegal residency
 - Sanitation impacts
 - Off-road vehicle use (unauthorized routes and bike trails)
 - Illegal garbage dumping (potential hazmat issues)
 - Abandoned campfires
 - Invasive plant populations
- Bike Trails
 - Soil erosion and sedimentation
 - Resource damage from unauthorized trail construction (e.g. trash, cutting trees, ground disturbance)
 - Wildlife harassment
- **Ski Park and Highway 89 Corridors** (includes Snowman's Hill, Nordic Center, Ski Area, Ash Creek Crossing). Concentrated economic zone, mixed ownership/management with varying development levels (commercial recreation/residential/timber).

- Icy road corridors with multiple accidents during winter months
- Light pollution; wintertime noise source.
- Modifications to Panther Creek stream channel causing erosion and sedimentation issues
- Public road access constraints; cost share road, access to private lands (residential)
- Multiple water/utility developments (McGinnis, Bear Springs, Ski Park).
- Intersection with groomed snowmobile trail system: high wintertime use areas with some mixed use (downhill ski traffic, Nordic skiing, dog sled races, snowmobiles)
- **Highway 97 and Military Pass Road**
 - Access to north and east side climbing trailheads
 - Concentrated firewood cutting (Lodgepole) with slash/fuel concerns
 - Concentrated Christmas tree cutting
 - Off-road vehicle use (unauthorized routes and bike trails)
 - Snowmobile use during winter months
 - Large areas of private land ownership with some residential use (Mt. Shasta Forest) and managed private timberland.
 - Hunting (primarily deer)
- **Community Interface Zones (public lands in close proximity to Mount Shasta City, McCloud and Weed.**
 - Illegal trail building, trespass and legal access concerns across inter-mixed private and federal parcels.
 - Utility rights-of-way (e.g. PacifiCorp lines, railroad ROW, AT&T corridor) as access corridors for OHV, 4x4 use, wildlife and potential invasive weed introduction
 - Illegal activities (dumping, woodcutting, Christmas tree cutting, long-term camping/living)
 - Legal use for walking, running, Nordic skiing, snowmobiling, mountain biking, etc. using Forest System roads leading directly from the edge of communities into the surrounding Forest.

Causal Mechanisms

- Direct access from Interstate 5 and less than six hours drive from multiple population centers (e.g. Sacramento, San Francisco, Portland, Reno/Sparks, Eureka)

- One of only two 14,000 + feet mountains in California (with Mt. Whitney) and a popular training climb for those planning larger climbs
- Site of some of the only easily accessible glaciers in the western states and one of the only paved and plowed roads that accesses a high elevation (6,800') parking lot
- International cultural significance of the mountain attracts wide variety of user groups.
- Paved or passenger car suitable road and trail access to meadows.
- The 1987 Harmonic Convergence at Ski Bowl, additional interest from several Rainbow Family gatherings, the Dali Lama visit, and the designation of Mt. Shasta as a spiritually significant site in websites and publications.
- Increased popularity of mountain climbing, hiking, backpacking, backcountry skiing, camping, spiritual quests
- Closure of community garbage disposal areas.
- Decreasing financial and personnel resources for recreation management, with an increase in private camping facilities nearby (Lake Siskiyou Resort, KOA, Castle Crags State Park)

Trends

- Growing State population and proximity to Interstate 5 may provide for increased use as other popular destinations become overcrowded (e.g. Tahoe basin, Sequoia)
- Recreation use has been slightly lower in the last 2 – 3 years (potentially due to very late winter seasons), but use of sites accessed by the Everitt Memorial Highway (e.g. McBride, Panther meadows campground, Sand Flat and Ski Bowl) has seen a generally steady increase over the past 15+ years. Traffic counter data indicates roughly 100,000 visitors on the road annually.
- Mt. Shasta Board and Ski Park has celebrated their 26th year. Previous proposal to re-develop skiing in the Old Ski Bowl (in the original location) have been withdrawn while local interest in expansion opportunities for the Ski Park have been expressed.
- The upper slopes of the mountain have been designated a traditional cultural property and future recreation management will be consistent with this designation.
- Interest in commercial outfitting and guiding has grown for guided outdoor adventures (climbing, skiing, survival training, etc.) and metaphysical experiences (meditation, ascension, channeling, etc.)
- Mountain bike use has grown, with increased interest in technical single track routes and “gravity” routes. Motorcross interest has also grown with increased use of single lane native surface roads. Both uses are currently unmanaged with the exception of the most recent bike trail system (Gateway), and have crossed onto private lands in trespass

