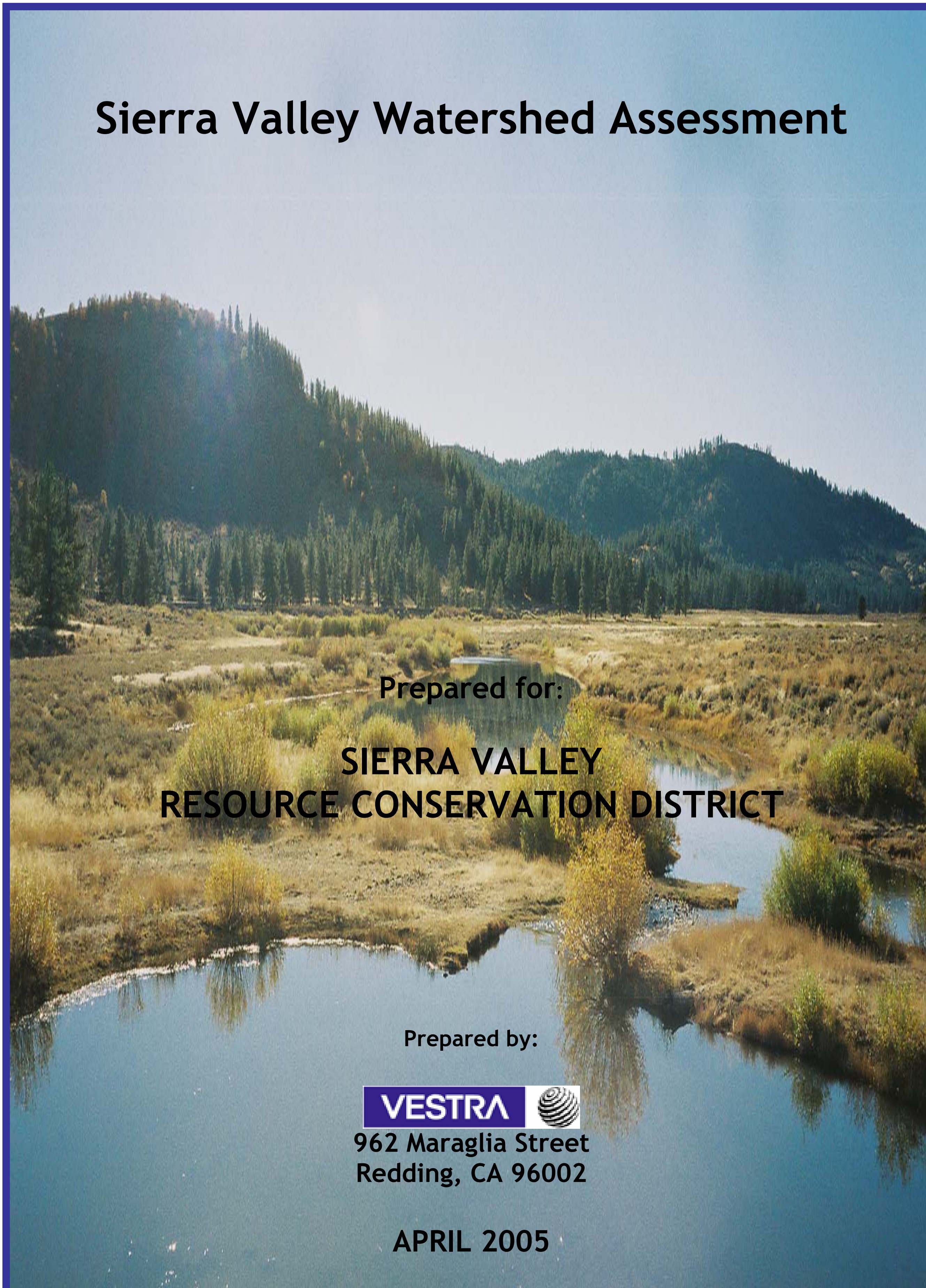


Sierra Valley Watershed Assessment

Prepared for:

SIERRA VALLEY
RESOURCE CONSERVATION DISTRICT

Prepared by:

VESTRA

962 Maraglia Street
Redding, CA 96002

APRIL 2005

Sierra Valley Watershed Assessment

Prepared for:

SIERRA VALLEY
RESOURCE CONSERVATION DISTRICT

Prepared by:

VESTRA
962 Maraglia Street
Redding, CA 96002

APRIL 2005

Section 1
INTRODUCTION

TABLES

FIGURES

Section 2
GENERAL WATERSHED HISTORY

TABLES

FIGURES

Section 3
GEOLOGY AND SOILS

TABLES

FIGURES

Section 4
HYDROLOGY

TABLES

FIGURES

Section 5
WATER QUALITY

TABLES

FIGURES

Section 6
BOTANICAL RESOURCES

TABLES

FIGURES

Section 7
FISH AND WILDLIFE RESOURCES

TABLES

FIGURES

Section 8
LAND USE

TABLES

FIGURES

Section 9
FORESTRY, FIRE, AND FUEL MANAGEMENT

TABLES

FIGURES

Section 10
CULTURAL CHARACTERISTICS

TABLES

Section 11
SIGNIFICANT FINDINGS, CONCLUSIONS, AND ACTION OPTIONS

SIERRA VALLEY WATERSHED ASSESSMENT ACRONYMS

AFDC	Aid to Families with Children
aft	acre-feet
AGR	Agriculture
bgs	below ground surface
BLM	Bureau of Land Management
CalEPPC	California Exotic Pest Plant Council
CARA	California Rivers Assessment
CCC	California Conservation Corps
CDC	California Department of Conservation
CDF	California Department of Forestry and Fire Protection
CDFA	California Department of Food and Agriculture
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
cfs	cubic feet per second
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
COLD	Cold freshwater habitat
CVMP	California Vegetation Management Plan
CWA	Clean Water Act
CWAP	Clean Water Action Plan
CWHR	California Wildlife Habitat Relationships
DAU	Deer Assessment Unit
DEM	Digital elevation model
dbh	diameter at breast height
DFPZ	Defensible Fuel Profile Zone
DNR	Department of Natural Resources
DO	Dissolved oxygen
DOQQ	Digital Orthogonal Quarter Quadrangle
DOT	Department of Transportation
DWR	Department of Water Resources
EC	Electrical conductance
EIS	Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FRAP	Fire and Resource Assessment Program
GAP	Gap Analysis Project
GIS	Geographic Information Systems
gpm	gallons per minute
GPRA	Government Performance and Results Act
HFQLG	Quincy Library Group
LCMMP	Land Cover Mapping and Monitoring Program
Ma	Million years ago
mg	milligram
mg/l	milligrams/liter
mL	Milliliters
msl	mean sea level
N	Nitrogen
NEPA	National Environmental Policy Act
NFMA	National Forest Management Act

NFP	National Fire Plan
NH3	Ammonia
NMFS	National Marine Fisheries Service
NIFC	National Interagency Fire Center
NOAA	National Oceanic and Atmospheric Administration
NO2	Nitrite
NO3	Nitrate
NPDES	National Pollution Discharge Elimination System
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NTU	Nephelometric turbidity units
NWGC	National Wildfire Coordinating Group
PAC	Protected Activity Center
PFC	Proper Functioning Condition Assessment
PJA	Professional Judgment Assessment
ppm	Parts per million
PRIA	Public Rangelands Improvement Act
P.U.C.	Public Utility Commission
REC-1	Water contract recreation
REC-2	Non-contact water recreation
RCD	Resource Conservation District
ROD	Record of Decision
RPA	Rangeland Renewable Resource Planning Act
RTP	Regional Transit Plan
RVD	Recreational Visitor Days
RWQCB	Regional Water Quality Control Board
SAF	Society of American Foresters
SCS	Soil Conservation Service
SNEP	Sierra Nevada Ecosystem Project
SNFPA	Sierra Nevada Forest Plan Amendment
SPLAT	Strategically Placed Area Treatment
SPWN	Spawning, reproduction, and/or early development
SRA	State Responsibility Area
SSURGO	Soil Survey Geographic
SVRCD	Sierra Valley Resource Conservation District
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
TANF	Temporary Assistance for Needy Families
TDS	Total dissolved solids
Tiger	Topologically Integrated Geographic Encoding and Referencing
TMDL	Total Maximum Daily Loads
TRPA	Tahoe Regional Planning Agency
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	Unites States Geological Survey
UWIZ	Urban Wildland Intermix Zone
VMP	Vegetation Management Plan
WARM	Warm freshwater habitat
WILD	Wildlife habitat
WUI	Wildland Urban Intermix Zone

Section 1

Section 1
INTRODUCTION

TABLES

FIGURES

Section 1
INTRODUCTION

OBJECTIVE

The mission of the Sierra Valley Watershed Assessment is to gather and integrate existing information on the physical, cultural, and demographic variables that characterize the Sierra Valley Watershed at the present and in the past. The project is primarily an existing conditions report that will be used as an educational tool and help guide residents and stakeholders in prioritizing future watershed projects within Sierra Valley. This watershed assessment can be considered the initial step in developing our knowledge of the existing conditions within the Sierra Valley Watershed ecosystem. It will be amended and extended as new information becomes available.

FUNDING SOURCES

The watershed assessment project is funded through a grant from the State Water Resources Control Board through the CalFed Watershed Management Program. Many other contributions from state, federal, and private sources have made this assessment possible.

TECHNICAL ADVISORY COMMITTEE (TAC)

The Sierra Valley Watershed TAC members are made up of Sierra Valley Resource Conservation District (SVRCD) staff and specialists from cooperating agencies. TAC members provided information and technical review for this project.

TAC members include:

Dan Martynn – Natural Resources Conservation Service
Dennis Heiman – Regional Water Quality Control Board
Fraser Sime – California Department of Water Resources
Jim Lidberg – California Department of Fish and Game
Larry Goldsmith – Sierra Valley Resource Conservation District
Randy Westmoreland – United States Forest Service, Tahoe National Forest
Jan Stine – Sierra Valley Resource Conservation District
Joanne Cox – State Water Resources Control Board

BACKGROUND

The SVRCD found the need to provide a comprehensive evaluation of environmental conditions within the hydrologic unit of Sierra Valley. The Sierra Valley forms the headwaters of the Middle Fork Feather River, a Category I Priority Watershed in the California Unified Watershed Assessment (NRCS 2004).

Watersheds with Category I status meet one or more of the following criteria:

1. Contains water bodies listed as having impaired beneficial uses (Yes or No; from the State Water Resources Control Board's Clean Water Act Section 303(d) list, 2002 update)

2. Watersheds identified by local groups as needing improvements (Yes or No; from the United States Department of Agriculture Geographic Priority Areas [Environmental Quality Incentives Program] database)

3. Watersheds with very high wildfire or fuel hazards potential (Top 50 = Yes; Rest = No; from the California Department of Forestry and Fire Protection Wildfire Potential database)

4. Watersheds with proposed and listed criteria of aquatic, wetland threatened, and endangered species (federal and state) (>0 Species = Yes; 0 Species = No; developed from the California Department of Fish and Game, Natural Heritage Division, Natural Diversity Database)

5. Watersheds with impairments in the quality of aquatic and riparian systems as determined by the California Rivers Assessment (CARA) professional judgment assessment (PJA) (25 or less points for either aquatic or riparian PJA = Yes; Rest = No)

6. Watersheds with streams or riparian areas identified as not functioning or functioning at risk, from the Proper Functioning Condition Assessment (PFC) in CARA. (If any PJA segments were identified as not functioning or functioning at risk, the watershed got a Yes; Rest = No)

As part of the Category I status, the Sierra Valley Watershed is a candidate for increased restoration activities due to impaired water quality or other natural resource goals. Identified impairments to water quality in the Middle Fork Feather River are dissolved oxygen, temperature, and sediment. The river has not been included on the State's 303(d) list as of the 2002 update published by the U.S. Environmental Protection Agency (USEPA) in July 2003 (SWRCB 2003). Although there exists some watershed condition documentation and current assessment work is being conducted, there is no comprehensive and complete assessment of existing watershed conditions. It has been suggested that Sierra Valley is a main contributor of sediment to the Middle Fork Feather River.

DATA SOURCES

Data sources used to assemble the Sierra Valley Watershed Assessment come from federal, state, and local sources. Generally, data sources are based primarily on published material. However, whenever possible data previously unavailable such as academic theses are incorporated into the document with TAC concurrence. Agencies responsible for providing available data include, but are not limited to, the United States Forest Service (USFS), United States Department of Agriculture (USDA), California Department of Transportation (DOT), California Department of Water Resources (DWR), State Water Resources Control Board (SWRCB), Bureau of Land Management (BLM), United States Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), California Department of Fish and Game (CDFG), Natural Resources Conservation Service (NRCS), and California Department of Forestry and Fire Protection (CDF).

LOCATION

The Sierra Valley Watershed is located in northeastern California in the Sierra Nevada Range. The general vicinity of the watershed is shown in Figure 1-1. The valley is the headwaters of the Middle Fork of the Feather River. Plumas and Sierra Counties bisect the watershed with a small portion of southwestern Lassen County in the northeast. The watershed boundary, its major tributaries, and general layout are included in Figure 1-2.

Rural lifestyles and a population density of approximately five persons per square mile generally characterize the watershed. The largest community in the watershed is Loyalton, an incorporated city in Sierra County, with a current population of 862. Other unincorporated towns in the watershed include Beckwourth, Vinton, Chilcoot, Sattley, and Sierraville. Ranching, farming, and timber are the primary resource activities throughout the watershed. Cattle, pasture and range, wild hay, alfalfa hay, and grain hay dominate the agricultural activities.

The Sierra Valley Watershed encompasses 297,657 acres and includes 28 sub-watersheds. A list of sub-watersheds is included in Table 1-1. The valley is known as the largest high-alpine valley in the continental United States. The following is a general discussion of the watershed's topography and variations in elevation. A more detailed discussion of events leading to the topography of the watershed can be found in Sections 2 and 3, "General Watershed History" and "Geology and Soils."

GENERAL WATERSHED ELEMENTS

Topography

The USGS is the primary agency responsible for supplying data for the topography section.

The Sierra Valley Watershed topography is typical of former lake basins. A large portion of the watershed's 297,000 acres is part of the valley floor. The low gradient of valley floor is a result of the Pleistocene lake that once occupied the valley. During this time, an abundance of glaciers could be found throughout the Sierra Nevada. Traces of these glaciers are found within the watershed today. The steep slopes of the surrounding Sierra Nevada still drain into the Sierra Valley, but now become the headwaters of the Middle Fork Feather River.

Table 1-1
SUB-WATERSHEDS OF SIERRA VALLEY

Alder Creek	Antelope Creek	Banta Creek	Bear Creek
Blatchley Creek	Carman Creek	Chilcoot	Correco Canyon
Cottonwood Creek	Dodge Canyon	E. Carman Creek	Franklin Cabin
Harding Point	Lemon Canyon	Martneck Canyon	Mt. Ina
Nichols Mill	Old Station	Palen Reservoir	Rock Creek
Rock Creek A	Ross Ranch Meadow	Sattley	Sierra Valley
S. Last Chance Creek	Turner Canyon	Upper Sulphur Creek	West Smithneck

Elevation

The USGS is the primary agency responsible for supplying data for the elevation section.

The average elevation of the watershed is just below 5,000 feet, with the surrounding mountains including Beckwourth Peak, climbing steeply above 8,000 feet. The town with the highest population, Loyalton, sits at 4,985 above mean sea level (msl). Watershed topography with elevation bands is included as Figure 1-3. A summary of USGS quadrangle maps within the watershed is included as Table 1-2. The slope gradient and aspect along the boundaries of the watershed vary significantly, but the valley floor is comparatively flat with a zero to five percent slope.

Table 1-2
SIERRA VALLEY WATERSHED
USGS 7.5 MINUTE QUADRANGLES

Antelope Valley	Beckwourth Pass	Calpine	Chilcoot
Clio	Constanta	Crocker Mountain	Dixie Mountain
Dog Valley	Evans Canyon	Frenchman Lake	Independence Lake
Loyalton	Portola	Reconnaissance Peak	Sardine Peak
Sattley	Sierraville	Webber Peak	

Climate

Sources of Data
The California Department of Water Resources, Desert Research Institute, and the Sierraville Ranger Station are the primary agencies responsible for contributing data for the climate section.

Historical Record
Real-time climate data are not available before circa 1900. In order to evaluate historic climate trends, scientists use glacial cores, lakebed deposits, tree line inventory, and tree ring data. California has experienced a number of significant trends in both temperature and precipitation that are very different from what is today considered "normal." In fact, around 1850, just as large numbers of Europeans entered western ecosystems, the region experienced a marked shift in climate from the abnormally cool and moderately dry conditions of the previous two centuries (the "Little Ice Age"), to the relatively warm and wet conditions that have characterized the past 145 years (Matthes 1939). This climactic shift is important to land managers for two interrelated reasons. First, the landscape changes that occurred since 1850 may not be entirely anthropogenic, but rather are attributable in part to the shift in climate. Second, the landscape of the immediate period should not be considered an exact model for what the watershed would be today had Europeans never colonized the region. Thus, attempts to restore "natural conditions" as part of an overall management plan should focus not on the pre-European landscape, but rather on the landscape that would have evolved during the past century and a half in the absence of Europeans (Stine 1996).

The period of the mid-1600s to mid-1800s is characterized as abnormally cool and dry. Scientists believe the dry period was preceded by several centuries of cool, wet conditions. Warm and relatively wet conditions by comparison are common for the past 145 plus years. This is documented from glaciers and tree rings as well as from lake deposits. Much of the data used to document historic climatic conditions for the watershed were extrapolated from data collected from the Sierra Nevada.

General Evidence

Records show (Clark and Gillespie 1995; Curry 1969) that after thousands of years of little or no glaciation (adding ice), the high elevation areas of the Sierra Nevada experienced an accumulation of snow and ice for several hundred years prior to 1850. This accumulation corresponds to a period of cooling over much of the globe that began in the fourteenth or fifteenth century and continued through the middle of the nineteenth century (Grove 1988). Matthes speculates that the small glaciers reached a peak extent around 1850 and began to recede to 87 feet between 1933 and 1941. Theoretically, this minor glaciation of the mid-sixteenth through mid-nineteenth centuries is attributable to some combination of increased precipitation (leading to greater accumulation) and decreased temperature (leading to less melting and sublimation). Since the lake level records presented earlier in this chapter are consistent in suggesting that climate was relatively dry during this period, it might be concluded as a working hypothesis that relatively low temperatures caused the advance of the ice. Various types of dendroclimatological (using tree rings to estimate climate) evidence support this hypothesis. The dendroclimatic record verifies that climate was both relatively cool and relatively dry during the centuries preceding the California gold rush (Stine 1996).

Graumlich's tree ring record from the southern Sierra provides the most detailed view of variations in the latest Holocene climate. That record confirms the period from 1650 to 1850 was generally dry, although it shows an important exception not evident in the lake or glacial records: the interval 1713–32 was anomalously wet. Graumlich's work also provides corroboration that the period from 1650 to 1850 was, by both Holocene and modern standards, abnormally cool (Stine 1996).

The tree ring studies allow the temperature factor to be isolated from the precipitation factor, an advantage that neither the lake record nor the glacial record can provide. Graumlich concluded that:

- Growing-season temperatures reached their lowest level of the past millennium around 1600 and then remained low by modern (1928–88) standards until around 1850
- Although the period from 1713 to 1732 was by modern standards characterized by relatively wet conditions, it was preceded by a century dominated by low precipitation which was followed by 130 years (particularly the period 1764–61) of anomalous drought
- The period from 1937 to 1986 was the third-wettest half-century interval of the past 1,000 plus years

Graumlich stresses that the same inferred droughts and temperature variations are reflected in other tree-ring studies in and adjacent to the Sierra Nevada by others.

Temperature and Growing Seasons

Average annual temperatures within the watershed range from a low of approximately 30ºF to a high of 63ºF. Temperatures are typically warm in the summer months with average maximum monthly temperatures occurring in July at approximately 84ºF in Sierraville and 86ºF 3 miles to the northwest of the watershed boundary in Portola. Temperatures ranging from the high 70s to the mid 80s are common throughout the watershed from June through September. Maximum temperatures have been recorded in August at 104ºF and 107ºF in Sierraville and Portola.

Temperatures in winter months average from 30ºF in Sierraville and 31ºF in Portola. Maximum temperatures from December through February range from the low to mid 40ºFs throughout the watershed. The lowest recorded temperature in Sierraville was –29ºF on December 9, 1972. Average monthly temperatures for Sierraville are included in Figure 1-4.

The first fall freeze generally occurs in September in Sierraville and the rest of the valley floor with May the last month of freezing temperatures. At higher elevations in the watershed, it is not uncommon to experience freezing temperatures throughout the year.

During January, Sierraville experiences daily temperature fluctuations of approximately 30ºF. In July, temperatures fluctuate nearly 40ºF.

Evaporation is the amount of water lost from a system due to the sun's radiation, air temperature, wind speed, and vapor pressure (relative humidity). Evaporation data, although typically used to schedule irrigation events, closely reflect the evaporation rates of surface water and are used to help calculate water balance of the watershed. Data published by the DWR in 1979 indicate the average evaporation rates from 1960 to 1970 for the area around Vinton. Although this is the only evaporation data available for the watershed it is assumed that the evaporation rates would be similar for the rest of the valley floor. The evaporation rates recorded for Vinton between 1960 and 1970 are shown in Table 1-3.

Table 1-3
EVAPORATION RATES FOR VINTON: 1960–1970

Year	Total	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1960					44	49	106	228	215	266	267	283	206
1961		127	80	57				171	208	282	331	239	209
1962		141						180	166	203	225	247	206
1963		108	22					81	130	163	283	263	164
1964		117	35					137	169	187	257	259	212
1965		154							165	178	198	198	164
1966		134							208	232	279	252	188
1967		138								128	214	177	133
1968		98							225	289	349	243	223
1969									245	201	307	317	226
1970										214	321	321	
Mean	1,716	127	46	57	44	49	106	159	192	213	276	254	193

Source: California Department of Water Resources 1979.

The growing season based on the freezing dates is approximately 60 to 90 days on the valley floor. The growing season typically shortens considerably in the mountainous regions to the west and south of the valley.

Precipitation

On average, most areas of the Sierra Valley Watershed receive approximately 15 to 20 inches of precipitation per year. Most precipitation falls during the winter months with 77 percent of the annual total received between November and March. Monthly averages are highest in January with 4.59 inches falling in Sierraville and 4.17 inches falling in Portola. Rainfall during the summer months is limited to thundershowers 5 to 10 days per year, accounting for less than 5 percent of the annual precipitation. Precipitation not only feeds the creeks and rivers of the region, but recharges the groundwater resource as well.

An isohyetal map of the watershed is included as Figure 1-5.

Snowfall

Snowfall data collected at the Sierraville Ranger Station (elevation 4,190 ft above msl) show January as having the highest average snowfall at approximately 17.9 inches with average annual snowfall of approximately 71.8 inches. The highest total snowfall recorded at the Sierraville Ranger Station was 242.3 inches in 1952.

In this high elevation valley, snow tends to stay on the ground for long periods. In January, the average snow depth in Sierraville is 5 to 6 inches, with snow depths consistently above two inches from December to April.

REFERENCES

California Department of Water Resources. 1979. *Evaporation from water surfaces in California*. Bulletin 73-79. November.

Clark, D. H., and A. R. Gillespie. 1995. Timing and significance of late-glacial and Holocene glaciation in the Sierra Nevada, California. *Quaternary International*.

Curry, R. R. 1969. Holocene climatic and glacial history of the Central Sierra Nevada, California. *Geological Society of America Special Paper*, 123.

Grove, J. M. 1988. *Little ice age*. London: Methuen.

Matthes, F. E. 1939. Report of the committee on glaciers. *Transactions of the American Geophysical Union,* 518-23.

NRCS (Natural Resources Conservation Service). 2004. In *Clean water action plan (CWAP) – California unified watershed assessment (1998)* [online]. Cited March 2004. Available from World Wide Web: http://www.ca.nrcs.usda.gov/features/projects/cwap.

SWRCB (State Water Resources Control Board). 2003. *The section 303(d) list of water quality limited segments* [online]. Sacramento. Available from World Wide Web: http://www.swrcb.ca.gov/tmdl/303d_lists.html.

Stine, Scott. 1996. Chapter 2: Climate 1650–1850. *The Sierra Nevada Ecosystem Project, Vol. 2*. Department of Geography and Environmental Studies, California State University, Hayward.

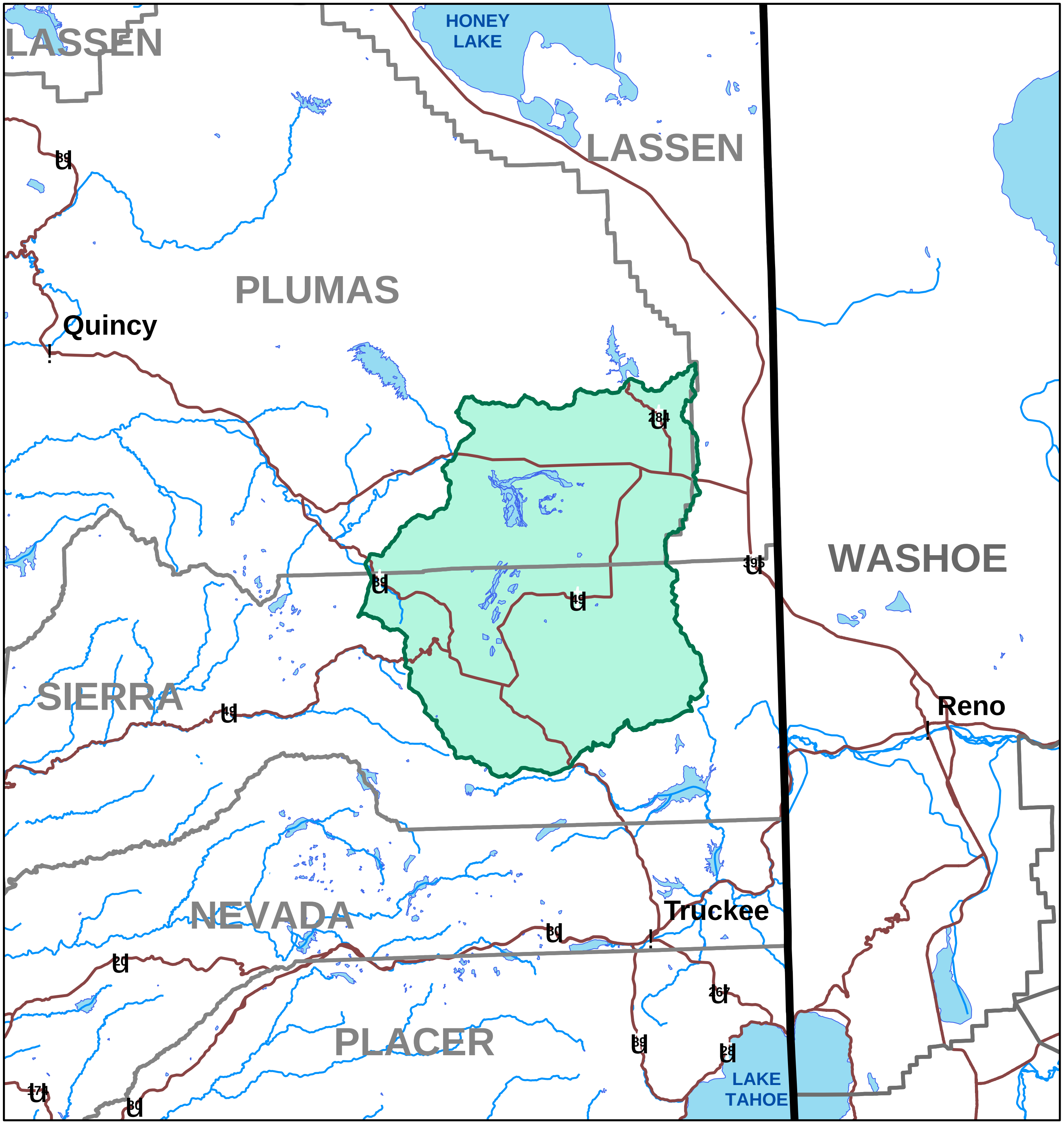


Figure 1-1
General Watershed Location
Sierra Valley Watershed

Legend

- State Boundary
- County Boundary
- Sierra Valley Watershed
- Water Body
- River or Stream
- State Highway

0 5 10 20 Miles

VESTRA

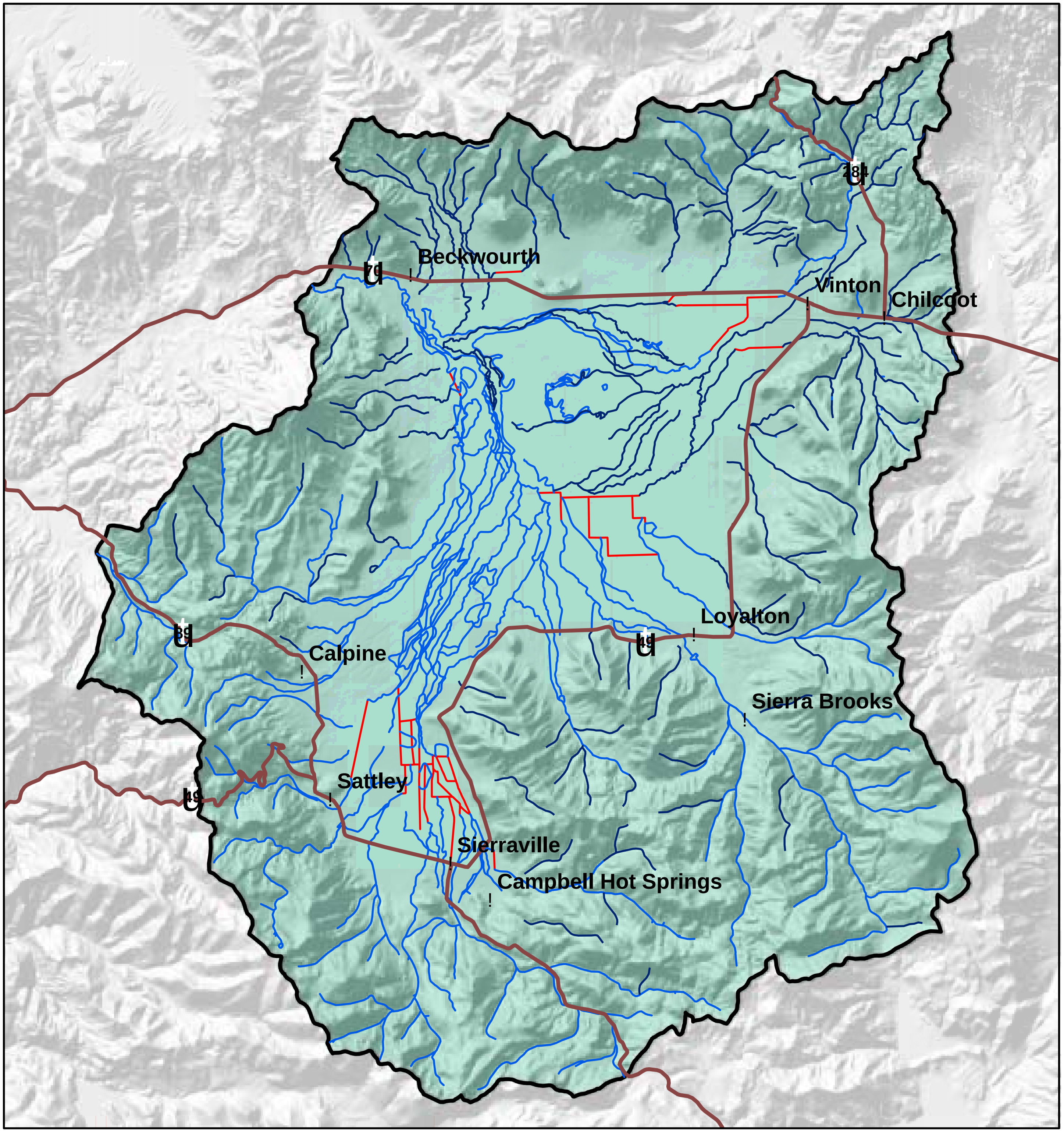


Figure 1-2
Watershed Boundary
Sierra Valley Watershed

Legend

- Sierra Valley Watershed
- State Highway
- Perennial Stream
- Seasonal Stream
- Canal

SOURCE: NATURAL RESOURCES CONSERVATION SERVICE

0 1.25 2.5 5 Miles

VESTRA

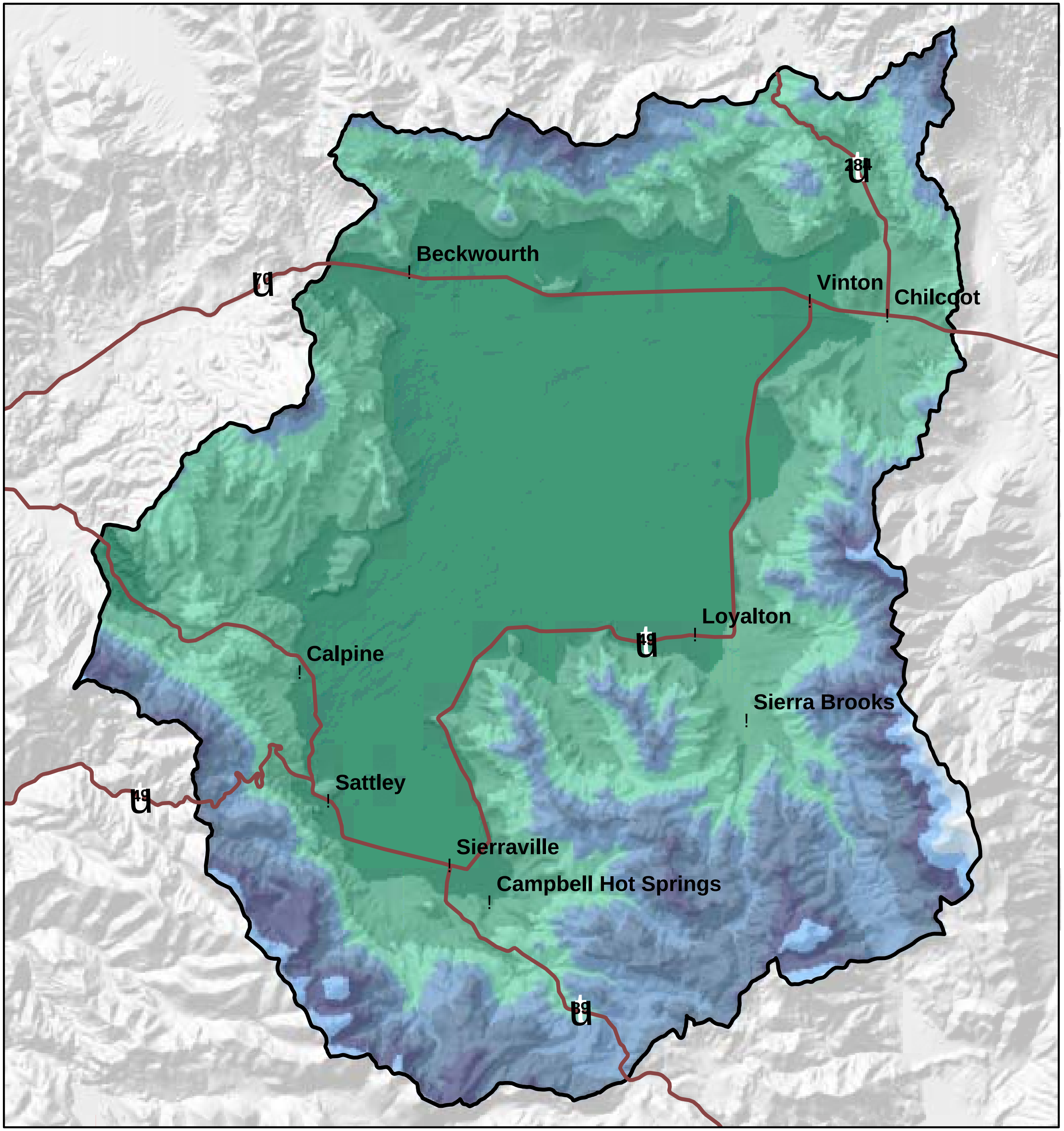


Figure 1-3
Watershed Topography with Elevation Bands
Sierra Valley Watershed

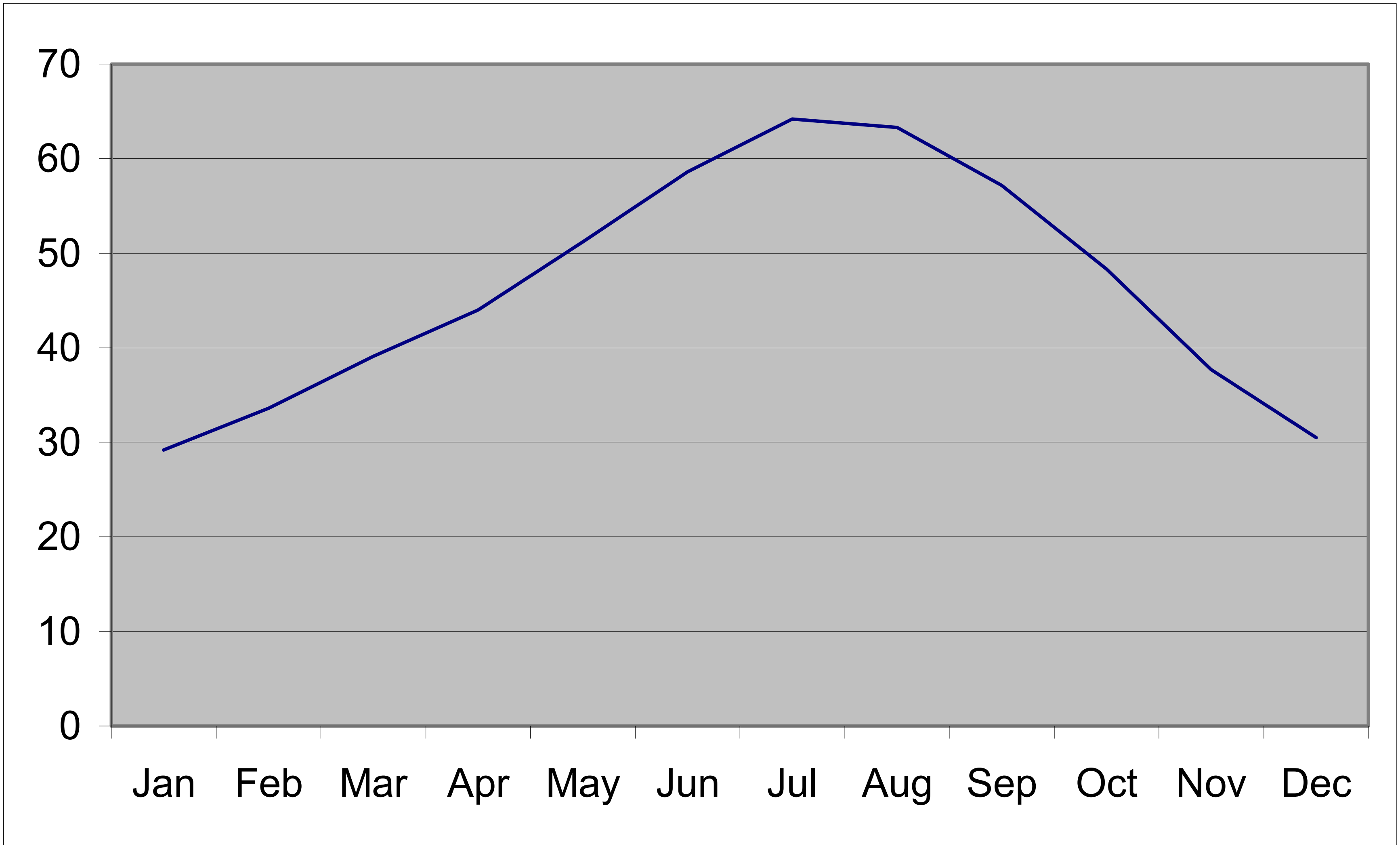
Legend

- Sierra Valley Watershed
- State Highways
- 5,000
- 5,500
- 6,000
- 6,500
- 7,000
- 7,500
- 8,000
- 8,500
- 9,000

Source: California Spatial Information Library: USGS 1 arc-second DEMs, 1999

0 1.25 2.5 5 Miles

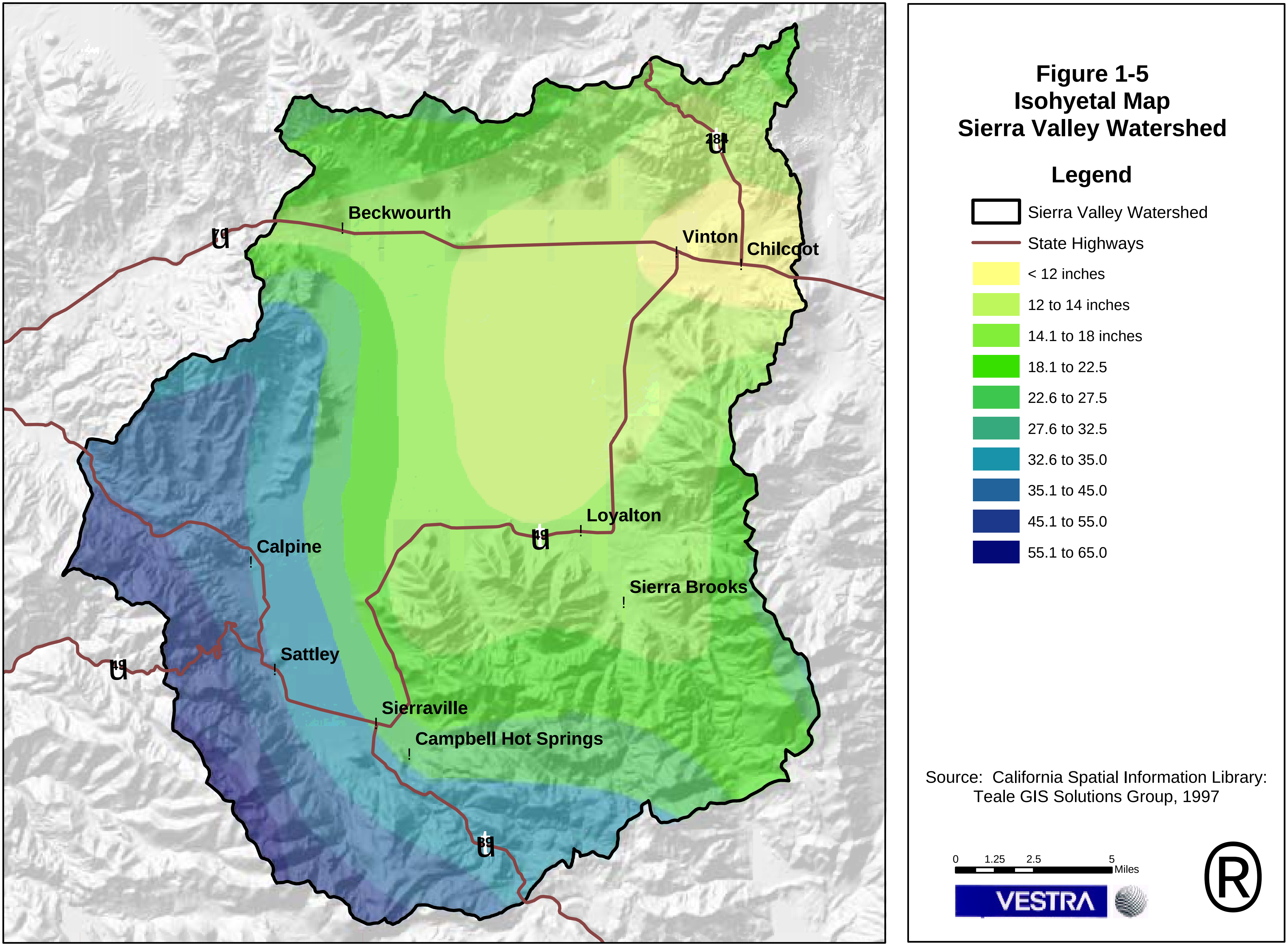
VESTRA



Source: Sierraville Ranger Station, California
NCDC 1971 – 2000 Monthly Normals

VESTRA

FIGURE 1-4
AVERAGE MONTHLY TEMPERATURES IN SIERRAVILLE
SIERRA VALLEY WATERSHED


Beckwourth
Vinton
Chilcoot
Loyalton
Calpine
Sierra Brooks
Sattley
Sierraville
Campbell Hot Springs
70
284
49
49
89
Figure 1-5
Isohyetal Map
Sierra Valley Watershed
Legend
Sierra Valley Watershed
State Highways
< 12 inches
12 to 14 inches
14.1 to 18 inches
18.1 to 22.5
22.6 to 27.5
27.6 to 32.5
32.6 to 35.0
35.1 to 45.0
45.1 to 55.0
55.1 to 65.0
Source: California Spatial Information Library: Teale GIS Solutions Group, 1997
0 1.25 2.5 5 Miles
VESTRA

Section 2

Section 2

GENERAL WATERSHED HISTORY

TABLES

FIGURES

Section 2
GENERAL WATERSHED HISTORY

The Sierra Valley Watershed was influenced and changed by input from both humans and nature. The most recent period of influence and change has been in response to the arrival of European settlers beginning in the middle of the nineteenth century. In the last 150 years, settlers have molded the watershed environment to fit their needs. The most significant impacts are related to the exclusion of fire, as well as logging, introduction of non-native grass species, and development. Prior to the arrival of Europeans, native peoples managed the landscape to meet their specific needs.

NATIVE PEOPLES

The Washo and the northeastern Maidu people first inhabited the watershed. It is believed the Watershed area supported occupation only in the late spring and summer. Prior to European contact, the entire Maidu population is said to have numbered approximately 4,000 individuals (Kroeber 1925) and the entire Washo population 3,000 individuals (Downs 1966). Due to disease introduced by European settlers, the populations of both tribes were severely reduced by the early 1900s. The Maidu territory is described as the area between present-day Susanville and Sacramento from north to south, and between the Sacramento River and the western crest of the Sierra Nevada from east to west. The Washo territory is located to the east of the Maidu extending into Nevada. The boundaries of the Washo and Maidu are shown in Figure 2-1 (Kroeber 1925). The tribes were bordered on the west by the southeastern Wintun; north by the Yahi, Astugewi, and northern Paiute; south by the Miwok and Eastern Mono; and east by the northern Paiute.

The Washo were subsistence people, preferring to live independently in their own small family unit. The family units with geographic and family ties would often "bunch" up into larger groups of three to four individual family units in the winter and intermittently throughout the year when it was advantageous (Downs 1966). The Washo spent the winters in the lowlands east of the Sierra Nevada, migrating to Lake Tahoe from early spring to early summer. The northern Washo, Welmetti, would come together to camp on the north shores of Lake Tahoe just as the eastern and southern Washo would gather on their respective shores of Lake Tahoe (Downs 1966). During the summer season, the Washo would travel to the west of Lake Tahoe to hunt and gather in the foothills and the small mountain valley areas of the Sierras. As summer changed to fall the family units and "bunches" would move east to gather at the piñyon groves on the foothills and then disperse to the small winter villages. Movements of the family or tribal units followed the changes in available resources of the seasons. The Washo family unit owned certain resources, such as piñyon groves and fishing platforms, in addition to the individually owned eagle hunting areas passed on from father to son (Downs 1966).

It is believed they used the resources found on the western side of Sierra Valley. The northeastern Maidu lived in permanent villages located on the ridge tops between the tributaries flowing into the North Fork of the Feather River (Kroeber 1925). Due to the unusually deep snows and marshy conditions found in Sierra Valley for most of the year, the Maidu spent little time in the Valley. It can be assumed that the Maidu in the northern most areas of their territory had contact with the Pit River tribe, but the mountain and hill Maidu never traveled more than 20 miles from their home village (Kroeber 1925). The individual Maidu family unit owned certain fishing spots as well as deer drive areas and fence structures associated with the area (Kroeber 1925). The Maidu set fires frequently in the areas they lived in with the intention of clearing brush and renewing annual grasses (Kroeber 1925).

In general, it is assumed that family members of the Maidu and the Washo carried foodstuffs from gathering and hunting areas back to the main camp. Travel was by footpath and trail. No structured farming activities were documented.

The northeastern Maidu territory included hundreds of acres of a rich foothill and mountain environment that provided them with a wide array of fish, deer, elk, bear, rabbit, upland birds, fish, waterfowl, and insects (Kroeber 1925). Forest areas provided the people with a liberal amount of acorns, pine nuts, and berries. The small mountain valleys provided a ready supply of herbs and grasses for food and building materials. The Washo people had a similar diet but had to travel greater distances to obtain food in the more arid and sparse environment. The Washo are also known to have supplemented their diet with an innumerable amount of small mammals as well as bighorn sheep and antelope (Downs 1966).

In the early spring, the Washo depended on the fishing in Lake Tahoe to augment the near-depleted winter reserves until snows melted and grasses and bulbs began to grow (Downs 1966). The Washo fished heavily and almost exclusively for the different species of fish found in Lake Tahoe and its tributaries during the spring and early summer. Once snows melted and spawning runs were over, the people began to focus on hunting and gathering. The Maidu of the hills and valleys fished salmon and suckerfish heavily, while the northeastern Maidu were probably limited to the trout found in the mountain streams of their territory (Kroeber 1925).

Acorns and pine nuts constituted a large portion of the available food staple for the northeastern Maidu. Large and small mammals were also an important source of food. Hunting strategies include bow and arrow, fire, fenced drives, nets, and snares (Kroeber 1925). For the Washo the pine nut was the most important winter staple. In the summer, numerous tuberous plants found in the mountain valleys were the main vegetative staple (Downs 1966). The Washo hunting strategies resembled those employed by the Maidu. The Washo used fire to drive deer and insects, and may have used it to clear brush and renew grasses like the Maidu (Downs 1966).

Additional information on the use of fire and other management tools by Native Americans is discussed later in this section.

EARLY CONTACT

Of the Native American tribes, the Washo were among the last to make contact with non-native explorers. Spanish explorers were the first non-natives to travel through the area (Downs 1966). A party of gold hunters viewed the valley in the summer of 1850, returning in the fall of 1851 to lay claim to a tract of land in the southern portion of the valley (Sinnot 1982). Jim Beckwourth, often attributed with the discovery of the valley, was traveling to the Pit River area in 1851 and discovered the low pass through the Sierra Nevada that enters Sierra Valley from the east. Beckwourth returned in the summer of 1852 guiding an emigrant train through the pass and stayed in Sierra Valley to establish a trading post and hotel (Sinnot 1982). A summary of key dates of early contact is included in Table 2-1.

Table 2-1 KEY DATES OF EARLY CONTACT	
Date	**Event**
1850	A. P. Chapman, William E. Jones, and George F. Kent view Sierra Valley while on an exploratory trip from the Downieville area.
Summer 1851	Jim Beckwourth discovers the pass through the Sierra Nevada Mountains and into Sierra Valley while in search of the Pit River area.
Fall 1851	A.P. Chapman returns with Joseph Kirby, I. K. McClain, and John Gardner to stake claim to land in the southern portion of the valley.
1852	Chapman and McClain erect cabin, Beckwourth builds trading post and hotel, and Lemmons and Culver built a cabin.
1854	Several hundred acres went into cultivation.
1850s	Numerous sawmills go into operation.
1858	Settlers' League formed to improve ranching and the general economy of the valley.
1860s	Industries of Sierra Valley are very diverse to meet the needs of the booming silver mining towns of the Nevada Territory. Non-native Timothy and Clover are sown in the valley. Timber harvest begins. Copper mining begins in the southeast corner of the valley. Several wagon roads built along the edge of the valley floor.
1860-1880	Italian-Swiss settle in the valley.
1863	First government survey of the valley is made.
1864	Post office established in Loyalton.
1866	Post office established in Beckwourth.
1896	Sierra Valley Railway from Plumas Junction to Beckwourth Pass to Vinton to Beckwourth to Claireville is completed.
1900-1910	Numerous railroad lines extended into and across the valley from the south and west. Several spurs are also constructed into timbered areas to facilitate log transport.
1901	Loyalton incorporated.
1913	Sierra Valley Water Company is formed.
1938	P.G.&E. provides electricity to the valley from Quincy.
1950s	Major roads of Sierra Valley reconstructed.
Source: Sinnot 1982	

By the late 1850s there were numerous trails and wagon roads established to handle the transport of goods from Sierra Valley to the Nevada Territory and back.

There were well-established communities in the southern and northern portions of the valley. The town of Beckwourth in the northern part of the valley was founded in 1852 and the southern town of Loyalton was founded in 1854. The northern part of the valley was settled by agriculturists and was less populated than the timbered southern portion of the valley. The southern portion of the valley had several small communities that supported the lumber industry of the area.

The Washo, living by opportunity by nature, were quick to adapt and take advantage of the European settlements and homesteads (Downs 1966). As the settlers brought traditional Washo gathering grounds into production for farming and grazing, the Washo recouped their loss by salvaging what settlers deemed to be of no value, ranging from kitchen utensils to edible castoffs from animal slaughter (Downs 1966). The ambitious settlers were in need of large quantities of manual labor for the various industries of the area, which the Washo were willing to provide having discovered the benefits of having money to buy goods (Downs 1966).

Figure 2-2 shows the differing county boundaries for the Sierra Valley from 1850 to present. Sierra County was officially made a county in 1852, with a booming population of 11,400 by 1860. Plumas County followed in 1854, with a population of 4,350 in 1860. The early settlers of Sierra Valley were most highly concentrated along the rim of the valley and in the forested areas. The predominant economic industries of the valley included dairy cattle, beef cattle, hay, and lumber.

The population of Sierra County saw a sharp decrease by 1870 with a population of 5,600, roughly half the total in 1860. The mining boom was rapidly declining, while the non-mining Plumas County population increased to only 4,650 by 1900. The highest concentration of people in Sierra Valley fell into two areas: the communities along Highway 70 from Beckwourth to Chilcoot and logging communities in the southern portion of the Valley.

Most logging activities were quite localized from 1850 to 1860. After 1861, the numerous sawmills located in the watershed primarily produced lumber to be shipped to Nevada and Utah. Agricultural activities in the watershed supplied goods to the mining districts to the south and east. The most notable good shipped from the valley in the late 1800s was butter, primarily made in Loyalton.

Plumas County has continued to grow while the population of Sierra County has hovered between 2,500 and 3,500 for the last 75 years. The lumber and dairy industries have declined substantially, as has beef and hay production, but to a lesser extent. The lumber industry has seen a two-thirds reduction in timber harvest on public lands. This reduction is the result of resource conservation concerns and the increasing awareness of the need to protect wildlife habitat. Currently, there are ongoing efforts to protect remaining old growth stands from logging.

HISTORY OF RESOURCE USE

The available resources of the area have been used to sustain the population. This section summarizes primary resources and management tools historically employed and attempts to present how these uses molded the ecosystems we see today.

Mining

The most concentrated mining activity was on the ledges of the canyons located between Antelope Valley and Sardine Peak, an area in the southeast region of the watershed. Copper and silver were the most common deposits found. Often, traces of gold were also found. Mining operations of this area were unprofitable through the years with no individual mining interest lasting over four years (Sinnot 1982). The mining activities of this area were responsible for the establishment of small settlements and improved roads. Effects of mining efforts on the Watershed are unknown. Mining activities to the northwest of the valley have degraded the water quality of the tributaries draining into the North Fork Feather River (Kattleman 1996). Elevated concentrations of mercury found in the upper tributaries of the Yuba, Bear, Middle Fork Feather, and North Fork Cosumnes Rivers are attributed to the amount of mercury used to extract gold (Kattleman 1996).

Timber and Milling

Lumbering was one of the principle industries of Sierra Valley from the beginning of European settlement in the 1850s. The need for lumber in and around the valley led to the establishment of several mills in the Watershed by the mid 1850s. From the 1850s through 1925 the forests of the Sierra Nevada were documented as being managed in the following way:

> Forests were regarded as inexhaustible and cleared land had more value than forested land. Initially, the trees harvested were those that were most valuable, that were near rivers, or that were accessible by oxen. Later, with the advent of railroads and ground skidding with cables, more distant stands could be harvested. Increasing populations of settlers greatly reduced the amount of old growth and changed the character of remaining stands through extensive "high-grade" logging, fire, and grazing (Helms and Tappeiner 1996).

The historic harvesting methods from the late 1850s to the mid 1900s seems to have had relatively little affect on soil erosion compared with the construction of roads used for log removal after WWII (Kattleman 1996). The sawmills of this period may have affected the streams of the watershed. "The large loads of sawdust-filled pools in the river clogged the gravels, and probably removed oxygen from the water, killing fish in the river" (Kattlemann 1996).

Practices, such as those described above, were stopped in 1890 by the California and Nevada government agencies. Currently, no serious pollution problems are associated with any abandoned lumber mills in the watershed (Kattlemann 1996).

From 1943 to 1973, landowners paid tax on standing timber value unless 70 percent of the trees per unit of land were harvested, resulting in heavy selective cutting (Helms and Tappeiner 1996). Logging technology changed just before World War II to add chain saws, trucks, and tractors to the tools used in the harvest process. The silvicultural strategy of this period was to remove those trees susceptible to insect attacks or disease, salvage of trees from burned areas, and to harvest the mature trees likely to die within 15 to 20 years (Helms and Tappeiner 1996).

Since 1988 two issues significantly reduced the amount of timber harvested as explained by Helms and Tappeiner:

> First, conservation and wildlife habitat concerns have resulted in a two-thirds reduction in the harvest of timber on public lands in California. Second, public opinion has led to efforts to withdraw the remaining old-growth stands from the commercial timber base (Helms and Tappeiner 1996).

To summarize, timber harvesting has had minimal long-term effects on watershed water quantity or quality as explained below by Kattlemann in 1996:

> Harvesting of trees, especially in large clear-cut blocks, is commonly perceived as a major impact on the hydrology of river basins. Although timber removal has dramatic effects on the water balance of the immediate site, consequences at the catchment scale are not so obvious. As with many of the land management activities

discussed in this chapter, the proportion of the catchment that is treated and the proximity of the treatment to water courses are critical in determining the impacts on water quantity, timing, and quality. In addition, associated activities such as road construction, yarding, slash treatment, and site preparation usually have much greater impacts than just the cutting of the trees. Hydrologic effects of selection harvests are generally considered to be less problematic than those of clear-cutting because the remaining trees remove soil moisture and provide some protection to the soil surface. Harvest effects must also be considered with respect to time. Fortunately, trees and other plants quickly reoccupy most harvested areas, reestablishing protection from raindrop impact, uptake of soil moisture, deposition of organic matter to the soil, and support of soil masses by roots. Slopes are most vulnerable to surface erosion and generation of excess water immediately after harvest or site preparation, but they have minimal root strength about a decade after harvest.

Vegetation

Vegetation of the Sierra Valley Watershed has changed significantly since the arrival of the first European settlers, including changes in species composition, diversity, and density. The two primary forces that modified the natural vegetation in the watershed are the introduction of non-native species and the exclusion of naturally occurring and Native American fire in the ecosystem. Climate, grazing, and timber management also modified pre-European vegetation.

Beginning with seeds in the stomachs of Spanish cattle and sheep that migrated with the missions into Northern California, through ornamental introduction of the twentieth century, the natural ecosystem of vegetative communities was bombarded by competition from non-native plants. In many instances, non-native species were well adapted to the climate of California, which resembled their native Mediterranean climates. These non-natives not only adapted well to California's climate, but they also lacked the natural pests and diseases to control their growth and development. In addition, many were of minimal palatability to native wildlife.

Most of the weeds present in our ecosystem today were imported within the last 150 years. Common weeds should be differentiated from noxious weeds discussed later in this document. Noxious weeds are those that pose a serious commercial or ecological threat and whose control is regulated or watched with concern.

Reference characteristics for major vegetative communities found in the watershed are discussed in the botanical section.

Coniferous Forest

Coniferous forests in the watershed have undergone significant changes in the last 100 years, as have coniferous forests throughout California. While there are many factors that contributed to change, the primary factor affecting the change in this forest community is likely the exclusion of fire. Climate as well as resource management activities have also changed forest composition.

These forests consisted of large mature individuals with a grass and forbs understory. Undergrowth was minimal and consisted of small aggregations of individual regeneration. These forests were dominated by shade-intolerant species such as ponderosa pine, Jeffrey pine, lodgepole pine, and red fir. White fir, incense cedar, and Douglas fir were incidental co-dominants

No detailed accounts of the early forests specific to the Sierra Valley Watershed were found. C. F. Cooper, John Muir, and others describe similar ponderosa pine forests and other coniferous forests in California in their literature. Excerpts from this literature follow.

Cooper described ponderosa pine forests of the Southwest with the following notes:

> They used to be open, park-like forests arranged in a mosaic of discrete groups, each containing 10 to 30 trees of a common age. Small numbers of saplings were dispersed among the mature pines, and luxuriant grasses carpeted the forest floor. Fires, when they occurred, were easily controlled and seldom killed a whole stand.
>
> Today, dense thickets of young trees have sprung up everywhere in the forests. The grass has been reduced and dry branches and needles have accumulated to such an extent that any fire is likely to blow up into an inferno that will destroy everything in its path.
>
> Lightening is frequent in the ponderosa pine region, and the Indians set many fires there. Tree rings show that the forests used to burn regularly at intervals of 3 to 10 years. The mosaic pattern of the forest has developed under the influence of recurrent lightening fires. Each even-aged group springs up in an opening left by the death of a predecessor (Cooper 1952).

Muir described a similar mosaic of open even-aged stands in the Sierra Nevada:

> The inviting openness of the Sierra woods is one of their most distinguishing characteristics. The trees of all the species stand more or less apart in groves, or in small irregular groups, enabling one to find a way nearly everywhere, along sunny colonnades and through openings that have a smooth, park-like surface. (Muir 1894)

Harold Biswell characterizes presettlement forests in the following way: California's primitive forests were kept open and park-like by frequent surface fires set by lightening and by the Indians. The forests were in a stable equilibrium, immune to extensive crown fires (Biswell 1961).

Agriculture

The principal agricultural endeavors of the Sierra Valley Watershed included dairy, beef cattle production, hay, and forage production. It is not known when the first livestock entered the Sierra Valley Watershed, but the Italian-Swiss immigrants had herds of both dairy and beef cattle in the valley by 1853. Livestock numbers fluctuated significantly over time. The vegetative communities of the Sierra Valley Watershed responded to the appropriate pressures of grazing. Historic sheep population numbers are shown in Table 2-2 and Figure 2-3.

In the 1850s, the most prominent of the four were dairies and the associated creameries. With the development of crossbred cattle that could produce both good beef steers and good milking cows, beef production was another agricultural endeavor in the watershed. In the early years massive barns were built in Sierra Valley to house both beef and dairy cattle during the winter months. The grasses of the valley were well suited to hay production, producing winter feed for the livestock in the valley as well as the pack mules traveling throughout the Sierra Nevada. Butter and lumber were the chief exports out of the valley in the late 1800s and into the early 1900s.

Table 2-2
HISTORICAL SHEEP POPULATIONS:
UNITED STATES CENSUS OF AGRICULTURE,
1919–2001, NAAS 1975–2001

Year	Plumas County	Sierra County
1940	2,143	878
1945	2,398	231
1950	390	84
1954	630	1,810
1964	93	59
1969	217	0
1975	200	100
1976	200	100
1977	200	100
1978	200	100
1979	300	100
1980	200	100
1981	300	100
1982	300	100
1983	300	100
1984	300	200
1985	200	200
1986	200	200
1987	300	200
1988	300	0
1989	400	0
1990	400	0
1991	300	0
1992	300	100

The sheep industry in California developed in two distinct periods, the first was from 1848 to 1860. This first phase resulted in the development of the California herds to feed mining efforts of the Gold Rush and growing municipalities in the Bay Area and Sacramento regions. The second phase occurred after 1860 and involved the growth and development of the internal California band.

Beginning in 1860, drought and pressure from farming and other interests, including cattle, forced the sheep higher into the eastern mountains. At the time, most cattle were kept on lower-elevation, higher-quality ranges that were often fenced. Sheep dominated other rangelands (Sudworth 1900; Leiberg 1902). Nomadic herders that moved with the sheep throughout the year tended these bands. During this time, there was no limit on how long animals used resources. Many attributed reduction of native perennials and replacement by more aggressive annuals in upper elevation grassy meadows and hillside systems to unregulated sheep grazing (Muir 1894; Douglass and Bibao 1975; Rowley 1985; Beesly 1996). It was John Muir who coined the term "hoofed locusts" for sheep, due to their observed effects on Sierran highlands. Regardless of the contemporary observers' accuracy or not in their assessment of damage caused by sheep, their views shaped the future of range and forest policy.

Table 2-3
HISTORICAL CATTLE POPULATIONS:
UNITED STATES CENSUS OF AGRICULTURE,
1919–2001, NAAS 1975–2001

Year	Plumas County		Sierra County	
	Beef Cows	Milk Cows	Beef Cows	Milk Cows
1940	5,332	1,944	2,081	1,062
1945	6,628	1,227	3,768	609
1950	4,559	716	1,973	392
1954	7,486	438	4,960	173
1964	-	-	2,617	118
1969	9,761	22	2,058	7
1975	10,800	100	4,500	100
1976	11,300	200	3,400	100
1977	10,900	200	3,400	100
1978	9,400	200	2,800	100
1979	7,000	100	4,000	100
1980	5,000	50	2,000	0
1981	7,000	0	3,100	0
1982	9,000	0	3,500	0
1983	8,000	0	4,000	0
1984	12,000	0	5,500	0
1985	13,000	0	4,500	0
1986	12,000	0	4,500	0
1987	12,000	50	5,000	0
1988	12,000	50	4,800	0
1989	13,000	0	5,500	50
1990	12,200	0	5,500	0
1991	11,400	0	4,800	0
1992	10,700	0	4,300	0
2001	7,000	0	3,000	0

From 1863 to 1864 severe droughts devastated California's livestock industry. Large numbers of animals died and many were pushed into higher elevations and less developed areas of Sierras for forage. The drought caused a shift from cattle to sheep. Historical accounts agree that excessive sheep grazing impacted rangeland conditions much more than cattle. The impact was due to a higher number of concentrated animals over a longer season. This was exacerbated by the sheepherders' burning practices that were more frequent and intense than those of Native Americans (Wagoner 1886). The first report by the California Department of Forestry in 1886 included recommendations to exclude sheep grazing from forested lands because of the damage (Wagoner 1886). Due to the lack of early regulations and nomadic nature of early range users, the vegetation was overused and gave little or no opportunity to recover. The herd management of individual sheepherders was reported to be reasonable, as each herd would move on and not return to the same grazing site for a suitable period of time. The combined effect of an unregulated number of herds created the overuse.

Between 1890 and 1920, cattle and sheep grazing peaked in Northern California. In the 15 years from 1880 to 1896, 20,000 to 80,000 head of sheep left California through the Gordon Trail, which extended from Red Bluff to north of Mt. Lassen, and north from Madeline Plains through the Upper Pit River Watershed, exiting California approximately 60 miles south of the Oregon border (Wentworth 1948). As many as 6,000 to 18,000 head per drive used a "trail" 50 to 60 miles wide as required for forage. Between 1870 and 1900, sheep were exported by the thousands to the Midwest, Wyoming, and Idaho from California (Wentworth 1948). In the late 1800s, the Sierra Valley Watershed area was used for summer sheep grazing by local sheep ranchers. Besides the local ranchers, the ranchers from the California counties of Yuba and Nevada and the state of Nevada used the watershed. In 1906, a reported 47,000 sheep were barred access to Sierra and Yuba County ranges (Sinnot 1982). Muir described the aftermath of sheep passage through Lassen:

> Incredible numbers of sheep are driven to the mountain pastures every summer, and their course is ever marked by desolation. Every wild botanic garden is trodden down, the shrubs are stripped of leaves as if devoured by locusts, and the woods are burned. Running fires are set everywhere, with a view to clearing the ground of prostrate trunks, to facilitate the movements of the flocks, and improve the pastures. The entire forest belt is thus swept and devastated from one extremity of the range to the other. . . . Indians burn off the underbrush in certain localities to facilitate deer hunting. Mountaineers carelessly allow their campfires to run, so do lumbermen, but the fires of the sheepmen, or *Muttoneers*, form more than ninety percent of all destructive fires that range the Sierra Forests (Muir 1894).

World War I demands for food and fiber caused use of range allotments to increase from 1914 to the mid-1920s. Also during this time, allotments were large and many of them were "community allotments" with several permittees, making monitoring of use more difficult, which resulted in higher use. During this time, the primary limiting factor to use was the lack of watering sources for stock; thus, areas close to water sources were depleted while remote areas were lightly used (Menke et al 1996).

During World Wars I and II, livestock use increased dramatically on public lands (Menke et al 1996). These increases caused overuse from 1914 to 1920 and 1939 to 1946. From 1914 to 1920, sheep use was higher due to demand for wool and mutton to supply the armed forces. In the later period, demand for cattle increased. It is not possible to separate the livestock use number from early data to match the geographic area of the Sierra Valley Watershed because county compiled the historical data.

Droughts from 1917 to 1935, and additional livestock grazing during the war years, further exacerbated an already critical problem. Despite lower sheep populations in Sierra Valley, the invasion of non-native species, specifically cheatgrass, following the depletion of native perennial grass has prevented these grasslands from returning to their previous conditions.

Prior to 1934, most livestock grazing in California was unregulated. Before the establishment of National Forests, the Sierra Nevada was subject to intense transient grazing by cattle and sheep. The high sheep populations in the Sierra Nevada jeopardized the range allotments and the local livestock economy (Menke et al 1996).

The passage of the Taylor Grazing Act in 1934, required assessment and evaluation of range conditions, and resulted in significant adjustments to grazing levels. Gradually during this period cattle began to replace sheep in many areas. The overuse of cattle increased soil compaction and increased the affect of livestock on the riparian zones (Lux 1995). Following 1930, the USFS adopted policies intended to balance range use and conditions. The policies included instituting term grazing privileges, limiting animals allowed under certain conditions, and closing some areas to grazing to allow recovery following the 1900s. The USFS also initiated predator control programs and poisonous plant reduction programs. The 1934 passage of the Taylor Act challenged the USFS control of watershed rangelands by creating a rival Grazing Service in the Department of the Interior. The competition between the two agencies forced the USFS to modify its practices to include longer lease periods and increase permit numbers. This resulted in increased use on rangelands following 1930 from the previous 20 years.

Stocking rates increased somewhat during the period of 1939 to 1946 in response to the needs of World War II, but in most cases were half of the 1920 stocking rates (Menke et al 1996). During this period of time many allotments were split into smaller units. For economic reasons, numerous sheep allotments were converted to cattle allotments.

Many range improvements implemented during 1934 to 1944 period included the addition of water sources for livestock to better disperse use. Addition of artificial water sources made additional upland areas suitable for grazing. In an effort to correct overgrazing of the previous decade, the USFS conducted significant plantings and seeding. Unfortunately, little attention was given to the use of native seed, so the seed mixtures used for reseeding were largely exotic. The seed mix most commonly used included wheat grass, common timothy, and smooth brome. Eradication of willows and aspens to maximize forage production was also common (Menke et al 1996).

Since 1970, public agencies increased the use of monitoring on rangelands. This coupled with declines in prices for beef cattle, and sheep resulted in a reduction in grazing numbers. The USFS increased its focus on the rehabilitation of the riparian communities in allotment areas.

Fire

Years of aggressive fire protection and timber management have dramatically changed the character of all of California's forest communities, including those of the Sierra Nevada Mountains. Evidence suggests that pre-European forests were open, park-like pine and fir forests subject to frequent low-intensity fires. These forests consisted of large, mature individuals with only a grass understory. Undergrowth was minimal and consisted of small aggregations of individual regeneration. Frequent fires rejuvenated grasslands and cleared deadfall and litter from the forests. The fires were low intensity, creeping fires that consumed only dead, down materials. Fast-moving crown fires common today, rarely occurred. Only infrequently did fire consume mature individuals. See Section 9, "Forestry, Fire, and Fuels Management," for a more detailed discussion of the impact of fire and its suppression on ecosystems.

Prior to suppression efforts in the twentieth century, lightning and native peoples ignited forests. Pre-settlement fire return intervals were generally less than 20 years throughout a broad zone extending from the foothills though the mixed conifer forests (McKelvey et al 1996). Almost every tribe in the western United States used fire to modify their respective environments. It is widely accepted that early Native Americans used fire widely as a tool, for hunting, and to manage resources needed for survival (Blackburn and Anderson 1993). This included burning grasslands to improve basket materials; foothills to assist in hunting small game and to encourage new edible shoots; and the coniferous forests to assist in hunting and to keep the forests open and passable. In addition, use of seeding and oak management to enhance food supplies is documented (Blackburn and Anderson 1993). Within California, at least 35 tribes used fire to increase the yield of desired seeds, 33 to drive game, and 22 groups used it to stimulate the growth of wild tobacco. Other reasons included making vegetable food available, facilitating the collection of seeds, improving visibility, and protection from snakes (Blackburn and Anderson 1993).

In many cases, Native American groups that exploited woodland-grass and chaparral also hunted animals and collected plants within portions of the coniferous forest belt, particularly the ponderosa pine regions. Evidence indicates that impact of the Native Americans was significant in the maintenance and evolution of vegetation types. Although ethnographic data is lacking, field studies in fire ecology show that frequent burns were common throughout the coniferous belt.

The ethnographic and field references to the time of burning indicate that Native American burning occurred in the coniferous forests during the late summer or early fall. Discussing the southern Maidu in the foothills and mountains east of Marysville and Sacramento, Beals (1933) notes the overall affect of burning:

> The land was apparently burned over with considerable regularity, primarily for the purpose of driving game. As a result, there were few young trees and all informants were agreed that in the area of permanent settlement, even so far up in the mountains as Placerville, the timber stand was much lighter than at present. . . . The Indians insist that before the practice of burning was stopped by the whites, it was often a mile or more between trees on the ridges, although the canyons and damp spots held thickets of timber.

