HAT CREEK
WATERSHED ASSESSMENT
&
WATERSHED MANAGEMENT PLAN

Prepared for

Fall River
Resource Conservation District

Prepared by

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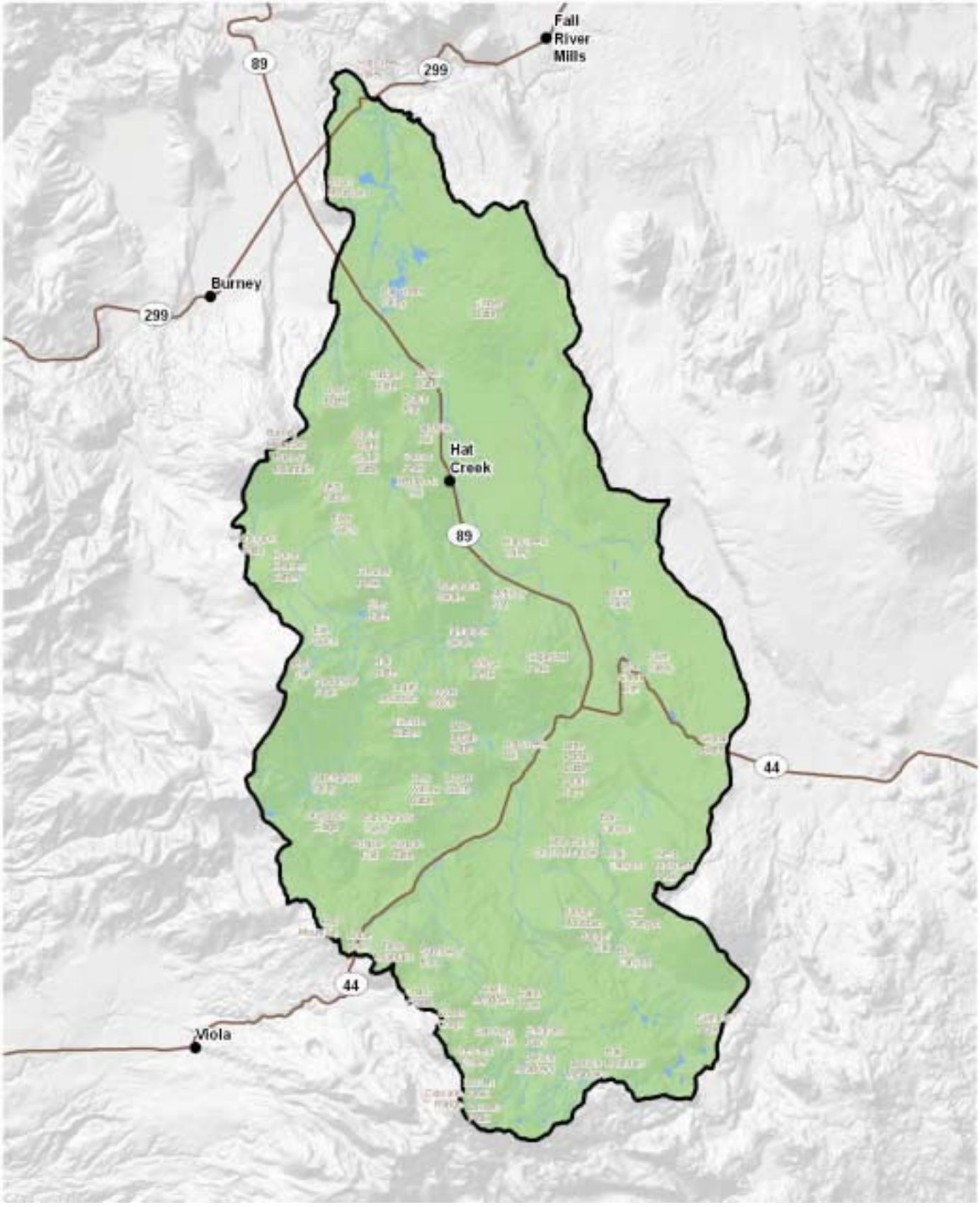
Hat Creek Watershed



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CONTRIBUTORS

The Watershed Assessment and Watershed Management Plan is being conducted by the Fall River Resource Conservation District (FRRCD) under a grant from the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (Proposition 50).

Members of the Hat Creek Watershed Technical Advisory Committee include:

- California Regional Water Quality Control Board (RWQCB)
- WM Beaty & Associates
- Fall River Resource Conservation District (FRRCD)
- Pit River Tribe
- Sierra Pacific Industries
- Northeastern California Water Association (NECWA)
- United States Forest Service, Hat Creek Ranger District
- Fall River Wild Trout Foundation
- Central Modoc River Center
- United States Forest Service (USFS), Lassen National Forest (Hat Creek Ranger District)
- Pacific Gas & Electric (PG&E)
- California Department of Fish and Game (CDFG)
- Burney Chamber of Commerce
- State of California Parks and Recreation Division
- Fall River Conservancy

In addition, the Sierra Institute for Community and the Environment – working on a grant from the Shasta County Resource Advisory Committee (RAC) – collaborated with the FRRCD on this assessment. Much of the initial scoping work completed for the assessment was augmented and expanded by the work of the Sierra Institute on their project. Our thanks.

WHAT IS A WATERSHED ASSESSMENT?

A watershed assessment is a method used to understand a watershed. It is a process for evaluating how well a watershed is functioning. Watershed assessments may include identifying important issues, examining historic conditions, evaluating present conditions and processes, and determining the effects of human activities. It can mean describing the parts and processes of the whole watershed and analyzing their functioning in general, or relative to some standard (such as a water quality standard or historic condition). It also can mean focusing on particular concerns about human activities, conditions, or processes in the watershed. Watersheds by their nature are fluid and complex, making it difficult to fully understand their processes and conditions. Understanding watersheds in California is all the more challenging due to the state's exceptionally diverse array of geographic and hydrologic conditions, which is overlain by an equally diverse set of social and economic conditions. The amount of data available about these conditions varies greatly from watershed to watershed, which adds to difficulty in understanding the watershed condition (Shilling, et al, 2005).

INTRODUCTION

The primary purpose of the Hat Creek Watershed Assessment (WA) and Watershed Management Plan (WMP) is to serve as a guide for the development of ecosystem improvements for the Hat Creek Watershed. This document was developed using available data, previous work by others, and other information available to the FRRCD. The WA/WMP identifies seven goals, management objectives for those goals, and management actions to achieve the goals and objectives.

The WMP discusses the primary issues and concerns for the watershed that have been developed by the FRRCD and Sierra Institute working under a separate RAC grant. The plan provides management recommendations for projects and other actions to address those concerns.

The purpose of the WA/WMP is to:

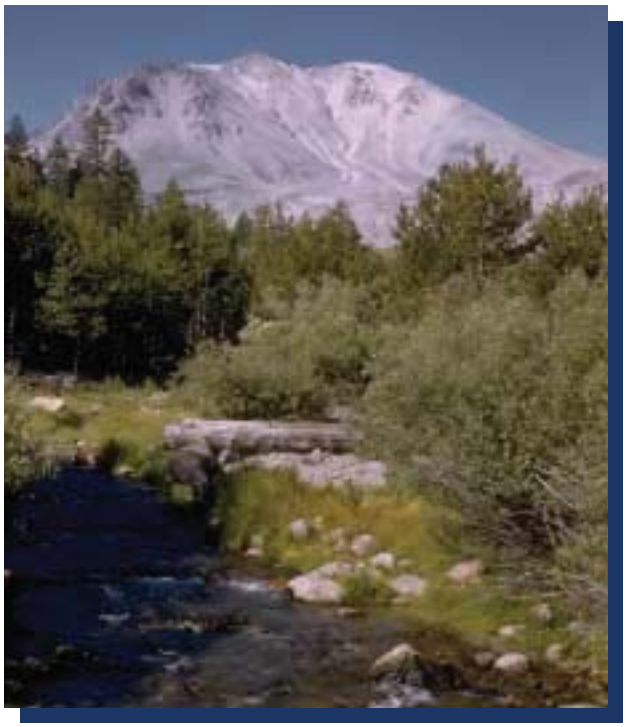
- Define conditions limiting or threatening watershed health
- Define actions needed to address conditions that are currently limiting or threatening watershed health
- Facilitate a better understanding of causes that are limiting or threatening those conditions
- Identify lead stakeholders for implementing management actions
- Identify information needs in the watershed
- Provide a framework for periodic evaluation of management results, reformulation of management approaches, and identification of new watershed management issues
- Support the maintenance and improvement of desired landscape conditions in the watershed (e.g. sustainable agricultural operations, open space, quality wildlife habitat)

The six goals discussed in this WA/WMP are:

1. Support community sustainability by strengthening natural-resource-based economies
2. Maintain high-quality water in Hat Creek
3. Maintain and improve forest health and vigor
4. Maintain availability of water in the system for irrigation demands and ecological needs
5. Maintain and improve habitat quality for indigenous cold water fish
6. Support and encourage better coordination of data collection, sharing, and reporting in the watershed

HAT CREEK WATERSHED ASSESSMENT

The Hat Creek Watershed is located in northeastern California in Shasta and Lassen Counties. Hat Creek flows north through the watershed and drains into the Pit River. The Hat Creek Watershed includes approximately 243,000 acres with 250 stream miles. Elevation in the watershed varies from 10457 feet above mean sea level at the Lassen Peak summit, located in the southern portion of the watershed, to the confluence with the Pit River at 2800 feet above mean sea level. The largely volcanic history of the region has done much to shape the topography and landforms present today. The watershed boundary is shown on Figure 1. Elevation bands are shown on Figure 2. Hydrology in the watershed is shown on Figure 3.



The Hat Creek Watershed is known for its cool, clear water and blue-ribbon wild trout. The watershed is in healthy condition today, with the exception of fuel-loading on USFS land. As long as landowners continue to keep the working landscapes in the watershed viable, and economic conditions and landscape uses improve, the health of the watershed will be maintained for years to come.

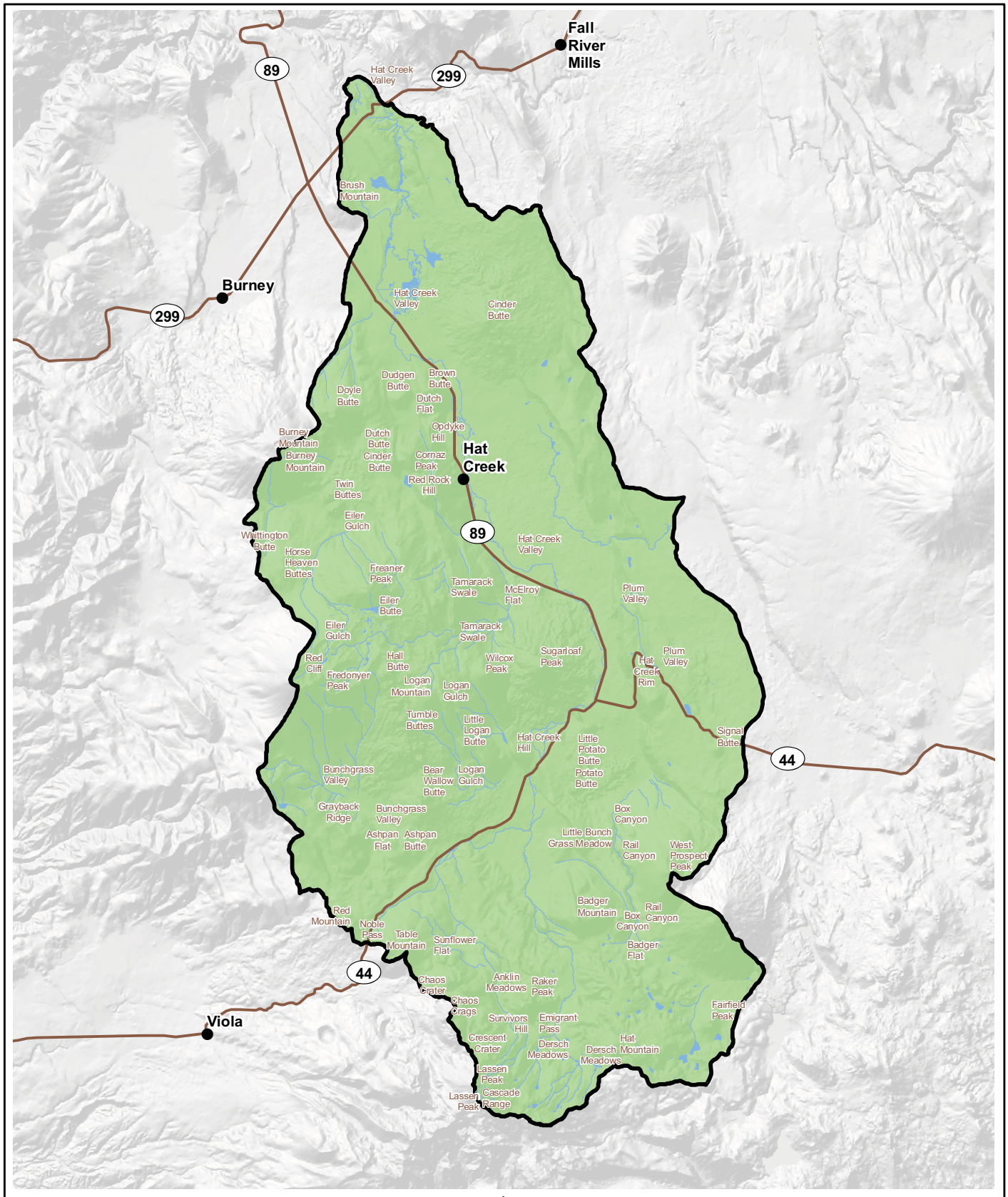


FIGURE 1
WATERSHED BOUNDARY
HAT CREEK WATERSHED

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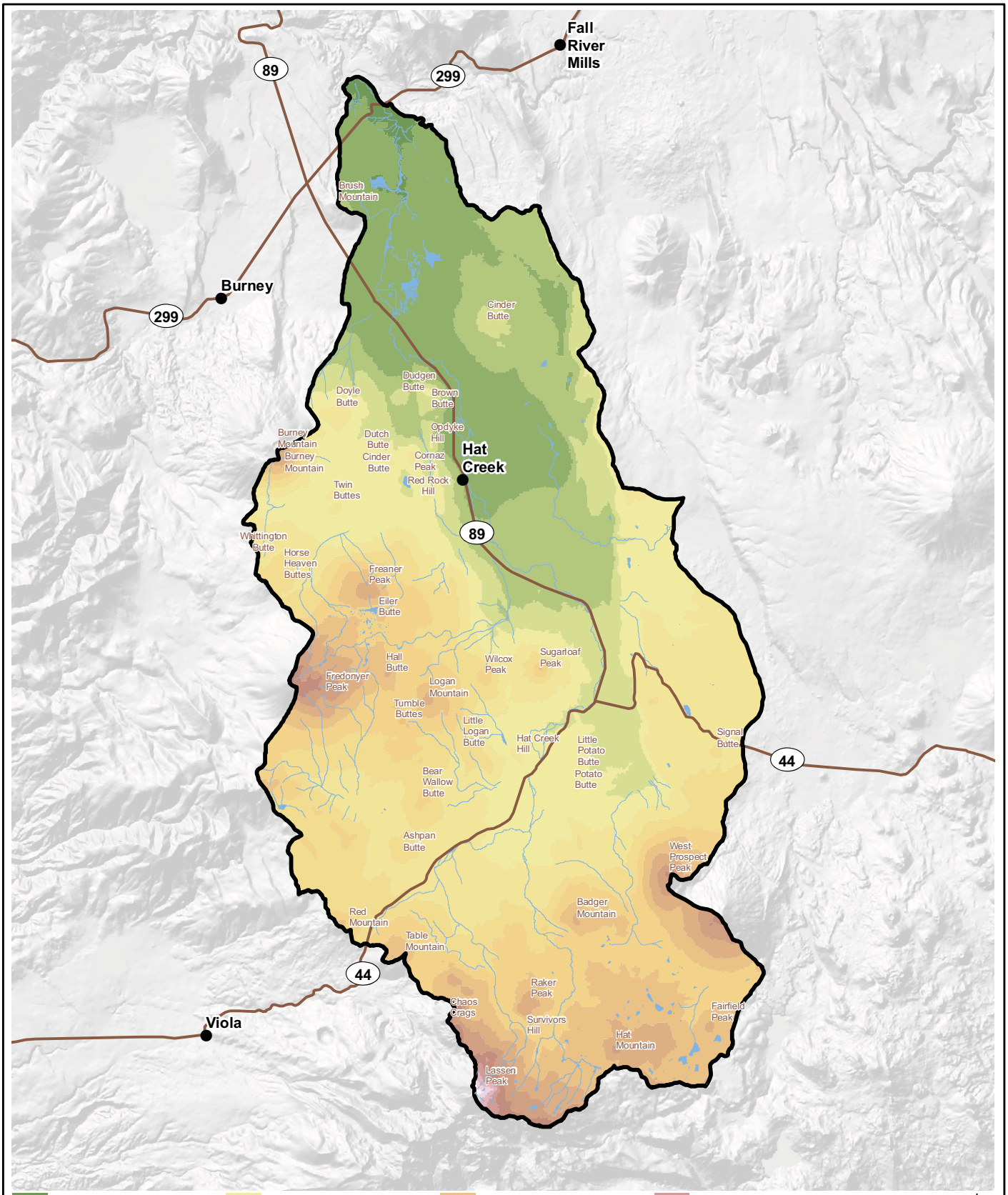

FIGURE 2
ELEVATION
HAT CREEK WATERSHED

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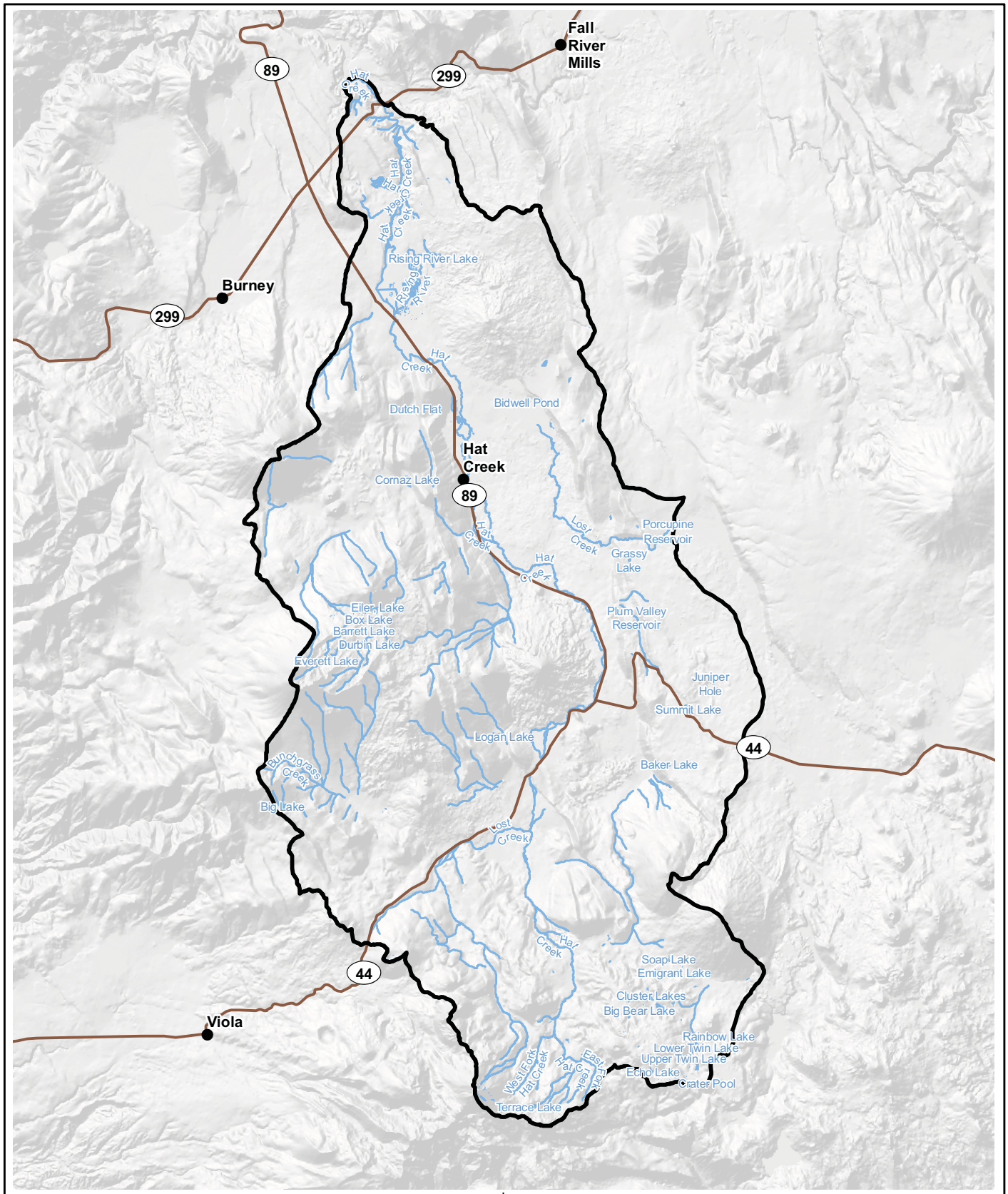

FIGURE 3
HYDROLOGY
HAT CREEK WATERSHED

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HISTORY

The land within the watershed has been inhabited by humans for thousands of years. The watershed was inhabited by the Achomawi (Pit River) peoples and the Atsugé who occupied the western section of the Atsugewi territory, the area between Mount Lassen and the Pit River, particularly along Hat Creek at the time of historical contact. The Achomawi claimed the entire Pit River region above what is now Montgomery Creek as their territory (Dixon, 1908). Their territory was bordered on the west by the Northern Yana and Shasta, north by the Modoc, south by the Yana, and east by the Paiute.