- Trends in meadow condition are variable. Due to their limited size and sensitivity to concentrated use trends in meadow condition can change quickly and are difficult to predict into the future. Meadow restoration projects (facilitated by the USFS Greenhouse, Native American partners, and the Mt. Shasta Bioregional Ecology Center), education on meadow impacts and the establishment of a caretaker position for Panther Meadows Campground, have reduced impacts and allowed for restoration of a portion of the Panther Meadow area.
 - Panther – Improvement habitat conditions over past decade due to restoration efforts but still at risk due to concentrated use
 - South Gate and Meadows – Trend is for continued decline in meadow vegetation
 - St. Germaine Meadows – Trend unknown
- Steady increase in human use in plantations located in wildland urban interface for mountain biking, camping, walking, running, and illegal dumping and living.
- Fluctuating concentrated use in Avalanche Gulch (specifically Lake Helen and Horse Camp)

Influences and Relationships

- Concentrated use is directly related to access and the condition and availability of the transportation system
- Without developed managed sites, users will create their own (e.g. parking areas, dispersed campsites, user trails, mountain bike trails, etc.)
- The potential for impacts to springs and wet meadows is directly related to access.
- Concentrated use areas are often correlated with user group conflicts.

Conclusions

- There is a need to evaluate capacity for the various types of recreation use, by the season of use and develop a recreation management plan and a Historic properties management plan for Panther Meadows and the Mt. Shasta Historic District for the watershed that is consistent with the protective designations (e.g. Wilderness, traditional cultural property, critical owl habitat) and to schedule the development of additional recreation facilities that direct use where appropriate and limit use where sites should be restored.
- There is a need to develop additional cooperative relationships with the Tribes, County, Cities, State and adjacent land owners to assess impacts of access (including closures and gates) and the combined effect of future land treatment measures and ownership patterns on long term public use and recreation.
- There is a need to assess the current condition of wet meadows and springs with an emphasis placed on areas experiencing concentrated use. Trends for meadow conditions

and current management practices should be evaluated for effectiveness in preventing resource impacts.

- There is a need to inventory and determine the condition of springs and isolated riparian habitats. Information is lacking on the full extent and distribution of small riparian/aquatic habitats and their condition.
- There is a need to develop long term management strategies and restoration actions for meadows and springs that have been impacted by concentrated use.
- There is a need to manage use in the plantations and educate people on the dangers of dumping.

Topic 2: User Conflicts

Present Condition

Limited and concentrated access to popular sites combined with a very limited amount of developed infrastructure and management direction has created user conflicts in areas within the watershed. Examples include Panther Meadow where the relatively new non-indigenous metaphysical use conflicts directly with the indigenous Native American values and ceremonies and the heavy pressure from standard tourist visitation from those traveling up the Everitt Memorial to the Ski Bowl parking lot for a short day hike. Bunny Flat sees similar conflicts during the winter months when constrained parking creates conflicts between snowmobile users, skiers, sledgers, and other visiting tourists attempting to negotiate the overflowing parking lot and limited toilet facilities. The Snowman's Hill area on Highway 89 can be congested and dangerous when the ski area, Nordic area and sledding use combine to fill all available parking areas and place individuals on the Highway where traffic may be traveling at 65 mph on snow covered or icy roads.

Causal Mechanisms

- Mt. Shasta is a climbing and spiritual destination for both national and international visitors in addition to strong local use for the small and marginally developed recreation sites located along the key access routes. Development and expansion of recreation facilities (e.g. Mt. Shasta Golf Course, Lake Siskiyou Resort, Mt. Shasta Board and Ski Park) on adjacent private land has provided for increased visibility and tourism in the watershed and to the limited number of developed Forest Service recreation sites.
- The Wilderness Area and the designation of Panther Meadows and the old Ski Bowl area and the upper reaches of Mt. Shasta as eligible traditional cultural properties makes new proposals challenging as competing interests participate in the National Environmental Policy Act (NEPA) process. This increases the cost of any project and reduces the ability of the Forest Service to respond to multiple needs at once.
- The volume of timber harvest on NFS lands has decreased in the past 25 years and most timber mills in the region have closed. McCloud Railway has transitioned to the Rail

Trail. A transition away from a timber based economy to a more recreation/tourist based economy has not been matched with a similar development of infrastructure to accommodate the new type of use and demand.

- Previously permitted or authorized uses may no longer be suitable on some National Forest System lands where policy has changed or more protective designations such as Wilderness are now in place (e.g. snowmobiling, filming, fundraising, motorized search and rescue in Wilderness; large and free-form group use in Panther Meadows; municipal dumps and septic ponds on NFS lands).
- Illegal dumping (concentrated in some areas).