The Washo used fire to drive insects to ditches where they could be gathered for drying to be made into nutritious flour. Historical records from ecosystems similar to the Sierra Valley suggest larger open stands of pine and fir with a short reoccurrence and common fire return interval. Most scientists agree that the vast ponderosa pine forests of the West evolved with frequent low-intensity ground fires. Because fire was so prevalent in the centuries before extensive Euro-American settlement (pre-settlement), many common plants exhibit specific fire-adapted traits such as thick bark and fire-stimulated flowering, sprouting, seed release, and/or germination.

In some places, land that had as many as 30 or 40 large ponderosa pines scattered across an acre in the early 1900s, now have 1,000 to 2,000 smaller-diameter trees per acre (Trachtman 2003). These fuel-dense forests are susceptible to destructive crown fires, which burn in the canopy and destroy most trees and seeds.

The decision to exclude fire from public lands came about as a result of a debate to permit light fire, such as burnings by Native Americans, or to use complete suppression. Logging and grazing interests held that light fires were beneficial because they reduce fuel loading and create more open forests. The United States Forest Service excluded fire on national forests after the "Big Blow-Up" in 1910, a firestorm that "incinerated 3 million acres in Idaho and Montana" (Trachtman 2003). The California Forestry Commission was created to hear disagreement on both sides of the argument. Finally, a study completed by Show and Kotok in 1923 showed that although repeated burning maintained an open and park-like condition, it killed young trees and discouraged regeneration of forests. The argument continued that if forests were to provide a sustainable timber supply, regeneration was required. In 1924, the Clarke-McNary Act was passed by Congress, which clearly established fire exclusion as national policy. Until 1910, the settlers of Sierra Valley let wildfires burn unless particularly valuable stands of timber or homes were threatened (Sinnot 1982). Decades ago, Aldo Leopold (1950) warned that working to keep fire out of the forest would throw nature out of balance and have untoward consequences. "A measure of success in this is all well enough," he wrote in the late 1940s, "but too much safety seems to yield only danger in the long run."

Several large wildfires occurred in the Sierra Valley Watershed in the last 90 years for which records have been maintained. California Department of Forestry and Fire Protection (CDF) fire history records from 1910 indicate a total of 142 wildfires within the Sierra Valley Watershed. Of these fires, 80 have been in excess of 100 acres in size. The most recent large fire that occurred in the watershed was the 5,693-acre Mart Fire of 2003. One of the largest wildfires in the watershed occurred in 1996. The Cottonwood Fire burned more than 43,000 acres.

Historical fire acreage is included in Table 2-4 and major areas burned by decade are shown in Figure 2-5.

Table 2-4
HISTORICAL ACREAGE BURNED SUMMARY
1910-2001

Date	Total Acres Burned	% Watershed Burned
1910 - 1920	6,285.28	2
1921 - 1930	6,757.81	2
1931 - 1940	19,882.61	7
1941 - 1950	3,985.48	1
1951 - 1960	24,272.94	8
1961 - 1970	2,043.42	1
1971 - 1980	3,821.49	1
1981 - 1990	592.95	0
1991 - 2001	44,128.94	15
TOTALS	**111,770.90**	

Fire had a significant affect on the landscape of rangelands in the watershed and all of California. The early Native Americans, sheepherders, and cattlemen used fire as a tool to manage natural landscapes. Many set fires behind them as they left the grazing lands in the fall. Ecologists disagree whether the fires were beneficial or damaging. They opened large areas of mountain and foothill communities for additional or transitional grazing (Menke et al 1996). Since the fire suppression of the 1920s, most if not all of original transitional range has been lost to over-dense brush or timber. Additional range was created only in response to wildfire (Menke et al 1996).

Wildlife

Changing vegetation and ecosystem dynamics in the Sierra Valley Watershed resulted in a change in the wildlife populations, although to a lesser degree than more intensively developed regions of California. According to Moyle (1996) the status of the wildlife was described as follows:

> The terrestrial vertebrate fauna of the Sierra Nevada is relatively intact. There have been few extinctions and most species appear to retain an approximation of their aboriginal geographic extent. The most important factor in population variability for nearly all species has been and continues to be habitat quantity and quality. Habitats that have suffered the greatest reductions in extent and integrity, and therefore the greatest losses of vertebrate biodiversity, appear to be the western-slope foothills, riparian habitats, and late-successional forests.

At the time of European settlement, large herds of tule elk (*Cervus elaphus*) and pronghorn antelope (*Antilocapra Americana*) were documented as present especially in the interior valleys, while mule deer (*Odocoileus hemionus*) dominated the foothills. During the nineteenth and early twentieth centuries, fur trapping for beaver (*Castor canadensis*), mink (*Mustela vison*), otter (*Lutra canadensis*), red fox (*Vulpes vulpes),* marten *(Martes Americana)*, fisher *(Martes pennantz)*, and trapping and shooting wolverines *(Gulo gulo)* as vermin greatly reduced all of these species.

Grizzly bears were well distributed in California at the time of Spanish settlement, recorded everywhere except the Great Basin, deserts, and eastern Modoc Plateau. They were concentrated in the open country of the valleys and coastal plains, especially in the riparian zones. They were distributed throughout the range, selecting open country including montane meadows and the alpine zone during the snow-free months. Although largely herbivorous, grizzlies preyed upon cattle and other stock. Settlers set out systematically to exterminate them. The last California grizzly bear (*Ursus arctos*) identified with reasonable certainty was killed by cattleman, Jesse B. Agnew, near Horse Corral Meadow, Sequoia National Forest, in August 1922; identification by the lower canine tooth was made by C. Hart Merriam (Storer and Tevis 1955).

During the time the state had a bounty for mountain lions, they were rarely seen but were plentiful. Recent regulations prohibiting the hunting of mountain lion and trapping of coyote have also likely had a significant affect on local deer and wildlife populations.

Bullfrogs almost completely replaced red-legged frogs and foothill yellow-legged frogs in many locations. This is a factor in the precipitous declines of the native Ranid frog species (Moyle 1973; Hayes and Jennings, 1986). Bullfrogs also impacted other species such as young western pond turtles, ducklings, and other aquatic and riparian vertebrates.

Fisheries

The Sierra Valley Watershed is crossed with numerous streams flowing north, northwest, and south to drain into the Middle Fork of the Feather River. The general belief is that waters above elevations of 6,000-feet in the Sierra Nevada were fishless until the influx of Euro-Americans in the 1850s. Euro-Americans were responsible for the introduction of fish to previously fishless waters with the first fish introduced being California natives from other habitats. In the 1870s, the first non-native species were introduced to the higher elevations of the Sierra Nevada (Moyle et al 1996).

Since the late 1800s, native fish populations in the West have been augmented with fish propagated in fish hatcheries in order to accommodate the fishing needs of a growing human population and to lessen the impact of over harvesting (Leitritz 1970). Fish, other than trout, have been sporadically planted from hatcheries or transplanted legally and illegally from other streams, lakes, and reservoirs.

Northern Pike, a non-native species and highly efficient predator of trout and other fish species was most likely introduced to Lake Davis sometime in 1994. It is believed the pike were illegally transplanted from unknown sources outside of California or possibly from nearby Frenchman Reservoir, where pike had also been illegally introduced. Beginning in August 1994, pike were found repeatedly in Lake Davis by anglers and DFG personnel during sampling operations.

In 1997, the DFG along with the Save Lake Davis Task Force began working together to eradicate the Northern Pike. By this time pike were found in great abundance in Lake Davis. In October 1997, the DFG chemically treated the lake in an effort to eradicate the pike. In July 1998, DFG began restocking the lake with over a million trout to rebuild the recreational trout fishery.

In 1999, pike was rediscovered in the lake. Subsequent monitoring efforts have shown that an established, reproducing population now exists.

Irrigation

Irrigation in the Sierra Nevada started as early as the 1860s, as new uses for mining ditches and flumes were realized. By 1887, the passage of the Wright Irrigation Act gave farming communities the authority to purchase, build, and operate their own irrigation systems (Larson 1996). The Sierra Valley Water Company was formed in July 1913 to provide irrigation water for Nevada, Plumas, and Sierra Counties (Sinnot 1982).

Small streams throughout the watershed area were used for small-scale irrigation during the summer months for hay and grain production. Frenchman Lake acted as an irrigation reservoir in the northern portion of the watershed. Waters were released and used for irrigation from both Frenchman Lake and the Little Truckee River.

By decree in 1940, the water rights of the Middle Fork of the Feather River stream system were divided into six groups: Last Chance Creek Group, Smithneck Creek Group, West Side Canal Group, Fletcher Creek Group, Little Truckee River Group, and Middle Fork of the Feather River Group.

Other sources of irrigation water in the Sierra Valley were both drilled and artesian wells. Within the last 50 years, increasing numbers of drilled wells in the watershed and the water pumped from them have depleted ground water levels. Concerns over diminishing groundwater led to the formation of a Sierra Valley groundwater management district in 1981. The goal of the management district is to preserve the groundwater resource in Sierra Valley and to protect the agricultural economy of the area for the common benefit of Sierra Valley (Sinnot 1982).

DEMOGRAPHICS

The earliest data available is the 1860 census due to the fact that both Sierra and Plumas County were portions of Yuba and Butte Counties respectively until the mid-1850s. Early boundary changes are shown in Figure 2-2 and a summary of settlements and their respective dates of establishment are summarized by original name in Table 2-5.

The demographics of the watershed changed over time with the movement of people and the consolidation of industrial centers in the valley area close to transportation corridors of railroads, highways, and waterways. Population estimates for county areas are given in Table 2-6 and presented graphically in Figure 2-6.

Table 2-5
FOUNDING DATES OF MAJOR SETTLEMENTS

Town/Settlement	Date Founded	Comments
Beckwourth	1852	First permanent Euro-American settlement established on the Plumas County side of Sierra Valley. Established by James P. Beckwourth.
Randolph	1853	First house built by W.C. and B.F. Lemmon and Ezra Culver. First Settlement on the Sierra County side of Sierra Valley.
Smith's Neck	1854	Established by a group of miner's by the name of Smith Company. Town was renamed Loyalton in 1863.
Summit	1857	Post Office established in 1861 and discontinued in 1897. Post Office reinstated in 1899 and renamed Chilcoot.
Sierraville	1858	John Lipscomb and John Mullen built first house in 1855 and sold it to William Arms in 1857. William Arms became Postmaster of the newly established post office in 1858.
Church's Corner	1860	Ezra Bliss Church and wife settled on 160 acres. Renamed Sattely in 1884 when Post Office was established.
Cleveland	n/a	Began as a station for the Sierra Mohawk Railroad. Renamed Vinton at time of Post Office establishment.
McAlpine	1919	Per Post Office decision this lumber camp Post Office was named Calpine.
Source: Sinnot 1982		

Table 2-6 HISTORICAL POPULATION DATA		
Decade	Population (by County)	
	Sierra	Plumas
1860	11,378	4,354
1870	5,619	4,489
1880	6,623	6,180
1890	5,051	4,933
1900	4,017	4,657
1910	4,098	5,259
1920	1,783	5,681
1930	2,422	7,913
1940	3,025	11,548
1950	2,410	13,519
1960	2,247	11,620
1970	2,365	11,707
1980	3,073	17,340
1990	3,318	19,739
2000	3,555	20,824
Source: University of Virginia Geospatial and Statistical Data Center 1998		

REFERENCES

Beals, R. L. 1933. Ethnology of the Nisenan. *University of California Publications in American Archaeology and Ethnology* 31(6):335–414.

Beesly, D. 1996. Reconstructing the landscape: an environmental history, 1820–1960. *Sierra Nevada Ecosystem Project: Final Report to Congress, vol. III, chap. 1*. Davis: University of California, Centers for Water and Wildland Resources.

Biswell, H. H. 1961. Manipulation of chamise brush for deer range improvement. *California Fish and Game* 47(2):125–144.

Blackburn, T. C., and K. Anderson. 1993. *Before the wilderness: environmental management by Native Californians*. Menlo Park, California: Ballena Press.

Cooper, C. F. 1952. The ecology of fire. *Scientific American* 204(4):150–160.

Douglas W. A., and J. Bibao. 1975. *Amerikanuak: Basques in the New World*. Reno: University of Nevada Press.

Downs, James F. 1966. *The two worlds of the Washo: an Indian tribe of California and Nevada*. San Francisco: Downs, James F. Holt, Rinehart and Winston.

Hayes, M. P., and M. R. Jennings. 1986. Decline of ranid frog species in western North America: Are bullfrogs (*Rana catesbeiana*) responsible? *Journal of Herpetololgy* 20:490–509.

Helms, J. A., and J. C. Tappeiner. 1996. Silviculture in the Sierra. *Sierra Nevada Ecosystem Project: Final Report to Congress, vol. II, chap. 15*. Davis: University of California, Centers for Water and Wildland Resources.

Kattleman, R. 1996. Hydrology and water resources. *Sierra Nevada Ecosystem Project: Final Report to Congress, vol. II, chap. 30*. Davis: University of California, Centers for Water and Wildland Resources.

Kroeber, A. L 1925. *Handbook of the Indians of California*. New York: Dover Publications Inc.

Larson, D. J. 1996. Historical water use priorities and public policies. *Sierra Nevada Ecosystem Project: Final Report to Congress, vol. II, chap. 8*. Davis: University of California, Centers for Water and Wildland Resources.

Leiberg, J. B. 1902. *Forest conditions in the northern Sierra Nevada, California*. Washington, D.C.: Government Printing Office.

Leitritz, E. 1970. A history of California's fish hatchery. *California Department of Fish and Game Fish Bulletin* 150:92.

Leopold, A. S. 1950. Deer in relation to plant succession. *North American Wildlife Conference Transactions* 15:571–580.

Lux, L. 1995. A history of the human element in the Sierran province. Appendix G of *Draft Environmental Impact Statement: Managing California Spotted Owl Habitat in the Sierra Nevada National Forests of California*. San Francisco: United States Forest Service.

Menke, et al. 1996. Rangeland assessment. *Sierra Nevada Ecosystem Project: Final Report to Congress, vol. III, Assessments, Commissioned Reports, and Background Information*. Davis: University of California, Centers for Water and Wildland Resources.

McKelvey, K. S., et al. 1996. Status of the Sierra Nevada. Vol. II. *Assessments and Scientific Basis for Management Options, Wildland Resources Center Report No. 37*. University of California, Davis.

Moyle, P. B., et al. 1996. Status of Fish and Fisheries. *Sierra Nevada Ecosystem Project: Final Report to Congress, vol. II, chap. 33*. Davis: University of California, Centers for Water and Wildland Resources.

Moyle, P. B. 1973. Effects of introduced bullfrogs, *Rana catesbeiana*, on the native frogs of the San Joaquin Valley, California. *Copeia* 1973:18–22.

Muir, John. 1894. *The mountains of California*. New York: Barnes & Noble.

Rowley, W. D. 1985. *United States Forest Service grazing and rangelands*. College Station, Texas: Texas A&M University Press.

Sinnot, James J. 1982. *History of Sierra County: Sierra Valley: Jewel of the Sierras*. Fresno: Mid-Cal Publishers.

Storer, T. I. and L. P. Tevis. 1955. *California grizzly*. Berkeley and Los Angeles: University of California Press.

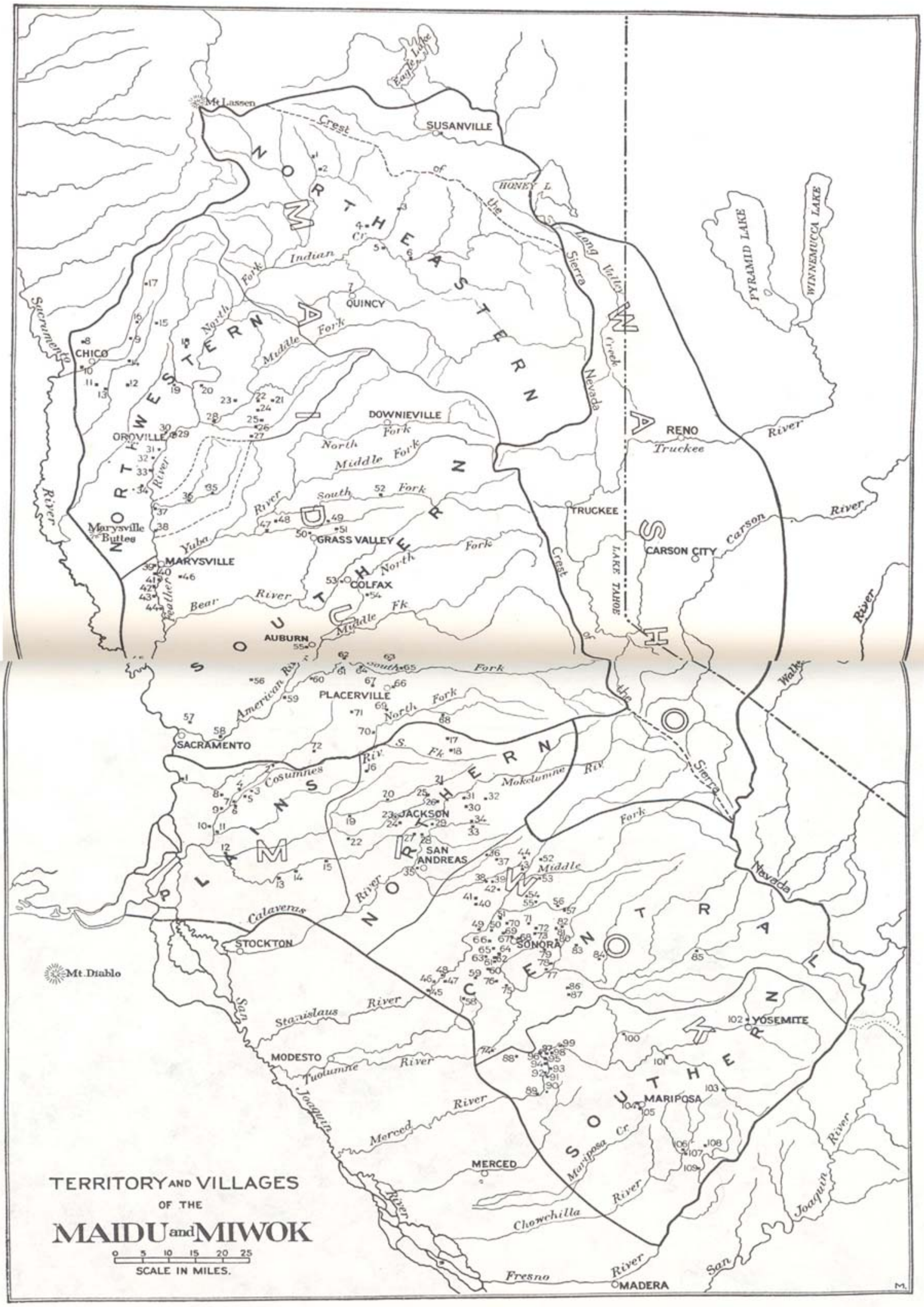
Sudworth, G. B. 1900. Stanislaus and Lake Tahoe forest reserves, California, and the adjacent territory. *Twenty–First Annual Report of the U.S.G.S. Part V, Forest Reserves*. Washington D.C.: Government Printing Office.

Trachtman, Paul. 2003. Fire fight: with forests burning U.S. officials are clashing with environmentalists over how best to reduce the risk of catastrophic blazes. *Smithsonian*. August.

University of Virginia Geospatial and Statistical Data Center. 1998. *United States historical census data browser* [online]. University of Virginia.[cited 17 March 2003] Available from World Wide Web: http://fisher.lib.virginia.edu/census/.

Wagoner, L. 1886. Report on the forests of the Counties of Amador, Calaveras, Tuolomme, and Mariposa. *First Biennial Report of the California State Board of Forestry for the Years 1885–1886*. Sacramento: California State Board of Forestry.

Wentworth, Edward N. 1948. *America's sheep trails*. Ames, Iowa: Iowa State College Press.



Source: Sinnot, James J. 1982. History of Sierra County: Sierra Valley: Jewel of the Sierras.

FIGURE 2-1
MAIDU AND MIWOK TERRITORY
SIERRA VALLEY WATERSHED

VESTRA

1850 1860 1870

FIGURE 2-2

EARLY COUNTY BOUNDARY CHANGES

SOURCE: CALIFORNIA ASSOCIATION OF COUNTIES

SIERRA VALLEY WATERSHED

VESTRA

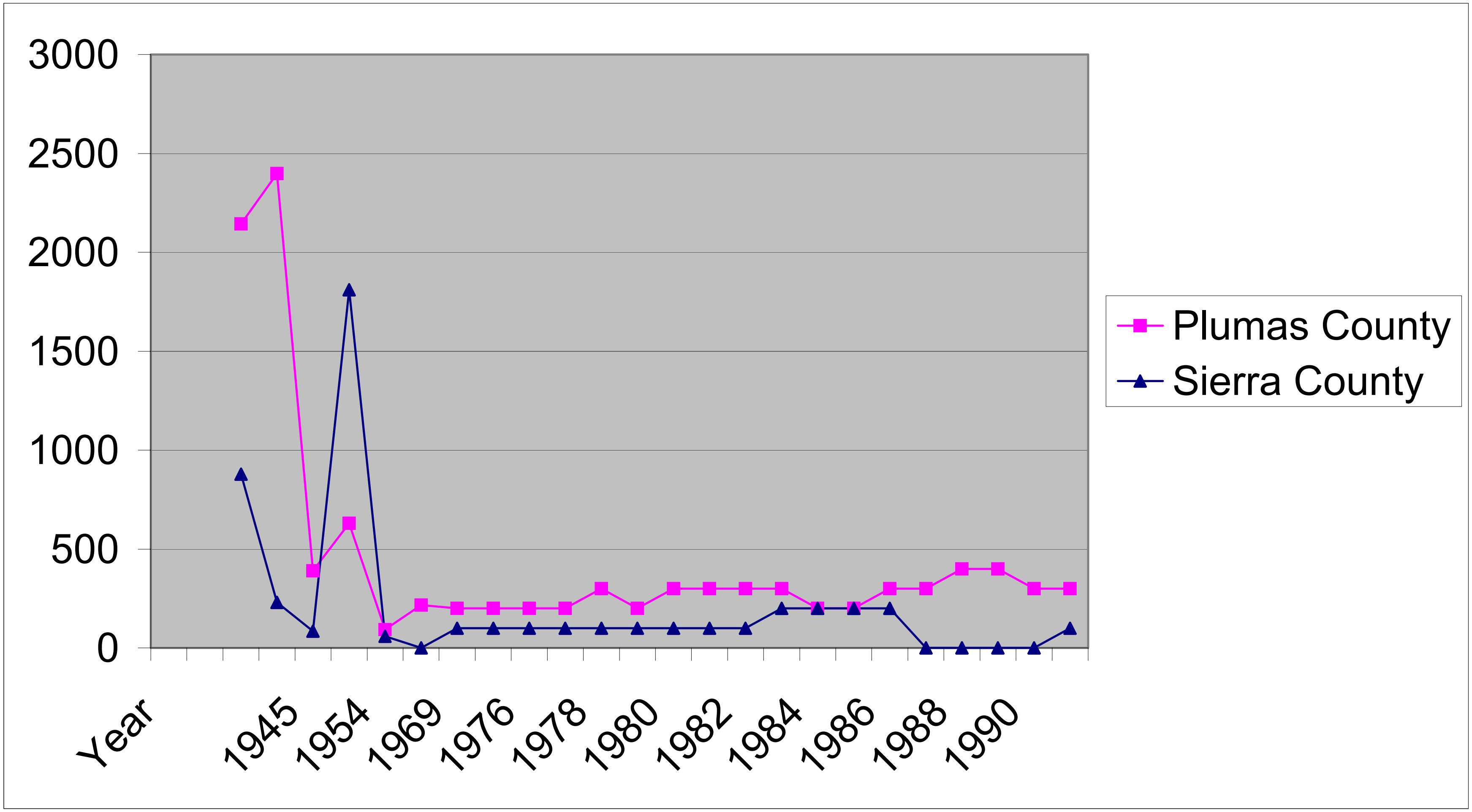
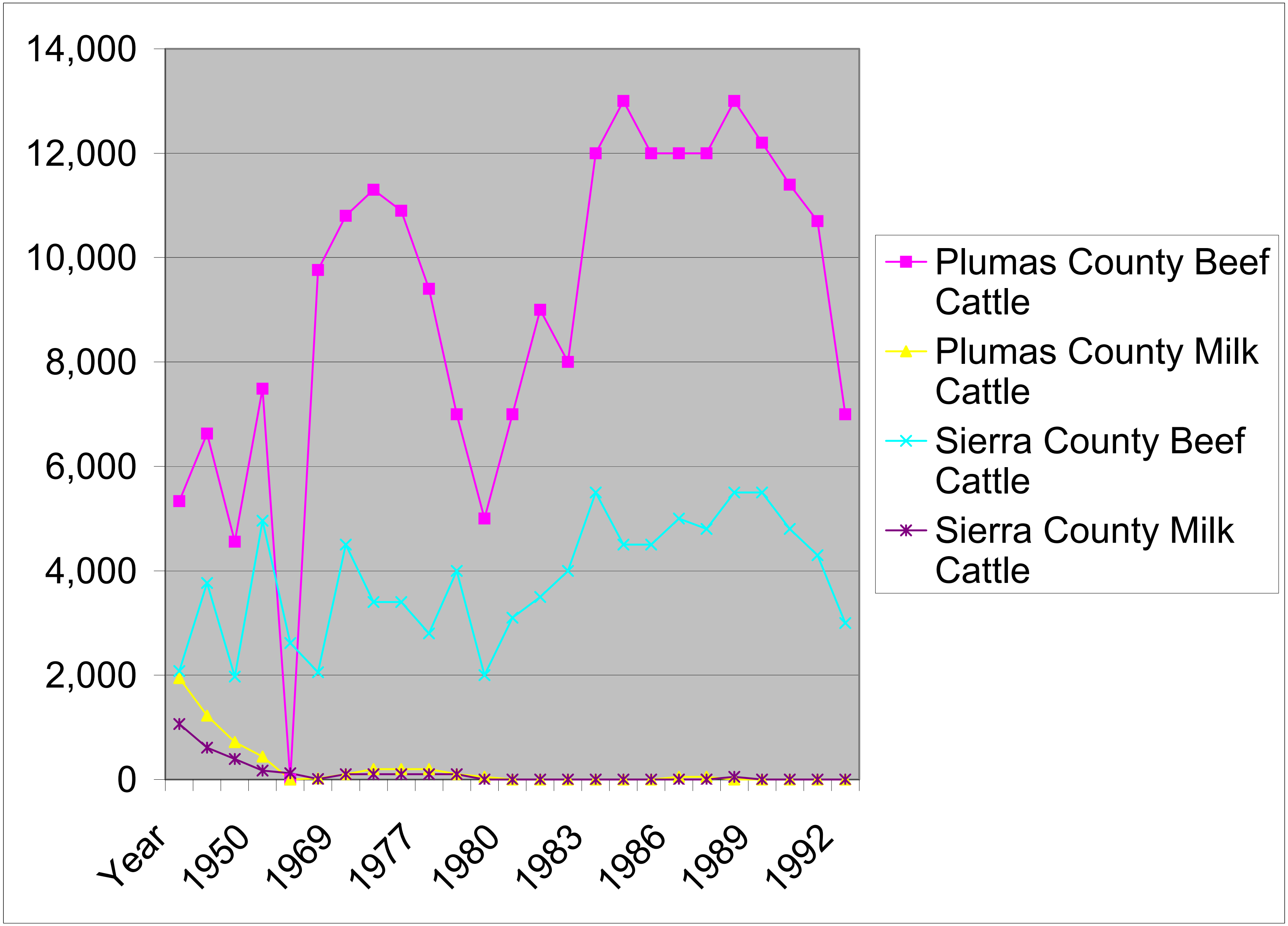


FIGURE 2-3
HISTORICAL SHEEP POPULATIONS
SIERRA VALLEY WATERSHED



VESTRA

FIGURE 2-4
HISTORICAL CATTLE POPULATIONS
SIERRA VALLEY WATERSHED

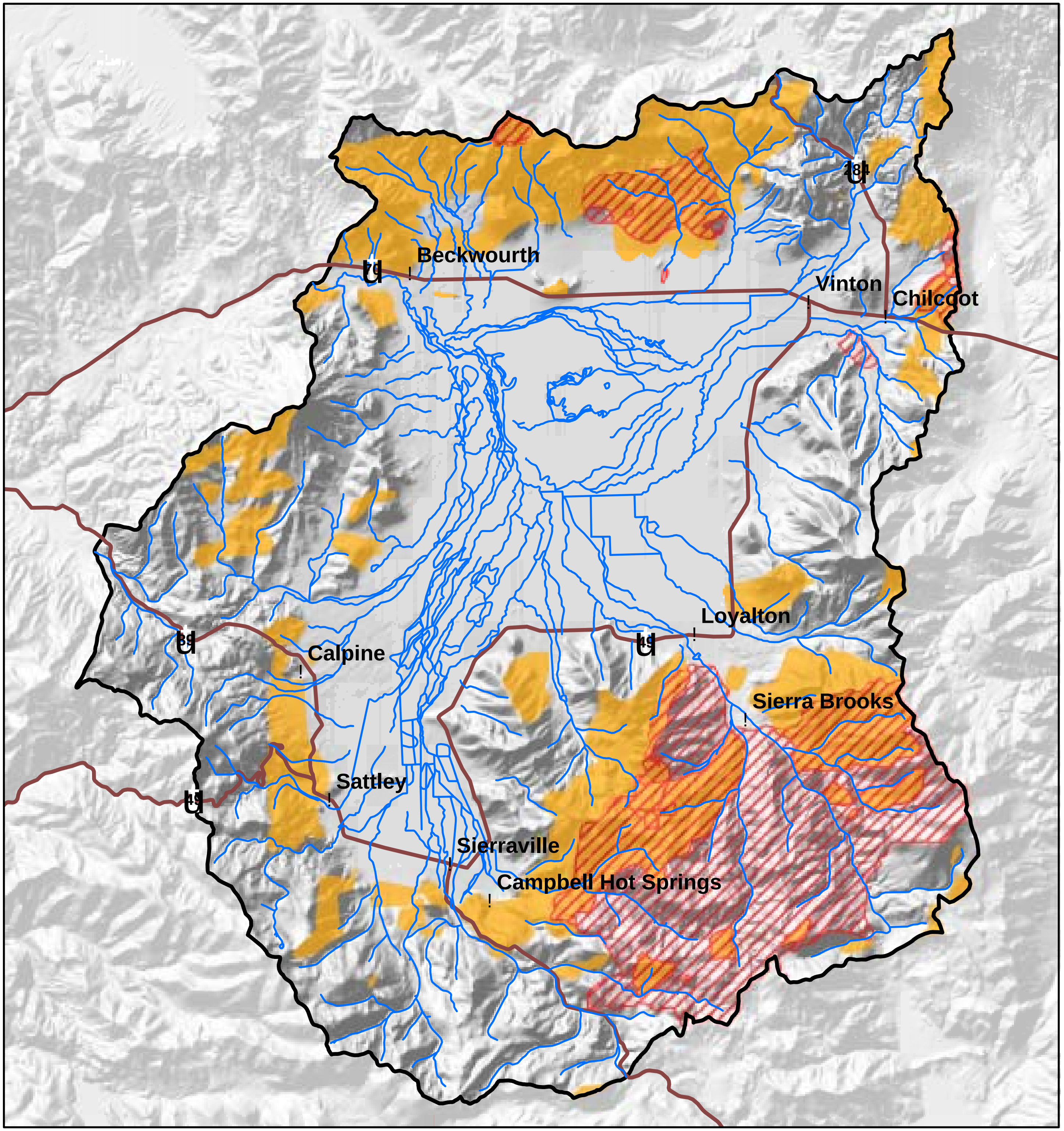


Figure 2-5
Major Areas Burned
Sierra Valley Watershed

Legend

- Rivers and Streams
- Sierra Valley Watershed
- State Highways
- 1910 - 1990
- 1991 - 2001

SOURCE: CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION, FIRE AND RESOURCE ASSESSMENT PROGRAM

0 1.25 2.5 5 Miles

VESTRA

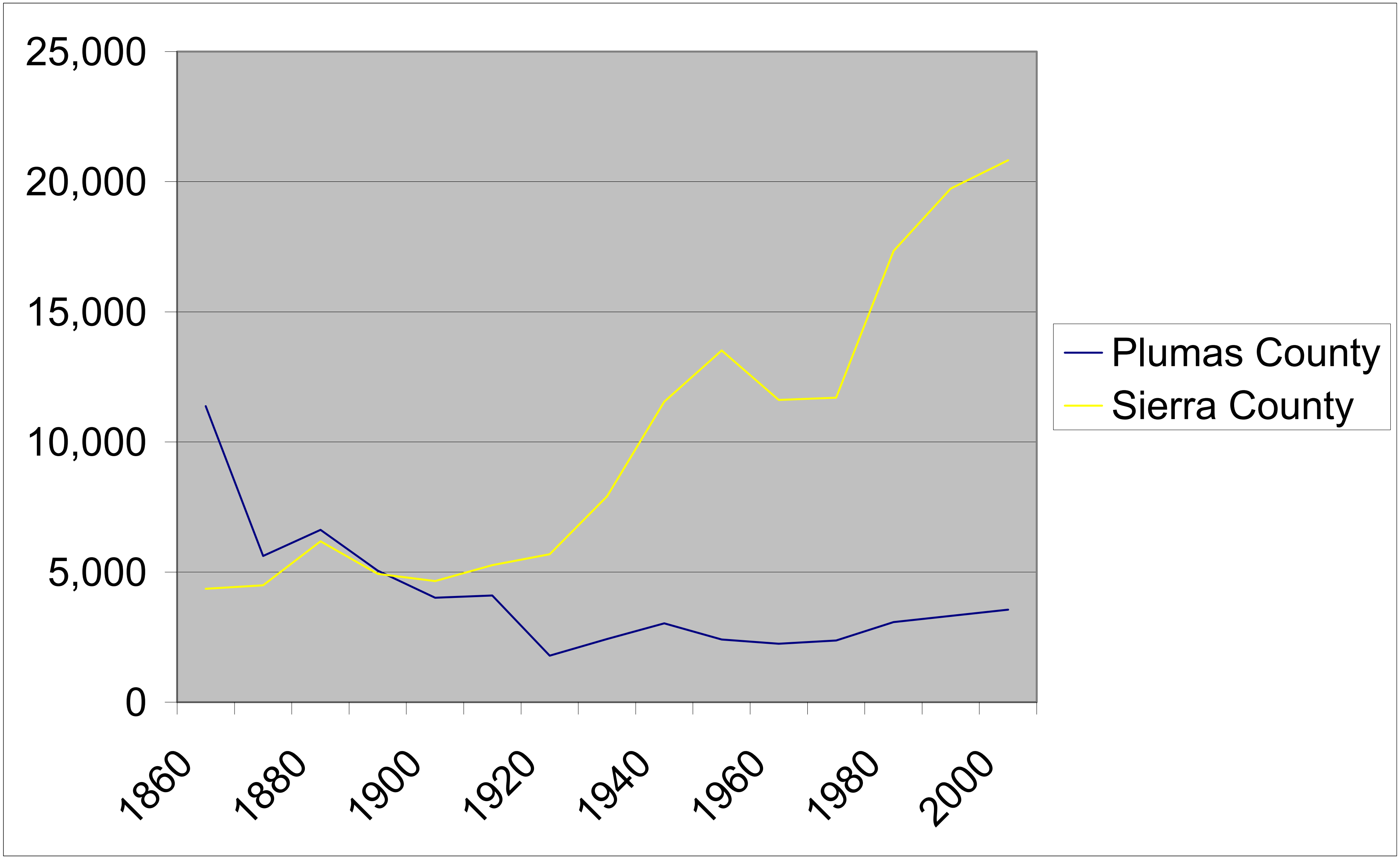


FIGURE 2-6
POPULATION TRENDS
SIERRA VALLEY WATERSHED

Section 3

Section 3
GEOLOGY AND SOILS

TABLES

FIGURES

Section 3
GEOLOGY AND SOILS

GEOLOGY

Introduction to Geology

California is subdivided by the California Division of Mines and Geology into 12 geologic provinces. Each province is distinguished by its unique geology, topographic relief, and climate. The Sierra Valley watershed lies within the northern Sierra Nevada geologic province. The Sierra Nevada geologic province is a continuous mountain range spanning 400 miles that extends in a north-northwest direction. Sierra Valley is located at the eastern edge of this province. The Sierra Nevada province is bordered to the north by the Lake Almanor/Honey Lake area and to the west is the Great Valley province. The southern border of the Sierra Nevada province is at the Tehachapi Mountains located near the southern end of the San Joaquin Valley.

Sierra Valley contains unique topographic features that are attributed partly to being one of the most faulted regions in California, carved by at least four stages of the Ice Age (DWR 1963). The valley lies among a series of northwest trending bands of volcanic ridges and peaks bounded to the west by granitic rocks and to the east by younger rocks of the depositional Hallelujah Formation.

Summary/Description

In general the watershed is largely composed of more recent pyroclastic eruptions and volcanic flows, which lie upon the metavolcanic and granitic basement rock. Locally, rocks of the Sierra Valley can be divided into three general groups: Jurassic and Cretaceous metavolcanic and granitic rocks, Tertiary volcanics, and Quaternary sedimentary deposits. These general rock types are described in more detail below.

A geologic map of the Sierra Valley Watershed is included as Figure 3-1. A soils map of the watershed is included as Figure 3-2. Geologic formations are included as Figure 3-3. A generalized geologic cross section is included as Figure 3-4. A glossary of terms is included at the end of the section.

Jurassic and Cretaceous Metavolcanic and Granitic Basement
The Jurassic (150 to 205 million years ago [Ma]) and Cretaceous (70 to 150 [Ma]) rocks of the Sierra Valley form the basement complex and consist largely of metamorphic rocks, plutonic granites, and granodiorites. These impermeable basement rocks are visible in the northeastern portion of the watershed surrounding Little Last Chance Creek and in the southwestern portion of the watershed forming the western margin of the Mohawk Valley Fault. They are also thought to underlie the more recent Tertiary volcanics of the Dixie Mountain and Loyalton Volcanoes, discussed below.

The metavolcanic and metasedimentary rocks of the region are thought to represent remnants of a Jurassic island arc system (Grose 2000a), which are accreted to the North American Continent and subsequently intruded by plutons of quartz diorite and granite. The rocks are generally massive, crystalline, and form rounded outcrops intruded by granitic pegmatite dikes (DWR 1983).

Tertiary Volcanic
Much younger volcanic deposits, which rest unconformably upon the Mesozoic basement rocks that began to develop nearly 10 million years ago (Grose 2000b), are present throughout the watershed. They consist largely of silicic tuffs and andesitic and dacitic flows and tuffs that rest unconformably upon the older metavolcanic and granitic basement rocks. Examples of volcanic rocks can be found along the valley foothills, or appear as isolated buttes and low hills in the valley and in prominent areas such as Antelope Valley Volcanic Center south of Loyalton, Loyalton Volcanic Center east of Loyalton, and the Sardine Peak complex located approximately 9 miles due south of the Loyalton Volcanic Center.

Volcanics of the Sierra Valley can be generally divided into four groups: (1) late Oligocene to early Miocene silicic tuffs, (2) mid Miocene andesitic flows and tuffs derived from local sources, (3) mid Miocene dacitic to andesitic flows, and (4) tuffs from the Antelope Valley Volcanic Center (Grose 2000c).

Quaternary Sediments
Sediments that make up the gently sloping foothills and valley floor are derived from a variety of sources including inflowing streams, deposits from the Sierra Valley Lake, glacial till, and volcanic eruptions. Volcanic deposits include volcanic fanglomerates, conglomerated sandstones and mudstones, tuff and tuff breccias, mudflow breccias, and ignimbrite series (Durrell 1966). These sediments were likely deposited in a lenticular fashion coarsening radially outward near the margins of the valley.

Faulting
The Sierra Valley lies among one of the most faulted regions in California. Three primary faults that include Grizzly Valley Fault, Hot Springs Fault, and Mohawk Valley Fault trend northwest and are suspected to dissect the watershed.

Grizzly Valley Fault
Grizzly Valley Fault is located in the northern section of the watershed and can be traced from Mapes Canyon north of Beckwourth, extending along Smithneck Creek until it goes to Sardine Valley. The Fault zone is approximately 10 miles long and 1 to 2 miles wide. Movement along the fault zone consists of left lateral high angle normal faults of which a small right-slip component of movement is suspected (Grose 2000b).

Hot Springs Fault
Hot Springs Fault parallels Grizzly Valley Fault and can be traced from Beckwourth southeast to where it intersects the Grizzly Valley Fault approximately 1 mile north of Sardine Valley. This fault's name refers to the hot spring wells and other thermal artesian wells located along this trace.

Mohawk Valley Fault
Mohawk Valley Fault trends northwest and is located throughout the Mohawk and Sierra Valleys southeast through Sierraville. The fault is a high angle normal fault with occurrences of dextral-divergent movement. Vertical offset is estimated to be from 1,640 to 3,870 feet (Sawyer 1995).

It is suspected that many of the normal faults have fractured the underlying basement rocks resulting in substantial variations in the depths of valley sediments. Some estimates are 800 feet below ground surface (bgs) up to 2,000 feet bgs (DWR 1963).

SOILS

Data Sources

Primary soils data available for the Sierra Valley Watershed include

- Soil Survey of Plumas National Forest Area published in 1985 by the United States Forest Service (USFS).

- Soil Survey of the Sierra Valley Area, California, Parts of Sierra, Plumas, and Lassen Counties published by the U. S. Department of Agriculture (USDA) in 1975

- Soil Survey Geographic (SSURGO) database for Sierra Valley Area, California, Parts of Sierra, Plumas and Lassen Counties

The majority of the soils within the watershed, including those throughout the valley floor, are described in detail by the 1975 USDA soil survey. Northern portions of the watershed not included within USDA soil survey are included in the 1985 USFS soil survey. Areas included in the USFS survey include USGS quadrangles Crocker Mountain, Dixie Mountain, Frenchman Lake, Constantia, Portola, and the Calpine Area.

Digital soils data is included in the SSURGO database available from the U.S. Department of Agriculture, Natural Resources Conservation Service, National Cartography and Geospatial Center. Areas included in the SSURGO database include USGS 7.5-minute quadrangles Portola, Reconnaissance Peak, Chilcoot, Beckwourth Pass, Calpine, Antelope Valley, Loyalton, Evans Canyon, Sattley, and Sierraville.

Introduction to Soils

Soils within the Sierra Valley Watershed vary considerably in productivity, depth, and use. Primary conditions responsible for the diverse soil characteristics include parent material, topography, and precipitation.

Parent material is the unconsolidated material from which soil develops; it may be deposited in place such as weathered rock, or it may be wind blown, such as sands in more arid climates. Physical and chemical makeup of the parent material has a direct impact on soil chemistry and fertility, especially early in the development process.

Topography is also a key factor in soil development. A steep slope will influence precipitation runoff and, depending on steepness, may inhibit sunlight affecting vegetative growth. Additionally, the amount of water increases along with velocity as it travels down slope, stripping developing soils from the source area. Entrained sediments are deposited in low-lying areas such as the valley floor as velocities decrease and sediment begins to fall out of suspension.

A brief description of common soil series present throughout the watershed is included below. The descriptions were obtained from the USDA Soil Survey of the Sierra Valley (USDA 1975). Soil series have been subdivided based on their association with mountainous terrain, terrace and alluvial fan deposits, or valley floors. A summary of the soil series within the watershed along with percentage of mapped area is included in Table 3-1.

Table 3-1
SOIL SERIES PERCENTAGE OF MAPPED AREA
SIERRA VALLEY WATERSHED ASSESSMENT

Soil Series	Total Acres	Mapped Area (%)
Acid Rock Land	3,791	2.59
Aldax	5,441	3.71
Badenaugh	1,948	1.33
Badenaugh P.D.V.	1,058	0.72
Balman	10,568	7.21
Basic Rock Land	9,246	6.31
Beckwourth	12,551	8.56
Bellavista	2,188	1.49
Bidwell	3,577	2.44
Bieber	3,268	2.23
Calpine	8,582	5.85
Coolbrith	4,843	3.30
Correlo	2,344	1.60
Delleker	3,835	2.62
Dotta	9,626	6.56
Galeppi	372	0.25
Glenbrook	1,054	0.72
Glenn	45	0.03
Haypress	1,451	0.99
James Canyon	3,702	2.52
Lovejoy	1,727	1.18
Loyalton	5,590	3.81
Martineck	3,782	2.58
Millich	298	0.20
Mottsville	2,137	1.46
Newland	1,348	0.92
Ormsby	5,062	3.45
Pasquetti	6,985	4.76
Portola	4,501	3.07
Quincy	558	0.38
Ramelli	15,844	10.81
Sattley	325	0.22
Sierraville	319	0.22
Smithneck	1,027	0.70
Toiyabe	3,708	2.53
Trojan	3,725	2.54
(not specified)	208	0.14
TOTAL	**146,633**	**100.00%**

NOTE: Percentages based on Soil Survey of the Sierra Valley Area (USDA 1975). Percentages do not represent percentage of watershed.

Summary/Descriptions

Mountainous Soils

Soil series found primarily in mountainous regions surrounding the Sierra Valley include Trojan, Delleker, Portola, Toiyabe, Haypress, Aldax, and Basic Rock Land soils. These soils cover approximately 22 percent of the mapped area.

Trojan Series The Trojan series consists of well-drained soils that form in place. These soils are derived from andesitic and basaltic conglomerates and breccias. Slopes range from nearly flat to steep, 2 to 50 percent, with elevations ranging from approximately 5,000 to 6,000 feet. The surface layer is dark brown, slightly acid stony sandy loam approximately 10 inches deep. The subsoil is light brown to reddish yellow, moderately acidic gravelly loam to gravelly clay loams to a depth of approximately 60 inches.

Annual precipitation is 12 to 24 inches, supporting stands of Jeffrey pine, big sagebrush, bitterbrush, squirreltail, and cheat grasses. The soils are primarily used for timber production and livestock grazing.

Delleker Series The Delleker series consists of well-drained to moderately well-drained soils that formed from volcanic tuffs. Slopes range from nearly flat to moderately sloping, 2 to 30 percent, with elevations ranging approximately 4,800 to 5,800 feet. The surface layer is light brown slightly acidic cobbly sandy loam and pale brown slightly acidic to medium acidic loams approximately 13 inches deep. The subsoil is pale brown to light yellowish brown moderately acidic sandy clay loams and clay loams to at least 60 inches.

The annual precipitation is 14 to 24 inches, supporting stands of Jeffrey pine, ponderosa pine, white fir, and cedar, black oak, and manzanita. Sagebrush, bitterbrush, and annual grasses and forbs are also associated with the Delleker Series.

Portola Series The Portola series consists of well-drained soils that are forming, at a depth of approximately 30 to 40 inches in mixed ashy material on the volcanic uplands (USDA 1975). These soils are found primarily in the foothills and mountainous uplands along the western rims of the watershed. Slopes range from moderately flat to steep, 9 to 50 percent, with elevations ranging approximately 4,800 to 6,000 feet. The surface layer is light gray to light brownish gray, moderately acidic cobbly coarse sandy loam approximately 9 inches thick. The subsoil is very pale-brown to light-brown, moderately acidic coarse sandy loams approximately 40 inches thick.

The annual precipitation is 14 to 24 inches, supporting stands of Jeffrey pine, cedar, sugar pine, white fir, and black oak. Bitterbrush, big sagebrush, manzanita, perennial and annual grasses and forbs are also associated with the Portola series.

Toiyabe Series The Toiyabe series consists of excessively well-drained soils that are forming in place in weathered granitic rock such as granodiorite, quartz diorite, and granite. These soils are found primarily in the mountainous uplands located in the northern and western regions of the watershed. Slopes range from flat to steep, 2 to 75 percent, with elevations ranging approximately 5,000 to 8,000 feet. The surface layer is grayish brown to light brownish gray, slightly acidic loamy coarse sands approximately 12 inches thick. The underlying parent material consists primarily of strongly weathered granodiorite.

The annual precipitation is 10 to 24 inches, supporting stands of Jeffrey pine, ponderosa pine, black oak, mountain mahogany, brush, forbs, and minor grasses. Bitterbrush and big sagebrush are also associated with the Toiyabe series.

Haypress Series The Haypress series is similar to the Toiyabe series in that the Haypress series consists of excessively drained soils that are forming in place in weathered granitic rock such as granodiorite, quartz diorite, and granite. These soils are also found primarily in the foothills and mountainous uplands around the rims of the watershed with slopes ranging from near flat to steep, 2 to 75 percent, with elevations ranging from approximately 5,000 to 8,000 feet. The surface layer is grayish-brown moderately acidic loamy coarse sand approximately 14 inches thick. The subsoil is brown moderately acidic loamy coarse sands which grade to pale-brown loamy sands that further degrade to weathered granites at a depth of approximately 50 inches.

The annual precipitation is 14 to 24 inches, supporting stands of Jeffrey and ponderosa pine, black oak, manzanita, serviceberry, ceanothus, and annual and perennial grasses and forbs. These soils found in lower elevations support big sagebrush and bitterbrush.

Aldax Series The Aldax series consists of excessively drained soils that are forming in material weathered from metamorphic rock or cobbly volcanic conglomerate and breccia. These soils are also found primarily in the foothills and mountainous uplands around the rims of the watershed with slopes ranging from near flat to steep, 5 to 75 percent, and elevations ranging approximately 4,500 to 8,000 feet. These soils are brown moderately acidic sandy loams to dark yellowish moderately acidic very gravelly loams. Bedrock is at a depth of approximately 12 inches.

The annual precipitation is 10 to 20 inches. These soils primarily support big sagebrush and cheat grass.

Basic Rock Land The Basic Rock Land consists of rough, rocky terrain. Rock outcrops and very shallow soils cover as much as 50 to 90 percent of the surface. These soils are also found primarily found in the foothills and steep mountainous uplands surrounding the watershed. The rock consists primarily of volcanics such as pyroclastic breccia, plugs, vents, flow rock, and tuff conglomerates.

Basic Rock Land supports spotty cover of sagebrush, annual and perennial grasses, and minor stands of timber. These soils are relatively unproductive other than serving as part of a protected watershed and as part of the habitat and escape cover for wildlife.

Minor soil types but not described within the mountainous soils also include the Millich and Bonta Series soils. Descriptions of these soil types are included in the Sierra Valley Area Soil Survey (USDA 1975).

Terrace and Alluvial Fan Soils
Soil series found primarily on terraces and alluvial fans surrounding the Sierra Valley consist of the Mottsville, Dotta, Martineck, and Bieber soils. These soils cover approximately 13 percent of the mapped area.

Mottsville Series The Mottsville series consists of excessively drained soils that are forming in course granitic alluvium. These soils are found on terrace deposits located in the northeastern regions of the watershed near Chilcoot. Slopes are generally flat, 2 to 9 percent, with elevations ranging approximately 4,800 to 5,200 feet. The surface layer is brown to dark brown moderately acidic loamy sands and loamy coarse sands approximately 10 inches thick. The subsoil is typically brown to yellowish brown, slightly to moderately acidic loamy sands that extend to a depth of more than 60 inches.

The annual precipitation is 8 to 16 inches supporting big sagebrush, cheat grass, Indian ricegrass, scattered bitterbrush, and minor forbs and grasses.

Dotta Series The Dotta series consists of well-drained soils forming in basic alluvium. These soils are found on lake terrace deposits around the rim of the valley, alluvial fans, foot slopes, and foothills surrounding volcanic uplands. Slopes are generally flat to moderately sloping, 0 to 30 percent, with elevations ranging approximately 4,800 to 5,200 feet. The surface layer is gray, slightly acidic sandy loam approximately 13 inches thick. The subsoils are generally gray to grayish brown moderately acidic heavy loams, sandy clay loams, and heavy sandy clay loams to a depth of at least 60 inches.

The annual precipitation is 8 to 18 inches, supporting big sagebrush, annual and perennial grasses, scattered stands of pine, and juniper.

Martineck Series The Martineck series consists of well-drained very stony soils forming in basic alluvium underlain by hardpan approximately 10 to 20 inches below ground surface. These soils are found on terrace deposits around the western and southern rims of the valley. Slopes are generally flat to moderately sloping, 2 to 30 percent, with elevations ranging approximately 4,500 to 5,200 feet.

The surface layer is grayish brown and gray moderately acidic very stony sandy loam approximately 6 inches thick. The subsoil is generally dark grayish brown to brown slightly to moderately acidic very stony clays to very stony sandy clay loams. The subsoil is generally underlain by pale yellow indurated hardpan.

The annual precipitation is 12 to 18 inches, supporting sagebrush, grasses, forbs, and scattered stands of Jeffrey pine.

Bieber Series The Bieber series consists of well-drained soils forming in mixed alluvium. These soils are found on terrace deposits on the valley floor and higher terraces such as those near Loyalton. Slopes are generally flat, 0 to 5 percent, with elevations ranging approximately 4,500 to 5,200 feet. The surface layer is gray moderately to slightly acidic sandy loams and heavy sandy loams approximately 6 inches thick.

The subsoil is generally brown slightly acidic sandy clay loams and sandy clays approximately 11 inches thick. The subsoil is underlain by a very hard silica cemented hardpan at a depth of approximately 17 inches below ground surface.

The annual precipitation is 12 to 18 inches, supporting sagebrush, silver sagebrush, and minor grasses and forbs.

Valley Soils

Soil series found on the valley floor and shallow terraces include the Ramelli, Balman, Pasquetti, Beckwourth, Calpine, and Dotta soils. These soils cover approximately 61 percent of the mapped area.

Ramelli Series The Ramelli series consists of poorly to very poorly drained soils that are forming in fine-textured mixed alluvium. These soils are commonly found in meadowlands throughout the watershed. Slopes are generally flat, 0 to 2 percent, with elevations ranging approximately 4,500 to 5,000 feet.

The surface layer is dark gray to dark grayish brown slightly acidic silty clay and clay approximately 7 inches thick. The subsoil is generally dark gray to gray, slightly acidic to moderately basic clay and sandy clay loams approximately 20 inches thick. The subsoil is underlain by light brownish gray to gray moderately basic to slightly acidic sandy loam and gravelly coarse sands to a depth of at least 77 inches below ground surface.

The annual precipitation is 12 to 18 inches, supporting wet meadow grasses and forbs, including sedges and wiregrass. The Ramelli series is closely associated with the Balman and Loyalton soils.

Balman Series The Balman series consists of poorly drained soils that are formed from mixed valley alluvium. These soils are primarily found on the valley floor and alluvial fans. Slopes are generally flat, 0 to 5 percent, with elevations ranging approximately 4,000 to 5,000 feet.

The surface layer is generally light brownish gray to gray highly basic and highly calcareous loams approximately 15 inches thick. The subsoils are gray to light gray moderately basic highly calcareous and stratified loams, sandy clay loam, sandy loam, and loamy coarse sands to a depth of more than 60 inches.

The annual precipitation is 10 to 20 inches, supporting silver sagebrush, annual grasses, sedges, and herbs.

Pasquetti Series The Pasquetti series consists of poorly drained to very poorly drained soils that are forming in ashy lake sediment. These soils are primarily found in basins on slopes that are generally flat, 0 to 2 percent, with elevations ranging approximately 4,500 to 5,000 feet.

The surface layer is generally very dark gray to dark gray moderately basic mucky silty clays and silty clays to a depth of approximately 20 inches below surface. The subsoil is generally dark gray moderately basic clay loam approximately 10 inches thick. The subsoil is underlain by light gray moderately basic clay loams and white or grayish brown very fine sandy loams and sandy loams to a depth of at least 60 inches below surface.

The annual precipitation is 12 to 20 inches, supporting wet meadow plants such as wiregrass, sedges, moss, grasses, and forbs.

Beckwourth Series The Beckwourth series consists of poorly drained soils that are formed from mixed valley alluvium. These soils are primarily found on the plains between Vinton and Beckwourth. Slopes are generally flat, 0 to 2 percent, with elevations ranging approximately 4,000 to 5,200 feet.

The surface layer is generally very dark gray to dark grayish brown moderately acidic loamy coarse sands approximately 15 inches thick. The subsoil is generally brown to pale brown slightly to moderately basic loamy coarse sands and coarse sandy loams approximately 20 inches thick. The subsoil is underlain by light yellowish-brown to pale brown loamy coarse sands and coarse sands that extend to a depth of at least 60 inches below ground surface.

The annual precipitation is 12 to 18 inches, supporting silver sagebrush, annual grasses, dryland sedge, and forbs.

Calpine Series The Calpine series consists of well-drained soils forming in granitic alluvium. These soils are primarily found on the western flats along the northern rim of the valley as well as low terraces and flood plains. Slopes are generally flat, 0 to 9 percent, with elevations ranging approximately 4,800 to 5,500 feet.

The surface layer is generally dark grayish brown strongly acidic coarse sandy loam approximately 20 inches thick. The upper subsoil is brown moderately acidic sandy loam approximately 10 inches thick. The lower subsoil is light yellowish brown and yellow moderately acidic sandy clay loam. The subsoils are underlain by light yellowish brown moderately acidic stratified loamy sands to a depth of at least 60 inches below surface.

The annual precipitation is 10 to 20 inches, supporting big sagebrush, silver sagebrush, bitterbrush, rabbitbrush, grasses, sedges, and forbs.

Dotta Series The Dotta series consists of well-drained soils forming in basic alluvium. These soils are found on lake terrace deposits around the rim of the valley, alluvial fans, foot slopes, and foothills surrounding volcanic uplands. Slopes are generally flat to moderately sloping, 0 to 30 percent, with elevations ranging approximately 4,800 to 5,200 feet. The surface layer is gray slightly acidic sandy loam approximately 13 inches thick. The subsoils are generally gray to grayish brown moderately acidic heavy loams, sandy clay loams, and heavy sandy clay loams to a depth of at least 60 inches.

The annual precipitation is 8 to 18 inches, supporting big sagebrush, annual and perennial grasses, and scattered stands of pine and juniper.

Land Capability

Land Capability Classification is a national system developed by the United States Department of Agriculture for primarily agricultural purposes. This classification groups farmable soils according to their potentialities and limitations for sustained production of commonly cultivated crops. This classification groups nonfarmable soils according to their potentialities and limitations for the production of permanent vegetation and risk of soil damage.

Soils in Classes I through IV are classified according to their limitations for sustained production of cultivated crops. The majority of soils in Class VI and those in Class VII may be used for forestry, pasture, or range. Soils in Class VIII are suitable only for nonagricultural purposes.

Soils in Sierra Valley watershed area range from Land Capability Class III to Class VIII. Approximately half of the valley floor is a combination of Land Capability Class III and Class IV soils. These soils are spread throughout the valley and are predominantly where the cultivated crops are produced. Land Capability Class VI soils encompass approximately half of the Sierra Valley floor and are used primarily for livestock grazing. Soils in the Land Capability Class VII to VIII are used for limited livestock grazing and primarily timber production.

Erosion Hazards

Four parameters, soil, slope, cover and climate, are considered when evaluating erosion hazards. Soil must be analyzed for detachability and permeability. Slope must be viewed for uniformity and steepness. Cover is important due to the density of both living and dead vegetation that shields the soil form the raindrop impacts. Climate is important in determining erosion hazards for the distribution of annual precipitation, intensity of storms, distribution of snowfall and snowmelt, and the freezing of the ground surface. All of these parameters are grouped together to provide a general sense of erosion potential of soils. Soils are designated as a "slight," "moderate," or "high" erosion hazard.

Soils on the Sierra Valley floor are classified primarily as a "slight" or "moderate" risk of erosion. The terrace and alluvial fan soils range from "slight" to "moderate" erosion risks. The mountainous soils are classified as "high" erosion hazards.

GLOSSARY

Amygdule: A gas cavity or vesicle in a volcanic rock that is filled with minerals such as zeolite, calcite, quartz, or chalcedony.

Aphanitic: A rock containing a crystalline groundmass too fine to be seen by the unaided eye.

Argillite: A compact rock, unusually hard derived from fine-grained sedimentary rocks, such as shale, mudstone, siltstone, and claystone. Commonly black.

Clastic: Pertaining to a rock or sediment composed principally of broken fragments that are derived from preexisting rocks or minerals and that have been transported some distance from their place of origin.

Felsic: An adjective applied to light-colored minerals of igneous origin such as quartz, feldspars, feldspathoids, and muscovite; also applied to igneous rocks that are mainly composed of such minerals as granite and rhyolite.

Granite: A plutonic rock in which quartz makes up 10 to 50 percent of the felsic components and the feldspar ratio is 65 to 90 percent.

Granodiorite: A group of coarse-grained plutonic rocks intermediate in composition between quartz diorite and quartz monzonite.

Greenstone: A field term applied to any compact, dark green, altered or metamorphosed basic igneous rock that owes its color to the presence of chlorite, actinolite, or epidote.

Keratophyre: Generally applied to silicic lavas characterized by containing albite or albite oligoclase, chlorite, epidote, and calcite.

Mafic: Term used to describe the amount of dark-colored iron and magnesium minerals in an igneous rock. Complement of felsic.

Metamorphic: Any rock derived from other rocks by chemical, mineralogical, and/or structural changes resulting from pressure, temperature, or shearing stress.

Phenocryst: A relatively large conspicuous crystal set in the finer-grained ground mass of an igneous rock such as (for example) a rhyolite or granite.

Phyllite: A metamorphosed rock, intermediate in grade between slate and mica schist. Minute crystals of graphite, sericite, or chlorite impart a silky sheen to the surfaces of cleavage (or schistosity).

Pyroclastic: Pertaining to fragmented (clastic) rock material formed by a volcanic explosion or ejection from a volcanic vent.

Quartz diorite: A group of plutonic rocks characteristically composed of dark-colored biotite mica or amphibole (especially hornblende), dark-colored pyroxene (especially augite), light-colored sodic plagioclase such as oligiclase or andesine, and quartz composing 5 to 20 percent of the light-colored constituents.

Quartz Monzonite: A plutonic (intrusive) rock in which quartz makes up 10 to 50 percent of the felsic components, and in which the ratio of alkali feldspar to total feldspar is 35 to 65 percent. With an increase in plagioclase feldspar and mafic minerals, it grades into granodiorite, and with more alkali feldspar, it grades into a granite.

Rhyolite: A group of volcanic rocks, typically porphyritic and commonly exhibiting flow texture, with phenocrysts in a glassy to crystalline groundmass.

Spilitic: Resembling altered basalt, which is generally vesicular containing low-temperature crystallization products characteristic of a greenstone.

REFERENCES

DWR (California Department of Water Resources). 1963. *Northeastern counties groundwater investigation*. Bulletin 98, vol. 1.

——. 1983. Sierra Valley Groundwater Study Memorandum Report.

Durrell. 1966. *Geology of northern California, tertiary and quaternary geology of the northern Sierra Nevada*. California Division of Mines and Geology Bulletin 190:185-197.

Grose, T. L. T. et al. 2000a. *Geologic map of the Chilcoot 15 minute quadrangle Lassen and Plumas Counties, California*.

——. 2000b. *Geologic map of the Portola 15 minute quadrangle Plumas County, California*.

——. 2000c. *Geologic map of the Sierraville 15 minute quadrangle Sierra and Plumas Counties, California.*

Sawyer, T.L. 1995. *Quaternary faults and fold database of the United States* [online]. Fort Collins, Colorado: U.S. Geological Survey, 2004 [cited March 2004]. Available from World Wide Web: http://qfaults.cr.usgs.gov.

USDA (U.S. Department of Agriculture). 1975. *Soil survey of Sierra Valley area, California, parts of Sierra, Plumas, and Lassen Counties.*

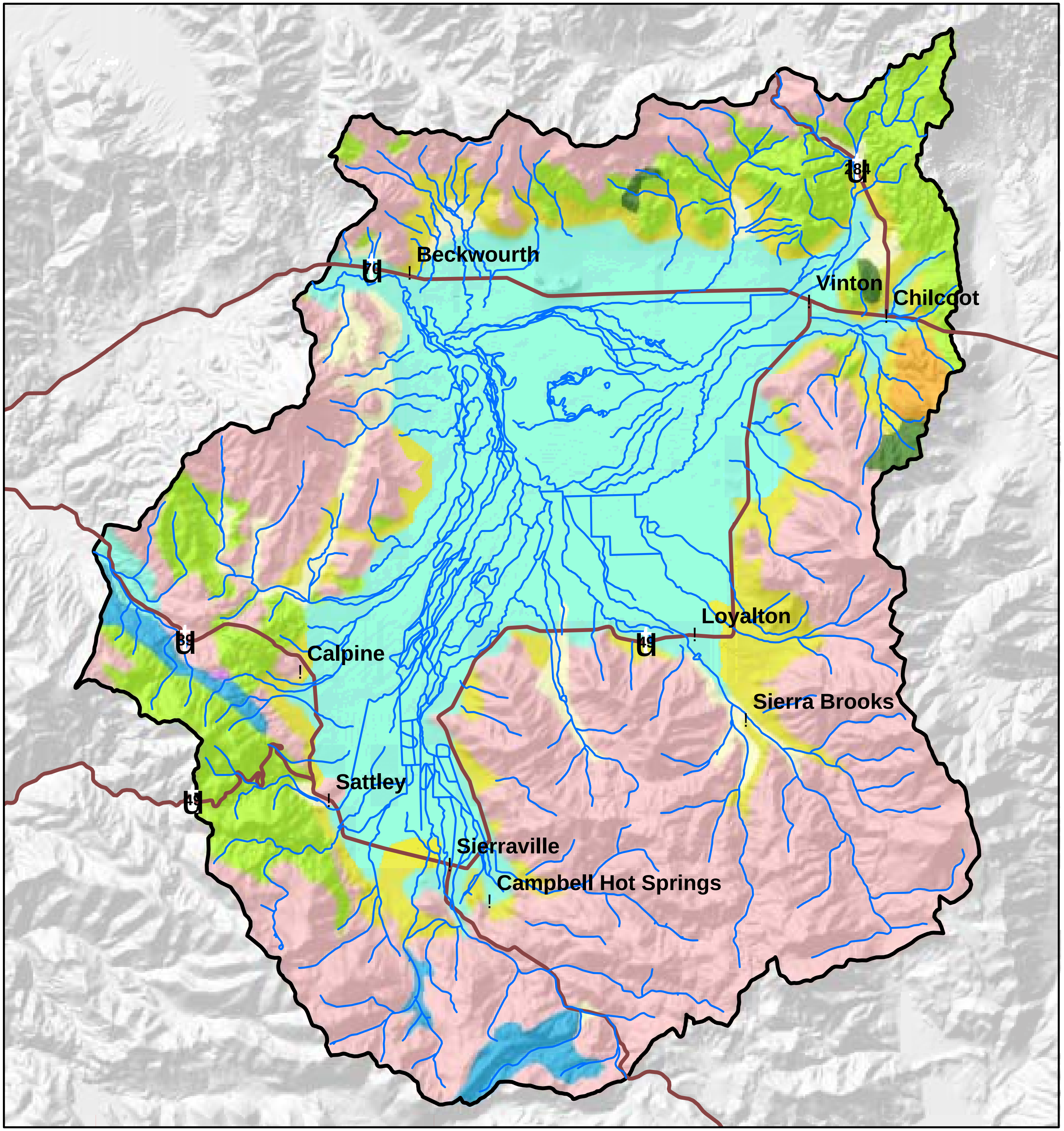


Figure 3-1
Geology
Sierra Valley Watershed

Legend

- Rivers and Streams
- State Highways
- Sierra Valley Watershed
- Alluvium
- Fan deposits
- Glacial deposits
- Granite, granodiorite
- Lake deposits
- Metavolcanic rocks
- Miocene-Pliocene volcanic rocks
- Oligocene-Miocene volcanic rocks
- Pliocene volcanic rocks

Source: California Department of Conservation, Division of Mines and Geology

0 1.25 2.5 5 Miles

VESTRA

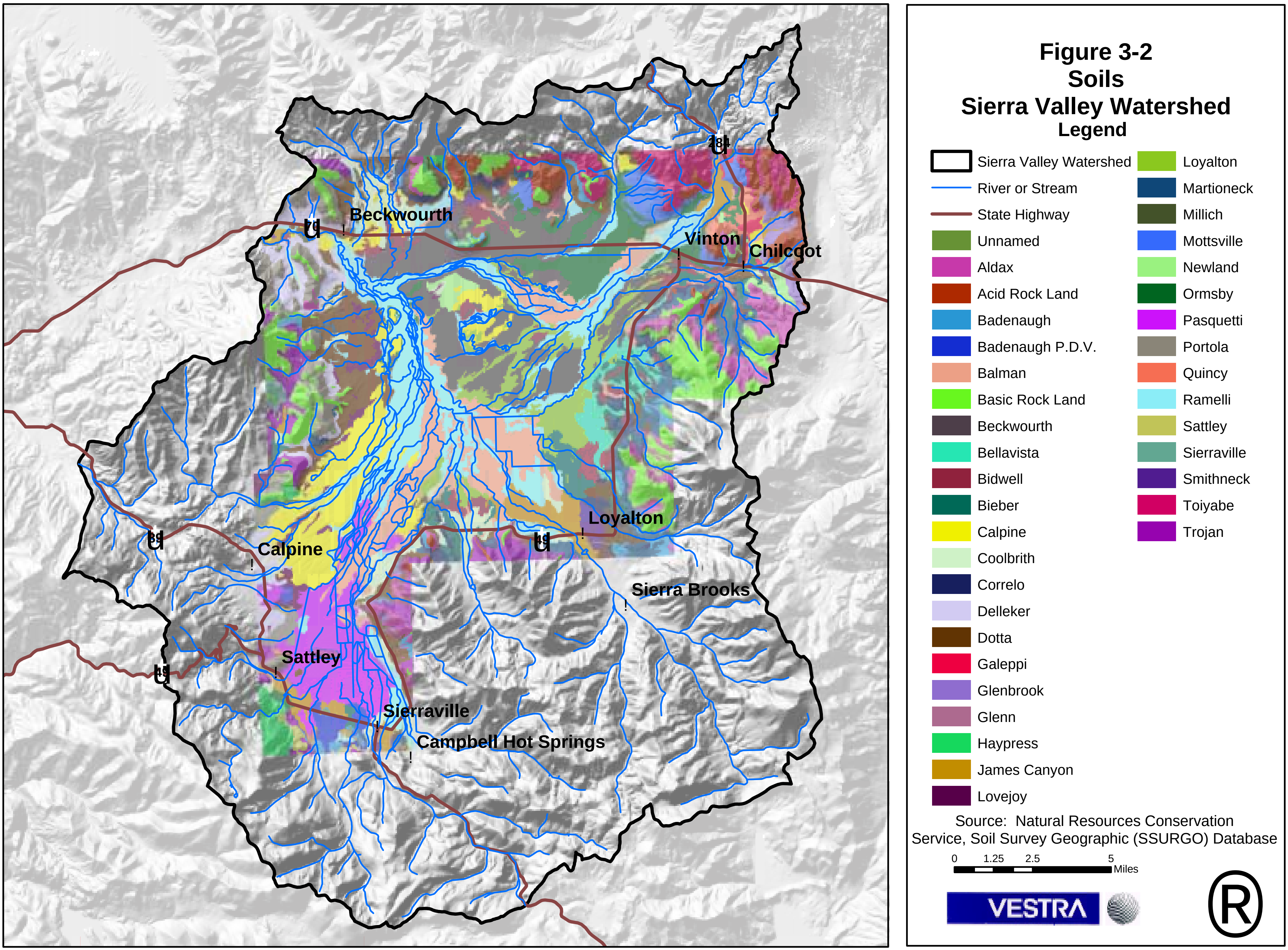


Figure 3-2
Soils
Sierra Valley Watershed
Legend
Sierra Valley Watershed
River or Stream
State Highway
Unnamed
Aldax
Acid Rock Land
Badenaugh
Badenaugh P.D.V.
Balman
Basic Rock Land
Beckwourth
Bellavista
Bidwell
Bieber
Calpine
Coolbrith
Correlo
Delleker
Dotta
Galeppi
Glenbrook
Glenn
Haypress
James Canyon
Lovejoy
Loyalton
Martioneck
Millich
Mottsville
Newland
Ormsby
Pasquetti
Portola
Quincy
Ramelli
Sattley
Sierraville
Smithneck
Toiyabe
Trojan
Source: Natural Resources Conservation Service, Soil Survey Geographic (SSURGO) Database
0
1.25
2.5
5
Miles
VESTRA
Beckwourth
Vinton
Chilcoot
Loyalton
Calpine
Sierra Brooks
Sattley
Sierraville
Campbell Hot Springs
70
284
89
49

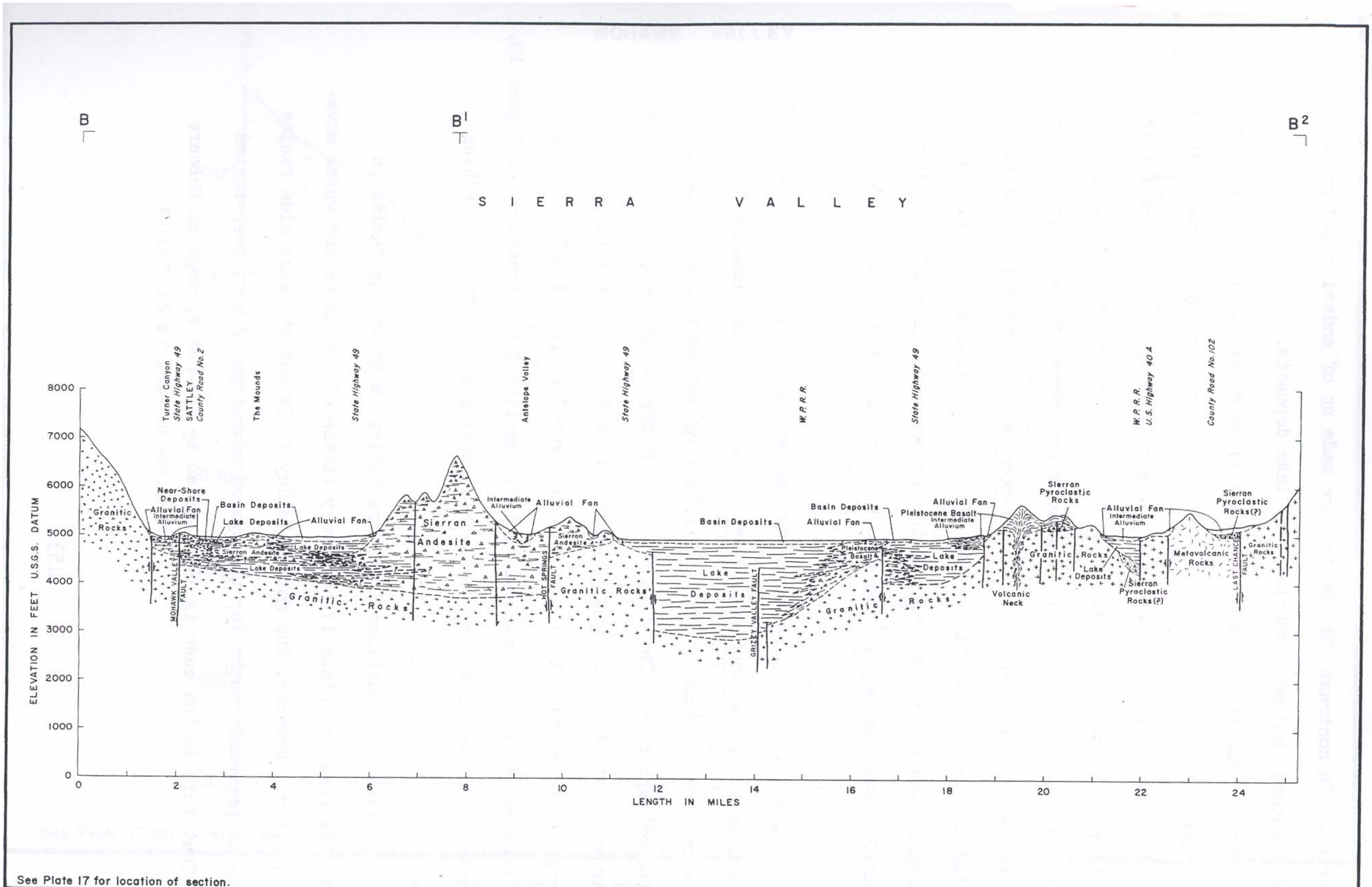
GEOLOGIC FORMATIONS IN SIERRA, MOHAWK, AND HUMBUG VALLEYS

Geologic Age			Geologic Formation	Stratigraphy	Approximate Thickness in Feet	Physical Characteristics	Water-Bearing Characteristics
Cenozoic	Quaternary	Recent	Sand Deposits	Qs	0-25	Qs: Loose, wind-blown sand.	Highly permeable but located above water table, hence contain little water.
			Basin Deposits	Qb	0-50	Qb: Unconsolidated silt and clay; may contain some alkali.	Low permeability; may yield small amounts of water to domestic wells.
			Intermediate Alluvium	Qal	0-50	Qal: Unconsolidated sand and silt with lenses of clay and gravel.	Moderate permeability. Yields moderate quantities of water to wells.
			Alluvial Fans	Qf	0-200	Qf: Unconsolidated gravel, sand, and silt with clay lenses.	Moderate to high permeability. Yields large amounts of water to wells. May contain confined water.
			Terraces	Qt	0-25	Qt: Unconsolidated gravel, sand, silt, and clay.	Moderate permeability. Yields moderate amounts of water to shallow wells.
		Pleistocene	Near-Shore Deposits	Qps	0-250	Qps: Slightly consolidated, bedded gravel, sand, and silt.	Moderately permeable. Yields moderate quantities of water to wells. Contains confined water.
			Lake Deposits	Qpl	0-2000	Qpl: Slightly consolidated, bedded sand, silt, and diatomaceous clay.	Moderately to highly permeable. Principal aquifer in valleys. Yields moderate to large quantities of water to wells. Contains confined water.
			Pleistocene Basalt	Qpvb	50-300	Qpvb: Jointed basalt flows containing zones of scoria.	Moderate to high permeability. May yield large quantities of water to wells. May contain confined water.
			Glacial Outwash	Qpo	0-100	Qpo: Poorly consolidated mixture of gravel and silt.	Moderate permeability. May locally yield moderate quantities of water to wells.
			Moraines	Qpm	0-700	Qpm: Slightly consolidated mixture of boulders, cobbles, sand, and rock flour.	Low permeability. A few areas may yield small amounts of water.
	Tertiary	Pliocene	Pliocene Lake Deposits	Tpl	0-3000?	Tpl: Bedded, consolidated sandstone and siltstone. Occurs only in Long Valley.	Low to moderate permeability. May yield moderate quantities of water to wells. May contain confined water.
			Rhyolite	Tvr	?	Tvr: Jointed, light gray rhyolite.	Essentially impermeable.
		Pre-Pliocene	Sierran Volcanic Rocks: Basalt	Tsvb	4000	Tsvb, Tsva, Tsvp, Tsv: Flows of fractured basalt. Plugs and flows of massive to platy andesite. Massive to bedded mudflows and tuffs.	Permeability ranges from poor to moderate. Basalt may be permeable, but is mostly located above zone of saturation and hence is unimportant to ground water. Andesite and pyroclastic rocks are essentially impermeable.
			Sierran Volcanic Rocks: Andesite	Tsva, Tsv			
			Sierran Volcanic Rocks: Pyroclastic Rocks	Tsvp			
Mesozoic	Jurassic to Cretaceous		Basement Complex: Granitic Rocks	JKgr	?	JKgr: Hard, nonweathered granitic rocks.	Essentially impermeable.
Pre-Cretaceous			Basement Complex: Metamorphic Rocks	pKm	?	pKm: Massive quartzite, slate, limestone, and meta-volcanic rocks.	Essentially impermeable.