The Achomawi preferred to live independently in small family groups; outsiders were discouraged, although intermarriage between family groups and the adjoining Agewani did occur. The family groups were autonomous from other groups. Each had its own organizational structure and customs. They inhabited permanent villages only in the winter, which were generally located near streams (Olmstead and Stewart, 1978). During the summer season they moved throughout the territory (Dixon, 1908). Movements of the family or tribal units followed the changes in available resources of the seasons.

Horse use is not widely documented; however, references report that the Achomawi traded for horses (Olmstead and Stewart, 1978). In general, it is assumed that materials were carried by family members or cached until their return in the spring or fall. Travel was via footpath and trail. No farming activities were documented. It is documented that the Achomawi used fire to manage the natural resources available to them (Blackburn and Anderson, 1993).

The two divisions of the Atsugewi inhabited different territories with dissimilar ecosystems. The Atsugé occupied the rugged lava-strewn valleys north of Mount Lassen, while the Aporié people resided on an upland (above 5000 feet) desolate plain; an area bordered by Burney Valley to the west, Hat Creek to the east, and the edge of the Pit River Valley on the north. This setting is dominated by harsh winters with heavy snows (Garth, 1978).

Semi-nomadic during the summer, the Atsugewi constructed autonomous, permanent winter villages at lower elevations along streams. Villages were comprised of three to twenty-five bark houses or earth lodges. Some large villages may have had populations of up to 100 individuals. Atsugewi foragers seasonally exploited more than 100 different plants and animals, which were indigenous to their territory. Activities related to obtaining food were their highest priorities (Garth, 1978).

During the 1820s, the first European settlers traveled through the area. As more Europeans arrived, disease and displacement resulted in the decline of native populations. The first explorers in the area included John C. Fremont in 1846 and Peter Lassen in 1849. The Noble Emigrant Trail passed through the Fall River Valley and brought many travelers through the area between 1830 and 1860. Hat Creek was aptly named when one of the travelers on the Noble Emigrant Trail lost his hat while crossing the creek (Shasta Historical Society, 1997).

In the years that followed, towns sprang up and most of the watershed was settled. Until the 1930s and 1940s, cattle ranching and timber were the largest uses of land, followed by dry-land farming for the production of grains and hay. Improvements in irrigation techniques and equipment made the farming of water-dependent crops possible within the watershed during this period.

Following the eruption of Mount Lassen on May 19, 1915, extensive flooding was apparently caused by the emplacement of a major lahar into Hat Creek. Ranchers and settlers in the lower reaches of Hat Creek were forced to move to high ground due to a rapid increase in the discharge of the creek. The flood resulted in tree loss and left immense rocks throughout the area (Shasta Historical Society, 1951).

CURRENT LAND OWNERSHIP AND USES

Over 60 percent of the watershed is held by the USFS and 14 percent by the National Park Service. Large private timber companies manage significant portions of the watershed. The watershed is predominantly comprised of native vegetation with the exception of the valley floor, which is used for intensive agriculture (hay and pasture) (DWR, 1999). In the central and northern portion of the watershed, areas of land are owned by large private ranches. Ownership is shown on Figure 4. Private land holdings greater than 1,000 acres are shown on Figure 5. The California Department of Water Resources (DWR) land use records are shown on Figure 6. Land use acreages are listed in Table 1. Ownership acreages are shown in Tables 2 and 3.

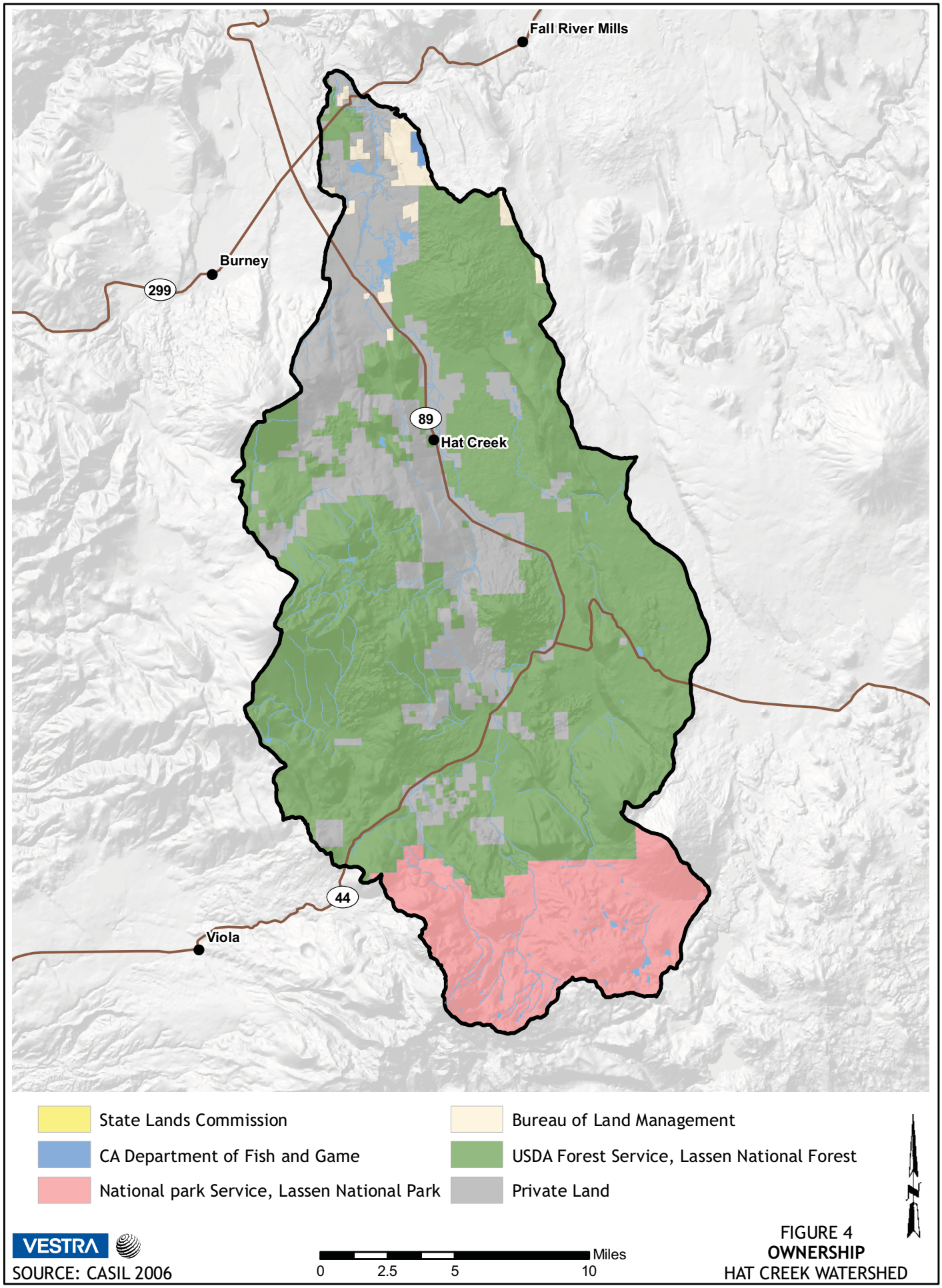

FIGURE 4
OWNERSHIP
HAT CREEK WATERSHED

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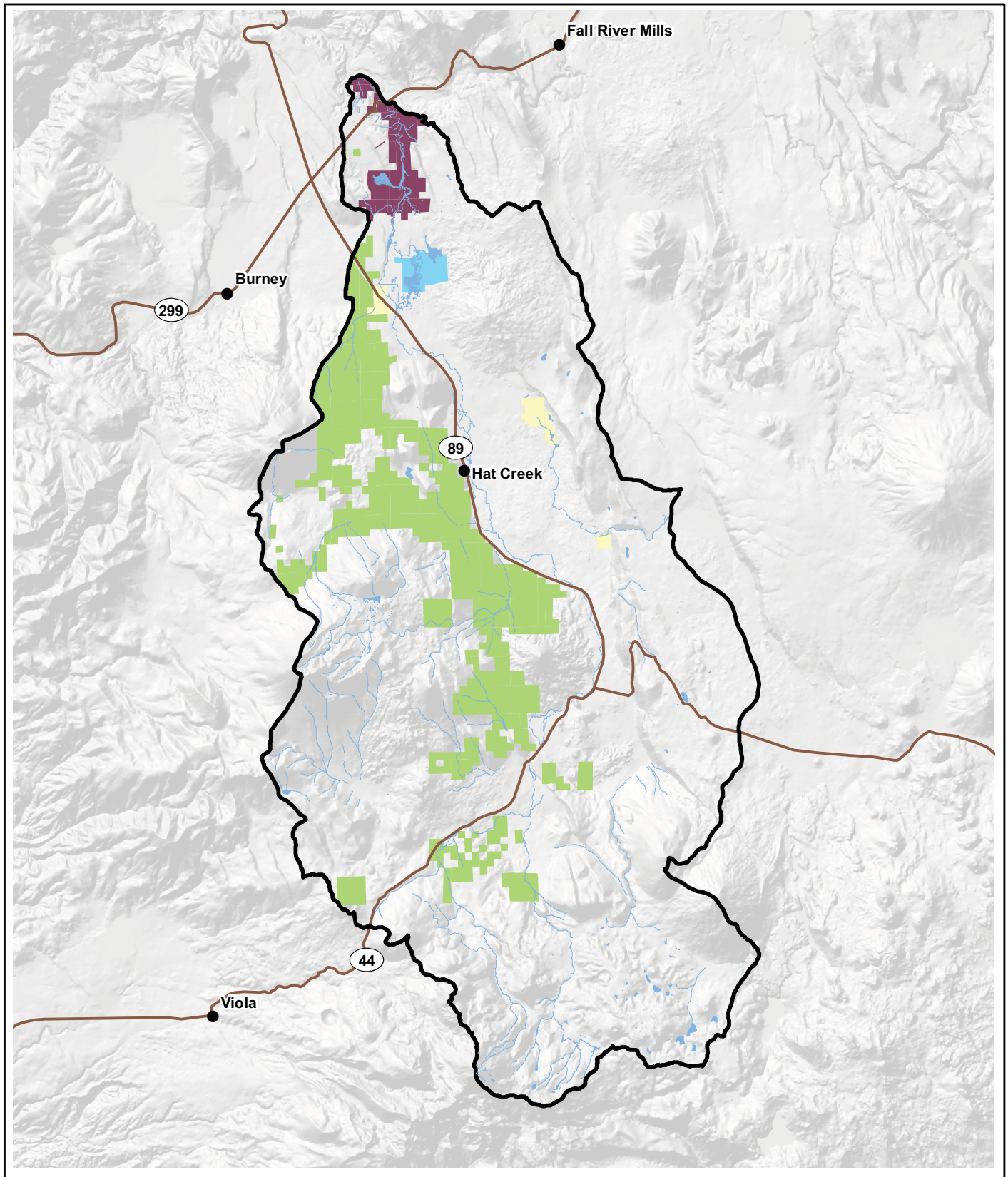

FIGURE 5
PRIVATE OWNERSHIP
OVER 1,000 ACRES
HAT CREEK WATERSHED

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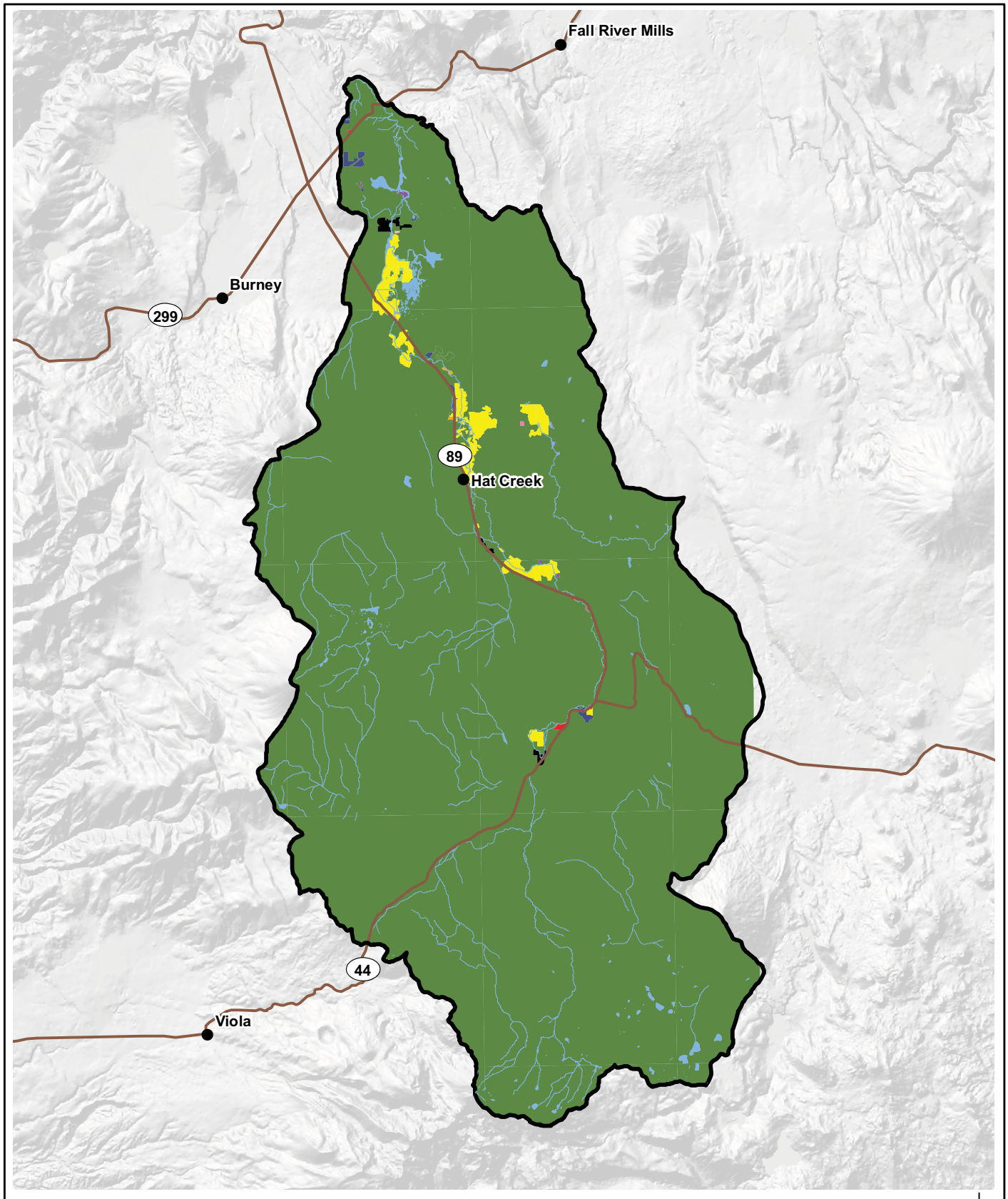

FIGURE 6
LAND USE
HAT CREEK WATERSHED

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Table 1 LAND USE	
Land Use Type	**Acres**
Idle Land	32
Pasture	3,622
Truck, Nursery, or Berry Crop	6
Native Vegetation	237,650
Water	732
Semi-agricultural or Incidental to Agriculture	64
Urban	330
Commercial	85
Industrial	85
Residential	384
Vacant	12

Table 2 OWNERSHIP		
Owner	**Acres**	**Percent of Watershed**
Private Land	50,449	21%
Bureau of Land Management	3,486	1%
National Parks Service	34,052	14%
USFS, Lassen National Forest	155,017	64%
CA Department of Fish and Game	301	<1%
State Lands Commission	5	<1%

Table 3 PRIVATE OWNERSHIP OVER 1,000 ACRES		
Owner	**Acres**	**Percent of Watershed**
Bidwell Ranches, Inc.	1,200	<1%
Eastwood, Clint	1,177	<1%
Fruit Growers Supply Co.	32,175	13%
PG&E	3,750	2%

SOCIO-ECONOMIC PROFILE

Rural lifestyles and a population density of less than 5 persons per square mile generally characterize the Hat Creek Watershed. The small community of Hat Creek is the most populated area in the watershed. Ranching, farming, and timber are the primary resource activities throughout the watershed.

FIRE AND FUELS

The wildfire regime in the Sierra Nevada and southern Cascade ranges has shifted from smaller, more frequent fires to larger, less frequent fires. This has increased the risk of damage from wildfires to both man-made structures and the local ecosystem of the area. The exact cause of this shift is unknown. The most commonly cited probable cause for the shift in wildfire regime, however, is decades of publicly mandated wildfire suppression leading to a buildup of fuels in forest understories (Chang, 1996). Other frequently cited reasons include effects on forest composition from climate change, alterations to fuel loads from grazing, and the cessation of intentional wildfire ignitions from Native Americans (Agee 1994; Skinner and Chang, 1996; Chang, 1996).

Twentieth-century fire-exclusion practices have been cited as the main cause of changes in forest structure and composition in forests of Lassen Volcanic National Park (LVNP), which includes the uppermost portion of the Hat Creek Watershed. Specifically, forest density has increased in both Jeffrey pine (*Pinus jeffreyi*) and Jeffrey pine-white fir (*Abies concolor*) forests, and white fir has increased in Jeffrey pine-white fir forests at the expense of Jeffrey

pine. In addition, higher-density understory populations were established between 80 to 140 years ago in Jeffrey pine-white fir forests. A dramatic overall decline in fire frequency was noted among all forest types during the post-European settlement period, which is listed to have begun in 1905 for this area (Taylor, 2000). A similar decline in fire frequency was estimated for a mixed-conifer forest in the Lassen National Forest farther south (Taylor, 2000). The timing of these changes in forest composition and structure and fire occurrence implicate wildfire suppression as the main cause. Similar changes have occurred elsewhere in the Sierra Nevada and southern Cascades, largely for the same reason (Taylor, 2000).

Given that a portion of the Hat Creek Watershed is located within LVNP, similar settlement patterns have likely affected the Hat Creek Watershed in much the same way. Furthermore, due to the similarity in forests occurring throughout the watershed, the same changes in forest composition and structure leading to an increased risk of larger, more catastrophic fires, have likely also occurred on Lassen National Forest lands because of wildfire suppression. Indeed, overstocked stands of white fir have been noted in and around the vicinity of the watershed, including some riparian areas of the perennial Hat and Lost Creeks and some ephemeral riparian corridors of Box Canyon, Rail Canyon, and Logan Gulch. Excess ground fuels in these areas have added to the elevated risk of structural damage from wildfires, as several dense stands of Manzanita brush along Hat Creek have been observed in close proximity to popular developed recreation sites. This presents a dangerous situation for recreationalists in the area and the residents of Old Station (USFS, 2007).

During the 2009 fire season, over 12,500 acres of the watershed were burned in the Hat Creek Complex wildland fires. These fires were caused by a series of lightning strikes that occurred during summer thunderstorms. Fire history from 1910 to 2009 in the watershed is shown on Figure 7. Table 4 shows a summary of acreage burned during the same timeframe.

Table 4
FIRE HISTORY

Time Scale	Acres
1910 - 1925	14,635
1926 - 1950	1,291
1951 - 1975	0
1976 - 2000	16,935
2000 - 2008	99
2009	12,603

Controlled burns are frequently used as a land management tool to restore forests to pre-European settlement conditions, thereby reducing the risk of damage to homes and other structures from wildfire. Controlled burns in LVNP have historically burned an average of approximately 300 acres per year. Considering that naturally occurring historic wildfires in the area are estimated to burn approximately 1,100 acres per year, land management recommendations have included prescribing much larger areas for controlled burns that would better mimic presettlement fires. In addition, because controlled burns often lead to the mortality of large-diameter tree species, manual methods of fuel reduction were recommended in place of controlled burns (Taylor, 2000).