Trends

- The Payment in Lieu of Taxes (PILT) revenue previously generated from timber sale receipts has declined sharply without alternate permanent legislation funding creating impacts to road and schools budgets, limiting new infrastructure and threatening historic service like snowplowing on the Everitt Memorial Highway.
- New green-energy development may provide some economic growth.
- High quality-of-life (e.g. clean air, clean water, good schools, low residential density and traffic) in the County may continue to attract recreation use and some residential growth as the State population grows.
- Diversification of private timber land to include additional uses (residential, industrial, conservation easements, recreation) to account for dropping timber production.
- The National Forest Service project (Travel Management) to reduce road density (and associated erosion and habitat effects) may directly affect historical use of access for woodcutting, hunting, and dispersed camping without suitable alternatives frustrates local residents and Forest land users.
- This coincides with the perception that support for these historical uses (woodcutting, hunting, in conjunction with timber management) has been supplanted by newer residents and transplants seeking non-consumptive and less traditional uses (e.g. kayaking, Nordic skiing, mountain biking) who oppose the traditional forest management practices of timber harvest. This change is affecting City Councils and local business as more diverse views and commercial ventures are introduced (e.g. Crystal shops, metaphysical guides).
- New trail development (e.g. Gateway, Rails to Trails) may create additional interest in the area with an increased need for support facilities for these uses.

Influences and Relationships

- User conflicts are directly related to access, overlapping recreation areas (camping areas and biking trails adjacent to each other, etc.), and type of land use area designation (wilderness area adjacent to road systems and motorized use e.g. snowmobiles)

- User conflicts related to limited parking in multi-sport use areas (e.g. bunny flat, Ski Park Highway)
- Sanitation issues from overcrowded recreation sites with little infrastructure (Bunny flat is main bathroom on the mountain and receives heavy use)
- Users create their own parking areas, dispersed campsites, user trails, mountain bike trails, etc. to get away from other users
- The potential for impacts to springs and wet meadows is directly related to access routes and user conflict
- User conflict between people that want to experience the wilderness in solitude versus experiencing large communal group use in areas within the wilderness (South side of the mountain, usually in Helen Lake area)
- Traffic issues occur at the Ski Park Highway and Highway 89 intersection from recreationists travelling up to the Mt. Shasta Board and Ski Park, the Nordic Center, Dogsled Express, and snowmobiling access where car collisions at the intersection have led to serious injury and death

Conclusions

A comprehensive review of current and future use is needed in order to identify the specific infrastructure that will be needed to accommodate, manage and limit the various uses on National Forest System lands. As use increases and the types of use continue to diversify (e.g. para-skiing), new conflicts are likely. Cooperation and coordination with local communities, the County, Tribes and adjacent private owners will be needed to prevent conflicting management and or unintended consequences.

Topic 3: Ownership and Regulatory Concerns

Present Condition

Landscape and resource management is affected by the checkerboard ownership pattern. This mixed ownership affects road density and visual quality from a recreation perspective. Mixed road rights (limited easements vs. full public use) can constrain both public access (gates, closures) and private rights and affect development or management opportunities if rights are unclear or legally limited. Further, mixed ownerships and road closures are a challenge to prescribed fire use on the adjacent NFS lands.

This checkerboard ownership pattern has also created thousands of miles of boundary management issues (timber trespass, occupancy trespass, and WUI zones). Challenges are both vegetative (fire and timber) and occupancy (road access, trespass, dumping). In some areas, original land line surveys were in error and current surveys have shifted section lines.

Some parcels previously managed for timber, have been rezoned for residential development without a larger planning effort to address utility access needs (power, phone) across the adjacent ownership or the need for year-round passenger car use on low-standard (Level 2) resource

management roads. State regulations for vegetation clearing and alternate access for fire safety can affect the adjacent land owners. The various regulatory designations (e.g. Wilderness, Critical Habitat Unit, Traditional Cultural Property, etc.) can influence/alter opportunities for both developed and commercial recreation and vegetation management.

Causal Mechanisms

- Railroad land grants of the 1860's creating alternating one mile square sections of private land for up to 30 miles on each side of the railroad tracks.
- County re-zoning of private land from timber management to residential.
- Overlapping and extensive designations of large portions of the watershed for specific uses (e.g. federally designated Wilderness Area, federally eligible traditional cultural property, federally designated Late Successional Reserve, and Critical Habitat Units, County designated residential, commercial and industrial zoning, etc.) limit location of development to address public use and vegetation management.