Source: DWR, 1983

FIGURE 3-3
GEOLOGIC FORMATIONS OF SIERRA VALLEY
SIERRA VALLEY WATERSHED

VESTRA



Source: DWR, 1983

VESTRA

FIGURE 3-4
GENERALIZED CROSS SECTION
SIERRA VALLEY WATERSHED

Section 4

Section 4

HYDROLOGY

TABLES

FIGURES

Section 4
HYDROLOGY

Basic information on the surface water hydrology, groundwater hydrology, and geomorphology of the Sierra Valley Watershed is presented in this section. The surface water portion includes a discussion of reference conditions, surface water runoff, dams, diversions and water rights. The groundwater portion includes a discussion of key groundwater basins and water use. Additional information on climate and land use is included in Section 1.

DATA SOURCES

Key data sources used in the preparation of this section are listed below. Additional information is provided in the references section.

- Daily Stream Flow Statistics for Middle Fork Feather River near Portola, Little Last Chance Creek below Frenchman Dam, and Big Grizzly Creek near Portola (USGS 2004a).
- Natural Resources of the Sierra Valley Study Area, Sierra and Plumas Counties (DWR 1973).
- Northeastern Counties Groundwater Investigation (DWR 1963).
- Sierra Valley Groundwater Study (DWR 1983).
- Sierra Valley Groundwater Study Update (DWR 1986).
- Hydrogeology and Groundwater Monitoring in Sierra Valley (Schmidt 2003).
- California Groundwater Bulletin 118-03 (DWR 2003a).

SURFACE WATER HYDROLOGY

The Sierra Valley Watershed is a subset of the Middle Fork Feather River Hydrologic Unit (HUC 18020123) as defined by the United States Geological Survey (USGS). As defined for this watershed assessment, Sierra Valley includes approximately 300,000 acres. In general, this definition includes the entire drainage area contributing to the Middle Fork Feather River at Portola, excluding the area draining to Little Last Chance Creek above Frenchman Dam, and the area draining to Big Grizzly Creek. The portion of Little Last Chance Creek above Frenchman Dam drains approximately 52,000 acres, and Big Grizzly Creek drains approximately 28,000 acres (DWR 1973). Previous studies have included one or both of these watersheds as part of Sierra Valley. For this reason, Sierra Valley is commonly reported to include approximately 350,000 acres (including the Little Last Chance Creek watershed above Frenchman Dam) or approximately 380,000 acres (including the Little Last Chance Creek watershed above Frenchman Dam and the Big Grizzly watershed).

Major tributaries contributing to the Middle Fork Feather River within the Sierra Valley Watershed include:

- Little Last Chance Creek
- Smithneck Creek
- Cold Stream
- Miller Creek
- Turner Canyon Creek

The Sierra Valley Watershed including the Middle Fork Feather River and major tributaries are shown on Figure 4-1. In addition, the Little Truckee Ditch supplies approximately 7,000 acre-feet of water annually to a tributary to Cold Stream (DWR 1973).

In order to discuss the hydrology of a watershed, it is necessary to quantify the volume of precipitation received within the watershed boundaries. The average annual precipitation in Sierra Valley varies from less than 15 inches on the east side of the watershed near Vinton to more than 60 inches southwest of Sierraville. Precipitation isohyetals are shown in Figure 4-2. The distribution of precipitation by area is summarized in Table 4-1. Using this information, the average annual precipitation across the valley is approximately 25.9 inches, or 642,900 acre-feet.

Table 4-1
PRECIPITATION SUMMARY

Precipitation Category	Annual Precipitation (inches)	Area [1] (acres)	Volume [2] (aft/yr)
0 to 8 inches	4	0	0
8 to 12 inches	10	11,195	9,300
12 to 15 inches	13.5	53,574	60,300
15 to 20 inches	17.5	66,898	97,600
20 to 30 inches	25	81,200	169,200
30 to 40 inches	35	37,097	108,200
40 to 50 inches	45	28,195	105,700
50 to 60 inches	55	16,650	76,300
60 to 70 inches	65	3,001	16,300
Total	25.9	297,810	642,900

[1] Determined using GIS precipitation data layer (CERES 1997).
[2] Rounded to the nearest 100.

Reference Conditions

Hydrologic data for the Sierra Valley Watershed prior to the turn of the century is limited. Assuming annual flows in the Middle Fork Feather River correlate with annual flows in the Sacramento River, hydrologic conditions along the Middle Fork Feather River can be estimated from Sacramento River data.

In the Sacramento River watershed, multi-year droughts were recorded between 1912–13, 1918–20, 1929–34, 1947–50, 1959–61, 1976–77, and 1987–92 (DWR 2000). The 1929–34 drought represents the most severe recorded drought. This historical record has been supplemented using tree ring data to estimate runoff in the Sacramento River between A.D. 869 and 1977 (Meko et. al 2001). Based on tree ring data, the 1929–34 droughts was less severe than epic droughts experienced around 1150 and 1350. These epic droughts lasted more than 100 years.

The lowest recorded annual flow on the Middle Fork Feather River at Clio, which is located downstream from Portola, was 54 cubic feet per second in 1961. Flow data for the Middle Fork at Clio are available from 1926 through 1978. Based on the years of overlap between the Clio and Portola stations, annual flows in the Middle Fork Feather River at Portola are approximately 70 percent of the flows at Clio.

Surface Water Runoff

Surface water enters Sierra Valley from Little Last Chance Creek below Frenchman Dam and leaves Sierra Valley from the Middle Fork Feather River east of Portola. In addition, Big Grizzly Creek enters the Middle Fork Feather River between the western boundary of the watershed and Portola. Historically, surface water discharge has been measured on Little Last Chance Creek, Big Grizzly Creek, and on the Middle Fork Feather River at Portola (USGS 2004a).

Average annual flow in Little Last Chance Creek below Frenchman Dam between 1959 and 1979 was 26.8 cubic feet per second or 19,400 acre-feet per year. Average annual flow in Big Grizzly Creek near Portola between 1926 and 1979 was 34.7 cubic feet per second or 25,100 acre-feet per year. Average annual flow in Middle Fork Feather River near Portola between 1969 and 1979 was 246 cubic feet per second or 177,800 acre-feet per year. These flows are summarized in Table 4-2.

Based on the measured flow rates, surface water runoff from the Sierra Valley Watershed averages 133,300 acre-feet per year (177,800 acre-feet per year – 19,400 acre-feet per year – 25,100 acre-feet per year).

The seasonal distribution of surface water runoff at the USGS gauging stations is summarized in Table 4-3, and the results from Middle Fork Feather River near Portola are shown on Figure 4-3. Earlier data for these stations are available from the California Department of Water Resources (DWR) (1973).

Table 4-2
ANNUAL MEAN STREAM FLOW
UNITED STATES GEOLOGICAL SURVEY

USGS Site Name	USGS Site Number	Period of Record [1]	Min. (cfs)	Max. (cfs)	Mean (cfs)	Mean (aft/yr)
Little Last Chance Creek below Frenchman Dam	11391400	1959-1979	3.39	57.5	26.80	19,400
Big Grizzly Creek at Grizzly Valley Dam	11391500	1926-1931 1951-1952 1955-1979	7.16	97.9	34.7	25,100
Middle Fork Feather River near Portola	11392100	1969-1979	70.8	490	246	177,800

[1] Based on a water year of October through September. For example, the 2004 water year extends from October 1, 2003 through September 30, 2004.

Table 4-3 MEAN MONTHLY STREAM FLOW (cfs)			
Month	**Big Grizzly Creek at Grizzly Valley Dam**	**Little Last Chance Creek near Chilcoot**	**Middle Fork Feather River near Portola**
January	27.6	3.76	538
February	35.6	11.7	354
March	61.1	14.8	609
April	120	44.0	429
May	76.7	79.6	318
June	22.5	59.7	135
July	11.2	31.8	43.8
August	10.1	46.2	29.0
September	4.77	13.0	18.3
October	7.08	5.87	34.8
November	10.0	2.38	72.4
December	24.8	2.43	117

In addition to the USGS stations, DWR has historically maintained several stations. These stations are listed on Table 4-4.

Table 4-4 ANNUAL MEAN STREAM FLOW CALIFORNIA DEPARTMENT OF WATER RESOURCES			
Station Description	**Period of Record**	**Mean (cfs)**	**Mean (aft/yr)**
Smithneck Creek near Loyalton	1937-1966	11.1	8,076
Bonta Creek near Sierraville	1940-1959	39.0	28,224
Miller Creek near Sattley	1940-1967	11.4	8,247
Little Truckee Ditch at Summit	1937-1966	19.4 [1]	7,039
[1] Average for 6-month irrigation season.			

Flood History

Widespread flooding has not been documented in Sierra Valley and data concerning flood control problems are minimal. Local flooding has occurred in Sierraville where over 1-foot of water was reported throughout the community in December 1955, and again in December 1963. Flooding has also been reported in Loyalton. Overall, however, storm damage within the watershed has been limited to erosion of shoulders, embankments, and unprotected portions of roadways during periods of local flooding. Construction of Grizzly Valley Dam and Frenchman Dam has provided incidental flood control benefits along Big Grizzly Creek and Little Last Chance Creek.

The California Department of Water Resources has mapped approximately 650 miles of flood plain in the Sierra Valley (DWR 2003b). The objective of the study was to provide the community and individual citizens with an additional tool to understand potential flood hazards currently not mapped as a regulated floodplain. The most recent data delineation of the 100-year flood plain is shown on Figure 4-4.

Jurisdictional Dams

One jurisdictional dam is located within the Sierra Valley Watershed, one jurisdictional dam controls surface flows entering the watershed, and one jurisdictional dam controls surface flows on Big Grizzly Creek which enters the Middle Fork Feather River between the western boundary of the watershed and Portola. Jurisdictional dams are defined as "artificial barriers, together with appurtenant works, which are 25 feet or more in height or have an impounding capacity of 50 acre-feet or more." Any artificial barrier under 6 feet, regardless of storage capacity, or that has a storage capacity less than 15 acre-feet, regardless of height, are not considered jurisdictional (CARA 2004). Numerous smaller dams also occur in the watershed.

The Palen Dam is located on Antelope Creek, west of Loyalton, and has a capacity of 146 acre-feet. In addition, Grizzly Valley Dam on Big Grizzly Creek forms Lake Davis, and Frenchman Dam on Little Last Chance Creek forms Frenchman Lake. The capacity of Lake Davis is 83,000 acre-feet, and the capacity of Frenchman Lake is 55,477 acre-feet. The Grizzly Valley and Frenchman dams were constructed as part of the State Water Project in 1966 and 1961, respectively.

Lake Davis provides recreation as well as fish and wildlife enhancement. Water from the reservoir also supplements water supplies to Sierra Valley, Plumas County, and the city of Portola through the six-mile Grizzly Valley Pipeline. Frenchman Lake provides water for irrigating land in Sierra Valley and enhances fish habitat in Little Last Chance Creek.

A third dam was proposed on Carman Creek about two miles north of Calpine in the western portion of the watershed (DWR 1973). The Sheep Camp Project would have included a reservoir with a storage capacity of 65,000 acre-feet and provided approximately 48,000 acre-feet of water on an annual basis. This project was not completed.

Water Rights

Water rights in the Sierra Valley Watershed are either appropriated or riparian. An appropriated right is an exclusive right to take a specific amount of water from a particular source for a specific use on a specific site for a specific amount of time. Riparian rights, on the other hand, belong to the land bordering a water source. The following discussion is provided as a general introduction to the concept of water rights and should not be considered a legal opinion (California Water Law & Policy 2003).

Appropriated Rights

An appropriative right is an entitlement to water based on a specific use. This type of right may be sold or transferred with the property or separately. In general, the party that first diverts the water has priority rights over subsequent appropriators or users. Actual levels of priority are generally specified in the appropriation. In situations where priorities conflict, or in situations where rights were established prior to the appropriation system, the rights may be adjudicated. Adjudications are judgments decreed by the court and carry the full force of law. The court or an assigned water master generally administers adjudicated rights. Water rights in the Sierra Valley Watershed have been adjudicated.

A senior may not change an established use of the water to the detriment of a junior. This restriction includes junior's reliance on a senior's return flow. A senior may not enforce a water right against a junior if such a right would not be put to beneficial use.

The elements of appropriation include:

- Intent to use the water
- Diversion or control of the water
- Reasonable and beneficial use of the water
- Priority of appropriation

Appropriative right is an acquisition of a water right subject to the issuance of a permit by the State Water Resources Control Board. The priority is based on the date a permit is issued. A priority-based permit system was implemented under the Water Commission Act of 1913. Presently, the system is codified in CWC § 1200, et seq.

Riparian Rights

A riparian right is the right to use water based on the ownership of property that abuts a natural watercourse. Water claimed by virtue of a riparian right must be used on the riparian parcel. Such a right is generally attached to the riparian parcel of land except where a riparian right has been preserved on non-contiguous parcels after the land has been subdivided, *Hudson v. Dailey*, (1909) 156 Cal. 617. Riparian rights were adopted in California as a part of the English Common Law when California entered statehood in 1850. At that time, however, gold miners were already operating under their own system of prior appropriation to claim water rights. Conflicts between appropriations and riparian rights have continued since.

In general, riparian users are entitled to enough water to make beneficial use of the water on the land as long as no other riparian users are harmed by such use. Riparian rights in California are now limited to "reasonable and beneficial use." In contrast to appropriative rights, there is no priority of riparian right; senior and junior riparian users do not exist. Water conflicts between riparian users are resolved on the basis of reasonable use. The court has held that in times of water shortage, all riparians must adjust water use to allow for an equal sharing of the available water supply.

California Doctrine

The California Doctrine is a system of water rights that recognizes both appropriative and riparian rights. Early California law recognized both appropriation and riparian rights by applying priority to disputes between appropriators and by applying riparian principles to disputes between riparian users. In 1872, California officially recognized the rights of appropriators by allowing the filing of water claims with county recorders. Within 14 years, the California Supreme Court had to determine who had superior water rights when a downstream riparian rancher and an upstream appropriator each claimed a superior right to use water. The Court held that riparian rights are superior to the rights of an appropriator except in cases where the water had been appropriated before the riparian acquired the patent to his land, and after the passage of the 1866 Mining Act, which recognized appropriation. Generally, a reasonable use by a riparian will trump an appropriative right so long as the patent to the riparian parcel was acquired from the United States prior to the date of appropriation.

In 1926 the Court held that a riparian could assert priority over an appropriator to make beneficial use of the water even if the riparian use was unreasonable. In response, in 1928 the California Constitution was amended to require all water use in California to be "beneficial and reasonable." Generally today, a riparian user cannot defeat an appropriative right unless the riparian user proves the appropriation is causing undue interference with the riparian user's reasonable use of the water.

Sierra Valley Water Rights

Water rights in Sierra Valley were established by the Superior Court of the State of California in Plumas County in 1939. Judgment and Decree 3095 was filed with Plumas County in 1940. The water rights are classified as special, interrelated, and surplus class. The special class rights are superior to all other rights, and the interrelated rights are divided into five priority classes ranging from one through five. The adjudicated water rights along Last Chance Creek, Smithneck Creek, West Side Canal, Fletcher Creek, Little Truckee River (imported water), and Middle Fork Feather River are summarized in Table 4-5 (Plumas County 1939). Diversions from the Little Truckee River into Sierra Valley were last identified in the Sierra Valley Agreement of 1993 (USGS 2001). The maximum allowable diversion from the Little Truckee River is 14,266 acre-feet per year, which is equivalent to 39.4 cubic feet per second during a six-month irrigation season.

Table 4-5
SUMMARY OF JUDGMENT AND DECREE 3095

Class	Irrigated Land (acres)	Import Class (cfs)	Special Class (cfs)	First Priority (cfs)	Second Priority (cfs)	Third Priority or Lower (cfs)	Total (cfs)
Special Class [1] (highest priority)	---	---	40.93	---	---	---	40.93
Last Chance Creek above Adams Neck	1,401.1	---	---	18.0	0.50	---	18.50
Last Chance Creek below Frenchman Creek	5,874.1	---	---	8.75	13.80	52.50	75.05
Last Chance Creek below Adams Neck	2,716.0	---	---	3.20	5.70	6.95	15.85
Smithneck Creek	5,886.6	---	---	10.94	33.91	23.09	67.94
West Side Canal	7,712.4	---	---	8.35	30.85	56.95	96.15
Fletcher Creek	583.9	---	---	1.55	3.90	0.63	6.08
Little Truckee River	---	60.00	---	---	---	---	60.00
Middle Fork Feather River	10,045.7	---	---	9.79	8.28	99.58	117.65
Total	40,363	60.00	40.93	60.58	96.94	239.7	498.15

[1] Special class rights for Last Chance Creek, Smithneck Creek, West Side Canal, and Middle Fork Feather River.

Irrigation Water Use

In 1995, the USGS (2004b) estimated that 98 percent of the surface water and groundwater used in the Middle Fork Feather River Hydrologic Unit was for irrigation. Approximately 85 percent of this water was diverted from surface water, and approximately 15 percent was pumped from groundwater. Although the Sierra Valley Watershed only constitutes a portion of the Middle Fork Feather River Hydrologic Unit (approximately 40 percent), it contains the majority of the irrigated land (approximately 85 percent). Estimated average annual irrigation water use for the Sierra Valley Watershed is summarized in Table 4-6.

Table 4-6
ESTIMATED AVERAGE ANNUAL IRRIGATION WATER USE

Water Source	Irrigated Land (acres)	Application Rate (feet) [1]	Consumptive Use (aft/yr)	Diversion (aft/yr)
Surface Water	34,600	2.5	86,500 [2]	96,111
Groundwater	3,300	2.0	6,600	6,600 [3]
Imported	2,500	2.5	6,300 [2]	7,040 [4]
Total	40,400 [5]	---	99,400	109,751

Assumptions
[1] Estimated average application rate for alfalfa and pasture.
[2] Assumes a conveyance loss of 10 percent.
Sources
[3] Average metered flow from DWR 1989 to 2002 (see Table 4-8).
[4] Average flow measured in Little Truckee Ditch (see Table 4-4).
[5] Irrigated acres from original adjudication (see Table 4-5).

GROUNDWATER

Drought conditions and increasing competition for surface water has led to limited groundwater development for irrigation in the watershed. Groundwater supplies are generally reliable in areas that have sufficient aquifer storage or where surface water replenishes the supply throughout the year. In other areas, such as Vinton and Loyalton, increased groundwater development has eliminated artesian conditions and resulted in local ground subsidence. These groundwater conditions and a concern that groundwater could be exported from the valley prompted Sierra and Plumas counties to request legislation to protect Sierra Valley groundwater resources. Senate Bill 1391, the Sierra Valley Groundwater Basin Act, was passed in 1980 and authorized the formation of the Sierra Valley Groundwater Management District to manage local groundwater resources, conduct technical investigations, and collect the data required to carry out the provisions of the Act. Detailed technical information, including recommendations, are available in the Sierra Valley Groundwater Study (DWR, 1983). Much of the groundwater data summarized in this section was collected in response to SB 1391.

Background

Groundwater can be defined as the portion of water occurring beneath the earth's surface, which completely fills (saturates) the void space of racks or sediment. Given that all rock has some degree of void space, it is fairly safe to say that groundwater can be found underlying nearly any location in the State. Several key properties help determine whether the subsurface environment will provide a significant, usable groundwater resource. Most of California's groundwater occurs in material deposited by streams, called alluvium. Alluvium consists of coarse deposits, such as sand and gravel, and finer-grained deposits such as clay and silt. The coarse and fine materials are usually coalesced in thin lenses and beds in an alluvial environment. In an alluvial environment, the coarse materials such as sand and gravel deposits, usually provide the best source of water and are termed aquifers, whereas the finer-grained clay and silt deposits are relatively poor sources of water and are referred to as aquitards.

Groundwater Basins

A groundwater basin is defined as alluvial aquifer or a series of alluvial aquifers with reasonably well-defined boundaries in a lateral direction and a definable bottom. Lateral boundaries are features that significantly impede groundwater flow such as rock or sediments with very low permeability or a geologic structure such as a fault. Bottom boundaries would include rock or sediments of very low permeability if no aquifers occur below those sediments within the basin.

Groundwater within the Sierra Valley Watershed is generally encountered in a near-surface unconfined aquifer, a deeper confined aquifer, and deep-seated thermal water associated with faulting. The unconfined and deeper confined aquifers are made up of lake and near shore deposits that extend up to 2,000 feet in depth. These deposits range in composition from permeable sands to nearly impermeable clays. The sand layers usually yield large quantities of confined groundwater.

Individual groundwater basins identified within the Sierra Valley Watershed are listed in Table 4-7 and are shown on Figure 4-5. The Sierra Valley Groundwater Basin is a well-defined basin with bedrock boundaries, and it is generally assumed that very little groundwater flows into or out of the basin. In other words, recharge occurs in the higher elevations and discharge occurs in the lower elevations. The groundwater basins within Sierra Valley are described briefly below (DWR 2003a).

Table 4-7
SIERRA VALLEY GROUNDWATER BASINS

Groundwater Basin	Subbasin	Basin Number	Basin Area (area within watershed)
Sierra Valley	Sierra Valley	5-12.01	117,700 (117,700)
Sierra Valley	Chilcoot	5-12.02	7,550 (7,550)
Mohawk Valley	---	5-11	19,000 (1,300)

Hydrogeology

Sierra Valley Subbasin
The Sierra Valley Subbasin is bounded to the north by Miocene pyroclastic rocks of Reconnaissance Peak, to the west by Miocene andesite of Beckwourth Peak, to the south and east by Tertiary andesite, and to the east by Mesozoic granitic rocks (Saucedo 1992).

The primary water-bearing formations in Sierra Valley are Holocene sedimentary deposits, Pleistocene lake deposits, and Pleistocene lava flows. The aquifers of the valley are mainly alluvial fan and lake deposits. The alluvial fans laterally grade from the basin boundaries into course lake and stream deposits. In the central part of the basin, alluvial, lake and basin deposits comprise the upper 30- to 200-feet of aquitard material that overlies a thick sequence of interstratified aquifers and aquicludes.

Holocene Sedimentary Deposits Holocene sedimentary deposits include alluvial fans and intermediate alluvium. Alluvial fans consist of unconsolidated gravel, sand, and silt with minor clay lenses. These deposits are located at the perimeter of the valley to a thickness of 200 feet. The fan deposits coalesce or interfinger with basin, lake, and alluvial deposits. Specific yield ranges from 8- to

17-percent. The fans are a major source of confined and unconfined groundwater and also serve as important recharge areas.

Intermediate alluvium consists of unconsolidated silt and sand with lenses of clay and gravel. Specific yield is estimated to range between 5- to 25-percent. This unit is limited in extent and is found along streams and centrally in the basin. The deposits are up to 50 feet in thickness and yield moderate amounts of groundwater to shallow wells.

Pleistocene Lake Deposits Lake deposits underlie the majority of the valley and range in thickness to 2000 feet. These provide most of the Sacramento River Hydrologic Region Sierra Valley Groundwater Basin groundwater developed in the valley. The deposits consist of slightly consolidated, bedded sand, silt, and diatomaceous clay with the sand beds yielding large amounts of groundwater to wells. Specific yield ranges from 1- to 25-percent. Well production reportedly ranges up to 3,200 gallons per minute (gpm).

Pleistocene Volcanic Rocks Pleistocene volcanic rocks consist of jointed and fractured basalt flows ranging in thickness from 50- to 300-feet. These rocks are moderately to highly permeable and yield large amounts of groundwater to wells. They also serve as a recharge area and, where buried by lake deposits, form confined zones with significant artesian pressures.

Sierra Valley Chilcoot Subbasin

The Chilcoot Subbasin is bounded to the north and east by Mesozoic granitic rocks and, to the south, by Tertiary Sierran basalt and pyroclastic rocks and Paleozoic metamorphic rocks. The basin is hydrologically connected to the Sierra Valley Subbasin to the west in the near surface but may be discontinuous at depth due to a bedrock sill. The surface drainage is tributary to Little Last Chance Creek, which drains to the Middle Fork Feather River.

The primary water-bearing formations in the Chilcoot Subbasin are the Holocene sedimentary deposits and silt and sand deposits, fractured and faulted Paleozoic to Mesozoic metamorphic and granitic rocks, and Tertiary volcanic rocks.

Holocene Sedimentary Deposits Holocene sedimentary deposits include alluvial fans and intermediate alluvium. Alluvial fans consist of unconsolidated gravel, sand, and silt with minor clay lenses. These deposits are located at the perimeter of the valley to a thickness of 200 feet and are a major source of confined and unconfined groundwater. The fan deposits coalesce or interfinger with basin, lake, and alluvial deposits. Specific yield ranges from 8- to 17-percent. The fans also serve as important recharge areas.

Intermediate alluvium consists of unconsolidated silt and sand with lenses of clay and gravel. Specific yield is estimated to range between 5- to 25-percent. This unit is limited in extent and is found along the margins of the basin. The deposits are up to 50 feet in thickness and yield moderate amounts of groundwater to shallow wells.

Holocene Silt and Sand Deposits Sand and silt deposits are located in the northeast portion of the subbasin. The deposits are generally unconsolidated and have high permeability and porosity. Potentially large quantities of water may be extracted.

Tertiary Volcanic Rocks Volcanic rocks make up a portion of the bedrock outcrop north of Chilcoot along Frenchman Lake road. These rocks are fractured and faulted and produce between 5- to 10-gpm where wells encounter interconnected openings in the rock.

Mesozoic Granitic Rocks and Paleozoic Metamorphic Rocks These rocks form the bedrock base of the subbasin and most of the surrounding mountain uplands. The metamorphic rocks underlie the eastern portion and the granitic rocks the western portion of the subbasin. Major north-south high angle faults form the contacts between these rocks. Several test wells drilled in a proposed subdivision in the area show that where wells encounter sufficient interconnected fractures, wells developed in these rocks can produce up to 20 gpm, but typically only produce 3- to 5-gpm.

Mohawk Valley Groundwater Basin

A small portion of the Mohawk Valley Groundwater Basin lies within the Sierra Valley Watershed. This groundwater basin occupies an elongated valley occupying a portion of a long, narrow graben. The graben is bounded on the southwest side by the Mohawk Valley fault. The east side of the valley is bounded by a group of northwest trending faults that branch from the Mohawk Valley fault near Gattley. The floor of the valley consists of a narrow strip of nearly flat alluvial material overlying lake sediments. Lake sediments also underlie the upland areas of the valley. Depth to bedrock is estimated to range between 1,500- to 3,000-feet. The basin is bounded to the northeast by Pliocene volcanic rocks of Penman Peak, to the east by Miocene volcanic rocks of Beckwourth Peak, and to the west and southwest by Paleozoic metavolcanic rocks and Mesozoic granitic rocks of the Sierra Nevada mountains. Sulphur Creek drains the southern half of the valley and enters Middle Fork Feather River near the midpoint of the valley and flows northwesterly (DWR 1963).

The primary water-bearing formations in the basin are Holocene sedimentary deposits and Pleistocene lake and near-shore deposits. The following summary of water-bearing formations is from DWR (1963).

Holocene Sedimentary Deposits Holocene sedimentary deposits include alluvial fans and intermediate alluvium. Alluvial fans consist of unconsolidated gravel, sand, and silt with minor clay lenses. Thickness of the deposits ranges to 200 feet. The fan deposits coalesce or interfinger with lake and alluvial deposits. Specific yield ranges from 8- to 17-percent. Intermediate alluvium consists of unconsolidated silt and sand with lenses of clay and gravel. Specific yield is estimated to range between 5- to 25-percent. This unit is limited in extent. The deposits are up to 50 feet in thickness and yield moderate amounts of groundwater.

Pleistocene Lake and Near-Shore Deposits Lake and near-shore deposits underlie the majority of the valley and range in thickness to over 2000 feet. These deposits consist of slightly consolidated, bedded sand, silt, and diatomaceous clay. The sand beds usually yield large quantities of confined groundwater. The near-shore deposits are composed of moderately permeable sand and gravel and, where saturated, yield moderate amounts of groundwater. Specific yield ranges from 1- to 25-percent.

Groundwater Recharge and Discharge

Most of the upland recharge areas are composed of permeable materials occurring along the upper portions of the alluvial fans that border the valley. These alluvial fans surround most of the valley and may be as much as 200 feet thick. Recharge to groundwater is primarily by way of infiltration of surface water from the streams that drain the mountains and flow across the fans. Specifically, Smithneck Creek has been identified as an important recharge area for the eastern half of the basin (DWR 1983). A minor amount of recharge may also be derived from some of the Sierran volcanic rocks located south of the valley (DWR 1963).

Groundwater discharge occurs primarily through evapotranspiration, seepage into streams, springs, flowing wells, and groundwater extraction.

The estimated groundwater storage in the basin is 7,500,000 acre-feet to a depth of 1000 feet (DWR 1963). DWR (1963) notes that the quantity of water that is useable is unknown. DWR (1973) estimates that the storage capacity is between 1,000,000 and 1,800,000 acre-feet in the top 200 feet of sediments based on an estimated specific yield ranging from 5 to 8 percent. These estimates include the Chilcoot Subbasin.

Groundwater Use

Irrigation is the primary use of groundwater in the Sierra Valley Watershed. Since 1989, groundwater extraction rates have been metered by DWR and the results are summarized in Table 4-8 (Schmidt 2003).

Table 4-8
SUMMARY OF METERED PUMPAGE 1989-2002 (Acre-Feet)

Year	Beckwourth	Vinton	Loyalton	Other	Total
1989	668	3,574	2,798	616	7,656
1990	489	5,139	3,875	628	10,131
1991	289	3,607	3,486	935	8,317
1992	120	3,326	4,548	1,119	9,113
1993	83	1,226	2,066	719	4,094
1994	388	1,558	3,831	1,552	7,329
1995	533	973	1,964	630	4,100
1996	778	1,692	2,457	892	5,819
1997	932	1,685	2,242	457	5,316
1998	212	606	2,336	311	3,465
1999	385	1,350	2,333	797	4,865
2000	417	2,599	1,938	1,015	5,969
2001	809	2,641	2,824	1,217	7,491
2002	1,099	2,393	3,225	1,596	8,313
Average	514	2,312	2,852	892	6,570

Groundwater Levels

The California Department of Water Resources collects semi-annual groundwater levels from 49 wells in the Sierra Valley Groundwater Basin (DWR 2004). The results show that an increase in groundwater development in the mid-late 1970s resulted in the cessation of flow in many artesian wells. Figure 4-6 is representative of a typical hydrograph for an irrigation well showing these trends.

Groundwater contour maps for fall 1999 and spring 2000, constructed using the DWR groundwater level data, are shown in Figures 4-7 and 4-8, respectively. The results show a noticeable groundwater depression near the center of Sierra Valley during the irrigation season (Figure 4-7).

PRELIMINARY WATER BUDGET

A preliminary water budget for the Sierra Valley Watershed is included in Table 4-9. The budget was developed to organize and summarize data presented above assuming 1) steady state conditions, 2) groundwater flow into or out of the watershed is not significant, and 3) water use data summarized in this section is representative of watershed conditions.

For the groundwater component, it was assumed that five percent of the rainfall and 10 percent of the runoff that reaches the stream channel contributes to groundwater recharge. Overall, this is approximately equal to nine percent of the annual precipitation. This value is less than the estimated value from the Maxey-Eakin (1949) relationship that is commonly used to estimate groundwater recharge in Basin and Range valleys. Using the Maxey-Eakin relationship, estimated groundwater recharge would be approximately 20 percent of the annual precipitation. Nine percent better matches the recharge estimate of 25,000 acre-feet per year presented by DWR (1983), and is consistent with the value of 11 percent developed for the Honey Lake Watershed (USGS 1990).

Table 4-9
PRELIMINARY WATER BUDGET
SIERRA VALLEY WATERSHED

Parameter	Symbol	Annual Value (aft/yr)	Percent of Precipitation	Source
Precipitation	P	643,000	100	Table 4-1
Surface Water Outflow via Middle Fork Less Surface Water Inflow	MF	133,300	21	Table 4-2
Surface Water Diverted	SWD	96,111	15	Table 4-6
Total Available Surface Water [1]	TASW	242,700	38	MF * 1.1 + SWD (MF adjusted for seepage)
Total Groundwater Recharge	RGW	56,470	9	RDI + RCS
Direct Infiltration	RDI	32,200	5	Assume 5% P
Channel Seepage	RCS	24,270	4	Assume 10% TASW
Total Groundwater Discharge	DGW	56,470	9	RDI + RCS
Well Pumpage	DW	6,600	---	Table 4-8
Spring and Riparian Areas	DET	49,970	---	DGW - DW
Watershed Evapotranspiration	WET	509,700	79	P – MF

[1] Total available surface water (TASW) is the volume of water that reaches a stream channel.

GEOMORPHOLOGY

Geomorphology is the study of landforms and the processes that create landforms, and fluvial geomorphology is the study of channel-forming processes. Understanding fluvial processes and the current condition of stream channels within the Sierra Valley Watershed is an important component of this watershed assessment.

Channel-forming processes include erosion, transport, and deposition. Erosion includes removal of sediment from hill slopes above the channel network as well as from channel banks and beds. Erosion within the channel may be lateral causing channels to get wider, or vertical causing channels to get deeper or to form gullies. Transport refers to the entrainment and movement of the material that is delivered to the channel, whether the material originates from within the channel or upslope. Channels transport water, sediment, and other materials such as wood and debris. Deposition of sediment, wood, and debris occurs when streams lose the physical capacity to transport the material. Deposition may occur within or above the channel.

The condition of the channel network in a watershed affects a wide variety of resources including the amount of water, sediment, and debris that the channel is capable of carrying; timing and duration of high-flow or flood events; health and vigor of riparian vegetation communities; water quality conditions including water temperature and turbidity; and habitat and passage conditions for fish and other aquatic organisms.

Data Sources

Digital elevation model (DEM) data were obtained from the USGS and used to de lineate stream channels throughout the watershed.

Channel Characteristics

River miles were digitally assigned to the major tributaries, beginning with zero at their confluences and increasing to their upstream ends. The results for Little Last Chance Creek, Smithneck Creek, Cold Stream and Turner Canyon Creek are shown on Figure 4-9. Longitudinal profiles along these tributaries are shown in Figures 4-10a through 4-10d.

Channel Slope

A Level 1 assessment calls for the division of the channel network into slope ranges of greater than 20 percent, between 3 and 20 percent, and less than 3 percent. These slope ranges divide the channel network into areas that are likely to respond similarly to changes in input variables.

Channels and unchanneled areas with slopes greater than 20 percent are classified as source reaches. These very steep slope areas are likely to be dominated by mass-wasting processes (e.g., debris flows, landslides, etc.) and contribute sediment and debris to stream channels downstream or downslope. Channels with slopes between 3 and 20 percent are classified as transport reaches. Both mass-wasting and fluvial processes may significantly influence these moderate-to-steep reaches, but the channel slopes are steep enough to transport the sediment and debris. Channels with slopes less than 3 percent are classified as response reaches because they are "likely to exhibit pronounced and persistent morphologic adjustments to changes in sediment supply" (DNR 1997). These classifications are summarized in Table 4-10.

Table 4-10 CHANNEL SLOPE RANGES, RESPONSE POTENTIALS TYPICAL BED MORPHOLOGIES		
Slope Range (percent)	**Response Potential**	**Typical Channel Bed Morphology**
>20	Source	Colluvial
3–20	Transport	Cascade, step pool, plane-bed, forced pool-riffle
<3	Response	Plane-bed, forced pool-riffle, pool riffle, regime

Source reaches (i.e., channels that are greater than 20 percent slope) are dominated by colluvial processes. Sediment and other debris tend to accumulate in these channels, not as a result of running water (fluvial processes), but as a result of debris flows, landslides, soil creep, and other mechanisms related more to weathering and gravity.

Transport reaches (i.e., channels between 3 and 20 percent slope) exhibit a high variability of channel forms. Generally, cascades dominate channels between 8 and 20 percent. The cascades may be vertical at some locations (e.g., at knickpoints where falling water has undercut a resistant rock outcrop), but may also fall along the hill slope gradient. These channels may be deeply entrenched within walls that range from bedrock to various types of unconsolidated colluvial material or they may be within shallow crenulations in a steep hill slope. Whatever the bank configuration, the steepness of the channel does not allow anything but very coarse substrate to remain, so bedrock or boulders usually dominate channel beds. In the four to eight percent slope range, channels are likely to have step-pool morphologies in which relatively short (typically vertical) cascades alternate with plunge pools. The spacing of the pools is inversely related to channel steepness: the steeper the gradient the shorter the distance between pools. Specifically, pool spacing is related to the ratio of step steepness (height/length of the step) to the average channel slope, which is commonly between one and two in free-forming step-pool channels (Abrahams et al 1995). Pool lengths are typically on the order of only three to four channel widths (Church 1994). In the three to four percent slope range, the likely channel types are plane-bed and forced pool-riffle.

Plane-bed channels may vary in roughness (i.e., coarseness of dominant substrate and amount of coarse material protruding from the bed), but they lack alternate pool-riffle or step-pool morphology. Instead, the beds are more uniform and relatively flat in both cross-section and longitudinal profile. Forced pool-riffle morphology is commonly found in bedrock-controlled channels. Bedrock outcropping along one side of a channel commonly results in scour of mobile material that creates and anchors a pool adjacent to the outcrop. Material scoured out of the pool tends to deposit immediately downstream of the pool creating a shallow riffle. The length and spacing of pools and riffles are controlled by the location of the resistant outcroppings rather than sediment transport and energy dissipation processes of free-forming pool-riffle channels (Church 1994). As a result, pools and riffles in this channel type may have very irregular lengths and spacing.

As with transport reaches, response reaches (i.e., channels with slopes less than three percent), which are the dominant channel morphology in the watershed, exhibit a variety of likely bed forms.

Likely channel types associated with the two to three percent slope range are the same as that of the three to four percent range: plane-bed and forced pool-riffle (see description above). In the one to two percent slope range, the likely bed morphologies include plane-bed (see description above) and pool-riffle. Pool-riffle beds are free-forming channels whose beds are constructed primarily of alluvium. The dominant features of these beds are the regularly spaced pools and riffles. The spacing of riffles and pools is found to be in close balance to channel dimensions; riffles and pools are typically spaced every five to seven bankfull channel widths (Leopold 1994). Pool-riffle beds are also common at slopes less than one percent.

Regime bed channels have sand beds and lack regular pool-riffle morphology. Regime beds typically do have bedforms such as ripples, dunes, and bars. Because of their low slopes and relatively lower sediment transport capacities, regime channels are among the most susceptible channel forms to perturbation and adjustment (Montgomery and Buffington 1993).

Figure 4-11 shows the Sierra Valley Watershed channel network with the response potential types determined by channel slope ranges (i.e., source, transport, response).

Channel Confinement

Channel response potential is also affected by channel confinement, which is the degree to which the channel and floodplain are contained by valley walls or hill slopes that restrict flood dissipation. The more confined the channel, the more the channel bed and banks are subjected to higher flood energies. A low-gradient channel that is highly confined, for example, may respond more like a transport reach than a response reach.

Channel reaches are commonly divided into three confinement categories including unconfined (i.e., valley width greater than four times the channel width), moderately confined (i.e., valley width between two and four times the channel width), and confined (i.e., valley width less than two times the channel width). Confinement was not determined as part of this assessment.

Disturbances and Perturbations

Disturbances and perturbations can occur as man-caused or natural processes in a watershed. Severe storms for example, may result in disturbances such as debris flows, landslides, and large-scale tree blow-downs that are substantial enough to cause geomorphic channel adjustments. An example of a natural perturbation would be a lightening-caused wildfire resulting in a change in storm runoff rates or an increase in sediment influx to a channel that begins to push the channel network out of its old balance and toward a new one.

Generally speaking, human-caused disturbances or perturbations are much more effective at causing systemic geomorphic channel adjustments than most natural disturbances. This is true even when the mechanisms (for example, fire) are identical. Part of the difference is that many human-caused disturbances or perturbations are widespread and ongoing, causing cumulative impacts that are more complex than naturally occurring perturbations.

Events that create watershed perturbations or disturbances include, but are not limited to, fire, severe storms, tectonic activity, flooding, grazing, logging, agriculture, roads, dam construction, water diversion, stream channelization, mining, and urbanization.

Fire

Fire deserves some specific discussion in its role as a disturbance/perturbation. Natural wildfires are among the agents that can cause disturbance within a watershed. Fire may also, however, be an intentional, human-caused disturbance or perturbation. In addition, fire has a greater potential to cause disturbance or perturbation since the advent of fire suppression as a forest management practice early in the twentieth century. Fire suppression has resulted in widespread over accumulation of fuels throughout the forests in the west. Now when wildfires ignite, whether natural or human caused, they burn with much greater intensity and are much more detrimental ecologically than they would have been before fire suppression. From a channel morphology perspective, high-intensity burns are much more likely to result in disturbance or perturbation than presuppression wildfires that burned in more open forest stands with much lighter fuel loads.

Roads

Roads can also create significant watershed perturbations by channel impingement and increased sediment supply, leading to bank instability and sedimentation (i.e., sediment deposition and reduction of dominant substrate sizes within the channel). Failure of road crossings, particularly culverts, can cause disturbances including, bed and bank erosion and change in channel course. Ungated roads may also promote erosion by allowing vehicles into areas that should be closed seasonally because of sensitive conditions.

At-Risk Channel Segments

Generally speaking, the most at-risk channel types in the study area are the lowest-gradient, unconfined channels. This channel type may be found throughout most of the watershed, with the exception of the steepest headwater tributary reaches. Low-gradient, unconfined channels are most prevalent, however, in the broad valleys of the study area.

REFERENCES

Abrahams, A. D., G. Li, and J. F. Atkinson. 1995. Step-pool streams: Adjustment to maximum flow resistance. *Water Resource Res*: 31:2593–2602.

California Water Law & Policy. 2003. *Water rights in California* [online]. Sacramento: California Resources Agency, 2001 [cited March 2003]. Available on World Wide Web: http://ceres.ca.gov/theme/env_law/water_law/water_rights.html.

CARA (California Rivers Assessment). 2004. *California rivers assessment interactive database* [online]. Sacramento: California Rivers Assessment, 1997 [cited March 2003]. Available on World Wide Web: http://endeavor.des.ucdavis.edu/newcara.

CERES (California Environmental Resources Evaluation System). 1997. Precipitation GIS data layer. Sacramento.

Church, M. 1994. *The rivers handbook, hydrological and ecological principles*. Oxford, England: Blackwell Scientific Publishing.

DNR (Department of Natural Resources). 1997. *Washington forest practices: Board manual, standard methodology for conducting watershed analysis under Chapter 222-22 WAC/Washington Forest Practices Board – Version 4.0*. Olympia, Washington: Department of Natural Resources, Forest Practices Division.

DWR. 1963. *Northeastern counties groundwater investigation, vol. 1 and 2*. California Department of Water Resources Bulletin 98.

——. 1973. *An interagency-multidisciplinary investigation of the natural resources of the Sierra Valley study area, Sierra and Plumas Counties*. California Department of Water Resources.

——. 1983. *Sierra Valley ground water study*. California Department of Water Resources. Memorandum Report.

——. 1986. *Sierra Valley ground water study update*. California Department of Water Resources. Memorandum Report.

——. 2000. *Preparing for California's next drought, changes since 1987–92*. California Department of Water Resources.

——. 2003a. *California's groundwater*. California Department of Water Resources Bulletin 118-03.

——. 2003b. *Floodplain management* [online]. Sacramento: California Department of Water Resources [cited March 2003]. Available on World Wide Web: http://www.fpm.water.ca.gov.

——. 2004. *Water data library* [online]. Sacramento: California Department of Water Resources [cited March 2003]. Available from World Wide Web: http://well.water.ca.gov

Leopold, L.B. 1994. *A view of the river*. Harvard University Press, Cambridge, MA.

Maxey, G.B. and T.E. Eakin. 1949. Ground water in White River Valley, White Pine, Nye, and Lincoln Counties, Nevada. *Water Resources Bulletin No. 6*. Carson City, Nevada: State of Nevada, Office of the State Engineer. TIC: 216819

Meko, D.M., M. D. Therrell, C. H. Baisan, and M. K. Hughes. 2001. *Sacramento River annual flow reconstruction* [online]. [Cited March 2003]. Available from the World Wide Web: ftp://ftp.ngdc.noaa.gov/paleo/treering/reconstructions/california/sacramento_flow.txt

Montgomery, D.R., and J.M. Buffington. 1993. Channel classification, prediction of channel response, and assessment of channel condition. *Timber, Fish, and Wildlife Agreement TFW-SH10-93-002*. Olympia, Washington: Department of Natural Resources.

Plumas County, 1939. *Judgment and decree 3095: In the Superior Court of the State of California in and for the County of Plumas* [online]. [Cited March 2003]. Available from World Wide Web: http://www.waterrights.ca.gov/hearings/Judgements/MiddleForkOfFeatherRiverJudgementDecree.pdf

Saucedo, G. J. and D. L. Wagner. 1992. *Geologic map of the Chico quadrangle, California*. Sacramento: California Division of Mines and Geology.

Schmidt, 2003. *Hydrogeology and Groundwater Monitoring in Sierra Valley*. Kenneth D. Schmidt and Associates.

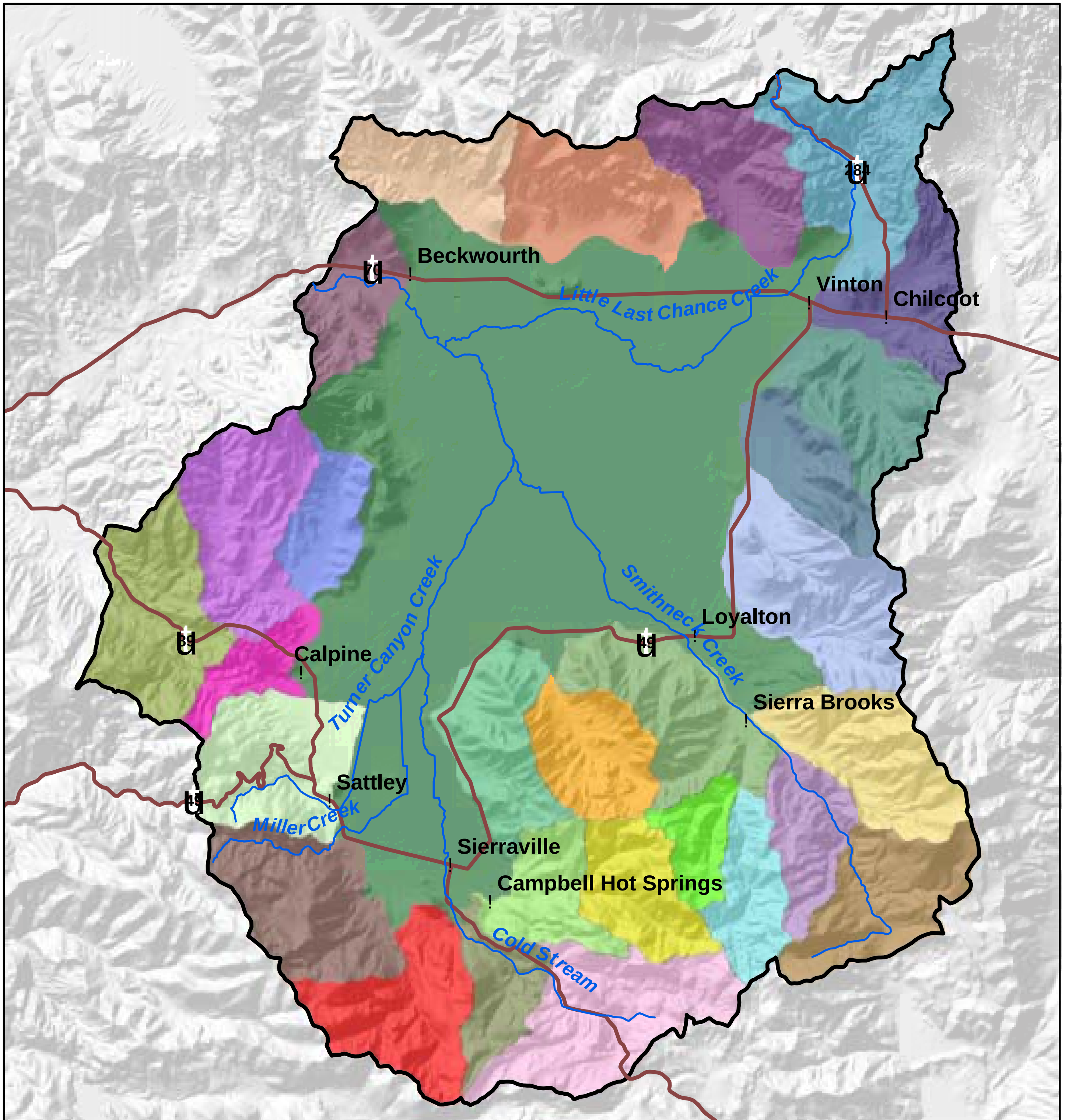
USGS. 1990. Groundwater resources of Honey Lake Valley, Lassen County, California, and Washoe County, Nevada. *U.S. Geological Survey Water-Resources Investigation Report 90-4050*.

——. 2001. River and reservoir operation model, Truckee River Basin, California and Nevada, 1998. *U.S. Geological Survey Water-Resources Investigation Report 01-4017*.

——. 2004a. *Surface water data for California* [online]. Washington, D.C.: U.S. Geological Survey, 2004 [cited March 2003]. Available from World Wide Web: http://waterdata.usgs.gov/ca/nwis/sw

——. 2004b. *The national water-use information program* [online]. Washington, D.C.: U.S. Geological Survey [cited March 2003]. Available from World Wide Web: http://water.usgs.gov/watuse/wunwup.html

Figure 4-1
Subwatersheds
Sierra Valley Watershed



Legend

- State Highways
- Major Tributaries
- Alder Creek
- Antelope Valley
- Banta Creek
- Bear Valley
- Blatchley Canyon
- Carman Creek
- Chilcoot
- Correco Canyon
- Cottonwood Creek
- Dodge Canyon
- East Carman Creek
- Franklin Cabin
- Harding Point
- Lemon Canyon
- Martneck Canyon
- Mt. Ina
- Nichols Mill
- Old Station
- Palen Reservoir
- Rock Creek
- Rock Creek A
- Ross Ranch Meadow
- Sattley
- Sierra Valley
- South Last Chance Creek
- Turner Canyon
- Upper Sulphur Creek A
- Upper Sulphur Creek B
- West Smithneck
- Sierra Valley Watershed

SOURCE: SIERRA VALLEY
RESOURCE CONSERVATION DISTRICT

0 1.25 2.5 5 Miles

VESTRA

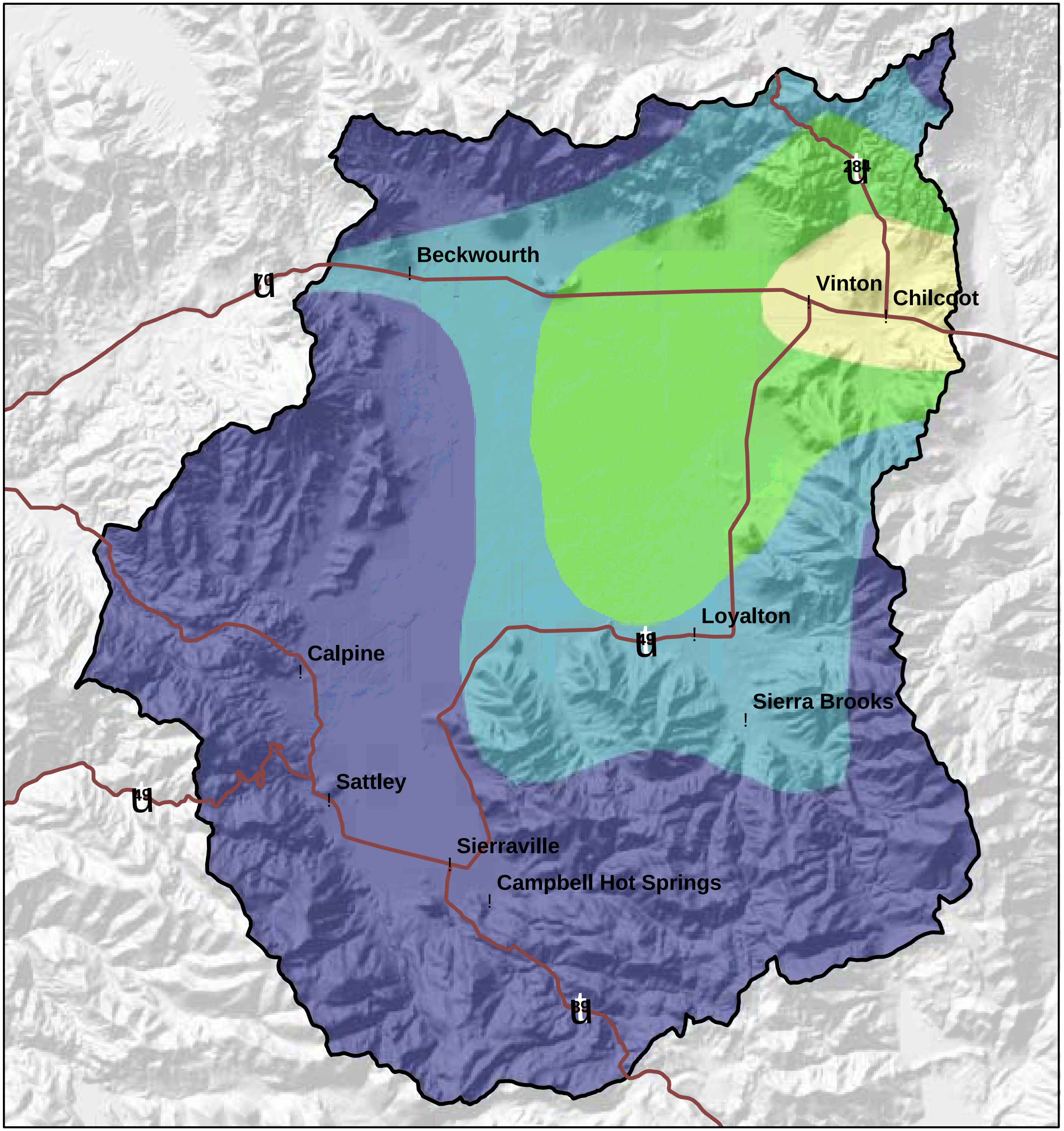


Figure 4-2
Average Annual Precipitation
(in inches)
Sierra Valley Watershed

Legend

- Sierra Valley Watershed
- State Highway
- 8.0 - 12.0
- 12.1 - 15.0
- 15.1 - 20.0
- > 20.0

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY

0 1.25 2.5 5 Miles

VESTRA

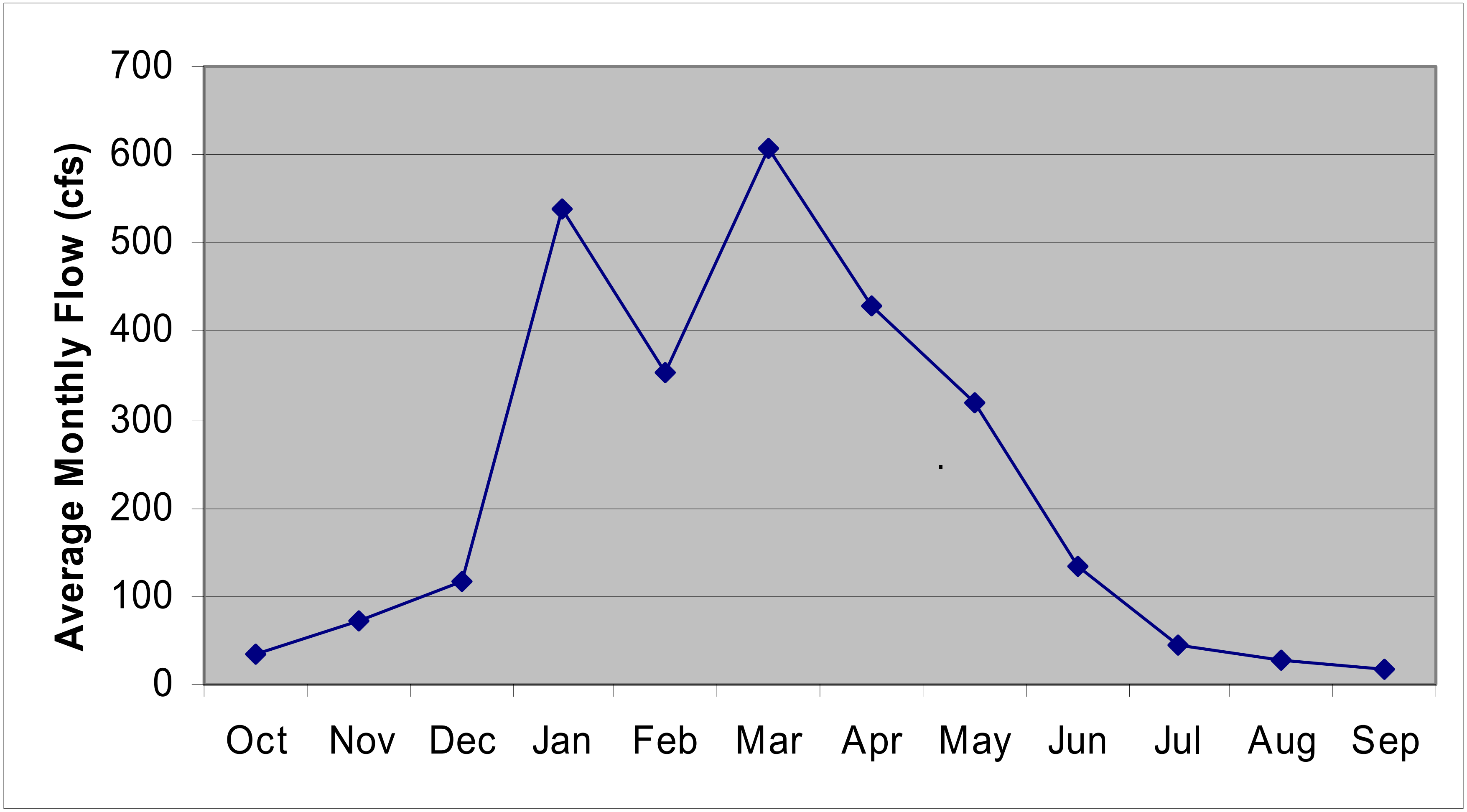


FIGURE 4-3
MEAN MONTHLY STREAM FLOW
MIDDLE FORK FEATHER RIVER NEAR PORTOLA
SIERRA VALLEY WATERSHED
SOURCE: UNITED STATES GEOLOGICAL SURVEY

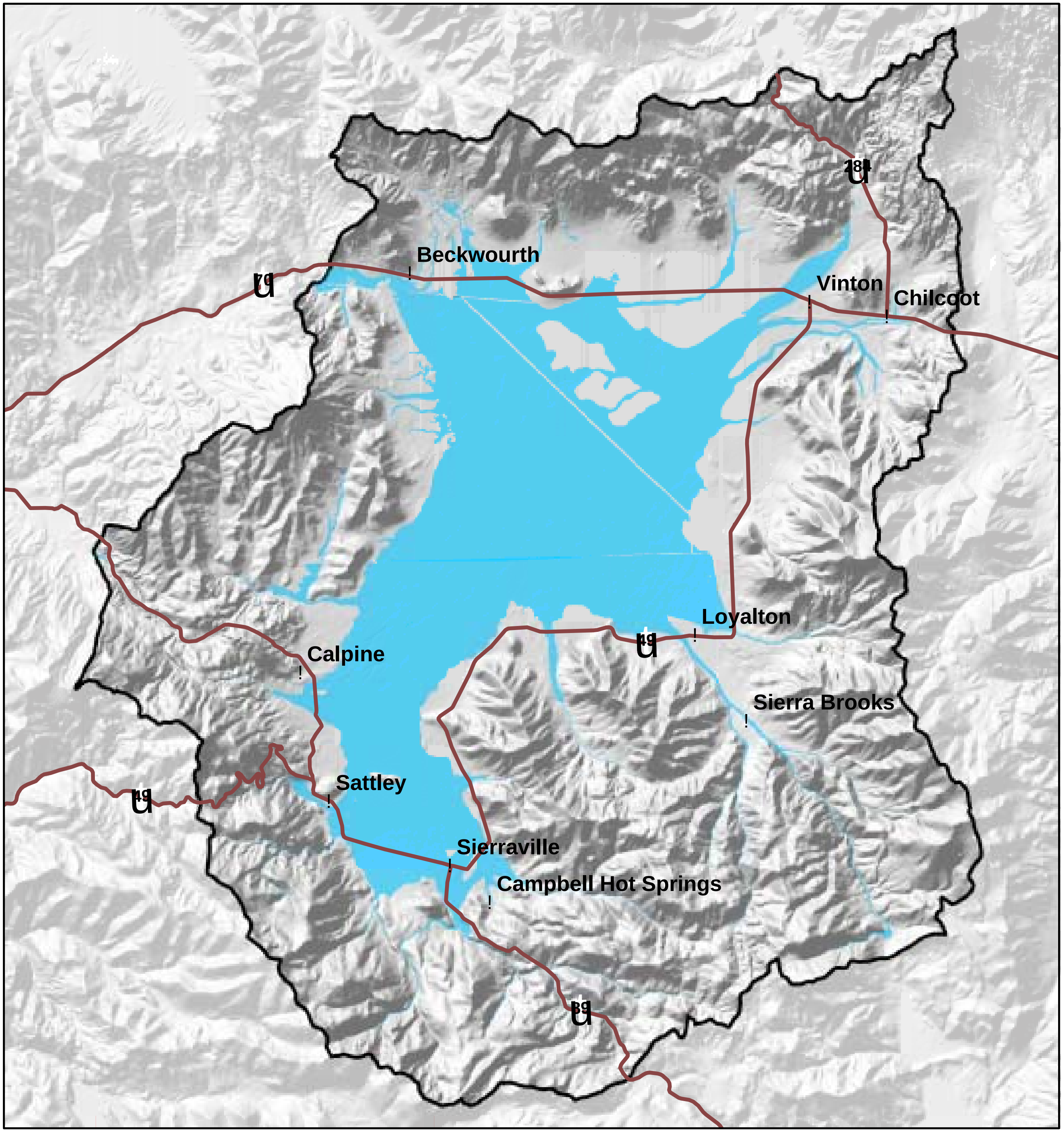


Figure 4-4
Areas of Potential Flood Hazard
Sierra Valley Watershed

Legend

- Sierra Valley Watershed
- State Highway
- Area of Potential Flood Hazard

SOURCE: DWR, AWARENESS FLOODPLAIN MAPPING PROJECT, 2003

0 1.25 2.5 5 Miles

VESTRA

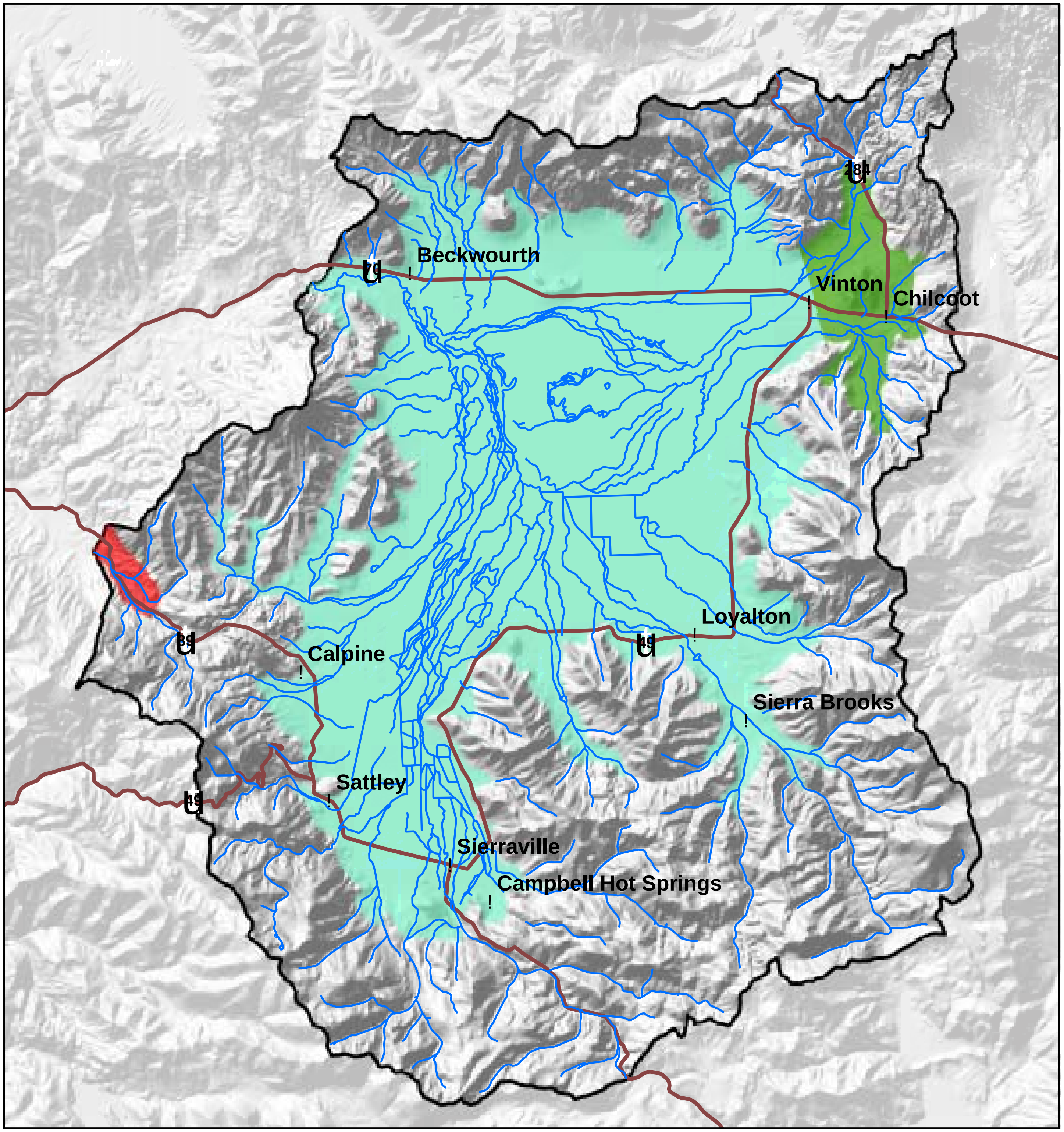


Figure 4-5
Groundwater Basins
Sierra Valley Watershed

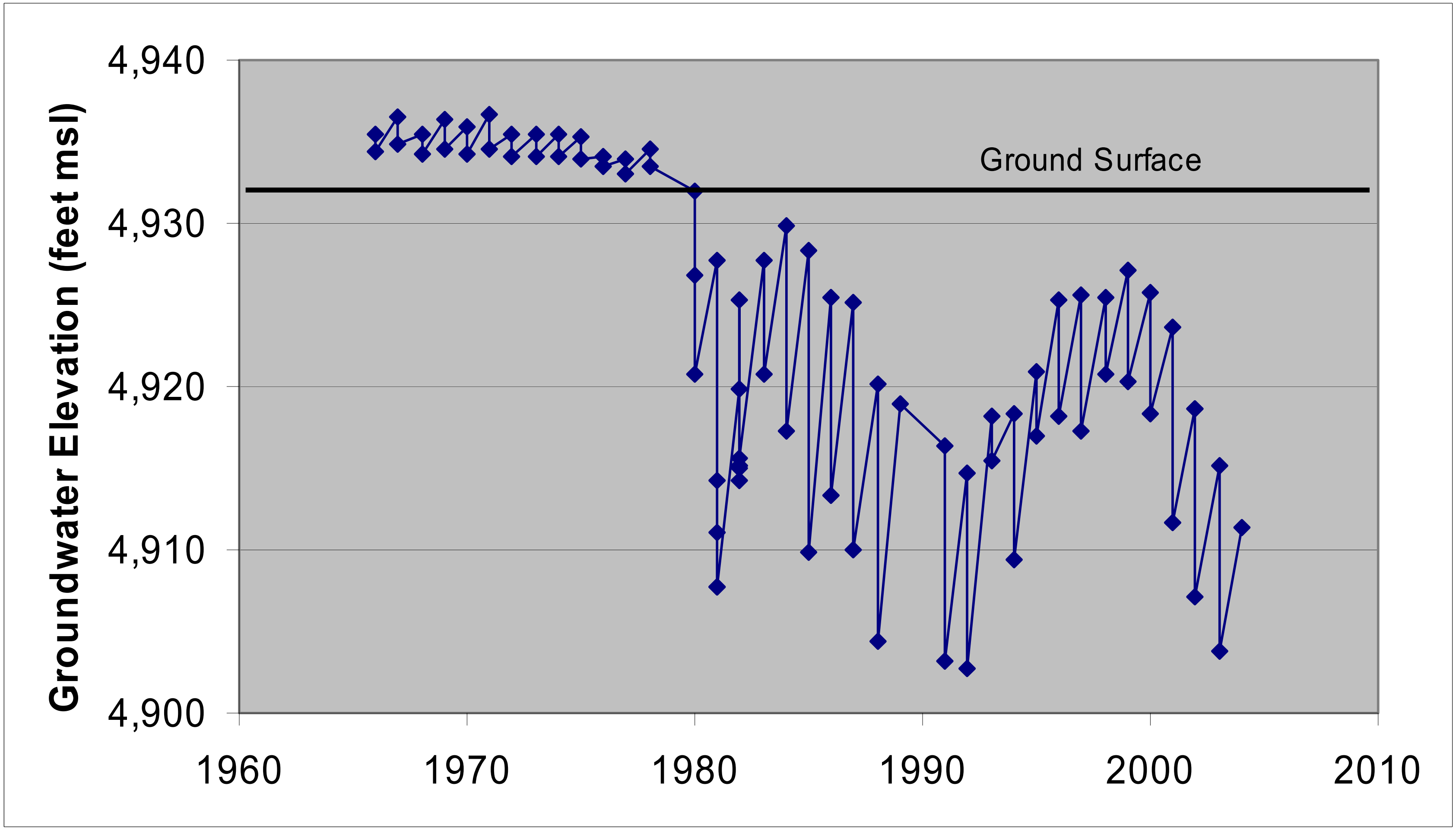
Legend

- Rivers and Streams
- State Highways
- Sierra Valley Watershed
- Mohawk Valley
- Sierra Valley - Chilcoot
- Sierra Valley