The Sierra Institute for Community and the Environment has reported that reducing the risk of wildfires in the Hat Creek Watershed is the top priority concern among its citizens. Furthermore, the Sierra Institute noted that many citizens have been frustrated with their lack of involvement in USFS forest fuel-thinning projects on surrounding lands. In response to these concerns, the Sierra Institute made the following recommendations for projects to decrease fuel loading and expedite these projects in ways that best cater to the needs of local citizens:

- Devote more resources to USFS project planning, environmental review, and contracting
- Engage environmental groups and the forest industry in USFS project planning and contract development to ensure that projects are environmentally acceptable and economically feasible
- Focus first on smaller-scale thinning-from-below and biomass projects that will not face great opposition
- Start with smaller demonstration projects and plan phased projects to allow time for review and adaptation
- Subsidize fuel reduction on private land

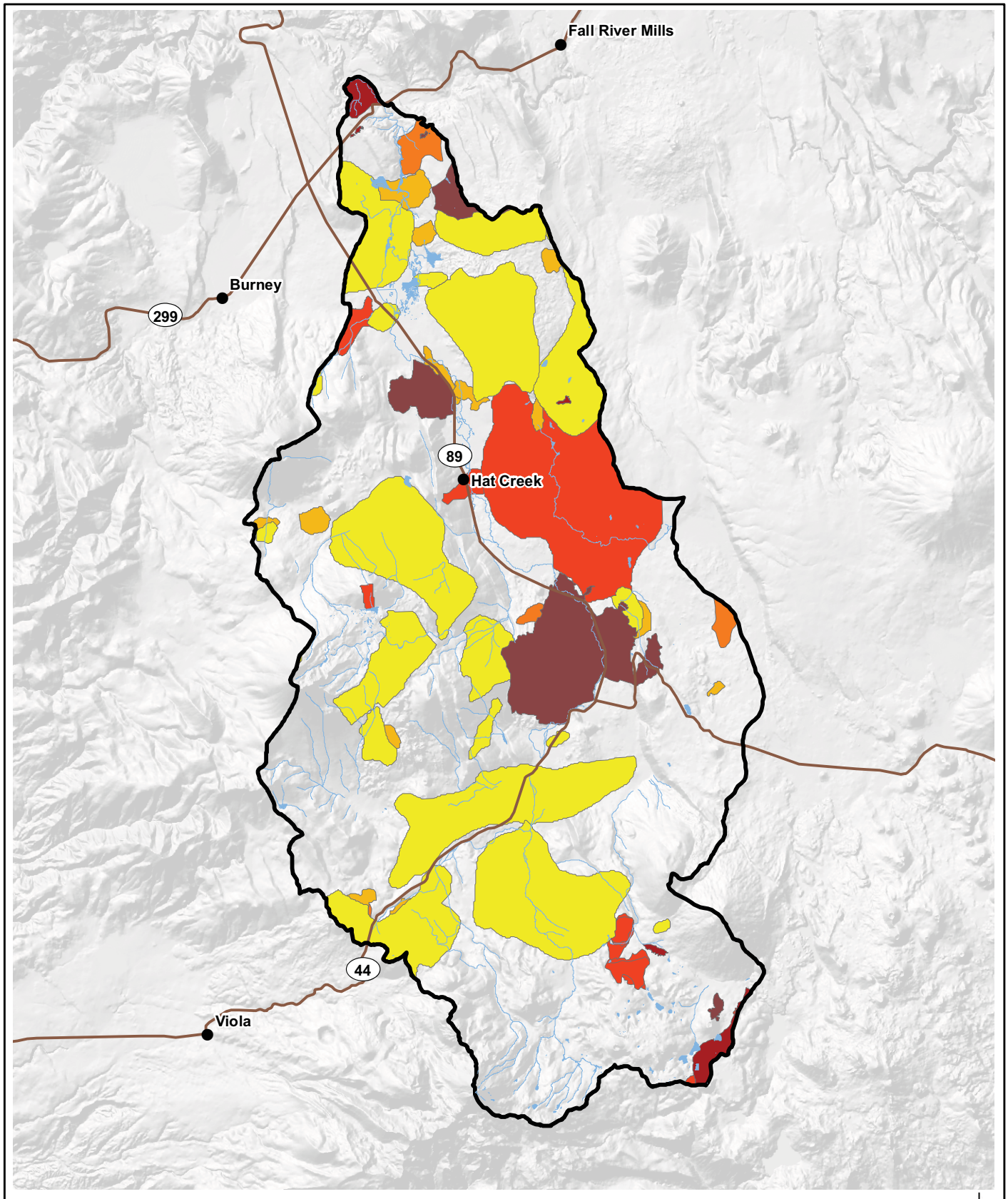

FIGURE 7
FIRE HISTORY
HAT CREEK WATERSHED

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PRECIPITATION, TEMPERATURE, AND SNOWFALL TRENDS

Recent changes in runoff patterns believed to be caused by warming trends have been observed in a number of mountainous watersheds in the western United States. Through their analysis of runoff data, Stewart et al. (2004) detected a shift in the timing of the center mass of flow (CT) towards earlier in the season in many western watersheds from 1948 to 2000. This shift was observed to be as high as 15 to 20 days earlier in high-elevation watersheds of the Sierra Nevada. Cayan et al. (1997) researched spring runoff patterns in the Sierra Nevada and found that the runoff pulse at the Merced River near Yosemite National Park shifted to approximately 7 days earlier in the season from 1948 to 1996. Although long-term runoff patterns are not available for these types of analyses in the Hat Creek Watershed, the analyses of water-year or monthly patterns in precipitation, temperature, and snowfall were used to provide better insight on potential changes in runoff that may have occurred in these watersheds.

Historic climate records from the Hat Creek Watershed were analyzed to identify climatic trends that would indicate a change in the amount of water occurring as precipitation or runoff on a monthly or water-year timescale. The data selected for these analyses came from the Western Regional Climate Center (WRCC) and the DWR California Data Exchange Center (CDEC), both which maintain a network of climate stations throughout California. Climate data from these stations are available for free download online (WRCC: http://www.wrcc.dri.edu/; CDWR: http://leva.water.ca.gov/). The information available from climate stations located in the watershed is summarized in Table 5. Figure 8 shows precipitation bands in the watershed.

Table 5
AVAILABLE CLIMATE DATA

Watershed	Climate Station Name/ID	Source	Elev (ft)	Lat (°)	Long (°)	Begin Date	End Date	Data Type Available[1]
Hat Creek	Hat Creek PH1 – 043824	WRCC	3020	40.933	121.550	1/11/1921	6/30/2009	P, SD, T
Hat Creek	Blacks Mtn Ranch – 040870	WRCC	5600	40.733	121.250	7/1/1948	7/31/1960	P, SD
Hat Creek	Manzanita Lake – 045311	WRCC	5850	40.533	121.567	1/1/1949	6/30/2009	P, SD, T
Hat Creek	Manzanita Lake – OMN/NMN	CDEC	5900	40.533	121.562	2/1/1936	5/1/2009	SWC
Hat Creek	Blacks Mtn – BMN	CDEC	6700	40.762	121.195	4/1/1945	4/1/2009	SWC
Hat Creek	Thousand Lakes – THL	CDEC	6500	40.710	121.577	2/1/1946	4/1/2009	SWC

NOTES:
[1] P = Precipitation; S = Snow Depth; SWC = Snow-Water Content; T = Average Temperature
Climate records used in the analyses came from the stations shaded in gray

Historic monthly and water-year records of precipitation, temperature, snow-water content, and snow depth were used for this analysis. Only monthly data from December through May was used, as precipitation occurring during these months typically represents the majority of the precipitation occurring during the water-year in the watershed. Historic discharge records greater than 30 years could not be obtained. An attempt was made to use climate records from at least one high-elevation (>6000 feet) and one low-elevation (<4000 feet) station within the watershed with a minimum record length of 50 years.

Monthly and water-year climate data were plotted over time to analyze the historic variations in climate data. The Mann-Kendall statistical procedure was used to evaluate trends at monthly (December through May) and water-year timescales. Precipitation and temperature time-series graphs with accompanying trend are included below for statistically significant trends.

Results of the historic precipitation, temperature, and snowfall analysis, including trends and associated statistical significance, are presented in Table 6.

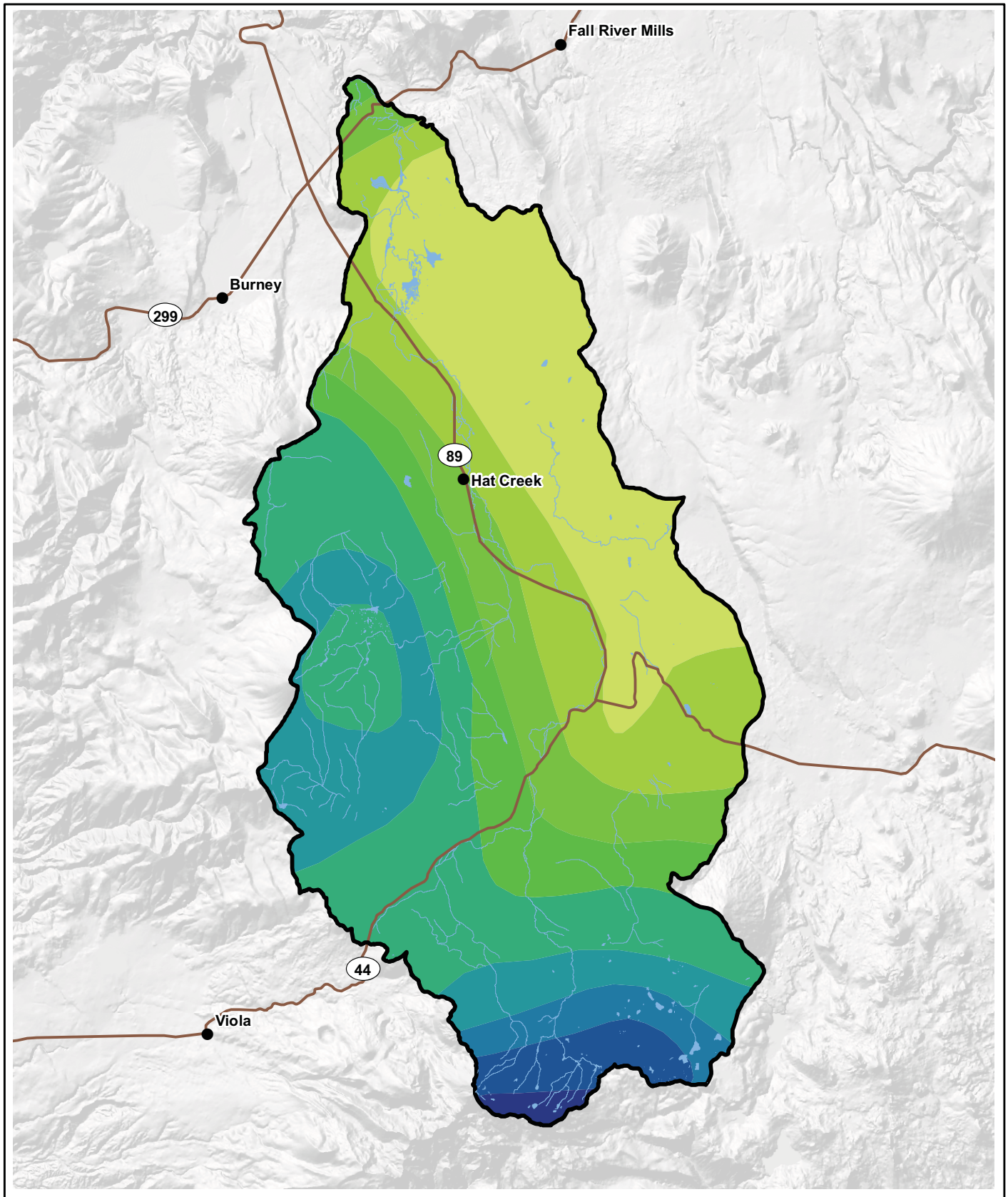

FIGURE 8
PRECIPITATION
HAT CREEK WATERSHED

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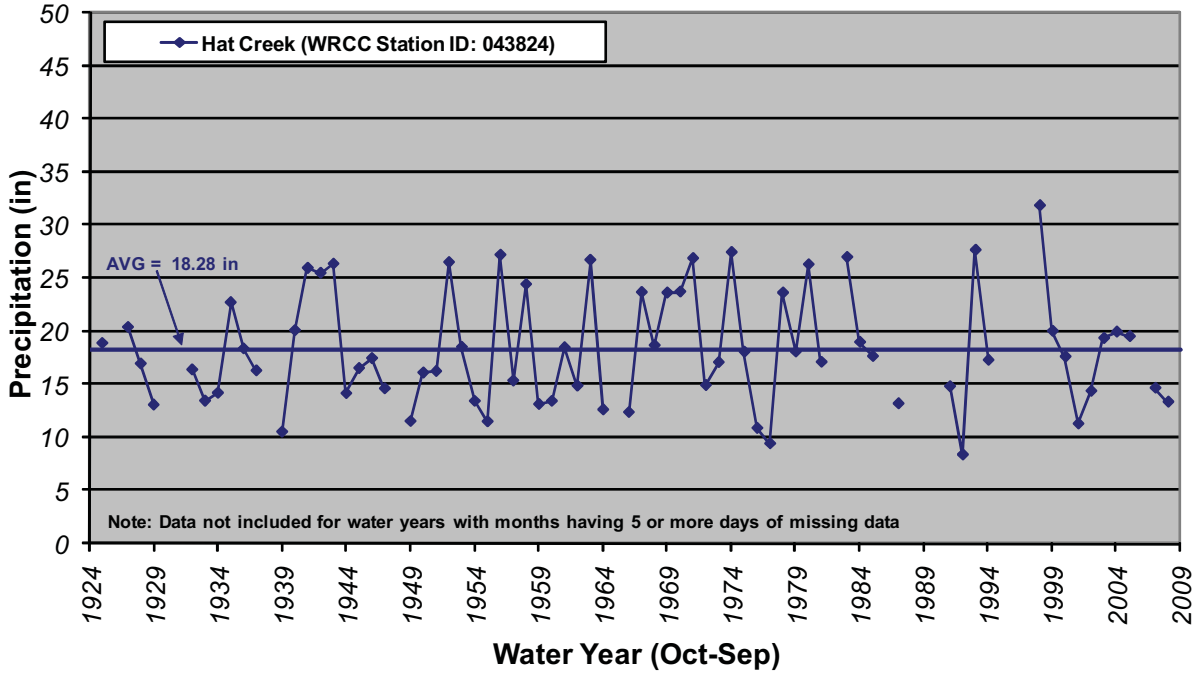
Historic Water Year Precipitation for Hat Creek Watershed (1924 - 2009)



Historic Mean Monthly Precipitation for Hat Creek Watershed (1949 - 2009)

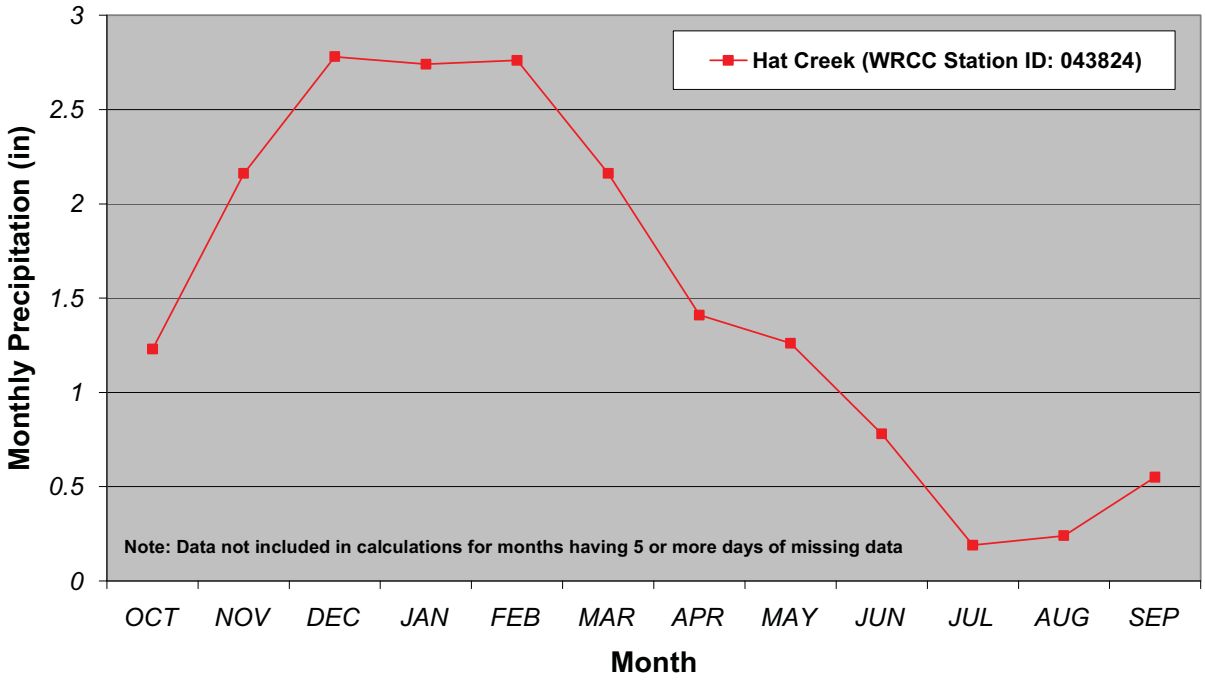


Table 6
HISTORICAL TEMPERATURE, PRECIPITATION AND SNOWFALL TRENDS
BURNEY CREEK AND HAT CREEK WATERSHEDS

Time	Precip Decadal Trend (in)	Statistical Significance	Temp Decadal Trend (ºF)	Statistical Significance	Snowfall Decadal Trend (in)	Statistical Significance
Burney, CA (WRCC Station Number: 041214) 1948 – 2009						
WY	Up 0.61	<80%	Up 0.75	<80%	Down 1.06	<80%
DEC	Down 0.38	<80%	Down 0.16	<80%	Down 0.32	<80%
JAN	Up 0.25	90%	Up 0.55	<80%	**Down 1.48**	**95%**
FEB	Up 0.13	<80%	Up 0.24	<80%	No Trend	<80%
MAR	Up 0.15	<80%	Up 0.45	90%	**Down 0.64**	**95%**
APR	Up 0.01	<80%	Up 0.09	<80%	Up 0.43	80%
MAY	Up 0.25	<80%	Up 0.55	80%	Down 0.08	<80%
Snow Mountain, CA (CDEC Station ID SMT) 1930 - 2009						
WY	--	--	--	--	--	--
DEC	--	--	--	--	--	--
JAN	--	--	--	--	--	--
FEB	--	--	--	--	--	--
MAR	--	--	--	--	--	--
APR	--	--	--	--	Down 0.64	<80%
MAY	--	--	--	--	--	--
Hat Creek, CA (WRCC Station Number: 043824) 1921-2009						
WY	Down 0.01	<80%	**Down 0.25**	**99%**	**Down 4.73**	**99%**
DEC	Up 0.04	<80%	Down 0.20	80%	Down 0.15	<80%
JAN	No trend	<80%	Up 0.10	<80%	**Down 0.94**	**99%**
FEB	Up 0.01	<80%	Down 0.03	<80%	**Down 0.69**	**99%**
MAR	Up 0.05	80%	Down 0.22	<80%	**Down 0.61**	**99%**
APR	Up 0.01	80%	**Down 0.40**	**95%**	**Down 0.26**	**99%**
MAY	Down 0.01	<80%	**Down 0.24**	**95%**	Down 0.11	90%
Manzanita Lake, CA (WRCC Station Number 045311) 1949 - 2009						
WY	**Down 0.92**	**95%**	Up 0.10	<80%	Down 1.58	<80%
DEC	Down 0.10	<80%	Down 0.36	<80%	Up 0.44	<80%
JAN	Down 0.31	<80%	**Up 0.75**	**95%**	Down 1.27	<80%
FEB	Down 0.02	<80%	Up 0.35	90%	Up 0.96	<80%
MAR	Down 0.04	<80%	**Up 0.92**	**99%**	Down 1.58	80%
APR	Down 0.04	<80%	Up 0.06	<80%	Up 0.92	<80%
MAY	Down 0.10	<80%	Up 0.25	<80%	Down 1.00	80%
Thousand Lakes, CA (CDEC Station ID THL) 1946 - 2009						
WY	--	--	--	--	--	--
DEC	--	--	--	--	--	--
JAN	--	--	--	--	--	--
FEB	--	--	--	--	Down 0.57	<80%
MAR	--	--	--	--	Down 1.04	<80%
APR	--	--	--	--	Down 1.40	<80%
MAY	--	--	--	--	Down 1.81	90%

NOTES:
WY = Water-year
-- Data not available for that month or water-year
Bold values indicate trends of statistical significance >= 95%
Snowfall recorded as snow depth for WRCC climate stations and snow-water content at CDEC stations
Historic temperature and precipitation data not available at SMT and THL climate stations
Historic snow-water content data only available for April at SMT and February – May at THL

Historical precipitation trends show monthly and water-year precipitation to have been largely stable at the Hat Creek climate station and decreasing at the Manzanita Lake climate station. Historical temperature trends show large increases for most historical months and for the water-year at Hat Creek, but decreased for most months and the water-year at Manzanita Lake. Historical snow-depth trends show a decrease for all winter to spring months and the water-year at Hat Creek. Manzanita Lake trends were not statistically significant.

Based on the trends at the Hat Creek station with a statistical significance of less than 5 percent, snow depth and precipitation appear to have slightly decreased over time. Because no trends in historic temperature were observed from the Hat Creek data, the decreased snow depth does not appear to have been caused by an increase in temperature. As indicated by the snow depth and snow-water content trends at the higher-elevation climate stations within the watershed, snow-water content appears to have decreased overall, although not to a statistically significant degree. Precipitation increased overall at the higher-elevation stations while temperature decreased, which further suggests that the decreases in snow depth and snow-water content in the Hat Creek Watershed were not caused by an increase in temperature.

Due to the low levels of statistical significance that were observed in the increasing precipitation and temperature trends, it is difficult to assess if these trends are likely to continue in the future. February and April snow depth were observed to decrease at higher levels of statistical significance, which is potentially indicative of a shift in runoff CT and spring-runoff pulse towards earlier in the season, similar to what was calculated by Stewart et al. (2004) and Cayan et al. (1997) in the Sierra Nevada. However, changes in runoff patterns cannot be concluded from this analysis without more statistically robust climatic trends or the use of long-term measurements of actual discharge from the watershed to more accurately calculate the historic runoff CT and spring-runoff pulse. The overall decrease in snow depth and snow-water content is likewise indicative of a potential shift in runoff CT and spring-runoff pulse towards earlier in the season; however, longer-term records are required in order to deduce changes in runoff patterns or hydrologic characteristics from the observed climatic trends.