Trends

- New economies that could boost County revenues and create jobs (e.g. wind energy, solar energy, hydroelectric power, bottled water) could be developed on lands interspersed with NFS lands further affecting access needs and potentially visual quality from NFS lands.
- Changing regulatory requirements or economic conditions could change land use and zoning away from timber resource management to non-resource based uses (e.g. residential, commercial industrial) further reducing forest habitat and increasing interface concerns.
- Past trends to develop ground and spring water sources (Dannone, Crystal Geysers, Nestle') may continue with unknown effects on local ground water levels or aquifers.

Influences and Relationships

- Larger developments often require road improvements (one lane to two lanes, native surface to chip seal or pavement). This affects the cost of road maintenance and road management and may modify the Forest Service Road Maintenance Objective (RMO) away from resource management and recreation, to residential, commercial or industrial.
- Previous and future upgrades to the major highway system will continue to improve the ease of access to the region and the location at the intersection of three main access routes (I-5, Hwy. 97 and Hwy. 89) will continue to direct traffic through the watershed and increase visibility of the opportunities available here.

Conclusions

- Based on key factors including: resource values, road rights of way, County/municipal needs, urban to wildland access, and fire safety (WUI) etc., isolated Forest Service and

private parcels should be evaluated for acquisition or disposal in the next update of the Land and Resource Management Plan.

- Opportunities exist for the Forest Service and County Planning Department to collectively identify constraints and needs for planned development in areas where zoning is changed to allow new uses.

Topic 4: Riparian Reserve Management

Present Condition

Current mapping of Riparian Reserves is known to over-represent the channel network. The current Riparian Reserve coverage overestimates the extent, distribution and connectivity of perennial, intermittent and ephemeral streams. The drainage density of active channels (those that flow annually and display evidence of annual scour) is considerably less than what is currently depicted on the Riparian Reserve maps. Conversely, it is believed that many small wet meadows, seeps and associated channels have not been mapped. The same issue also exists for unstable areas. The existing GIS coverage showing the unstable land component of Riparian Reserves is reconnaissance in nature, and needs to be refined. The first step in this refinement was accomplished during this Watershed Analysis process, when small active landslides (debris slides) were mapped and inner gorge mapping defined.

Causal Mechanisms

- Incomplete field verification of perennial, intermittent and ephemeral stream channels.
- Incomplete field verification and inventory of springs, seeps and wet meadows.
- Improved technology (e.g. lidar imagery) has improved mapping of topographic features including channels which has elevated the need for field verification to determine which channels qualify as Riparian Reserves.

Trends

- Improved technology has resulted in refined channel mapping but very limited field verification has occurred in recent years.
- Mapping of springs and spring attributes has increased over the past decade but there is still a need to continue to identify these features.

Influences and Relationships

- The Riparian Reserve land allocation affects management for all resource areas including fuels, vegetation management and recreation.
- Maps of Mount Shasta may be over-representing the channel network and misrepresenting water availability.

Conclusions

- There is a need to refine the Riparian Reserve coverage so that it accurately depicts the distribution of hydrologic features and unstable areas in the watershed. **Map 5-1**, “DEM Generated Streams and Transportation/Utility Corridors” displays perennial and intermittent streams (derived from National Hydrography Data Set (NHD) coverage) as well as more subtle channels derived from the new high resolution Digital Elevation Model of the project area (DEM Drainages). This map likely represents an upper limit to the total stream channel Riparian Reserve, and future field inventories are expected to identify a considerable proportion of these which do not meet Riparian Reserve criteria (annual scour). However, it is possible that field inventories could identify a few more channels not identified on the map.

Chapter 6: Opportunities

This step discusses management opportunities within the context of each applicable core topic, issue, key question and the conclusions generated in Step 5. Although presented within the context of the primary topic, many opportunities respond to multiple core topics. Table 24 through Table 27 display the management opportunities organized by core topic.