SOURCE: DWR, 2003

0 1.25 2.5 5 Miles

VESTRA



VESTRA

FIGURE 4-6
TYPICAL HYDROGRAPH
WELL # 22N16E04A01M
SIERRA VALLEY WATERSHED

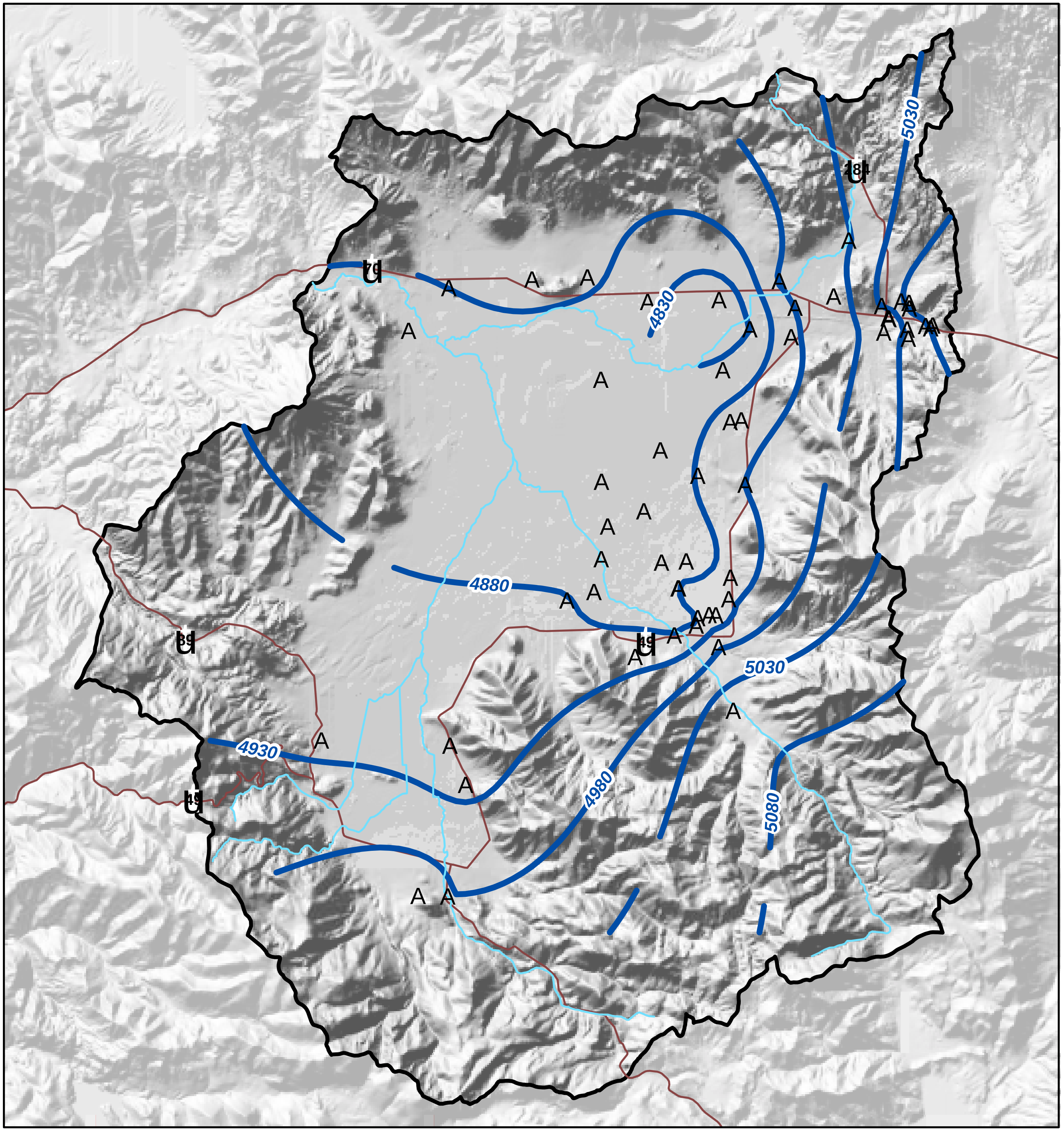


Figure 4-7
Fall 1999
Groundwater Contours
Sierra Valley Watershed

Legend

- State Highway
- Major Tributary
- Sierra Valley Watershed
- Fall 1999 Groundwater Contour
- A Fall 1999 Monitoring Well

SOURCE: DWR, 2004

0 1.25 2.5 5 Miles

VESTRA

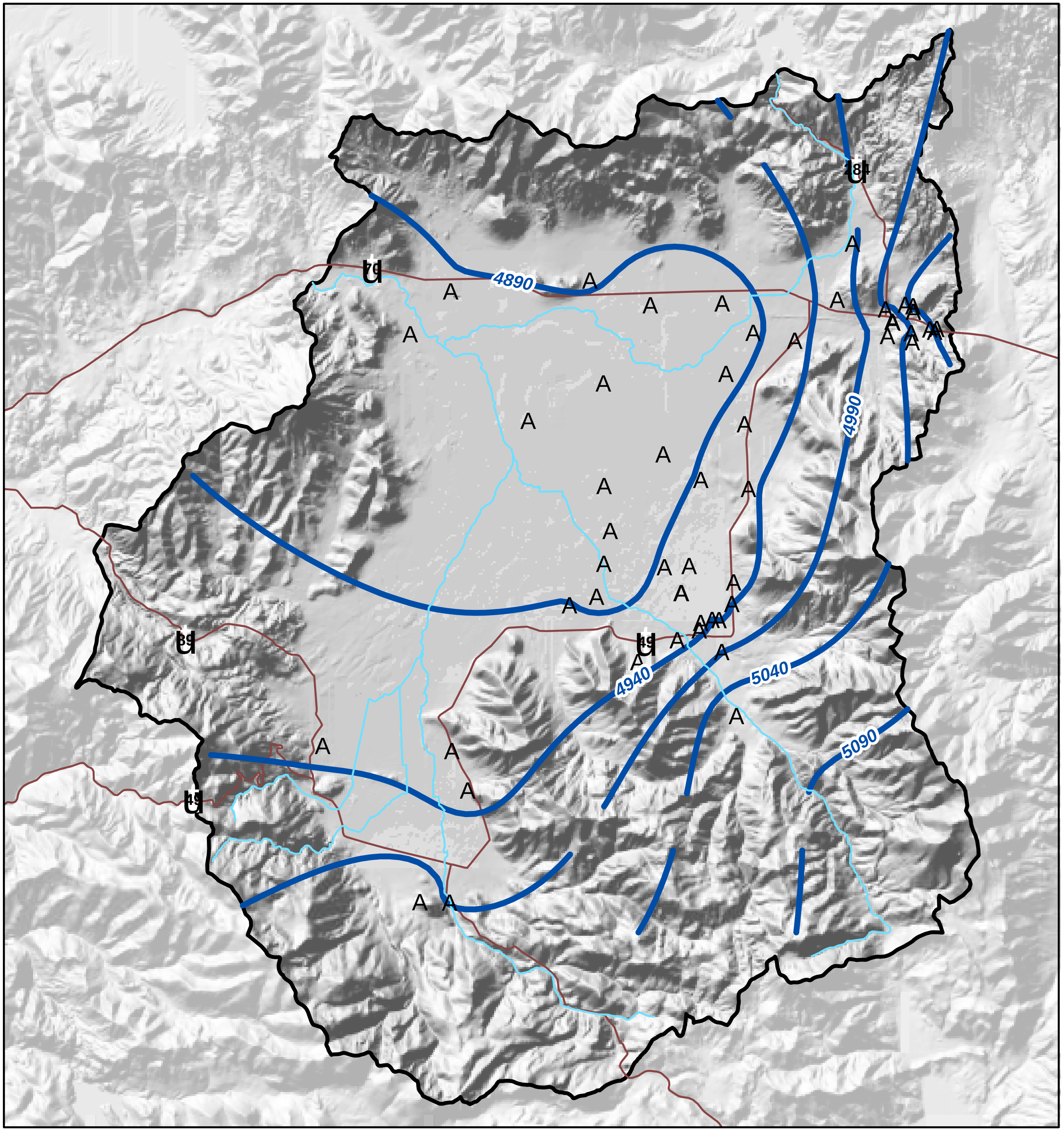


Figure 4-8
Spring 2000
Groundwater Contours
Sierra Valley Watershed

Legend

- State Highway
- Major Tributary
- Sierra Valley Watershed
- Spring 2000 Groundwater Contour
- A Spring 2000 Monitoring Well

SOURCE: DWR, 2004

0 1.25 2.5 5 Miles

VESTRA

®

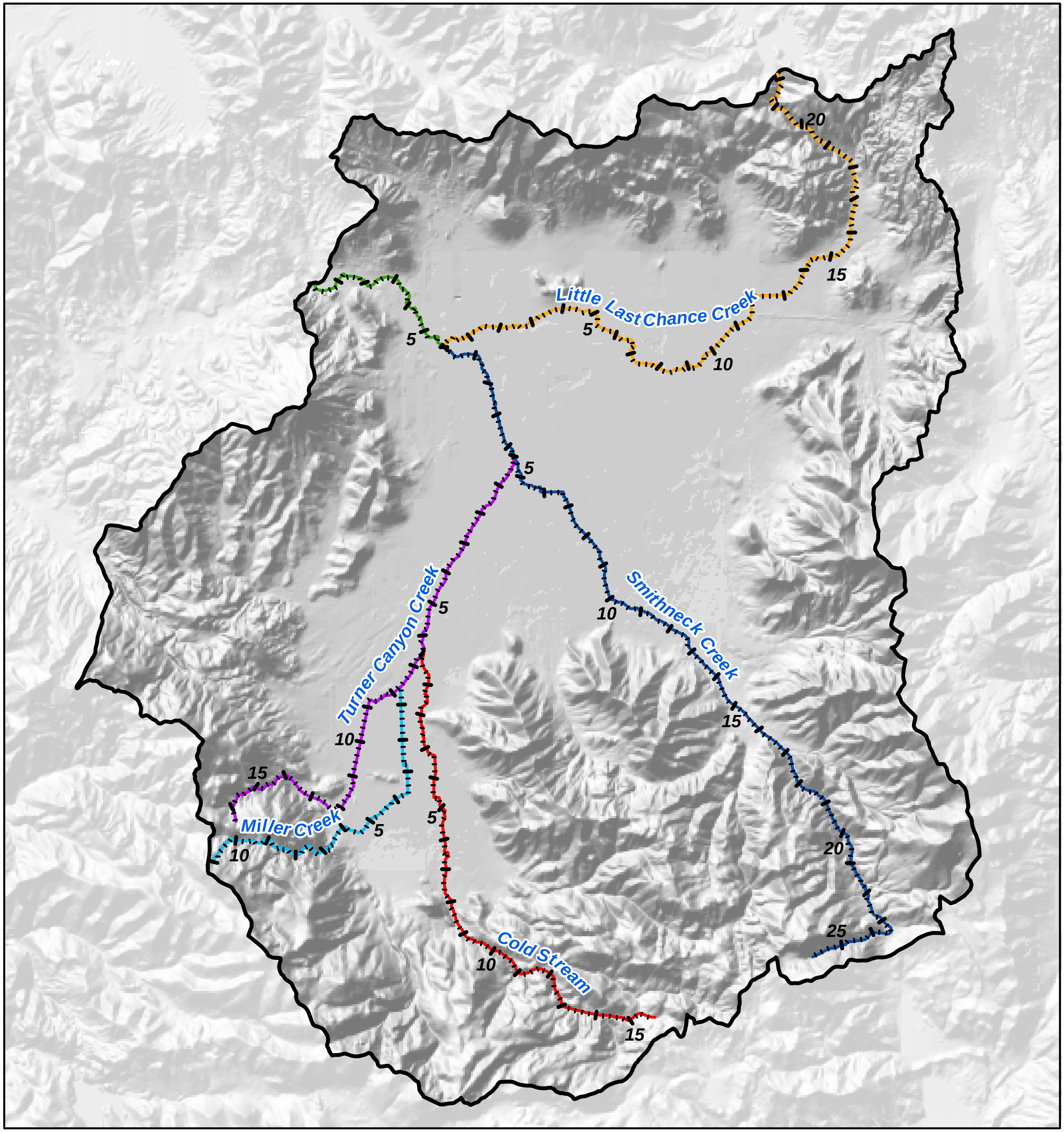


Figure 4-9
Stream Miles
Sierra Valley Watershed

Legend

- Sierra Valley Watershed
- Cold Stream
- Little Last Chance Creek
- Middle Fork Feather River
- Miller Creek
- Smithneck Creek
- Turner Canyon Creek

* Each hatch represents 0.2 miles

VESTRA

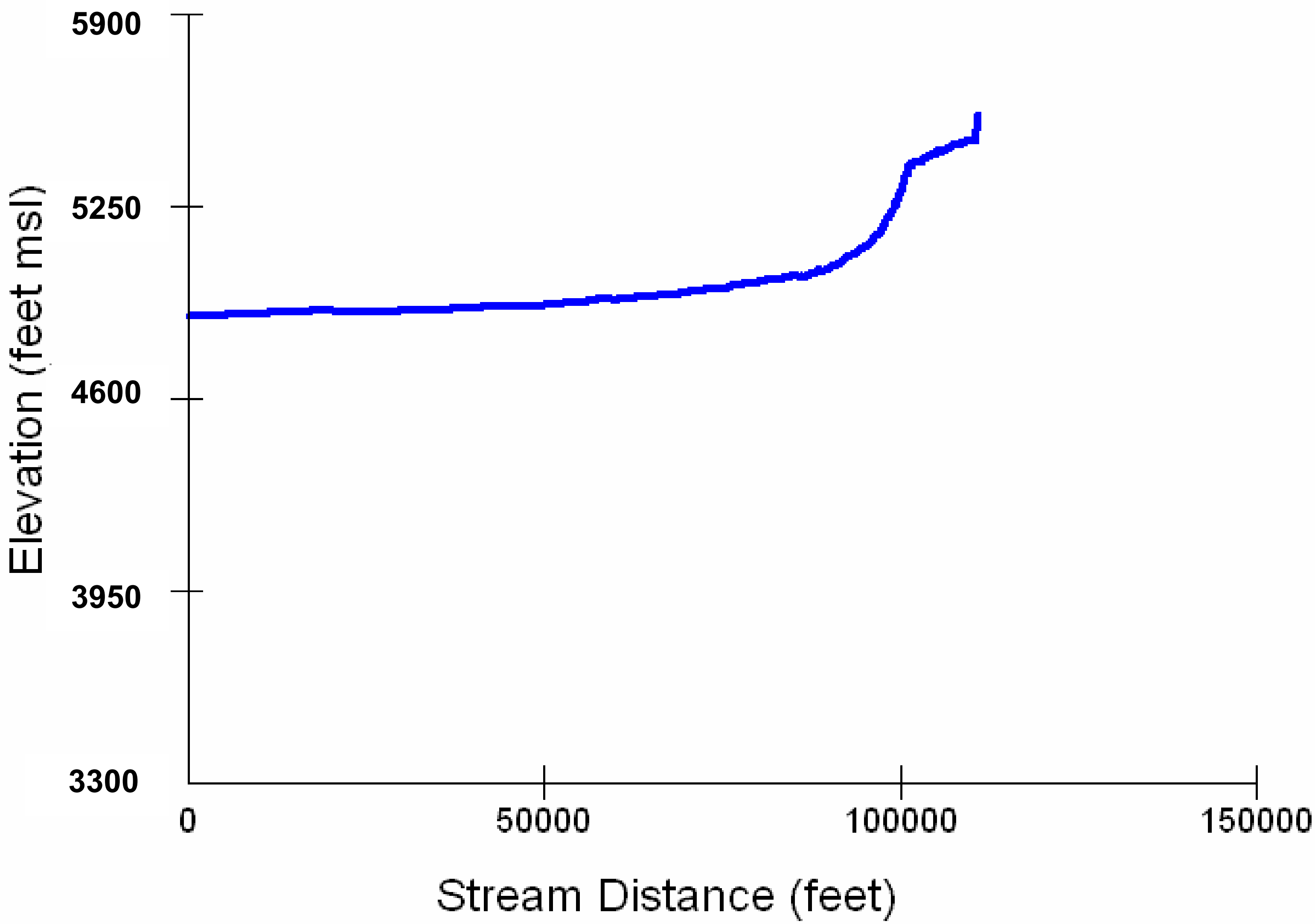


FIGURE 4-10a
LITTLE LAST CHANCE CREEK LONGITUDINAL PROFILE
SIERRA VALLEY WATERSHED

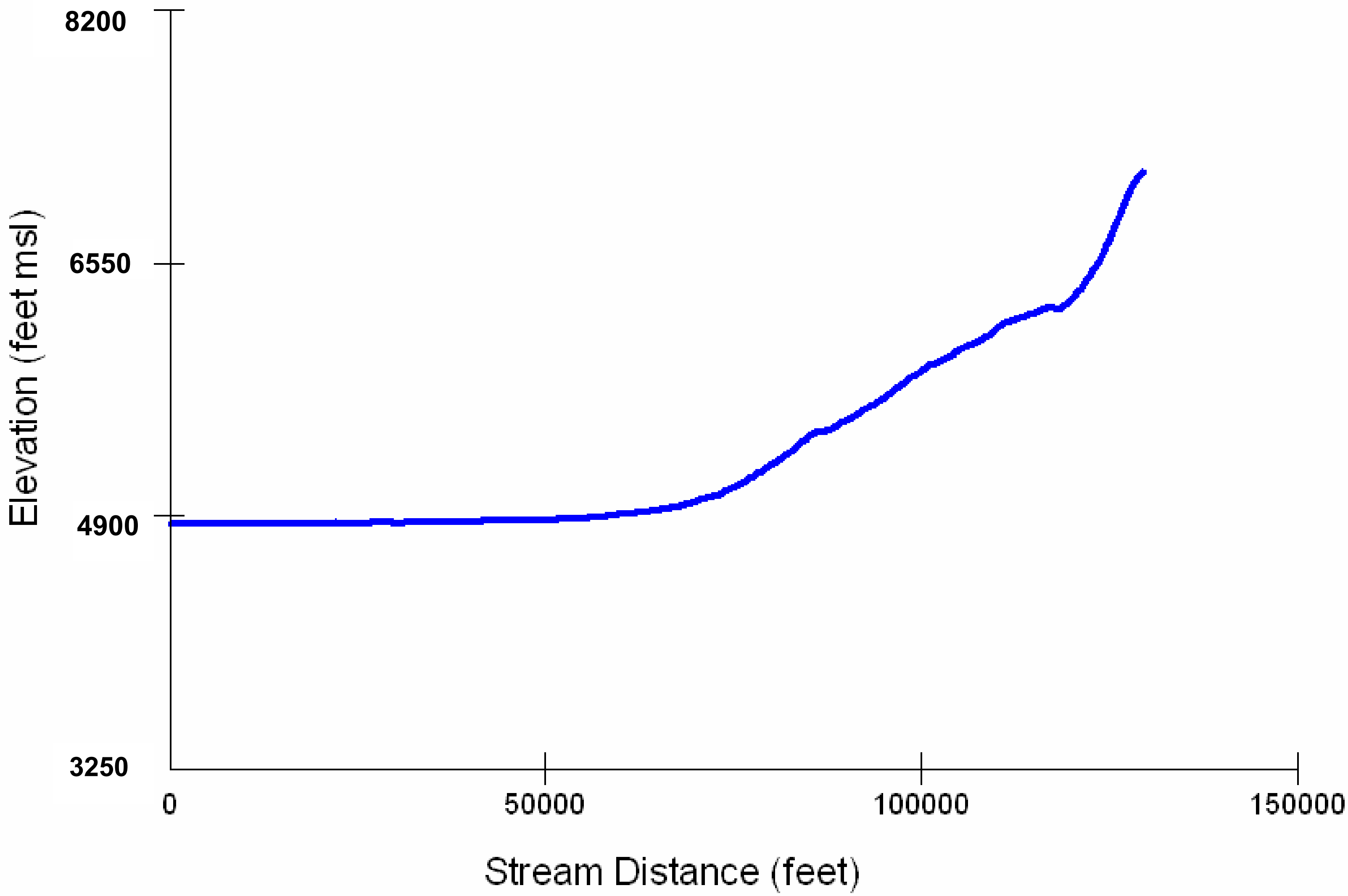
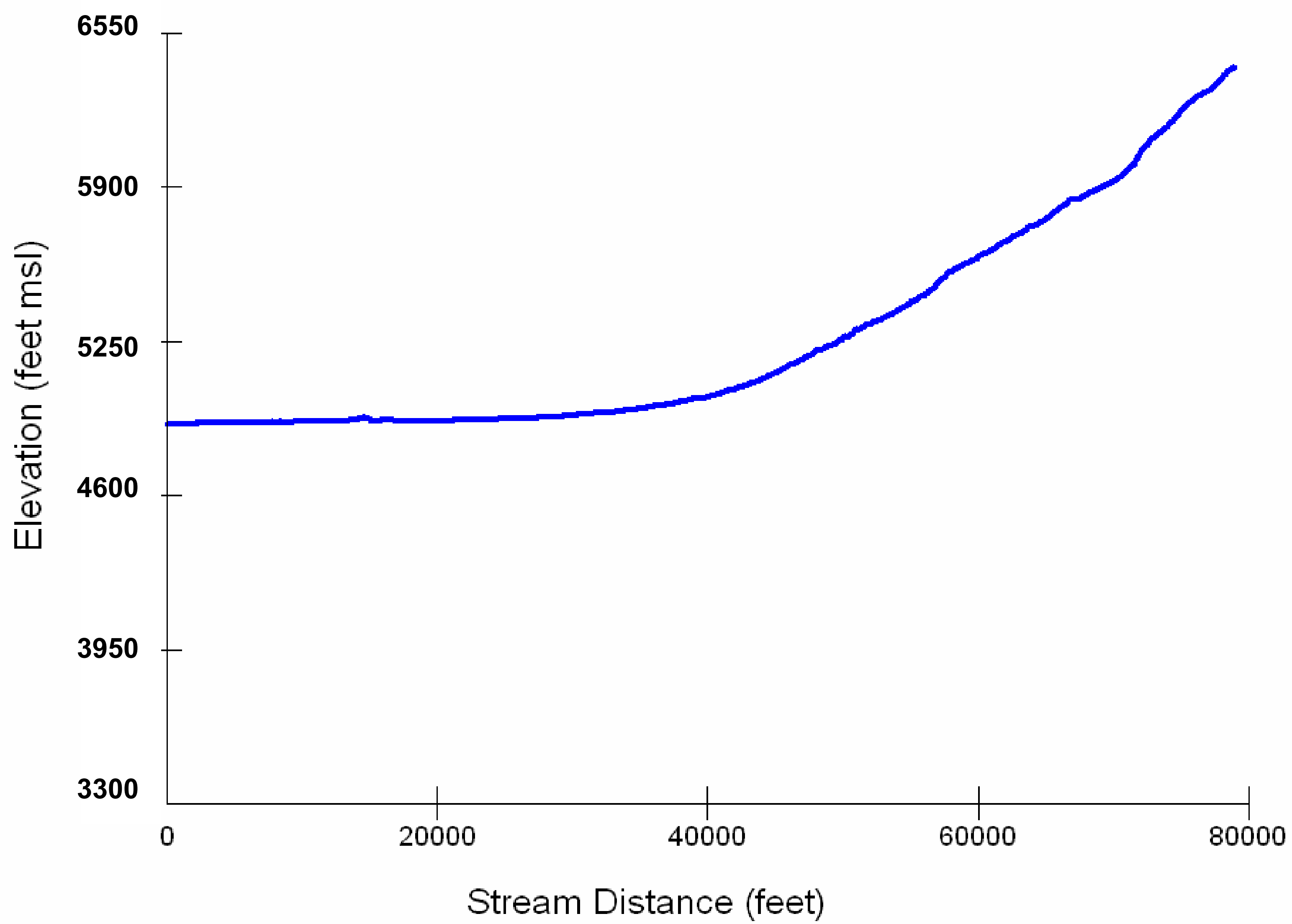
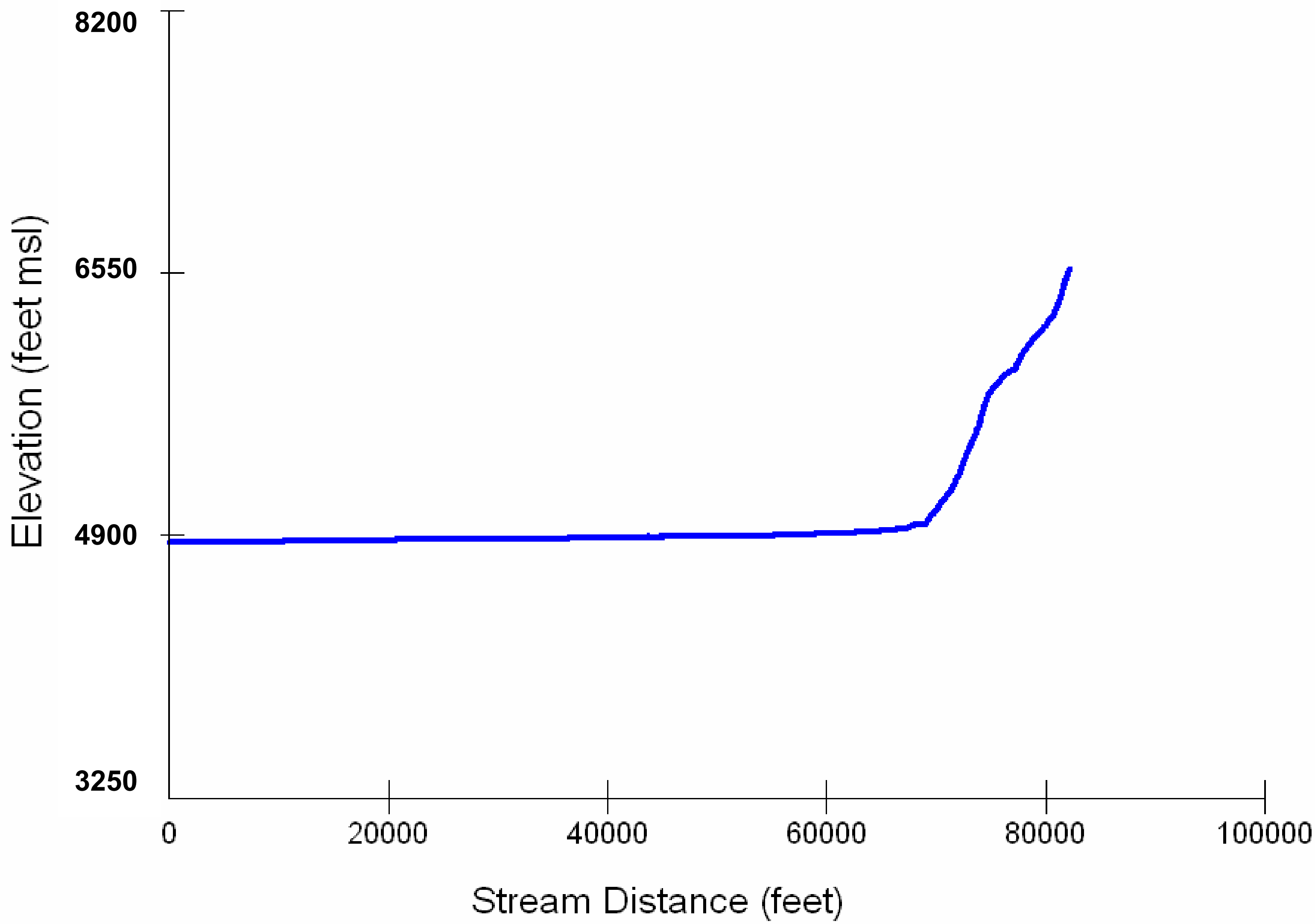


FIGURE 4-10b
SMITHNECK CREEK LONGITUDINAL PROFILE
SIERRA VALLEY WATERSHED



VESTRA

FIGURE 4-10c
COLD STREAM LONGITUDINAL PROFILE
SIERRA VALLEY WATERSHED



VESTRA

FIGURE 4-10d
TURNER CANYON CREEK LONGITUDINAL PROFILE
SIERRA VALLEY WATERSHED

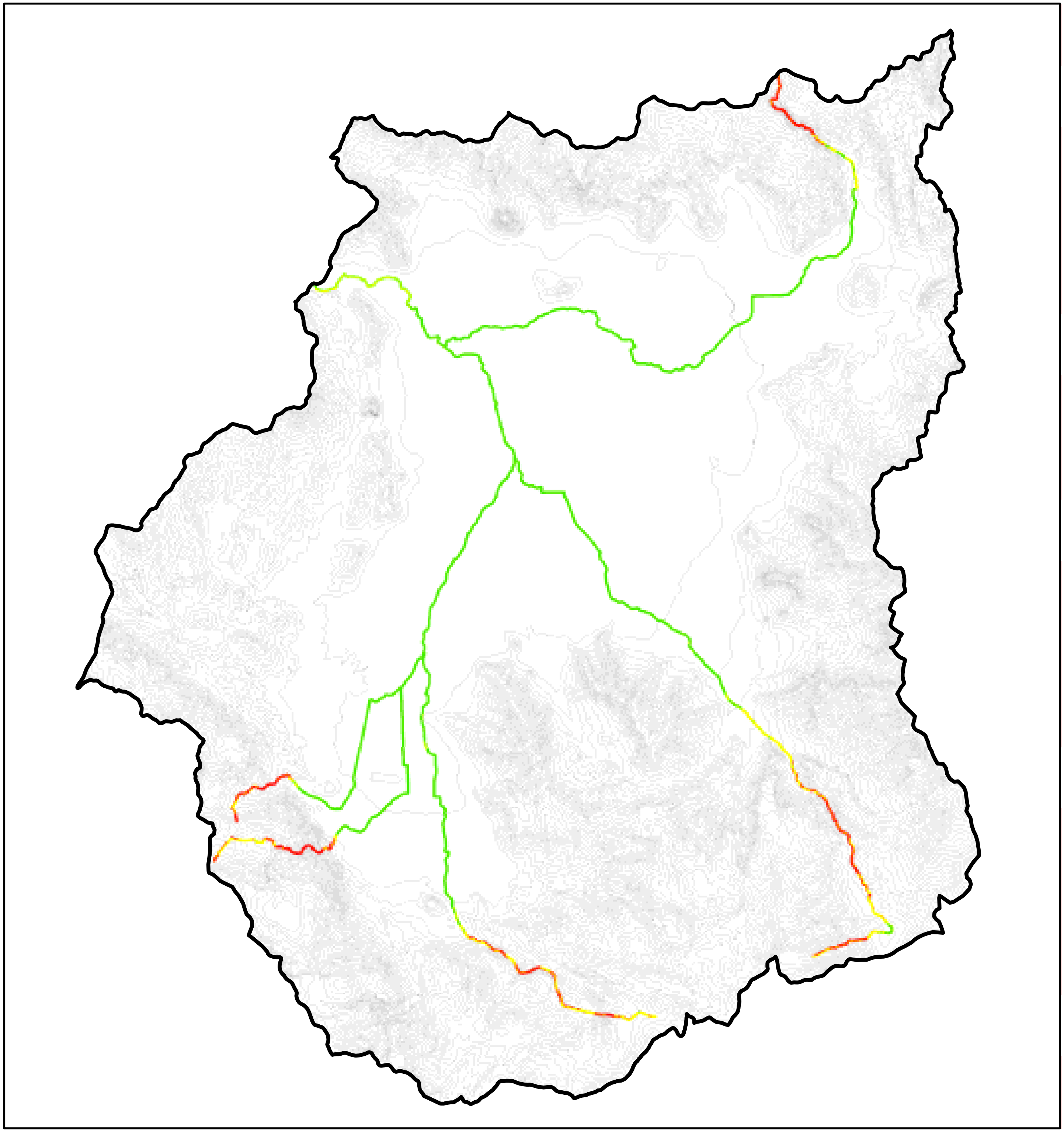


Figure 4-11
Channel Network with Response Potential Types Sierra Valley Watershed

Legend

- Sierra Valley Watershed
- Response (< 3% slope)
- Transport (3 - 20% slope)
- Source (> 20% slope)

0 1.25 2.5 5 Miles

VESTRA

®

Section 5

Section 5
WATER QUALITY

TABLES

FIGURES

Section 5
WATER QUALITY

DATA SOURCES

Quality and availability of water have been primary concerns in the Sierra Valley for some time. Studies of surface water and groundwater have been completed by various agencies. Sources of water quality data used for this section include information from the State Water Resources Control Board (SWRCB), Regional Water Quality Control Board (RWQCB), United States Geological Survey (USGS), California Department of Water Resources (DWR), Feather River Coordinate Resource Management Group (FRCRM), and the California Department of Pesticide Regulation (DPR).

WATER QUALITY STANDARDS

Section 303 of the Clean Water Act (CWA), 33 U.S.C. §1313, provides for promulgation of water quality standards by states. The standards consist of designating uses of water and developing water quality criteria based on the designated uses (40 CFR §131.3(i)). The criteria are "elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use" (40 CFR §131.3(b)). Water quality standards for the Sierra Valley Watershed are presented in the Water Quality Control Plan for the Sacramento and San Joaquin River Basin.

The CWA requires states to protect beneficial uses of waters of the United States within their jurisdictional boundaries. The USEPA regulations to implement the CWA further require states to adopt water quality criteria (referred to as "objectives" in California) that protect the designated "beneficial uses" of water bodies. The designated beneficial uses, the water quality criteria to protect those uses, and an anti-degradation policy constitute water quality standards.

A water quality standard defines the water quality goals for a water body, or portion thereof (in part), by designating the beneficial use or uses to be made of the water. States adopt water quality standards to protect public health or welfare, enhance the quality of water, and serve the purposes of the CWA. "Serve the purposes of the Act" (as defined in Sections 101 (a) (2) and 303 (c) of the CWA) means that water quality standards should, at a minimum:

- Provide, wherever attainable, water quality for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water. This goal is commonly restated as the water should be "fishable and swimmable."

- Consider the use and value of State waters for public water supplies, propagation of fish and wildlife, recreation, agriculture, and industrial purposes, and navigation.

Basin Plans consist of a designation or establishment for the waters within a specified area of beneficial uses to be protected, water quality objectives to protect those uses, and a program of implementation needed for achieving the objectives. State law also requires that Basin Plans conform to the policies set forth in the Water Code beginning with Section 13000 and any state policy for water quality control. Since beneficial uses, together with their corresponding water quality objectives, can be defined per federal regulations as water quality standards, the Basin Plans are considered regulatory references for meeting state and federal requirements for water quality control (40 CFR 131.20).

A Basin Plan must identify all of the following (Water Code Section 13240–13244):

- Beneficial uses to be protected
- Water quality objectives
- Program of implementation needed for achieving water quality objectives
- Surveillance and monitoring to evaluate the effectiveness of the program

Basin Plans are adopted and amended by the RWQCB using a structured process involving peer review, public participation, state environmental review, and state and federal agency review and approval.

The Basin Plan for the Sacramento and San Joaquin River Basin, which includes the Sierra Valley Watershed, was first adopted in 1975. In 1989, a second edition was published. The second edition incorporated all the amendments which had been adopted and approved since 1975, updated the Basin Plan to include new state policies and programs, restructured and edited the Basin Plan for clarity, and incorporated the results of triennial reviews conducted in 1984 and 1987. In 1994 a third edition was published incorporating all amendments adopted since 1989, including new state policies and programs, restructuring and editing the Basin Plan to make it consistent with other regional and state plans, and substantively amending the sections dealing with beneficial uses, objectives, and implementation programs. The current edition, or fourth edition, incorporates two new amendments adopted since 1994. One amendment deals with compliance schedules in permits and the other addresses agricultural surface drainage discharges.

The CWA establishes a goal that, where attainable, all waters will be "fishable-swimmable" (CWA Section 101(a)(2)). In implementing this goal, USEPA requires that states designate all waters as "fishable-swimmable." In addition to the mandatory beneficial use protections, the CWA also requires the identification of other beneficial uses to be protected. To develop water quality standards, states first identify all attainable uses of a water body. Examples of such uses include aesthetic enjoyment, fishing, swimming, and protection of aquatic life and wildlife. States then adopt water quality standards for individual designated uses. Uses may be designated as either existing, or potential future uses. An existing use is any use that has existed in the stream at any time since November 28, 1975 (40 CFR 131.3). A potential use is a use that may or may not have existed in the water body since November 28, 1975.

Water Quality objectives are set in the Basin Plans and are the combination of beneficial uses and criteria to protect the identified use. The Porter-Cologne Water Quality Control Act defines water quality objectives as "the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area" (Water Code Section 13050(h)). In establishing water quality objectives, the RWQCB considers, among other things, the following factors:

- Past, present, and probable future beneficial uses

- Environmental characteristics of the hydrographic unit under consideration, including the quality of water available

- Water quality conditions that could reasonably be achieved through the coordinated control of all factors, that affect water quality in the area

- Economic considerations

- The need for developing housing within the region

- The need to develop and use recycled water

As noted earlier, California water quality standards include the designation and protection of beneficial uses and the water quality objectives adopted to protect these uses.

Beneficial Uses

Beneficial use designations are the foundation of water quality management strategies in California. State law defines beneficial uses of California's waters that may be protected against quality degradation to include (and not be limited to) "domestic; municipal; agricultural and industrial supply and power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves" (Water Code Section 13050(f)). Protection and enhancement of existing and potential beneficial uses are primary goals of water quality planning.

Significant points concerning the concept of beneficial uses are the following:

- All water quality problems can be stated in terms of whether there is water of sufficient quantity or quality to protect or enhance beneficial uses.

- Beneficial uses do not include all of the reasonable uses of water. For example, disposal of wastewaters is not included as a beneficial use. This is not to say that disposal of wastewaters is a prohibited use of waters of the State; it is merely a use that cannot be satisfied to the detriment of beneficial uses. Similarly, the use of water for the dilution of salts is not a beneficial use although it may, in some cases, be a reasonable and desirable use of water.

- The protection and enhancement of beneficial uses require that certain quality and quantity objectives be met for surface and ground waters.

- Fish, plants, and other wildlife, as well as humans, use water beneficially.

Designated Uses

Designated beneficial uses of the surface waters in Sierra Valley are the following:

- Agriculture: Irrigation and Stock Watering
- Recreation Contact: Canoeing and Rafting, and Other Noncontact
- Freshwater Habitat: Warm and Cold
- Spawning: Cold
- Wildlife Habitat

Agriculture (AGR)
Uses of water for farming, horticulture, or ranching include, but are not limited to, irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing.

Water Contact Recreation (REC-1)
Uses of water for recreation activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, waterskiing, skin and scuba diving, surfing, whitewater activities, fishing, or use of natural hot springs.

Non-contact Water Recreation (REC-2)
Uses of water for recreation activities involving proximity to water but where there is generally no body contact with water nor any likelihood of ingestion of water. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

Warm Freshwater Habitat (WARM)
Uses of water that support warm-water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates. (Resident does not include anadromous.)

Cold Freshwater Habitat (COLD)
Uses of water that support cold-water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates. (Resident does not include anadromous.)

Spawning, Reproduction, and/or Early Development (SPWN)
Uses of water that support high-quality aquatic habitats suitable for reproduction and early development of fish (salmon and steelhead only).

Wildlife Habitat (WILD)
This includes uses of water that support terrestrial or wetland ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources (Water quality control Plan [Basin-Plan] for the RWQCB Central Valley Region 1998).

Numeric and Narrative Water Quality Standards

Numeric and narrative Water Quality Standards have been developed to protect the beneficial uses identified. These are presented in the Basin Plan document and other planning documents prepared by the RWQCB or SWRCB.

Temperature
Temperature objectives for COLD interstate waters, WARM interstate waters, and Enclosed Bays and Estuaries are specified in the Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays of California including any revisions. There are also temperature objectives for the Delta in the SWRCB's May 1991 Water Quality Control Plan for Salinity. Narrative temperature objectives include the following:

- The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the RWQCB that such alteration in temperature does not adversely affect beneficial uses.

- At no time or place shall the temperature of COLD or WARM intrastate waters be increased more than 5ºF above natural receiving water temperature. In determining compliance with the water quality objectives for temperature, appropriate averaging periods may be applied provided that beneficial uses will be fully protected.

Dissolved Oxygen
For surface water bodies outside the legal boundaries of the Delta, the monthly median of the mean daily dissolved oxygen concentration shall not fall below 85 percent of saturation in the main water mass, and the 95-percentile concentration shall not fall below 75 percent of saturation. The dissolved oxygen concentrations shall not be reduced below the following minimum levels at any time:

- Waters designated WARM 5.0 milligrams per liter (mg/l)
- Waters designated COLD 7.0 mg/l
- Waters designated SPWN 7.0 mg/l

Nutrients (Biostimulatory Substances)
Water shall not contain biostimulatory substances that promote aquatic growths in concentrations that cause nuisance or adversely affect beneficial uses.

Turbidity
The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.
Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases in turbidity attributable to controllable water quality factors shall not exceed the following limits:

- Where natural turbidity is between 0 and 5 Nephelometric Turbidity Units (NTUs), increases shall not exceed 1 NTU

- Where natural turbidity is between 5 and 50 NTUs, increases shall not exceed 20 percent

- Where natural turbidity is between 50 and 100 NTUs, increases shall not exceed 10 NTUs

- Where natural turbidity is greater than 100 NTUs, increases shall not exceed 10 percent

In determining compliance with the above limits, appropriate averaging periods may be applied provided that beneficial uses will be fully protected. Exceptions to the above limits will be considered when a dredging operation can cause an increase in turbidity. In those cases, an allowable zone of dilution within which turbidity in excess of the limits may be tolerated will be defined for the operation and prescribed in a discharge permit.

Specific numeric limits are also identified in the Policy for Implementation of Toxic Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California.

PAST STUDIES

USGS 1970-1971

The USGS conducted a water quality survey of the Middle Fork Feather River from May 1970 to September 1971. USGS sample locations are shown on Figure 5-1. The study included sampling at four primary sites correlated with gaging stating locations and 38 additional sites located from Sierra Valley to Merimac.

The upper most primary site was located between Beckwourth and Portola (site 9) outside of the Sierra Valley Watershed. This site however, provides a good indication of trends in water quality of the Feather River as it leaves Sierra Valley. The additional sites within to the watershed are shown on Table 5-1.

Table 5-1
USGS SAMPLE LOCATIONS

Site ID	Name/Location	River Distance (in miles upstream from 900-foot altitude)
1-T	Little Last Chance Creek	97.9
2	Middle Fork Feather River at Summit School	91.9
3	Middle Fork Feather River at Sierra Valley	88.3
4	Middle Fork Feather River at Marble Lane	83.1
5-T	Tributary to Middle Fork Feather River at Marble Lane	---
6-T	Tributary to Middle Fork Feather River at Marble Lane, near Marble Springs	---
7	Middle Fork Feather River at Beckwourth	79.4
8-T	Grizzly Creek near mouth	---

Various physical, chemical, and microbiological measurements indicated that the water quality in the reach of the Feather River from Sierra Valley to Merimac were generally good and met recommended criteria for most freshwater organisms and for recreational use. Water quality in the upper reach of the river, just downstream from Sierra Valley, was reported as less desirable; turbidity and color especially were reported to have rendered the water a esthetically less pleasing in this reach. Water quality improved downstream owing to dilution by better quality water inflowing from tributaries (USGS 1973).

Data for the eight sites within Sierra Valley are summarized on Table 5-2.

Table 5-2
USGS WATER QUALITY DATA SUMMARY

*ID	Avg. Water Temp C˚)	pH	Specific Conductance	Dissolved Oxygen	JTU
1-T	9.8	7.6	113	9.0	1
2	15.8	7.3	145	7.1	3
3	18.8	7.9	159	8.2	4
4	20.5	8.3	173	7.6	10
5-T	20.6	7.2	135	5.0	4
6-T	19.3	7.1	123	5.1	3
7	20.5	7.3	168	5.0	10
8-T	21.2	7.6	106	7.7	1

*The USGS study had 35 sample locations, but only eight are in the watershed boundary. Results are averages of samples taken during the entire length of the study.

DWR 1972-1973

DWR and United States Forest Service (USFS) conducted a surface water survey during the fall of 1972 and the spring of 1973. The purpose of the survey was to summarize the present surface water quality in Sierra Valley. Field test parameters at selected surface water locations included temperature, pH, electrical conductance (EC), and dissolved oxygen (DO). Figure 5-1 shows the DWR sample locations.

The sampling sites were selected primarily to give an overview of the basin quality. In the study area, access was also a major consideration in locating sampling points. Every effort was made to locate the sampling points near road crossings or where roads were nearest to the streams.

The study found that the Middle Fork Feather River and its tributaries in the Sierra Valley generally are of good quality for most beneficial uses. The water is of calcium-magnesium bicarbonate type and generally alkaline. Hardness ranged from soft to moderately hard. Low readings of DO were observed in surface waters in the valley floor and in the Feather River below Beckwourth.

FRCRM 2000-2002

The FRCRM Watershed Monitoring Program conducted field monitoring of surface water in the Feather River from October 1, 2000 to December 30, 2001. This study provides the only recent water quality data for Sierra Valley. The FRCRM is an alliance of 21 natural resource management agencies, local landowners, and public and private sector groups working towards restoration of the Feather River watershed. The FRCRM was awarded a Clean Water Act 319 (h) grant in 1998 to develop a two-year water monitoring pilot program in the upper Feather River. The goal of the program is to identify and evaluate long term trends in watershed condition resulting cumulatively from restoration activities, land management changes, and natural processes.

The monitoring approach consisted of three basic components that vary in scale, parameters, and sampling interval. They include:

- Continuous monitoring of temperature and surface flow at eight continuous recording stations located strategically in the watershed. Collect continuous turbidity data at two locations to evaluate the effectiveness of two types of instruments. Collect bedload and suspended sediment samples for flow conditions.

- Biannual monitoring of 21 designated reference reaches that include selected physical and biological parameters. Measurements include stream morphology, water chemistry, habitat of macro-invertebrates, and fisheries, and basically follow protocols established by the USFS.

- Assess the current state of the watershed in order to produce a "snapshot" of baseline water condition prior to initiating the monitoring program.

The selected monitoring strategy was based on the Stream Condition Inventory Protocol described by the USFS with some modification. The program is integrated with other ongoing river monitoring activities conducted by federal and state agencies and citizens. A technical subcommittee composed of FRCRM committee members, agency specialists, and academic reviewers provide technical guidance on implementation of the program. The monitoring program looked at four different stream systems: Indian and Spanish Creeks (East Branch North Fork Feather River), North Fork Feather River, and the Middle Fork Feather River. Sierra Valley is located in the Middle Fork Feather River watershed. Online monitoring data is included on the Feather River Coordinated Resource Management's Website, http://www.feather-river-crm.org/monitoring.html.

The only sampling station in Sierra Valley was located at Beckwourth. The study summarized the condition of water quality at the Beckwourth sampling station as follows.

> "Geomorphic parameters were mostly ambiguous at this site. However, some trends did show that pebbles coarsened, and that the channel is imperceptibly increasing in entrenchment, with a deepening average bankfull depth, and max bankfull depth increasing at cross-sections 1 and 3, all of which could indicate a declining trend, and at least warrant further monitoring. Slope is only graphed

from the 1999 survey, because water surface elevations were not available due to a dry channel in 2001 and 2003. When there is water in the channel, it is marginal for trout. Presumably because of the low flow, this site had the worst overall water quality. It had the highest TDS and EC, and was five times higher in phosphorus than the next highest site. It also had the highest ammonia, and second highest nitrate/nitrite. It had the highest concentration of Al, Cd, Cr, Fe, Pb, and Zn; second highest in Se and Cu; third highest in As; and fourth highest in Hg and Mn. It was not sampled in September 2003 but had the highest fecal coliform in 2001. Again, due to the lack of continuous surface water, there has not been a fish survey at this site, and macros were only collected in 1999 (FRCRM 2003)."

The results from samples taken June 20, 2001, 7:00AM, at the Middle Fork Feather River, Beckwourth are included in Table 5-3.

Table 5-3
RESULTS FROM FRCRM SAMPLING
BECKWOURTH STATION, JUNE 20, 2001

Sample Type	Result	Units
Temperature	55.6	°F
Dissolved Oxygen	5.5	ppm
PH	8	PH
Turbidity	26	NTU
EC	271	umhoms/cm
Alkalinity	126	mg/l
Total Suspended Solids	22	mg/l
Total Dissolved Solids	192	mg/l
Nitrate/Nitrite	0.11	mg/l
Ammonia	0.2	mg/l
Orthophosphate	0.01	mg/l
Total Phosphorus	0.81	mg/l
Fecal Coliform	302	Colonies
Aluminum	2390	ug/l
Arsenic	2.32	ug/l
Cadmium	0.0038	ug/l
Chromium (total)	1.09	ug/l
Copper	2.85	ug/l
Iron	2640	ug/l
Lead	0.961	ug/l
Magnesium	58.3	ug/l
Mercury	2.16	ug/l
Nickel	0.65	ug/l
Selenium	0.22	ug/l
Vanadium	0.0008	ug/l
Zinc	5.06	ug/l

WATER QUALITY SUMMARY

The results of these three studies are summarized in the following sections.

Temperature

Water temperature is a fundamental parameter of water quality and an integral component of aquatic habitat. Chronic and significant water temperature exceedances above natural variability of a stream are likely to impact aquatic biota (Haynes, 1970 and Beschta et al., 1987). Furthermore, elevated temperatures can trigger conditions that affect other water quality parameters such as dissolved oxygen. Natural watershed parameters that impact stream temperature include (WFP, 1997):

- **Geography** (latitude, longitude, elevation)
- **Climate** (air temperature, relative humidity, wind velocity and cloudiness)
- **Stream Channel Characteristics** (stream depth, width, velocity, substrate composition and water clarity)
- **Riparian or Topographic Blocking** (percent shade, canopy, vegetation height, crown radius and topographic angle.)
- **Water Source** (mountain streams, low elevation runoff or groundwater)

Physical conditions in Sierra Valley that impact water temperatures include low flows, shallow slow moving water, and largely unvegetated stream banks. Because the Feather River meanders though the open valley at a low gradient, it is subject to warming by solar radiation.

This is verified by air temperature vs. water temperature data for the FRCRM station at Beckworth, plotted on Figure 5-2 that shows the interaction of air temperature on water temperature.

Many chemical, physical, and biological properties of water are functions of, or are related to, temperature. Temperature has an effect on the ability of water to absorb gases, such as, oxygen, nitrogen, and carbon dioxide. The warmer the water, the less gas it can absorb. Warmer water also increases microbial activities and can affect the oxygen demand of the system as well as the growth of algae populations. Warmer water temperatures may also have a harmful effect on aquatic life. The maximum temperatures that adult fish can tolerate vary with the species of fish, prior acclimatization, oxygen availability, and the combined effects of other pollutants.

The temperature in the main stem of the Feather River in Sierra Valley is anticipated to be affected by precipitation, snow melt and runoff as well as air temperature. This is shown in previous studies conducted in the valley.

pH

Generally speaking, the pH of water describes its place on an acidity alkalinity scale, which ranges from 0.0 to 14.0, with 7.0 being the neutral point. A reading below 7.0 indicates acidic water, whereas a reading above this value indicates alkaline water. The greater the departure of the pH value from the neutral value (7.0), the greater is the capability for an acidic or alkaline reaction. In most cases, the waters of the Sierra Valley are alkaline, generally having a pH between 6.5 and 8.5. This is not a serious departure from neutral, and no problems are indicated.

Specific Conductance

Specific conductance is a measure of the ability of a solution to conduct an electrical current, which in the case of water, can be related to the concentration of dissolved solids. Conductance is a particularly convenient determination because it can be determined fairly accurately in the field with portable instruments. Since conductance is a good indicator of the mineral quality of the water, a change in conductance between sampling dates is an indication that the mineral quality has changed.

The specific conductivity of samples taken in the Sierra Valley was found to consistently fall within the Class I category for irrigation water. To be considered Class I irrigation water, excellent to good, water should have a conductance of less than 750 mmhos/cm. The highest conductance measured was 360 mmhos/cm at the Middle Fork Feather River near Beckwourth with an average reading of 134 mmhos/cm throughout the Sierra Valley Watershed. Table 5-4 shows the irrigation water classifications based on conductivity.

Table 5-4
IRRIGATION WATER CLASSIFICATIONS BASED ON CONDUCTIVITY

Classes of water	Electrical Conductivity (dS/m) [1]
Class 1, Excellent	≤0.25
Class 2, Good	0.25–0.75
Class 3, Permissible[2]	0.76–2.00
Class 4, Doubtful[3]	2.01–3.00
Class 5, Unsuitable[3]	≥3.00

1dS/m at 25ºC = mmhos/cm
[2]Leaching needed if used
[3]Good drainage needed and sensitive plants will have difficulty obtaining stands
Source: Bauder et al 2003

Dissolved Oxygen

In water, dissolved oxygen (DO) is necessary for the support of most forms of aquatic life. There is generally not much concern about a surplus of DO, but only with a deficiency. The content of DO in water at equilibrium with a normal atmosphere is dependent on the temperature and salinity of the water. The ability of the water to hold oxygen decreases with increases in temperature or dissolved solids.

Fish and other aquatic organisms require DO to survive. As water moves past gills or other breathing apparatus, microscopic bubbles of DO are transferred from the water into to their blood by diffusion. Like other diffusion processes, however, the transfer is more efficient above certain concentrations. In other words, although DO may be present, concentrations may be insufficient to fully support aquatic life. Table 5-5 shows the dissolved oxygen process.

Table 5-5
DISSOLVED OXYGEN PROCESS

Mechanism	Seasonal		Diurnal	
	Winter	**Summer**	**Day**	**Night**
Rate DO is produced through photosynthesis	Lower	Higher	Higher	Lower
Rate DO is consumed through respiration	Lower	Higher	Higher	Lower
Solubility of oxygen in water	Higher	Lower	Lower	Higher
Dominant mechanism controlling DO concentration	Solubility		Photosynthesis	

Dissolved oxygen concentrations sufficient to fully support aquatic life depend on the organism and other parameters such as physical condition, water temperature, and presence of other chemicals or pollutants. Consequently, it is difficult to designate minimum DO concentrations for individual fish and other aquatic species. For example, at 41ºF, trout require about 50 to 60 milligrams (mg) of oxygen per hour. At 77ºF, they may require up to five or six times this amount. Typically, it is assumed that DO concentrations greater than 6 and 8 milligrams per liter are sufficient for the normal warm- and cold-water fish activity, respectively (USEPA 1987).

Dissolved oxygen concentrations can be reduced by living organisms or decaying materials in water. DO can be replenished from the air, but this is a slow process in streams with little turbulence. Green aquatic plants such as algae, periphyton (plants attached to submerged objects), and bottom-attached plants can also add oxygen to the water during periods of daylight, but their death and decomposition may rob streams of oxygen at night.

Diurnal variations in DO concentration were much greater at the Portola, Delleker, and Sloat stations than at the downstream Merimac station in the USGS study, indicating that rates of plant photosynthesis and community respiration are higher in the upper reach of the river than in the lower reach. This situation is also reflected in the results of the planktonic algae survey conducted in 1971 when algal counts of 2, 436, 143, 334, 255, and 48 cells per milliliter were found at Beckwourth. Fluctuations in monthly DO saturation were greater at the upstream sampling stations and minimal at the Beckwourth station. The USGS study showed that the upstream reach of the river is subject to greater biological activity (USGS 1973).

Measurements for pH and alkalinity varied in response to photosynthetic reactions. Carbon dioxide reached maximum concentrations in the early morning and decreased to minimum during active photosynthesis in the afternoon. During photosynthetic period, pH was higher because of carbon dioxide consumption by green plants. The alkalinity concentrations remained almost unchanged during the 24-hour period indicating adequate buffer capacity of the river water.

Biological Oxygen Demand (BOD) and Total Organic Carbon (TOC) are indicators of organic loading and can significantly affect DO. In the USGS study, the mean values of BOD and TOC decreased significantly in the downstream direction, indicating higher concentrations of organic substances in the upstream reaches of the river. Sources of organic material can be from material sources, such as the seasonal decomposition of grasses and rushes, or from human influences, such as agricultural runoff (manure) or septic effluent.

Turbidity

The turbidity of water is due to suspended clay, silt, finely divided organic matter, microscopic organisms, and similar substances. The measure of turbidity in water is actually a measure of water clarity. The higher the turbidity values, the lower the clarity. When bodies of water become turbid, there is less penetration of light, less productivity of phytoplankton, less fish production, and less recreation use (Grissinger and McDowell 1970).

The highest turbidity measurements would be expected to occur during periods of high flow, when streams are carrying the maximum amounts of suspended material. In all three surveys, the upper Sierra Valley locations were found to be more turbid than downstream locations. Turbidity can also be a function of increased biological activity as well as other factors, such as algae growth.

Nitrogen and Phosphorus

Nitrogen, like phosphorus, is an essential element for algae and other aquatic plants. Unlike phosphorus, however, nitrogen comprises 79 percent of the atmosphere. Common forms of nitrogen are atmospheric nitrogen (N), ammonia (NH3), nitrite (NO2), nitrate (NO3), and organic nitrogen. Natural sources of nitrogen in aquatic environments result from the conversion of atmospheric nitrogen into nitrates and ammonia by bacteria and blue-green algae, and the conversion of ammonia into nitrite, and nitrite into nitrate. This conversion process is part of the nitrogen cycle. Organic nitrogen is found primarily in amino acids. Human sources of nitrogen include effluent from wastewater treatment plants and runoff from feedlots, pasture, and agricultural lands that have been fertilized. Because inadequate concentrations of nitrogen and phosphorus often limit plant growth, the two nutrients are important in controlling the extent of productivity of aquatic plants. Other elements known to be important plant nutrients are calcium, magnesium, potassium, iron, silicon, sulfate, and carbon, though, in most water, they usually are present in excess concentrations. The minimum concentrations of nitrogen and phosphorus for active plant growth (an algal bloom for example) have not been firmly established, but a wide range of minimum requirements is reported in the literature.

Generally, mean concentrations of nitrogen and phosphorus for the upstream stations are significantly higher than those for the downstream stations (USGS 1973). The higher nutrient content in samples from the Portola and Delleker stations probably reflects input from Sierra Valley. The lower nitrogen and phosphorus concentrations at the Sloat and Merrimac stations are likely due to dilution by various tributaries and to plant uptake as the river flows downstream (USGS 1973). The average upstream total phosphorus was 0.054 mg/l with a high of 0.170 mg/l observed at the Delleker station. Downstream concentrations dropped with average readings of 0.038 mg/l.

Metals

Only the recent FRCRM study showed increased metal concentration in the upstream sample locations at Beckwourth See previous summary statement.

WATER QUALITY DISCUSSION

The water quality in Sierra Valley is affected by a number of natural and human induced contributions and is not appreciably different from similar low gradient braided stream systems throughout the western United States with human habitation. Total precipitation is likely the single most influential factor to seasonal water quality in Sierra Valley, since the primary contributor to many of the water quality problems found in the valley is low flow conditions. Low precipitation and late season problems are exacerbated by policy and land use decision and water adjudications that occurred over 100 years ago. The primary of these is the use of water for human needs, such as domestic supply and irrigation. The more the snow pack and longer the contribution of melting snow to the valley floor, the better the water quality. As the summer temperatures increase, the low gradient meandering channels of the Feather River in the valley floor begin to warm. The warming increases algae and plant growth that can contribute to the low DO seen in all three previous studies. The presence of coliform bacteria is likely contributed from livestock grazing in the valley floor. Increased temperatures are a function of solar radiation on the slow moving water, as well as, seasonal low flow conditions. Additional potential contributors to water quality deviations are noted in the following section.

Both humans and natural processes affect the quality of surface and groundwater. No data are available for periods prior to the settlement of Sierra Valley, however it is sufficient to say some impact from human habitation is likely. For this discussion, potential water quality impacts have been grouped into agriculture, urbanization, and erosion.

- Agriculture
- Urbanization
- Erosion

Agriculture

Sierra Valley Agricultural Summary

The Sierra Valley supports over 40,000 acres in irrigated agricultural production and is also the headwaters to the Middle Fork Feather River. Multiple tributaries converge in the northwestern portion of the valley near Beckwourth and form the Middle Fork Feather River. Water from these tributaries is used extensively throughout their journey across the valley. The majority of irrigated agriculture is in extensive flood irrigated pastures. Groundwater is typically used in sprinkler irrigation, primarily used with pivots, and with wheelines and handlines to a lesser extent. All surface irrigation tailwater flows back into these tributary channels and helps provide water for flows in the Middle Fork Feather River.

Crops Produced

Agriculture in Sierra Valley is centered on beef cattle and hay crop production. The growing season in Sierra Valley is limited, with it being one of the coldest agricultural zones in California.

The growing season is the limiting factor for agriculture in the valley. Crop production is shown on Figure 5-3.

Irrigated pasture for livestock production is the primary land use in Sierra Valley. The Sierra Valley's abundance of water, forage, and ideal summer climates has created an agricultural industry around beef cattle production. In 2002, livestock production held the highest production value of any agricultural commodity and accounted for approximately $2.8 million in revenue for both Sierra and Plumas Counties combined.

Alfalfa and alfalfa/grass mixtures are also major crops produced in the valley. Alfalfa from the Sierra Valley is typically very high quality. Grain production is limited in scale due to the colder growing season, and main grain crops include barley, wheat and oats. Grains are commonly used as a crop rotation in alfalfa production. The majority, if not all, of the grain produced in Sierra Valley is raised for grain hay.

In the 1980s and 1990s, a sod farm producing turf grass was located in Sierra Valley. This farm was located near Vinton just south of Highway 70. This crop was probably the most intensive agricultural crop ever produced in Sierra Valley. This operation moved out of the area in the late 1990s.

Agricultural Water Development

Agriculture has been using surface water in Sierra Valley since settlement. Over the years, tributaries have been manipulated for agricultural purposes. Tributaries used for irrigation include Little Last Chance Creek, Fletcher Creek, West Side Canal, Hamlin Creek, Miller Creek, Turner Creek, Smithneck Creek, Adams Neck Creek, Frenchman Creek, Cold Creek, Webber Creek, and Perry Creek. Some tributary channels on the valley floor have been channelized and reconstructed to move water more efficiently.

The majority of stream modifications have occurred on Cold Stream Creek, Carman Creek, Miller Creek, and Turner Canyon Creek, all located in the southwestern portion of the valley. These water bodies have had extensive channel work done over the years, primarily in the form of channelization. Other creeks, such as Little Last Chance Creek and Smithneck Creek both contain artificial modifications. The Little Truckee Ditch was constructed to supply irrigation water to Webber Creek, a tributary to Cold Stream Creek near Sierraville.

According to DWR Land Use Classifications, Sierra Valley contains 432 miles of perennial streams, 271 miles of seasonal streams and canals account for a total of 37 miles throughout the valley floor. The majority of the streams on the valley floor have been severely modified for agricultural purposes.

Water Rights and Irrigation

Water rights in Sierra Valley were outlined in 1939 by the Superior Court of the State of California in Plumas County. In 1940, Judgment and Decree 3095 was filed in Plumas County. Water rights of Last Chance Creek, Smithneck Creek, West Side Canal, Fletcher Creek, Little Truckee River (imported), and Middle Fork Feather River were adjudicated under Judgment and Decree 3905. The Middle Fork Feather River irrigates 10,045.7 acres and the Last Chance Creek irrigates 9,991.2 acres. These two water bodies account for over 20,000 irrigated acres, or roughly half of the total surface water irrigation in Sierra Valley. The West Side Canal supplies water to 7,712.4 acres and Smithneck Creek supplies water to 5,886.6 acres.

Agricultural Water Use

Irrigation water in Sierra Valley is primarily supplied by snowmelt and is in high demand during the late summer and early fall months, DWR 1973 found that irrigation water requirements were sufficiently met with existing surface water sources, based on data from DWR Bulletin No. 94-17. Ten years later, DWR released the Sierra Valley Groundwater Study. This report described the surface water supply in Sierra Valley beginning to "dwindle and fall short of agricultural demands sometime between midsummer and fall" (DWR 1983). This report also expressed that some historically artesian wells in Sierra Valley were no longer flowing, presumably due to an increase in groundwater extraction.

Over the years, agricultural water use in the valley has shifted from primarily flood irrigated to a mixture of flood irrigated and sprinkler irrigated. Many irrigated pastures are flood irrigated with flashboard diversions. In the 1980s, center pivots were installed extensively on the northeastern portion of Sierra Valley. Center pivots were attractive to agricultural producers because they reduce labor costs, maximize irrigation water efficiency, and allow more acreage under irrigation. In the 1980s, the largest ranch in Sierra Valley at the time (Feather River Ranch) was the primary source of center pivots, with 28 installed on the ranch throughout this decade. Since this time, the total number of pivots has decreased overall in the valley. At the highest point, there were approximately 30 center pivots in operation; in 2004, there are just over 20 in use. More recently, renewed interest in pivots has led to the installation of new center pivot systems. Irrigated ground is shown on Figure 5-4.

Chemical Use

Pesticide use in the Sierra Valley is extremely limited. Pesticide use records indicate that overall pesticide use in irrigated agriculture has dropped substantially over the years. In 1993, over 5,000 pounds of active ingredients of pesticides were applied to irrigated crops in both Plumas and Sierra Counties. This number has declined steadily since, and in 2002, only 815 pounds of active ingredients were applied to irrigated crops in these two counties. Pesticide use data was extracted from both Sierra and Plumas Counties for the time between 1993 and 2002 (Table 5-6). Data was not conclusive from 1995 to 1998. Pesticide use for 2002 is by section shown on Figure 5-5.

Alfalfa Alfalfa hay is a crop that typically does not use many pesticides. An herbicide treatment in the spring with Velpar or Gramoxone is common for weed control. Usually, these treatments occur in the early spring and ground rigs are used to apply them. Other applications of Roundup (glyphosate) are common around field borders and in spot treatments within the fields, and are typically applied with a portable backpack sprayer. In 2002, there were 40 alfalfa chemical applications in both Sierra and Plumas Counties (Table 5-7). Occasionally, alfalfa weevils are present in alfalfa hay crops, and insecticides such as Furdan and Lorsban may be used. This practice is not common in Sierra Valley.

Table 5-6 2002 PLUMAS AND SIERRA COUNTIES PESTICIDE USE			
Location	**Gross Pounds**	**# of Applications**	**Percentage of Total (%)**
Plumas County			
Forests	18,701.0	175	59.3
Right of way	10,648.0	68	33.8
Landscape	1,181.0	104	3.7
Alfalfa hay	407.3	21	1.3
Structural pest control	403.4	381	1.3
Pasture	64.0	48	0.2
Wheat	42.5	2	0.1
Oats	33.9	1	0.1
Regulatory	20.2	20	0.1
Ornamental turf	12.1	4	0.0
Rangeland	5.2	3	0.0
All Sites in County	**31,519.0**	**831**	**100**
Sierra County			
Forests	6,661.0	350	89.5
Landscape	416.3	34	5.6
Alfalfa hay	294.7	19	4.0
Right of way	27.9	7	0.4
Regulatory	22.2	19	0.3
Structural pest control	17.9	182	0.2
All Sites in County	**7,440**	**350**	**100**

Table 5-7 PLUMAS AND SIERRA COUNTIES ALFALFA HAY PESTICIDE USE*						
Year	**# of Apps**	**lbs Applied**	**Treated Acres**	**# of Apps**	**lbs Applied**	**Treated Acres**
	Plumas County			**Sierra County**		
1993	9	980	2,560	2	193	240
1994	24	2,285	2,637	4	256	555
1995	Data for 1995, 1996, 1997and 1998 was not available, but was provided in raw form late in the document process. It is incomplete, but available in the offices of the Agricultural Commissioner.					
1996						
1997						
1998						
1999	23	1,719	1,844	7	172	155
2000	37	2,259	3,434	5	91	86
2001	26	723	3,093	8	55	284
2002	21	407	2,326	19	294	560
TOTAL	**140**	**8,373**	**15,894**	**45**	**1,061**	**1,880**
*Total pounds of active ingredients applied per county						

Primary chemicals used in alfalfa in the Sierra Valley include the following:

- Glyphosate (Roundup)
- Hexazinone (Velpar)
- Paraquat (Gramoxone)
- Imazethapyr (Pursuit)

Grain Grain crops, such as wheat, oat, rye, and barley commonly use a broadleaf herbicide at one time early in the growing season. 2,4-D is a common herbicide for broadleaf weed control. This herbicide is not frequently used and is applied by a ground rig. 2,4-D is the only chemical that has been used in the Sierra Valley on grain crops in 2002. There were only three chemical applications to grain crops in both Sierra and Plumas Counties in 2002.

Pasture (Irrigated & Nonirrigated) Both irrigated and nonirrigated pastures use a limited amount of herbicides for weed control. Typically, 2,4-D is used to control broadleaf weeds in pasture stands. Herbicides are typically applied in the spring and with a ground rig or a backpack sprayer for spot treatments.

Sod/Turf Grass When sod was produced in Sierra Valley, pesticide use was at its peak. In 1994, 1,696.9 pounds of active ingredient of Malathion was reportedly used in Plumas County on general pasture. This material most likely was used on the sod operation as an insecticide. In the late 1990s, this operation moved to another location, reducing the overall pesticide use in Sierra Valley dramatically.

2002 California County Statistics The most recent data on pesticide use information for both Sierra and Plumas Counties is in the 2002 Pesticide Action Network Pesticides Database—California Pesticide Use and with the California Department of Pesticide Regulation—California Pesticide Information Portal. Data were inconclusive for agricultural chemical use from 1995 to 1998 (Table 5-8).

> ***Sierra County*** Irrigated agriculture (alfalfa) accounted for approximately 295 pounds of active ingredients of pesticides used in Sierra County in 2002. This is approximately 4 percent of the total amount of active ingredients applied in Sierra County, assuming all sites had an estimated 7,440 pounds of active ingredients applied total in 2002. Sierra County rated 55th out of the 58 California counties for the total amount of active ingredients applied in the county. The overall agricultural pesticide use in Sierra County is in a downward trend.
>
> ***Plumas County*** Irrigated agriculture (alfalfa, pasture, wheat, and oat) accounted for nearly 550 total pounds of active ingredients applied in 2002. This accounts for an estimated 1.7 percent of the county's total pesticide applications, which totaled an approximately 31,500 pounds of active ingredients applied in 2002. The majority of pesticides used in Plumas County are from the forest operations. Plumas County rated 51st out of all 58 California counties for pesticide use in 2002. The overall agricultural pesticide use in Plumas County is in a downward trend.

Table 5-8 PLUMAS AND SIERRA COUNTIES TOTAL AGRICULTURAL CHEMICAL USE*			
Year	**Plumas (lbs)**	**Sierra (lbs)**	**Total Both Counties (lbs)**
1993	5,063.5	258.9	5,322.4
1994	4,465.5	256.1	4,721.6
1995	Data for 1995, 1996, 1997and 1998 was not available, but was provided in raw form late in the document process. It is incomplete but available in the offices of the Agricultural Commissioner.		
1996			
1997			
1998			
1999	2,316.2	171.7	2,487.9
2000	2,386.9	139.6	2,526.5
2001	1,295.0	56.4	1,351.4
2002	519.9	295.2	815.1
Average	**16,047.0**	**1,177.9**	**17,224.9**
*Pounds of active ingredient applied			

Noxious Weed Eradication Sierra Valley is a host to many noxious weeds. In 2002, both Sierra and Plumas Counties used a combination of biological, mechanical, and chemical control as noxious weed eradication methods. Weeds that required chemical controls are Dalmatian toadflax, mediterranean sage, musk thistle, perennial pepperweed, rush skeletonweed, scotch thistle, spotted knapweed, wavyleaf thistle, and yellowspine thistle. Typically, these noxious weeds are not found within irrigated agricultural fields but are found in rangelands and adjacent to roads. These weeds are also being targeted by mechanical and biological methods of control.

Organic Agriculture Both Plumas and Sierra Counties show that in 2002, only two different agricultural operations were certified organic. These two farms totaled 9.5 acres in size.

Agricultural Management Practices

Tillage The crops produced in Sierra Valley require minimal tillage operations. Tillage operations typically include ripping/chiseling, plowing, and disking. These are all land preparations prior to planting the crop. Due to the rising cost of fuel, tillage operations are becoming less and less frequent.

Grain hay crops most likely use the most tillage out of any crop produced in Sierra Valley because they are planted annually. The soil is prepared for planting during the summer and the crop is planted in the fall. It should be noted that although grain crops use the most tillage, the fields are seeded in the fall and cover is established for the winter season, resulting in minimal soil erosion. In 2002, grain hay crops were planted on 663 acres in Plumas County and on 446 acres in Sierra County.