RECREATION

Recreation in the Hat Creek Watershed is primarily associated with fishing and hunting, although camping, hiking, and wildlife watching are also popular. The Pacific Crest Trail runs through the watershed along the west shore of Baum Lake. Waterfowl hunting occurs around Crystal Lake, and wildlife viewing is especially popular at Baum and Crystal Lakes (Stewardship Council, 2007). The Cassel Campground includes ADA-compliant campsites. Boating with non-motorized, electric trolling motorboats is popular at Baum Lake.

Lassen Volcanic National Park provides access to a number of volcanic and geothermal resources as well as camping, hiking, backpacking, and picnicking. Approximately 74 percent of the park is located in a designated Wilderness Area (U.S. Department of the Interior, 2005). The park offers camping at seven developed campgrounds. Backcountry camping is available to individuals in possession of a wilderness permit. Campgrounds provide access to fishing areas, hiking trails, and volcanic and geothermal areas within the park.

Approximately 155,017 acres of Lassen National Forest and 34,052 acres of LVNP are located within the Hat Creek Watershed. The Hat Creek Ranger District of the Lassen National Forest manages 62 miles of the Pacific Crest Trail and several smaller hiking trails located on National Forest and Park lands within the watershed. An extensive network of dirt roads both east and west of Hat Creek within the watershed in Lassen National Forest provides access to these recreation opportunities. The Thousand Lakes Wilderness Area provides over 21 miles of hiking trails, including the Bunchgrass Trailhead, Cypress Trailhead, and the Tamarack Trailhead.

The Hat Creek Recreation Area is one of the most popular areas in the Lassen National Forest, and its popularity is growing. Heavy use during the summer months is believed to be contributing to declining conditions with respect to soil, vegetation, and riparian conditions within and adjacent to Hat and Lost Creeks within the watershed. The Hat Creek corridor has a high level of dispersed recreation use. It is common during high-volume weekends (Memorial Day, Fourth of July, and Labor Day) for up to 20 recreational vehicles to be parked within half-acre areas adjacent to the creek in the Big Pine and Twin Bridges areas. This presents a high risk for wildfire ignition, and introduces sources of sediment and human waste contamination. The Old Station area has the highest number of human-caused ignitions in the Hat Creek District. In 2007, the USFS noted that “a wildfire in this corridor would not only represent a highly dangerous situation for forest visitors and residents of Old Station, but would likely lead to highly degraded conditions with respect to soil, vegetation, and watershed values.” Just such a fire occurred in 2009.

There are numerous unauthorized off-highway vehicle (OHV) routes in the vicinity of Hat and Lost Creeks. Routes are being created by all-terrain, 4-wheel drive, and other motorized vehicles, and the number and mileage of these unauthorized routes are growing at an exponential rate. Their creation and continued use damage soil and vegetation. During the rainy season, OHV trails contribute to undesirable water diversion, erosion, and sedimentation to Hat and Lost Creeks. There are also several existing unclassified roads across the watershed that can alter drainage patterns, provide sediment sources, and facilitate additional route creation (USFS, 2007).

The Lassen National Forest recently completed an inventory of OHV roads, trails, and areas to identify routes that could be added to the National Forest Transportation System without environmental or economic impacts. The goal is to develop a transportation system that is manageable, environmentally sensitive, and economically viable. The rapid expansion of OHV travel in the area has impacted the natural and cultural resources. Unmanaged OHV use has resulted in unplanned roads and trails, erosion, watershed and habitat degradation, and impacts to cultural resource sites. Improved management of wheeled-vehicle use will allow enhanced opportunities for public enjoyment, including motorized and non-motorized recreation experiences (USFS, 2006).

Hat Creek Park, managed by the Shasta County Department of Public Works, provides public access to catch-and-release fly-fishing. The park, located along Highway 299, is a day-use facility that includes a roadside rest area, picnic area, and a place to view nature and wildlife.

DISPERSED RECREATION

Many of the dispersed recreation areas along Hat and Lost Creeks are experiencing declining soil, vegetation, and riparian conditions. Areas of particular concern include the west side of Hat Creek across from Cave Campground, the area just south of Big Pine Campground, and the area around the Twin Bridges crossing of Hat Creek near the confluence of Hat and Lost Creeks (also known as “The Peninsula”).

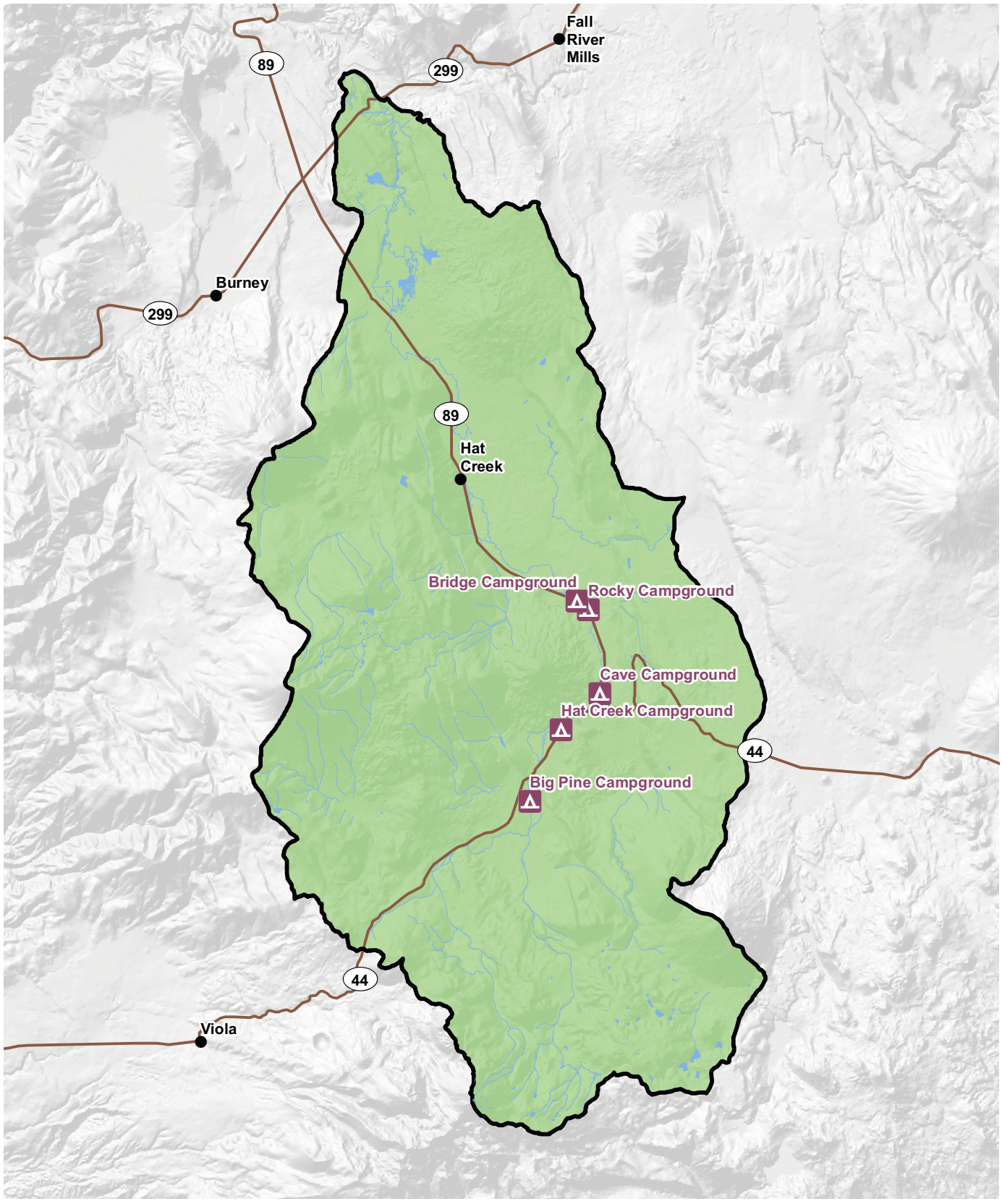
Cave Campground – The area on the west side of Hat Creek across from Cave Campground has been a popular site for dispersed recreation. Recreational vehicles, pickup trucks, 4x4s, cars, ATVs, and dirt bikes have used one particular area to the extent that groundcover has been reduced to 0 to 10 percent over 2 to 4 acres of land. Boulders, log barriers, and signs have been placed to discourage overuse immediately adjacent to Hat Creek. Some of the measures have been effective and groundcover is improving. Other areas continue to be heavily used, preventing groundcover recovery. Where barricades are not present, vehicles are able to be driven to within a few feet of the creek. Outside campers park in the area for free and walk across a footbridge to use the facilities within the developed campground for which other users have paid. The proximity of these facilities encourages continued use of this dispersed area (USFS, 2007).

Big Pine Campground – The area adjacent to Hat Creek and south of the Big Pine Campground receives heavy use by dispersed recreationists. Several sites located near Hat Creek experience heavy vehicle and foot traffic, which has destroyed all groundcover. Campfires in the area are a problem as sites adjacent to the creek provide sediment sources and opportunities for ashes and trash to wash into the creek during high flows. Vehicle traffic has created ruts and destroyed groundcover in large areas adjacent to Hat Creek (USFS, 2007).

Twin Bridges Campground – The area located near the confluence of Hat and Lost Creeks is used heavily by campers and OHV riders. As a result, the area has very little groundcover. This has created conditions which lead to direct contribution of sediment to Hat Creek during runoff events. The popularity of the area has also contributed to the creation of many new OHV trails and illegal OHV use of the Pacific Crest Trail, which runs through this area. Dispersed camping and heavy equestrian use also occurs on the east side of Hat Creek, between the Pacific Crest Trail and Hat Creek (USFS, 2007).

DEVELOPED RECREATION

There are several developed recreation sites in the Hat Creek Watershed which have experienced riparian and soil impacts related to excessive use. Users have trampled streambanks and damaged riparian vegetation, removing groundcover and compacting soils. These impacts have led to additional sediment input and channel morphology changes, which in turn affect aquatic habitat and diminish the value of the resources that recreationalists have come to enjoy in the area (USFS, 2007). The campgrounds described in this section are shown on Figure 9.



Developed Recreation Campground Location

VESTRA

SOURCE: CASIL 2006

0 2.5 5 10 Miles

FIGURE 9
DEVELOPED RECREATION CAMPGROUNDS
HAT CREEK WATERSHED

P:\GIS\70809\Figures\HatCreek\70809_Campgrounds.mxd

Bridge and Rocky Campgrounds – The Bridge and Rocky Campgrounds, located along Highway 89, are well used with fishing access to Hat Creek. This use has caused the trampling of vegetation, damage and removal of groundcover, and creation of sediment sources. Perpendicular side trails along the creek have led to increased erosion and sediment input to Hat Creek (USFS, 2007).

Cave Campground – This site, located across Hat Creek, has many campground units located within 300 feet of Hat Creek. High use along the streambank has resulted in areas of reduced groundcover and impacted riparian vegetation (USFS, 2007).

Hat Creek Campground, Group Camp, and Day Use Area – This large developed recreation facility is located along Hat Creek, south of Old Station, along Highways 44 and 89. Several of the campground sites are located within 300 feet of the creek. The group-camp loop gets heavy use across a 1-acre area, which destroys groundcover and prevents growth of understory vegetation. The day-use area located just north of the main campground is subject to heavy fishing usage, which has resulted in bare soils, trampled vegetation, and compacted surfaces adjacent to the creek (USFS, 2007).

Big Pine Campground – The majority of campsites in this small campground located along USFS Road 32N13 are located within 300 feet of Hat Creek. The area is experiencing a loss of groundcover and damage to riparian vegetation along the western bank of the creek (USFS, 2007).

RV PARKS AND RESORTS

There are several privately owned RV parks and resorts in the watershed within the Hat Creek corridor that provide access to hiking and fishing along Hat Creek. These facilities increase the potential for human trampling of vegetation along streambanks, thereby increasing the potential for sediment introduction into Hat Creek. Other facilities have and regularly manage a fenced riparian corridor.

Hat Creek Hereford Ranch RV Park and Campground – This developed RV park and campground is located along Hat Creek off of Highway 89. Amenities include showers, full RV hookups, tent sites, a laundromat, and general store. A trout-stocked pond with public beach and campground are also located onsite.

Hat Creek Resort and RV Park – This well-developed lodging and recreation area is located off of Highway 44 on Hat Creek in Old Station. Lodging opportunities include small cabins, RV hookups, and tent camping. Some of the amenities located onsite include a convenience store, showers, a laundromat, picnic areas, and several recreation grounds. The grounds provide access to fishing on Hat Creek and hiking on the Pacific Crest Trail.

Rancheria RV Park – This RV park is located off of Highway 89 in Hat Creek. Lodging opportunities include nightly cabin rentals, RV hookups, and tent camping. Onsite amenities include showers, a laundromat, a restaurant, and 3-acre fish-stocked lake.

Rippling Waters Resort – This resort, located off of Highway 89 in Hat Creek, offers cabin rentals along with designated picnic areas. It provides access to fishing on Hat Creek as well as other smaller tributaries.

GROUNDWATER

Groundwater in the Hat Creek Watershed predominantly flows from south to north at a gradient of 3 to 5 feet per mile towards the Pit River, following the surface topography (Parfitt, 1984). Springs and disappearing streams are common in the region and make up the bulk of groundwater flow due to the existence of fractured and permeable volcanic rocks throughout the watershed. The discharge rates for the springs in the watershed vary from approximately 60 to 300 cubic feet per second (18,000 to 217,200 acre-feet per year), and are known to experience rapid flow decreases during droughts, suggesting high aquifer interconnectivity to the recharge area (Rose et al., 1996). The depth to groundwater at the northern end of the watershed is generally 50 to 70 feet, while greater than 300 feet at the southern end. The higher water table elevation at the northern end of the watershed greatly increases the potential for groundwater development in this region. Well yields are generally 18 gallons per minute and range from a low of 8 gallons per minute to a high of 35 gallons per minute (Parfitt, 1984).

Groundwater is largely confined to three groundwater basins that include the Lake Britton Area, the Modoc Plateau Pleistocene Volcanic Area, and the Modoc Plateau Recent Volcanic Area. Information regarding groundwater resources of the Modoc Plateau Pleistocene Volcanic Area and the Modoc Plateau Recent Volcanic Area could not be obtained at the time of writing this report (DWR, 2003).

The Lake Britton Area Groundwater Basin is a 22-square-mile basin bounded by Pleistocene basalt to the south, Tertiary andesite to the west, and Miocene basalt and Pliocene andesite to the north. Approximately 20 percent of this basin exists within the watershed, encompassing only the extreme northern end of the watershed. The combined groundwater extraction for municipal and industrial uses in the basin is 5 acre-feet; deep percolation of applied water is 10 acre-feet. Based on information from 17 well completion reports, the average domestic groundwater well depth in the basin is 133 feet with a range of 46 to 415 feet (DWR, 2003).

WATER QUALITY

The limited amount of data able to be obtained indicates that water quality in the Hat Creek Watershed is generally good. The United States Geological Survey (USGS) collected four rounds of samples from Hat Creek near the town of Old Station for general minerals and field parameters from July to December 1977. In addition, DWR collected quarterly samples from August 2000 to May 2008 farther downstream, near Cassel, for general minerals and field parameters and for total and dissolved metals. The results of the analyses from the USGS and DWR are presented in Tables 7 and 8, respectively. The results of the DWR metals analyses are presented in Table 9. Current regulatory standards for a given constituent, when available, are presented in the final row of each table. No exceedances of the current regulatory standards were noted for any of the samples collected and analyzed. The results of two rounds of sampling for semi-volatile and volatile organic carbons collected by the DWR in February and May 2001 were below the laboratory detection limits.

Table 7
USGS GENERAL MINERALS AND FIELD PARAMETER RESULTS OF HAT CREEK NEAR OLD STATION

Sample Date	Termperature (°C)	Specific Conductivity (umohs/cm)	Hydrogen Ions (mg/L)	Dissolved Oxygen (mg/L)	pH (units)	Carbon Dioxide (mg/L)	Acid Neutralizing Capacity (mg/L as CaCO3)
7/14/1977	11	153	0.00001	9.7	7.9	1.9	77
8/15/1977	11	140	0.00001	9.9	8.1	1.2	77
9/12/1977	11	152	0.00001	9.6	7.9	1.9	77
12/13/1977	8.5	154	0.00002	10.5	7.7	2.9	75
Regulatory Standard	**--**	**--**	**--**	**--**	**6.5 to 8.5**	**--**	**--**

SEDIMENTATION

The northern portion of the Hat Creek Watershed is especially susceptible to increased sediment loading. The 1998 Assessment of Erosion and Sedimentation in the Hat Creek Hydroelectric Project Vicinity study found that Corral Creek was a point source of sediment to the Hat Creek Wild Trout Area. Corral Creek is located on the west side of Hat Creek, near the Carbon Bridge fishing access. Check dams were placed to catch some of the sediment from migrating farther downstream, but bank cutting during high flows have put the dams at risk for washouts. In addition, Cinder Flats Creek was found to have active headcuts working up through the drainage and an extremely degraded floodplain and channel due to historic overgrazing. It is unknown how much recovery has taken place in the creek. The Stewardship Council has concluded that an assessment of the potential for restoration of Cinder Flats and Corral Creeks is necessary to restore hydrologic function and enhance riparian habitat (Stewardship Council, 2007).

Table 8
DWR GENERAL MINERALS AND FIELD PARAMETER RESULTS OF HAT CREEK AT CASSEL

Sample Date	Specific Conductivity (umohs/cm)	pH (units)	Total Alkalinity (mg/L as CaCO3)	Ammonia (mg/L)	Ammonia (mg/L as N)	Dissolved Ammonia (mg/L as N)	Dissolved Calcium (mg/L)	Total Calcium (mg/L)	Dissolved Chloride (mg/L)	Hardness (mg/L CaCO3)	Hardness (mg/L - CaCO3)	Dissolved Hardness (mg/L as CaCO3)	Total Hardness (mg/L as CaCO3)	Dissolved Nitrate (mg/L)	Dissolved Nitrate + Nitrite (mg/L as N)	Dissolved Nitrite (g/l as N)	Dissolved Organic Nitrogen (mg/L as N)	Ortho-phosphate (mg/L as P)	Dissolved Ortho-phosphate (mg/L - P)	Total Phosphorus (mg/L)	Dissolved Potassium mg/L)	Dissolved Sodium (mg/L)	TDS (mg/L)	TSS (mg/L)	Dissolved Sulfate (mg/L)
8/21/2000	--	--	--	--	--	0.01	9	--	1	47	--	--	--	--	0.1	--	--	0.04	--	0.06	2.4	7	96	<1	2
11/21/2000	--	--	--	--	--	0.02	10	--	1	54	--	--	--	--	0.14	--	--	--	0.06	0.07	2.4	8	97,101[1]	<1	2
2/20/2001	137	7.7	66	--	--	0.02	9	--	1	51	--	--	--	0.5	0.13	<0.01	--	--	0.06	0.07	2.2	8	99	2	2
5/30/2001	--	--	--	--	--	0.03	8	--	1	46	--	--	--	--	0.08	--	--	--	0.06	0.07	2.1	7	--	<1	2
8/29/2001	--	--	--	--	--	--	8	--	1	45	--	--	--	--	0.15	--	--	--	0.04	0.07	2.2	7	97	2	2
11/20/2001	--	--	--	--	--	--	9	--	1	52	--	--	--	--	0.13	--	--	--	0.04	0.08	2.4	8	104	2	2
2/20/2002	--	--	--	--	--	--	10	10	<1	54	--	--	54	--	0.12	--	--	--	0.04	0.07	2.3	8	86	4	2
5/29/2002	--	--	--	--	--	--	9	10	<1	47	--	--	54	--	<0.1	--	--	--	<0.1	<0.2	2	7	82	1	2
11/26/2002	--	6.6	71	--	--	<0.1	7	9	1	36	--	--	51	--	0.1	--	--	--	<0.1	<0.1	1.6	6	87	1	2
2/25/2003	--	6.8	71	--	--	0.01	10	10	1	54	--	--	54	--	0.13	--	--	--	0.05	0.06	2.3	8	82	1	2
6/10/2003	--	6.2	68	--	--	0.01	8	9	1	--	47	45	--	--	0.05	--	--	--	0.03	0.07	1.9	6	77	2	2
11/13/2003	--	7.6	68	--	--	0.02	9	9	1	--	47	45	--	--	0.18	--	--	--	0.1	0.08	2.1	7	101	2	2
3/23/2004	--	7	66	--	--	0.01	9	10	1	--	54	51	--	--	0.08	--	--	--	0.06	0.08	2.3	8	86	2	2
5/25/2004	--	6.7	63	--	--	0.01	9	10	1	--	54	51	--	--	0.07	--	--	--	0.06	0.06	2.3	8	85	3	2
8/17/2004	--	6.8	62	--	--	0.02	10	10	1	--	54	50	--	--	0.1	--	--	--	0.05	0.06	2.2	7	90	4	2
11/16/2004	--	7.3	66	--	--	0.02	9	10	1	--	50	47	--	--	0.16	--	<0.1	--	0.06	0.14	2.3	7	97	3.2	2
2/10/2005	--	6.5	69	--	--	0.02	10	10	1	--	54	54	--	--	0.12	--	--	--	0.06	0.06	2.4	8	99	4	2
5/10/2005	--	7.2	64	--	--	0.02	9	9	1	--	51	47	--	--	0.07	--	--	--	0.05	0.07	2.1	7	94	2	2
8/16/2005	135	6.9	67	--	--	0.02	9	9	2	--	47	47	--	--	0.09	--	--	--	0.06	0.06	2.4	7	91	<1	2
11/2/2005	138	8.3	70	--	<0.1	--	9	10	1	--	54	51	--	--	--	--	--	--	--	0.11	2.3	8	99	5	2
2/8/2006	137	7.7	64	--	<0.1	<0.01	9	10	1	--	54	51	--	--	0.11	--	--	--	0.06	0.06	2.2	7	96	3	2
5/9/2006	132	8	65	--	<0.1	<0.01	9	10	2	--	50	47	--	--	0.06	--	--	--	0.05	0.05	2.2	7	92	6	2
8/8/2006	135	7.8	63	--	<0.1	0.02	10	10	2	--	50	50	--	--	0.1	--	--	--	0.05	0.05	2.1	8	96	2	2
11/7/2006	133	7.9	66	--	<0.1	0.02	10	10	1	--	54	54	--	--	0.17	--	--	--	0.06	0.06	2.1	8	96	7	2
2/6/2007	137	8	66	--	--	0.03	10	10	1	--	54	54	--	--	0.13	--	--	--	0.05	0.06	2.2	8	89	6	2
5/1/2007	122	8	61	<0.1	--	0.03	9	9	1	--	47	47	--	--	0.08	--	--	--	0.04	0.06	2	7	91	5	3
7/31/2007	130	7.9	64	0	--	0.02	9	9	2	--	47	47	--	--	0.08	--	--	--	0.04	0.05	3	7	90	1	2
11/14/2007	138	7.6	66	0	--	0.01	9	10	1	--	54	47	--	--	0.14	--	--	--	0.04	0.06	2.1	7	105	<1	2
2/6/2008	130	7.5	66	--	--	0.05	9	9	1	--	51	51	--	--	1.65	--	--	--	0.07	0.07	2.1	7	90	5	2
5/13/2008	131	8	64	--	--	0.02	9	10	<1	--	52	52	--	--	0.06	--	--	--	0.05	0.05	2.2	7	88	2	2
Reg Standard	**--**	**6.5-8.5**	**--**	**1.5**	**1.5**	**1.5**	**--**	**--**	**230**	**--**	**--**	**--**	**--**	**10**	**10**	**10**	**10**	**--**	**--**	**--**	**--**	**--**	**20**	**--**	**--**	**250**