Issue: Natural Disturbance Regimes (unique volcanic, landslide, debris flow hazards)

Develop and manage information on known hazards including volcanic, debris avalanches, debris slides, rock fall, and debris flows. Make relevant information easily available to land managers and the public

- Actively cooperate with the US Geological Survey on their on-going assessment of volcanic and debris flow hazards at Mount Shasta
- Refine mapping of active landslides and unstable areas within the analysis area.
- Evaluate potential geologic hazards to human life and safety in all areas experiencing concentrated use on National Forest lands (e.g. Panther Meadows, Lake Helen, Ski Bowl, Bunny Flat, climbing routes, etc.). Utilize the recently completed reconnaissance level assessment for the Northern Province in: “Geologic Hazard Assessment for Developed Recreation Sites: Phase 1” November 1, 2011.
- Look for opportunities to facilitate and support research efforts on Mt. Shasta for glacier/volcanic/seismic studies. This includes installation of instruments to monitor seismicity, deformation, and thermal spring characteristics, some of which require Special Use Permits.
- Employ the following tools to assist with resource inventories:
- Employ the following tools to assist with resource inventories:

- Time Sequence Air Photo Inventory- Do historical air photo inventory of debris flows for 1944, 1951, 1964, 1971, 1975, 1980, 1985, 1990, 1995, 2003, 2012; Map deposits and altered channels save as lines and polygons, and characterize debris flows. Do the same for future debris flow events.
- Conduct a search of District files and other sources to map and characterize historical snow avalanches and compile data into an electronic data base. Do the same for future snow avalanches.
- Road/Stream Diversions- Use 1-meter DEM to: Identify road stream diversions;
- Other Diversion Potential Sites on Fans- Use 1-meter DEM to: Identify potential channel diversion sites on fans;
- Inner Gorge- Use 1-meter DEM to: Refine mapping of inner gorge and debris slides
- Geomorphic Mapping- Use 1-meter DEM to: Identify older debris slide scars and potential unstable areas.
- Google Earth Imagery- Use Google Earth imagery to complete rapid assessments of recent debris flow history.
- Compile and digitize District records on fatalities and injuries to recreationists. Analyze for patterns which might suggest changes to current recreation management practices.

Riparian Reserves

- Refine mapping of unstable land component of Riparian Reserve mapping.

Roads and Infrastructure

- Complete sediment source inventories for roads and trails in Mt. Shasta Watershed.
- Complete a Travel Analysis Plan including INFRA updates for Mt. Shasta Watershed.
- Evaluate and identify opportunities to pursue rights-of-way access.
- Complete road maintenance economic analysis.
- Integrate all sediment source inventories and travel analysis projects with information on active disturbance areas to inform management decisions concerning road maintenance, reconstruction, decommissioning, closure, etc.). Employ new analysis tools (such as high resolution DEMs) when evaluating interactions between roads and natural disturbance regime.
- Design stream crossings associated with debris flow channels to be compatible with debris flow activity.
- Identify opportunities to relocate or realign roads, trails and trailheads outside of active areas such as debris flow channels, landslides, and rock slides.

- Implement existing travel management framework.
- Incorporate information about known hazards when developing plans for new infrastructure.
- Identify opportunities to improve transportation infrastructure (e.g. improve roads for vegetation management and facilitate access to dispersed use areas).
- Pursue Stewardship opportunities to fund needed work. Consider opportunities to improve rec. sites in association with transportation infrastructure projects.
- Resolve management and maintenance issues associated with Ski Park Highway.
- Manage (maintain or decommission) plantation roads.
- Partner with Siskiyou County for plowing Everitt Memorial Highway. Consider alternative methods for funding plowing costs (e.g. Recreation Enhancement Act fee (REA) during winter months).

Emergency Response

- Improve communication plan to the public
- Coordinate with each Chamber of Commerce for visitor information
- Support and expand the Mt. Shasta Avalanche Center to provide current condition reports and safety messages to the visiting public.

Issue: Vegetation Management

Vegetation can be managed so that it is more resilient to natural disturbance (e.g. natural and prescribed fire, insects and disease). Some options may include:

- Mechanical treatment in Ponderosa Pine plantations to reduce fuels
- Mechanical treatment in brush fields to provide fuel breaks and reduce fuel density
- Thinning in natural stands (mixed conifer) to reduce stand density and ladder fuels
- Continue and/or increase management treatments to restore vegetation diversity in artificial monotype stands
- Increase disturbance frequencies to reduce intensity

Red fir, White fir, Mixed conifer vegetation types

The objectives are to restore these vegetation types to their pre settlement conditions and to maintain the health of the tree types into the future. This can be done by reducing stocking through silvicultural thinning treatments and by reintroducing fire on a regular interval that mimics the natural fire regime. It is also the objective to keep tree mortality at endemic levels while reducing the chances of large catastrophic losses from disease and/or wildfire.

Conifer Hardwood Mix

The objective is to restore the hardwood component back to its pre settlement condition, when the hardwoods, black oak in particular, played a larger role in the landscape as a whole. This can be done by reducing conifer encroachment on the hardwoods and reintroducing fire onto the landscape on a regular interval that mimics the natural fire regime.