Alfalfa will require tillage to prepare the soil to plant, but alfalfa is a perennial crop that will maintain a stand for five to seven years. After the soil preparation, there will not be any tillage operations until the stand has been worn out. This crop provides adequate soil cover for the winter season. In 2002, alfalfa hay was produced on 4,756 acres in Plumas County and on 875 acres in Sierra County.

Irrigated pastures rarely, if ever, use tillage operations. Once a pasture stand is established, it can survive indefinitely. Irrigated pastures provide excellent cover for the soil during the winter months. The minimal tillage operations in irrigated agricultural fields indicate that abnormal soil erosion most likely does not pose a problem. Irrigated pastures were located on 35,000 acres in Plumas County and on 11,445 acres in Sierra County in 2002.

Grazing With beef cattle as the primary agricultural commodity of Sierra Valley, grazing management should be analyzed for impacts on water quality. Livestock are traditionally not wintered in Sierra Valley, with the harsh winters, high cost of hay and labor, and the susceptibility to flooding. Historically, cattle were wintered in Sierra Valley in large barns. Some livestock are still wintered in the valley today, and the rest are shipped down to the low elevation foothills of the Sacramento Valley. Grazing management has not changed significantly over the years.

Water Quality Impacts of Irrigated Agriculture

The Regional Water Quality Control Board has recently determined that discharges from irrigated agricultural lands could affect the quality of water in the state. In order to better define and regulate agricultural discharges, the RWQCB determined it was necessary to adopt the Conditional Waiver of Waste Discharge Requirements (Resolution R5-2003-0105) to address irrigated land discharges. Overall, irrigated agricultural lands in Sierra Valley use minimal amounts of chemicals. The majority of chemicals used are not in irrigated or non-irrigated agriculture, but more for forest management. The limited amounts of chemicals used are most likely applied during the spring months. Tillage of agricultural lands is very limited in Sierra Valley, indicating that a significant source of sediment should not occur from tilled fields. Flood irrigation practices have been documented as affecting water quality. Generally, flood irrigation with tailwater has the ability to, among other things, reduce dissolved oxygen levels, increase temperature, increase nutrients, and increase turbidity. These effects have not been documented for the Sierra Valley. Pastures with open access to streams and irrigation ditches are extremely sensitive to overgrazing. Overgrazing often can lead to the loss of riparian vegetation and trampling of stream banks. This process often leads stream banks to widen and become shallower. This increases the impacts of solar radiation on water and ultimately results in higher water temperatures.

Agricultural Stewardship and Water Quality

Although agriculture may have negative impacts on the environment, many farmers and ranchers have decided to be proactive and help minimize potential pollution problems. The agricultural industry has helped develop a series of best management practices that minimize pollution impacts. The State Water Resources Control Board, UC Cooperative Extension, USDA Natural Resources Conservation Service, and the California Association of Resource Conservation Districts helped create the California Rangeland Water Quality Management Plan, a voluntary program where farmers and ranchers address water quality issues on their properties. The California Rangeland Water Quality Management Plan provides an essential resource for ranchers to develop voluntary ranch water quality plans. Short courses have been led by the UC Cooperative Extension and the Natural Resources Conservation Service to provide information on impaired waterbodies, water quality, TMDLs, and basin plans. At the end of these short courses, plans are developed by the ranchers that include the goals and objectives of the ranch, property information, ranch maps, ranch operations, ranch management practices, non-point source assessments and planned improved management practices.

Urbanization

Development pressure in Sierra Valley has grown tremendously over the past few decades. The southern end of the valley is within driving distance to the population centers of Truckee and Reno, and commuters are flocking to Sierra Valley in droves. Relatively cheap land prices and a rural atmosphere are attractive to commuters looking for a place to raise their family. The primary urbanized areas in the Sierra Valley are limited to Loyalton and Sierraville.

Golf courses are also a land use that will most likely increase in the future. With Plumas and Sierra Counties both heavily reliant upon recreation and tourism to fuel the economy, it is inevitable that more golf courses will be established in and around the Sierra Valley. Currently, only one golf course is located in the foothills of the Sierra Valley and holds 16 acres of irrigated greens and fairways.

In urban and suburban areas, buildings and pavement cover much of the land surface, which do not allow rain and snowmelt to soak into the ground. Instead, most developed areas rely on storm drains to carry large amounts of runoff from roofs and paved areas to nearby waterways. The stormwater runoff carries pollutants such as oil, dirt, chemicals, and lawn fertilizers directly to streams and rivers, where they can harm water quality.

The porous and varied terrain of natural landscapes like forests, wetlands, and grasslands traps rainwater and snowmelt and allows them to filter slowly into the ground. In contrast, impervious (nonporous) surfaces like roads, parking lots, and rooftops prevent rain and snowmelt from infiltrating, or soaking, into the ground. Most of the rainfall and snowmelt remains above the surface, where it runs off rapidly in unnaturally large amounts. Storm sewer systems concentrate runoff into smooth, straight conduits. This runoff gathers speed and erosional power as it travels underground. When this runoff leaves the storm drains and empties into a stream, its excessive volume and power blast out streambanks, damaging streamside vegetation and wiping out aquatic habitat. These increased storm flows carry sediment loads from construction sites and other denuded surfaces and eroded streambanks. They often carry higher water temperatures from streets, rooftops, and parking lots, which are harmful to the health and reproduction of aquatic life. The loss of infiltration from urbanization may also cause groundwater changes. Although urbanization leads to great increases in flooding during and immediately after wet weather, in many instances it results in lower stream flows during dry weather. Many native fish and other aquatic life cannot survive when these conditions prevail.

Urbanization increases the variety and amount of pollutants carried into streams, rivers, and lakes. The pollutants include the following:

- Sediment
- Oil, grease, and toxic chemicals from motor vehicles
- Pesticides and nutrients from lawns and gardens
- Viruses, bacteria, and nutrients from pet waste and failing septic systems

- Road salts
- Heavy metals from roof shingles, motor vehicles, and other sources
- Thermal pollution from dark impervious surfaces such as streets and rooftops

These pollutants can harm fish and wildlife populations, kill native vegetation, foul drinking water supplies, and make recreational areas unsafe and unpleasant (USEPA 2003).

Individual septic tanks with leach fields and municipal collection and treatment systems are the two basic methods for handling domestic wastes in the study area. The common method of waste disposal in rural areas, such as Sierra Valley, is by individual septic tank-leach fields. Far from being a simple device, the septic tank is a complete sewage treatment plant buried in the backyard. The overlying soils absorb any odors produced in the system and the underlying and adjacent soil in contact with the leach field supports a biological system of purification. Burial, however, makes operation and maintenance of the system difficult.

This method has an economic advantage in rural areas over collection and treatment systems, but can present certain problems. These problems evolve because the success of a septic tank-leach field depends on sparse population, a thick and permeable soil mantle, an adequate vertical distance from the leach field to ground water, and proper maintenance. Where these conditions do not exist, one must expect an eventual system failure, which results in contamination of surface and/or ground waters and a threat to human health.

To avoid such problems in new construction and land developments, the RWQCB adopted "Guidelines for Waste Disposal from Land Developments." These guidelines contain minimum criteria for septic tank-leaching systems and describe the policies and principles applied by the RWQCB in implementing the guidelines. The application of these guidelines in cooperation with county health departments is necessary because of the overwhelming number of individual septic tank-leach field systems in use, making adoption of waste discharge requirements for each system an unmanageable task. The adoption of these standards by the RWQCB does not preclude the counties from adopting standards, which better fit their areas, but the standards must be as stringent as the RWQCB guidelines.

Where population is sufficiently dense, a municipal collection and treatment system is both economically and environmentally sound. The city of Loyalton has had its own collection and treatment system since 1957. The system was designed to provide treatment for 148,500 gallons of effluent per day. The treatment consists of bar screens and an imhoff tank to remove solid materials, and two acres of oxidation ponds six feet deep. The oxidation ponds are located about 1 mile north of Loyalton and discharge to Smithneck Creek.

Beckwourth County Service Area constructed a collection system and facultative stabilization ponds to serve the community of Beckwourth. The ponds are located about a half mile southeast of the community. The waste discharge requirements for this system specify that the discharge shall not cause a pollution, neither the treatment nor the discharge shall cause a nuisance, the mean daily flow shall not exceed 18,000 gallons per day, and there shall be no discharge to surface waters.

Erosion

Primary sources of erosion and sedimentation in Sierra Valley are:

- Urbanization
- Agricultural practices
- Timber harvesting and road construction
- Catastrophic events (fire)

Housing development, including construction of roads and development can change the frequency and duration of storm events. Concentrated water from impervious areas, such as roads and parking lots, roofs, and driveways can result in increased sediment movement.

Some runoff is expected from agricultural fields or fields following plantage or harvest activities. Generally, however, field runoff is controlled via the use of agricultural return systems or irrigation conveyance channels. Livestock access along stream banks can contribute to sediment loading and erosion. Also, the rising and lowering of natural channels due to irrigation can result in bank instability and erosion activity.

Diversions, whether for industrial, irrigation, or other reasons, will often have considerable impact. Although the water returns to the stream below the diversion, it may now carry loads of nutrient or other chemicals, or be changed in other ways, depending on the purpose for which it was used. Channels built to contain the stream will modify its hydrology, sediment load, and bed and substrate stability (Gehrke et al 1995).

Timber harvesting activities can result in short term sediment increases in stream sediment loading. Timber harvest activities at the turn of the century created considerable sediment and erosional events. Current regulations and best management practices for both timber harvesting and forest road construction have significantly reduced the possible impacts of timber harvesting on water quality.

The greatest potential source of sediment loading into a watershed is the catastrophic event such as fire. In this event thousands, if not tens of thousands, of acres of vegetation are destroyed subjecting the watershed to significant sediment loading (see Section 9, "Forestry, Fire, and Fuel Management," for additional information).

The deposition of sediment into a waterway can significantly diminish the water quality and aquatic habitat. Sediment deposition in a waterway makes the water more turbid and does not allow as much light to penetrate the water. This causes problems for aquatic plants that need sunlight in order to perform photosynthesis. Suspended sediments in the water have the potential of clogging the gills of aquatic organisms and covering the stream bottom. Deposition of sediment on the stream bottom can lead to the suffocation of fish eggs and benthic macro invertebrates, and can cause the destruction of natural spawning substrate. Also, with an increased amount of particles in the water, dissolved oxygen levels are reduced because of higher water temperatures.

Pesticides, some metals, and other toxins may sometimes cling to suspended sediments in water and increase the concentration of toxins in water with high amounts of suspended sediments. Similarly, phosphate can also enter a waterway by attaching to eroded particles. When in high levels, phosphate in the water can lead to algal blooms and lower the amount of dissolved oxygen in a waterway (NBDELG 2000).

GROUNDWATER QUALITY

Unlike surface water quality, which is subject to rapid change over a wide range because of the vagaries of nature or the influence of man's activities, or both, groundwater quality remains relatively uniform in time. The principal natural factors that control the chemical characteristics of groundwater are the geologic environment to which the water is exposed and the geologic history of the basin (DWR 1973).

Although the quality of most of the groundwater in Sierra Valley is excellent, there are localized areas where the water is not suitable for some beneficial uses (DWR 1973, SVGMD 1986). Precipitation and surface runoff that are the major sources of groundwater recharge in Sierra Valley are of excellent mineral quality. They are biocarbonate in character (DWR 1983).

Past Studies

The first major inventory to determine the quality of groundwater in the Sierra Valley Basin was conducted between the years 1955 and 1957 (DWR 1983). The data collected was published in Bulletin 98, "Northeastern Counties Groundwater Investigation," dated February 1963. Additional sampling has been conducted by DWR periodically since 1957. These data are published in the Bulletin 130 series. DWR also sampled selected wells in the fall of 1972 and spring of 1973. An additional DWR study was conducted in 1983. DWR also prepared eight annual updates on groundwater conditions in the Sierra Valley Basin, extending through spring 1991. Kenneth D. Schmidt and Associates prepared a triennial updated extending through spring 1994, a quadrennial update extending through spring 1998, and again in 2003.

Primary sources of data used for this assessment are:

- Natural Resources of the Sierra Valley Study Area, DWR 1973
- Sierra Valley Groundwater Study, DWR 1986
- Sierra Valley Groundwater Management District Reports, 1985 to 1996
- Hydrogeologic Evaluation for Sierra Valley, Kenneth Schmidt and Associates, 2003

All of these previous studies determined that Sierra Valley groundwater is generally of good mineral quality with total dissolved solids (TDS) contents ranging from about 101 to 1,620 mg/l. Analyses indicate that the well waters have a median TDS concentration of about 188 mg/l and electrical conductivity (EC) ranged from 55 to 3,380 umhos/cm at 25° C with a median of 293 umhos/cm. The EC measurements show higher concentrations in the central western portion of the valley and are probably related to the hot springs. ECs in the fringe areas and recharge areas of the valley are low, reflecting the excellent quality of the recharge water. Comparison of 1981 and 1985 EC records show a slight improvement in the EC of some well waters. Most well waters showed little or not change in other parameters. The groundwaters of this valley are generally sodium bicarbonate in character. Higher levels of calcium bicarbonate waters appear in the rechange areas around the valley.

DWR 1973

The water quality portion of the study included the evaluation of geochemistry, temperature, pH, specific conductance, hardness, iron, arsenic, fluoride, boron, and nitrate. The figures from this study are included as Figure 5-6a through 5-6g.

Geochemistry
The geochemistry of groundwater contained within the various sedimentary formations is affected by numerous factors. The groundwaters found in the Sierra Valley Basin are of three basic types: sodium bicarbonate, calcium bicarbonate, and sodium chloride. As would be expected, in some cases the water is a mixture of these three groundwater types, and under this condition, sodium and bicarbonate are the predominate ions.

Sodium bicarbonate groundwaters are found in the central and northern portion and in a strip along the western side of the basin. The sodium bicarbonate groundwaters in the basin are similar to the groundwater found in lake deposits. Sodium chloride type groundwaters of the Sierra Valley Basin occur in hot springs, thermal artesian wells, and in a few low temperature wells located along the western side of the basin. Calcium bicarbonate type groundwaters found around the rim of the basin originate from surface water runoff.

Temperature
The DWR 1973 report found temperatures to generally meet requirements for beneficial uses. Two areas of increased temperature water occur in the basin: (1) an area located between Beckwourth and Vinton, and (2) an area along the Grizzly Valley and Hot Springs faults.

pH
In most cases, the groundwaters of the Sierra Valley Basin are alkaline, generally having a pH between 7.0 and 8.0. This is not a serious departure from neutral and no problems are indicated.

Specific Conductance
Specific conductance of groundwater in the Sierra Valley Bain in 1972 exceeded the domestic standard of 300 umhos/cm in an area between Beckwourth and Vinton corresponding to an area of hot springs.

Hardness
As would be expected, the hardness in the groundwaters is slightly higher than in the surface waters. Of the 34 wells sampled for hardness in 1972, the water from 25 wells was classified as soft, 8 wells classified as moderately hard, and 1 well classified as hard.

Iron
Iron and manganese tend to precipitate as hydroxides and stain laundry and porcelain fixtures. The recommended limit for iron in drinking water is 0.3 mg/l. This limit is not based upon

physiological considerations, for iron in trace amounts is essential for nutrition; the limit is based on aesthetic and taste considerations. Two areas of increased iron concentrations were found in the 1973 study and are shown on Figures 5-6e.

Arsenic
Arsenic was found in 8 of the 36 wells tested during the years 1957, 1960, 1967, 1972, and 1973. Two of the wells were found to contain concentrations of arsenic above 0.05 mg/l in 1973. These wells are located along the Hot Springs Fault, as indicated by their high temperatures and concentration of minerals, and had arsenic concentrations of 0.15 and 0.64 mg/l, respectively. In general, arsenic concentrations are elevated near the thermal areas (DWR 1973).

Fluoride
Likewise, an area of high fluoride concentrations falls roughly along the trace of the Hot Springs Fault. Since this area is also the location of thermal waters that are not normally used for drinking waters, there appear to be no fluoride hazards in the groundwater used for domestic water purposes.

Boron
Boron frequently is found in significant concentrations in California groundwater. The concentrations are usually related to upward migration of deep-seated connate or magmatic waters or to leaching from geologically older formations. Alfalfa, an important crop in the study area, can tolerate concentrations as high as 2.0 to 4.0 ppm. Other high tolerance crops are sugar beets, onions, turnips, asparagus, cabbage, carrots, and lettuce. Concentrations of boron found in the wells sampled during the 1973 study showed boron concentrations are generally correlated with elevated temperatures. Water from between Beckwourth and Vinton, the water has a concentration of greater than 2.0 ppm (Class III irrigation water and are centered along the Hot Springs Fault.

Nitrates
DWR determined that the weather conditions of the water year seem to affect the nitrate concentrations in the groundwater. In wet years, the concentrations rise, and in dry years the concentrations fall to little or nothing. Elevated nitrates were detected in a limited number of wells in 1973. The high nitrates in the groundwater appear to be of surface origin. This assumption is supported by the observation that the concentration fluctuations follow the wetness of the year. Nitrates are fairly soluble and their concentrations would be expected to increase in groundwater near the surface when there is more water available to dissolve them. DWR determined that a detailed study would be required to determine if a nitrate problem exists in the basin.

DWR 1983

A three-year investigation was initiated by DWR in 1980 to better define the hydrogeology of Sierra Valley. In part, the study included evaluation of groundwater quality.

Geochemistry
Generally the 1983 study confirmed the bicarbonate character of water in the valley with the exception of the Hot Springs area.

Temperature
1983 work confirmed previous work that the highest water temperatures are generally associated with deep artesian wells in the west central portion of the valley along and between the Grizzly Valley and Hot Springs Fault. Groundwater exceeding 68° F are also found elsewhere, but usually they are also associated with deep wells (DWR 1983).

Electrical Conductivity
Likewise they found that the EC of groundwater in Sierra Valley varies greatly from less than 200 umhos/cm to about 2,600 umhos/cm. The groundwaters having the highest EC values are the thermal waters in the west central portion of the basin. An even larger area of the western and central portions of the basin is underlain by groundwaters that have EC values in excess of 800 umhos/cm. Most of these waters have ECs that exceed the recommended maximum for drinking water and are considered marginal for irrigation use (DWR 1983).

Boron
Boron concentrations in Sierra Valley groundwater show a similar pattern to the EC pattern, with very high levels associated with the thermal waters in the west central portion of the basin but much lower levels in the basin fringes and recharge areas. Boron concentrations in the thermal waters have exceeded 8 mg/l, while in the basin fringes they are usually less than 0.3 mg/l. An area in the northeastern portion of the basin between the Buttes and Vinton is underlain by groundwater with boron concentrations exceeding 2 mg/l (DWR 1983).

Fluoride
Along the Hot Springs Fault, elevated levels of fluoride were found at concentrations exceeding the 2.0 mg/l. These higher levels were found in thermal waters do not meet other drinking water standards. DWR stated that over the period of monitoring in the basin, fluoride concentrations have remained about the same in these well waters. At several other locations in the basin, monitoring data indicate that some reductions in fluoride concentrations have occurred (DWR 1983).

Nitrate, Ammonia, and Other Concentrations
A limited number of wells in the valley were found to yield water containing nitrate in excess of drinking water standards. Ammonia was also detected in several well waters in elevated levels, indicating that anaerobic environments must exist locally in the groundwater basin. Hydrogen sulfide had also been detected in some wells, also indicating an anaerobic environment.

Sierra Valley Groundwater Management District 1986

Sierra Valley Groundwater Management District (SVGMD) conducted a study in 1986 to determine chance in groundwater quality over time. The study was based on a water quality comparison between 70 water samples gathered in 1981 and 65 water samples gathered in 1985. A change was observed in electrical conductivity. Although patterns are similar, there was a general decrease in EC at the measured wells. This suggests there has been a slight reduction in total dissolved solids in the basin. Precipitation for this five-year period was above average for three of the years. It was suspected that the reduced EC levels were in response to the higher precipitation (SVMGD 1986). There was no other significant trend of change in the other chemical analyses for this period.

Alkalinity and pH
Alkalinity levels during the study show that Sierra Valley groundwaters, when expressed as calcium carbonate, ranged from 27 to 588 mg/l while the pH values ranged from 6.3 to 9.6 with a median of 7.3 These levels are within the expected range for good quality bicarbonate-type waters and should provide good buffering against sudden pH impacts. No change from previous data was identified.

Hardness
Sierra Valley well waters range in hardness from 0 to 610 mg/l (expressed as calcium carbonate) with a median of 68 mg/l. These waters are considered soft. No change was identified.

Sulfate and Chlorides
Throughout the valley, chloride levels in the groundwaters are generally low. Concentrations ranged from 0 to 542 mg/l with a median of 6 mg/l. Sulfate concentrations in Sierra Valley are low. Analysis of waters from the 88 well samples range from 0 to 777 mg/l with a median concentration of 3 mg/l. The two wells producing sulfate waters are located in the northwestern portion of the valley at Beckwourth.

Boron
Boron appears to pose no widespread problems in the overall conditions of Sierra Valley groundwater. In this study, nine wells produced waters with boron concentrations exceeding 2 mg/L, while seven wells produced levels exceeding 4 mg/l. Of the seven wells, five were associated with hot springs, while the other two were located at Beckwourth. The low boron concentrations in the valley groundwater are 0.0 to 8.5 mg/l, with the median level of 7.3 mg/l. Between 1981 and 1985, the boron levels have not changed significantly in the valley's groundwater.

Nitrates and Ammonia
Nitrate levels in the well waters of Sierra Valley were generally low. Of 106 wells monitored for nitrate, only four wells exceeded recommended limits of 45 mg/l. The presence of ammonia was detected in several water wells, sampled in 1981. Four wells were then sampled in the area for ammonia levels. The results ranged from 12 to 32 mg/l, which is considered high and not normally found in natural groundwaters. No reasons for the increases were provided in the study.

Kenneth D. Schmidt and Associates 2003

In 2000, the SVGMD received a grant to conduct additional hydrogeologic investigations in the valley. The project included the sampling of 27 supply wells. Kenneth D. Schmidt and Associates conducted the work. Results are included in Table 5-9.

Shallow Zones
Five wells were sampled to identify the shallow zone. These ranged in depth from as shallow as 25 feet deep. Temperatures of water from these wells ranged from 52 to 62° F. TDS concentrations in water from most of these wells ranged from about 180 to 400 mg/l. Water from one well had a TDS concentration of 981 mg/l, with abnormally high sodium (189 mg/l) and bicarbonate (620 mg/l) concentrations. pH values for these wells ranged from 6.9 to 7.8.

Nitrate concentrations ranged from less than 0.4 to 21 mg/l. Sodium and chloride concentrations were highest in water from the two shallow dug wells. Boron concentrations ranged from less than 0.05 to 1.3 mg/l. Concentrations of fluoride and iron were low. Manganese concentrations were low in water from the three deeper wells, but exceeded the recommended MCL in water from the two shallow dug wells. There is a trend for lower TDS wells to be near the edge of the valley.

Deeper Wells

Water temperatures usually ranged from about 75 to 85° F. pH values ranged from 7.5 to 8.4, somewhat elevated and typical of deep groundwater in alluvial deposits. The waters were usually of the sodium bicarbonate type. Nitrate concentrations were less than 0.4 mg/l, indicative of reduced conditions in the deep zone. Sodium concentrations ranged from about 30 to 140 mg/l. Boron concentrations ranged from 0.1 to 2.2 mg/l. Iron concentrations ranged from 0.1 to 1.1 mg/l, and exceeded the recommended MCL for drinking water of 0.3 mg/l in water from two of the five wells. Manganese concentrations ranged from 0.04 to 0.27 mg/l, and exceeded the recommended MCL of 0.05 mg/l for drinking water in water from four of the five wells. The lowest TDS concentrations (130 to 200 mg/l) were found in water from deep zone wells near the edge of the valley. These wells are near the north edge of the valley.

CONCLUSIONS

Overall, water quality in the watershed has been good since the first sampling done by DWR in 1957. Irregular sampling periods and varying locations make it difficult to construct direct correlations in data collected in the late 1960s and early 1970s to more recent water quality data from 2002.

REFERENCES

Bauder, T. A., R. M. Cardon, R. M. Waskom, and J. G. Davis. 2003. *Irrigation water quality criteria.* Crop Series No. 0.506.

Beschata, R.L., R.E. Bilby, G.W. Brown, L.B. Holtby, and T.D. Hofstra. 1987. *Stream temperature and aquatic habitat: fisheries and forest interactions.* Proceedings from a symposium held February 1986, University of Washington, Seattle, WA: 1991-232

California Department of Pesticide Regulation. 2004. *California pesticide information portal.* Sacramento: California Department of Pesticide Regulation, 2002 [cited March 2003]. Available from the World Wide Web at http://calpip.cdpr.ca.gov/cfdocs/calpip/prod/map/mapNav.cfm

DWR (California Department of Water Resources). 1973. *Natural resources of the Sierra Valley study area.* A Cooperative Study by Federal, State, and local Agencies, issued by DWR-Central District CPA/ 1020.10.

——. 1983. *Sierra Valley ground water study*. California Department of Water Resources. Memorandum Report.

Table 5-9
ANALYTICAL RESULTS OF GROUNDWATER SAMPLING PERFORMED IN AUGUST 2002

Analysis	Units	Well ID S=Shallow, I=Intermediate, D=Deep								
		MW-2 (S)	MW-2 (I)	MW-2 (D)	MW-3 (S)	MW-3 (I)	MW-3 (D)	MW-4 (S)	MW-4 (I)	MW-4 (D)
Total Hardness	mg/l	60.4	31.4	22.3	18.2	11.6	11.6	43.8	55.4	44.6
Calcium	mg/l	11	6	4	4	3	3	6	9	8
Magnesium	mg/l	8	4	3	2	1	1	7	8	6
Potassium	mg/l	5	9	9	6	8	8	4	8	8
Sodium	mg/l	10	23	31	38	41	51	40	78	96
Total Cations	meq/l	1.8	1.9	2.0	2.2	2.2	2.7	2.7	4.7	5.3
Boron	mg/l	ND	0.06	0.10	0.35	0.36	0.35	0.12	0.41	0.83
Copper	µg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	µg/l	70	80	260	370	ND	120	460	520	60
Manganese	µg/l	210	160	110	80	10	30	100	190	130
Zinc	µg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
Gypsum	mg/l	0.1	0.3	0.3	0.4	0.5	0.5	0.4	0.6	0.7
SAR	mg/l	0.6	1.8	2.9	3.9	5.2	6.5	2.6	4.6	6.2
Total Alkalinity	mg/l	90	80	80	110	100	100	120	130	110
Hydroxide	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbonate	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bicarbonate	mg/l	110	100	90	130	130	120	140	160	140
Sulfate	mg/l	ND	7	14	ND	1	12	ND	ND	ND
Chloride	mg/l	ND	4	5	2	6	15	27	91	125
Nitrate	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoride	mg/l	ND	ND	0.1	0.4	0.3	0.2	ND	ND	ND
Total Anion	meq/l	1.8	1.9	1.9	2.2	2.3	2.7	3.1	5.2	5.8
pH	units	7.4	7.5	7.8	7.8	7.9	7.9	7.5	7.2	7.7
E.C.	umhos/cm	170	193	216	214	231	286	329	578	637
TDS	mg/l	144	153	156	182	190	210	224	354	383

——. 2003. *California's groundwater bulletin 118, Sierra Valley groundwater basin.*

Gehrke, P.C., P. Brown, C.B. Schiller, D.B. Moffatt, and A.M. Bruce. 1995. *River regulation and fish communities in the Murray-Darling system, Australia.* In: Regulated Rivers: Research and Management 11, 363-375.

Grissinger, E.H. and L.L. McDowell. 1970. *Sediment in relation to water quality.* Water Resources Bulletin, vol. 6, No. 1, p. 7-14.

Haynes, H.B. 1970. *The ecology of running water.* Liverpool: Liverpool University Press.

NBDELG (The New Brunswick Department of Environment and Local Government). 2000. *The 2000 review of Petitcodiac River causeway and fish passage issues.* Prepared by Eugene Niles, Special Advisor to The Minister of Fisheries and Oceans.

Plumas Corporation. 2004. *Feather River Coordinated Resource Management Watershed Monitoring Program SWRCB Agreement #00-115-150-0 with Plumas Corporation (October 1, 2000 – December 30, 2003) Final Report.*

Kenneth D. Schmidt and Associates. 2003, May 1. *Technical Report on 1998-2003 Hydrogeologic Evaluation for Sierra Valley.*

USGS. 1973. *Water quality in the middle fork Feather River California May 1970 through September 1971.* U. S. Department of the Interior Geological Survey Water Resources Division.

USEPA (U. S. Environmental Protection Agency). 1987. *Quality criteria for water.* EPA-440/5-86- 001.

——. 2003. In *Protecting water quality from urban runoff* [online]. Washington, D. C.: U. S. Environmental Protection Agency, 2003 [cited March 2003]. Available from World Wide Web: http://www.epa.gov/nps

WFP (Washington Forest Practices Board). 1997. *Standard methodology for conducting watershed analysis.*

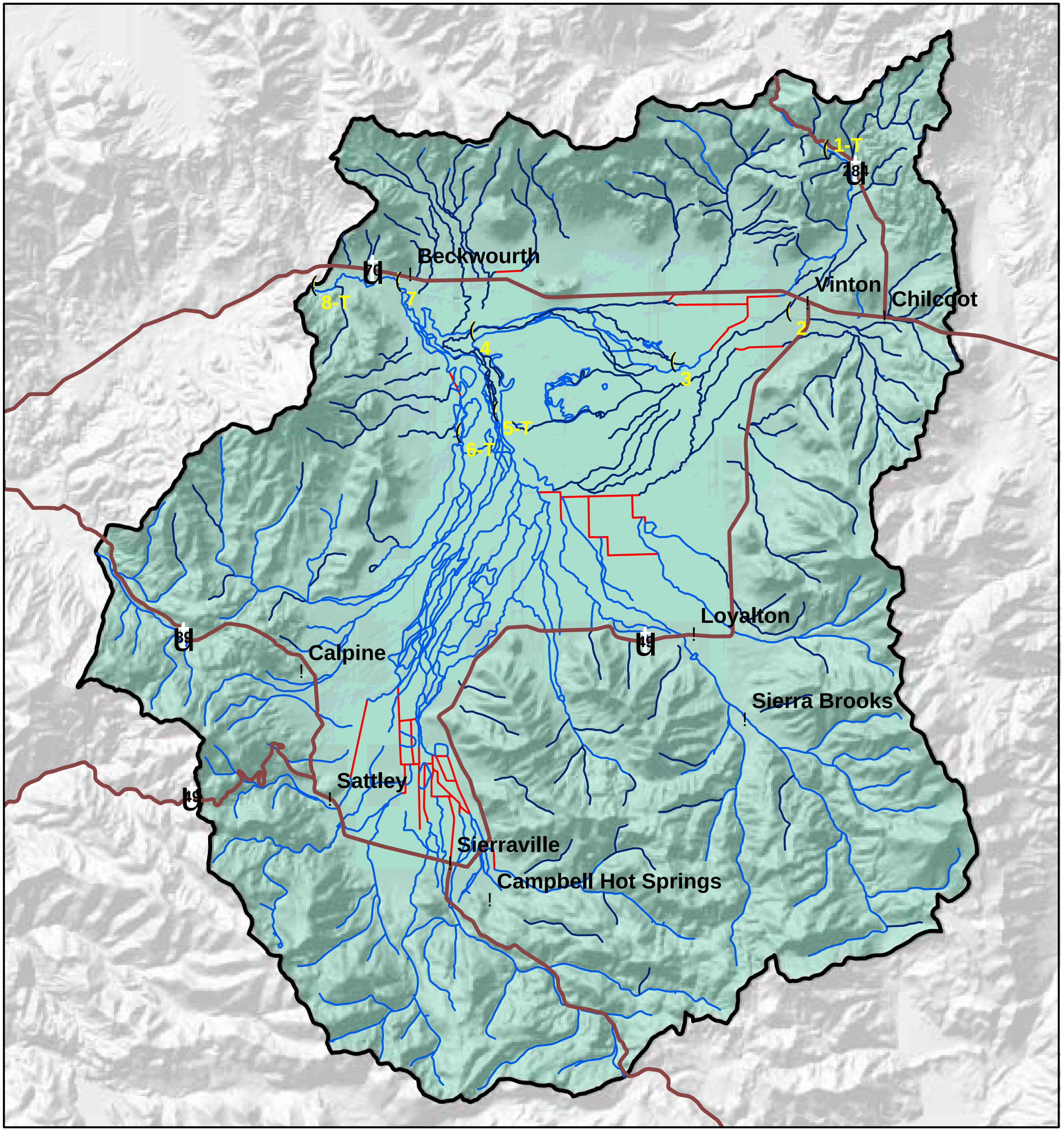


Figure 5-1
USGS Sample Locations
Sierra Valley Watershed

Legend

- Sierra Valley Watershed
- State Highway
- Perennial Stream
- Seasonal Stream
- Canal
- USGS Sample Locations

SOURCE: U.S. DEPARTMENT OF THE INTERIOR GEOLOGIC SURVEY WATER RESOURCES DIVISION

0 1.25 2.5 5 Miles

VESTRA

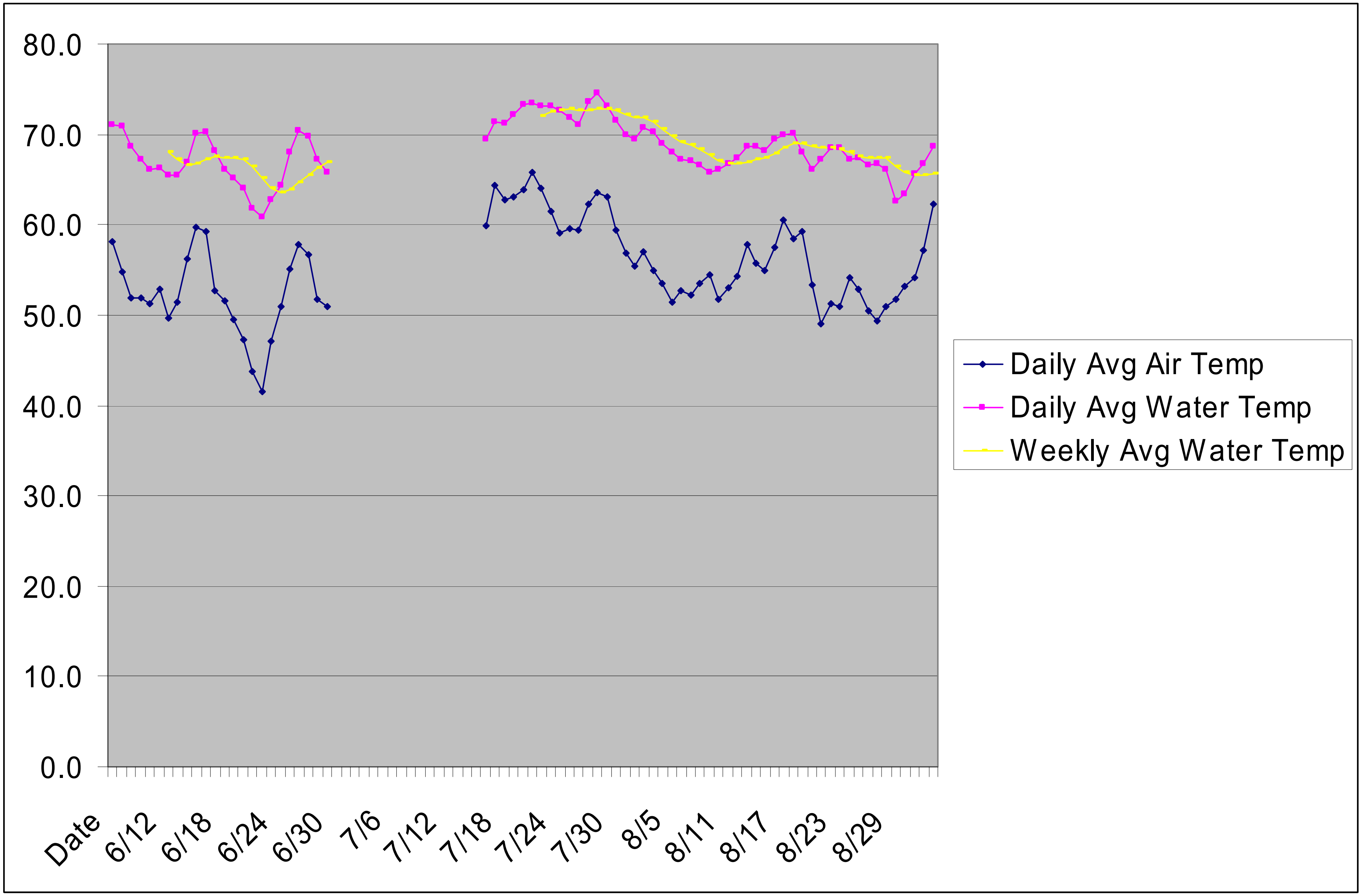
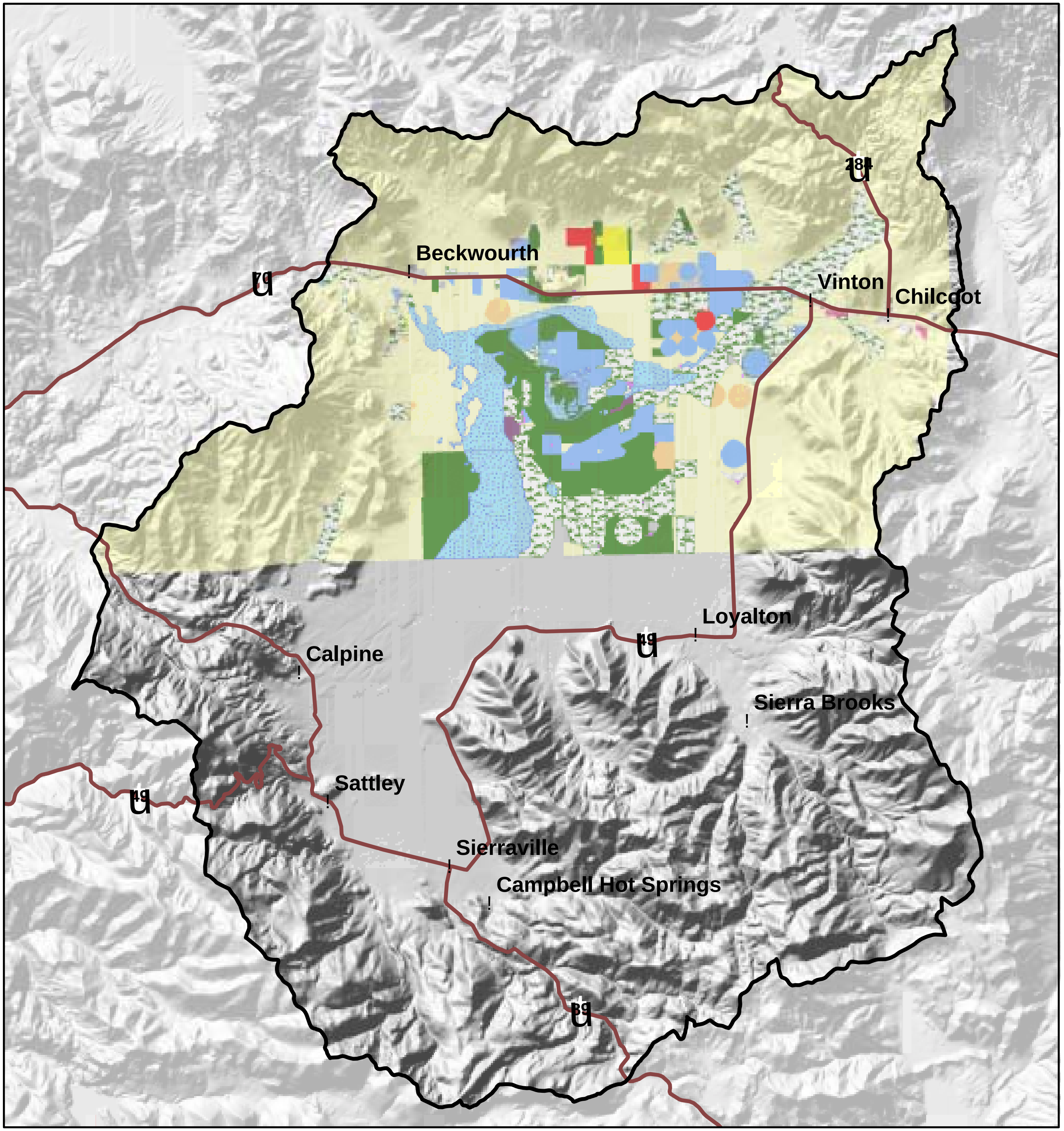


FIGURE 5-2
TEMPERATURE EVALUATION – CRMP DATA
SIERRA VALLEY WATERSHED

Figure 5-3
Crop Type Summary
Sierra Valley Watershed



Legend

- Sierra Valley Watershed
- State Highways
- Barley
- Land not cropped the current or previous crop season
- Alfalfa & alfalfa mixtures
- Mixed pastures
- Native pasture
- Induced high water table native pasture
- Flowers, nursery & Christmas tree farms
- Natural high water table meadow
- Grass landS
- Native vegetation
- Farmsteads

SOURCE: CALIFORNIA DEPARTMENT OF WATER RESOURCES, 1997 (DATA NOT AVAILABLE FOR SIERRA COUNTY

0 2 4 8 Miles

VESTRA

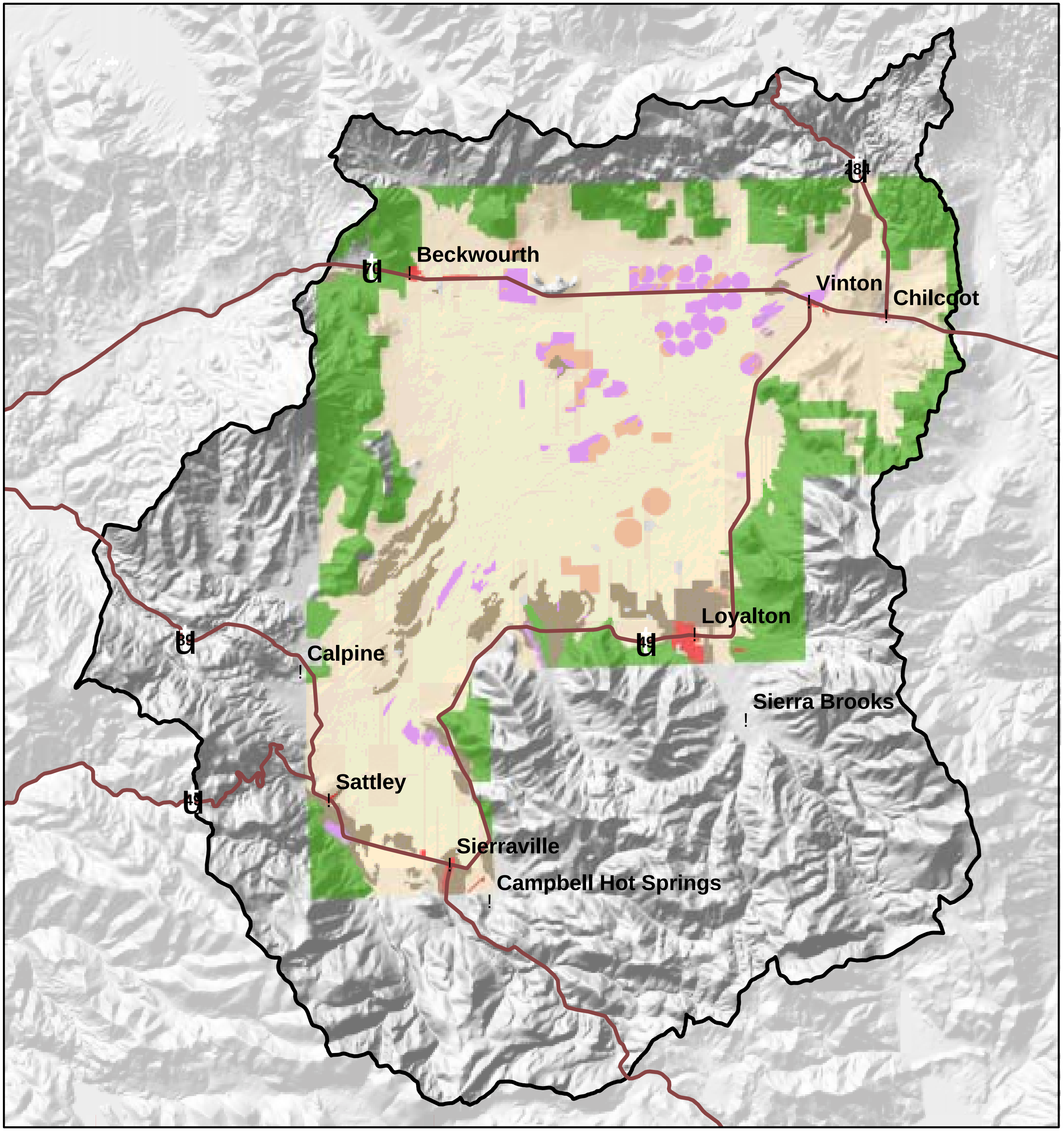


Figure 5-4
Irrigated Ground Lands
Sierra Valley Watershed

Legend

- Sierra Valley Watershed
- State Highways
- FMMP Urban and Built-Up Land - 783 acres
- FMMP Grazing Land - 35,845 acres
- FMMP Farmland of Local Importance - 90,187 acres
- FMMP Prime Farmland - 8,515 acres
- FMMP Farmland of Statewide Importance - 4,718 acres
- FMMP Unique Farmland - 2,642 acres

Note: FMMP Prime, Statewide Importance, and Unique are irrigated in Sierral Valley

SOURCE: STATE OF CALIFORNIA DEPARTMENT OF CONSERVATION DIVISION OF LAND RESOURCE PROTECTION FARMLAND MAPPING AND MONITORING PROGRAM

0 1.25 2.5 5 Miles

VESTRA

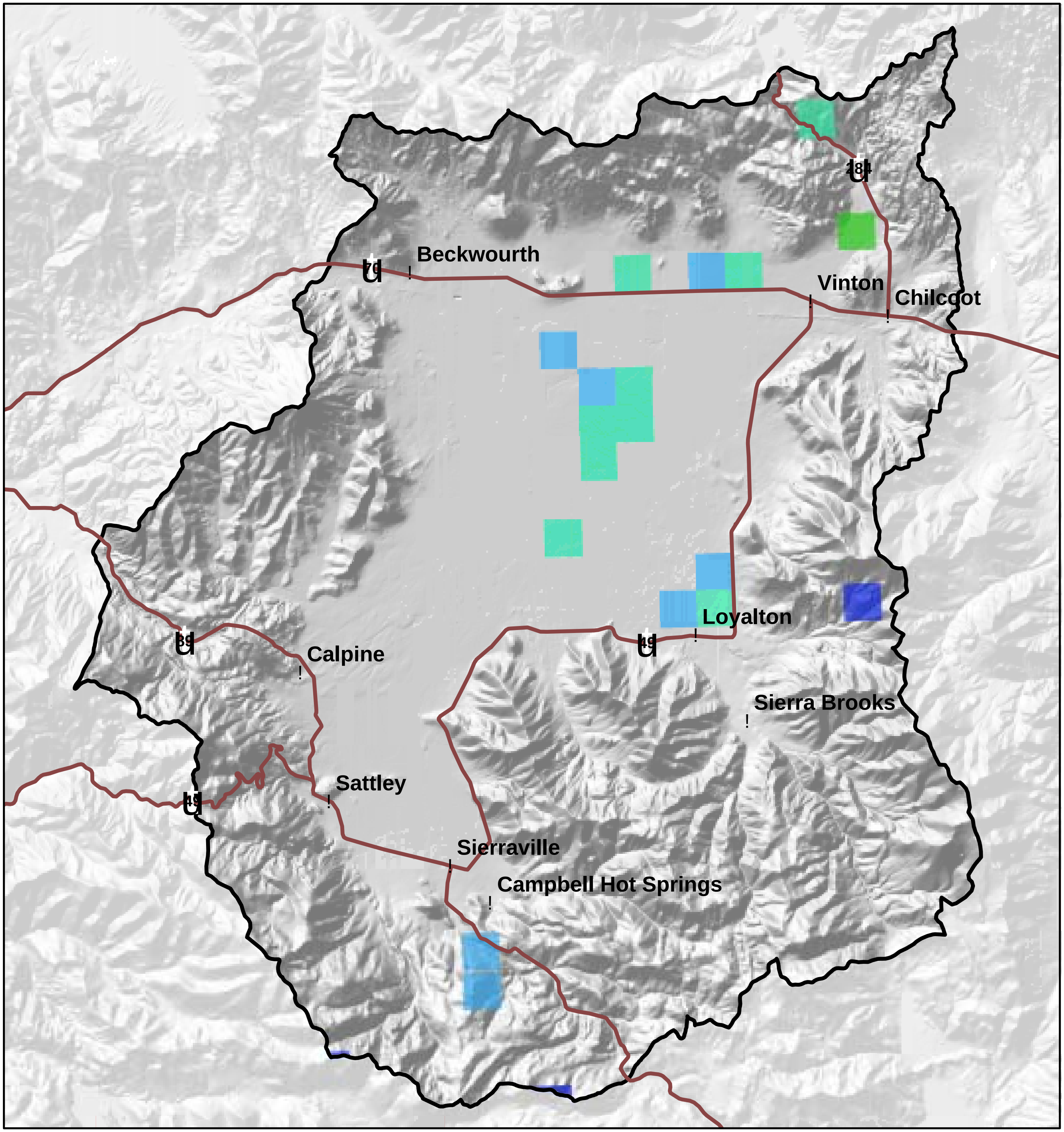


Figure 5-5
Reported 2002 Agricultural Pesticide Use (in pounds)
Sierra Valley Watershed

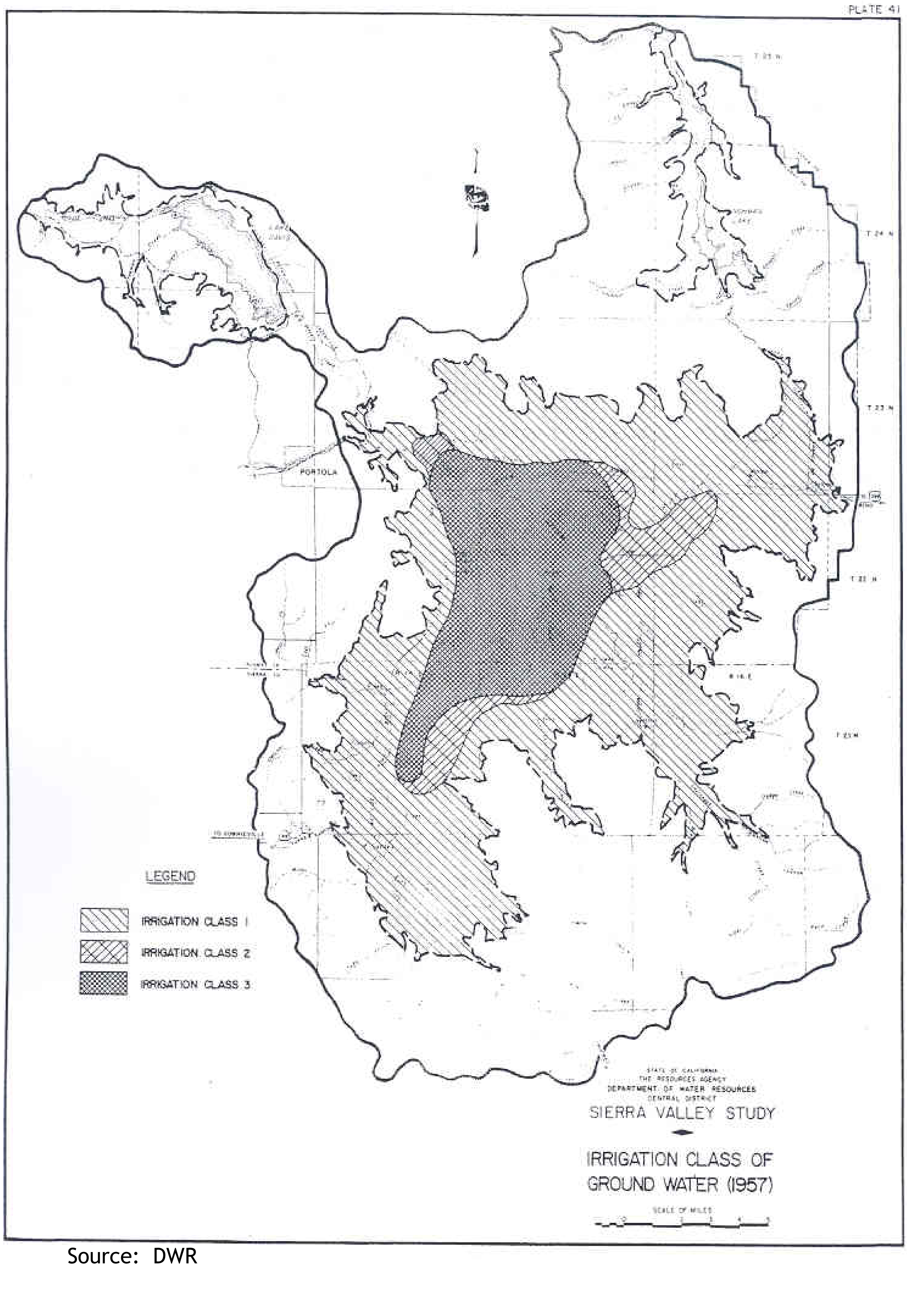
Legend

- Sierra Valley Watershed
- State Highways
- 0 - 20 pounds
- 21 - 50 pounds
- 51 - 100 pounds
- > 100 pounds

SOURCE: STATE OF CALIFORNIA
DEPARTMENT OF PESTICIDE REGULATION

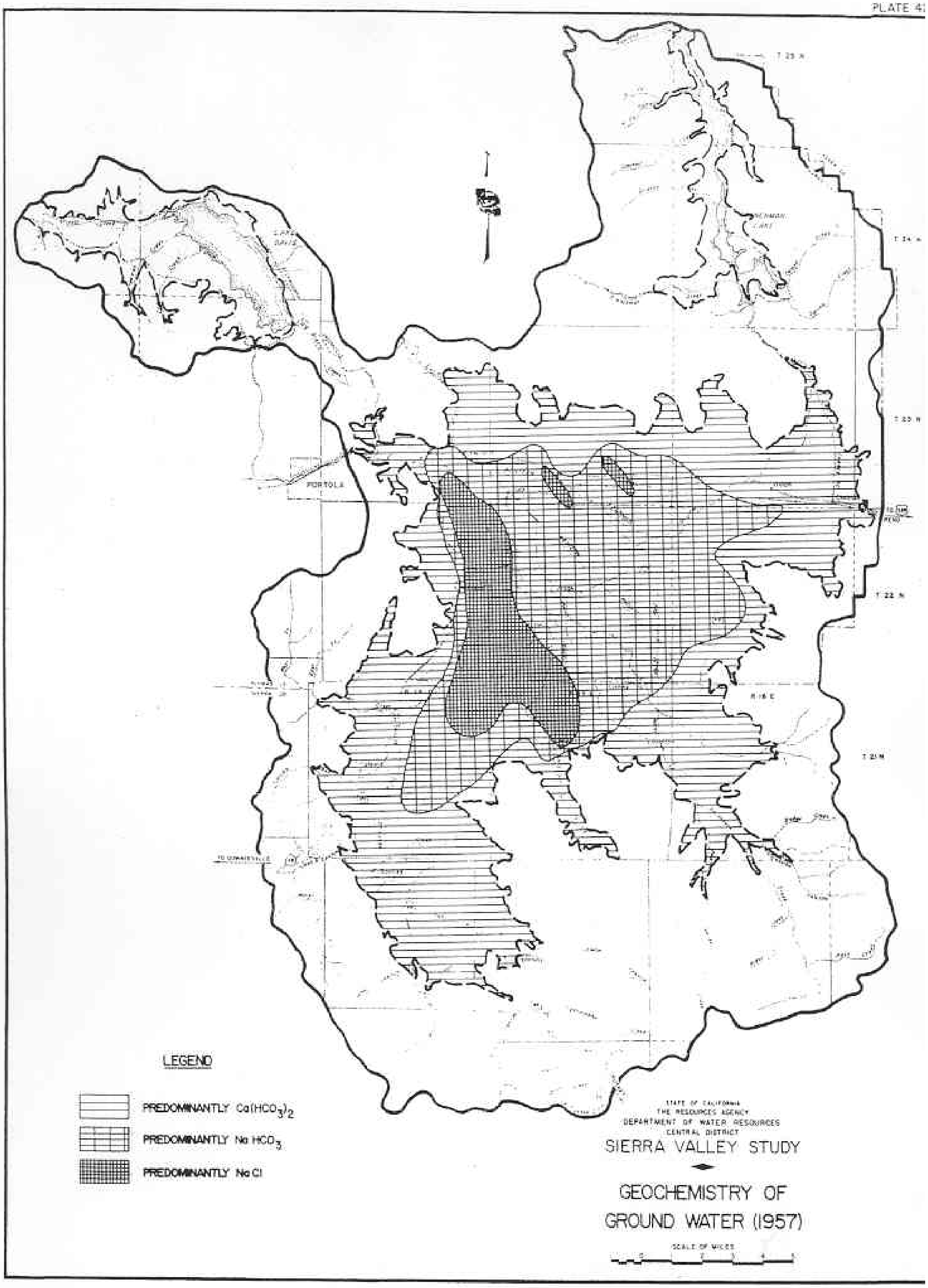
0 1.25 2.5 5 Miles

VESTRA



Source: DWR

FIGURE 5-6a
IRRIGATION CLASS OF GROUNDWATER (1957)
SIERRA VALLEY WATERSHED



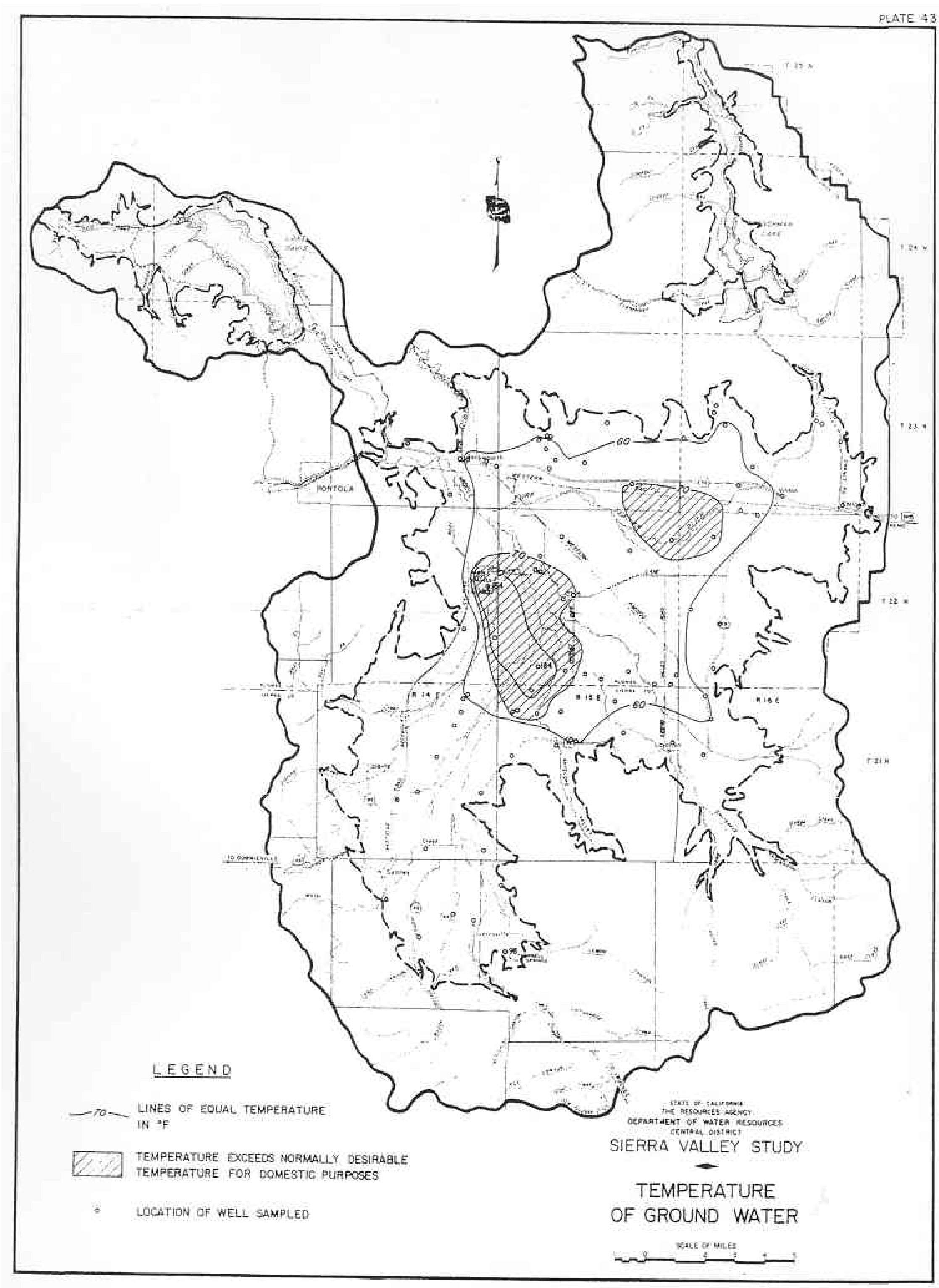
Source: DWR

FIGURE 5-6b

GEOCHEMISTRY OF GROUNDWATER (1957)

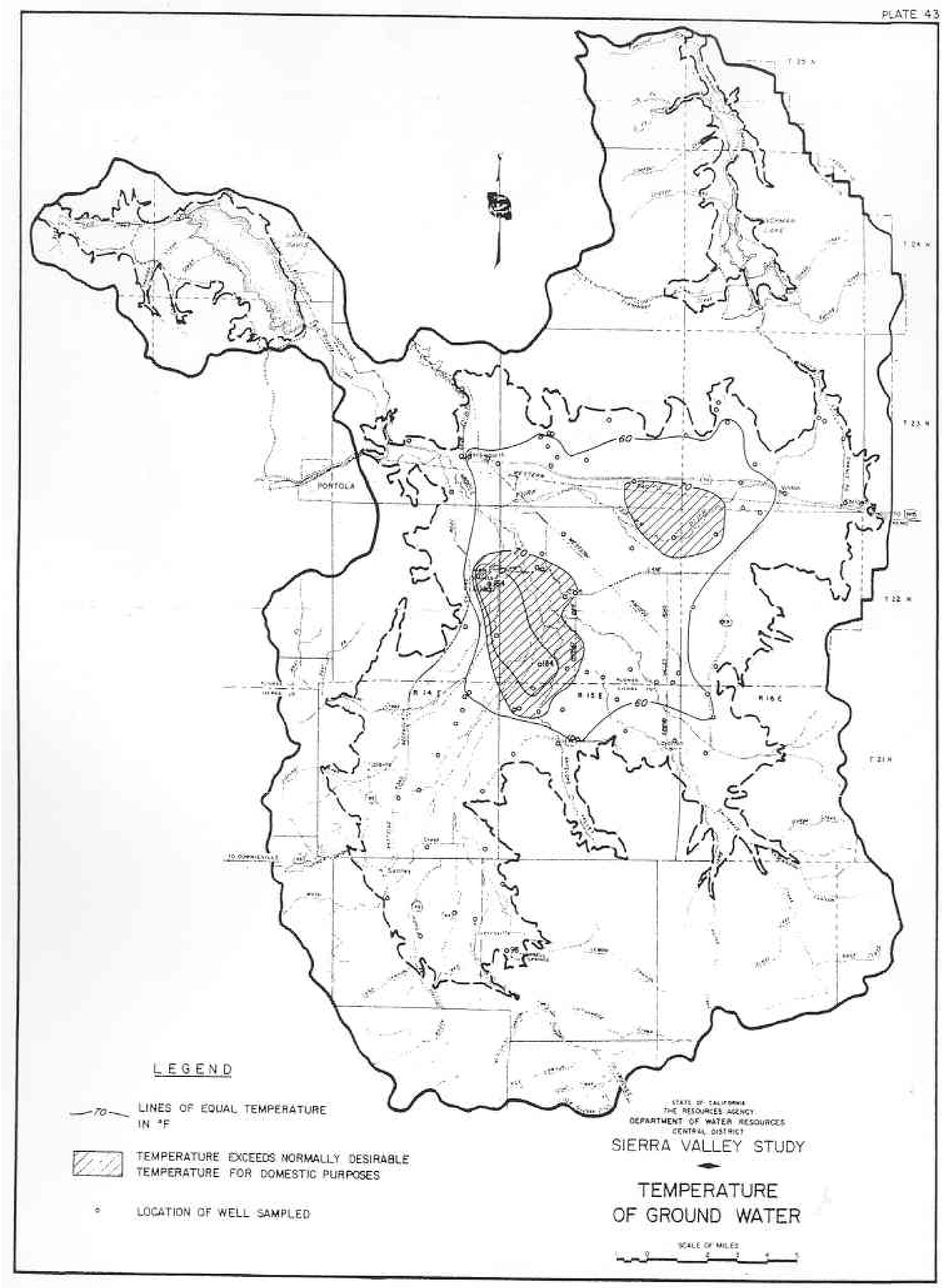
SIERRA VALLEY WATERSHED

VESTRA



Source: DWR

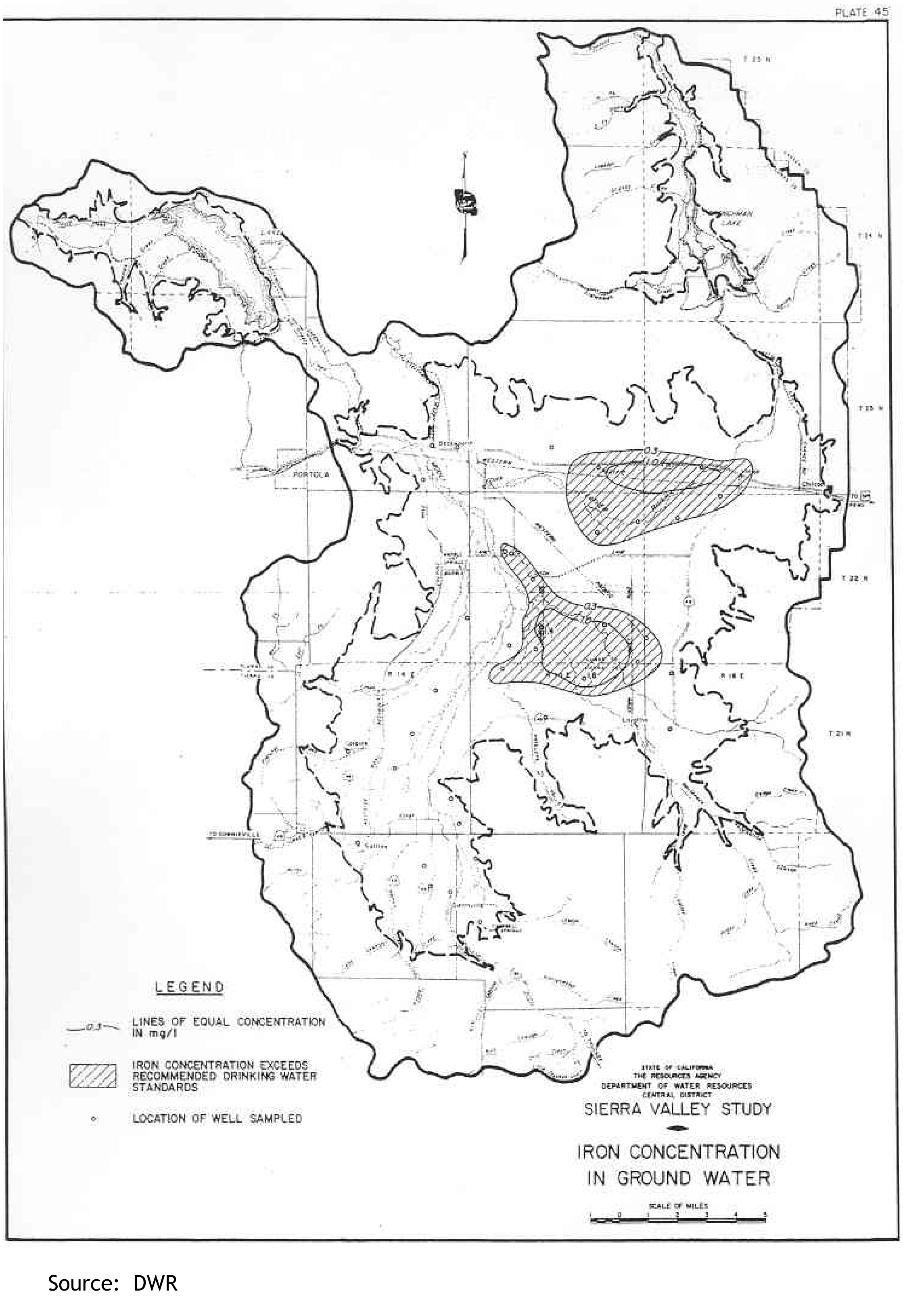
FIGURE 5-6c
TEMPERATURE OF GROUNDWATER
SIERRA VALLEY WATERSHED



Source: DWR

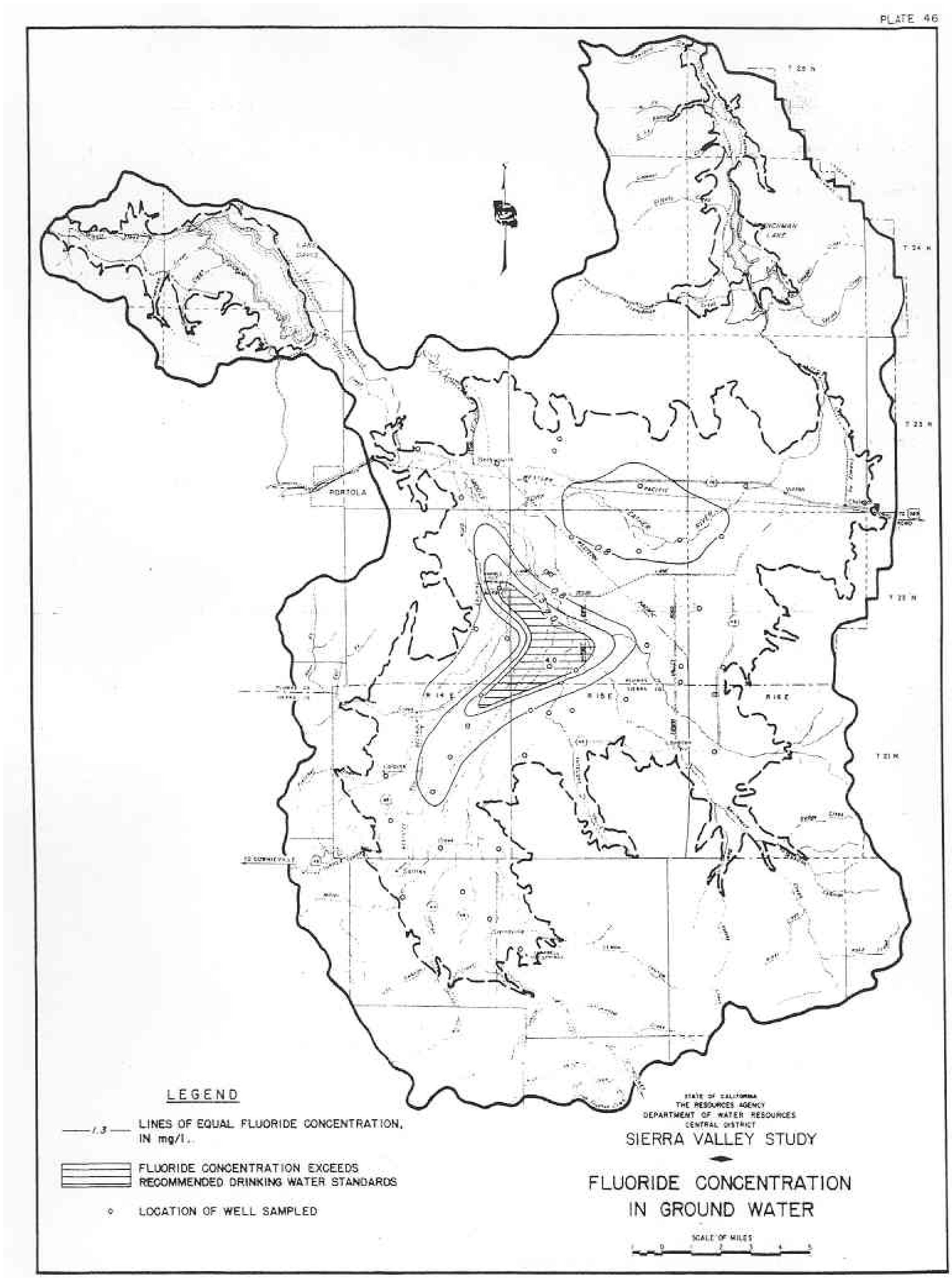
FIGURE 5-6d
SPECIFIC CONDUCTANCE OF GROUNDWATER
SIERRA VALLEY WATERSHED

VESTRA



Source: DWR

FIGURE 5-6e
IRON CONCENTRATION IN GROUNDWATER
SIERRA VALLEY WATERSHED

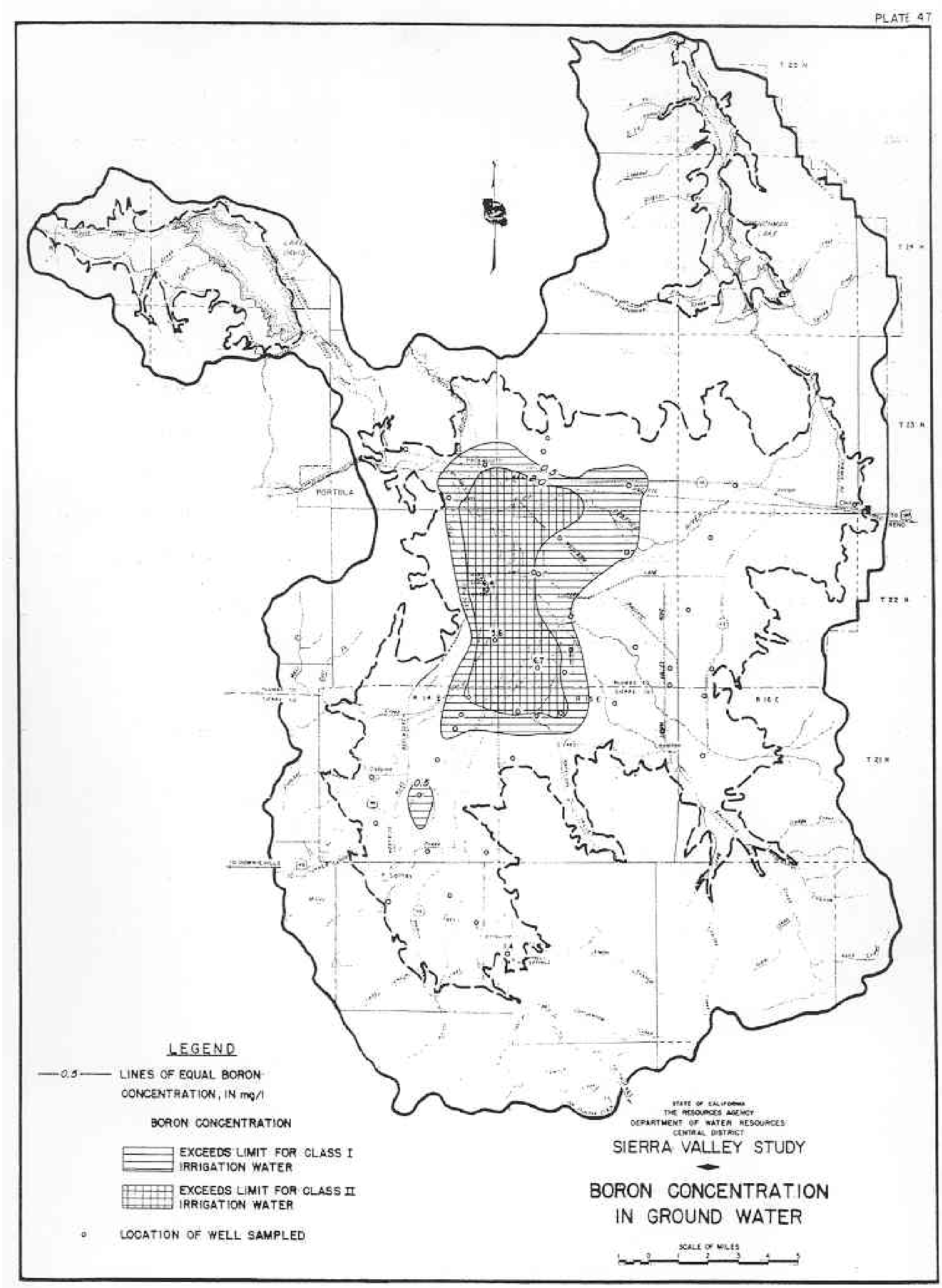


Source: DWR

FIGURE 5-6f

FLUORIDE CONCENTRATION IN GROUNDWATER

SIERRA VALLEY WATERSHED



Source: DWR

FIGURE 5-6g
BORON CONCENTRATION IN GROUNDWATER
SIERRA VALLEY WATERSHED

Section 6

Section 6
BOTANICAL RESOURCES

TABLES

FIGURES

Section 6
BOTANICAL RESOURCES

The 300,000-acre Sierra Valley Watershed is characterized by an intrusion of Modoc plateau vegetation into the forests of the northern Sierra Nevada range. The upland vegetation is dominated by eastside conifer forest types interspersed with patches of chaparral, riparian, and meadow communities. The valley is similar in character to Big Valley in Modoc County. The lowland vegetation is dominated by a combination of agriculture and braided wetlands. Sagebrush scrub is found along the periphery of the cultivated valley floor and the eastern hills. The composition of the ecological communities found in the watershed has changed notably since the early days of California statehood. Reasons for these changes are both natural and anthropogenic—pertaining to climate, fire, invasive exotic plants, agriculture, timber harvest, and livestock grazing.