NOTE: [1] More than one analyses were used for this sample

Table 9
DWR METALS ANALYSIS OF HAT CREEK AT CASSEL

Sample Date	Aluminum (ug/L)	Arsenic (ug/L)	Boron (mg/L)	Cadmium (ug/L)	Chromium (ug/L)	Copper (ug/L)	Iron (ug/L)	Lead (ug/L)	Magnesium (mg/L)	Manganese (ug/L)	Nickel (ug/L)	Selenium (ug/L)	Silver (ug/L)	Zinc (ug/L)
Dissolved Metals Analyses														
8/21/2000	--	--	<0.1	--	--	--	--	--	6	--	--	--	--	--
11/21/2000	--	--	<0.1	--	--	--	--	--	7	--	--	--	--	--
2/20/2001	--	--	<0.1	--	--	--	--	--	7	--	--	--	--	--
5/30/2001	--	--	0.1	--	--	--	--	--	6	--	--	--	--	--
8/29/2001	--	--	<0.1	--	--	--	--	--	6	--	--	--	--	--
11/20/2001	--	--	<0.1	--	--	--	--	--	7	--	--	--	--	--
2/20/2002	--	--	<0.1	--	--	--	--	--	7	--	--	--	--	--
5/29/2002	--	--	<0.1	--	--	--	--	--	6	--	--	--	--	--
11/26/2002	--	--	<0.1	--	--	--	--	--	5	--	--	--	--	--
2/25/2003	--	--	<0.1	--	--	--	--	--	7	--	--	--	--	--
6/10/2003	--	--	<0.1	--	--	--	--	--	6	--	--	--	--	--
11/13/2003	--	--	<0.1	--	--	--	--	--	6	--	--	--	--	--
3/23/2004	7.81	0.934	<0.1	<0.001	1.03	0.27	9.8	<0.002	7	0.71	0.23	<0.056	0.01	0.05
5/25/2004	--	--	<0.1	--	--	--	--	--	7	--	--	--	--	--
8/17/2004	--	--	<0.1	--	--	--	--	--	6	--	--	--	--	--
11/16/2004	1.99	0.822	<0.1	<0.012	1.02	0.22	<4.5	<0.01	6	0.04	0.2	<0.163	<0.011	<0.029
2/10/2005	1.43	0.833	<0.1	<0.077	0.59	0.13	<3.03	<0.002	7	0.14	0.21	<0.154	<0.002	<0.015
5/10/2005	140	0.785	<0.1	<0.029	1.02	0.38	104	0.012	6	0.83	0.3	<0.208	<0.009	0.19
8/16/2005	4.19	0.743	<0.1	<0.004	0.72	0.25	<3.27	<0.018	6	0.47	0.14	<0.222	<0.013	<0.031
11/2/2005	2.81	0.774	<0.1	<0.009	1.17	0.24	<3.13	<0.004	7	0.12	0.23	<0.186	<0.009	0.06
2/8/2006	12.9	0.822	<0.1	<0.007	0.78	0.19	11.1	<0.006	7	1.87	0.27	<0.249	<0.027	<0.036
5/9/2006	3.43	0.8	<0.1	<0.1	0.71	0.25	4.2	<0.04	6	0.66	0.2	<0.2	<0.03	0.16
8/8/2006	4.88	0.804	<0.1	<0.1	0.87	0.28	16.2	<0.04	6	0.81	0.26	<0.2	<0.03	<0.1
11/7/2006	14.2	0.926	<0.1	<0.1	0.87	0.28	21.1	<0.04	7	0.79	0.3	<0.2	<0.03	0.52
2/6/2007	6.64	0.902	<0.1	<0.1	0.73	0.21	11.3	<0.04	7	0.77	0.3	<0.2	<0.03	0.2
5/1/2007	2.8	0.896	<0.1	<0.1	0.8	0.3	18.1	<0.04	6	3.85	0.1	<0.2	<0.03	0.23
7/31/2007	11.2	0.849	<0.1	<0.1	0.77	0.17	3	<0.04	6	0.19	0.11	<0.2	<0.03	0.17
11/14/2007	1.29	0.761	<0.1	<0.1	0.73	0.18	<0.1	<0.04	6	0.27	<0.1	<0.2	<0.03	<0.1
2/6/2008	0.8	0.777	<0.1	<0.1	0.84	0.29	5.2	<0.04	7	0.13	0.21	<0.2	<0.03	0.14
5/13/2008	0.7	0.825	<0.1	<0.1	0.75	0.36	5.9	<0.04	7	0.27	0.25	<0.2	<0.03	0.2
Reg Standard	**200**	**10**	**0.09**	**2**	**50**	**7**	**300**	**30**	**--**	**50**	**100**	**5**	**1**	**65**
Total Metals Analyses														
8/21/2000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
11/21/2000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2/20/2001	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/30/2001	--	--	--	--	--	--	--	--	--	--	--	--	--	--
8/29/2001	--	--	--	--	--	--	--	--	--	--	--	--	--	--
11/20/2001	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Reg Standard	**200**	**10**	**0.09**	**2.1**	**50**	**7.3**	**300**	**34**	**--**	**50**	**100**	**5**	**1.23**	**67**
Total Metals Analyses														

Table 9
DWR METALS ANALYSIS OF HAT CREEK AT CASSEL

Sample Date	Aluminum (ug/L)	Arsenic (ug/L)	Boron (mg/L)	Cadmium (ug/L)	Chromium (ug/L)	Copper (ug/L)	Iron (ug/L)	Lead (ug/L)	Magnesium (mg/L)	Manganese (ug/L)	Nickel (ug/L)	Selenium (ug/L)	Silver (ug/L)	Zinc (ug/L)
2/20/2002	--	--	--	--	--	--	--	--	7	--	--	--	--	--
5/29/2002	--	--	--	--	--	--	--	--	7	--	--	--	--	--
11/26/2002	--	--	--	--	--	--	--	--	7	--	--	--	--	--
2/25/2003	--	--	--	--	--	--	--	--	7	--	--	--	--	--
6/10/2003	17.3	0.74	--	<0.031	0.5	0.22	3.2	<0.006	6	--	0.19	<0.296	<0.251	<0.088
11/13/2003	7.79	0.886	--	<0.023	0.55	0.67	5.9	0.007	6	--	0.3	<0.033	<0.006	0.12
3/23/2004	49.6	0.958	--	0.007	1.04	0.62	33.5	0.02	7	--	0.28	<0.092	<0.044	0.22
5/25/2004	13.7	0.832	--	<0.003	0.91	3.12	7.4	<0.003	7	--	0.24	0.09	<0.034	0.07
8/17/2004	17.3	0.767	--	<0.004	0.42	0.55	14.2	0.007	7	--	0.25	<0.249	<0.145	0.06
11/16/2004	35	0.835	--	<0.034	1.24	0.55	60.3	0.038	6	--	0.27	<0.24	0.414	0.24
2/10/2005	18.6	0.915	--	<0.045	1.13	0.29	22.4	0.028	7	--	0.22	<0.154	<0.01	0.17
5/10/2005	169	0.806	--	<0.025	1.18	0.44	117	0.026	7	--	0.32	<0.227	<0.027	0.29
8/16/2005	17.8	0.746	--	<0.004	0.77	0.36	13.7	<0.018	6	--	0.15	<0.222	<0.013	0.05
11/2/2005	16.8	0.81	--	<0.009	1.33	0.28	14.1	0.015	7	--	0.25	<0.186	<0.009	0.17
2/8/2006	52.6	0.837	--	<0.007	0.96	0.35	36.3	0.013	7	--	0.32	<249	<0.027	0.24
5/9/2006	23.4	0.844	--	<0.1	0.76	0.39	29.8	<0.04	6	--	0.24	<0.2	<0.03	0.23
8/8/2006	33.7	0.847	--	<0.1	0.89	0.35	27.8	<0.04	6	0.69	0.3	<0.2	<0.03	0.14
11/7/2006	33.9	0.967	--	<0.1	0.95	0.37	45.8	<0.04	7	<0.2	0.31	<0.2	<0.03	1.13
2/6/2007	24.9	0.926	--	<0.1	0.84	0.3	31.6	<0.04	7	--	0.35	<0.2	<0.03	1.6
5/1/2007	66.1	0.921	--	<0.1	1.08	0.31	95.8	0.064	6	0.28	0.18	<0.2	<0.03	2.09
7/31/2007	13.3	0.868	--	<0.1	0.85	0.23	24.2	<0.04	6	0.59	0.19	<0.2	<0.03	1.37
11/14/2007	13	0.744	--	<0.1	0.81	0.2	22.8	<0.04	7	0	0.12	<0.2	<0.03	1.16
2/6/2008	30.3	0.866	--	<0.1	0.99	0.37	36.7	<0.04	7	--	0.22	<0.2	<0.03	1.79
5/13/2008	19.9	0.835	--	<0.1	0.89	0.55	31.9	0.067	7	--	0.34	<0.2	<0.03	2.13
Reg Standard	**200**	**10**	**0.09**	**2.1**	**50**	**7.3**	**300**	**34**	**--**	**50**	**100**	**5**	**1.23**	**67**

NOTE: [1] Regulatory standard determined using California Toxics Rule Maximum Concentration Level assuming hardness of 50 mg/L

Muskrat, cattle, and anglers have been identified as contributors to the sedimentation problem in the watershed. Burrowing by muskrat in streambanks is particularly prevalent in low-elevation banks due to easier access for the animal, and these types of banks are common along Hat Creek. Muskrat burrowing has reduced the integrity of streambanks locally, causing the banks to be more prone to erosion during high flows or runoff events. Vegetation trampling along the creek caused by cattle grazing and fishing use has further reduced channel integrity, ultimately increasing channel width and decreasing sediment transport capacity of the creek, causing sediment deposition to increase locally (Cook, 2010; pers. communication). Furthermore, the cumulative impact from these factors has resulted in a loss of shaded undercut areas that offer prime habitat for fish and aquatic insects (California Trout Inc., 2010).

There are some signs that effects from sedimentation in Hat Creek may be improving. A large sediment slug migrated downstream to portions of the Wild Trout Area of lower Hat Creek during the 1980s to 1990s. It was noted in the late 1990s, however, that the sediment slug was diminishing, indicating that its migration downstream was a one-time event. Much of the coarse sediments, gravels, and bedrock of the Wild Trout Area that were formally impacted by the sediment slug are now re-exposed, once again providing for healthy trout habitat. In addition, recreationalists who frequent the area mistakenly identify a seasonal vegetation boom that causes a decrease in water surface elevation for an increase in sedimentation, indicating that the sedimentation problem in the area may be exaggerated at times (Cook, 2010; pers. communication).

Restoration efforts are underway to restore Hat Creek to a more natural condition. California Trout, CDFG, and PG&E have collectively begun a pilot restoration project in an attempt to reduce sedimentation impacts from deteriorating streambanks and improve aquatic plant and animal habitat. The agencies have begun to restore an area of the creek by shoring damaged streambanks with logs, backfilling eroded areas, and revegetating the banks to improve aquatic habitat. These efforts are also aimed at reducing further damage from muskrats by discouraging burrow construction through the streambank restoration design (California Trout Inc., 2010). In addition to these restoration efforts, the Sierra Institute has identified riparian area restoration as a major concern of the citizens in and around the watershed. The Sierra Institute recommends more wildlife habitat improvement projects, such as meadow restoration, along with better forest management and noxious weed and muskrat control projects to address this concern.

WATER RIGHTS

Water rights in the Hat Creek Watershed are managed by both the Hat Creek Service Area Watermaster (DWR, Northern California District) for agricultural use and PG&E for the generation of hydroelectricity. Watermaster manages water rights according to Shasta County Superior Court Decree No. 5724 dated May 14, 1924, and Shasta County Superior Court Decree No. 7858 dated May 7, 1935. The present service area, established on September 11, 1929, is located in eastern Shasta County, north of LVNP. The area begins approximately 3 miles south of the town of Old Station and extends at a 2-mile width for 20 miles to the north to the confluence with the Rising River. The majority of water used from the Hat Creek system by original decreed water-rights holders was for irrigation; much of the water that is currently diverted from the creek continues to be used for this purpose (DWR, 2000).

Decree No. 5724 (1924) established irrigation and non-irrigation allotments for 18 periods of rotation between “upper” and “lower” user groups from May 1 through October 28 of every year. Three additional water rights for continuous irrigation were established by Decree No. 7858 (1935), although these are not normally supervised by the Watermaster. The “upper” water rights user groups require a total flow of 153 cubic feet per second, while the “lower” water rights user groups require a total flow of 166 cubic feet per second. When the upper users’ rights are being served, the lower users still receive a minimum flow for stock water (DWR, 2000). The various distributions from the Hat Creek system, along with the decreed and present-day owners of these distributions, are shown in Table 10.

Water is generally diverted through diversion dams into ditches that convey the water to the individual user. Water used for irrigation is typically achieved by flood irrigation, and some fields have been leveled in recent years to improve irrigation efficiency. Because the water supply of Hat Creek mostly comes from springs and snowmelt derived from Lassen Peak, the creek normally contains enough water to meet the demands of the water-rights holders through June. The supply then typically decreases below the maximum allotments specified in the 1924 and 1935 decrees, but total allotments rarely decrease below 75 percent of the decreed amount due to outflow from perennial springs (DWR, 2000).

Table 10
HAT CREEK WATERMASTER SERVICE AREA DISTRIBUTIONS
ESTABLISHED BY DECREE NOS. 5724 (1924) AND 7858 (1935)

DWR Tract No.[1]	Upper Rotation		Lower Rotation	
	Allotment (cfs)	Type	Allotment (cfs)	Type
29	0.050	Continuous	0.050	Continuous
26	10.275	Maximum	0.250	Minimum
27	1.000	Maximum	0.125	Minimum
28[3]	3.3125	Continuous	3.3125	Continuous
25[4]	2.375	Continuous	2.375	Continuous
24	0.960	Continuous	0.960	Continuous
35	0.500	Maximum	0.125	Minimum
23	18.000	Maximum	1.250	Minimum
22	21.075	Maximum	1.000	Minimum
37	1.125	Maximum	0.250	Minimum
32	2.125	Maximum	0.250	Minimum
36	0.500	Continuous	0.500	Continuous
17-21[5]	1.022	Continuous	1.022	Continuous
16	3.500	Maximum	0.750	Minimum
33-34[6]	0.3125	Continuous	0.3125	Continuous
15	0.500	Continuous	0.500	Continuous
38	2.500	Maximum	1.750	Minimum
14	4.375	Maximum	0.750	Minimum
12	3.375	Maximum / Minimum	9.625	Maximum + Minimum
13	6.875	Maximum / Minimum	12.250	Maximum + Minimum
8	5.000	Maximum	2.250	Minimum
10	0.750	Minimum	22.250	Maximum
11	13.500	Maximum	0.750	Minimum
9	2.000	Minimum	21.250	Maximum
7	1.000	Minimum	9.950	Maximum
6	4.600	Maximum	0.000	Minimum
39	0.375	Minimum	1.500	Maximum
31	0.375	Minimum	1.250	Maximum
30	0.250	Minimum	2.750	Maximum
40	0.125	Minimum	2.000	Maximum
41	0.125	Minimum	3.500	Maximum
5	1.000	Minimum	12.250	Maximum
4	0.500	Minimum	8.000	Maximum
42	0.135	Minimum	0.540	Maximum
2	24.250	Maximum	1.000	Minimum
3	0.250	Minimum	12.250	Maximum
1	0.500	Minimum	8.000	Maximum
TOTALS[7]	153.135	--	166.285	--

NOTES:
[1] Individual present and decreed owners within presented tracts can be accessed online at http://www.water.ca.gov/watermaster
[2] Decreed amount is a maximum and minimum allotment of 0.1000 cfs 0.000 cfs, respectively
[3] Decreed amount is a maximum and minimum allotment of 6.125 cfs and 0.500 cfs, respectively
[4] Decreed amount is a maximum and minimum allotment of 3.750 cfs and 0.500 cfs, respectively
[5] Decreed amount is a maximum and minimum allotment of 1.625 cfs and 0.500 cfs, respectively
[6] Decreed amount is a maximum and minimum allotment of 0.500 cfs and 0.125 cfs, respectively
[7] Represents values quoted by Hat Creek Service Area Watermaster that include channel losses and additional information contained in 1924 and 1935 Decrees and non-decreed right derived from April 3, 1962 G. D. Miexner letter to USFS.

Water rights owned by PG&E in the Hat Creek Watershed are managed according to the license issued by the Federal Energy Regulatory Commission (FERC) on November 4, 2002, for the Hat Creek Hydroelectric Project (FERC No. 2661) (PG&E Environmental Services, 2006). The run-of-river project consists of two developments: Hat Creek No. 1 and Hat Creek No. 2. Hat Creek No. 1 is a 12-foot-high, 231-foot-long concrete buttress overflow diversion dam that impounds a 13-acre reservoir known as Cassel Pond. Water is diverted from Cassel Pond to a concrete powerhouse with a generating capacity of 10,000 kilowatts (kW). Hat Creek No. 2 is a 29-foot-high, 120-

foot-long concrete gravity overflow diversion dam that impounds an 89-acre reservoir known as Baum Lake. Water is diverted from Baum Lake to a concrete powerhouse with a generating capacity of 10,000 kW (Federal Register, 1999). The Hat 1 and Hat 2 bypass reaches were created to route flows around the two dams to maintain fish populations in Hat Creek. Per approved FERC license, flows must be maintained at a minimum of 8 cubic feet per second in both bypass reaches. In addition, the downstream flow of the Hat 2 bypass measured at the Joerger Diversion Dam must be maintained at a minimum of 43 cubic feet per second, which receives accretion flow from the Hat 2 springs (PG&E Environmental Services, 2006).

PG&E STEWARDSHIP LANDS ISSUES

In December 2003, as part of a bankruptcy settlement for PG&E, the Pacific Forest and Watershed Lands Stewardship Council was established to protect the 140,000 acres of watershed lands in the Sierra Nevada and Cascade Mountain Ranges of California owned and managed by PG&E. The main objectives of protecting these lands include:

- Protection of the natural habitat of fish, wildlife, and plants
- Preservation of open space
- Outdoor recreation by the general public
- Sustainable forestry
- Agricultural uses
- Historic values

PG&E has maintained these objectives through donation of conservation easements that restrict development and by donating lands in fee to public entities and non-profits that have similar conservation objectives as those listed above (Stewardship Council, 2007). The lands being protected according to these guidelines have been broken down into 11 watersheds and further subdivided into 47 distinct planning units, which includes the Hat Creek Planning Unit of the Pit-McCloud River Watershed.

The Hat Creek Planning Unit consists of 3,208 acres within the Hat Creek Watershed. The objectives and means of implementation recommended by the Stewardship Council for carrying out land protection within this planning unit are included below (Stewardship Council, 2007). The Hat Creek Planning Unit is shown on Figure 10.