Ponderosa pine (non-plantation)

The objective is to reduce the stocking levels, to levels that are sustainable over time and to make the pine stands more resistant to large scale insect and disease outbreaks. This can be done by use of silvicultural treatments as well as the reintroduction of fire on a regular interval that mimics the natural fire regime. It is also the objective to keep tree mortality at endemic levels while reducing the chances of large catastrophic losses from disease and/or wildfire.

Knobcone and Lodgepole pine stands

The objective is to reduce the amount of mortality by thinning the stands and allowing increased resources to the residual trees. When opportunity allows, diversity should be incorporated into the knobcone pine stands by planting a mix of species that can successfully survive on the site.

Western juniper

- Treat juniper stands to manage them at historic natural levels
- Reintroduce fire on a regular interval to maintain density and the range of the species

White bark pine

Monitor the white bark pine health and manage as needed.

Plantations

- Maintain plantations at sustainable density levels while meeting Visual Quality Objectives for the watershed
- Control sanitation and dumping concerns with the tactful use of road closures
- Incorporate species diversity when the opportunities arise
- Plant a mix of species that historically occur in the range
- Reintroduce fire on a regular interval to help reduce the occurrence of catastrophic wildfire and create the natural stand conditions prior to wildfire suppression

Sensitive Plants

- Re-design trails or design infrastructure that avoids *Companula* populations on the mountain (high elevations)
- Control grazing area in the allotment management plan

Noxious Weeds

- Continue to map and treat populations in plantations along the Everitt Memorial Highway
- Partner with communities and local organizations to spread awareness and prevention measures
- Implement prevention measures throughout the watershed

Issue: Fire Exclusion

Fire

- Update fire management activities including hand/mechanical fuel reduction treatments, the use of prescribed fire and utilizing unplanned fires for resource benefits including:
 - reduced fire effects and fire behavior in the watershed area
 - meet land management objectives (vegetation management, WUI, wildlife habitat, etc.)
 - restoring fire processes where compatible with other resource needs
- Fuel reduction treatments should focus on the Wildland Urban Interface, then areas where high resource values are subject to high hazard and high risk, followed by those areas with the greatest fire return interval departure. Incorporate fuel reduction zone objectives, as outlined in the Fire Management Plan, in all vegetation and administrative planning efforts.
- Return fire to the ecosystem through the use of low intensity managed fire (both natural-ignition wildfires and prescribed fires) throughout the watershed analysis area to reduce fuels, improve forest health, and restore the ecosystem to historical conditions. Utilize fire to restore and maintain meadows and riparian areas. Historical return intervals may be maintained through planned or unplanned ignitions.
- Utilize a collaborative landscape approach with adjacent landowners, Tribes, and agencies to reduce the risk of uncharacteristic wildfire in the watershed area. Continue to work with the Fire Safe Council's to coordinate projects across jurisdictional boundaries. Look for new opportunities to collaborate with additional land management organizations. Incorporate traditional knowledge into management techniques.
- Ensure there is access during fire season and during periods of project implementation.

- Coordinate with Cal Fire regarding cross training, fire response, current fire management policies on National Forest System lands, and fire management messages given to the public.
- Plan projects to allow prescribed fire at the landscape level. This may include burn-only treatments where mechanical treatments are not required or not feasible given other restraints with vegetation removal. Include multiple fire entries in the project decision document.
- Keep the public informed on Forest Service projects and management actions. This will be especially important as we modify fire management techniques to conform to new policy direction.
- Develop and maintain fire-safe sites for recreational and general use of the National Forest (see fire restrictions)

Issue: Habitat Quality

Wildlife Species and Habitat

- Partner with the California Department of Fish and Game, California Deer Association, Mule Deer Foundation, Rocky Mountain Elk Foundation and others to develop habitat enhancement projects for deer, elk and other early seral wildlife species.
- Work with the U.S. Fish and Wildlife Service to implement the recovery action objectives as outlined in the Northern Spotted Owl Recovery Plan and critical habitat plans. Implement the recommendations in the Forest Wide LSR Assessment within the four Late Successional Reserves located in the watershed. Update habitat maps in 2012 when USFWS issues new ruling.
- Perform site specific and species specific surveys for federally listed or candidate species and Forest Service Sensitive or species of special concern and their potential habitats within the watershed in order to assess priorities for management actions or protections.
 - Examples of such surveys are:
 - Breeding bird surveys as no current presence/absence or abundance and distribution information is available.
 - Pika surveys at the higher elevations in the alpine dwarf shrub habitat type.
 - Amphibian surveys within Squaw Valley Creek.
 - Goshawk and forest carnivores surveys in suitable mid and late seral habitat.
 - Re-establish and expand past NSO 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.