DATA SOURCES

A variety of literature provides general information on botanical resources of interest in the watershed. Published literature relevant to local or regional conditions are cited including a California Department of Water Resources (DWR) (1973) study of the Sierra Valley and papers from the Sierra Nevada Ecosystem Project's (SNEP) (1996) final report to Congress. A complete bibliography of references is included at the end of this section. Remote-sensed imagery is analyzed to help describe the current distribution of vegetative communities in the watershed. Ancillary geographic information systems (GIS) layers (e.g., annual precipitation, historic fire perimeters) are employed to further illustrate local patterns. The California Natural Diversity Database (CNDDB) is used to identify known occurrences of rare, threatened, and endangered plants. Information on locally occurring invasive plants was provided by staff at the Plumas-Sierra Counties Department of Agriculture. Interviews with various experts and persons with local knowledge provide an important source of information. Although these individuals are not explicitly cited with physical documentation in the section, they are Randy Westmoreland, Larry Ford, and Susan Urie of the Tahoe National Forest; Karl Bishop of the Plumas Sierra Counties Department of Agriculture; and Jan Stine of the Sierra Valley Resource Conservation District.

Two remote-sensed data sets (Table 6-1) are the primary information sources used to describe the current mosaic of vegetation communities covering the Sierra Valley Watershed. Both sources have significant limitations, but taken together and in connection with ancillary GIS layers, they provide information about the large-scale distribution of vegetation in the watershed. The accuracy of the imagery may not be reliable for characterizing areas less than 500 to 5,000 acres in size. However, aerial photographs and location of recent fires were used to quality check and correct the two primary vegetation sets. As part of this watershed assessment, all of the vegetation data sets mentioned above are imported into and analyzed using GIS.

The Land Cover Mapping and Monitoring (LCMMP) vegetation data is derived from multi-spectral LANDSAT TM imagery. The Fire and Resource and Assessment Program (FRAP), a cooperative project of the California Department of Forestry and Fire Protection (CDF) and the United States Forest Service (USFS), maintains and updates this spatial database which is available through the Internet. The base layer for LCMMP is 1991 LANDSAT imagery. However, a process of change

Table 6-1 PRIMARY AND ANCILLARY DATA SETS USED TO DESCRIBE THE CURRENT DISTRIBUTION OF VEGETATIVE COMMUNITIES IN THE SIERRA VALLEY WATERSHED	
Primary Data Sets	**Description**
LCMMP, Vegetation Data Fire and Resource Assessment Program	Vegetation mapping from LANDSAT TM using Calveg system but cross-walked to the CWHR classification system. 1991 baseline updated in 1996 and 2001. 2.5 acre (100 meter pixel) minimum mapping unit. Algorithms used to group pixels into larger polygons with similar vegetation characteristics.
Gap, Land Cover/Vegetation Layer California Gap Analysis Project	Vegetation mapping crosswalked to WHR. Source data is 1990 LANDSAT TM and other supporting sources such as aerial photography and soil maps. 100 or 250-acre minimum mapping unit depending on vegetation type.
Ancillary Data Sets **DOQQ**, Digital Orthophoto Quadrangle GeoTiff California Spatial Information Library	Black and white digital aerial photographs available as quarter quadrangle mosaics. Year 1998 images are geo-rectified and digitized to 1-meter pixel resolution.
Fire Perimeters Fire and Resource Assessment Program	Statewide GIS layer of large fire history. 300-acre minimum for California Department of Forestry and Fire Protection tracked fires since 1950 and 10 acre for US Forest Service tracked fires since 1910.
Average Annual Precipitation	Statewide GIS layer of average annual precipitation.
Forest Productivity	Timber productivity site class mapping from Department of Water Resources (1973).
Late Successional Forest Ranking	Sierra Nevada Ecosystem Project's ranking of public lands for their contribution to late successional forest function (Franklin and Fites-Kaufmann 1996).
Wetlands	GIS layer of valley floor wetlands

detection was used to update individual polygons to 1996 or 2001 conditions. The minimum mapping unit for the LCMMP data is 100 meters by 100 meters (i.e., 2.5 acres). LCMMP uses the Calveg vegetation classification system (USFS 1981). The data is cross-walked into the California Wildlife Habitat Relationships (CWHR) classification system. The CWHR system stratifies vegetation into tree-dominated, shrub-dominated, herbaceous-dominated, and non-vegetative types. The key criterion for tree-dominated classification is at least 10 percent area must be covered in trees. Size and density classes within vegetation types are explained in Table 6-2. Accuracy statistics for the LCMMP data are available online from the FRAP website.

The University of California at Santa Barbara's California Gap Analysis Project created the Gap vegetation layer. The portions of the data set for the Sierra Valley Watershed are primarily derived from 1990 LANDSAT TM imagery, but aerial photography and soil maps were used to refine the satellite data. The GAP data uses the CHWR classifications for vegetation type and density class. The mapping scale is much larger than for the LCCMP data. The minimum mapping unit for Gap is either 100 or 250 acres depending on the vegetation type.

Table 6-2 THE CWHR CLASSIFICATION SYSTEM FOR TREE-DOMINATED HABITATS			
Classification Attribute	**Classification Scheme**		
Size Class	1	Average tree diameter:	< 1 inch
	2	Average tree diameter:	1-6 inches
	3	Average tree diameter:	6-11 inches
	4	Average tree diameter:	11-24 inches
	5	Average tree diameter:	> 24 inches
Density Class	S	Canopy closure:	10-25 %
	P	Canopy closure:	25-40 %
	M	Canopy closure:	40-60 %
	D	Canopy closure:	60-100 %

Digital orthogonal quarter quadrangle (DOQQ) photographs for 1998 are used to quality check the vegetation classifications provided by the LCMMP and Gap data. For example, it appears that LCMMP classifications may confuse distinctions between annual grassland, wet meadow, and montane riparian CHWR types. The photographs reveal bare ground and effects of recent stand fire replacing fires in some places. Consequently, the FRAP fire perimeter map is used to re-categorize some of these fire effected areas. All LCMMP polygons labeled as CHWR size class "0" occurring within the boundaries post-1994 fires are reclassified as "Recent Post Fire." Due to lack of updating since 1990, the entire intersection between Gap polygons and the post-1994 fires are reclassified as "Recent Post Fire."

For the purposes of this watershed assessment, the similar CWHR classes from the LCMMP and Gap data are grouped together as the "lifeforms" defined in Table 6-3. As noted above, the CWHR classifications grouped in the "Recent Post Fire" and "Wet Meadow/Grassland/ Riparian" Lifeforms are done so largely because of quality corrections provided by study of the ancillary GIS data. A core reason for using lifeforms is the limited clarity of the two satellite-derived vegetation map sets makes it difficult to accurately distinguish the more detailed CWHR types. However, CHWR vegetation types are discussed later in the section where information that is more detailed is available.

ECOLOGICAL PROCESSES AND PATTERNS

On large scales, ecological forces at work in a region shape vegetation patterns. Climate, topography, soil, frequency of natural disturbance such as fire, and human management are all driving factors that affect how vegetation is distributed on the landscape at any given point in time. Patterns in nature are rarely unchanged. Trees grow and die; while fires and other natural calamities periodically destroy entire forests. Agriculture and irrigation modify conditions on the valley floor. The mosaic of vegetation types (e.g., conifer forest, sagebrush, wetlands, etc.) constantly changes over time but the pattern remains. We can use ecology to describe the range of variability in vegetation patterns and the trend of change in a place.

Table 6-3 MAJOR VEGETATION LIFEFORMS USED IN THIS WATERSHED ASSESSMENT AND THE CROSSWALKING OF CWHR AND CALVEG VEGETATION CLASSIFICATION SYSTEM		
Lifeform	**CWHR Types Included in Lifeform**	**Calveg Types Included in Lifeform**
Montane Conifer	Douglas fir, ponderosa pine, eastside pine, red fir, sub alpine conifer, Sierran mixed conifer, white fir	Eastside pine, mixed conifer-pine, mixed conifer-fir, ponderosa pine, ponderosa pine-white fir, red fir, subalpine conifers white fir western white pine
Agriculture	Cropland	Agriculture
Sagebrush Scrub	Sagebrush, bitterbrush	Basin sagebrush, bitterbrush
Recent Post Fire	n/a	n/a
Wetland/ Grassland	Wet meadow, annual grassland	Annual grass/forbs, wet meadow (grass/sedge/rush), perennial grass
Deciduous Riparian/ Hardwood	Montane riparian, aspen, montane hardwood, montane hadwood-conifer	Mountain alder, willow, willow (riparian scrub) willow-aspen, quaking aspen, California black oak
Chaparral	Montane chaparral	Montane mixed chaparral
Other	Juniper, barren, water, lacustrine	Quaking aspen, western juniper, barren
Urban	Urban	n/a

The Sierra Valley forms a westerly extension of Modoc Plateau vegetation into the northern mountains of the Sierra Nevada range (Figure 6-1). During the last ice age, the Sierra Valley was a lake but its waters eroded though the Sierra Crest and drained into the Feather River. Deep lake sediments still underlie the valley floor.

Cold continental air moving off the Great Basin area of Nevada leads to cold winter temperatures, and a shorter growing season than in other parts of northern California. Weather coming off the Pacific Ocean is forced upward by the Sierra Mountains to the west of the watershed. As the clouds rise they cool, condense, and shed most of their moisture in form of storms in the mountains. This creates a rain shadow effect on the east side. Average annual precipitation drops from a high of 65 inches at higher elevations in the southwest of the watershed to a mere 10 to 20 inches on the valley floor (Figure 6-2).

Plants create food from sunlight by a chemical process called photosynthesis. Net primary production is a term ecologists use to describe growth or total sum of energy plants in an area capture minus energy lost through life and death processes. Temperature, soil, nutrients and the availability of water indirectly influence and limit productivity. Due to the rain shadow effect, moisture is a limiting factor on growth for coniferous forest in the watershed. The distribution of coniferous forest within the watershed is restricted to the higher elevations where annual precipitation is sufficient to permit higher levels of productivity. During the dry months of summer, northeast facing slopes situated in the southwest corner of the watershed are more sheltered from the sun than other aspects. As a result, forests on these slopes conserve water more effectively and tend to be higher in productivity. Trees on dry sites or unprotected aspects are shorter in stature and take longer to grow to large diameters. On the valley floor, grasses and sagebrush historically covered much of the area. The upper headwaters of the Feather River drain as braided watercourses across western portions of the valley. Naturally, hydric conditions in conjunction with agricultural irrigation support pockets of wetland and riparian communities. Sagebrush scrub and juniper woodland are found in the middle elevations between alfalfa fields of the valley and coniferous forests of the surrounding uplands.

Historically, fire played a key role in the patterns of forest vegetation found in the watershed and throughout the eastern Sierra. Frequent low intensity ground fires consumed downed wood and killed most of the smaller trees. As a result, much of the forest had an open park-like condition with grasses and sagebrush under widely spaced, large diameter ponderosa and Jeffrey pines. The effects of fire were not uniform. The catastrophic stand-replacing fires that are more common today occurred in the past as well. In moister areas on sheltered north facing slopes patches of denser forest including classic late seral forests developed. In these places, the ecological process of forest succession proceeded further between disturbance events. White fir seed blown across the winter snows seeded in the spring below established pines. The shade-tolerant fir trees eventually grew up into multiple layers of a closed canopy forest. Over time and at increased densities, individual trees died creating gaps as well as snags (e.g., standing dead trees) and downed logs. Both the open park-like and the classic old growth forests described above existed in the eastern Sierran landscape. Limited productivity and frequent fires kept the driest, lower elevation and easternmost portions of the Sierra Valley Watershed in grassland and sagebrush. Grass fires consumed tree seedlings thus checking the expansion of juniper and other trees into lower elevation areas.

As part of ecosystems, human activities affect the distribution of vegetation. Native Americans used fire widely as a tool; both for hunting and to manage other resources needed for survival (Blackburn et al 1993). This included the burning of grasslands to improve basket materials, burning of grassland and sage communities to assist in hunting small game and encourage new edible shoots; and burning in the coniferous forests to assist in hunting and keeping the forests open and passable.

Over the last 150 years, activities of European settlers significantly altered ecological conditions in the Sierra Valley Watershed. The United States' acquisition of California from Mexico in 1848 plus the discovery of gold in 1849 led to large numbers of new settlers moving westward. Swiss and Italian immigrants settled in the Sierra Valley in the 1850s. Their farms and ranches produced food for sale to the silver miners of western Nevada. Between 1860 and 1880, the acreage of improved land in Sierra County increased by almost 600 percent (Momsen 1996). In the years between 1880 and 1912, sheepherders moved north along eastern Sierra up through to Modoc County. Uncontrolled levels of overgrazing led to precipitous declines in the availability of native forage plants in the lowlands and uplands (Menke et al 1996).

In a personal communication to Brett Furnas by L. Ford of the Tahoe National Forest in 2004, it was stated that between the 1880s and 1935, the forests surrounding the Sierra Valley were cut heavily and the most mature conifers in the watershed are now only 80 to 100 years old. The suppression of wildfires over the last 50 to 100 years altered forest structure as great a degree as timber harvest. The absence of frequent low intensity fires over most of the landscape allowed the stocking of shade tolerant and fire intolerant species to increase. Today, conifer forests are denser and contain more white fir than 100 years ago. These conditions make it more difficult for pine regeneration to occur naturally.

Some invasive exotic weeds such as perennial pepperweed and cheatgrass are established in the watershed. These weeds can displace native vegetation and difficult to eradicate. Alfalfa and other agricultural crops grown on the valley floor replace native vegetation. Irrigation is required to support these crops.

Not all of the effects of human management on the environment are negative. Cattle, timber, and agricultural crops are valuable products for use by the Californian people and help to support local economies. Forestry management and harvesting is often used as a tool to thin and reduce tree densities in the absence of frequent low intensity fires and they provide needed wood projects to consumers. Irrigation for agricultural purposes can create artificial wetlands that serve as nesting habitat for migrating birds. Alfalfa is more water efficient than other crops and provides habitat for many wildlife species.

REFERENCE CONDITIONS

The estimated relative amounts of the different vegetative lifeforms present in the watershed are featured in Table 6-4. Vegetation maps using the LCMMP and Gap data are featured in Figures 6-3 and 6-4. Coniferous forest makes up approximately one third of the watershed. It is generally restricted to mountainous portions of the watershed and places with more than 22 inches of average annual precipitation. Agricultural lands and other grasslands cover approximately one quarter of the watershed. These areas are concentrated in the lower flatter portions of the watershed where average annual precipitation is generally below 18 inches. To the east, about one fifth of the watershed is covered by sagebrush scrub in areas of middle elevation and precipitation. Other less prevalent vegetation lifeforms include chaparral, wetlands, grasslands, and deciduous riparian and other hardwoods.

A partial list of non-tree plants occurring in the watershed is provided in Table 6-5. This information was compiled from plant species lists for the CDFG's Antelope Valley and Crocker Meadow wildlife areas that cover mostly sagebrush scrub and lower elevation montane conifer lifeforms.

VALLEY FLOOR VEGETATIVE LIFEFORMS

For the purpose of this assessment, the valley floor is defined by the Sierra Valley US Department of Agriculture (USDA) subecoregion where slopes are generally less than five percent. It includes approximately 115,000 acres or about 40 percent of the watershed.

Urban Areas

Urban areas including Loyalton, Sierraville, Sattley, Calpine, Beckwourth, and Vinton cover less than 1,000 acres of the watershed. A higher concentration of invasive exotic weeds is on developed and disturbed lands near these towns. Large mature cottonwoods grow in many of these towns. Fruit trees and ornamental plants are also common.

Agricultural Lands

Agricultural fields are the most common vegetative community on the valley floor. They cover nearly 100,000 acres. Alfalfa (*Mendicago sativa*) grown for hay is the primary crop (Figure 6-5a). Much of the hay is sent to the Central Valley and California Coast for livestock feed in

Table 6-4 RELATIVE AMOUNTS OF MAJOR VEGETATIVE LIFEFORMS IN THE SIERRA VALLEY WATERSHED			
Lifeform	**Overall Estimate (%)**	**LCMMP (%, acres)**	**Gap (%, acres)**
Montane Conifer	**32**	31.9 96,424	32.8 97,764
Agriculture	**27**	26.3 78,385	28.1 83,523
Sagebrush Scrub	**20**	21.5 62,935	19.0 56,549
Recent Post Fire	**10–12**	9.5 28,143	14.7 43,745
Chaparral	**3–4**	4.5 13,151	3.3 9,734
Wetland/Grassland	**2–5**	4.9 14,465	1.2 3,713
Deciduous Riparian/Hardwood	**< 1**	0.7 2,227	n/a
Other	**< 1**	0.4 1,074	0.9 2,629
Urban	**0.3**	0.3 853	n/a

dairies. Alfalfa is a perennial legume (e.g., pea family) that grows in dense canopy stands once established. Alfalfa is harvested three to four times a year in the Sierra Valley and it is three to six years before replanting is required. Roots go 9 to 15 feet or deeper making alfalfa a more efficient user of water than many other crops. Irrigation is still a prerequisite for growth in the Sierra Valley (Putnam et al 2001). More information on alfalfa and other agricultural crops of the Sierra Valley is discussed in Section 8, "Land Use."

Grasslands and Sagebrush Scrub

Before Swiss, Irish, and Italian settlers came to the Sierra Valley in the 1860s, wetlands, grasslands, and sagebrush scrub covered most of the valley floor. Today, grasslands and sagebrush scrub cover areas not cultivated or used for pasture. Unlike the annual grasslands of the Central Valley that have been widely populated by invasive exotic grasses since the arrival of Europeans, native perennial grasses still largely characterize much of the grasslands of Sierra Valley. This may be since the colder continental climate east of the Sierras is less conducive to the survival of annual grasses of Mediterranean origin. Sandberg bluegrass (*Poa secunda*), Idaho fescue (*Festuca idahoensis*), various needlegrasses (*Stipa* spp.*)*, and wildrye (*Elymus* spp.) are native grasses found in the Sierra Valley. There are notable invaders of Sierra Valley grasslands. Cheatgrass (*Bromus tectorum*) is one invasive exotic annual grass of European origin that is a problem on disturbed (e.g., overgrazed or eroded) sites in grassland and sagebrush scrub communities within the watershed, as stated in a personal communication to Brett Furnas by S. Urie of the Tahoe National Forest in 2004. Cheatgrass can increase the risk of fire and out compete native grasses.

Table 6-5 PARTIAL LIST OF NON-TREE PLANTS THAT OCCUR IN THE WATERSHED	
Scientific Name	**Common Name**
Achnatherum speciosum	desert needlegrass
Amelanchier alnifolia	Saskatoon serviceberry
Amsinckia spp.	fiddleneck
Arctostaphylos patula	greenleaf manzanita
Artemisia tridentata	big sagebrush
Astragalus argophyllus	silverleaf milkvetch
Astragalus lentiginosus	specklepod milkvetch
Astragalus webberi	Webber's milkvetch
Balsamorhiza sagittata	arrowleaf balsamroot
Bromus tectorum	cheatgrass
Camissonia tanacetifolia	tansyleaf suncup
Carex spp.	sedge
Ceanothus prostrates	squaw carpet
Ceanothus velutinus	snowbrush
Cercocarpus spp.	mountain mahogany
Cercocarpus ledifolius	curlleaf mountain mahogany
Chrysothamnus nauseosus	rubber rabbitbrush
Elymus elymoides	squirreltail
Ivesia aperta	Sierra Valley mousetail
Ivesia baileyi	Bailey's ivesia
Ivesia sericoleuca	Plumas mousetail
Ivesia webberi	wire mousetail
Juncus spp.	rush
Leymus cinereus	basin wildrye
Poa secunda	one-sided bluegrass
Purshia tridentata	antelope bitterbrush
Rosa woodsii	Woods' rose
Salix lasiolepi	arroyo willow
Salix lutea	yellow willow
Symphoricarpos rotundifolius	Mountain snowberry
Tetradymia spp.	horsebrush
Trifolium lemmonii	Lemmon's clover
Urtica dioica	stinging nettle
Wyethia mollis	woolly wyethia
Source: Plant species lists for the Antelope Valley and Crocker Meadows CDFG wildlife areas. http://www.dfg.ca.gov/lands/wa/region2/antelopevalley.html http://www.dfg.ca.gov/lands/wa/region2/crockermeadows.html	

The sagebrush and bitterbrush CWHR types are primary forms of sagebrush scrub found in the watershed. They are characterized by big sagebrush (*Artemisia tridentata*), antelope bitterbrush (*Purshia tridentata*), curlleaf mountain mahogany (*Cercocarpus ledifolius*) and rubber rabbitbrush (*Chrysothamnus nauseosus*), as well as native grasses. The distinction between sagebrush scrub and grasslands is not always clear as grasses occur in sagebrush scrub, and sagebrush and bitterbrush occur in grasslands. The distribution of sagebrush scrub is more concentrated in the eastern portion of the watershed.

Wetlands, Vernal Pools, and Riparian Vegetation

There are at least 5,000 acres of flooded and seasonally flooded wetlands on the valley floor (Figure 6-6). The largest wetland is an approximately 3,000-acre fresh emergent wetland CWHR type community characterized by marshes where the Feather River braids into multiple channels and pools to the southeast of Beckwourth. Bulrushes (*Scirpus* spp.) and other species that grow in these wetlands are adapted to anaerobic saturated soil conditions. Sedges and rushes grow along the fringes of smaller wetlands and seasonally flooded areas found elsewhere on the valley floor (Figure 6-5b). Extensive areas of sagebrush scrub and agricultural field are also seasonally flooded.

Vernal pools are an important subclass of wetlands. They are seasonally flooded depressions in the land underlain by a hardpan soil layer that limits drainage. They fill with water in the winter, flourish with life in the spring; and dry out in the summer. These pools occur singly or in complexes and differ from other ephemeral wetlands. They often support a specialized set of plants and animals including a relatively large number of threatened and endangered species.

The California Department of Fish and Game (CDFG) defines the Sierra Valley Vernal Pool Region as the western portion of the Sierra Valley; the intermountain valleys of the Diamond Mountains such as Squaw Queen and Davis Lake valleys; and portions of Sierra and Nevada Counties in the vicinity of Truckee. A report by the CDFG (Keeler-Wolf et al 1998) describes the condition of vernal pools in this region. There are no extensive vernal pool complexes in the region. CNDDB maintained by the CDFG inventories the locations of vernal pools and other biological resources throughout California. All four CNDDB-noted vernal pools in the region lie within the Sierra Valley. These occurrences are small complexes consisting of several small pools. Additional isolated small pools not noted in CNDDB may also occur throughout the region. Figure 6-7 shows the location of the four vernal pool complexes as well as CNDDB occurrences for two vernal pool associated rare plants. These plants are Sierra Valley ivesia (*Ivesia aperta*) and Plumas ivesia (*Ivesia sericoleuca*). Other taxa occurring near these pools include three species of *Downingia*; *Eryngium alismaefolium; Navarretia leucocephala* ssp. *minima; Veronica scutellata; Plagiobothryshispidulus; Perideridia bolanderi; Myosurus minimu; Eleocharis acicularis;* and *Deschampsia danthonoides*. The Sierra Valley pools described in the CNDDB are all surrounded by rush (*Juncus* spp.) dominated meadows.

Patches of willows and other riparian vegetation grow along streams and other watercourses in the Sierra Valley (Figure 6-5c). Long linear stretches exist along irrigation canals.

UPLAND VEGETATIVE LIFEFORMS

For the purpose of this assessment, the watershed uplands are defined as those areas surrounding the Sierra Valley USDA subecoregion. Upland slopes are generally greater than five percent. The uplands include approximately 180,000 acres or about 60 percent of the watershed.

Sagebrush Scrub

Sagebrush scrub transitions from the valley floor up through the lower slopes into the montane conifer lifeform where big sagebrush and bitterbrush populate the ground story of open stands of eastside pine. Sagebrush scrub is a dominant feature of the landscape on the hills northeast of Loyalton (Figure 6-5d). Sagebrush combined with juniper is found in the hills to the northeast of Sierraville.

Montane Conifer

Approximately half of the upland areas in the Sierra Valley Watershed are covered by coniferous forest. These forests are mostly concentrated on slopes in the southwest half of the watershed. A timber productivity map from the DWR (1973) study of the Sierra Valley area partially explains the distribution of conifers in the watershed (Figure 6-8). Site classification is a common method foresters use to quantify the productivity of different sites for growing trees. The reasons for differing productivity are a function of factors: annual precipitation, soil quality, length of growing season, and aspect. The most productive timberlands are located on northwest facing slopes receiving higher rates of annual precipitation. Less than 15 percent of the forestland is on moderately productive Site Class II land, whereas over 75 percent of the forestlands lie on poorly productive Site Class IV and V lands.

Within the montane conifer lifeform (Figure 6-5f) there are at least four different yet overlapping CWHR-defined forest types (Figure 6-9). Red fir forests occur at the highest elevations along the watershed's southwestern border. This CWHR type generally occurs between 6,000 and 9,000 feet elevations in the Sierra Nevada. Red fir (*Abies magnifica*) is a species of true fir characterized by a red-purple bark on mature trees. The red fir CWHR type often grows in monotypic even-aged stands on thin soils where summer time competition for moisture limits the distribution of other plants (Mayer and Laudenslayer 1988). Within the watershed, red fir occurs in dense stands with little else growing below. This forest type also exists in a more open condition in places where "shelterwood" forestry has been practiced or on rocky sites. In more open stands, various brush species including pinemat manzanita (*Arctostaphylos nevadensis*), ribes, and ceanothus species occupy the ground layer. The white fir CWHR type occurs below the red fir forest, generally between 5,000 and 6,000 feet. It is similar in structure except that white fir (*Abies concolor*) is the dominant species. Greenleaf manzanita (*Arctostaphylos patula*) and snowbrush (*Ceanothus velutinus*) occur in openings and disturbed areas, as stated in a personal communication to Brett Furnas by S. Urie of the Tahoe National Forest in 2004.

Sierran mixed conifer forest in the watershed is a combination of conifer species including white fir, ponderosa pine (*Pinus ponderosa*), sugar pine (*Pinus lambertiana*), and incense cedar (*Calocedrus decurrens*). There is also a component of Douglas fir (*Pseudotsuga menziesii*) in the forests above Calpine. A high density of stems and multiple canopy layers characterizes the Sierran mixed conifer CWHR type. Due to its shade tolerant foliage, white fir clogs the lower strata of Sierran mixed conifer stands. However, a variety of shrubs, herbaceous plants, and grasses grow in small openings and in places where canopy cover is less dense (Mayer and Laudenslayer 1988). The eastside pine CWHR forest type grows near the valley floor and on other sites of low timber productivity. Sierran mixed conifer is the dominant forest type of the southwestern slopes of the watershed while eastside pine is the most common forest type in the northern and eastern portions of the watershed. Ponderosa pine dominates the eastside pine forest, but Jeffrey pine (*Pinus jeffreyi*) and western juniper (*Juniperus occidentalis*) also occur. Due to low site productivity, the structure of eastside pine tends to be more clumpy and open than Sierran mixed conifer. Sagebrush scrub associated species including: big sagebrush, antelope bitterbrush, Curlleaf Mountain mahogany, mule ears, and Idaho fescue inhabit the ground layer (Mayer and Laudenslayer 1988).

One hundred and fifty years ago, the structure and composition of conifer forests within the watershed were quite different from conditions today. Large areas of forest remained in an open, park-like condition due to frequent low-intensity fires occurring as regularly as every 5 to 15 years. These fires were less likely to kill mature thick-barked pines, but instead consumed fuels and limited regeneration. Over the passage of centuries, pockets of younger trees survived the fires growing up to replace parent trees. Denser old growth stands of the red fir, white fir, and Sierran mixed conifer types existed on higher productivity sites at higher elevations on northerly aspects. Research on fire scars and historical conditions from the Blue Mountains of eastern Oregon suggest that in past centuries less than 20 percent of dry east-side pine forested landscapes were covered by dense multi-layered old growth forest. These refugia would have been located in places where topographical conditions prevented frequent fires (USFS 2001).

It is also important to note climatic conditions in the Sierra Nevada over the last several hundred years have been wetter, warmer, and more stable than climates of the past 2,000 years. Consequently, natural and anthropogenic changes in future climate will likely affect disturbance regimes and the distribution and composition of forest types in the watershed.

A national policy of fire suppression over the last 50 to 100 years is one factor that led to dramatic changes in forest structure throughout western forests. The exclusion of natural fires led to increased forest tree densities in the watershed. Without frequent low-intensity fire white fir has become a more frequent component than it was 150 years ago. Successful natural regeneration by shade intolerant pine species is less likely. A reasonable guess about the watershed forests before European arrival is that they were mostly open eastside pine and patchy Sierran mixed conifer with red fir forest at higher elevations. Logging has also altered forest structure. Between the late 1800s and 1935, much of commercially valuable conifers in the watershed were harvested. During the same period residents of the Sierra Valley used smaller residual trees for fuelwood. Consequently, present day Sierran mixed conifer forests mostly contain mid-sized trees (e.g., less than 24 inches diameter at breast height (dbh) of 60 to 100 years of age. In contrast, the average ponderosa pine tree before 1900 was three to four feet dbh and 250 to 350 years old (McKelvey and Johnston 1992). More information on fire suppression and forestry is discussed in Section 9, "Forestry, Fire, and Fuels Management." The historical pattern of livestock grazing has also affected forest structure. Severe overgrazing and seasonal burning associated with sheepherding between 1880 and 1910 led to soil degradation and deforestation in many places on the east slopes of the Sierra (Menke et al 1996). The relatively young age (e.g., less than 100 years) of much of the forest in the watershed is partially the result of the massive pulse of even-aged conifer regeneration that occurred upon the cessation of sheep grazing, burning and logging from the early era of European settlement..

A project (Gruell 2001) of repeat photography at locations where historic photographs were taken provides visual evidence of changing ecological conditions in Sierra Nevada forests. Some of the photographs from this project are excerpted in Figure 6-10.

- ***Photograph a*** demonstrates the open park line structure of pine-dominated forests resulting from frequent low intensity fires, but also shows the effects of severe over-grazing occurring during the sheepherding era.

- ***Photograph b*** shows how the density and composition of western forests have changed in the absence for frequently occurring fires.

- ***Photograph c*** shows the patchy distribution of forests and openings at the scale of the landscape under past conditions.

- ***Photograph d*** demonstrates how current landscape conditions are more homogenous than in the past.

- ***Photograph e*** documents the effects of early era logging.

- ***Photograph f*** demonstrates a legacy of early logging: 80 to 100 years old forests.

Satellite-derived map information about present day tree size and canopy closure for forests in the Sierra Valley Watershed is provided in Figures 6-11 and 6-12. The Sierran mixed conifer forests of the southern watershed typically contain 300 to 500 stems and 250 to 350 square feet of basal area per acre. There are only a few trees per acre greater than 24 or 30 inches dbh. However, there is a greater frequency of trees 30 to 50 inches dbh in the Red Fir forest because of inaccessibility during the early logging era. Isolated groves of un-logged closed canopy old growth forest occur on less than 1,000 acres throughout the watershed. Lightly harvested, (e.g., sanitation and salvage silviculture), stands of old growth forest account for a few thousand additional acres. However, the potential for the establishment of old growth on forests within the watershed is considered low compared to other locations within the Sierra Nevada. In an assessment of the SNEP, the most productive forests within the watershed were stated as providing only a low contribution late successional forest function (Franklin and Fites-Kaufman 1996, Figure 6-13).

Montane Meadows, Riparian Areas, Aspen, and Other Hardwood Communities

Wet meadows, montane riparian and aspen are three CWHR types found in close association on upland areas of the watershed. As noted in the discussion of Reference Conditions, the satellite-derived vegetation mapping is limited in its ability to distinguish between these types.

Wet meadows are places where a high year-round water table is unfavorable for the survival of tree and shrub roots. Saturated soil conditions are often the result of topographical features such as hanging valleys and places near low gradient, meandering streams. Low herbaceous plants dominate wet meadows because they can tolerate the high water table. Sedges (*Carex* spp.), rushes (*Juncus* spp.), grasses, and broadleaved forbs are the most common plants. Stingers of willows (*Salix* spp.) are scattered throughout larger meadows.

At more than 200 acres, Carman Valley is the largest wet meadow community in the watershed uplands. Characteristic species include tufted hairgrass (*Deschampsia caespitosa*), Kentucky bluegrass (*Poea pratensis*), and American bistort (*Polygonum bistortoides*). Stringers of willows (*Salix* spp.) occur, but aspen is infrequent. Throughout the Sierra Nevada, wet meadows are impacted by numerous factors including overgrazing and mining. It is believed that soil structure in Sierran meadows generally had built up over the last 10,000 years. Erosion leading to stream channelization and the conversion of wet meadows to drier systems subject to invasion by sagebrush and conifers has been the trend over the last century (Kattelmann and Embury 1996). Historic railroad construction and other practices have led to erosion problems in Carman Valley. USFS, in a partnership effort with other entities including SVRCD, restoration work has been implemented in the meadow system. Documentary videotape has been produced on the restoration efforts and its effects, contact SVRCD for more information.

Willows, black cottonwood (*Populus trichocarpa*), alder (*Alnus* spp.), and aspen (*Populus tremuloides*) are the deciduous "hardwood" trees that characterize montane riparian communities found in the upper watershed. This vegetation type occurs as thin linear strips along stream margins where conifers are not dominant. In contrast to the coniferous forest, deciduous riparian vegetation is rarely taller than 50 feet. Fire, high winds channeled through mountain gorges, and the flooding of streams are disturbance regimes that periodically kill large riparian conifers allowing establishment of the montane riparian type. Montane riparian vegetation also often occurs along the periphery of wet meadows or as stringers within meadows

One possible factor leading to reduced vigor and regeneration of deciduous riparian trees in the watershed is the exclusion of fire. Aspen are likely less widespread in the watershed than 100 years ago. The succession of conifer forest since the early era of logging and the advent of active fire suppression efforts has resulted in shade intolerant aspen being shaded out by conifers. Furthermore, fewer gaps in the forest provide less opportunity for aspen regeneration. Additionally, cattle's grazing impacts those areas where aspen does regenerate. To date less than 50 acres of aspen stands have been restored on USFS lands, but more work is planned on hundreds of acres. Restoration involves the removal of competing conifers in order to release residual aspen and to promote aspen regeneration from root suckers. Within the Smithneck Creek drainage, there are occurrences of thick aspen regeneration on sites recently burned by the 1994 Cottonwood Fire. The largest occurrences of mature aspen exist along the Feather River in the Yuba Pass area to the west of Beckwourth.

Black oak (*Quercus kelloggii*) is an infrequent component of forests within the watershed. In fact, it is not typically found on the east side of the Sierra Nevada. A low point in the Sierra Crest at where the Feather River leaves the watershed has facilitated the eastern expansion of black oak and Douglass fir ranges. For example, a small stand of black oak grows on private land on a north facing butte slope visible from County Road A23 between Calpine and Beckwourth.

Recent Post Fire and Chaparral

Since 1994, fires have burnt 44,000 acres within the watershed. Most of the burnt areas occurred on montane conifer and sagebrush scrub lifeforms. These areas amount to 10 percent of the watershed or 25 percent of the uplands. Due to the scale and changes occurring in the recently burned areas, they are treated as a separate lifeform in this assessment (Figure 6-5e).

The largest burned area (i.e., 40,000 acres) is from the 1994 Cottonwood Fire in the Smithneck Creek drainage south of Loyalton. Salvage logging occurred on 15,000 to 20,000 acres, whereas residual green trees and snags remain standing on portions of the remainder. USFS lands that were forested before the fire were mostly replanted between 1995 and 1997, although some follow-up planting still continues. Overall, about 20,000 acres, or 50 percent, of the fire area was replanted. Of this acreage, 7,000 to 10,000 acres were circular hand grubbed to control competing vegetation. Additionally, there are plans to treat some areas with herbicide. Based on a post-fire inventory, the USFS developed a ranking system that rates coverage by brush vegetation as high, medium, or low. Areas ranked as "high" will be prioritized for herbicide treatment though at this time, treatment has been stayed by court order. At the scale of the entire burn area, the relative abundance of brush species (e.g., chaparral) is comprised mostly of snowbrush (approximately 80 percent) and greenleaf manzanita (approximately 20 percent).

The post fire areas are in the early stages of succession. Management will play a crucial role in affecting the speed and trajectory of this path. Some areas will return quicker to the montane conifer lifeform whereas others may remain longer in the chaparral lifeform that currently dominates less than five percent of the watershed. The montane chaparral CWHR type describes most chaparral communities in the watershed. Species composition varies from place to place but may include different species of ceanothus; manzanita; mountain mahogany; bitter cherry (*Prunus emarginata*); and sierra chinkapin (*Castanopsis sempervirens*). Within 10 years of establishment, chaparral can become very dense and delay conifer dominance for up to 50 years. Alternatively, chaparral may remain on drier rockier sites indefinitely (Mayer and Laudenslayer 1988).

SPECIAL-STATUS PLANTS

Background

The Sierra Valley is a moderately rich area for rare plants when compared with other places in California (CDFG 2003). Rare plants are either limited in geographic distribution or they occur in small isolated populations. The reasons for rarity can be natural or human. Some plants may be adversely affected by the destruction of habitat or the introduction of exotic invasive weeds. Other plants may be naturally rare because of unique biological or genetic features. Endemism is also a factor for rare plants adapted to limited soil types or to climatic conditions that were characteristic of past eras (Nakamura and Nelson 2001).

Special-status plants are species that are protected under the California and federal Endangered Species Act, or other regulations. Special-status plants are also species considered sufficiently rare by the scientific community. They qualify for consideration and protection pursuant to the California Environmental Quality Act (CEQA).

Categories of special-status plants include:

- Plants listed or proposed for listing as threatened or endangered under the Federal Endangered Species Act (50 CFR 17.12 [listed plants] and various notices in the Federal Register [proposed species])

- Plants listed or proposed for listing by the State of California as threatened or endangered under the California Endangered Species Act (14 CCR 670.5) or listed as rare under the California Native Plant Protection Act (California Fish and Game, Code, Section 1900 et seq.)

- Plants that meet the definitions of rare or endangered under CEQA (State CEQA Guidelines, Section 15380)

- Plants considered by the California Native Plant Society (CNPS) to be “rare, threatened, or endangered in California” (Lists lB and 2 in CNPS 2003)

- Plants listed by CNPS as plants about which more information is needed to determine their status and plants of limited distribution (Lists 3 and 4 in CNPS 2001), which may be included as special-status species on the basis of local significance or recent biological information

Assessing Special Status in the Watershed

Due to the size of the watershed, the following assessment for the potential occurrences of special status plants is limited to a search of the CNDDB (November 2003 data) within watershed boundaries. The database only contains known occurrences. Therefore, additional special status plants may occur in the watershed. Plants with known occurrences near the watershed may also occur inside the watershed if suitable habitat exists. The CNPS maintains an online Inventory of Rare Plants (CNPS 2003) that features information on the habitats and statewide distribution of special status plants. A publication of the University of California (Nakamura and Nelson 2001) provides pictures and identification tips for selected rare plants of northern California. The CNDDB search yielded 10 special status plants known to occur within the watershed. This includes one occurrence of a species designated a candidate for federal listing under the federal Endangered Species Act. All of the plants are listed in Table 6-6.

Species Accounts

Webber's ivesia (*Ivesia webberi*) was first designated a federal candidate species in 1990. However, the plant was removed from candidate status due to a revised prioritization process and lack of sufficient information on the species. Extensive field surveys were conducted between 1990 and 1998. New information was used to return Webber's ivesia to the federal candidate status in 1992. Naturalists first discovered the plant in 1872 at a site in the Sierra Valley. Its known global distribution is currently limited to 15 sites in California and Nevada. Although the total population is estimated at 4.8 million plants, the total acres covered are only about 186. The present day Sierra Valley population is estimated to be between 5,000 and 5,120 plants on 40 acres (Witham 2000). Webber's ivesia is a perennial, low spreading herb with silky haired grayish leaflets and bright yellow ball-like heads of flowers (Figure 6-14). It is not likely to be confused with other species of Ivesia also found in the Sierra Valley. Webber's ivesia is restricted to shallow clayey soils derived from volcanic ash. It generally occurs on slopes above large valleys. In these places Webber's ivesia is often the dominant of co-dominant vegetation with sagebrush or squirrel-tail grass. The list of plants surveyed at the Webber's ivesia site in the Sierra Valley includes: *Artemisia arbuscula; Artemisia tridentata; Bromus tectorum; Antennaria dimorpha; Arenaria congesta; Balsamorhiza hookeri;* and *Trifolium macroecphalum*. Potential threats to the Sierra Valley population of Webber's ivesia include road maintenance and off road vehicles, development, and invasive plant species (Witham 2000). As noted in the survey list above, cheatgrass (*Bromus tectoru*) was found at the Sierra Valley site that occurs close to a road.

Sticky pyrrocoma is a forb belonging to the sunflower family (Figure 6-15). It is endemic to the Sierra Valley and is considered a sensitive species by the USFS. The plant grows in a variety of habitats on the valley floor, including near wetlands and in sagebrush scrub. The total global population of sticky pyrrocoma is estimated at 400,000, with only 40,000 on USFS land and the rest mostly on private lands. The largest occurrence is near Beckwourth including an estimated 200,000 plants (Urie 2003).

Table 6-6 SPECIAL STATUS PLANTS KNOWN TO OCCUR IN THE SIERRA VALLEY WATERSHED					
Scientific Name	**Common Name**	**Family**	**Legal Status**	**RED Code**	**Number of Occurrences***
Astragalus lemmonii	Lemmon's milk-vetch	Fabaceae	1B	2-2-2	2
Astragalus pulsiferae var. pulsiferae	Pulsifer's milk-vetch	Fabaceae	1B	3-2-2	29
Epilobium howellii	Subalpine fireweed	Onagraceae	1B	3-1-3	1
Erigeron nevadincola	Nevada daisy	Asteraceae	2	2-1-1	2
Ivesia aperta var. aperta	Sierra Valley ivesia	Rosaceae	1B	2-2-2	58
Ivesia baileyi var. baileyi	Bailey's ivesia	Rosaceae	2	3-1-1	1
Ivesia sericoleuca	Plumas ivesia	Rosaceae	1B	1-2-3	69
Ivesia webberi	Webber's ivesia	Rosaceae	FC 1B	3-3-2	1
Pyrrocoma lucida	Sticky pyrrocoma	Asteraceae	1B	3-1-3	96
Stanleya viridiflora	Green-flowered prince's plume	Brassicaceae	2	3-1-1	1

Federal Candidate for Listing: FC = Candidate for Federal listing under the Endangered Species Act
CNPS Lists:
List 1B: Defined by CNPS as "plants rare, threatened, or endangered in California and elsewhere"
List 2: Defined by CNPS as "plants rare, threatened, or endangered in California, but more common elsewhere."
CNPS Rarity – Endangerment-Distribution (R-E-D) Code - To increase the refinement of assigning plants to categories, CNPS uses a scheme that combines three complementary elements that are scored independently. These components are:
R (Rarity) – addresses the extent of the plant, both in terms of numbers of individuals and the of its distribution
1 Rare, but found in sufficient numbers and distributed widely enough that the potential for extinction is low at this time.
2 Distributed in a limited number of occurrences, occasionally more if each occurrence is small.
3 Distributed in one to several highly restricted occurrences, or present in such small numbers that it is seldom reported.
E (Endangerment) – embodies the perception of the plant's vulnerability to extinction for any reason
1 Not endangered.
2 Endangered in a portion of its range.
3 Endangered throughout its range.
D (Distribution) – which focuses on the overall range of the plant
1 More or less widespread outside California.
2 Rare outside California.
3 Endemic to California.

INVASIVE PLANTS AND NOXIOUS WEEDS

Some experts consider invasive species to be a serious threat to global biodiversity second in importance only to direct habitat loss and fragmentation. Invasive plants are usually non-native species that spread easily and displace native species. The problem of these "weeds" or "pest plants" in California is widespread and serious due to the state's varied topography, geology, and climate. Invasive plants can adversely impact native vegetative communities by altering patterns of nutrient cycling, hydrological processes, and the intensity of fire (Bossard et al 2000). Invasive weeds can also have economic impacts by reducing the quality of range forage for livestock.

Classification Systems

Plant pests are defined by law, regulation, and technical organizations; and are regulated by many different sources, which include the California Department of Food and Agriculture (CDFA), USDA, and the California Exotic Pest Plant Council (CalEPPC). The CDFA uses an action-oriented pest-rating system. The rating assigned to a pest by the CDFA does not necessarily mean that one with a low rating is not a problem; but the rating system is meant to prioritize response by the CDFA and County Agricultural Commissioners. Plants on the CDFA's highest priority "A" list are defined as plants "of known economic importance subject to state-county enforced action involving eradication, quarantine regulation, containment, rejection, or other holding action."

A group of technical experts called the CalEPPC developed a list of plant pests specific to California wildlands. The CalEPPC list is based on information submitted by land managers, botanists, and researchers throughout the state, and on published sources. The list highlights non-native plants that pose serious problems in wildlands (i.e., natural areas that support native ecosystems, including national, state, and local parks; ecological reserves; wildlife areas; national forests; Bureau of Land Management [BLM] lands; etc.). Plants found mainly in disturbed areas, such as roadsides and agricultural fields and plants that establish sparingly and have minimal impact on natural habitats are not included on the list. The CDFA and CalEPPC list categories are explained in more detail in Table 6-7.

Invasive Plants Found in the Sierra Valley Watershed

According to the Plumas-Sierra Counties Department of Agriculture (Bishop 2004) there are at least 22 CDFA- and CalEPPC-rated invasive plants known to occur in the Sierra Valley. This list is provided in Table 6-8. Known locations within the watershed where some of these weeds are established are featured in Figure 6-16.

Dalmatian toadflax (*Linaria genistifolia dalmatica*) is member of the figwort (*Scrophulariaceae*) family. It is a waxy blue-green leaved perennial of Mediterranean origin, which grows as high as four feet. This weed aggressively invades rangelands including open low-elevation coniferous forests and adjacent sagebrush scrub. As Dalmatian toadflax is a prolific seed producer that also spreads through a creeping root system. This plant is difficult to control once it becomes established. The weed is a concern to range managers because it is unpalatable and displaces edible native vegetation.

Scotch thistle (*Onopordum acanthium var. Acanthium*) is a spiny plant with a large fleshy taproot. It seeds can remain viable for 30 years or more. Of European and Mediterranean origin, this weed invades disturbed areas and a variety of vegetative communities. It occurs along Highway 89 in the southern portion of the watershed. This weed is a concern to range managers because it spreads aggressively and can form dense patches that are impenetrable to livestock and wildlife.

Spotted knapweed (*Centaurea maculosa*) is a short-lived perennial that predominantly reproduces from seed, but it forms a new shoot each year from a taproot. Native to central Europe this weed may have been spread to the western United States through contaminated alfalfa seed. This plant grows in disturbed areas and dry rangelands, but also survives in moister areas better than closely related diffuse knapweed (*Centaurea diffusa*). Spotted knapweed has a low palatability to livestock and wildlife.

Table 6-7 CDFA AND CalEPPC LIST CATEGORIES FOR INVASIVE PLANTS AND NOXIOUS WEEDS	
CDFA List Categories	
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 the discretion of a commission or an organism 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 List Categories
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.

Leafy spurge (*Euphorbia esula*) is an herbaceous European weed species characterized by an extensive root system that goes as deep as 15 feet. The entire plant contains a thick milky latex liquid, and alkaloid that is toxic to animals. Cattle generally do not eat this weed and avoid grazing in grasslands where leafy spurge occurs in dense concentrations. Infestations of leafy spurge are difficult to control and can result in significant reductions in the carrying capacity of rangelands for supporting livestock. The weed also reduces the productivity of crops when it spreads on agricultural lands. It is currently known to occur at only one location in Sierra Valley.

Musk thistle (*Carduus nutans*) is another spiny thistle native to Europe. It is a prolific seed producer (e.g., 20,000 per plant) that can quickly form dense stands. Musk thistle invades a variety of vegetation types including forest, range, and agricultural lands. Musk thistle is less successful at spreading in healthy range and pasturelands where vigorously growing grasses out compete the weed for growing space.

Table 6-8 CDFA AND CalEPPC-LISTED INVASIVE PLANTS PRESENT IN THE SIERRA VALLEY WATERSHED			
Scientific Name	**Common Name**	**Present in Sierra Valley**	**List**
Linaria genistifolia dalmatica	Dalmatian Toadflax*	Yes	CDFA A
Onopordum acanthium var. Acanthium	Scotch Thistle*	Yes	CDFA list: A
Centaurea maculosa.	Spotted Knapweed*	Yes	CDFA list: A CalEPPC: Red Alert
Euphorbia esula	Leafy Spurge*	Yes	CDFA list: A CalEPPC list: A2
Carduus nutans	Musk Thistle*	Yes	CDFA list: A
Lepidium latifolium	Perennial Pepperweed*	Yes	CDFA list: B CalEPPC: A1
Cirsium arvense	Canada Thistle	Yes	CDFA list: B CalEPPC: B
Cardaria draba	Heart-Podded Hoarycress	Yes	CDFA list: B CalEPPC: A2
Salvia aethiopis	Mediterranean Sage*	Yes	CDFA list: B
Centaurea solstitialis	Yellow Star thistle*	Yes	CDFA list: C CalEPPC: A1
Cuscuta ssp.	Dodder	Yes	CDFA list: C
Convolvulus arvensis	Field Bindweed	Yes	CDFA list: C
Hypericum perforatum	Klamath Weed	Yes	CDFA list: C CalEPPC: B
Taeniatherum caput-medusae	Medusa Head	Yes	CDFA list: C CalEPPC: A1
Tribulus terrestris	Puncture Vine	Yes	CDFA list: C
Salsola tragus	Russian Thistle	Yes	CDFA list: C
Cynodon dactylon	Bermuda Grass	Yes	CDFA list: C
Cytisus scoparius	Scotch Broom	Yes	CDFA list: C CalEPPC: A1
Baccharis neglecta	Poverty Weed	Yes	CDFA list: C
Bromus tectorum	Cheat Grass	Yes	CalEPPC: A1
Cirsium vulgare	Bull Thistle	Yes	CalEPPC: B
Conium maculatum	Poison Hemlock	Yes	CalEPPC: B

Note: Source is Bishop, 2004.
* denotes those weed species for which there are control efforts occurring in the Sierra Valley

Perennial pepperweed (*Lepidium latifolium*) is suspected of being introduced into California with contaminated sugar beet seeds in the 1930s. It is a 1- to 6-foot-high member of the mustard family (*Brassicaceae*), which is also called "tall whitetop" because of its densely clustered flowers. Native to southern Europe and western Asia, perennial pepperweed grows well in seasonally wet areas including ditches and streamsides. It also invades dryer areas such as road edges and hillsides. Its deep, spreading roots, and numerous seeds make perennial pepperweed difficult to control. It out competes native vegetation and crops and often forms its own monoculture. Perennial pepperweed is common throughout the watershed.

Yellow star thistle (*Centaurea solstitialis*) is a thorny annual of Mediterranean origin that grows from a taproot. Much of California is infested by this weed, which colonizes various soil types on waste areas, roadsides, pastures, and dry rangelands. Low numbers of yellow star thistle may colonize an area for several years before the plants become genetically adapted to the site after which the population explodes and spreads rapidly. It is important to eradicate small populations of this plant. Fortunately, yellow star thistle is still uncommon throughout the watershed. Pictures of yellow starthistle and other invasive plants of the Sierra Valley Watershed are featured in Figure 6-17.

Diffuse knapweed (*Centaurea diffusa*) may potentially occur in the watershed, but its presence so far is not noted (Bishop 2004). It spreads easier than the closely related spotted knapweed (*Centaurea maculosa*). Large amounts of diffuse knapweed grow along Highway 395 in nearby Nevada.

Control of Invasive Plants

It is typically easier to control small populations of weeds before they become established in an area. Once a species of invasive plant spreads into a native vegetative community or cultivated land it can be very difficult to eradicate. The ability to grow on a variety of soils and rapidly spread through abundantly produced seeds allows many weeds to spread quickly and re-colonize a site after a control treatment. Deep spreading root systems also help some weeds to spread and recover after control efforts. Weed control methods include cultural control (e.g., management of livestock grazing), 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 weed). Several years of repeated treatments as well as a combination of methods are often part of an effective strategy for eradicating a weed species from an area.

There are ongoing active efforts against at least seven weed species in the watershed (Table 6-9). Most of these efforts involve chemical control with the herbicides Garlan ®, Roundup ®, Transline ®, and Telar ®. The time of year for applying these chemicals is important for targeting particular lifestages of weeds. This targeting may differ with the different types of herbicides. The Plumas-Sierra Counties Department of Agriculture oversees the application of these chemicals at infested sites (Bishop 2004). Backpack sprayers are typically used. Each site is generally treated a couple times a year. A first application may occur in early summer followed by a repeat treatment later in the summer. The Plumas-Sierra Counties Department of Agriculture provides information and herbicides to Sierra Valley residents who wish to control weeds on their property. One landowner has worked for several years to eradicate leafy spurge from his property.

Transline ® is very effective in controlling yellow star thistle. On the other hand, varieties of herbicides are used to combat spotted knapweed. This species is a priority for treatment because it is close to eradication in the valley. Mediterranean sage (*Salvia aethiopis*) is currently less of a priority for treatment.

Biological control methods are used for controlling two species of weeds occurring in the watershed. A species of weevil is used to attack musk thistle. The insect eats the seed producing tissues of this plant, thereby destroying its only means of spreading. The Plumas-Sierra Counties Department of Agriculture aggressively treats this weed using both biological and chemical methods.

Table 6-9 CONTROL OF WEED SPECIES IN THE SIERRA VALLEY WATERSHED		
Weed Species	**Distribution and Control Status**	**Control Methods**
Dalmatian toadflax	Several occurrences in the watershed. Working toward eradication.	Herbicide application with Garlan ®, Roundup ® and Telar ®.
Scotch thistle	Close to eradication.	
Spotted knapweed	Close to eradication.	Herbicide application with Transline ® and Telar ®. -Bio-control with weevils.
Leafy spurge	One location in the watershed. Landowner effort to eradicate it	
Musk thistle	Several occurrences in the watershed. Complete eradication will be difficult.	Herbicide application with Transline ® and Telar ®. Bio-control with weevils.
Perennial pepperweed	Common in the watershed.	Roadside herbicide application with Telar ®
Mediterranean Sage	Several occurrences in the watershed. Lower priority for control.	Herbicide application with Telar ®, Roundup ® and Garlan ®.
Yellow starthistle	Uncommon in the watershed, but more prevalent in nearby Portola. Close to eradication in watershed.	Herbicide application with Transline ®.
Source: Bishop, 2004		

REFERENCES

Bishop, K. Plumas-Sierra Counties Department of Agriculture. 2004. Electronic and personal communication with Brett Furnas.

Blackburn, Thomas C. and Kat Anderson. 1993. *Before the wilderness: Environmental management by Native Californians.*

Bossard. C. C., J. M. Randall, and M. C. Hoshovsky (Editors). 2000.

CDFG (California Department of Fish and Game). 2003. *Atlas of the biodiversity of California*. Sacramento.

CNPS (California Native Plant Society). 2003. *Inventory of rare and endangered plants* [online]. Sacramento: California Native Plant Society. [cited July 2003]. Available from World Wide Web: http://www.cnps.org/inventory

DWR (California Department of Water Resources). 1973. *Natural resources of the Sierra Valley study area*. Sacramento.

Franklin, J. F. and J. Fites-Kaufman. 1996. *Assessment of late-successional forests of the Sierra Nevada. Sierra Nevada Ecosystem Project: Final Report to Congress, Volume II*. Davis: University of California, Centers for Water and Wildland Resources.

Gruell, G. E. 2001. *Fire in Sierra Nevada forests: A photographic interpretation of ecological change since 1849*. Missoula: Mountain Press Publishing.

Kattelmann, R. and M. Embury. 1996. *Riparian areas and wetlands. Sierra Nevada Ecosystem Project: Final report to Congress, volume III.* Davis: University of California, Centers for Water and Wildland Resources.

Keeler-Wolf, T., et al. 1998. *California vernal pool assessment – preliminary report.* Sacramento: California Department of Fish and Game.

Mayer, K. E. and W. F. Laudenslayer (editors). 1988. *A guide to wildlife habitats of California.* Sacramento: California Department of Forestry and Fire Protection.

McKelvey, K. S. and J. D. Johnston. 1992. *Historical perspectives on forests of the Sierra Nevada and the transverse ranges of southern California: Forest conditions at the turn of the century.* UDSA Forest Service General Technical Report PSW-GTR-133.

Menke et. al. 1996. *Rangeland assessment. Sierra Nevada Ecosystem Project: Final Report to Congress, vol. III, Assessments, Commissioned Reports, and Background Information.* Davis: University of California, Centers for Water and Wildland Resources.

Momsen, J. H. 1996. *Agriculture in the Sierra. Sierra Nevada Ecosystem Project: Final report to Congress, volume II.* Davis: University of California, Centers for Water and Wildland Resources.

Nakamura, G. and J. K. Nelson (editors). 2001. *Illustrated field guide to selected rare plants of northern California.* University of California, Agriculture and Natural Resources Publication 3395. Oakland, California.

Putnam, D, M. Russelle, S. Orloff, J. Kuhn, L. Fitzhugh, L. Godfrey, A. Kiess and R. Long. 2001. *Alfalfa, wildlife and the environment.* University of California, Davis.

Urie, S. Tahoe National Forest. 2003. Species assessment of *Pyrrocoma lucida.* Draft document.

US Forest Service. 1981. Calveg Categories.

USFS (U. S. Forest Service). 2002. *Pacific Northwest research station* [online]. U. S. Forest Service [cited July 2003]. Available from the World Wide Web: http://www.fs.fed.us/pnw

Witham, C. W. 2000. *Current knowledge and conservation status of Ivesia webberi in Nevada. Report.* Prepared for the Nevada Department of Conservation and Natural Resources and the US Fish and Wildlife Service.

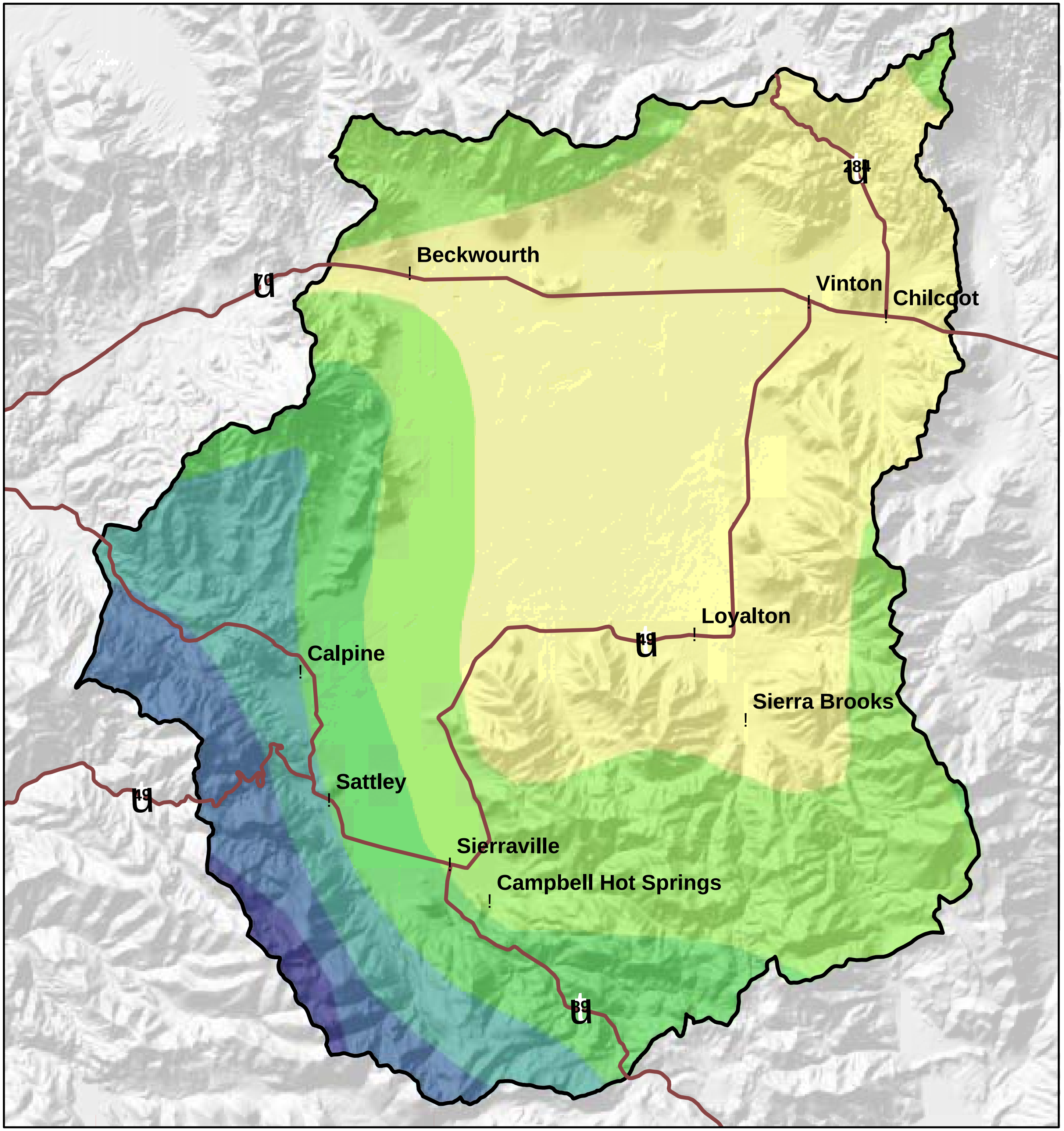


Figure 6-1
Average Annual Precipitation in Inches
Sierra Valley Watershed

Legend

- Sierra Valley Watershed
- State Highway
- 0 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY: TEALE GIS SOLUTIONS GROUP, 1997

0 1.25 2.5 5 Miles

VESTRA

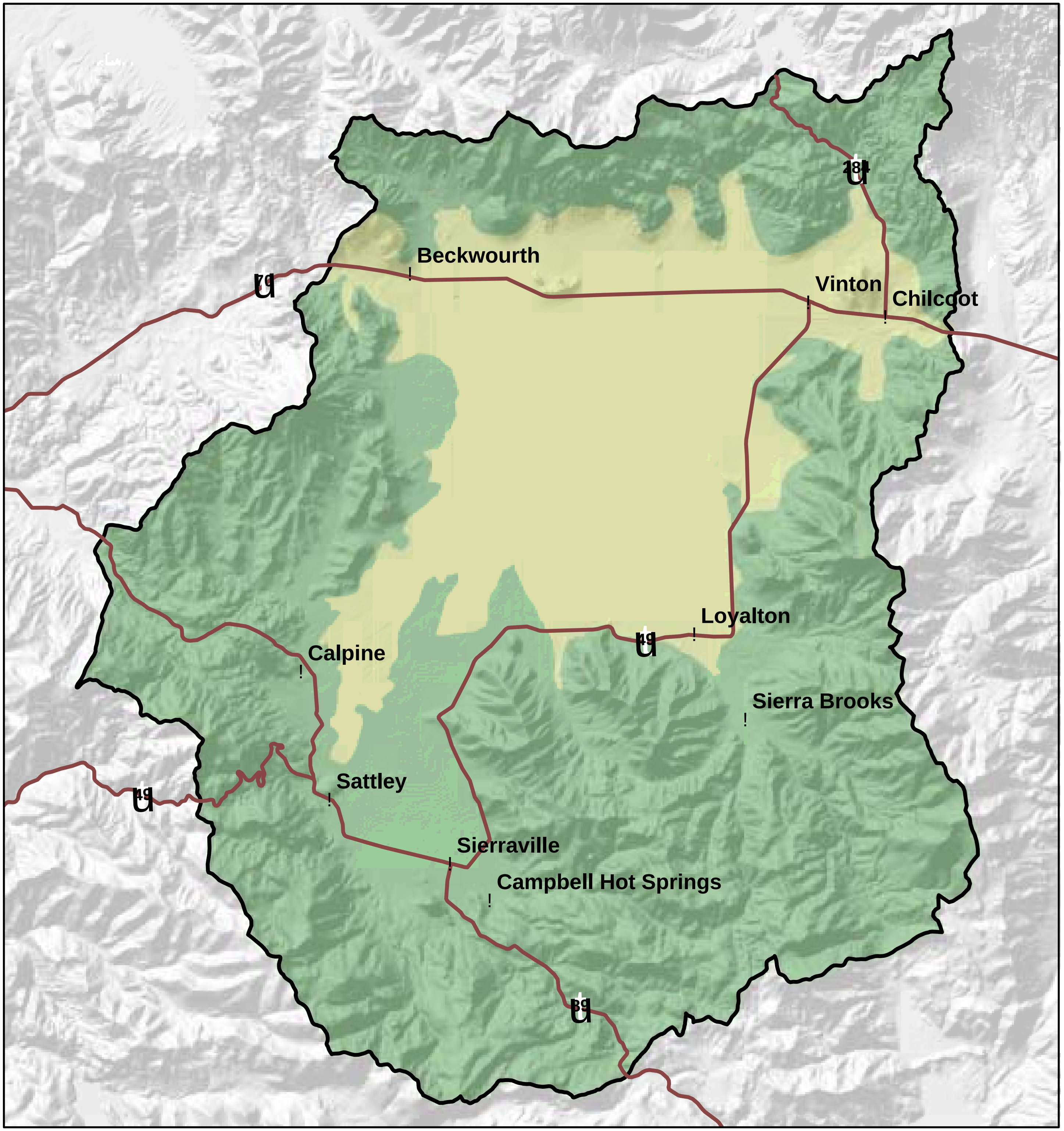


Figure 6-2
Sierra Valley Intrusion of the Modoc Plateau Vegetation into the Sierra Nevada
Sierra Valley Watershed

Legend

Sierra Valley Watershed
State Highway
Modoc Ecoregion
Sierra Nevada Ecoregion

0 1.25 2.5 5 Miles

VESTRA

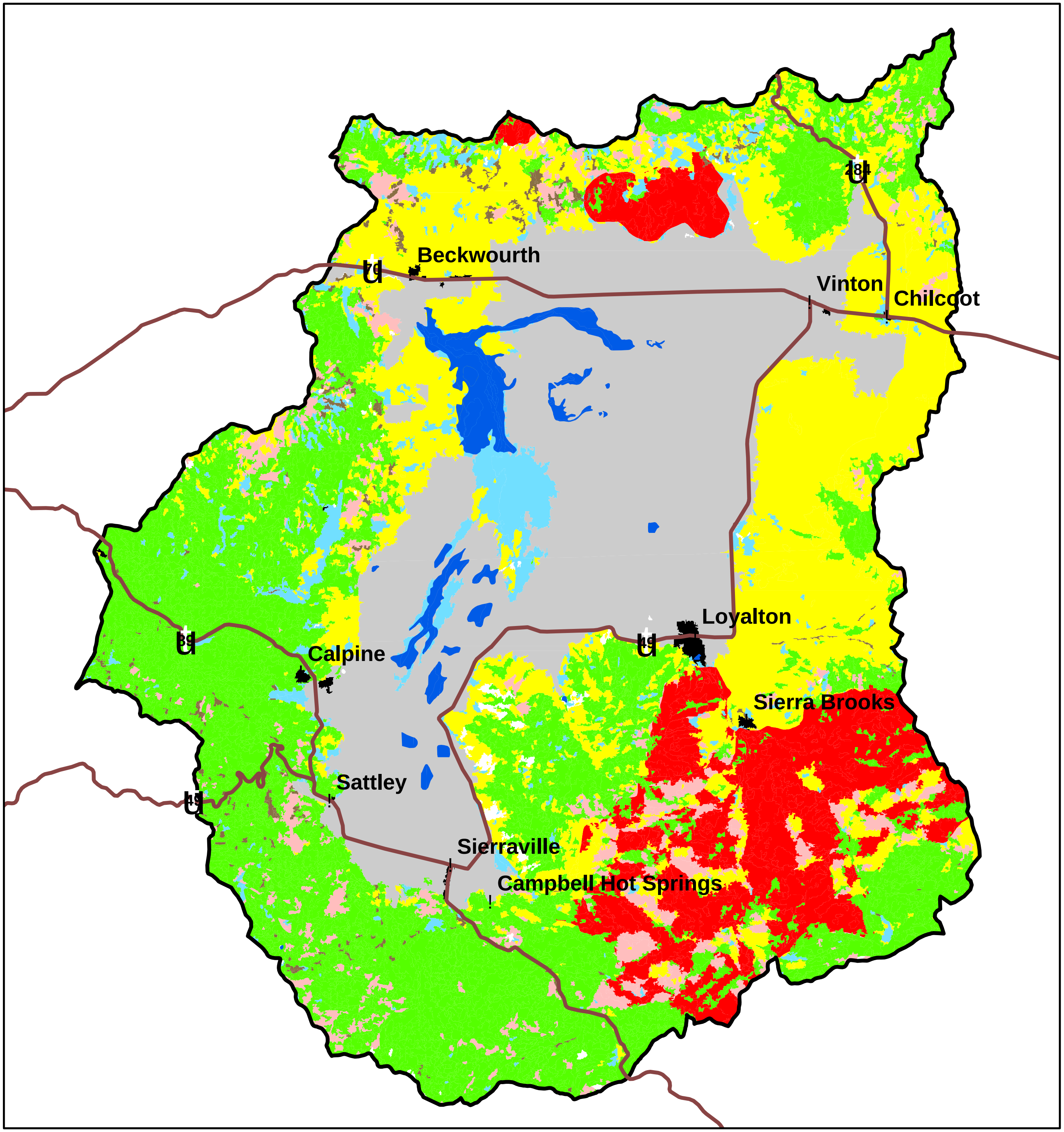


Figure 6-3
LCMMP Vegetation Mapping
Sierra Valley Watershed

Legend

- State Highway
- Sierra Valley Watershed
- Agriculture
- Chaparral
- Meadow/Grassland
- Montane Conifer
- Not Classified
- Recent Post Fire
- Riparian/Hardwood
- Sagebrush Scrub
- Urban
- Water Body

*Note: The Recent Post Fire lifeform represents areas burnt over by fires since 1990. The largest burnt area is from the 1994 Cottonwood Fire. The vegetative composition of this lifeform is in transition. Some areas have been replanted with conifers whereas other areas have re-vegetated naturally with chaparral species. More information on this lifeform is discussed in the UPLAND VEGETATIVE LIFEFORMS sub-section.