- ***Preserve and enhance habitat in order to protect special biological resources.*** Implement by conducting surveys to identify resources, restrict unauthorized OHV roads to enhance habitat and reduce habitat fragmentation, assess potential for restoration of Cinder Flats and Corral Creeks to restore hydrologic function and enhance riparian habitat, remove unnecessary fencing to improve wildlife movement, encourage silvicultural practices to encourage bald eagle nesting, cease tree harvest along waterway shorelines, develop a noxious weed management program, control muskrat populations, support Shasta crayfish habitat restoration, and develop a wildlife and habitat management plan.
- ***Preserve open space in order to protect natural and cultural resources, viewsheds, and the recreation setting.*** Implement by applying permanent conservation easements.
- ***Enhance recreational facilities in order to provide additional educational opportunities and enhance the recreation experience***. Implement by installing interpretive signage regarding wildlife, native species, and traditional use at Crystal Lake, Baum Lake, and the Pacific Crest Trail; revegetate disturbed areas at Baum Lake; install signage on fishing regulations at the Hat Creek No. 2 Powerhouse; encourage CDFG to update Hat Creek Wild Trout project signage at the Hat Creek No. 2 Powerhouse; provide public facilities at the Carbon Bridge Fishing Access point; and assess the potential for youth program opportunities.
- ***Develop and implement forestry practices in order to contribute to a sustainable forest, preserve and enhance habitat, as well as to ensure appropriate fuel load and fire management***. Implement by evaluating existing timber inventory data and developing a forest management plan, fuels management plan, and a fire management and response plan.
- ***Identify and manage cultural resources in order to ensure their protection***. Implement by conducting a cultural resources survey and an ethnographic study to identify traditional use areas, developing a cultural resources management plan, and coordinating with Native American entities.

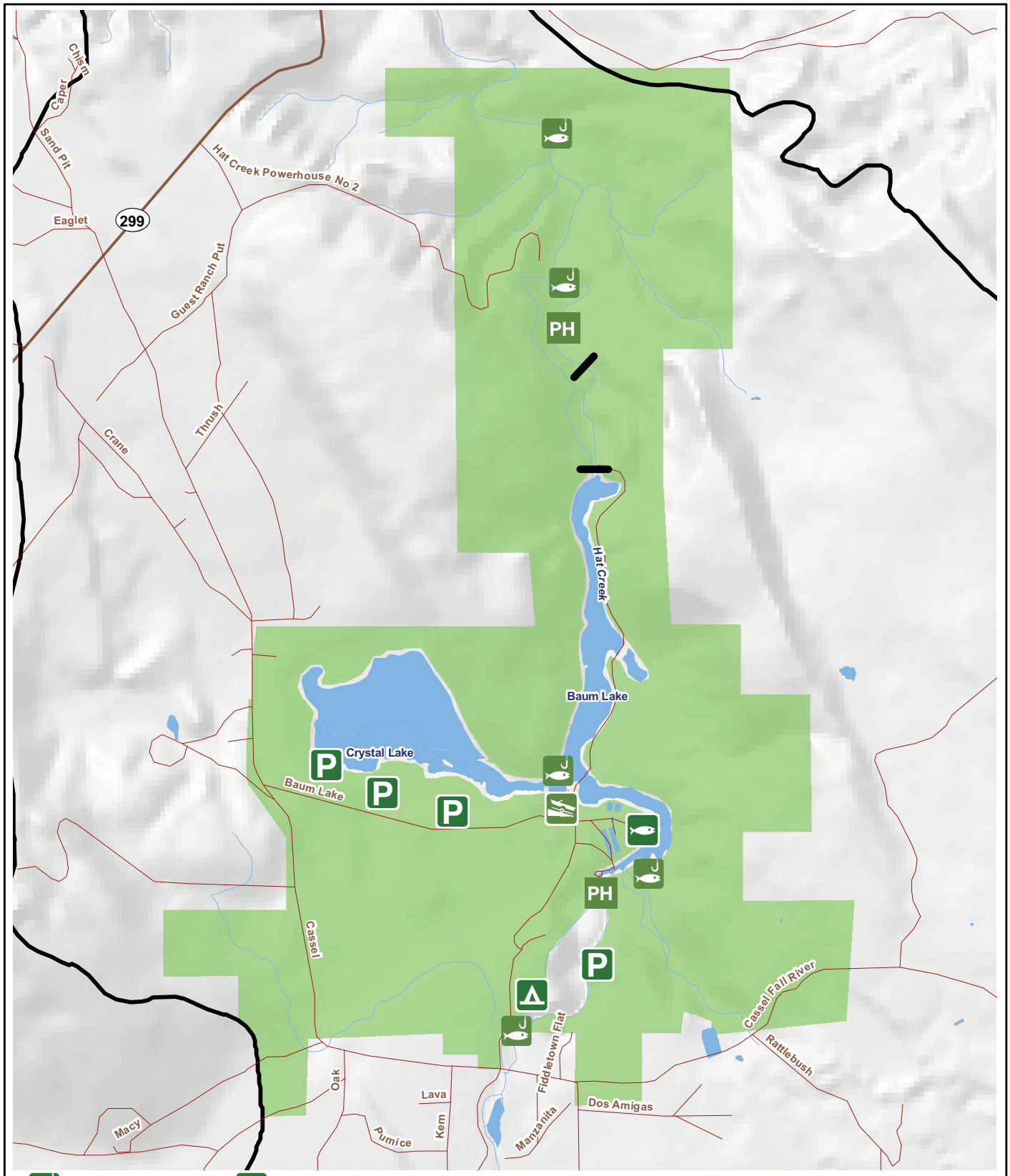


FIGURE 10
HAT CREEK PLANNING UNIT
HAT CREEK WATERSHED

VESTRA

SOURCE: STEWARDSHIP COUNCIL 2007

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The Stewardship Council has recommended that the land and land uses in the Hat Creek Planning Unit be preserved and enhanced by focusing on biological and cultural resource values as well as popular recreation resources. The objective is to preserve and enhance cultural and important plant and wildlife resources, as well as enhance educational opportunities and sustainable forestry management. More information regarding the recommended land protection objectives for the Hat Creek Planning Unit can be found on the Stewardship Council website (www.lcp.stewardshipcouncil.org).

BIOLOGICAL RESOURCES

The Hat Creek Watershed contains a diverse habitat and is home to several threatened and endangered species. California Natural Diversity Database (CNDDB) occurrences are shown on Figure 11. A list of these occurrences is shown in Table 11. The habitat resources are used by a variety of waterfowl, raptors, and aquatic species including great blue heron, osprey, bald eagle, bank swallow, Shasta crayfish, big-eye marbled sculpin, and rough sculpin. Waterfowl and other birds use the fresh-water emergent wetland habitat and other water bodies for nesting, wintering, and staging. Bald eagles nest near Hat Creek and forage throughout the watershed. The nesting territory in the watershed is one of the most productive bald eagle nesting territories in the state and has been chosen to contribute nestlings for the San Francisco Zoo captive breeding program and Catalina Island reintroduction project (Stewardship Council, 2007).

VEGETATION

The vegetation in the Hat Creek Watershed is typical of that found at mid-elevations in the southern Cascade and northern Sierra Nevada mountain ranges. Vegetation composition varies within the watershed based on physical and environmental factors. Where favorable topography is present (i.e., less steep), agricultural uses are more common. Available moisture is a key determinant in vegetative community composition with drier sites to the east supporting more drought-tolerant species. Higher elevations and areas with cooler aspects support species, such as red fir, that are not found at lower elevations within the watershed or on warmer and drier southern exposures. Generally, most of the watershed is dominated by mixed conifer forests that may include a well represented hardwood component. Mountain meadows of various sizes are common along drainages and in low-lying areas. Drier areas tend to support juniper and sage species similar to Great Basin steppe communities. Forests tend to be patchy, with large areas of montane chaparral on south-facing slopes and, in some places, as the result of historic wildfire. Lower in the watershed, the topography is gentler, and agricultural use has led to the development of irrigated crop and pasture land. Figure 12 shows the current vegetation in the watershed. Historical vegetation types from 1934 are shown on Figure 13, and Figure 14 shows historical vegetation types from 1977. Tables 12, 13, and 14 show the acreages for the current and historical vegetation types found in the watershed. Common vegetation species found in the watershed are shown in Table 15.

RANGELAND

Over the last 150 years, settlers of mostly European descent have significantly altered ecological conditions in the Hat Creek Watershed. Spanish soldiers and missionaries from Mexico first brought cattle and other livestock to southern California in the second half of the eighteenth century. Grazing and the introduction of exotic cereal grains and grasses, such as barley, rye, and clover, markedly altered the composition of California native grasslands. Overgrazing stressed perennial species, such as native bunchgrasses. Well-adapted, opportunistic European annual species fared better in the disturbed environment, and have become the dominant species of today's grasslands (Pit River Alliance, 2004).

WILDLIFE

The intermountain region in general, and the Hat Creek area in particular, is known for supporting abundant wildlife. Largely because of the low human population density, this relatively undeveloped portion of California is occupied by wildlife species that occur in an array of habitat types, from interior forests to sparsely vegetated barrens. Heavily forested areas provide habitat for species such as spotted owls, northern goshawks, and pine martens, while open habitats support species such as mule deer and greater sandhill cranes. Aquatic species in the Hat Creek area benefit from the clear, cold-water habitat found within the watershed. Notable aquatic vertebrate and invertebrate species unique to this area include Shasta crayfish and rough sculpin. Common wildlife species found in the watershed are shown in Table 16.

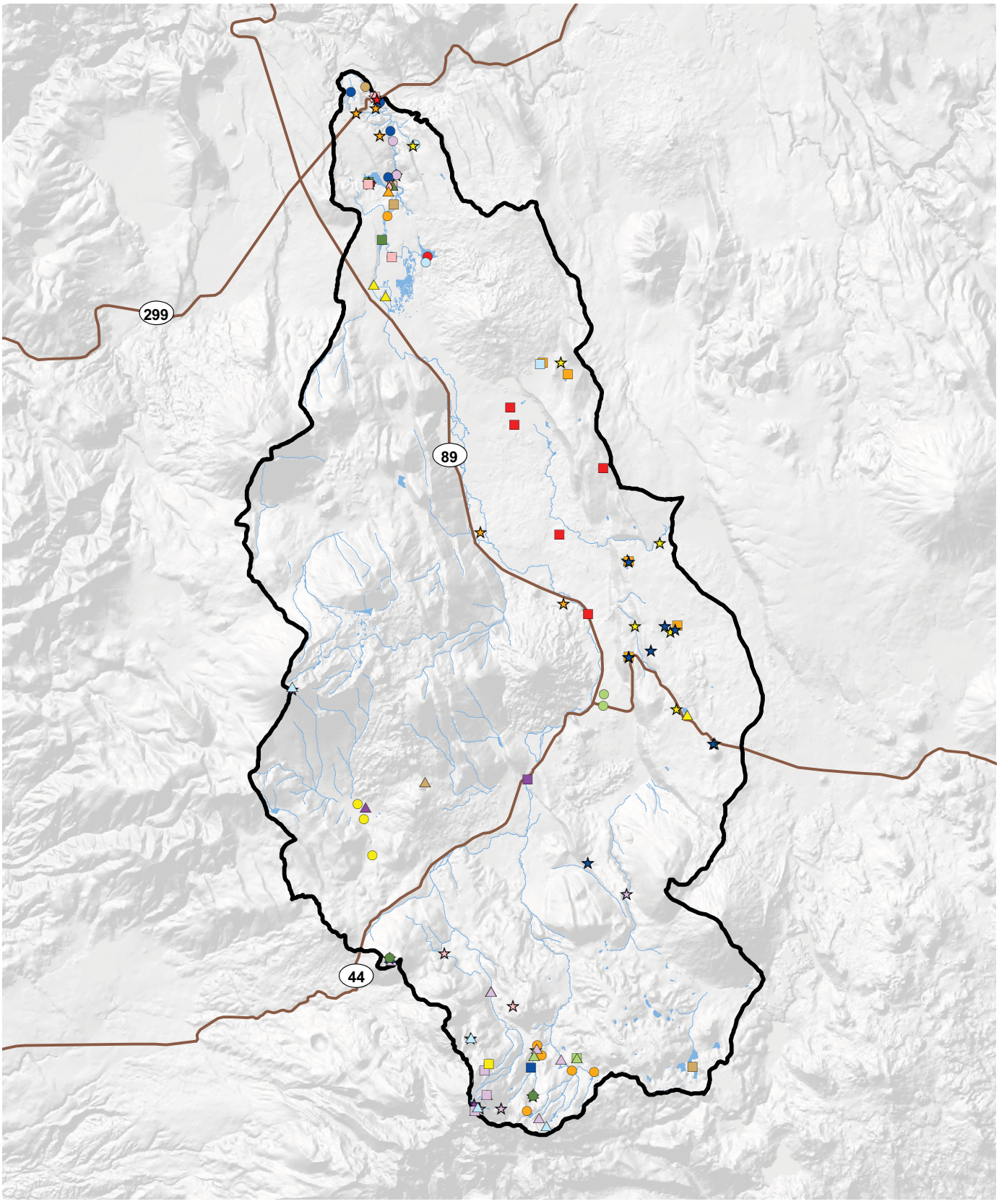

FIGURE 11
CNDDB OCCURRENCES
HAT CREEK WATERSHED

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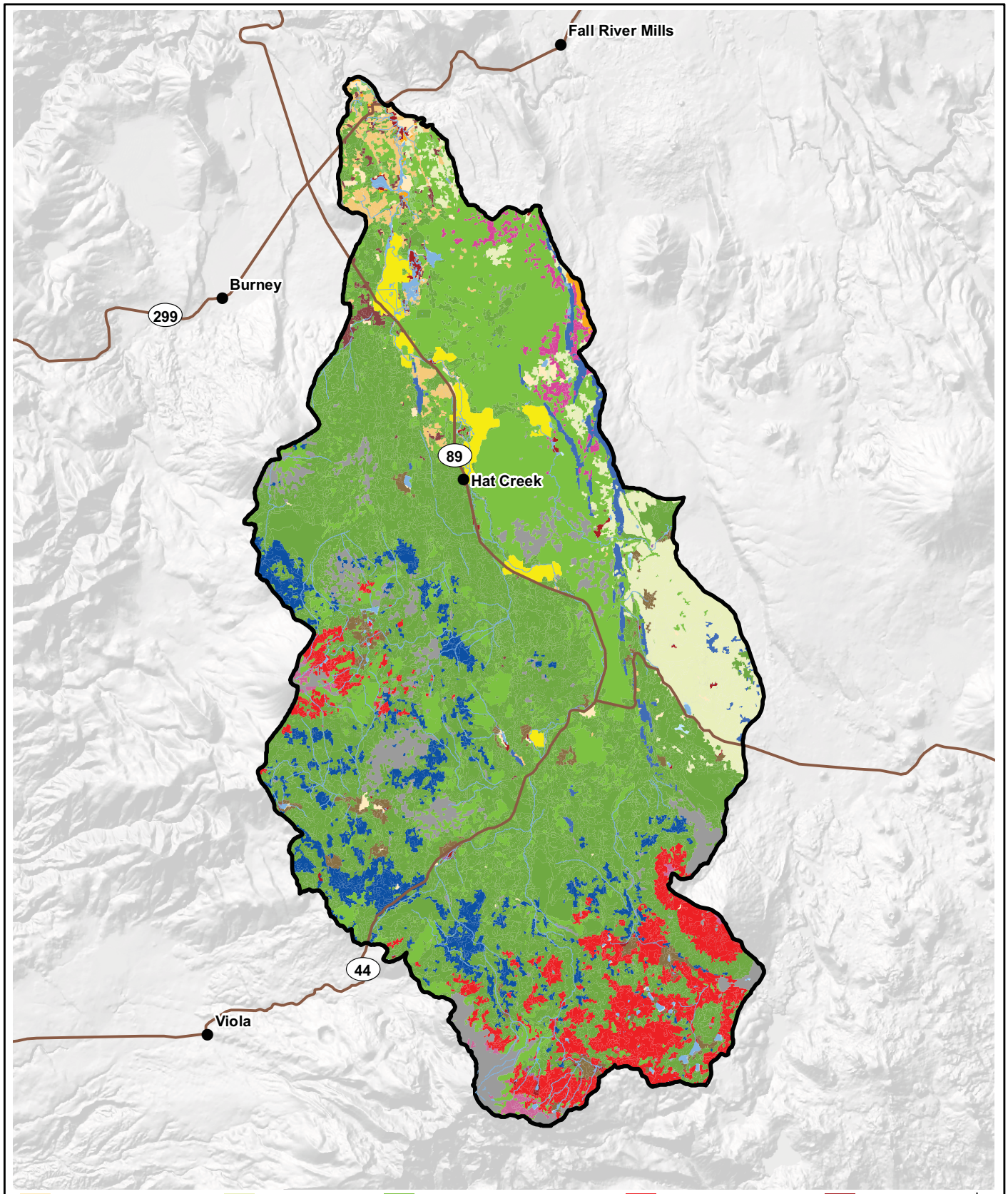

FIGURE 12
VEGETATION
HAT CREEK WATERSHED

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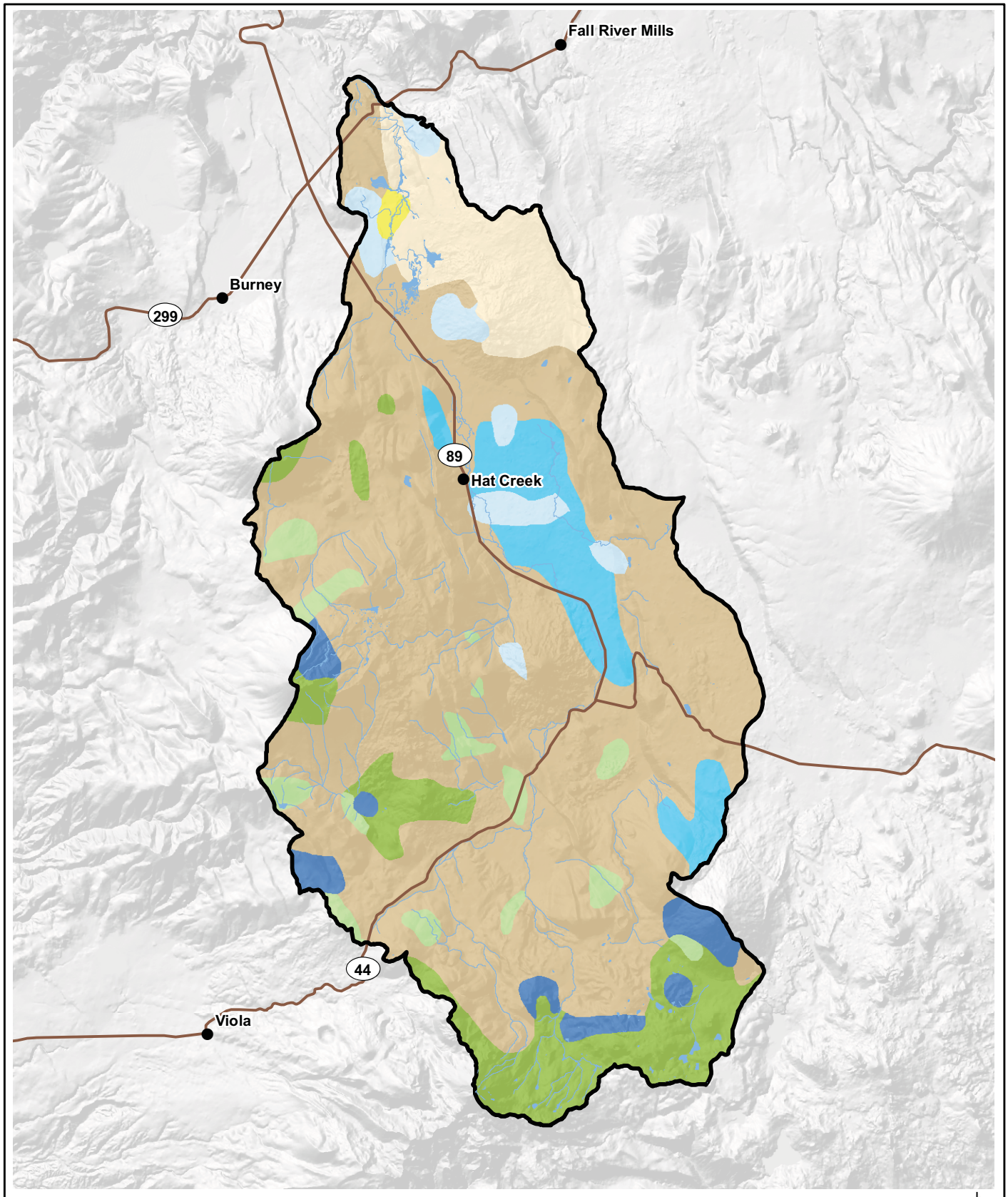