- Conduct aquatic mollusk surveys, particularly near springs and seeps that may be impacted by erosion or management actions.
- Evaluate current condition and capability of late-successional reserves located in urban interface areas and develop management strategies to improve management of LSR's for multiple resource objectives (e.g. fire and fuels, recreation, habitat).

Meadows, spring, seeps, perennial channels

- Complete inventory and mapping of wet meadows, springs and seeps. Incorporate new information into Riparian Reserve coverage.
- Employ new technology (e.g. lidar imagery, remote sensing) to evaluate vulnerability of sensitive habitats (meadows, seeps, springs) to future disturbance (e.g. climate change, seismic activity, etc.).

Hydrology

- Decommission abandoned spring infrastructure and associated water developments.
- Refine Riparian Reserve mapping.

Soils

- Plantations: When planning projects in plantations with past topsoil-windrow site-preparation, assessment and analysis needs to specifically consider soil organic matter retention, and project design features recommended with the objective of preventing further (cumulative) impacts (such as limitations on soil displacement and prescribed burning, for example), and/or recommending restorative actions (such as respreading windrows) if and where necessary.

Caves

- Evaluate bat habitat conditions in known caves within the analysis area
- Monitor cave use and condition

Issue: Recreation/Public Use

Develop and provide more recreational facilities to accommodate visitors

Trails-

- Evaluate all user-created trails and routes for possible improvement and addition to the Forest Service Trail System. Consider opportunities to connect trails to access points and to collaborate with communities and the Mt. Shasta Board and Ski Park to create connected systems from existing access points.

- Panther Meadows Traditional Cultural Properties
 - Design and complete construction of the trail system in the mid and lower portions of the meadow
 - Consider establishing an 8 person maximum group size
 - Evaluate options to curtail use during the wet period of the spring season and restrict use to authorized trails (e.g. new regulations in Forest Order)
 - Consider eliminating dog use in the meadow except on the through trail to Gray Butte
 - Evaluate opportunities to communicate with and educate local and non-local groups about impacts occurring in Panther Meadows and methods to minimize impacts (e.g. off-trail use, wet season use, illegal commercial use, illegal dumping of cremations, leaving of offerings, entering the upper spring, etc.).
- South Gate Meadows
 - Design and build a Forest Service trail system and rehabilitate existing and poorly located user-created trails
 - Develop and institute regulations to restrict camping in meadow.
- Hummingbird Meadows
 - Redesign trail system to avoid the meadow
- Ski Bowl
 - Remove and restore sites with remaining infrastructure from the Ski Shasta installation (including roads) and create loop trail system to vista sites within the Ski Bowl.
- Mountain Bike Trails
 - Manage and expand current single track trail system
 - Evaluate suitability for a downhill trail along Everitt Memorial Highway
 - Consider relocating downhill biking trails to Rainbow Ridge
- John Muir Trail (Sisson Trail)
 - Re-develop the Sisson trail along or near the historic route
- Nordic Trails
 - Evaluate opportunities to expand the Forest Service Nordic trail system and potentially connect trails in Bunny Flat or Red Fir Flat areas to the Nordic Center trail system.
- Consider a Mt. Shasta perimeter trail (circumference)
- Bolum Creek Trail

- Relocate user trails and develop a Forest Service trail
- If the McCloud to Mt. Shasta portion of the McCloud Railway is decommissioned, consider a Rails to Trails development for that section
- Update INFRA database for all trails

Campgrounds/Recreation Locations

- Look for opportunities for additional developed and dispersed camping sites both along the Everitt Memorial Highway and elsewhere (consider health and safety at recreation sites). Examples could include:
 - Evaluate opportunities to redesign Panther Meadows Campground to define campground boundary, establish a maximum campsite occupancy of 8 people. Consider limitation to length of stay to three nights, consider restricting dogs from the campground
 - Consider the elimination of camping in the entire Ski Bowl basin except at Panther Meadows Campground and camping associated with climbing
 - Consider restricting use of the Upper Ski Bowl to day use between 6:00 am and 12:00 am
 - Consider restricting overnight parking in the Lower Ski Bowl Parking lot to no more than seven consecutive days
 - Expansion of McBride Springs Campground
 - Evaluate possible additional campgrounds in: Swamp Creek, Bunny Flat, Red Fir Flat, Sand Flat areas and the McKenzie Butte Road (31 Road)
 - Develop water sources along Everitt Memorial Highway at developed recreation sites
 - Expand campground capacity in areas outside the watershed boundary in order to disperse some use away from the mountain
 - Partner with the Ski Park to review opportunities along the Ski Park Highway alignment to improve/increase facilities
 - Evaluate support facilities for new recreation pursuits (e.g. paraglide use on the Military Pass Road)
 - Map and evaluate dispersed shooting area on North side of mountain off Hotlum road and elsewhere for safety
- Develop partnerships with local organizations (e.g. Trail Association, Bioregional Association, Sierra Club Foundation, etc.) to provide multiple avenues and collaborative efforts to support managed public use including grant funding and matching funds.