SOURCE: CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION, FIRE AND RESOURCE ASSESSMENT PROGRAM

0 1.25 2.5 5 Miles

VESTRA

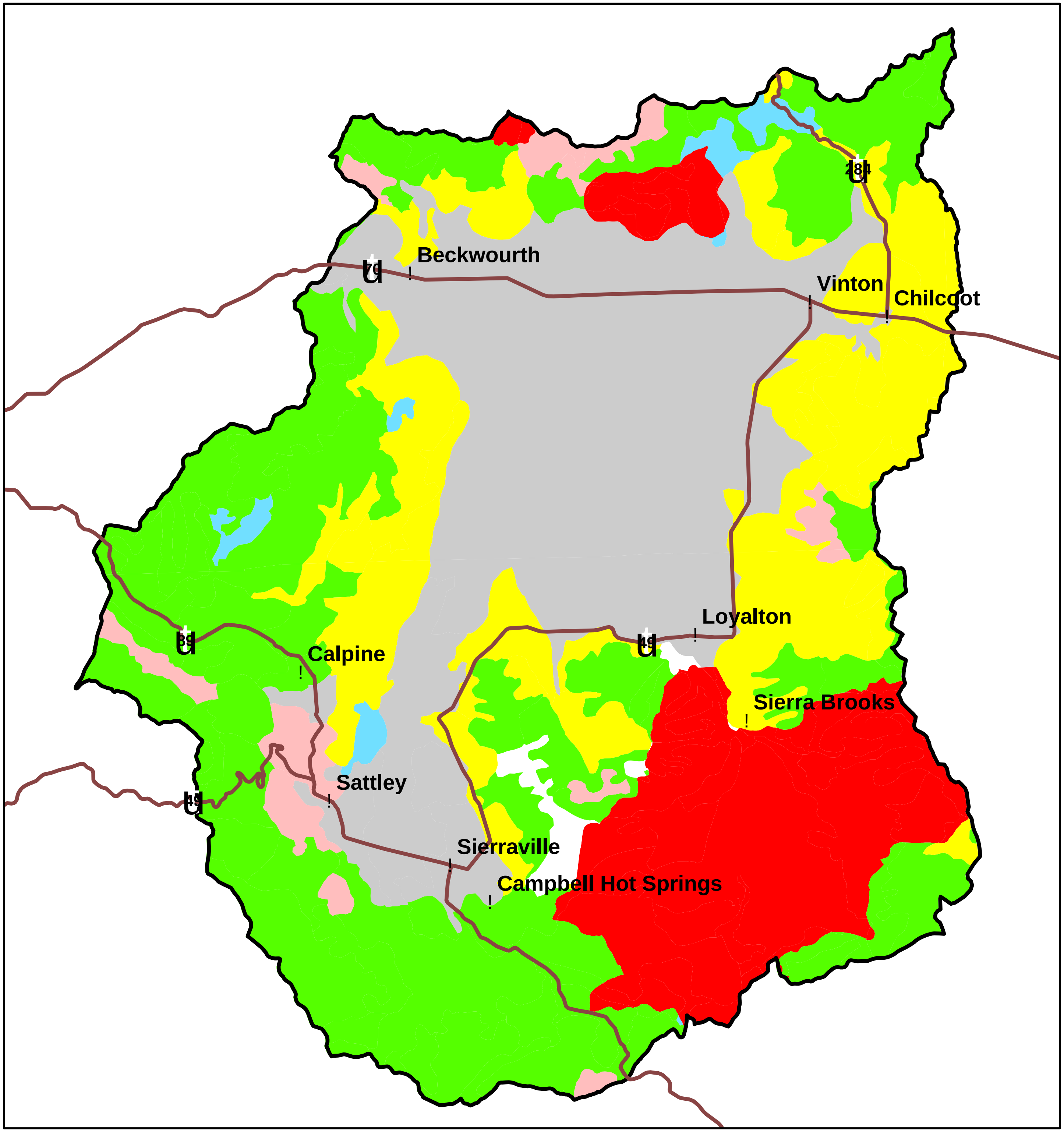


Figure 6-4
Gap Vegetation Mapping
Sierra Valley Watershed

Legend

- State Highways
- Sierra Valley Watershed
- Agriculture
- Chaparral
- Meadow/Grassland
- Montane Conifer
- Not Classified
- Recent Post Fire
- Sagebrush Scrub

SOURCE: UC SANTA BARBARA GAP VEGETATION ANALYSIS

0 1.25 2.5 5 Miles

VESTRA


(a) Agricultural Field


(b) Wetland


(c) Riparian Vegetation


(d) Sagebrush Scrub


(e) Recent Post Fire


(f) Montane Conifer

All photographs by Brett Furnas

VESTRA

FIGURE 6-5
EXAMPLES OF SIERRA VALLEY VEGETATIVE LIFEFORMS
SIERRA VALLEY WATERSHED

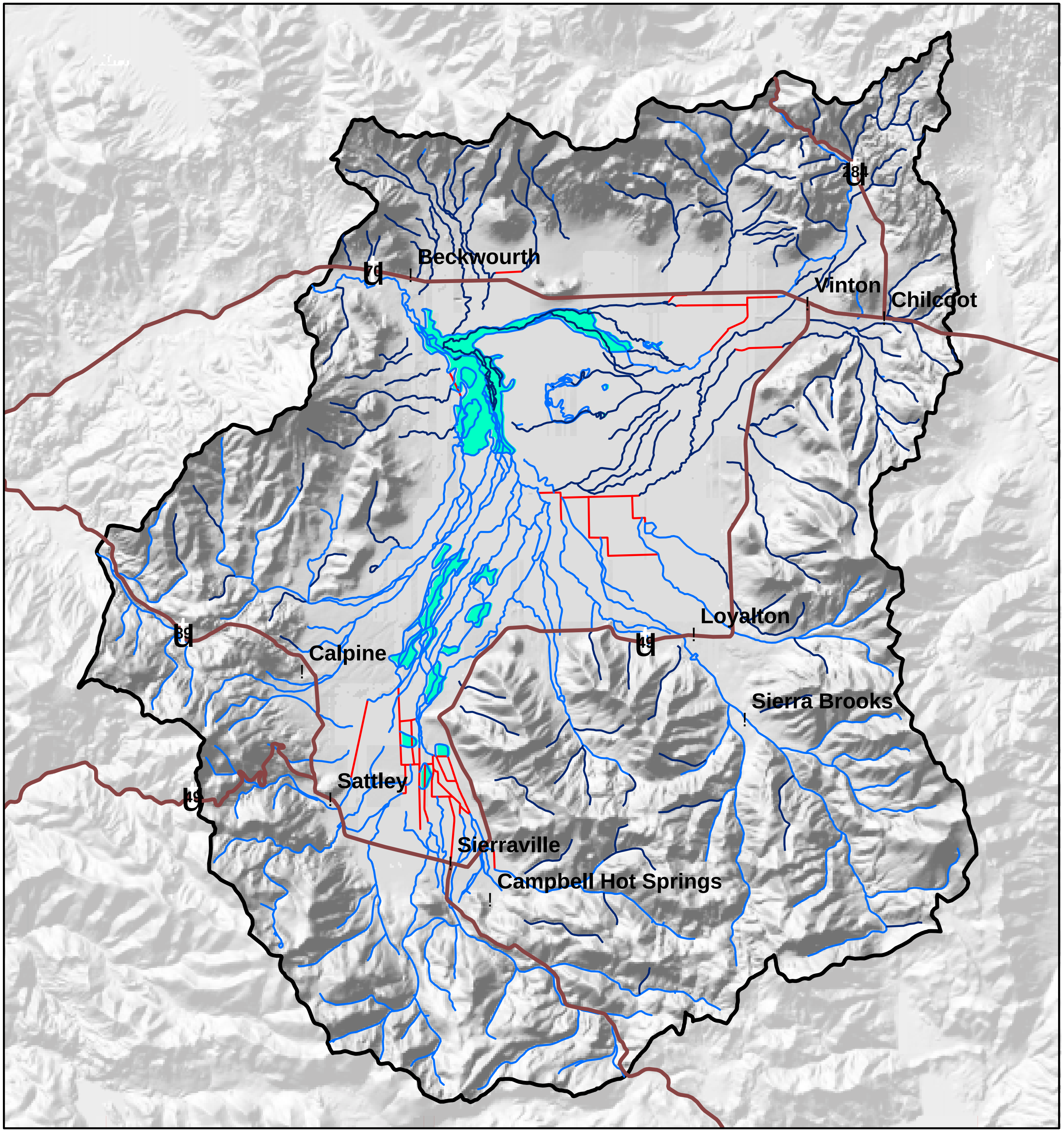


Figure 6-6
Wetlands
Sierra Valley Watershed

Legend

- State Highway
- Perennial Stream
- Seasonal Stream
- Man-Made Canal
- Wetland

0 1.25 2.5 5 Miles

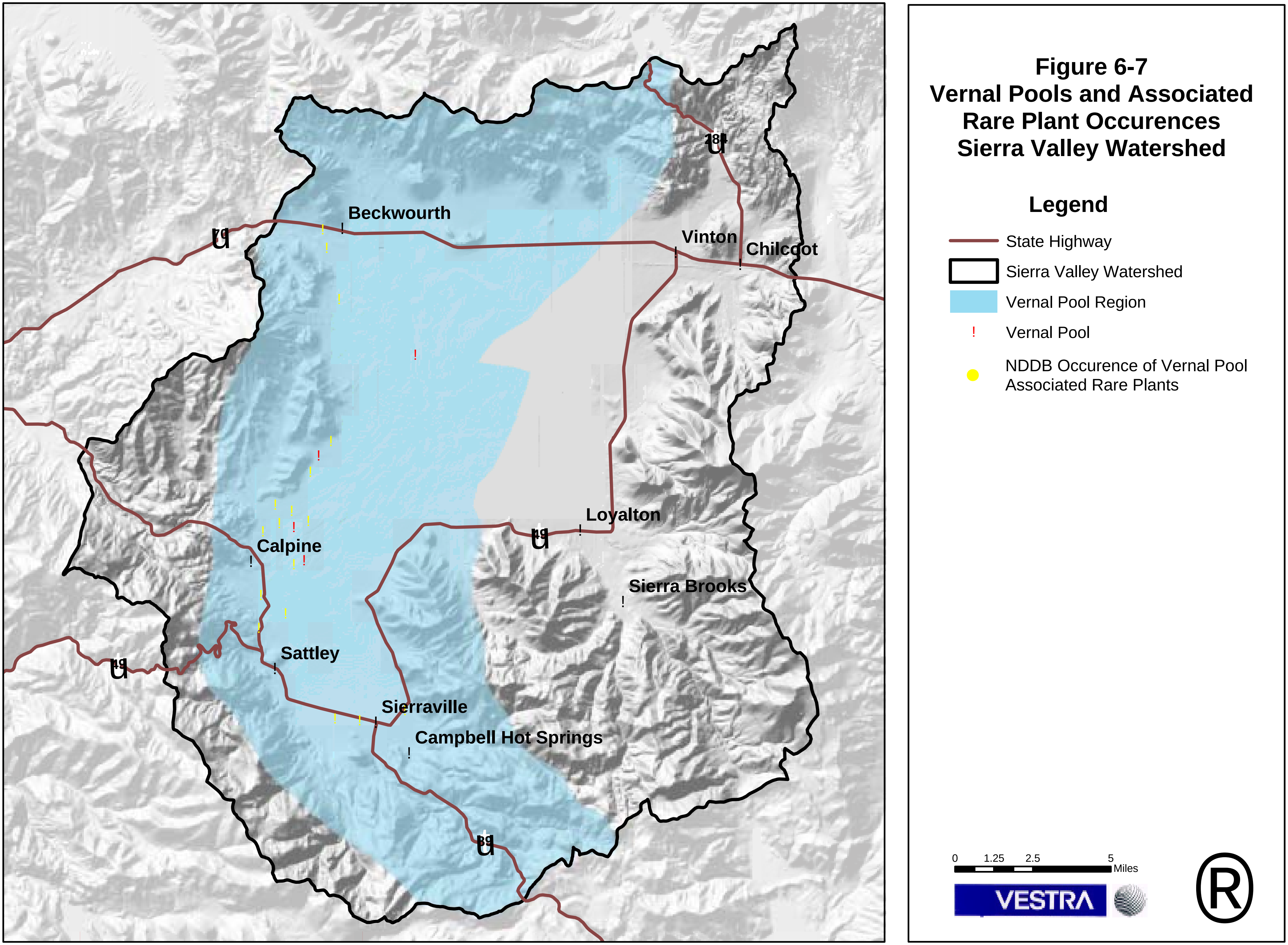


Figure 6-7
Vernal Pools and Associated
Rare Plant Occurences
Sierra Valley Watershed
Legend
State Highway
Sierra Valley Watershed
Vernal Pool Region
Vernal Pool
NDDB Occurence of Vernal Pool Associated Rare Plants
Beckwourth
Vinton
Chilcoot
Loyalton
Calpine
Sierra Brooks
Sattley
Sierraville
Campbell Hot Springs
70
284
49
89
0
1.25
2.5
5
Miles
VESTRA

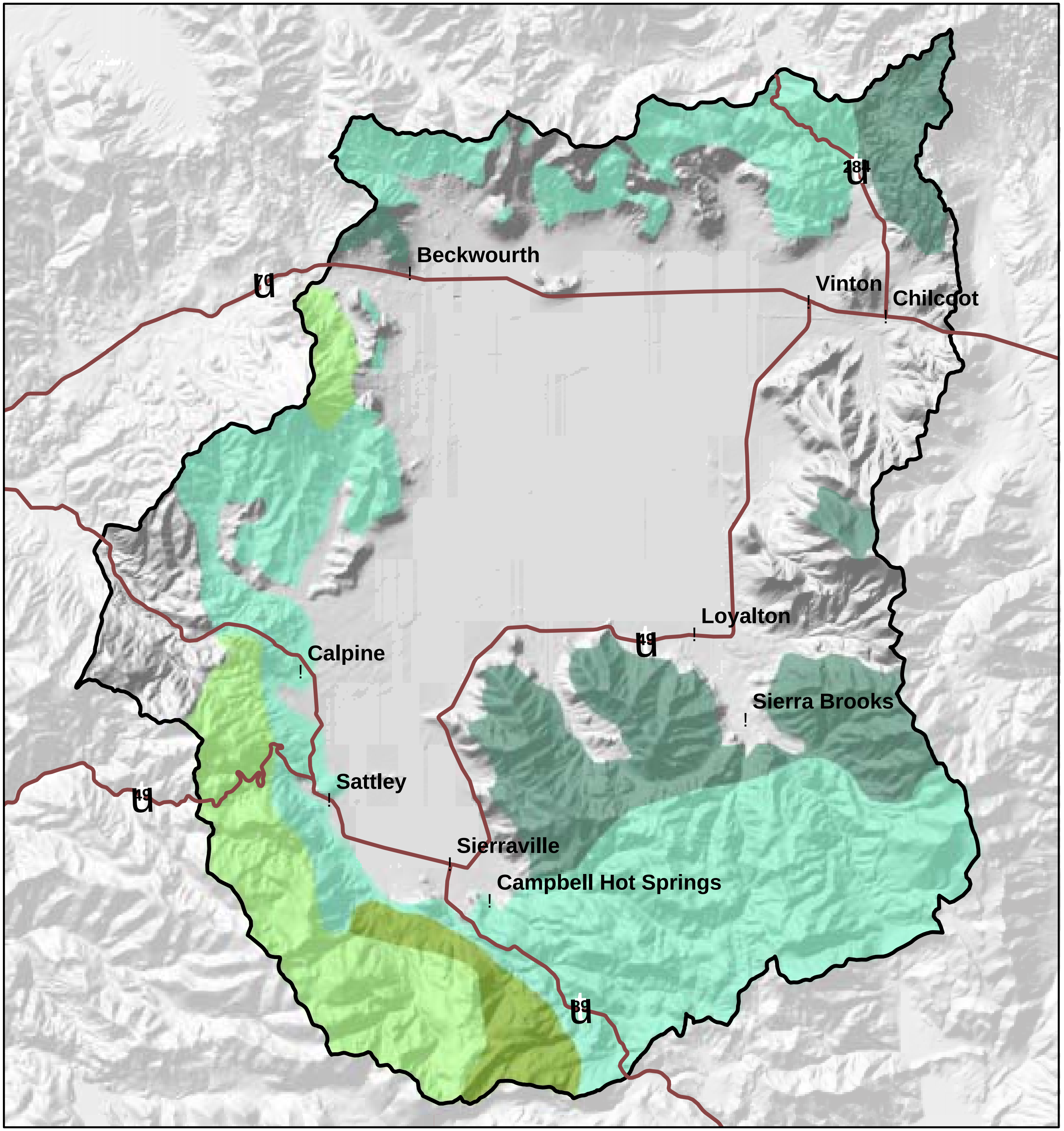


Figure 6-8
Forest Productivity
Sierra Valley Watershed

Legend

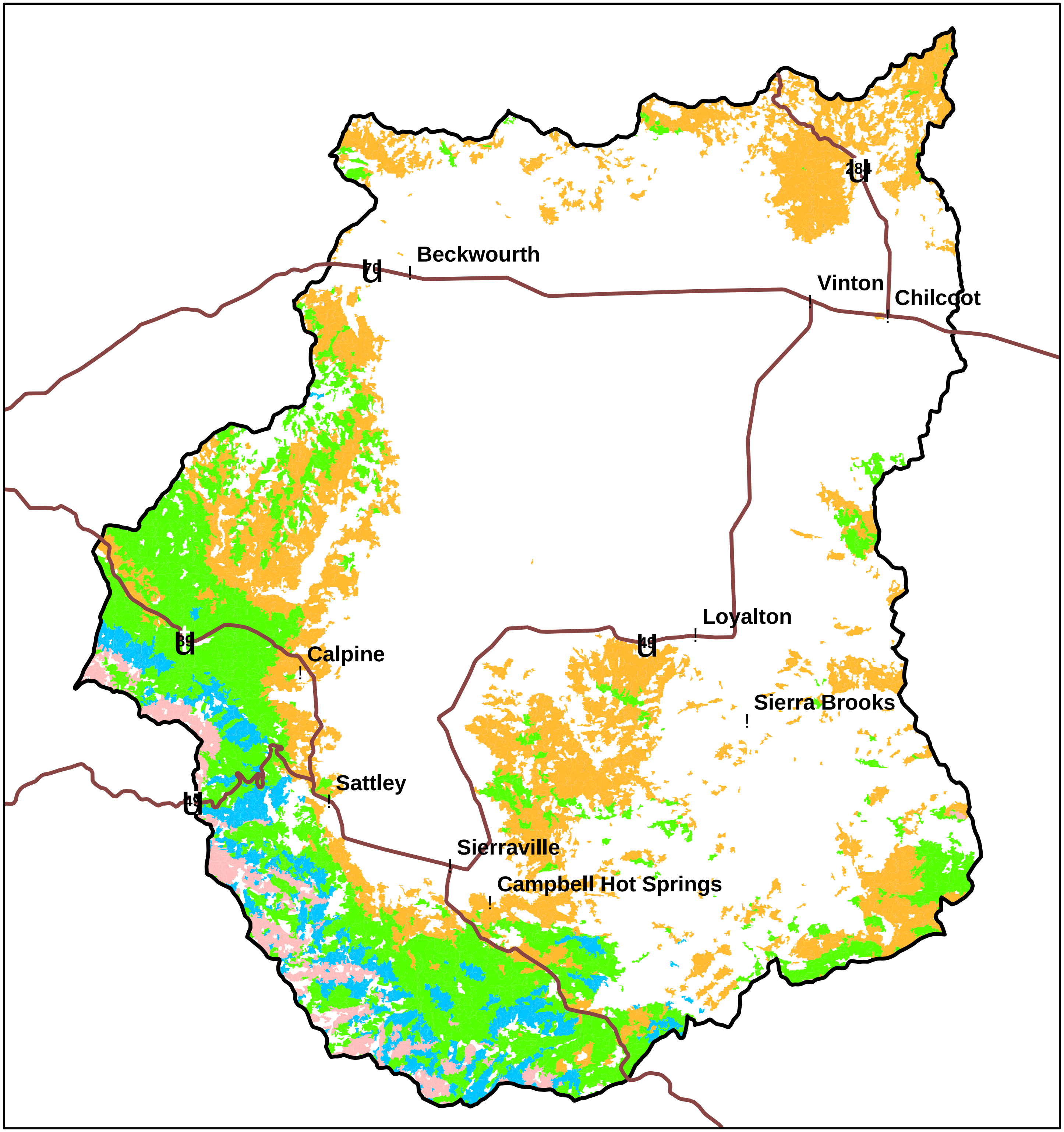


Figure 6-9
Conifer Forest Types
Sierra Valley Watershed

Legend

- State Highways
- Sierra Valley Watershed
- Eastside Pine
- Red Fir
- Sierran Mixed Conifer
- White Fir

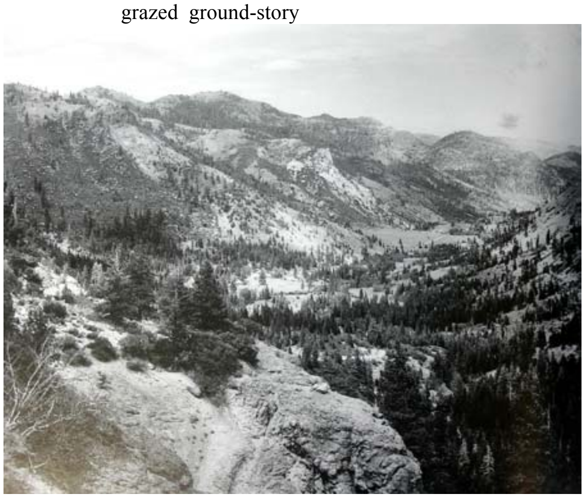
Source: California Department of Forestry and Fire Protection, Fire and Resource Assessment Program

0 1.25 2.5 5 Miles

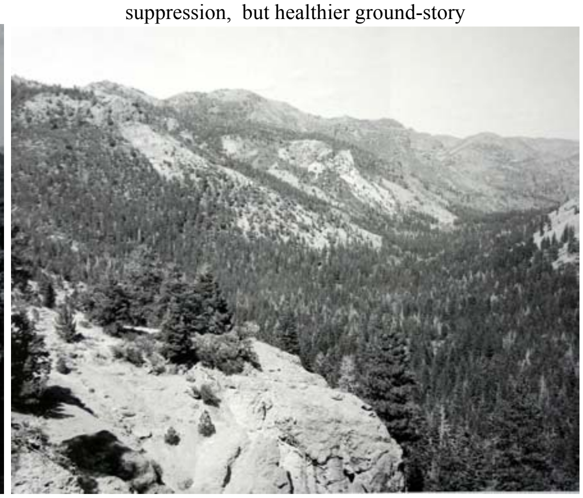
VESTRA

1910 (a) Open park-line forest stand with severely over-grazed ground-story

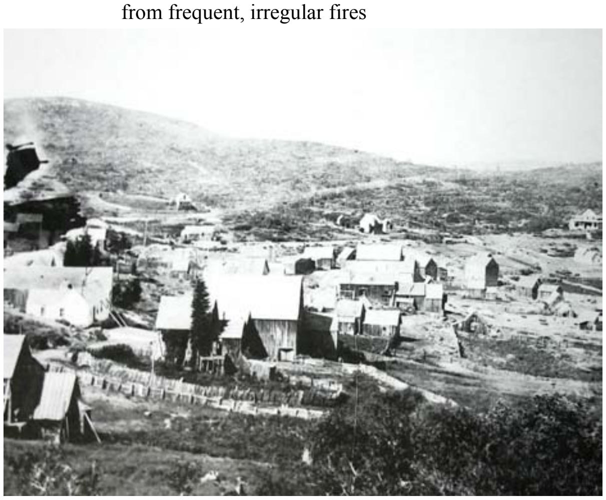
1995 (b) Dense under-story of small trees due to fire suppression, but healthier ground-story



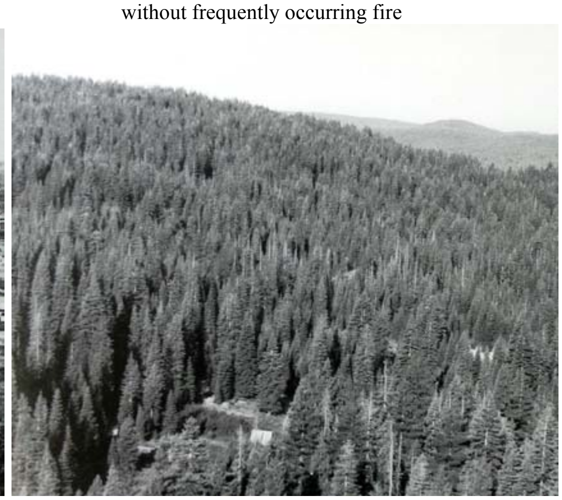
1929 (c) Patchy mosaic of forest and openings resulting from frequent, irregular fires



1993 (d) Relatively homogenous spread of dense forest without frequently occurring fire



1890 (e) The early era of logging on accessible lands



1993 (f) Landscape of 80 - 100 year old trees

All photographs excerpted from Gruell, 2001

FIGURE 6-10

A CENTURY OF CHANGE IN SIERRA NEVADA FORESTS – PHOTOGRAPHIC COMPARISON OF HISTORICAL AND CURRENT CONDITIONS

SIERRA VALLEY WATERSHED

VESTRA

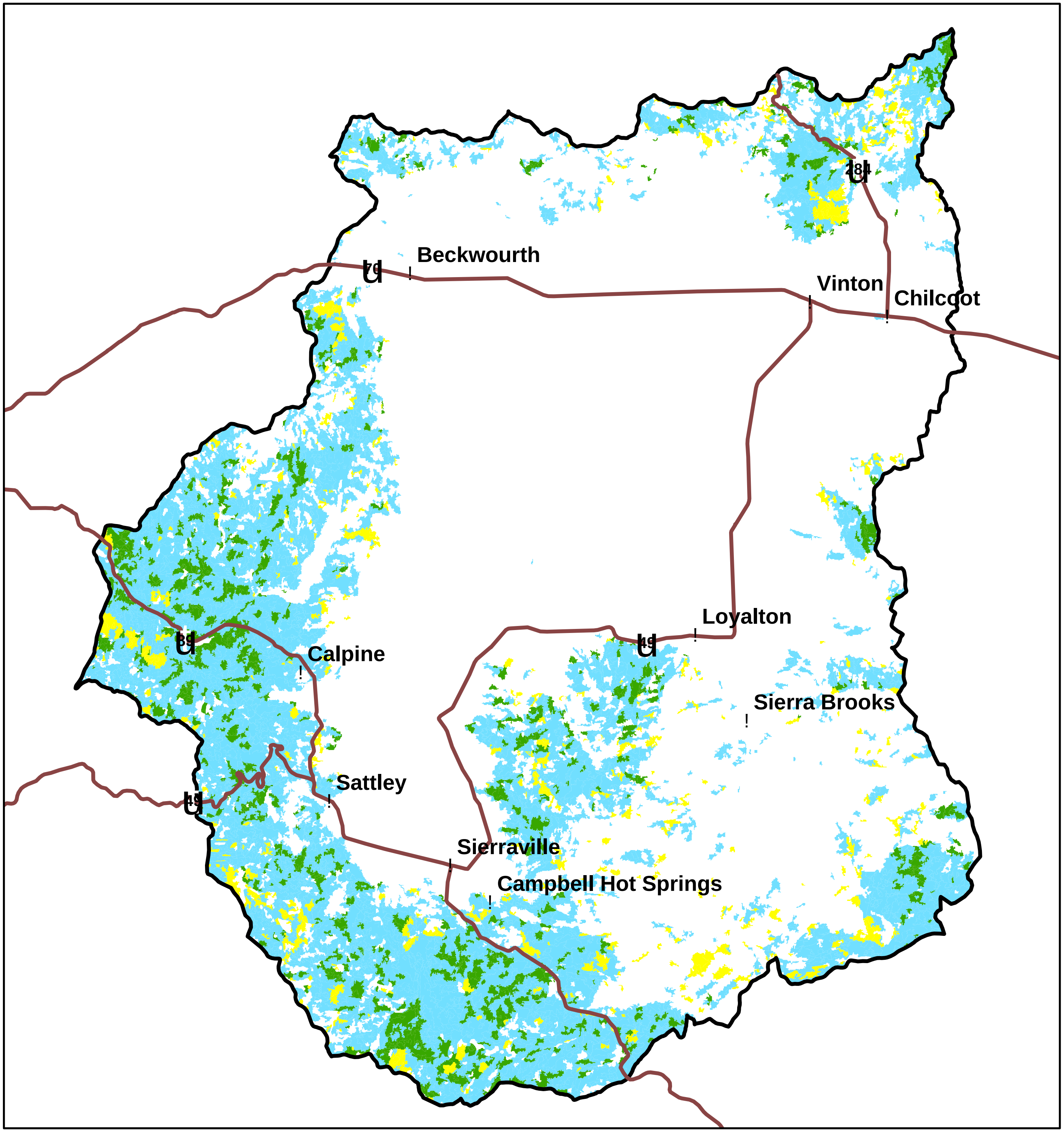


Figure 6-11
Distribution of Large Conifers
Sierra Valley Watershed

Legend

- State Highway
- Sierra Valley Watershed
- Greater than 24 inches in diameter
- 12 to 24 inches in diameter
- Less than 12 inces in diameter

SOURCE: CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION, FIRE AND RESOURCE ASSESSMENT PROGRAM

0 1.25 2.5 5 Miles

VESTRA

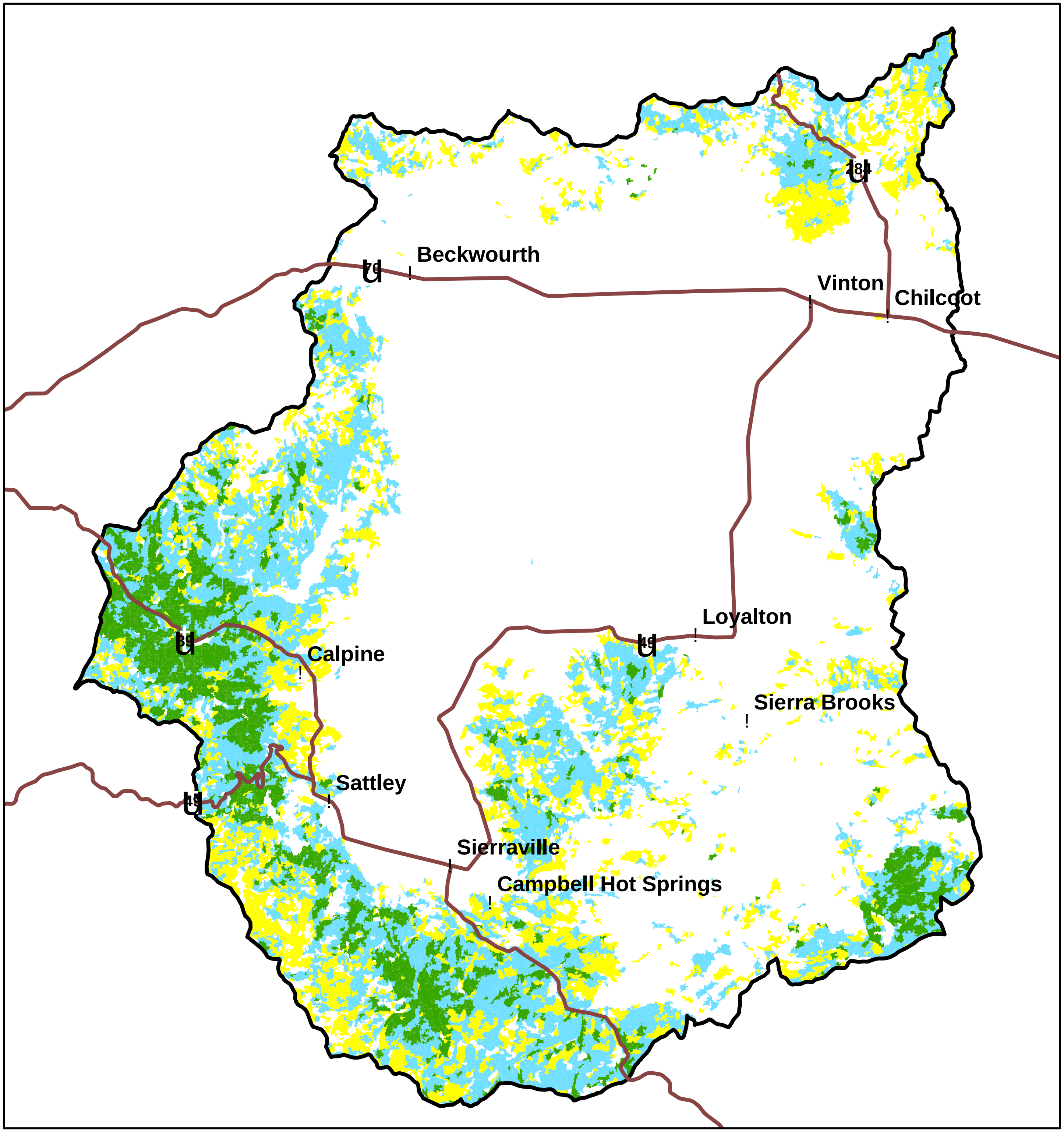


Figure 6-12
Distribution of Dense and Open Forest Sierra Valley Watershed

Legend

- State Highways
- Sierra Valley Watershed
- Greater than 60 percent canopy cover
- 40 to 60 percent canopy cover
- 10 to 40 percent canopy cover

SOURCE: CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION, FIRE AND RESOURCE ASSESSMENT PROGRAM

0 1.25 2.5 5 Miles

VESTRA

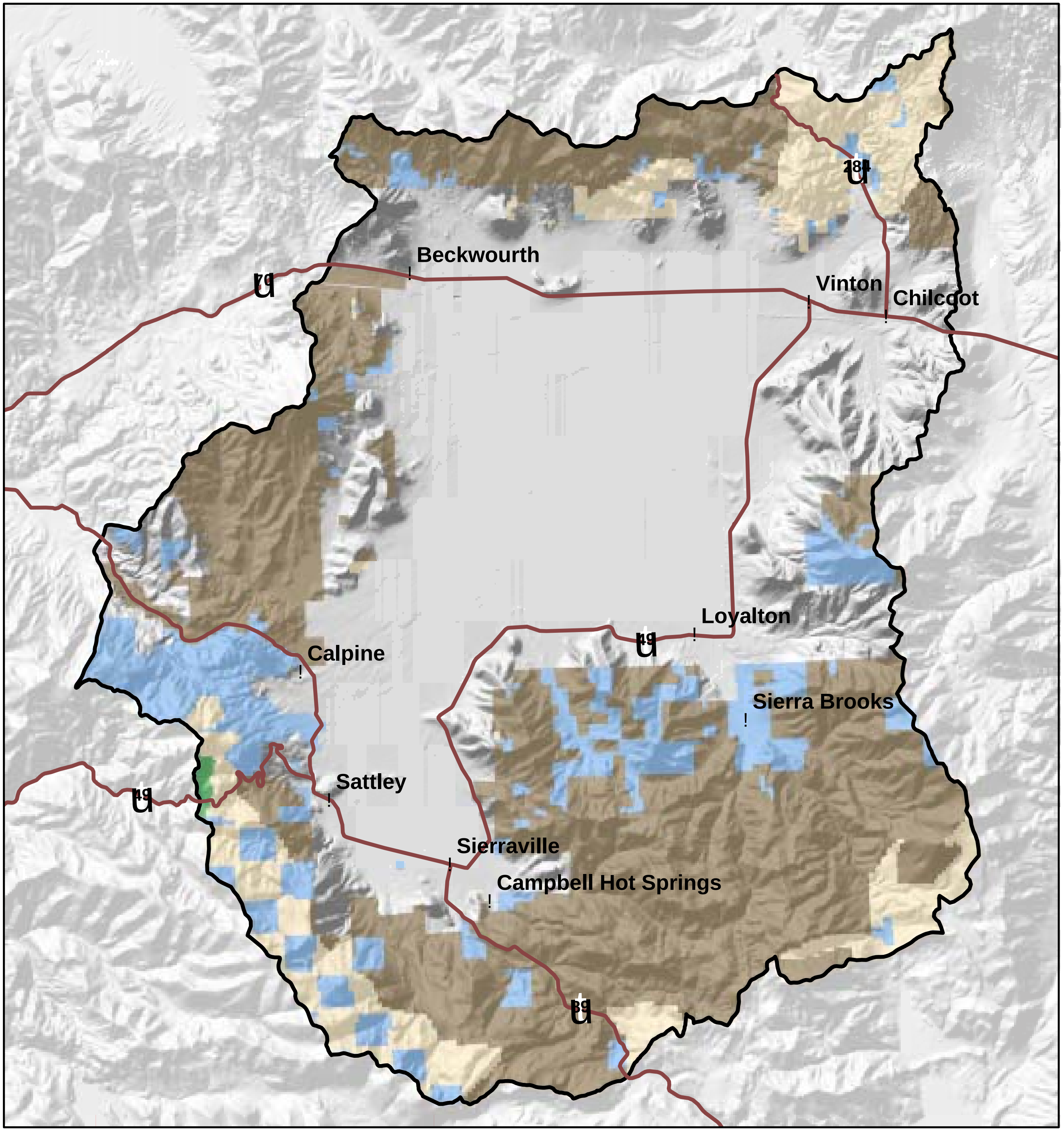


Figure 6-13
Sierra Nevada Ecosystem Project Ranking of Public Lands with Regard to Their Contribution to Late Successional Forest Function
Sierra Valley Watershed

Legend

- Sierra Valley Watershed
- State Highway
- Very Low Contribution
- Low Contribution
- Moderate Contribution
- Private Land

SOURCE: FRANKLIN AND FITES-KAUFFMANN, 1996

0 1.25 2.5 5 Miles

VESTRA

®

FIGURE 6-14
IVESIA WEBBERI
SOURCE: WITHAM, 2000
SIERRA VALLEY WATERSHED

VESTRA

FIGURE 6-15
PYRROCOMA LUCIDA
SOURCE: © 2001 DEAN WM. TAYLOR
SIERRA VALLEY WATERSHED

VESTRA

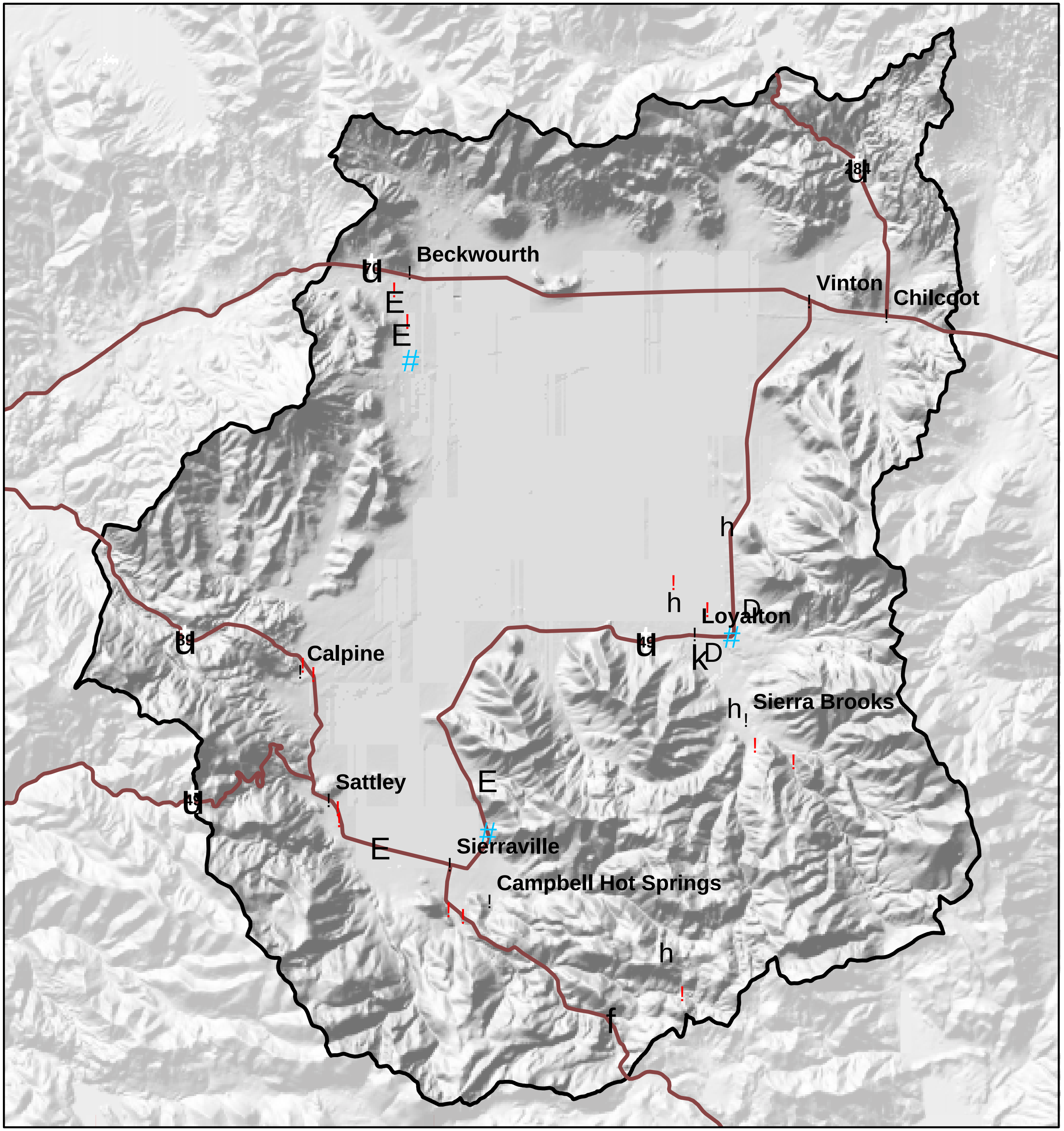


Figure 6-16
The Distribution of CDFA "A" and CalEPPC "A1" Listed Weeds Sierra Valley Watershed

Legend

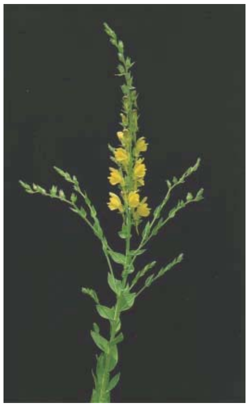
- State Highways
- Sierra Valley Watershed
- D Dalmatian toadflax
- k Leafy spurge
- h Musk thistle
- ! Perennial pepperweed
- f Scotch thistle
- # Spotted knapweed
- E Yellow starthistle

SOURCE: BISHOP, 2004

0 1.25 2.5 5 Miles

VESTRA

Dalmatian Toadflax



Scotch Thistle

Spotted Knapweed

Leafy Spurge

Musk Thistle

Perennial Pepperweed

Yellow Starthistle

VESTRA

FIGURE 6-17
CDFA "A" AND CalEPPC "A1" LISTED WEED SPECIES
SOURCE: BUREAU OF LAND MANAGEMENT
SIERRA VALLEY WATERSHED

Section 7

Section 7
FISH AND WILDLIFE RESOURCES

TABLES

FIGURES

Section 7
FISH AND WILDLIFE RESOURCES

INTRODUCTION

Tens of species of fishes, hundreds of species of terrestrial vertebrates and possibly thousands of invertebrate species use a variety of habitats in the Sierra Valley Watershed. Only a few of these species are considered threatened or endangered. Changing vegetation and stream conditions and the introduction of a variety of exotic animals affected the quality of habitat currently available to native species.

DATA SOURCES

A variety of literature provides general information on fish and wildlife resources in the watershed. Published literature relevant to local or regional conditions are cited including a California Department of Water Resources (DWR) (1973) study of the Sierra Valley and papers from the Sierra Nevada Ecosystem Project's final report to Congress (1996). A complete bibliography of references is included at the end of this section. The California Wildlife Relationships (CWHR) system is used to predict which wildlife species may occur in the watershed. The California Natural Diversity Database (CNDDB) and results of United States Forest Service (USFS) surveys are used to identify known occurrences of threatened and endangered species of fish and wildlife. Much of the biological information on threatened and endangered species is found on the California Department of Fish and Game (CDFG) website (http://www.dfg.ca.gov). Checklists, surveys and other information on birds, bats and butterflies known from the vicinity of watershed are found on the website of San Francisco State University's Sierra Nevada Field Campus (http://www.sfsu.edu/~sierra/). This website is a particularly rich local source of information on wildlife in the vicinity of the Sierra Valley. For example, it contains a bird checklist with information on the habitats used by and time of year that numerous bird species are present in the watershed. The results of the CDFG's semi-annual deer surveys conducted by airplane are used to provide population trend information for this game species. Interviews with various experts and persons with local knowledge provide an important source of information. Although these individuals are not all explicitly cited, with physical documentation, in this section, they are Craig Wilson, Deborah Urich, Larry Ford, and Susan Urie of the Tahoe National Forest; Jim Lidberg and Lori Powers of the California Department of Fish and Game, Lisa Heki of the U.S. Fish and Wildlife Service, Jim Steele of San Francisco State University, and Jan Stine of the Sierra Valley Resource Conservation District.

The CWHR system is a classification system for describing the different types of wildlife habitat found throughout California. The distribution of CWHR habitats found in the watershed and how they are grouped into "lifeforms" (defined in Section 6, "Botanical Resources,") due to the limitations of Landsat, for the purpose of this assessment, are discussed in detail in Section 6, "Botanical Resources." The CWHR system also contains habitat suitability models for over 600 species of terrestrial vertebrates. For each species in every structural stage of each habitat type, the models rate habitat quality as high, moderate, or low for reproductive, cover, and foraging life functions. Figure 7-1 shows an example of a CWHR habitat suitability model (see Table 6-2 in Section 6, "Botanical Resources," for size and density classes within vegetation types).

The CNDDB is maintained by the CDFG. It is a database of known occurrence of threatened, endangered, and other special status animals and plants. As is, it only features positive occurrence data. The lack of information on certain species being reported in the database does not necessarily mean that these species do not occur in the watershed. The results of USFS surveys are also used to assess the potential for occurrence of special status species. Extensive surveys for a variety of animals have been conducted on the Tahoe National Forest since 1999. In particular, 150 remote camera stations were placed for detecting fur-bearers (e.g., weasels, foxes, martins, fishers, etc.) as stated in a personal communication to Brett Furnas by C. Wilson of the Tahoe National Forest.

The 1973 DWR study includes important survey and mapping information of the occurrences of various native and exotic fish. It also includes limited information on stream habitat quality. Information from more recent habitat survey work on Tahoe National Forest streams is used to supplement information from the DWR report.

HABITATS THAT SUPPORT TERESTRIAL VERTEBRATES

Terrestrial vertebrates are animals with spinal cords including birds, mammals, reptiles, and amphibians that use dry land habitats within the watershed for all or a portion of their life cycle. CWHR modeling is used to predict the wildlife species likely to occur in the major terrestrial habitats or lifeforms found in the watershed. Over 250 species of terrestrial vertebrates may potentially occur and find high quality habitat somewhere in the watershed. This includes 171 birds, 70 mammals, 12 reptiles, and 5 amphibians. Nearly 40 percent of these animals are predicted to be present during the summer months only. Less than 10 percent are predicted to be present in the winter only. An additional 100 terrestrial vertebrate species may also potentially occur in the watershed, but habitat quality would be of lesser quality for these animals.

Table 7-1 shows the relative biodiversity of the lifeforms in the watershed. Upland meadow and riparian habitats support the highest number of terrestrial vertebrate species. The montane conifer lifeform also provides food and shelter to a relatively high number of species. Although they may support fewer overall numbers of species, the valley wetland and agricultural lifeforms provide high quality habitat to migrating waterfowl species.

Table 7-1
RELATIVE TERRESTRIAL VERTEBRATE BIODIVERSITY FOR LIFEFORMS FOUND

	Species Richness by Lifeform					
	All Lifeforms	**Agriculture**	**Valley Wetland**	**Sagebrush Scrub**	**Upland Meadow and Riparian**	**Montane Conifer**
Habitat Suitability High	**258**	**64**	**73**	**54**	**174**	**108**
Moderate		106	110	103	243	166
Low	364	134	133	146	275	210
Modeled CWHR Types		IRH	FEW	SGB, BBR	WTM, MRI, ASP	SMC, WFR, RFR, EPN

Notes: The species richness numbers are generated by CWHR single condition detail and an Excel macro program which uses "OR" logic, such that a species is included if it finds habitat of threshold quality (e.g., high, moderate, low) in one of the modeled CWHR habitats for at least one of its life functions (e.g., reproduction, cover, forage). The modeled CWHR types are: IRH – Irrigated Hay Field, FEW – Fresh Emergent Wetland, SGB – Sagebrush, BBR – Bitterbrush, WTM – Wet Meadow, MRI – Montane Riparian, ASP – Aspen, SMC – Sierran Mixed Conifer, WFR – White Fir, RFR – Red Fir, EPN – Eastside Pine.

Agricultural Habitats and Wildlife Species

Since the arrival of European settlers in the 1850s and 1860s, the native grassland, sagebrush scrub, and wetland habitats that naturally covered the Sierra Valley have been significantly modified by agriculture and grazing. Today there are approximately 80,000 acres of agricultural lands within the watershed. Although these agricultural habitats are less diverse than the native habitats they replaced, alfalfa fields that characterize much of the valley floor provide high quality habitat to numerous species of invertebrate and vertebrate wildlife. Dense foliage over much of the year, retention of moisture after irrigation, and provision of food resources are three factors that make alfalfa fields extremely productive for arthropods (e.g., insects, spiders, and mites) (Putnam et al 2001). These arthropods provide a food base for many species including songbirds, swallows, bats, and waterfowl. In some places where there is good connectivity with upland habitats, deer graze on alfalfa during winter months. In the summer, birds of prey such as golden eagle and Swainson's hawk hunt for rodents periodically flushed from underground burrows by irrigational flooding. The frequent mowing and harvest of alfalfa fields with mechanical equipment can negatively impact ground nesting birds and other wildlife. Examples of measures many farmers do take to reduce these impacts include: efforts to flush out birds before mowing, removal and artificial incubation of eggs, and leaving unharvested strips of habitat during the nesting season (Putnam et al 2001).

Table 7-2 lists those species that are predicted by CWHR to occur and find high quality habitat within the agricultural lands found on the valley floor of the Sierra Valley Watershed. These species include 54 birds and 10 mammals.

Table 7-2
WILDLIFE SPECIES POTENTIALLY OCCURRING THAT MAY FIND HIGH-QUALITY HABITAT IN THE AGRICULTURAL LIFEFORM

Birds	European Starling	Sandhill Crane [summer]
American Avocet [summer]	Great Blue Heron	Say's Phoebe [summer]
American Coot	Great Horned Owl	Short-Eared Owl
American Crow	Horned Lark	Tree Swallow [summer]
American Kestrel	House Finch	Tundra Swan [winter]
American Pipit [winter]	House Sparrow	Turkey Vulture [summer]
American Wigeon	Killdeer	Violet-Green Swallow [summer]
Bank Swallow [summer]	Long-Billed Curlew [summer]	Western Kingbird [summer]
Barn Swallow [summer]	Mallard	Western Meadowlark
Black Tern [summer]	Merlin [winter]	Western Screech Owl
Black-Billed Magpie	Mountain Bluebird	Wilson's Phalarope [summer]
Black-Necked Stilt [summer]	Mourning Dove	
Brewer's Blackbird	Northern Flicker [summer]	**Mammals**
Brown-Headed Cowbird	Northern Harrier	Belding's Ground Squirrel
California Gull	Northern Pintail	Black-Tailed Jackrabbit
California Quail	Northern Pygmy Owl	Botta's Pocket Gopher
Canada Goose	Northern Rough-Winged Swallow [summer]	California Ground Squirrel
Cliff Swallow [summer]	Northern Shrike [winter]	House Mouse
Common Nighthawk [summer]	Prairie Falcon	Long-Tailed Vole
Common Raven	Purple Martin [summer]	Mountain Pocket Gopher
Cooper's Hawk	Red-Winged Blackbird	Northern Pocket Gopher
	Ring-Billed Gull [winter]	Striped Skunk
	Rock Dove	Western Harvest Mouse

Source: CWHR - query for Sierra and Plumas counties at High habitat suitability for at least one life function (e.g., reproduction, cover, feeding). Additional GIS analysis using range maps used to select only those species with ranges intersecting the watershed or passing within 5 miles of the watershed. Seasonal notations indicate that a species is migratory and only uses the habitat for part of the year.

Valley Floor Wetland Habitats and Wildlife Species

Permanent and seasonal wetlands cover up to 5,000 acres of mostly private land on the valley floor. The largest wetland known as the Marble Hot Springs area is characterized by year round pools, sloughs, and marsh plants such as bulrushes. Various waterfowl and furbearers, including beaver and muskrat, use this habitat. Islands of vegetation within the deeper water afford protection to ground nesting birds from predators such as raccoon and fox. The western aquatic garter snake is also found in this lifeform. Sierran wetlands including those in Sierra Valley have been substantially modified over the last 150 years due to the diversion of the pre-existing hydrology. Some wetland areas were drained to improve conditions for grazing or development. In other areas, new wetlands have been created through water diversion for irrigation purposes. In general, the structural complexity of Sierran wetlands has been simplified by the channelization of watercourses that feed wetlands and the introduction of exotic plant species (Kattlemann and Embury 1996).

Table 7-3 lists those species predicted by CWHR to occur and find high quality habitat somewhere within the wetlands found on the valley floor of the Sierra Valley Watershed. These species include 58 birds, 9 mammals, 3 reptiles, and 3 amphibians.

Table 7-3
WILDLIFE SPECIES POTENTIALLY OCCURRING THAT MAY FIND HIGH-QUALITY HABITAT IN VALLEY FLOOR WETLANDS

Amphibians	Golden Eagle	Tundra Swan [winter]
Bullfrog	Great Blue Heron	Violet-Green Swallow [summer]
Great Basin Spadefoot	Great Horned Owl	Virginia Rail
Pacific Chorus Frog	Green-Winged Teal [winter]	Western Grebe
	Killdeer	Willet [summer]
Birds	Lesser Scaup [winter]	Wilson's Phalarope [summer]
American Bittern [summer]	Long-Billed Curlew [summer]	Wood Duck [summer]
American Coot	Mallard	Yellow-Headed Blackbird [summer]
American Wigeon	Marsh Wren [summer]	
Bank Swallow [summer]	Northern Harrier	**Mammals**
Barn Swallow [summer]	Northern Pintail	American Beaver
Black Tern [summer]	Northern Rough-Winged Swallow [summer]	American Mink
Black-Crowned Night Heron [summer]	Northern Shoveler	Common Muskrat
Blue-Winged Teal [summer]	Osprey	Common Porcupine
Brown-Headed Cowbird	Peregrine Falcon	Gray Fox
California Gull	Purple Martin [summer]	Northern River Otter
Canada Goose	Redhead	Raccoon
Canvasback [winter]	Red-Tailed Hawk	Striped Skunk
Cinnamon Teal [summer]	Red-Winged Blackbird	Vagrant Shrew
Clark's Grebe	Ring-Billed Gull [winter]	
Cliff Swallow [summer]	Ring-Necked Duck	**Reptiles**
Common Merganser	Ruddy Duck	Common Garter Snake
Common Nighthawk [summer]	Sandhill Crane [summer]	Western Aquatic Garter Snake
Common Snipe [winter]	Short-Eared Owl	Western Terrestrial Garter Snake
Common Yellowthroat [summer]	Snowy Egret [summer]	
Eared Grebe [summer]	Song Sparrow	
European Starling	Sora [summer]	
Gadwall	Tree Swallow [summer]	

Source: CWHR - query for Sierra and Plumas counties at High habitat suitability for at least one life function (e.g., reproduction, cover, feeding). Additional GIS analysis using range maps used to select only those species with ranges intersecting the watershed or passing within 5 miles of the watershed. Seasonal notations indicate that a species is migratory and only uses the habitat for part of the year.

Sagebrush Scrub Habitats and Wildlife Species

Sagebrush scrub forms the transition between upland and lowland habitats. It is more widespread on the drier uplands that cover the eastern portion of the watershed. There are approximately 60,000 acres of this lifeform in the watershed. It predominantly includes the sagebrush CWHR type and to a lesser extent, the bitterbrush CWHR type. Due to its lower elevation and palatable shrubs, sagebrush scrub within the watershed provides important winter range for deer. Sagebrush scrub in the eastern portion of the watershed may provide habitat for Great Basin associated species including sage grouse and pronghorn antelope.

The pronghorn antelope used to be widespread throughout California's native grassland, sagebrush scrub, and desert habitats including much of the Sacramento and San Joaquin central valleys. Today, the largest remaining pronghorn antelope populations in the state exist in eastern and northeastern California in Siskiyiou, Modoc, Lassen, Shasta, and Mono Counties (CNDDB). Pronghorn antelope is an infrequent inhabitant of the eastern Sierra Valley Watershed. There were several incidental sightings in the recent years, and a group of three pronghorn antelope was documented using northeastern parts of the watershed until 1992.

Table 7-4 lists those species predicted by CWHR to occur and find high quality habitat within the sagebrush scrublands of the Sierra Valley Watershed. These species include 25 birds, 25 mammals, 3 reptiles, and 1 amphibian.

Table 7-4
WILDLIFE SPECIES POTENTIALLY OCCURRING THAT MAY FIND HIGH-QUALITY HABITAT IN SAGEBRUSH SCRUB

Amphibians	Red-Tailed Hawk	Long-Tailed Weasel
Great Basin Spadefoot	Rock Wren	Merriam's Shrew
	Sage Grouse	Mountain Cottontail
Birds	Sage Sparrow [summer]	Mule Deer
American Kestrel	Sage Thrasher [summer]	Northern Grasshopper Mouse
Barn Owl	Say's Phoebe [summer]	Ord's Kangaroo Rat
Barn Swallow [summer]	Turkey Vulture [summer]	Panamint Kangaroo Rat
Black-Billed Magpie	Vesper Sparrow [summer]	Pinon Mouse
Brewer's Sparrow [summer]		Pronghorn
Burrowing Owl	**Mammals**	Pygmy Rabbit
California Quail	American Badger	Sagebrush Vole
Chukar	Black-Tailed Jackrabbit	Striped Skunk
Common Nighthawk [summer]	Bobcat	White-Tailed Antelope Squirrel
Common Raven	Canyon Mouse	White-Tailed Jackrabbit
Golden Eagle	Coyote	Yellow-Pine Chipmunk
Gray Flycatcher [summer]	Dark Kangaroo Mouse	
Green-Tailed Towhee	Deer Mouse	**Reptiles**
Horned Lark	Gray Fox	Gopher Snake
Long-Eared Owl	Great Basin Pocket Mouse	Striped Whipsnake
Northern Rough-Winged Swallow [summer]	Least Chipmunk	Western Rattlesnake
Peregrine Falcon		

Source: CWHR - query for Sierra and Plumas counties at High habitat suitability for at least one life function (e.g., reproduction, cover, feeding). Additional GIS analysis using range maps used to select only those species with ranges intersecting the watershed or passing within 5 miles of the watershed. Seasonal notations indicate that a species is migratory and only uses the habitat for part of the year.

Upland Meadow and Riparian Habitats and Wildlife Species

For terrestrial vertebrates, upland meadow and riparian habitats are the most diverse lifeform in the watershed. Table 7-5 lists those species predicted by CWHR to occur and find high quality habitat somewhere within the upland meadow and riparian lands of the Sierra Valley Watershed. These species include 119 birds, 45 mammals, 7 reptiles, and 3 amphibians. Low herbaceous plants dominate wet meadows including sedges and rushes. Stingers of willows are scattered throughout larger meadows. Conifers and deciduous riparian vegetation including cottonwood and aspen characterize the edges of meadows. Ecotones or the transitions between distinct vegetation types are often rich habitats because they merge a greater variety of habitat elements. In the watershed the upland meadow and riparian lifeform provides an edge between herbaceous/shrub, deciduous tree, and conifer-dominated habitats. Of the 174 species listed in Table 7-5, over 50 percent are modeled in CWHR as finding higher quality habitat in places where these types of ecotones exist.

Neotropical migrant birds, such as the willow flycatcher, winter in Central and South America and return to the Sierra in the summer to breed in the riparian and meadow habitats. Riparian habitats throughout the state are of key importance to breeding birds because this lifeform is severely impacted by development, agriculture, grazing, water diversion, and fire suppression. Today, riparian vegetation makes up less than 0.5 percent of the state's land area (RHJV 2000). Besides habitat loss, nest parasitism by brown-headed cowbird (*Molothrus ater*) is a threat to riparian and meadow breeding birds including vireos, warblers, and flycatchers. By placing its eggs in the nests of other species, the cowbird reduces the reproductive success of other species. Grazing and agriculture are practices that enhance foraging habitat for cowbirds by altering natural grassland, meadow, and riparian vegetation. Unfortunately, this trend increased the pressure on many species of riparian-associated breeding birds (RHJV 2000).

In the watershed, the historical construction of railroad grades in the late 1800s led to the diversion of water away from the 200-acre meadow complex in Carman Valley leading to the drying out and shifting vegetation composition of the meadow. A recent restoration project by the USFS and other partners has re-diverted water through the meadow, as stated in a personal communication to Brett Furans in 2004 by C. Wilson and S. Urie of the Tahoe National Forest. As noted in Section 6, "Botanical Resources," the national policy of aggressively suppressing western forest fires throughout much of the twentieth century led to a decline in the regeneration of aspen stands as these shade intolerant trees are overtopped by conifers in a forested landscape that has become much denser over the last 50 to 100 years. The USFS is planning further restoration work for aspen stands in the watershed by removing competing conifers in some places and promoting aspen regeneration as stated in a personal communication to Brett Furnas in 2004 by L. Ford of the Tahoe National Forest. At the statewide scale, restoration of riparian and meadow habitats is part of a strategy to expand the ranges of Neotropical migrants such as Bell's vireo (*Vireo bellii*). Historically, this species was a common bird found in riparian habitats throughout California. Today, the bird's range in the state is limited to small pockets in southern California (RHJV 200).

Table 7-5
WILDLIFE SPECIES POTENTIALLY OCCURRING THAT MAY FIND HIGH-QUALITY HABITAT IN UPLAND MEADOWS AND RIPARIAN

Amphibians	Long-Billed Curlew [summer]	Wood Duck [summer]
Great Basin Spadefoot	Long-Eared Owl	Yellow Warbler [summer]
Mountain Yellow-Legged Frog	Macgillivray's Warbler [summer]	Yellow-Headed Blackbird [summer]
Pacific Chorus Frog	Mallard	Yellow-Rumped Warbler
	Mountain Bluebird	
Birds	Mountain Quail	**Mammals**
Acorn Woodpecker	Mourning Dove	American Beaver
American Coot	Nashville Warbler [summer]	American Marten
American Dipper [winter]	Northern Flicker [summer]	American Mink
American Kestrel	Northern Goshawk	American Pika
American Pipit [winter]	Northern Harrier	Belding's Ground Squirrel
American Robin	Northern Pintail	Big Brown Bat
American Wigeon	Northern Pygmy Owl	Black Bear
Band-Tailed Pigeon [summer]	Northern Rough-Winged Swallow [summer]	Bobcat
Bank Swallow [summer]	Northern Saw-Whet Owl	Botta's Pocket Gopher
Barn Owl	Northern Shrike [winter]	Broad-Footed Mole
Barn Swallow [summer]	Osprey [summer]	Brush Mouse
Barred Owl	Peregrine Falcon	Bushy-Tailed Woodrat
Belted Kingfisher	Prairie Falcon	Common Muskrat
Bewick's Wren [winter]	Purple Martin [summer]	Common Porcupine
Black Swift [summer]	Red-Breasted Sapsucker [summer]	Coyote
Black-Billed Magpie	Red-Tailed Hawk	Deer Mouse
Black-Crowned Night Heron [summer]	Red-Winged Blackbird	Ermine
Black-Headed Grosbeak [summer]	Ring-Billed Gull [winter]	Fisher
Brewer's Blackbird	Ring-Necked Duck	Gray Fox
Brown-Headed Cowbird	Rough-Legged Hawk [winter]	Hoary Bat
Bullock's Oriole [summer]	Rufous Hummingbird [summer]	Long-Eared Myotis
California Gull	Sage Grouse	Long-Legged Myotis
California Quail	Sandhill Crane [summer]	Long-Tailed Vole
Calliope Hummingbird [summer]	Savannah Sparrow [summer]	Long-Tailed Weasel
Canada Goose	Sharp-Shinned Hawk	Montane Vole
Canyon Wren	Short-Eared Owl	Mountain Beaver
Cassin's Vireo [summer]	Snowy Egret [summer]	Mountain Lion
Chipping Sparrow [summer]	Song Sparrow	Mountain Pocket Gopher
Cliff Swallow [summer]	Sora [summer]	Mule Deer
Common Merganser	Spotted Owl	Northern Flying Squirrel
Common Nighthawk [summer]	Spotted Sandpiper [summer]	Northern Grasshopper Mouse
Common Raven	Steller's Jay	Northern Pocket Gopher
Common Snipe [winter]	Swainson's Thrush [summer]	Raccoon
Common Yellowthroat [summer]	Tree Swallow [summer]	Red Fox
Cooper's Hawk	Tundra Swan [winter]	Ringtail
Dark-Eyed Junco	Turkey Vulture [summer]	Silver-Haired Bat
Downey Woodpecker	Violet-Green Swallow [summer]	Snowshoe Hare
Dusky Flycatcher [summer]	Virginia Rail	Striped Skunk
European Starling	Warbling Vireo [summer]	Vagrant Shrew
Fox Sparrow	Western Bluebird	Water Shrew
Gadwall	Western Meadowlark	Western Harvest Mouse
Golden Eagle	Western Screech Owl	Western Jumping Mouse
Great Blue Heron	Western Tanager [summer]	Western Spotted Skunk
Great Horned Owl	Western Wood-Pewee [summer]	Yellow-Bellied Marmot
Green-Winged Teal [winter]	White-Breasted Nuthatch	Yellow-Pine Chipmunk
Hairy Woodpecker		

Table 7-5 (cont.) **WILDLIFE SPECIES POTENTIALLY OCCURRING IN THE SIERRA VALLEY WATERSHED THAT MAY FIND HIGH QUALITY HABITAT IN UPLAND MEADOWS AND RIPARIAN**		
Hammond's Flycatcher summer	White-Crowned Sparrow	**Reptiles**
Hermit Thrush summer	White-Throated Swift summer	California Mountain Kingsnake
Horned Lark	Wild Turkey	Common Garter Snake
House Wren summer	Willet summer	Gopher Snake
Killdeer	Williamson's Sapsucker	Rubber Boa
Lazuli Bunting summer	Willow Flycatcher summer	Western Aquatic Garter Snake
Lesser Scaup winter	Wilson's Phalarope summer	Western Skink
Lewis' Woodpecker	Wilson's Warbler summer	Western Terrestrial Garter Snake
Lincoln's Sparrow	Winter Wren	
Source: CWHR - query for Sierra and Plumas counties at High habitat suitability for at least one life function (e.g., reproduction, cover, feeding). Additional GIS analysis using range maps used to select only those species with ranges intersecting the watershed or passing within 5 miles of the watershed. Seasonal notations indicate that a species is migratory and only uses the habitat for part of the year.		

Montane Conifer Habitats and Wildlife Species

The watershed contains nearly 100,000 acres of montane conifer habitat. This lifeform includes red fir, white fir, Sierran mixed conifer, and eastside pine CWHR types. Monotypic red fir and white fir stands are found at higher elevations in the southwest portion of the watershed. Pine marten, red fox, western tanager, pileated woodpecker, and spotted owl are species that use these forests. Sierran mixed conifer is the most extensive forest habitat found in the watershed. It includes a variety of conifer species as well as ground story shrubs and herbaceous plants in canopy gaps. This forest type provides nesting habitat for raptors and chickadees as well as summer foraging range for deer. Eastside pine is the lowest elevation forest type. This lifeform is characterized by ponderosa pine over sagebrush scrub associated ground story species. White-headed woodpecker, sagebrush lizard, and winter range deer use eastside pine habitats.

Table 7-6 lists those species predicted by CWHR to occur and find high quality habitat somewhere within the montane conifer forests of the Sierra Valley Watershed. These species include 69 birds, 32 mammals, 6 reptiles, and 1 amphibian.

The numbers and types of wildlife species that use forest habitats are affected by structural conditions within those forests and the availability of habitat elements such as herbaceous plants for food or tree cavities for nesting in. Open eastside forests maximize diversity by providing space for both trees and non-tree habitat elements to grow. At the same time, larger older trees provide greater benefits to wildlife including perches and cavities within dead or dying trees. The CWHR predictive models illustrate these patterns in Figure 7-2. The figure shows that the diversity of those species listed in Table 7-6 decreases with respect to foraging habitat as canopy cover increases, whereas diversity with respect to reproductive habitat increases as average tree size increases. Regardless of overall species richness, different wildlife species have different requirements with regard to forest habitat structure. Table 7-7 provides examples of species that prefer large trees or large tree closed canopy forests for nesting or denning. The table gives examples of species that prefer open forests for foraging and those species with no preference at all.

Table 7-6
WILDLIFE SPECIES POTENTIALLY OCCURRING
THAT MAY FIND HIGH-QUALITY HABITAT IN MONTANE CONIFER

Amphibians	Nashville Warbler [summer]	Big Brown Bat
Long-Toed Salamander	Northern Flicker [summer]	Black Bear
	Northern Goshawk	Bobcat
Birds	Northern Pygmy Owl	Brush Mouse
American Kestrel	Mountain Chickadee	Bushy-Tailed Woodrat
American Robin	Mountain Quail	Common Porcupine
Bald Eagle	Northern Saw-Whet Owl	Coyote
Band-Tailed Pigeon [summer]	Olive-Sided Flycatcher	Deer Mouse
Barn Owl	Osprey [summer]	Douglas' Squirrel
Barn Swallow [summer]	Peregrine Falcon	Ermine
Barred Owl	Pileated Woodpecker	Fisher
Black Swift [summer]	Pine Grosbeak	Golden-Mantled Ground Squirrel
Blue Grouse	Prairie Falcon	Gray Fox
Brown Creeper	Purple Finch	Hoary Bat
California Spotted Owl	Purple Martin [summer]	Long-Eared Chipmunk
Calliope Hummingbird [summer]	Pygmy Nuthatch	Long-Eared Myotis
Cassin's Finch	Red Crossbill	Long-Legged Myotis
Chipping Sparrow [summer]	Red-Breasted Nuthatch	Long-Tailed Vole
Clark's Nutcracker	Red-Breasted Sapsucker [summer]	Long-Tailed Weasel
Common Nighthawk [summer]	Red-Tailed Hawk	Mountain Beaver
Common Raven	Rough-Legged Hawk [winter]	Mountain Lion
Dark-Eyed Junco	Ruby-Crowned Kinglet	Mule Deer
Dusky Flycatcher [summer]	Rufous Hummingbird [summer]	Northern Flying Squirrel
Evening Grosbeak	Sharp-Shinned Hawk	Pinon Mouse
Ferruginous Hawk [winter]	Steller's Jay	Raccoon
Flammulated Owl [summer]	Townsend's Solitaire	Silver-Haired Bat
Fox Sparrow	Turkey Vulture [summer]	Striped Skunk
Golden Eagle	Violet-Green Swallow [summer]	Trowbridge's Shrew
Golden-Crowned Kinglet	Warbling Vireo [summer]	Western Gray Squirrel
Great Horned Owl	Western Tanager [summer]	Western Spotted Skunk
Green-Tailed Towhee [summer]	Western Wood-Pewee [summer]	
Hairy Woodpecker	White-Breasted Nuthatch	**Reptiles**
Hammond's Flycatcher [summer]	White-Headed Woodpecker	Northern Alligator Lizard
Hermit Thrush [summer]	White-Throated Swift [summer]	Rubber Boa
Hermit Warbler [summer]	Williamson's Sapsucker	Sagebrush Lizard
Juniper Titmouse		Western Fence Lizard
Lewis' Woodpecker	**Mammals**	Western Rattlesnake
Mountain Bluebird	Allen's Chipmunk	Western Terrestrial Garter Snake
	American Marten	

Source: CWHR - query for Sierra and Plumas counties at High habitat suitability for at least one life function (e.g., reproduction, cover, feeding). Additional GIS analysis using range maps used to select only those species with ranges intersecting the watershed or passing within 5 miles of the watershed. Seasonal notations indicate that a species is migratory and only uses the habitat for part of the year.

As discussed in Section 6, "Botanical Resources," fire suppression, grazing, and timber harvesting are three factors that explain changing habitat conditions in the watershed's forests. The suppression of naturally occurring frequent low-intensity fires led to denser forests with fewer herbaceous plants and shrubs that provide food for many species of wildlife. Overgrazing has also affected the quality of foraging habitat. On the other hand, timber harvesting, beginning in the nineteenth century, has removed most of the larger, older trees. These trends may be affecting the quality of habitat available to species that require open forests or large trees.

Table 7-7 EXAMPLES OF WILDLIFE SPECIES WITH SIMILAR REQUIREMENTS WITH REGARD TO FOREST HABITAT STRUCTURE			
Reproductive Habitat Suitability		**Foraging Habitat Suitability**	
Gets better as trees get bigger and denser	Gets better as trees get bigger regardless of density	Gets worse as trees get denser regardless of tree size	Not affected by tree size or density
California Spotted Owl Pileated Woodpecker Northern Goshawk Fisher Northern Flying Squirrel	Great Horned Owl Mountain Chickadee Northern Flicker Black Bear Raccoon	Calliope Hummingbird Chipping Sparrow Mountain Bluebird Mule Deer Mountain Quail	Bald Eagle Olive Sided Flycatcher Steller's Jay Big Brown Bat Deer Mouse
Notes: Determinations made using the CWHR habitat suitability models for forested types such as the one featured in Figure 7-1.			