FIGURE 13
1934 VEGETATION
HAT CREEK WATERSHED

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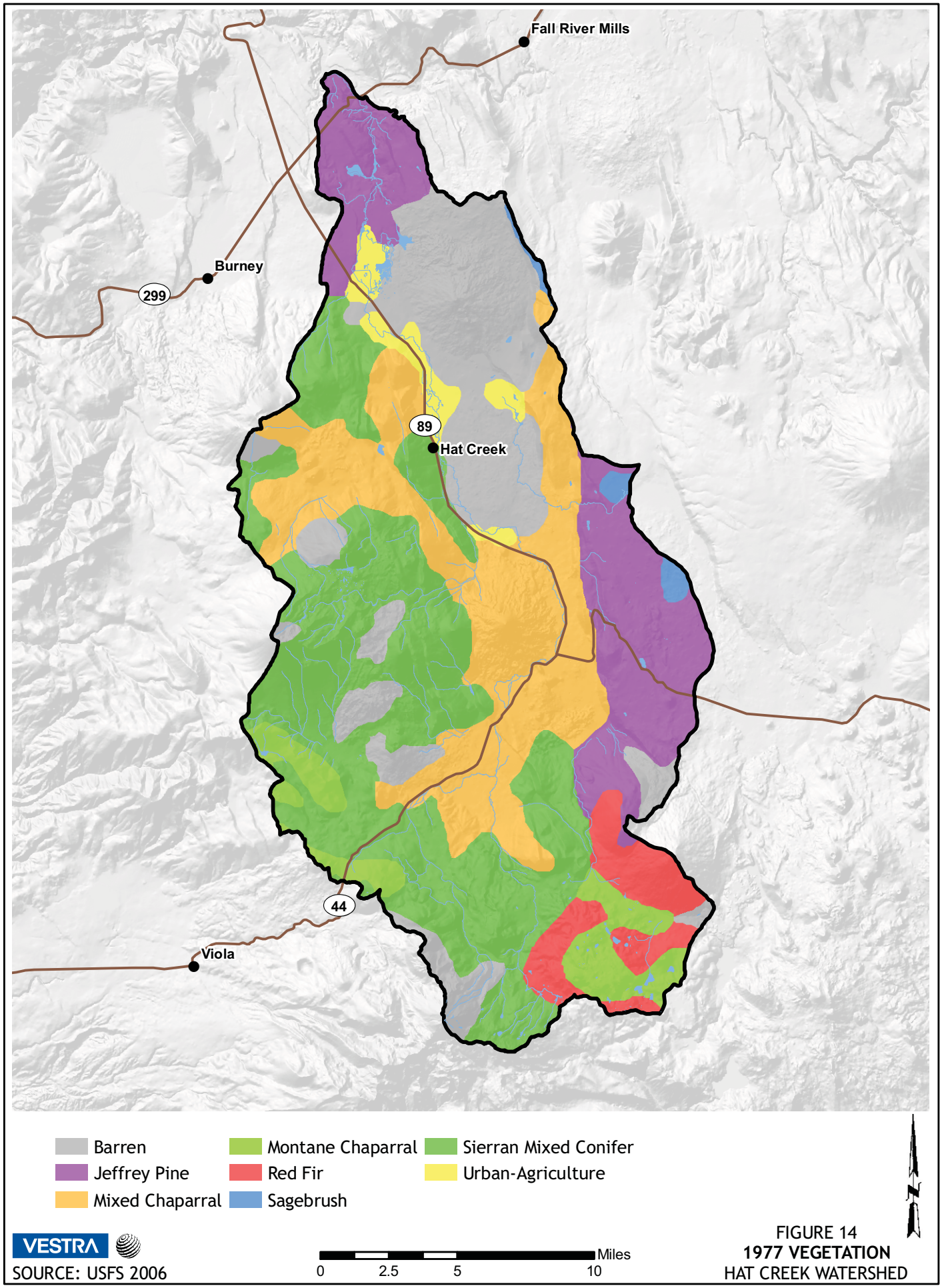

FIGURE 14
1977 VEGETATION
HAT CREEK WATERSHED

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Table 11
CNDDB

Scientific Name	Common Name
Plants	
Iliamna bakeri	Baker's globe mallow
Gratiola heterosepala	Boggs Lake hedge-hyssop
Silene suksdorfii	Cascade alpine campion
Potamogeton zosteriformis	Eel-grass pondweed
Draba aureola	Golden alpine draba
Tuctoria greenei	Greene's tuctoria
Mielichhoferia tehamensis	Lassen Peak copper moss
Smelowskia ovalis var. congesta	Lassen Peak smelowskia
Hulsea nana	Little hulsea
Hierochloe odorata	Nodding vanilla-grass
Asplenium septentrionale	Northern spleenwort
Pogogyne floribunda	Profuse-flowered pogogyne
Eriogonum pyrolifolium var. pyrolifolium	Pyrola-leaved buckwheat
Orcuttia tenuis	Slender Orcutt grass
Erigeron nivalis	Snow fleabane daisy
Astragalus pulsiferae var. suksdorfii	Suksdorf's milk-vetch
Collomia larsenii	Talus collomia
Juga acutifilosa	Topaz juga
Animals	
Pyrgulopsis archimedis	Archimedes pyrg
Haliaeetus leucocephalus	Bald eagle
Riparia riparia	Bank swallow
Colligyrus convexus	Canary duskysnail
Rana cascadae	Cascades frog
Myotis thysanodes	Fringed myotis
Helisoma newberryi	Great Basin rams-horn
Ardea herodias	Great blue heron
Grus canadensis tabida	Greater sandhill crane
Lasiurus cinereus	Hoary bat
Lanx patelloides	Kneecap lanx
Hydroporus leechi	Leech's skyline diving beetle
Myotis evotis	Long-eared myotis
Myotis volans	Long-legged myotis
Accipiter gentilis	Northern goshawk
Fluminicola seminalis	Nugget pebblesnail
Pandion haliaetus	Osprey
Martes pennanti (pacifica) DPS	Pacific fisher
Vulpes vulpes necator	Sierra Nevada red fox
Lasionycteris noctivagans	Silver-haired bat
Corynorhinus townsendii	Townsend's big-eared bat
Actinemys marmorata	Western pond turtle
Myotis yumanensis	Yuma myotis
Fish	
Cottus klamathensis macrops	Bigeye marbled sculpin
Pit R. Drainage Rough Sculpin/Shasta Crayfish Spring Stream	Pit R. Drainage Rough Sculpin/Shasta Crayfish Spring Stream
Cottus asperrimus	Rough sculpin
Pacifastacus fortis	Shasta crayfish

Table 12
CURRENT VEGETATION

Vegetation Type	Acres	Percent of Watershed
Annual Grass	1,391	1%
Aspen	59	<1%
Barren	11,991	5%
Blue Oak-Foothill Pine	61	<1%
Cropland	4,342	2%
Eastside Pine	14,603	6%
Juniper	2,241	1%
Lacustrine	921	<1%
Lodgepole Pine	3,657	2%
Mixed Chaparral	515	<1%
Montane Chaparral	49,045	20%
Montane Hardwood Conifer	1,261	1%
Montane Hardwood	4,048	2%
Montane Riparian	11	<1%
Ponderosa Pine	582	<1%
Red Fir	16,782	7%
Subalpine Conifer	897	<1%
Sagebrush	3,410	1%
Sierran Mixed Conifer	112,568	46%
White Fir	14,004	6%
Wet Meadow	919	<1%

Table 13
1934 VEGETATION

Vegetation Type	Acres	Percent of Watershed
Agricultural Lands	853	0%
Deforested Lands (potential forest lands)	9,290	4%
Grazing Lands	17,909	7%
Irrigated Lands	7,805	3%
Non-commercial Rocky Forested Lands (includes both subalpine and high barren lands)	24,844	10%
Pine and Pine Fir Forested Lands	158,363	65%
True Fir Forested Lands	7,568	3%
Watershed Lands (non-forested lands)	16,677.5	7%

Table 14
1977 VEGETATION

Vegetation Type	Acres	Percent of Watershed
Barren	45,128	19%
Jeffrey Pine	36,074	15%
Mixed Chaparral	53,280	22%
Montane Chaparral	12,643	5%
Red Fir	11,963	5%
Sagebrush	2,045	1%
Sierran Mixed Conifer	75,833	31%
Urban - Agriculture	6,345	3%

Table 15
COMMON VEGETATION SPECIES FOUND IN THE WATERSHED

Forest Trees	Forest Understory	Chaparral/Brush	Meadows & Edges
Ponderosa pine	Mule's ear	Green-leaf manzanita	Annual grasses
Sugar pine	Arrowleaf balsamroot	Deer brush ceanothus	Tule bulrush
White fir	Pinemat manzanita	Snow brush ceanothus	Sedges
Douglas-fir	Native forbs	Bitter cherry	Willows
Incense cedar	Various grasses and grasslike plants	Mountain whitethorn	Lodgepole pine
California black oak		Chinquapin	Cottonwood
Pacific dogwood		Antelope bitterbrush	Alder
Vine maple			
Juniper			

Table 16
COMMON WILDLIFE SPECIES FOUND IN THE WATERSHED

Forest	Chaparral/Brush	Meadows & Edges	Aquatic Habitats
Birds			
Northern goshawk	California quail	Bald eagle	Osprey
Spotted owl	Spotted towhee	Northern harrier	American dipper
Mountain quail	Mourning dove	Great blue heron	American white pelican
Olive sided flycatcher	American crow	Yellow warbler	Waterfowl
Hermit thrush	Western bluebird	Short-eared owl	Shorebirds
Cooper's hawk	Blue-gray gnatcatcher	Common yellowthroat	
Red-breasted nuthatch		Sandhill crane	
Mammals			
Pine marten	Deer mouse	California ground squirrel	American mink
Northern flying squirrel	Golden mantled squirrel	Beaver	Beaver
Long-eared myotis	American badger	Western pocket gopher	Vagrant shrew
Spotted skunk	Black-tailed jackrabbit	Coyote	
Bobcat	Mountain lion		
Other			
California mountain kingsnake	Western rattlesnake	Common gartersnake	Cascade frog
Long-toed salamander	Western fence lizard	Bullfrog	Western pond turtle
California newt	Gopher snake	Foothill yellow-legged frog	Shasta crayfish
Rubber boa	Striped racer	Pacific chorus frog	Rough sculpin
Northern alligator lizard			

FISHES AND CRAYFISH

Historically, fish were introduced to various rivers, lakes, and streams for a number of reasons; the Hat Creek Watershed is no exception. As a result, the fish assemblage in the watershed is a mix of native and introduced, warm-water and cold-water fish species (Table 17). Some spatial separation of species occurs where habitat or water conditions favors one group or another; however, many of the species can tolerate a variety of habitat conditions. The fisheries resources in the watershed are both ecologically and economically important, and over the past several decades much emphasis has been placed on maintaining and restoring the recreational trout fishery in Hat Creek and in protecting the unique aquatic species that are native to the system.

Wild Trout Fishery

Rainbow Trout (*Oncorhynchus mykiss*) are native to Hat Creek, but their distribution has increased dramatically due to fish planting above natural barriers (Moyle, 2002). [SR1]Rainbow trout use many habitats, but are most abundant in cool, clear, swifter-flowing stream sections with adequate shade and riffles and predominately rocky bottoms (Moyle and Daniels, 1982). The highest abundance of rainbow trout occurs in habitats where they coexist with pit sculpin, brown trout, and speckled dace (Moyle and Daniels, 1982). Females dig redds (i.e. spawning "nests") and lay eggs in gravel, usually at the end of a pool or in a riffle, at water depths of 10 to 150 cm and water velocities ranging from 20 to 150 centimeters per second (Moyle, 2002). Females lay 200 to 12,000 eggs that hatch in 3 to 4 weeks, and fry emerge from the gravel 2 to 3 weeks later (Moyle, 2002). Many local residents and guides believe that the trout fishery in Hat Creek is declining. Review of CDFG abundance records is inconclusive. The lack of data on this valuable resource was noted in the Assessment.

Table 17
FISHES FOUND IN THE WATERSHED

Common Name	Scientific Name
Native Species:	
Pit brook lamprey	*Entosphenus lethophagus*
Rainbow trout	*Onchorhynchus mykiss*
Tui chub	*Gila bicolor ssp.*
Speckled dace	*Rhinichthys osculus*
Sacramento sucker	*Catostomus occidentalis*
Rough sculpin	*Cottus asperrimus*
Bigeye marbled sculpin	*Cottus klamathensis macrops*
Pit sculpin	*Cottus pitensis*
Non-native Species:	
Rainbow trout (planted)	*Onchorhynchus mykiss*
Brown trout	*Salmo trutta*
Brook trout	*Salvelinus fontinalis*
Sunfishes	*Lepomis spp.*

Hatchery Fish Planting

Since the late 1800s, native fish populations in the West have been augmented with fish propagated in hatcheries to accommodate the fishing needs of a growing human population and to lessen the impact of over-harvesting (Leitritz, 1970). Fishing pressure can greatly impact the natural balance of fish populations. Consequently, fish hatcheries plant millions of trout annually to provide for the demand of anglers and to maintain balanced fish populations (Leitritz, 1970). The introduction of trout from hatcheries may influence wild trout population structure and genetic composition, and in some ways be detrimental to the Hat Creek wild trout fishery. However, modern stocking programs generally take this into consideration and are implemented so as to minimize adverse effects on naturally produced fish. Current fish-stocking practices are designed to augment wild fish populations during periods of intense angling pressure (opening weekend for trout season, holiday weekends, near heavily fished stream access points). Catch-sized fish are released specifically to be taken by anglers. This practice may actually benefit the Hat Creek wild trout fishery by reducing the number of wild fish taken during these peak recreational use periods. Simply put, the ratio of wild fish to hatchery fish is reduced due to the abundance of planted fish.

Over the past century, the mechanics of fish planting have seen an evolution in operating procedures. Mules and wagons were the initial mode of transport. While the railroad allowed fish to be moved over large distances, transportation from train to the water was done with mules and wagons. In 1907, the State of California bought and modified a car to function as a fish transport (Leitritz, 1970). As roads and cars became more abundant, wagons and the railroad became obsolete (Leitritz, 1970). Mules, however, remained a valuable means of transportation to reach remote areas, such as high mountain lakes that are inaccessible by road (Leitritz, 1970). In 1946, the airplane replaced mules after it was discovered that fingerlings could be dropped into lakes without apparent harm (Leitritz, 1970). Recent evidence has shown that fish dropped from planes are temporarily stunned or disoriented and, without nearby cover, are susceptible to predation.

Three fish hatcheries (Mount Shasta Hatchery, Crystal Lake Hatchery including the Pit River Hatchery, and Burney Creek Hatchery) have contributed the majority of the planted trout in the watershed. Minor trout-planting activities for this area have come from the Darrah Springs Hatchery, Lake Almanor Hatchery, Domingo Springs Hatchery, and the Coleman National Fish Hatchery. Short accounts on the history of these hatcheries are provided below.

Since 1910, fish other than trout have been sporadically planted from hatcheries or transplanted legally and illegally from other streams, lakes, and reservoirs into the Hat Creek system. CDFG declined to provide access to historical planting records for Hat Creek, but is currently reevaluating their fish-stocking program as part of an Environmental Impact Report/Environmental Impact Study designed to address impacts to native species that may occur as the result of stocking. Warm-water fishes are not stocked by CDFG, but generally may be planted by individuals under permits issued by CDFG, and they are often introduced illegally by individuals interested in spreading sportfish but unaware of the potential damage these species can cause to native species. It is unknown if any public waters in the Hat Creek Watershed have been recently stocked with warm-water fish under this permit program.

OTHER COLD WATER INDIGENOUS SPECIES

Rough Sculpin

(Federal - Species of Concern; California - Fully-protected, Threatened): The rough sculpin (*Cottus asperrimus*) is a small (less than 3.3 inch), bottom-dwelling fish with extremely restricted range, limited to the lower reaches of the Pit River and its spring-fed tributaries from Hat Creek (Daniels 1987, Daniels and Courtois, 1982; Daniels and Moyle, 1978; Ellis and Hesseldenz, 1993; Moyle, 2002). Within this range, its actual distribution is fragmented and is generally restricted to cool, clear, spring-fed habitat, primarily in the Fall River drainage, lower Hat Creek (at and below Crystal Lake), Sucker Springs, and patchy mainstem or reservoir habitat with suitable conditions. Unlike many sculpin that occupy rocky or cobbly habitat, the rough sculpin is generally found over finer substrates (silt, sand and gravels), often in association with native aquatic vegetation (Daniels 1987, Brown 1991). They feed primarily on aquatic invertebrates. Pairs establish nests underneath rock or woody debris, placing eggs on the underside of the covering structure and guarding the nest. Larvae and juveniles are benthic, remaining near the nest area. Spawning timing varies in the different populations, apparently taking place between September and January in the Fall River drainage and from February to May in lower Hat Creek.

The rough sculpin is classified as “fully protected” by the State of California. Unlike other species protected by the CDFG Code and California Endangered Species Act, no take of the rough sculpin is permissible under California statute due to its status as “fully protected.” CDFG may authorize the taking of such species for necessary scientific research, including efforts to recover fully protected, threatened, or endangered species (amended in 2003). “Take” is defined under the Endangered Species Act as to hunt, pursue, kill, or capture a listed species, as well as any other actions that may result in adverse impacts when attempting to take individuals of a listed species. The species is also protected as “threatened” under the Endangered Species Act. Therefore, rough sculpin are both a conservation and regulatory priority. At this time, CDFG cannot legally authorize take of rough sculpin, and any instream project in Hat Creek must completely avoid take of, as well as adverse impacts to, the rough sculpin.

Conservation concerns for the rough sculpin include habitat loss due to changes in substrate or availability of spawning sites caused by downstream sediment influxes or bank erosion; smothering of habitat by detritus caused by reduced flows and increased vegetative decay associated with extensive beds of invasive vegetation (eg. *Eurasian watermilfoil*); changes in water quality caused by warm, nutrient-rich agricultural runoff or water withdrawals for agriculture and hydroelectric projects; reduced spring-flow caused by excessive groundwater withdrawal; and predation by non-native fishes.

Shasta Crayfish

(Federal - Endangered; California - Endangered): Shasta crayfish (*Pacifastacus fortis*) is one of only three crayfish species native to California and one of only five crayfish species native west of the Continental Divide (all in the genus *Pacifastacus*). The Shasta crayfish has an extremely restricted range, limited to the lower reaches of the Pit River and its spring-fed tributaries. Within this range, its actual distribution is quite fragmented and limited to only a few areas (USFWS, 1998). Most populations of Shasta crayfish occur in pristine headwater spring pools and streams where there are abundant lava cobbles and boulders on clean gravel or sand (Ellis, 1997, 1999). Shasta crayfish prefer stable, unembedded cobble substrate in systems with minimal sediment transport. This type of habitat is found primarily in the Fall River and Hat Creek subdrainages and Sucker Springs Creek in the lower reaches of the Pit River drainage. Because of the spring-fed nature of these waters, the habitat in the spring areas is generally pristine and constant, with almost no seasonal or annual change in water temperature, flow, or clarity (Ellis, 1997, 1999).

INVASIVE SPECIES

Non-Native and Invasive Animals

A number of non-native, introduced, or invasive species occur within the Hat Creek Watershed (see Table 18). From an ecological perspective, introduced species are often considered invasive because they can negatively affect native species, either directly (through predation) or indirectly (through competition). However, some species have intentionally been introduced by humans and can be desirable in some circumstances (e.g., brown trout, wild turkeys). Be that as it may, even desirable non-native species may impact natural ecosystem function and be considered “invasive.”

Table 18
COMMON NON-NATIVE AND INVASIVE ANIMALS IN THE HAT CREEK WATERSHED

COMMON NAME	SCIENTIFIC NAME	IMPACTS
Bullfrog	*Rana catesbeiana*	Predator, competes with natives
Muskrat	*Ondatra zibethicus*	Physically impacts habitat
Various bass	Family *Centrarchidae*	Predator, competes with natives, desirable
Sunfish	Family *Centrarchidae*	Predator, competes with natives
Ringneck pheasant	*Phasianus colchicus*	Desirable, negligible
Signal crayfish	*Pacifastacus leniusculus*	Predator, competes with natives
Feral cats	*Felis catus*	Predator, competes with natives
Wild turkey	*Meleagris gallopavo*	Desirable, negligible
European starling	*Sturnus vulgaris*	Competes with natives
House sparrow	*Passer domesticus*	Competes with natives
Brown trout	*Salmo trutta*	Predator, competes with natives, desirable

Some invasive species can be more detrimental than others. For example, large-mouth bass and brown trout are aggressive predators that feed extensively on native fishes, crayfishes and amphibians, and can significantly suppress or extirpate native populations. Bullfrogs limit populations of native amphibians and other aquatic organisms directly through predation but also by outcompeting native species for space and food. This is because bullfrogs reproduce and mature faster than many native frogs and are more aggressive predators. Bullfrogs are known to prey on young aquatic birds, fishes, and snakes.

Signal crayfish (*Pacifastacus leniusculus*) are indigenous to the western United States but are not native to the Sacramento or Hat Creek drainages. However, this species has become established in many parts of the world, including the Hat Creek drainage and, like many invasive species, signal crayfish can displace native species of crayfish through competition, predation, or the spread of disease. In the Hat Creek drainage, the native Shasta crayfish (*P. fortis*) is listed as Endangered under the both the California and Federal Endangered Species Acts with competition from the signal crayfish considered one of the primary threats to the species (see Shasta crayfish below).

Other species, such as muskrat, become a nuisance when impacting habitat for other species or damaging structures used by property owners (levees, canals, irrigation head gates, etc.). Although the muskrat is native to parts of California, the species is not known to have been present in the Pit River drainage prior to about the 1930s. The muskrat has caused significant damage to channel banks in Hat Creek and other waterways where they burrow into banks and accelerate erosion. Muskrat damage not only creates ecological damage, but may also reduce productivity of agricultural operations (either crops or livestock). Controlling muskrat populations can be difficult due to their high reproductive rate, ability to disperse relatively long distances, and muskrat predators, such as the coyote, may be targeted for removal by humans as well. Nonetheless, trapping, poisoning, and shooting muskrat may be effective if conducted systematically. Habitat modification and physical exclusion combined with direct control is likely to be more effective at controlling muskrat damage over longer periods of time.