High concentrated use areas

- Map and evaluate concentrated use areas (camping, parking, etc.)
- Design and implement a capacity study for both traditional recreation and non-traditional metaphysical or spiritual uses on the mountain (including commercial uses)
 - Pilot studies for high concentration use areas that manages and limits use
 - Identify protocols
- Plan and create a Recreation Strategy (minimum 5-years) that:
 - Identifies the full complement of current uses and volume of users and identifies Capital Improvement Project needs to manage current and expected use.
 - Include a visitor education strategy and structure including awareness of history, indigenous peoples, volcanic geologic hazards and actions to take when hazardous events occur
 - Continue the “pack out” program within the wilderness area; seek opportunities for additional funding or partnerships for support
 - Update the Forest Orders for wilderness and wet meadows
 - Evaluate opportunities for a recreation pass or use fee to support infrastructure management (e.g. toilet pumping, signing, pack-out, water testing, etc.) and management
 - Develop partnerships with groups for restoration work and trail development
 - Seek partnerships provide increase awareness of outdoor forest ethic
 - Collaborate with the communities for use and safety of Forest margins shared with residential users (e.g. illegal dumping, illegal residency, shooting, etc.)
 - Restore and re-vegetate of Panther Meadows Karuk Tribe ceremonial location
 - Old Ski Bowl
 - Clean-up of Old Ski Bowl Area (pavement, garbage, pipes)
 - Redesign and develop destination parking area with educational/interpretive information and trail system for day users.
 - Based on capacity information, implement outfitter guide policy direction for appropriate mix of guides and user days
 - Develop a Historic Properties Management Plan for all eligible properties on Mt. Shasta

Interpretation

- Develop a comprehensive Sign Plan that includes: directional, informational, regulatory and interpretive information for all recreation sites and update current signs

- Develop partnerships with local Tribes to interpret their history, beliefs, and safety concerns
- Develop partnership with the Volcanic Legacy Scenic Byway
- Collaborate with the Klamath National Forest for a geologic interpretive plan, including web materials, brochures and video displays for office reception areas
- Develop interpretive materials for the Black Butte Geologic Special Interest Area

Ownership and Regulatory

- Review current Land Adjustment Guide and confirm or update opportunities to consolidate National Forest System ownership for the benefit of improved infrastructure management (e.g. simplify road/boundary management).
- Update land ownership records to reflect accurate information, including rights of way
- Cooperate with County and City administrations to share information and changes to regulation or policy

Other Opportunities

- Update Shasta-Trinity Land and Resource Management Plan; expand discussion of management direction for all uses within the watershed (e.g. recreation, Native American uses, special uses, lands, fuels, etc.)

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Acronyms

AT&T: American Telephone and Telegraph

CalVO: California Volcanic Observatory

CHU: Critical Habitat Unit

CM: Centimeter

DBH: Diameter at Breast Height (4.5 feet)

DEM: Digital Elevation Model

FR: Federal Register

FRID: Fire Return Interval Departure

FWS: Fish and Wildlife Service

GIS: Geographic Information System

HUC: Hydrologic Unit Code

INFRA: Internal Forest Service Database

LRMP: Land and Resource Management Plan

LSR: Late Successional Reserve

MPH: Miles Per Hour

NEPA: National Environmental Policy Act

NFS: National Forest System

NSO: Northern Spotted Owl

NWCG: National Wildfire Coordinating Group

OHV: Off-Highway Vehicle

PCE: Primary Constituent Elements

REA: Recreation Enhancement Act

RMO: Road Maintenance Objective

ROW: Right of Way

SP: Southern Pacific Railroad

ST: Shasta-Trinity

TCP: Traditional Cultural Property

TES: Threatened and Endangered Species

USFS: United States Forest Service

USGS: United States Geological Service

WA: Watershed Assessment

WUI: Wildland Urban Interface