Because eradication of invasive species is difficult and costly, preventing initial invasion is extremely important. Several fish species have been introduced to the Hat Creek drainage over many decades. Most were planted to increase opportunities for recreational angling but also compete with, or prey directly on, native fish stocks. Currently, under California's Wild Trout program (SB 384, Heritage and Wild Trout Program), fish stocking in Hat Creek has now been eliminated (see Fisheries section). The spread of invasive aquatic mollusks and plants is also a major threat in many areas of the United States and California and has already impacted Hat Creek with the introduction and spread of *Eurasion watermilfoil*, an invasive aquatic weed. Invasive mussels (e.g. zebra mussel, New Zealand mudsnail) have not yet been introduced into the Pit River drainage, but have arrived on the West Coast. If introduced into Hat Creek, disastrous impacts on all components of the aquatic system may occur, including the natural ecosystem, agriculture, recreation, and power generation. Properly cleaning boats, trailers, waders, decoys, and other items that come into contact with waters in various drainages is critically important to stemming the transfer of organisms between water bodies. In New Zealand, the use of felt-soled wading boots is no longer permitted because of concerns related to clinging invasive species and concomitant transfer of organisms (mollusk, fungi, plants, and disease vectors) between watersheds. Signs and inspection stations are commonly used near boat ramps in southern California and near Lake Tahoe in an effort to increase public awareness and avoid

transferring aquatic invasive species between areas. The CDFG as well as other state and federal agencies oversee various programs designed to limit problems associated with invasive species.

Invasive Weeds

Invasive weeds are considered to be a major problem in the United States for their potential to adversely affect the economy and natural environment of a given area. In the Hat Creek Watershed, a number of invasive species have wreaked havoc on the economy and environment by outcompeting native plant and animal species, altering the natural fire frequency or severity, lowering crop production, decreasing available water supplies, reducing rangeland productivity, hindering recreational opportunities, and increasing erosion. A listing of invasive weeds that are known to exist in the Hat Creek Watershed is provided in Table 19. The associated California Department of Food and Agriculture (CDFA) and California Exotic Pest Plant Council (CalEPPC) ratings are also shown in Table 19, which provides an indication of the severity of negative impacts caused by each species. The CDFA and CalEPPC list categories are explained in more detail in Table 20.

Table 19
NOXIOUS WEEDS OF THE HAT CREEK WATERSHED

Scientific Name	Common Name	CDFA and CALEPPC Ratings
Acroptilon repens[2]	Russian Knapweed	CDFA = B
Alianthus[2]	Tree of Heaven	CALEPPC = A2
Centaurea diffusa[2]	Diffuse Knapweed	CDFA = A
Centaurea maculosa[2]	Spotted Knapweed	CDFA = A, CALEPPC = Red Alert
Centaurea solstitialis[2]	Yellow Starthisle	CDFA = C, CALEPPC = A1
Centaurea squarrosa[1]	Squarrose Knapweed	CDFA = A
Cirsium arvense[2]	Canada Thistle	CDFA = B, CALEPPC = B
Cystisus scoparius[2]	Scotch Broom	CDFA = C, CALEPPC = A1
Hypericum perforatum[2]	Klamath Weed	CDFA = C, CALEPPC = B
Lepidium latifolium[2]	Perennial Pepperweed (Tall Whitetop)	CDFA = B, CALEPPC = A1
Lythrum salicaria[1]	Purple Loosestrife	CDFA = B, CALEPPC = Red Alert
Onopordum acanthium[1]	Scotch Thistle	CDFA = A
Spartium junceum[2]	Spanish Broom	CALEPPC = B
Tribulus Terrestris[2]	Puncture Vine	CDFA = C

NOTES:
[1] Mapped in watershed by Shasta County
[2] Identified in watershed by Shasta County Department of Agriculture Weights and Measures

Table 20
CDFA AND CALEPPC NOXIOUS WEED CATEGORY DESCRIPTIONS

CDFA Listing	
A	An "A" rated organism is one of known economic importance subject to state/county-Enforced action involving eradication, quarantine regulation, containment, rejection or other holding action.
B	An organism of known economic importance subject to eradication, containment, control or other holding action at the discretion of the individual county agricultural commissioner, or an organism of known economic importance subject to state endorsed holding action and eradication only when found in a nursery.
C	An organism subject to no state-enforced action outside of nurseries except to retard spread generally at discretion of a commission or subject to no state-enforced action except to provide for pest cleanliness standards in nurseries.
Q	An organism requiring temporary "A" action pending determination of a permanent rating. The organism is suspected to be of economic importance but its status is uncertain because of incomplete identification or inadequate information.
D	No action.
CalEPPC Listing	
A	Most Invasive Wildland Pest Plants; documented as aggressive invaders that displace natives and disrupt natural habitats. Includes two sub-lists: List A-1: widespread pests that are invasive in more than three Jepson regions, and List A-2: regional pests invasive in three or fewer Jepson regions.
B	Wildland Pest Plants of Lesser Invasiveness; invasive pest plants that spread less rapidly and cause a lesser degree of habitat disruption; may be widespread or regional.
Red Alert	Pest plants with potential to spread explosively; infestations currently small or localized. If found, alert CalEPPC, County Agricultural Commissioner, or California Department of Food and Agriculture.

Once invasive plants have spread into native vegetative communities, such as annual grassland or conifer forest, eradication is quite difficult. Weed control methods include physical control (e.g. burning, hand-pulling), chemical control (e.g. selective or non-selective herbicides) and biological control (e.g. insects that eat the pest). A group of 16 state and federal agencies, called the California Interagency Noxious Weed Coordinating Committee, created the Calweed database that provides information on weed control projects underway in California counties. Of the 25 weed control projects listed for Shasta County, none are currently listed for Hat Creek Watershed.

DATA GAPS

The following major data gaps were identified during the Hat Creek Watershed Assessment:

Trout

- Data on trout abundance, distribution, and habitat use
- Historical planting records
- Effects of downstream sediment flows on trout population

Sculpin

- Presence in and use of downstream sediment flows by sculpin, including availability of spawning habitat
- Effect of bank erosion and collapse on distribution of habitat availability of sculpin
- Potential impacts of non-native warm-water fishes on localized sculpin populations

Shasta crayfish

- Monitoring of Shasta crayfish populations, distribution, and expansion of non-native signal crayfish
- Potential impacts of non-native warm-water fishes on localized crayfish populations

WATERSHED MANAGEMENT PLAN

This section includes a discussion of the principal issues and concerns that have been identified during development of the watershed assessment and presents management actions necessary to address those concerns. The list of issues and concerns is based on the results and input from the watershed community. Although watershed issues and concerns are discussed separately in the sections that follow, it should be recognized that the factors impacting watershed condition are highly interrelated.

Note that *Goals* and associated *Management Actions* are in no particular order or prioritization. Stakeholders are encouraged to use these as a framework for continuing and expanding project work.

1. Support community sustainability by strengthening natural-resource-based economies
2. Maintain high-quality water in Hat Creek
3. Maintain and improve forest health and vigor
4. Maintain availability of water in the system for irrigation demands and ecological needs
5. Maintain and improve habitat quality for indigenous cold water fish
6. Support and encourage better coordination of data collection, sharing, and reporting in the watershed

GOAL 1: SUPPORT COMMUNITY SUSTAINABILITY BY STRENGTHENING NATURAL-RESOURCE-BASED ECONOMIES

Management Objectives

1. Support economic development opportunities that sustain and improve watershed health
2. Explore the potential to expand renewable energy businesses
3. Maintain a sustainable timber industry

4. Use conservation enhancements for natural resource management and provide for sustainable family agricultural operations
5. Enhance hunting and other outdoor recreational opportunities and awareness
6. Improve recreational opportunities and diversity of activities in the watershed to increase tourism dollars
7. Sustain and improve game species populations

Management Objective 1
Support economic development opportunities that sustain and improve watershed health

The hard-working people of the watershed should determine their own economic destiny by identifying and planning for natural resource sustainability and development opportunities. Existing agricultural businesses can be diversified and new natural-resources-related businesses can be started.

Management Actions:

1. Promote agriculture and nature-based tourism within the watershed
2. Enhance hunting, fishing, and other outdoor recreational opportunities and awareness

Management Objective 2
Explore the potential to expand renewable energy businesses

Numerous sources of green power exist in the watershed including wind, water, cogeneration, and solar byproduct. Resources from the Hat Creek Watershed feed a cogeneration plant located in Burney. Other sources of power generation can be explored to meet growing overall demand. The State of California and the United States have set goals to reduce reliance on foreign and domestic fossil fuels. This objective can help meet those goals.

Management Actions:

1. Support an energy assessment within the combined watershed area in order to identify existing conditions, plan for strategic sites of new developments, and reduce any potential detrimental impacts to the environment
2. Use biomass, hydro- and geothermal, wind, and solar sources to meet local, state, and national goals of energy independence

Management Objective 3
Maintain a sustainable timber industry

The watershed is located in a major timber-producing area and assists in supporting two active mills in Burney, as well as mills in the greater Redding area. In the past, many more mills were located in the region and contributed to the local economy. Abundant timber supplies still exist and can be sustainably managed to create fire-safe communities, as well as woody biomass-use industry that will result in jobs for local families.

Management Actions:

1. Conduct fuel-reduction projects and improve defensible space in wildland/urban interface areas to improve forest health and protect property and human lives
2. Use stewardship contracts with USFS and the Bureau of Land Management for communities and local non-profits on public land to manage forest units in a sustainable manner and allow forest revenues to remain in the local community

Management Objective 4
Use conservation enhancements for natural resource management and provide for sustainable family agricultural operations

Opportunities exist from local and external sources of technical and financial assistance to restore and enhance the environment conditions that will help provide a productive and balanced economy within the watershed.

Management Actions:

1. Seek opportunities from government and non-government organizations (e.g., land trusts, conservancies) to implement long-term conservation easements; search for partnership opportunities to establish grass banks that will help improve rangeland, riparian areas, and streambanks through proper rest and rotation of grazing areas
2. Explore opportunities for carbon sequestration and carbon credits in the watershed to improve soil quality and help achieve a balanced global carbon cycle

Management Objective 5
Enhance hunting and outdoor recreational opportunities and awareness

The opportunity to enhance watershed health will result in corresponding improvements in wildlife and fisheries habitat, the foundation of outdoor recreational opportunities such as hunting, fishing, camping, wildlife viewing, etc. This recreation can greatly contribute to the economic diversity of the watershed.

Management Actions:

1. Implement stated restoration objectives in previous sub-goals
2. Expand partnerships to develop appropriate recreation infrastructure
3. Create an advertising campaign to promote local recreation opportunities
4. Do a market analysis and feasibility study on the economic viability of expanding recreational opportunities

Management Objective 6
Improve recreational opportunities and diversity of activities in the watershed to increase tourism dollars

Management Actions:

1. Conduct market analysis on economic viability of expanding recreation
2. Upgrade existing USFS campground and day-use facilities along Hat Creek
3. Capture and encourage private recreation opportunities in the watershed
4. Develop additional off-creek camping and recreational opportunities that may include OHV areas, snowmobile parks, horse camping (i.e., Twin Bridges)
5. Encourage use of existing communities

Management Objective 7
Sustain and improve game species populations

Game hunting can be a significant source of revenue from tourism dollars in the Hat Creek Watershed. This can include both big game (deer) and waterfowl.

Management Actions:

1. Improve habitat management activities in the watershed
2. Address growing mountain lion population
3. Restore aspen habitat

GOAL 2: MAINTAIN HIGH-QUALITY WATER IN HAT CREEK

Management Objective 1
Improve overall water quality in Hat Creek by implementing actions that address problem conditions (e.g. excessive channel erosion, degraded aquatic habitat, etc.

Water quality in Hat Creek is incredibly clear and cold and is the product of natural factors and past and present land and water use practices in the watershed. The management strategy to protect and improve water quality is a suite of actions intended to improve watershed condition. Most of these actions are addressed in the other goal

statements of this document. The expectation is that implementation of these actions will result in less sediment loading throughout the watershed.

Management Actions:

1. Solicit willing landowners and secure public and private funding assistance for projects that accomplish any of the following:
   - ❖ Reduce fuel loading
   - ❖ Improve channel stability and reduce erosion
   - ❖ Improve instream and riparian habitat conditions
2. Address water quality concerns with irrigation and livestock management, and implement a program that promotes and rewards good management practices at the individual ranch and farm level.

Management Objective 2
Comply with the requirements of the Regional Board's Irrigated Lands Regulatory Program (ILRP) and implement a program that promotes and rewards good management practices at the individual ranch and farm level

The RWQCB has adopted an ILRP that applies to anyone discharging irrigation tailwater. Most ranch and farm owners have sought program compliance by being a member of a regional coalition that has received a conditional waiver of waste discharge from the RWQCB. For the Hat Creek Watershed, the group coalition that has been organized is Northeastern California Water Association (NECWA). Under the current coalition program, dischargers are required to become coalition members and pay a fee primarily used for administration to comply with the program. If monitoring shows results that exceed water quality standards, the coalition must prepare a management plan that addresses the cause of the exceedence. Stakeholders in the watershed question the value of the ILRP in that it is costly to landowners and provides no actual benefit to the water quality. The program should be replaced with a program like U.C. Cooperative Extension's California Rangeland Water Quality Management Plan, which is voluntary and effective.

Management Actions:

1. Work with landowners and managers to implement management practices to maintain the high quality of water in Hat Creek
2. Continue to provide the option of membership in a group coalition for purposes of meeting the requirements of the RWQCB's ILRP
3. Work with RWQCB staff to develop a long-term program that promotes and rewards implementation of good management practices at the individual ranch and farm level

Management Objective 3
Monitor water quality at selected locations in Hat Creek to track changes in conditions

Water quality monitoring can be an important feedback mechanism to assess whether watershed conditions are improving, staying constant, or getting worse. A long-term monitoring program may be needed to assess management change and watershed health over time, however monitoring can be costly. Private monitoring has shown there are no problems in the southern reaches of Hat Creek.

Management Actions:

1. Periodically conduct watershed-wide monitoring to provide comprehensive information on water quality conditions in individual tributaries and strategic locations on Hat Creek
2. Conduct an assessment of the potential for restoration of Cinder Flats and Corral Creeks to restore hydrologic function and enhance riparian habitat

Management Objective 4
Reduce sediment loading into Hat Creek

Sediment loading can be introduced from a variety of sources including bank erosion, human disturbance, fire, and other catastrophic events – some which are human-caused and some natural.

Management Actions:

1. Decrease risk of catastrophic fire in the watershed
2. Reduce shoreline damage from impacts of dispersed recreation
3. Redesign roads and culverts in uplands to reduce sediment inflow
4. Control non-native plant and animal populations, specifically muskrat

Management Objective 5
Assist landowners to develop management practices for managing riverbank erosion

Landowners and managers along streams and floodplains face different land management challenges. Many land managers along these areas do not fully understand the complexity of factors regarding properly functioning conditions of streams and floodplains, or do not have the resources to manage these areas in a sustainable manner.

GOAL 3: MAINTAIN AND IMPROVE FOREST HEALTH AND VIGOR

Management Objective 1
Reduce impacts of dispersed recreation on Hat Creek and the surrounding habitat

Management Actions:

1. Approach OHV use areas to control habitat impacts as long as current permitted users are not limited
2. Mitigate impacts from high use recreation areas

Management Objective 2
Reduce threat of catastrophic wildfires

Management Actions:

1. Thin forest lands, remove excess biomass
2. Increased USFS management and action in forest lands; devote more USFS resources to planning, environmental review, and contracting
3. Construction of fuel breaks and other defensible areas
4. Evaluate addition of prescribed fire to ecosystem following fuel reduction activities
5. Focus on forest restoration to develop fire resilient landscape
6. Consider stewardship contracting
7. Increase monetary and other incentives for fuel reduction on private holdings
8. Evaluate full impact of USFS-prescribed burning programs

Management Objective 3
Improve habitat diversity in the watershed

Management Actions:

1. Increase variety in seral condition
2. Restore parts of the watershed to pre-fire exclusion condition
3. Protect and encourage populations of native plants and wildlife
4. Encourage establishment of native population and control non-native populations

5. Plan and implement noxious and non-native weed control projects using all available tools
6. Remove non-native terrestrial mammals from Hat Creek
7. Develop meadow restoration projects to restore native species form and function
8. Continue to encourage and use livestock grazing as a tool for meadow management, enhancement, and recreation

GOAL 4: MAINTAIN AVAILABILITY OF WATER IN THE SYSTEM FOR IRRIGATION DEMANDS AND ECOLOGICAL NEEDS

Management Objectives

1. Encourage landowners and users to be as efficient with water management as possible by encouraging piping and usage of irrigation conveyance structures
2. Keep as much water as possible within the Hat Creek system
3. Provide opportunities for education in water efficiency, range management, and crop management to increase yields with less water

Management Objective 1
Encourage landowners and users to be as efficient with water management as possible, encourage piping and usage of irrigation conveyance structures

Management Actions

1. Promote the use of efficient irrigation techniques to assist landowners and seek financial help to implement those techniques
2. Implement projects that demonstrate new and innovative solutions for irrigation that maintains flows in Hat Creek

Management Objective 2
Keep as much water as possible within the Hat Creek system

Management Actions

1. Support development of a groundwater study and possible groundwater management plan for the watershed

Management Objective 3
Provide opportunities for education in water efficiency, range management, and crop management to increase yields with less water

Management Actions

1. Provide information to the watershed community on programs and opportunities for transfer, and possibly sale, of existing water rights
2. Assist NECWA to develop and promote a Sustainable Management Practices Program

GOAL 5: MAINTAIN AND IMPROVE HABITAT QUALITY FOR INDIGENOUS COLD WATER FISH

Hat Creek is widely known for its value as a trout fishery; significant tourism interest and activities that are generated by the value of this resource. During the assessment, stakeholders expressed concerns that the fishery was declining or was not as resilient as in years past.

Management Objective 1
Develop a better understanding of the dynamics of wild trout populations in Hat Creek
A significant data gap addressed in the watershed assessment portion of the project was the lack of current and detailed data on the dynamics of wild trout populations in the creek as well as any assessment of the impacts of individual stressors on the populations

Management Actions:

1. Develop a wild trout abundance index and program for long-term monitoring of trout population in Hat Creek
2. Assess habitat differences between upper and lower Hat Creek, and suitability for wild versus planted fish
3. Develop an indicator of the impact of non-native fish and planted fish on the wild trout population
4. Encourage maintenance and improvement of habitat and healthy populations of rough sculpin and Shasta crayfish under existing recovery programs to allow delisting

Management Objective 2
Maintain and restore blue-ribbon wild trout fishery

The spring-fed cold water conditions in Hat Creek are ideal to cold-water indigenous species including trophy trout. Stressors were identified that can limit the ability of the system to continue to support the cold water fishery; these include sediment loading, non-native plant intrusion, loss of ecosystem balance and function, and the addition of non-native warm-water invasive species (i.e. bass).

Management Actions:

1. Develop and implement methods to reduce or eliminate muskrat den impacts
2. Expand trophy trout habitat area in upper watershed
3. Work with PG&E to address and monitor impacts of hydropower releases
4. Work with USFS and others to control sediment after fire
5. Address sediment source from dispersed recreational use
6. Encourage habitat improvements in the upper watershed relating to sediment generation

Management Objective 3
Support Shasta crayfish restoration efforts

The remaining populations of Shasta crayfish are limited.

Management Actions:

1. Support adherence to existing recovery plan
2. Reduction of population of non-native competition and predator species

Management Objective 4
Increase the understanding of rough sculpin ecology so as to protect this rare species while achieving trout management objectives

Management Actions:

1. Determine use by sculpin of fine sediments and vegetation mats
2. Determine use of downstream sediment flows by sculpin, including availability of spawning habitat
3. Determine effect of bank erosion and collapse on distribution and habitat availability of sculpin
4. Examine potential impacts of non-native warm-water fishes on localized sculpin populations

Management Actions:

1. Increase awareness about Hat Creek
2. Assist NECWA to develop and promote a Sustainable Management Practices Program
3. Promote programs that protect and enhance riparian vegetation development (such as fencing)

GOAL 6: SUPPORT AND ENCOURAGE BETTER COORDINATION OF DATA COLLECTION, SHARING, AND REPORTING IN THE WATERSHED

Management Objectives

1. Develop a standard watershed improvement project directory for stakeholders within the watershed

Many of the projects conducted in the watershed are unknown to the local community for a variety of reasons. However, documenting the success stories and quantifying the project benefits are vital to improving management practices, securing funding, and informing stakeholders. Sharing of data is also needed for planning purposes. The permitting process is necessary to implement projects, and sharing of data across ownership boundaries can help streamline the process and improve project capacity and effectiveness.

Management Objective 1
Develop a standard watershed improvement project directory for stakeholders within the watershed

Funds used to implement projects within the watershed often come from a variety of sources, and each of these sources often has independent reporting requirements. In addition, each stakeholder group that implements projects often has unique reporting requirements.

Management Actions:

1. Create a working group to discuss projects and encourage interaction
2. Create a directory of key resource managers and distribute to allow improved communication

CONCLUSIONS

This WA/WMP successfully engaged the entire watershed community to discuss important resource concerns and determine a suite of management actions that would improve watershed conditions. The FRRCD encourages stakeholders to lead project activity on these actions, some of which will include implementation projects (e.g. restoration of degraded channels) while others will focus on completing other planning projects (e.g. developing a groundwater management plan). Regardless, future success will require collaboration of all interested stakeholders and a concerted effort by those living within the watershed.

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