Other Terrestrial Habitats

Over the last decade, more than 40,000 acres in the watershed were burnt by wildfires (see discussion of LCMMP imagery in Section 6, "Botanical Resources.") The largest burn was the 1994 Cottonwood Fire that occurred in the Smithneck Creek drainage located in the southeastern portion of the watershed. Approximately 50 percent of the Cottonwood Fire area has been salvaged logged and replanted with conifers. This treatment will hasten the return of these areas to forested habitat. Some areas of the burn not salvaged contain large numbers of standing dead trees or snags. These snags provide nesting cavities and a valuable source of insect food for woodpeckers and other animals.

Now much of the planted and unplanted post-fire area is dominated by brush species including ceanothus and manzanita. The montane chaparral CWHR habitat type may provide high quality habitat to 56 animals potentially occurring in the watershed. Some of these species are Bewick's wren; spotted towhee; barn owl; brush mouse; Botta's pocket gopher; mountain lion; ringtail; and northern alligator lizard. Shrub species provide important forage to deer and other species. The nutritional value of montane chaparral declines, as plants grow older, tougher, denser, and less diverse in terms of species composition. In coming years, the USFS plans to treat the thickest areas of brush with herbicide. Although these treatments will accelerate the return of these sites to forestland, one study suggests that herbicide use may also increase the diversity of shrub species present before trees take over the sites (DiTomaso et al 1997).

INVERTEBRATES

Invertebrates are animals including insects, spiders, snails, worms, and crustaceans that have no backbone or spinal column. On a global scale, it is estimated that more than 95 percent of all animal species are invertebrates. The state of knowledge on all these species is incomplete and most of them are not identified or studied. Sierra Nevada habitats such as those found in the Sierra Valley Watershed likely support thousands of species of invertebrates.

One study roughly estimates the total number of insect species throughout California at 100,000 (Kimsey 1996). The study further notes the low endemism of Sierran insects. Endemic species are those species whose entire population is restricted to a limited geographic area. Kimsey reports that only 0.9 percent of the 100,000 insect species are endemic to the Sierra Nevada, whereas 12 percent are endemic to the state. The two reasons given for this phenomenon are: the Sierras offer few unique habitats not found in other states; and that the Sierra range is geologically young so there has been little time for new, unique, and isolated species to develop through the evolutionary process.

Although there are few endemic insect species in the Sierra Nevada, the region is unusually diverse in terms of butterflies (Shapiro 1996). San Francisco State University maintains a Sierra Nevada Field Campus in the watershed. On its website, the campus posts a list of over 120 butterfly species that were observed in the watershed and its vicinity (see Table 7-8). This list includes swallowtails, whites, sulphurs, gossamer-wing butterflies, brush-footed butterflies, and skippers. It is believed that climate change possibly played a role in recent changes in Sierra Valley butterfly fauna (Shapiro 1996). Populations of field crescent (*Phyciodes campestris montana*) and clouded sulphur (*Colias philodice*) disappeared. Ox-eyed wood nymph (*Cercyonis pegala boopis*) declined drastically in numbers. Additionally, tailed copper (*Lycaena arota arota*) were displaced by Nevada tailed copper (*Lycaena arota virginiensis).*

Table 7-8
PARTIAL LIST OF BUTTERFLIES KNOWN TO OCCUR WITHIN THE SIERRA VALLEY WATERSHED

Clodius Parnassian (*Parnassius clodius*) Sierra Nevada Parnassian (*Parnassius behrii*) Pipevine Swallowtail (*Battus philenor*) Anise Swallowtail (*Papilio zelicaon*) Indra Swallowtail (*Papilio indra*) Western Tiger Swallowtail (*Papilio rutulus*) Two-tailed Swallowtail (*Papilio multicaudata*) Pale Swallowtail (*Papilio eurymedon*) Pine White (*Neophasia menapia*) Becker's White (*Pontia beckerii*) Spring White (*Pontia sisymbrii*) Checkered White (*Pontia protodice*) Western White (*Pontia occidentalis*) Margined White (*Pieris marginalis*) Cabbage White (*Pieris rapae*) Large Marble (*Euchloe ausonides*) California Marble (*Euchloe hyantis*) Pacific Orangetip (*Anthocharis sara*) Stella Orangetip (*Anthocharis stella*) Gray Marble (*Anthocharis lanceolata*) Orange Sulphur (*Colias eurytheme*) Tailed Copper (*Lycaena arota*)	Moss' Elfin (*Callophrys* (*Incisalia*) *mossii*) Western Pine Elfin (*Callophrys* (*Incisalia*) *eryphon*) Johnson's Hairstreak (*Callophry*s (*Loranthomitoura*) *johnsoni*) Thicket Hairstreak (*Callophrys* (*Loranthomitoura*) *spinetorum*) Nelson's Hairstreak (*Callophrys* (*Mitoura*) *nelsoni*) 'Siva' Juniper Hairstreak (*Callophrys* (*Mitoura*) *gryneus siva*) Gray Hairstreak (*Strymon melinus*) Spring Azure (*Celastrina ladon*) Western Tailed-Blue (*Everes amyntula*) Pacific Dotted-Blue (*Euphilotes enoptes*) Western Square-dotted Blue (*Euphilotes battoides*) Arrowhead Blue (*Glaucopsyche piasus*) Silvery Blue (*Glaucopsyche lygdamus*) Northern Blue (*Lycaeidaes idas*) Melissa Blue (*Lycaeides melissa*) Greenish Blue (*Plebejus saepiolus*) Boisduval's Blue (*Icaricia icarioides*) Shasta Blue (*Icaricia shasta*) Acmon Blue (*Icaricia acmon*) Lupine Blue (*Icaricia lupini*) Sierra Nevada Blue (*Agriades podarce*) Great Spangled Fritillary (*Speyeria cybele leto*) Coronis Fritillary (*Speyeria coronis*)	Green Comma (*Polygonia faunus*) Hoary Comma (*Polygonia gracilis zephyrus*) California Tortoiseshell (*Nymphalis californica*) Mourning Cloak (*Nymphalis antiopa*) American Lady (*Vanessa viginiensis*) Painted Lady (*Vanessa cardui*) West Coast Lady (*Vanessa annabella*) Common Buckeye (*Junonia coenia*) Lorquin's Admiral (*Limenitis lorquini*) California Sister (*Adelpha bredowii*) 'California' Common Ringlet (*Coenonympha tullia california*) Ringless Common Ringlet (*Coenonympha tullia ampelos*) Common Wood Nymph (*Cercyonis pegala*) Great Basin Wood Nymph (*Cercyonis sthenele*) Small Wood Nymph (*Cercyonis oetus*) Great Arctic (*Oeneis nevadensis*) Monarch (*Danaus plexippus*) Silver-spotted Skipper (*Epargyreus clarus*) Mexican Cloudywing (*Thorybes mexicana*) Northern Cloudywing (*Thorybes pylades*)

Table 7-8 (continued)
PARTIAL LIST OF BUTTERFLIES KNOWN TO OCCUR WITHIN THE SIERRA VALLEY WATERSHED

Lustrous Copper (*Lycaena cupreus*) Purplish Copper (*Lycaena helloides*) Lilac-bordered Copper (*Lycaena nivalis*) Edith's Copper (*Lycaena editha*) Gorgon Copper (*Lycaena gorgon*) Ruddy Copper (*Lycaena rubidus*) Blue Copper (*Lycaena heteronea*) Mariposa Copper (*Lycaena mariposa*) Golden Hairstreak (*Habrodais grunus*) Great Purple Hairstreak (*Atlides halesus*) Behr's Hairstreak (*Satyrium behrii*) Sooty Hairstreak (*Satyrium fuliginosum*) California Hairstreak (*Satyrium californica*) Mountain-Mahogany Hairstreak (*Satyrium tetra*) Sylvan Hairstreak (*Satyruim sylvinus*) Hedgerow Hairstreak (*Satyruim saepium*) Goldhunter's Hairstreak (*Satyrium auretorum*)	Zerene Fritillary (*Speyeria zerene*) Callippe Fritillary (*Speyeria callippe*) Great Basin Fritillary (*Speyeria egleis*) Northwestern Fritillary (*Speyeria hesperis irene*) Hydaspe Fritillary (*Speyeria hydaspe*) Mormon Fritillary (*Speyeria mormonia arge*) Pacific Fritillary (*Boloria epithore*) Leanira Checkerspot (*Thessalia leanira*) Northern Checkerspot (*Chlosyne palla*) Hoffmann's Checkerspot (*Chlosyne hoffmanni*) Field Crescent (*Phyciodes campestris montana*) California Crescent (*Phyciodes orseis*) Mylitta Crescent (*Phyciodes mylitta*) Variable Checkerspot (*Euphydryas chalcedona*) Edith's Checkerspot (*Euphydryas eidtha aurilacus*) Satyr Comma (*Polygonia satyrus*) Bramble Hairstreak (*Callophrys affinis perplexa*) Brown Elfin (*Callophrys (Incisalia) augustinus*) 'Alpine' Sheridan's Hairstreak (*Callophrys sheridani lemberti*)	Dreamy Duskywing (*Erynnis icelus*) Propertius Duskywing (*Erynnis propertius*) Mournful Duskywing (*Erynnis tristis*) Persius Duskywing (*Erynnis persius*) Pacuvius Duskywing (*Erynnis pacuvius*) Two-Banded Checkered-Skipper (*Pyrgus ruralis*) Common Checkered-Skipper (*Pyrgus communis*) Arctic Skipper (*Carterocephalus paleamon*) Juba Skipper (*Hesperia juba*) Western Branded Skipper (*Hesperia colorado*) Lindsey's Skipper (*Hesperia lindseyi*) Sonora Skipper (*Polites sonora*) Sandhill Skipper (*Polites sabuleti*) Dun Skipper (*Euphyes vestris*) Rural Skipper (*Ochlodes ruralis*) Woodland Skipper (*Ochlodes sylvanoides*) Umber Skipper (*Poanes melane*) Common Roadside-Skipper (*Amblyscirtes vialis*)

Source: San Francisco State University Website, Sierra Nevada Field Campus http://www.sfsu.edu/~sierra

The agricultural fields of Sierra Valley support a wide diversity of insect life. Researchers have identified over 1,000 arthropod species (e.g., insects, spiders, mites, etc.) that inhabit California alfalfa fields (Putnam et al 2001). Less than one percent of these species are the pests that damage crops. Some of these insects, such as the ladybird beetle and parasitic wasps, provide a natural source of crop protection by preying on alfalfa pest species. The majority of arthropod species not detrimental to crops provide a rich food base for hundreds of animals.

AQUATIC HABITATS AND SPECIES

The watershed provides aquatic habitat to at least 15 species of fish (see Table 7-9). Half of these species are non-native fish either planted as game or introduced accidentally. Two native fishes (rainbow trout and mountain whitefish) and two introduced fishes (brown trout and eastern brook trout) use upland cold-water streams and lakes. Four native fishes (Lahontan redside, speckled dace, mountain sucker and riffle sculpin) and six exotic fishes (green sunfish, bluegill, brown bullhead, largemouth bass, golden shiner, and common carp) primarily use warm water streams, channels, and sloughs found on the valley floor. Eight of these species (rainbow trout, brown trout, eastern brook trout, mountain whitefish, green sunfish, bluegill, brown bullhead, and largemouth bass) are game fishes.

Table 7-9 NATIVE AND EXOTIC FISHES OF THE SIERRA VALLEY WATERSHED	
Native	**Non-native**
Rainbow trout (*Oncorynchus mykiss*)	Brown trout (*Salmo trutta*)
Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) *	Eastern brook trout (*Salvelinus fontinalis*)
Mountain whitefish (*Prosopium williamsoni*)	Green sunfish (*Lepomis cyanellus*)
Lahontan redside (*Richardsonius egregius*)	Bluegill (*Lepomis macrochirus*)
Speckled dace (*Rhinichtys osculus*)	Brown bullhead (*Ameiurus nebulosus*)
Mountain sucker (*Catostomus platyrhynchus*)	Largemouth bass (*Micropterus salmoides*)
Riffle sculpin (*Cottus gulosus*)	Golden shiner (*Notemigonus chrysoleucas*)
	Common carp (*Cyprinus carpio*)

* This species was recently re-introduced to the watershed on a trial basis, to the Palen Reservoir on Antelope Creek
Source: DWR, 1973 and corroborated by Urich, pers. comm., 2004

Habitat Conditions

There are approximately 626 miles of streams and channels in the watershed. Of this amount, there are 340 miles of warm water streams and interconnected channels located on the valley floor including agricultural channels and diversions (DWR 1973). Over 5,000 acres of wetlands and sloughs in the Marble Hot Springs area provide deeper water habitat to mountain sucker, largemouth bass, and other warm water fishes.

A DWR (1973) report on the Sierra Valley area provides survey information on upland cold-water stream habitat supporting rainbow trout, brown trout, and eastern brook trout. The report identified 79 miles of cold water habitat (see Table 7-10 and Figure 7-3). There are at least 47.8 miles of fish bearing, cold water stream habitat in the watershed's southwestern drainages including Fletcher Creek, Turner Creek, Berry Creek, Hamlin Creek, Dark Canyon, Coldstream, Lemon Canyon, Bonta Creek, Blatchley Canyon, Rice Canyon, Cottonwood Creek, and Onion Creek. These streams flow through both the Tahoe National Forest and privately owned industrial timberland where streamside buffer zones are required by state law. The 1973 report describes many of these streams (e.g., Bonta, Dark Canyon, Berry, and Turner creeks) as well watered from the higher annual rainfall falling along the Sierra Crest. It notes that flows from these streams are stable such that summer flows rarely drop below four cubic feet per second (cfs). Summer flows in Coldstream are augmented by cross-basin diversion from the Little Truckee River for agricultural purposes. The 7-acre Colburn Lake at the headwaters of Berry Creek provides additional trout habitat.

The DWR report indicates that there are at least 24.7 miles of fish-bearing cold water stream habitat in the watershed's southeastern drainages including Smithneck Creek, Bear Valley Creek, Alder Creek, Badenaugh Creek, and Dodge Creek. These streams run through the Tahoe National Forest and two CDFG wildlife areas. Except for the main stem of Smithneck Creek, late summer flows on the various Smithneck tributaries are below two cfs. Higher water temperatures make these streams less productive for trout than streams in the southwestern drainages. The planting of catchable size rainbow trout in Smithneck Creek supplements resident populations of naturalized brown trout.

According to the DWR report, there are six miles of fish bearing cold-water stream habitat on Little Last Chance Creek extending to the watershed's northern boundary at Frenchman Lake. This stretch of stream runs from the valley floor up through Little Last Chance Canyon on the Plumas National Forest. Cold-water stream habitat along the Middle Fork Feather River between Portola

Stream	Trout Species Present – 1973*	Other Species Present	Coldwater Stream Miles*	Estimated Late Summer Flow (cfs)	Trout Species Planted by CDFG Since 1997**
Southwestern Drainages					
Fletcher Creek	EBT		2.5	0.5	
Turner Creek	RT, BT, EBT		4.0	4	
Berry Creek	RT, EBT		5.7	4	
Hamlin Creek	BT, EBT	SD, CP	3.0	6	
Dark Canyon	BT, EBT		2.5	6	
Lower Coldstream	RT, BT, EBT	SU	4.0	3	
Upper Coldstream	RT, BT, EBT	SU	7.3	1	RT
Lemon Canyon	BT		3.5	Int.	
Bonta Creek	RT, BT		6.7	5	
Blatchley Canyon	RT, BT		1.7	0.5	
Rice Canyon	RT, BT		2.3	0.1	
Cottonwood Creek	RT, BT		4.0	0.2	
Onion Creek	EBT		0.6	0.1	
Southeastern Drainages					
Smithneck Creek	RT, BT	SU	9.3	5	RT, BT
Bear Valley Creek	RT, BT	SU	7.5	0.5	
Alder Creek	RT, BT		2.2	0.1	
Badenaugh Creek	RT, BT		3.7	1.5	
Dodge Creek	RT, BT		2.0	0.1	
Other Drainages					
Middle Fork Feather River	RT, BT, EBT	SD, CP, SU, LR, GS	0.5	10	RT
Little Last Chance Creek	RT	SD, SU	6.0	2	RT, BT

Table 7-10
FISH AND HABITAT INFORMATION FOR STREAMS IN THE SIERRA VALLEY WATERSHED

Source: DWR, 1973*; Powers, Pers. Comm., 2004**
Key: RT – Rainbow Trout; BT – Brown Trout; EBT – Eastern Brook Trout; SD – Speckled Dace; CP – Common Carp; SU – Mountain Sucker; LR – Lahontan Redside; GS – Golder Shiner

and Beckwourth is of low quality for trout and other cold-water fishes because of elevated water temperatures due to the great distance the water travels in the relatively flat valley floor, siltation and nutrient loads resulting from agricultural practices on the valley floor, and competition with exotic fishes. During summer months, most of the water passing through the valley is diverted for irrigation purposes so the water reaching the Middle Fork Feather River is largely drain water from alfalfa fields.

Geographic information system analysis suggests there are an additional 207 miles of upland streams in the watershed besides those identified by the DWR report as fish bearing cold-water stream habitat. Most of these streams lie in the eastern and northern portions of the watershed where summer flows are intermittent or reduced to trickles below 0.2 cfs. These streams are unlikely to support productive trout fisheries. Two stream systems in the western watershed may possess flow and temperature conditions for supporting trout fisheries. These include 21.7 miles along Carman Creek and its tributaries and 17.5 miles along Sulphur Creek and its tributaries. However, the 1973 DWR report states that Carman Creek does not contain any trout species. Furthermore, the report does not address the Sulphur Creek system, which is the only part of the Sierra Valley watershed assessment area that does not drain into the Sierra Valley. This stream drains into the Middle Fork Feather River below Portola.

In recent years, the Tahoe National Forest has conducted stream habitat surveys and temperature monitoring in the streams in the southern part of the watershed as stated in a personal communication to Brett Furnas in 2004 by D. Urich of the Tahoe National Forest. Pebble count surveys have assessed the quality of spawning gravels. Temperature monitors have measured daily variations in water temperature. The overall findings so far are that current conditions in many of the streams are unstable possibly due to the cumulative effects of the 1994 Cottonwood Fire; a major flood event in 1997; roads and skid trails related to timber harvesting; water diversion for agricultural purposes; and livestock grazing. Delivery of fine sediments from multiple sources affects the quality of spawning gravels in many places. The daily variation in summer stream temperature has been measured at about 12°F in a number of streams. The recruitment of large woody debris important for adding complexity to stream channels is considered deficient. Cross-basin diversion of water from the Little Truckee River down Coldstream has increased peak flows through a confined and erosive channel.

There are two fish passage barriers in the watershed. The first is a privately-owned dam located at Palen Reservoir. The second is a DWR dam located at Frenchman Lake at the headwaters of Little Last Chance Creek. A dam built in the 1980s on Carman Creek blocks (or partially blocks) access to cold-water stream habitat higher up on the creek system. Small numbers of trout have been observed upstream in recent years.

A cement diversion canal about 0.5 miles above Palen Resevoir on Antelope Creek is a partial fish passage barrier. The canal is no longer used for irrigation purposes, but it blocks movement by juvenile and smaller fish. However, larger-sized Lahontan cutthroat trout introduced into Palen Reservoir have been observed passing across the barrier. Potential stretches of seasonally cold-water stream habitat and spawning gravels exist above the barrier, but the quality of actual upstream habitat has been low in recent years due to drought.

Native Fishes

Rainbow trout continues to be the most widely distributed fish in the western Sierra. It is found in most cold-water streams in the watershed. Although many of the rainbow trout in the watershed are planted as "catchable" size fish, naturally reproducing rainbow trout generally spawn from February through June in upland tributaries. They use their tails to dig depressions called "redds" in stream gravels where eggs are laid. Well-oxygenated cold water and suitable gravels free of silt are required for successful incubation, hatching, and rearing of juvenile trout.

Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) were re-introduced by the CDFG in the mid-1990s on a test basis into the Palen Reseivoir on Antelope Creek. In subsequent years, individual trout were observed moving upstream of the reservoir, but it is unknown whether successful spawning occurred. In 2002 to 2003, the reservoir was drained to a low level so that most of the trout could be collected in order to assess the health and the presence of diseases within the introduced test population. The draining project was achieved through a partnership between the U.S. Fish and Wildlife Service, the CDFG and the private landowner at Palen Reservoir. The U.S. Fish and Wildlife Service concluded that the Palen Reservoir was not a viable option for providing brood or grow-out capability. However, further planting of the species in Palen Reservoir may be an option in the future for providing recreational fishing opportunities.

Mountain whitefish is a member of the trout family that inhabits lakes and larger streams. It prefers deeper water and pools where it feeds on bottom dwelling organisms. In the spring, it moves upstream to shallower waters to spawn. The mountain whitefish, native to the Truckee River drainage, were introduced to Coldstream by means of water diverted from the Little Truckee River. They are not common in the watershed (DWR 1973).

Lahontan redside is a small minnow rarely longer than 3 inches. It occurs in the Middle Fork Feather River and valley floor channels and sloughs. Speckled dace is a slightly larger minnow that is distinguished by the fact that is it the most widely distributed native fish in California. It occurs in similar habitats as the redside, but also occurs in Hamlin Creek and Little Last Chance Creek below Frenchman Lake. The speckled dace frequently dwells in rocky turbulent riffles where it feeds on snails and insect larvae. Both of these minnow species are fairly common in valley floor waters (DWR 1973, Schoenherr 1992).

Mountain sucker is adapted to a variety of habitats and it occurs in valley floor watercourses as well as in Coldstream, Smithneck Creek, Bear Valley Creek, and Little Last Chance Creek (DWR 1973). Compared to other sucker species, its numbers and distribution declined in other parts of the Sierra Nevada (Moyle et al 1996).

Riffle sculpin is endemic to California. It requires high quality cold-water habitat and has been extirpated from a number of middle elevation streams throughout the Sierra Nevada (Moyle et al 1996). It may still occur in the Middle Fork Feather River.

Exotic Fishes

Half of the fish species found in the Sierra Valley Watershed are exotic. Some of these fishes (e.g., largemouth bass, brown trout, eastern brook trout) were deliberately introduced as game species. Others, such as golden shiner, were introduced accidentally by live-bait anglers (DWR 1973). Non-native fishes adversely affect native fish populations through predation, competition for resources, and hybridization. This problem is a greater concern in waters adjacent to the watershed than within the watershed itself. For example, predation by northern pike (*Esox lucius*) is a serious problem in Lake Davis, and non-native trout has largely displaced Lahontan cutthroat trout in much of the Truckee River system (Moyle et al 1996). There are no pike known to exist in the watershed.

In the Sierra Valley Watershed, most of the introduced non-trout species (e.g., green sunfish, bluegill, brown bullhead, largemouth bass, golden shiner, common carp) are restricted to valley floor waters. Some of these exotic fishes may be limiting trout production in Coldstream, Smithneck Creek, lower Hamlin Creek, and Colburn Lake (DWR 1973). Rainbow trout spawn in the spring, whereas brown and brook trout are fall spawners. Consequently, there is probably not genetic mixing between native and exotic trout in the watershed. However, native trout may be impacted by habitat competition and predation of juveniles by exotic brown and brook trout.

Naturalized populations of brown trout are established along low gradient streams such as Smithneck Creek and Coldstream and in the lower portions of Hamlin, Berry, and Turner Creeks.

Naturalized populations of eastern brook trout are only present in colder high elevation streams or in heavily shaded spring fed streams on the west side of the watershed. These streams include Dark Canyon, Berry, Turner, and Fletcher Creeks (DWR 1973).

Brown bullhead is common in valley floor warm waters. Green sunfish occurs in valley floor sloughs. Largemouth bass occur in the Middle Fork Feather River (DWR 1973).

Fishing and Fish Planting History

Recreation fishing is a popular outdoor activity that supports the local economy. Statewide trout angling is estimated to generate more than 75,000 jobs and $3 billion in personal income annually (Hopelain 2003; Moyle et al 1996). The most popular fishing sites are just outside the watershed at Lake Davis and Frenchman Lake. Streams throughout the watershed are used for cold and warm water fishing. State regulations require that persons engaging in fishing possess a license and abide by season dates, catch limits, and other rules. The 45-mile stretch of the Middle Fork Feather River immediately west of the watershed is designated as a wild trout stream by the CDFG. In order to facilitate the health of naturally reproducing rainbow trout populations in these waters, only catch and release fishing with barbless hooks is allowed.

Fish planting in California has occurred since the mid-nineteenth century when local species such as the California golden trout were transported above waterfalls and across drainages. By the 1870s, exotic game species including brown trout and eastern brook trout were planted in Sierra Nevada streams by private individuals, sporting clubs, and government agencies. In the 1940s and 1950s, the CDFG took over official responsibility for stocking California streams, lakes, and reservoirs. This effort was aided by the construction of a statewide network of hatcheries (Moyle et al 1996).

Today, these hatcheries raise and plant about 13 million catchable trout, 1 million sub-catchable trout, and 12 million fingerling trout. Catchable trout are six to eight inches in length and are planted with the expectation that 50 percent will be caught within two weeks of release. These fish are planted in streams and lakes, whereas four to six-inch long sub-catchable trout are generally used to stock reservoirs. Fingerling trout are mainly planted in high elevation mountain lakes (Moyle et al 1996).

CDFG records show that since 1997 rainbow and brown trout have been planted in some years in watershed streams including Little Last Chance, Smithneck, Coldstream and the Middle Fork Feather River. More information on the streams where fish have been planted is provided in Table 7-10. Information from the DWR (1973) report indicates that in past decades, Coldstream and Smithneck Creeks are planted with catchable trout, whereas Colburn Lake was planted with fingerling trout.

Aquatic Invertebrates

Aquatic invertebrates form a complex web at the base of the food chain in Sierra Valley watershed streams. Some of these organisms shred coarse organic matter such as leaf litter. Others graze algae off rocks. Other organisms gather plankton and floating organic material. Predators feed on the other groups of invertebrates. In general, shredders and collectors are more common upstream, whereas grazers are more common downstream (Schoenherr 1992). Caddisflies, mayflies, and stoneflies are insects that mature through larvae stage in aquatic environments, but develop into flying insects that use terrestrial habitats. They are an important food source for trout and other fishes. The California crayfish (*Pacifutacus leniusculus*) is the one species of crayfish known to occur in the watershed. It occurs in the Middle Fork Feather River (DWR 1973).

In contrast, of terrestrial invertebrates, there is a high degree of endemism for aquatic invertebrates found in the Sierra Nevada. It is estimated that at least 400 species of aquatic invertebrates in the Sierra Nevada are endemic to the Sierra (see Table 7-11).

Table 7-11
DIVERSITY AND ENDEMISM OF AQUATIC INVERTEBRATE SPECIES IN THE SIERRA NEVADA

	Estimated Number of Species			
Taxon	**Total in California**	**Total in Sierra**	**Endemic to Sierra**	**Percentage Endemic to Sierra (%)**
Stoneflies (Plecoptera)	167	122	31	25
Alderflies (Megaloptera: Sialidae)	6	4	0	0
Dobsonflies (Megaloptera: Corydalidae)	11	7	?	n/a
Caddisflies (Trichoptera)	308	199	37	19
Net-winged Midges (Diptera: Blephariceridae)	16	11	1	9
Mountain Midges (Diptera: Deuterophlebeiidae)	6	4	1	25
Snails and Clams (Mollusca)	?	40	8	20
Fairy Shrimp (Anostraca)	23	10	1	10

Source: Erman, 1996–Table 35.2

Broad taxa monitoring of aquatic invertebrates may be a useful tool for assessing stream conditions. Higher species richness and larger organism size are generally expected to be positively correlated with healthy ecological function in streams. This type of monitoring has been used as an assessment tool throughout the Sierra over the last 80 years (Erman 1996). However, a chapter included in the Sierra Nevada Ecosystem Project's Report to Congress provides the following cautionary advice in regard to the use of broad taxa monitoring of aquatic invertebrates as a stream assessment tool:

> The natural variability of invertebrate assemblages in streams is poorly known in the Sierra. One-time or one-season invertebrate sampling cannot reveal the 'health" of a stream or the extent of cumulative impacts in a stream basin at present. Changes over time in taxa richness and other various indices can show the direction of effect (i.e., are conditions worsening or improving?). Invertebrate sampling is a useful tool in stream monitoring if controls (references) in time and/or space (depending on the objectives of the study) are established, and if the limitations of stream-bottom substrate sampling are understood (Erman 1996).

Threatened and Endangered Fishes

There are no anadromous salmon or steelhead trout in the watershed or in the Feather River system above the Oroville Dam. The Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*), a federally listed threatened species, occurs at Independence Lake on the Little Truckee River immediately south of the watershed. Water is diverted from this river to supply irrigation needs in the Sierra Valley. However, there is currently no connectivity between Independence Lake and the Sierra Valley due to a diversion barrier above the confluence of the Little Truckee River and Independence Creek.

As previously discussed in detail, Lahontan cutthroat trout were re-introduced into the watershed on a trial basis in the mid-1990's at the Palen Reservoir on Antelope Creek.

THREATENED, ENDANGERED AND OTHER SPECIAL STATUS SPECIES

Species may be "listed" as threatened or endangered under the federal and California endangered species acts. Although there are differences between these two sets of law, an endangered species is a native species or subspecies of a bird, mammal, fish, amphibian, reptile, invertebrate, or plant that is in serious danger of becoming extinct throughout all, or a significant portion, of its range (because of loss of habitat, change in habitat, over exploitation, predation, competition, or disease). Both laws prohibit "take," generally defined as harassing, harming, pursuing, hunting, shooting, killing, trapping, capturing, or collecting listed animals or an attempt to achieve any of these proscribed activities. The process for listing a species is that any individual can petition the appropriate agency (US Fish and Wildlife Service for federal, or California State of Fish and Game Commission for state) to do so. The petition is reviewed and a decision is made whether the petition is warranted. Listing triggers a set of procedures that includes the development of a recovery plan. The federal law also requires the identification of "critical habitat" important for the recovery of a species. Both laws allow, "incidental take" under special circumstances. This includes after a Section 7 or 10 consultation for federally listed species; or after approval of a habitat management plan under Section 2081 of Fish and Game Code; or a natural community conservation plan for state-listed species.

In addition to formal listing, there are varieties of other designations used by federal and state agencies for prioritizing the protection of other species of special concern. The supplemental designations addressed in this Section include:

- ***California Fully Protected Animal*** State designation similar to threatened and endangered statuses. It prohibits "take."

- ***California Species of Special Concern*** State designation for species of interest to the CDFG because of potential threats, but the status does not trigger any specific restrictions.

- ***Board of Forestry Sensitive Species*** State designation includes habitat buffer restrictions per the California Forest Practice Rules that regulate timber harvest.

There are 10 species of threatened or endangered animals and two candidate species for listing that may occur in the watershed (see Table 7-12). This includes one fish, one amphibian, seven birds, and three mammals. Bald eagle, greater sandhill crane, peregrine falcon, and willow flycatcher were documented in the watershed at times after the year 2000. Swainson's hawk and wolverine were observed at times between 1990 and 2000. Extensive surveys by the USFS and habitat factors suggest that great gray owl, Sierra Nevada red fox, and fisher are not currently present in the watershed. Pictures of the threatened and endangered candidate species are featured in Figure 7-4.

Table 7-12
THREATENED AND ENDANGERED ANIMALS THAT POTENTIALLY OCCUR IN THE SIERRA VALLEY WATERSHED

SPECIES	T & E STATUS	OTHER SPECIAL STATUSES
Fishes		
Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*)	FT	
Amphibians		
Mountain yellow-legged frog (*Rana mucosa*)	FC	CSSC
Birds		
Bald eagle (*Haliaeetus leucocephalus*)	SE, FT	BOFS
Bank swallow (*Riparia riparia*)	ST	
Great gray owl (*Strix nebulosa*)	SE	BOFS
Greater sandhill crane (*Grus Canadensis tabida*)	ST	CFP
Peregrine falcon (*Falco peregrinus anatum*)	SE	CFP, BOFS
Swainson's hawk (*Buteo swainsoni*)	ST	
Willow flycatcher (*Empidonax traillii*)	SE	
Mammals		
Wolverine (*Gulo gulo*)	ST	CFP
Sierra Nevada red fox (*Vulpes vulpes necator*)	ST	
Fisher (*Martes pennanti*)	FC	CSSC

Notes:
SE – State-listed endangered species
ST – State-listed threatened species
FE – Federally-listed endangered species
FT – State-listed threatened species
FC – Candidate species for federal listing
CFP – California Fully Protected Species
CSSC – California Species of Special Concern
BOFS – Board of Forestry Sensitive Species

Lahontan Cutthroat Trout

This federally listed threatened species was reintroduced into the watershed on a trial basis. It is discussed in detail in the "Aquatic Habitats and Species" subsection.

Mountain Yellow-Legged Frog

In April 2003, the United States Fish and Wildlife Service (USFWS) found that a previously submitted petition to list the Sierra Nevada population of the mountain yellow-legged frog (*Rana mucosa*) as an endangered species is warranted. The USFWS also noted that it does not have enough resources to go through the listing process for this species until after higher priority species are addressed. Because of this action, the mountain yellow-legged frog in the Sierra Nevada is currently designated a candidate species for federal listing. A restriction on "take" does not apply to candidate species. California sport fishing regulations already prohibit capture or possession of this frog.

The USFWS (2003a) also noted that estimated mountain yellow-legged frog populations have declined by 50 to 80 percent in the Sierra Nevada. There is a 1998 CNDDB occurrence of this frog approximately one mile south of the watershed along the Little Truckee River. The watershed includes part of the historic range of this amphibian.

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) is a state endangered and federally threatened species. It is designated as a fully protected species by the State of California. The greatest threat to the species was the widespread use the pesticide DDT that caused abnormalities in bald eagle eggshells and led to nesting failure. Bald eagles were abundant throughout California. By the late 1960s and early 1970s, fewer than 30 nesting pairs remained in California (CDFG website). A nationwide ban on DDT in the early 1970s at the time of the federal listing is one reason for the recovery of this species. The bald eagle nesting population in the state steadily increased over the last 30 years (Figure 7-5). Due to these increases, the bird is proposed for federal delisting.

Bald eagles generally nest in montane conifer habitats. Nests are usually in the upper portions of large or deformed trees and are often situated within one mile of water. There are no known nest sites in the watershed, but there is a nest site 10 miles southeast of the watershed known from a 1997 CNDDB occurrence. The bald eagle is a migratory species that was observed over-wintering on the valley floor after traveling from summer habitats to the north.

Bank Swallow

The bank swallow (*Riparia riparia*) is a California threatened species. It is the smallest North American swallow. Bank swallow feeds on flying insects and nests within burrows dug into near vertical earthen banks along streams, coastal bluffs, and sand and gravel pits (CDFG 2004). The bird often nests in colonies. As a migratory species, the bank swallow spends summer and spring in California and over-winters in South America. Per CNDDB and local biologists interviewed during the preparation of this document, there are no known bank swallow burrows in the watershed. There is a year 2000 CNDBB occurrence of bank swallow five miles east of the northeast corner of the watershed.

Great Gray Owl

The great gray owl (*Strix nebulosa*) is state-listed as an endangered species. It is also designated as a USFS sensitive species. This bird has the longest wingspan (e.g., 5 feet) of any North American owl. It is associated with montane meadows surrounded by dense, late seral forest containing snags and broken topped trees for nesting. It forages primarily on rodents, including voles and gophers. Long grasses are important for supporting vole populations. Logging of large trees and grazing of long meadow grasses are potential reasons for great gray owl population declines (CDFG website).

There is a 1984 CNDDB record of a great grey owl in the watershed. However, extensive USFS surveys since 1994 have not detected any great grey owls. Due to the lack of large trees in association with un-grazed meadows, it is unlikely that this species currently occurs in the watershed.

Greater Sandhill Crane

The greater sandhill crane (*Grus Canadensis tabida*) is a California threatened species. The California population is estimated at 3,400 to 6,000 (CDFG 2004). This species in California predominantly nests in wetland habitats in northeastern California and over-winters in the Central Valley. The species is known for its elaborate, graceful, and ritualistic dance of courtship. This ground nesting species prefers to lay its eggs on small grass mounds surrounded by water 4 to 10 inches deep to provide protection from predators.

Habitat loss and degradation, especially in Central Valley wintering grounds, are a threat to the greater sandhill crane. The birds are forced to share smaller areas where there is less food available, leading to increased risk of disease due to overcrowding. In summer breeding habitats, agricultural practices can be a threat if nests and young birds are destroyed during mowing (CDFG 2004).

There is suitable nesting habitat in valley floor wetlands found in the watershed and greater sandhill cranes have been observed nesting there. Attempted nesting was noted at the meadow in Carman Valley; no successful attempts were recorded there. The nesting failures there were the result of nest predation by coyotes and raccoons. It is anticipated that the recent restoration of the meadow, which includes the construction of ponds with islands, will raise the water table, thereby reducing the risk of predation and increasing chances of successful crane reproduction. There are nine CNDDB occurrences of greater sandhill crane in the watershed from 1998 and 2000. Eight of these occurrences are on private lands on the valley floor. Additionally, according to a CDFG biologist, there are approximately four dozen known greater sandhill crane nesting sites known from valley floor wetland habitats.

Peregrine Falcon

The American peregrine falcon (*Falco peregrinus anatum*) is a California-listed endangered species. It was de-listed as a federally endangered species in 1999. There are over 190 known nesting sites in California. Although the data from various monitoring studies are not directly comparable, the information suggests that the California population has not decreased and may be increasing (CDFG 2004). The falcon is a migrating species that preys on birds it catches in the flight. It often nests in high cliffs.

In the watershed, there is one nesting pair in Township 22 North, Range 14 East, Section 10. The nest site was last confirmed occupied in 2001 and it was recorded as periodically occupied during the 1990s. The species was initially reintroduced into the Sierra Valley in the late 1980s by means of "cross-fostering" whereby peregrine falcon chicks were placed in the nests of prairie falcon (*Falco mexicanus*) adults.

Swainson's Hawk

The Swainson's hawk (*Buteo swainsoni*) is a California-listed threatened species. It is a medium sized hawk that breeds in California and winters in Mexico or South America. The loss of grassland and agricultural habitats to residential and commercial development is a serious threat to this species. In 1994, the California population was estimated at 800 pairs. The number is believed to have been as high as 17,000 in historical times (CDFG 2004). There are no known nesting sites in the watershed, but a pair was sighted flying near Loyalton in the spring of 1998.

Willow Flycatcher

The willow flycatcher (*Empidonax traillii*) is a California-listed endangered species. It is a summer resident of California where it breeds in riparian and meadow habitats. Willow flycatcher builds nests in willows or other riparian shrubs. The bird perches on the branches of this vegetation from which it "hawks" out above meadow grasses and water to capture flying insects. According to one researcher, nesting and foraging habitats are generally meadows larger than 10 acres with stringers of willows and other shrubs generally covering over 20 to 30 percent of the area (Green et al 2003).

However, according to a local researcher of willow flycatcher populations within the watershed, suitable habitat that is likely to foster successful reproduction includes a combination of vegetation and hydrological factors. Even a small, isolated clump (e.g., 20 ft. by 20 ft.) of mature willow shrubs may provide high quality nesting habitat if it is surrounded by a depression that holds standing water during the early summer breeding season. In addition to supporting insects for willow flycatchers to feed on, the low gradient water provides a protective moat for safeguarding against nest predation by ground squirrels, chipmunks, and other small mammals. Hydrological changes within montane meadows that have dried up these habitats are probably the greatest threat to willow flycatcher populations in the watershed. On the other hand, cowbird brood parasitism of willow flycatcher nests is believed to be minimal within the watershed.

The CDFG has developed a predictive model based on LANDSAT imagery for mapping potential habitat. This modeling maps 4,783 acres of potential habitat within the watershed (Figure 7-6), but the modeling probably overestimates the amount of suitable nesting habitat where both willows and suitable hydrological conditions are found. In particular, areas of mapped habitat to the north of Highway 70 are of uncertain accuracy.

Within the watershed, willow flycatchers have been observed in areas recovering from the 1994 Cottonwood Fire. They have also been documented using meadow habitats in the Carman Valley and the Ramelli Ranch area on Forest Service lands near Beckwourth. Small numbers of willow flycatchers have been observed during wet years during the breeding month of June at both locations. Slightly larger numbers have been recorded in late summer when birds are dispersing from other places after breeding. The occurrences of willow flycatcher noted during the breeding season appear to correlate with wetter winters and high snow pack. However, the post breeding occurrences are noted every year and do not seem to be related to wet years. Typical results from the surveys conducted by the Sierra Nevada Field Campus are 2 willow flycatchers caught by mist netting during the early summer breeding period in the Carman Valley (during wet years), versus four or five in the Carman Valley and two to three at Ramelli Ranch during late summer of any year.

To date, no successful reproduction by willow flycatchers has been documented in the watershed. However, it is anticipated that nesting habitat in the recently restored Carman Valley meadow will gradually improve in coming years as the small willows currently found there grow up around newly created ponds. Successful reproduction has been documented immediately south of the watershed in Perazzo Meadows and along the Little Truckee River. In recent years, 20 to 26 nesting pairs were recorded at these sites south of the watershed (Green et al 2003). Additional information is available with at the San Francisco State University Sierra Nevada Field Campus Website available online at http://www.sfsu.edu/~sierra/.

Wolverine

The wolverine (*Gulo gulo*) is a California-listed threatened animal. There is little information on the population status of this rare animal in California. The wolverine is a small, short-legged bear. It is generally found at higher elevations; the mean elevation of 150 sightings is 8,000 feet, although the range is 1,600 to 14,200 feet (CDFG 2004). This omnivorous species eats berries, fungi, live prey, and carrion.

The Tahoe National Forest's remote camera stations have detected no wolverines. However, there was a 1998 sighting within the watershed in Township 20 North, Range 15 East, Section 5. In 2003, there was another sighting south of the watershed near Interstate 80. Considering that wolverines have home ranges hundreds of square miles large and that they can travel 10 miles or more without resting, it is possible that these sightings could be of the same individual.

Sierra Nevada Red Fox

The Sierra Nevada red fox (*Vulpes vulpes necator*) is a California-listed threatened species. This rare native fox is distinguished from introduced lowland foxes in that it is slightly smaller and has darker colored fur. California sightings are generally between 5,000 and 7,000 feet (CDFG 2004). Like the wolverine, little is known about this subspecies in California.

Valley floor habitats in the watersheds are probably too low and unsuitable for the shy Sierra Nevada red fox. Though upland meadows in the watershed may provide suitable habitat, Tahoe National Forest's remote camera stations have not detected the Sierra Nevada red fox.

Fisher

In April 2003, the USFWS found that a previously submitted petition to list the west coast population of the fisher (*Martes pennanti*) as an endangered species is warranted. The USFWS (2003b) also noted that it does not have enough resources to go through the listing process for this species until after higher priority species are addressed. Due to this action, the fisher in California is currently designated a candidate species for federal listing. Restrictions on "take" do not apply to candidate species.

The fisher, a member of the weasel family (*Mustelidae*), is characterized by a triangular-shaped head. As a predator, it eats a variety of small mammals and birds. It is associated with late seral forest habitats and uses large diameter trees and snags for denning its young and resting during long distance travels in search of food. Fisher populations may be negatively affected by trapping in the last century. Fragmentation of mature forest habitat is considered a key threat today. At a landscape scale, there is concern about the genetic implications of isolation of the southern Sierran fisher population from the North Coast population (Zielinski et al 1995). Figure 7-7 demonstrates this isolation by means of comparing historical and post-1990 CNDDB occurrences.

Although there are historical occurrences of fisher near the watershed, it is unlikely that the species is currently present. The Tahoe National Forest's 150 remote camera stations have never detected fisher despite capturing 50 pictures of the closely related marten (*Martes americana*).

Other Special Status Species

In addition to the threatened and endangered species discussed above, there are 22 other animals designated as California fully protected animals, California species of special concern, or Board of Forestry sensitive species. These animals, listed in Table 7-13, are drawn from those species that potentially occur in the watershed and find some areas of high quality habitat in at least one of the lifeforms per the CWHR species models.

Table 7-13
SPECIAL STATUS SPECIES THAT POTENTIALLY OCCUR IN THE WATERSHED

Species	Special Status	Species	Special Status
Birds		Sage Grouse	CSSC
Burrowing Owl	CSSC	Sharp-Shinned Hawk	CSSC
California Spotted Owl	CSSC	Short-Eared Owl	CSSC
Cooper's Hawk	CSSC	Yellow Warbler	CSSC
Golden Eagle	CSSC, BOFS	Western Pond Turtle	CSSC
Great Blue Heron	CSSC	White-Tailed Jackrabbit	CSSC
Long-Eared Owl	CSSC		
Northern Goshawk	CSSC, BOFS	**Mammals**	
Merlin	CSSC	American Badger	CSSC
Northern Harrier	CSSC	Pygmy Rabbit	CSSC
Osprey	CSSC, BOFS	Ringtail	CFP
Prairie Falcon	CSSC	Sierra Nevada Snowshoe Hare	CSSC
Purple Martin	CSSC		

Notes: CFP – California Fully Protected Species; BOFS – Board of Forestry Sensitive Species; CSSC – California Species of Special Concern

The California spotted owl (*Strix occidentals occidentals)* is a California species of special concern. It is a different subspecies than the federally listed threatened northern spotted owl. The California spotted owl has been petitioned for listing, but the USFWS (2003c) denied the petition on the grounds that there is no statistical evidence of population decline and the trend on the federal lands under the Sierra Nevada Framework will be an increase in suitable nesting, roosting, and foraging habitats.

The northern goshawk (*Accipiter gentilis*) is a California species of special concern and a Board of Forestry Sensitive Species. This hawk generally nests and hunts in closed canopy forests with open under stories allowing flight through trees. It is a stealthy creature that relies on ambush to capture prey species including small birds and mammals. Several goshawk territories are located either in the watershed or nearby.

The USFS has two other special statuses it uses for considering wildlife species when making forest management decisions. These designations are Sensitive Species and Management Indicator Species. Species with these designations that may potentially occur in the watershed are not explicitly addressed in this assessment. However, many of the species under these designations are also California Species of Special Concern or rely on similar habitats as other special status species discussed in greater detail in this assessment. More information on USFS Sensitive Species potentially occurring within the watershed can be found online at http://www.fs.fed.us/r5/projects/sensitive-species/. More information on USFS Management Indicator Species can be found online at http://www.fs.fed.us/r5/snfpa/final-seis/vol1/chapter-3/3-2/323.html.

WILDLIFE POPULATIONS OF SPECIAL INTEREST

Deer

Deer is the state's most popular game mammal attracting between 165,000 and 200,000 hunters annually (CDFG 1998a). The CDFG is the government agency responsible for hunting regulations. These rules differ by hunting zones throughout the state. The Sierra Valley Watershed includes the X6b and X7a hunting zones. The boundary between these zones is Highway 70.

The watershed provides habitat to three subspecies of mule deer. Rocky Mountain mule deer (*Odocoileus hemionus hemionus*) is the most common, followed by Columbian black-tailed deer (*Odocoileus hemionus columbianus*), followed by California mule deer (*Odocoileus hemionus californicus*). The latter two subspecies are found mostly on the western slopes of watershed. All of the subspecies either belong to the Loyalton-Truckee, Sloat, or Doyle herds. The Loyalton-Truckee Herd is the largest herd. It uses habitats in the southern and eastern portions of the watershed. The Sloat Herd uses habitats in the western part of the watershed. The Doyle Herd uses habitats in the northern portion of the watershed.

Deer browse on tender new growth that is digestible and high in protein. Shrubs including ceanothus, mountain mahogany, and bitterbrush are preferred browse sources. Forbs and grasses are also important. In montane conifer, chaparral, and sagebrush scrub habitats, early seral and open stages are generally the most productive for deer forage. As conifers become denser and shrub species mature, there is less high-protein young growth available for deer browse (Figure 7-8). Deer require areas of moderately dense forest or chaparral for fawning and cover from predators and extreme temperatures. Deer move seasonally between summer and winter range habitats. They move upslope in the summer to montane conifer habitats. In the winter, they move downslope to places where snow is less than 15 inches deep. Preferred winter range habitat in the watershed consists of bitterbrush and mountain mahogany.

Within the watershed, deer rarely cross the highway to venture out on to agricultural habitats on the valley floor between Vinton and Sierraville. However, significant numbers of deer are known to graze from alfalfa fields on the privately owned Green Gulch Ranch between Beckwourth and Vinton. This activity occurs during the late fall. There is unbroken access for Doyle Herd deer to these fields from upland habitats on the Dixie Mountain State Game Refuge and Forest Service lands.

Statewide deer population numbers have decreased significantly since peak numbers in the 1950s and 1960s. This decline is largely the result of long-term declines in habitat quality. The trend is most pronounced in the northeastern portion of California including the Sierra Valley Watershed. Denser forests with thick mats of duff below them are much more common today than 150 years ago due to the exclusion of naturally occurring fire from Sierran forests. This ecological condition has greatly reduced the quantity and nutritional quality of ground story shrubs and herbaceous plants required by deer as forage in their summer range habitats. On the other hand, urban and agricultural development has decreased vegetative diversity in winter range habitats.

The watershed is part of the CDFG's North East Sierra "Deer Assessment Unit" (DAU). Rocky Mountain mule deer are the most common subspecies in this DAU. Deer populations in the DAU declined from 40,000 to 10,000 between 1992 and 1996 (CDFG 1998a). In more recent years, semi-annual survey flights conducted by the CDFG show a slight decline of one or two percent a year for deer populations within the watershed. The CDFG also collects harvest data (CDFG 2004) for each hunting zone through hunting tag returns. Figure 7-9 shows the locations of reported deer harvest for the two deer hunting zones that intersect the watershed. These data suggest that early seral habitat provided by the 1994 Cottonwood Fire may be temporarily enhancing deer forage conditions in the watershed. Of the 73 reported deer kills in the watershed in 2002, the overwhelming majority was from the vicinity of the Cottonwood Fire. However, this boost in deer foraging habitat is expected to taper off over the next several years as brush within the fire area matures and becomes denser and less nutritious. These deer belong to the Loyalton-Truckee Herd.

There are three CDFG-owned wildlife areas in the watershed totaling approximately 9,000 acres. The primary purpose of these areas is the enhancement of deer habitat. Controlled burning and the planting of bitterbrush are examples of active management occurring in these areas for improving habitat conditions (Rogers 1999).

The feeding of deer by people can adversely affect the health of deer. The practice can lead to artificially high concentrations of deer in too small an area resulting in increased incidence of lung diseases and intestinal parasites that affect deer. Consumption of unhealthy foods can result in malnourishment. An analogy provided by one CDFG biologist likens the feeding of deer by people to eating at a fast food restaurant: "it is not good for you, but it tastes good, so you come back for more." The feeding of deer by humans may also attract a greater number of deer predators such as mountain lion to an area, as stated in a personal communication to Brett Furnas in 2003 by D. O. Smith of the Department of Fish and Game.

Bear

The California black bear *(Ursus americana californiensis)* uses montane conifer, riparian, and meadow habitats throughout the watershed. As an omnivorous species, its food sources vary by season and availability. Ants are a common summer food. Berries and nuts are eaten in the fall. However, bears are notorious for scavenging through garbage and other food sources near campsites and homes. Bears den and hibernate in tree cavites, hollow logs, and caves.

The bear is a game species in California. Statewide population has increased steadily over the last quarter century from 10,000 and 15,000 animals in 1982 to 25,000 and 30,000 animals in 2003. Approximately 40 percent of the state's bears inhabit the Sierra Nevada, but the population is less dense than along the North Coast. Bear density in the Sierras is estimated at 0.5 to 1.0 animals per square mile (CDFG 2004). This figure suggests that there may be over 80 bears using upland habitats in the watershed.

There is little specific information on bear populations in the watershed. Table 7-14 supplies information on bear harvest through hunting in Plumas and Sierra Counties. This information is based on bear tags returned to the CDFG.

Table 7-14 BEAR HARVEST IN PLUMAS AND SIERRA COUNTIES, 1994–2003										
	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**Average**
Plumas County	85	93	77	98	96	71	49	82	75	61	78
Sierra County	34	21	16	32	12	33	31	34	28	16	26
Source: CDFG, 2003											

Mountain Lion

The mountain lion (*Felis concolor*) uses a variety of habitats throughout the state. It uses chaparral and other brushy stages of habitat for cover and reproduction. The mountain lion primarily preys on deer, but may also eat rabbits, porcupines, rodents, and occasionally domestic animals and livestock. It is mostly nocturnal.

Between 1906 and 1963, the mountain lion was labeled a "bountied predator." During this era, at least 12,500 lions were hunted and killed. In 1972, recreational hunting of mountain lion was prohibited. Depredation permits may still be issued for taking lions that kill, injure, or threaten livestock or pets. The number of such permits issued statewide by the CDFG increased steadily from 40 in 1980 to 200 in 1990 (CDFG 1998b).

Mountain lion populations throughout California are increasing. The statewide numbers of these animals have grown since the mid-1970s. There are increased incidences of mountain lion sightings and attacks on humans since 1990. There were only nine attacks and three persons killed statewide by mountain lions in the last decade.

Mountain lion densities in the Sierras can be as high as 7 to 10 individuals per 100 square miles (CDFG 1998b). This suggests that there are as many as 10 or 20 mountain lions using upland habitats within the watershed. The high concentration of deer and the availability of chaparral habitat in the area burnt by the 1994 Cottonwood Fire suggest that the southwest portion of the watershed may be an especially productive area for mountain lions. Besides following the deer they prey on, the competition for territories among an increasing number of mountain lions is a reason that these animals become more common in the wildland-urban interface. The growth of California urban and suburban development also increases the likelihood of contact between mountain lions and humans (CDFG 1998b).

Waterfowl

The Sierra Valley is known for the numbers of migrating waterfowl that stop at valley floor wetlands to rest during the spring and fall. A growing number of bird watchers visit the Marble Hot Springs wetland area within the watershed. On any given day from fall through winter, bird watchers are typically present at this site.

There are numerous migration routes of different bird species leading between summer nesting habitats as far north as Canada and the artic regions in the north; and warmer winter habitats as far south as Central and South America. The Sierra Valley lies along the path of what is known as the Pacific Flyway. Thousands of acres of wetlands in the Marble Hot Springs area are key resting and feeding habitat for these migrating birds. In addition to this large natural wetland, flooded agricultural and pasturelands on the valley floor provide functional wetland habitats for supporting migrating and resident waterfowl. These seasonal wetlands are fed by diversion of water into the watershed from the Little Truckee River. Valley floor wetlands provide spring through summer habitat for large numbers of nesting waterfowl including mallard, green-winged teal, cinnamon teal, white-face ibis and various rails and coots. Some waterfowl species including the Canada goose do not migrate and are resident in the watershed year round. A list of waterfowl species using Sierra Valley wetland habitats is featured in Table 7-15. Pictures of these species are shown in Figure 7-10.

Table 7-15
WATERFOWL SPECIES THAT USE SIERRA VALLEY WETLANDS

Tundra Swan (*Cygnus columbianus*)	Gadwall (*Anas strepera*)
Great Basin Canada Goose (*Branta canadensis moffitti*)	American Widgeon (*Mareca americana*)
Wood Duck (*Aix sponsa*)	Northern Shoveler (*Spatula clypeata*)
Pintail (*Anas acuta*)	Lesser Scaup (*Aythya affinis*)
Green-winged Teal (*Anas carolinensis*)	Redhead (*Aythya americana*)
Cinnamon Teal (*Anas cyanaptera*)	Ring-necked Duck (*Aythya collaris*)
Mallard (*Anas platyrhynchos*)	Ruddy Duck (*Oxyura jamicensis*)
	Common Merganser (*Mergus merganser*)

Source: DWR, 1973 and CWHR - query for Sierra and Plumas Counties at High habitat suitability for at least one life function (e.g., reproduction, cover, feeding). Additional GIS analysis using range maps used to select only those species with ranges intersecting the watershed or passing within 5 miles of the watershed.

Non-Native Species

Some wildlife species currently found in the watershed were not found in the area historically. These species are referred to as exotic or non-native. Some were introduced from other countries (e.g., European starlings), while others were introduced from other regions of the United States (e.g., muskrat). The 14 non-native species potentially occurring in the watershed are listed in Table 7-16. Additionally, there are livestock and feral populations of escaped domestic animals including cats, goats, and horses.

The bullfrog, native to the eastern United States, was introduced to California in the early 1900s. It is the largest frog in the state and it eats invertebrates and other frogs. It can be a serious problem to native amphibians, which it displaces from habitats. In recent years, bullfrog populations have increased in the Carman Valley Meadow and along the Middle Fork Feather River.

The rock dove, more commonly known as a pigeon, is found in irregularly used barns, buildings, cliffs, and bridges that provide high perches away from predators. Found in most habitat types, it especially thrives near humans and agriculture areas where it eats waste grain and agriculture crops. The rock dove was introduced to North America from Europe by immigrants in 1606 and observed in Ohio by the 1930s. The species is known to be a carrier of dangerous epidemics and infections and can infect native doves with vectors and avian bacteria.

Table 7-16 NON-NATIVE SPECIES THAT POTENTIALLY OCCUR IN THE SIERRA VALLEY WATERSHED	
Amphibians Bullfrog (*Rana catesbiana*) **Birds** Brown-Headed Cowbird (*Molothrus ater*) Chukar (*Alectoris chukar*) European Starling (*Sturna vulgaris*) House Sparrow (*Passer domesticus*) Rock Dove (*Columba livia*) White-Tailed Ptarmigan (*Lagopus leucurus*) Wild Turkey (*Meleangris gallopavo*)	**Mammals** Black Rat (*Rattus rattus*) Brown Rat (*Rattus norvegicus*) House Mouse (*Mus musculus*) Muskrat (*Ondatra zibethicus*) Virginia Opossum (*Didelpis virginiana*) Wild Pig (*Sus scrofa*)
Source: Graber 1996	

The European starling is probably one of the best-documented exotic birds in North America. It is found throughout the United States and in parts of Mexico and Canada. The starling is a serious pest to agriculture and urban areas. It has been documented that as many as one million individuals have flocked together during the winter to feed in agriculture areas. The starlings can out-compete cavity nesting native species such as bluebirds, flycatchers, and woodpecker

The muskrat occurs in freshwater marsh habitat throughout the Central Valley, northeastern California, and the Colorado River Basin. Its name is derived in part by two musk glands located in the lower abdomen. The species is an adept swimmer and most commonly seen in water at dawn or dusk. It builds "lodges" from emergent vegetation that provides protection from the weather and provides areas to nest. It is responsible for the deterioration of levees and instability of soils near the land-water fringe because it also burrows in banks for the same reason. The muskrat is not thought to directly compete with any freshwater marsh herbivores.

The ring-necked pheasant is a medium size game bird. The species was first introduced from China to the Willamette Valley of Oregon in 1881 and then in the 1880s in California. By 1925, the pheasant population established itself in California with sufficient numbers to allow the opening of a hunting season. The ring-necked pheasant is generally found on agricultural lands where grain crops exist near herbaceous and woody cover. This pheasant is not reported to cause reductions in other native species. Many native animals benefit from the presence of pheasants, especially those that prey on their eggs and chicks (e.g., raccoon, skunk, fox, coyote, river otter) or adults (e.g., coyote, fox, Cooper's hawk).

REFERENCES

CDFG (California Department of Fish and Game). 1998a. *An assessment of mule and black-tailed deer habitats and populations in California with special emphasis on public lands administered by the Bureau of Land Management and the United States Forest Service*. Report to the Fish and Game Commission.

——. 1998b. Special mountain lion issue. *Outdoor California* 57(3).

——. 2004. *Annual bear take report*. Wildlife Programs Branch.

DWR (California Department of Water Resources). 1973. *Natural resources of the Sierra Valley study area*. Sacramento, California.

DiTomaso, J., D. B. Marcum, M. S. Rasmussen, E. A Healy, and G. B. Kyser. 1997. Post-fire herbicide sprays enhance native plant diversity. *California Agriculture* 51(1):6-11.

Erman, N. A. 1996. *Status of aquatic invertebrates. Sierra Nevada Ecosystem Project: Final report to Congress, volume II*. University of California, Davis, California.

Graber, D. M. 1996. *Status of terrestrial vertebrates. Sierra Nevada Ecosystem Project: Final report to Congress, volume II*. University of California, Davis, California.

Green, G. A., H. L. Bombay and M. L. Morrison. 2003. *Conservation assessment of the willow flycatcher in the Sierra Nevada*.

Hopelain, J. S. 2003. *Strategic plan for trout management*. California Department of Fish and Game.

Kattlemann, R. and M. Embury. 1996. *Riparian areas and wetlands. Sierra Nevada Ecosystem Project: Final report to Congress, volume III*. University of California, Davis, California.

Kimsey, L. S. 1996. *Status of terrestrial insects. Sierra Nevada Ecosystem Project: Final report to Congress, volume II*. University of California, Davis, California.

Moyle, P. B. R. M. Yoshiyama and R. A. Knapp. 1996. *Status of fish and fisheries. Sierra Nevada Ecosystem Project: Final report to Congress, volume II*. University of California, Davis, California.

Putnam, D, M. Russelle, S. Orloff, J. Kuhn, L. Fitzhugh, L. Godfrey, A. Kiess and R. Long. 2001. *Alfalfa, wildlife and the environment*. University of California, Davis, California.

RHJV (Riparian Habitat Joint Venture). 2000. *The riparian bird conservation plan: A strategy for reversing the decline of riparian associated birds in California*. Version 1.0. California Partners in Flight. Available from World Wide Web: http://www.prbo.org/calpif/.

Rogers, R. D. 1999. Protecting and managing deer winter range at Antelope Valley Wildlife Area. *Outdoor California*. September-October issue.

Schoenherr, A. A. 1992. *A natural history of California*. Berkeley: University of California Press.

Shapiro, A. M. 1996. *Status of butterflies. Sierra Nevada Ecosystem Project: Final report to Congress, volume II*. University of California, Davis, California.

USFWS (U. S. Fish and Wildlife Service). 2003a. *Listing of Sierra Nevada population of mountain yellow-legged frog under ESA found warranted but precluded*. News Release, January 16.

——. 2003b. *Fisher*. News Release, April 7.

——. 2003c. *California spotted owl doesn't require ESA protection, wildlife service concludes*. News Release, February 10.

USFS (U. S. Forest Service). 1999. *California spotted owl protected activity centers and home ranges*. Sierra Nevada Forest Plant Amendment Project.

Zielinski, W. J., T. E. Kucera, and R. H. Barret. 1995. *Current distribution of the fisher, Martes pennanti, in California*. California Fish and Game, 81(3), 104-112.

Size and Stage Classes	Rep.	Cov	Feed
1 Seedling Tree			M
2S Sapling Tree Sparse	L	L	M
2P Sapling Tree Open	L	L	M
2M Sapling Tree Moderate			
2D Sapling Tree Dense			
3S Pole Tree Sparse	M	M	M
3P Pole Tree Open	M	M	M
3M Pole Tree Moderate			
3D Pole Tree Dense			
4S Small Tree Sparse	H	H	H
4P Small Tree Open	M	M	H
4M Small Tree Moderate			
4D Small Tree Dense			
5S Medium/Large Tree Sparse	H	H	H
5P Medium/Large Tree Open	M	M	H
5M Medium/Large Tree Moderate			
5D Medium/Large Tree Dense			

Notes: In the CWHR system size and canopy cover classes are used to categorize forest structural stages as defined in Table 7-2. Habitat suitability ratings are as follows: H – Habitat is optimal for species occurrence, and it can support relatively moderate population densities at moderate frequencies. M – Habitat is suitable for species occurrence, and it can support relatively moderate population densities at moderate frequencies. L – Habitat is marginal for species occurrence, and it can support relatively low population densities at low frequencies. Unsuitable – Habitat is unsuitable for species occurrence, and the species is not expected to occur in the habitat.

VESTRA

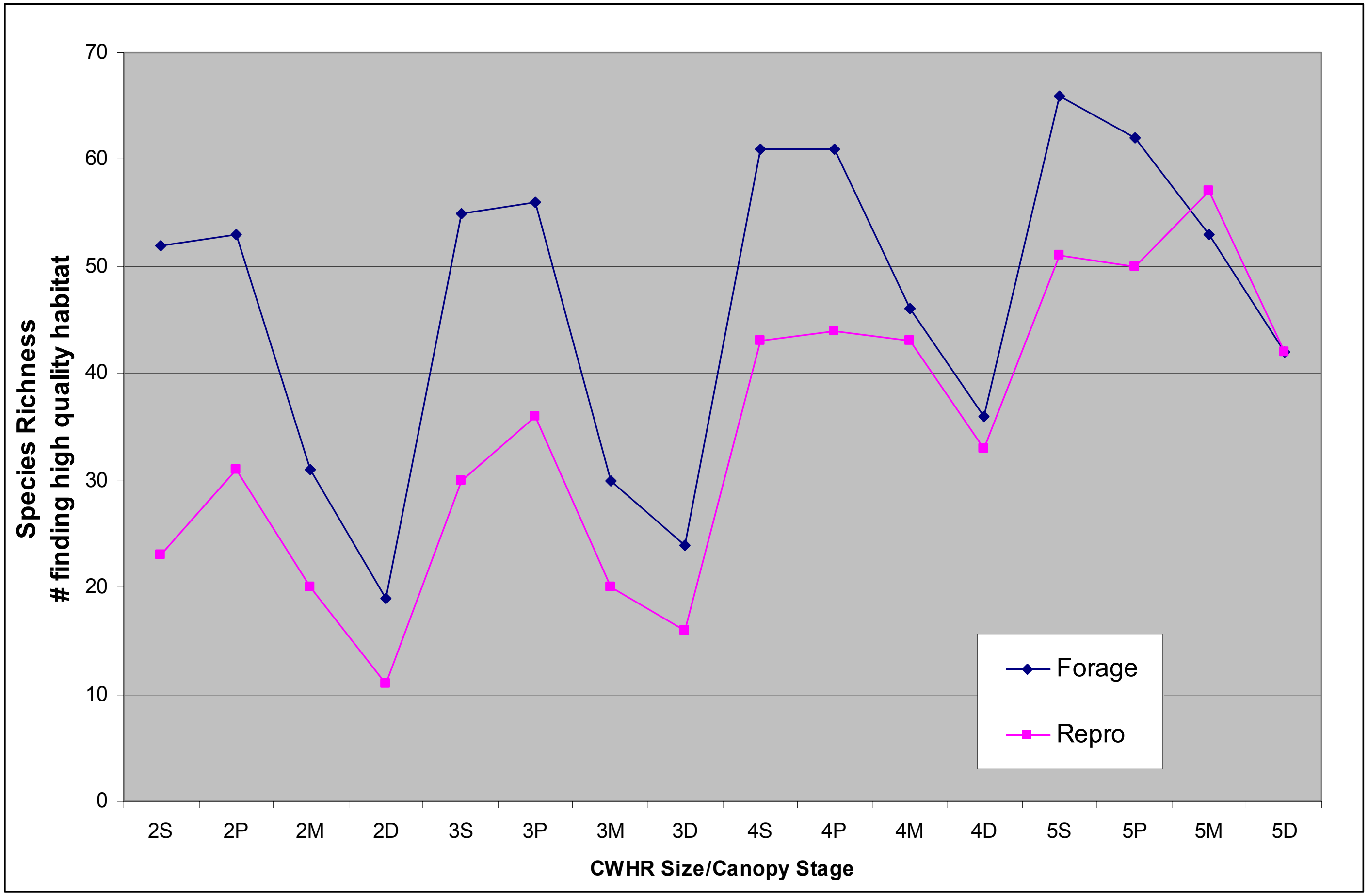
FIGURE 7-1

EXAMPLE OF CWHR HABITAT SUITABILITY MODEL

(MOUNTAIN BLUEBIRD IN EASTSIDE PINE)

SOURCE: CALIFORNIA ASSOCIATION OF COUNTIES

SIERRA VALLEY WATERSHED



This graph represents predicted patterns in species richness for animals using Sierran mixed conifer habitats in the Sierra Valley Watershed. It shows that more species use this forest habitat type for foraging than for nesting. It also shows that biodiversity generally increases as average tree size increases, but generally decreases as forest conditions become denser.

This graph was created by the WHR_Biodiversity Excel macro based on results from a CWHR single condition detail query. The species for which CWHR Size/Canopy Stage species richness statistics are graphed are those species listed in Table 7-6. Species richness is graphed independently for reproductive and foraging habitat functions. In the CWHR system, size and canopy cover classes are used to categorize forest structural stages as defined in Table 6-2.

VESTRA

FIGURE 7-2
BIODIVERSITY PATTERNS AND FOREST STRUCTURAL CONDITIONS FOR WILDLIFE USING SIERRAN MIXED CONIFER
SIERRA VALLEY WATERSHED

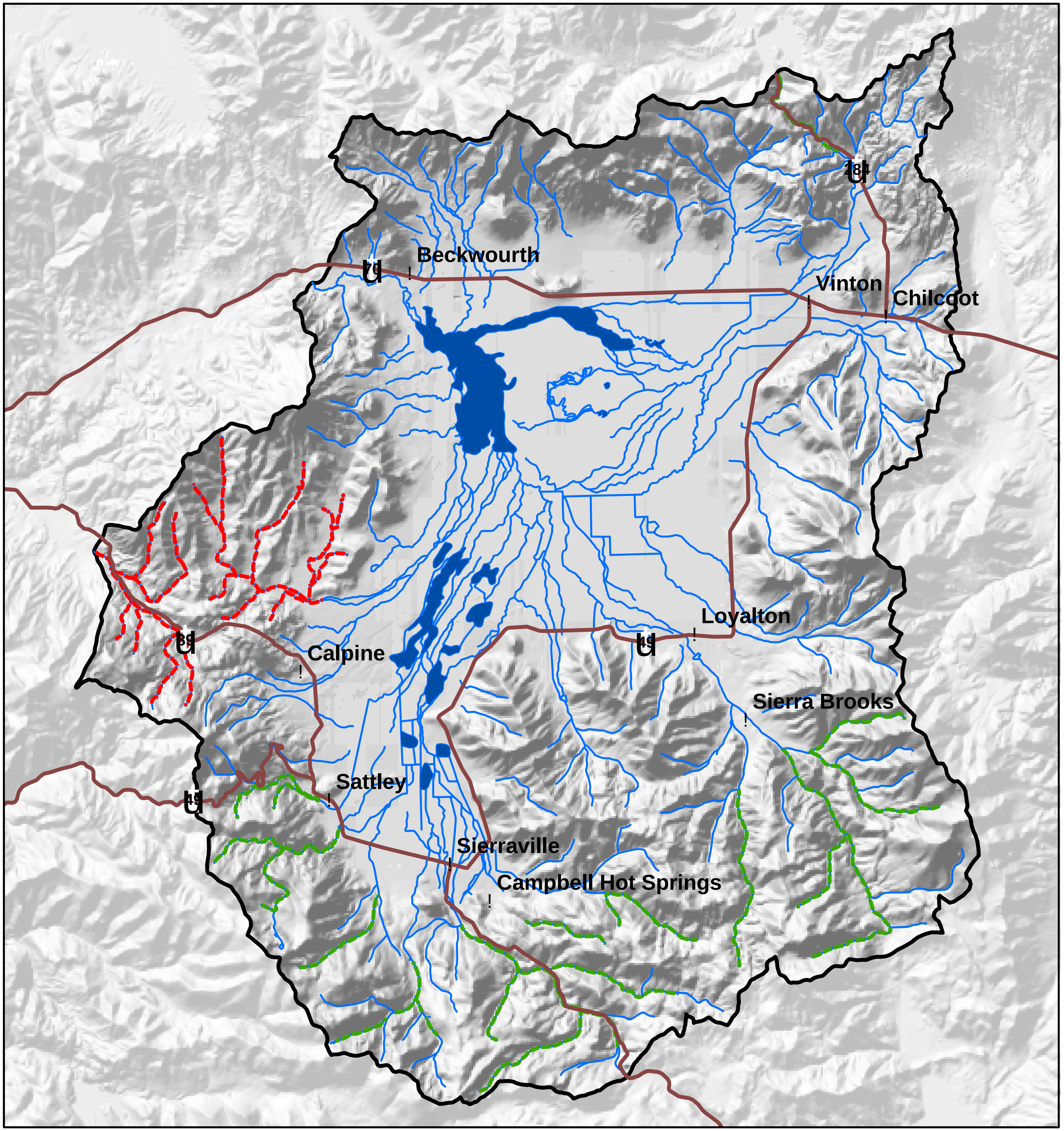


Figure 7-3
Cold Water Habitat
Sierra Valley Watershed

Legend

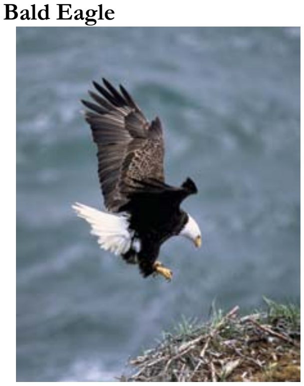
- Sierra Valley Watershed
- Wet Meadows
- State Highways
- River or Stream
- Potential Fish Bearing or Un-Surveyed Cold Water Stream Habitat
- Surveyed Fish Bearing Cold Water Stream Habitat

SOURCE: DWR 1973 AND SUPPLEMENTAL GIS ANALYSIS

0 1.25 2.5 5 Miles

VESTRA

Bald Eagle



National Image Library
U.S. Fish and Wildlife Service

Bank Swallow

University of Michigan Museum of Zoology

Great Gray Owl

Copyright © 2001 Ann Cook

Sandhill Crane

Gerald and Buff Corsi
© 2001 California Academy of Sciences

Peregrine Falcon

National Image Library
U.S. Fish and Wildlife Service

Swainson's Hawk

National Image Library
U.S. Fish and Wildlife Service

Willow Flycatcher

Ohio Department of Natural Resources.

Red Fox

Gerald and Buff Corsi
© 2001 California Academy of Sciences

Wolverine

Gerald and Buff Corsi
© 2001 California Academy of Sciences

Fisher

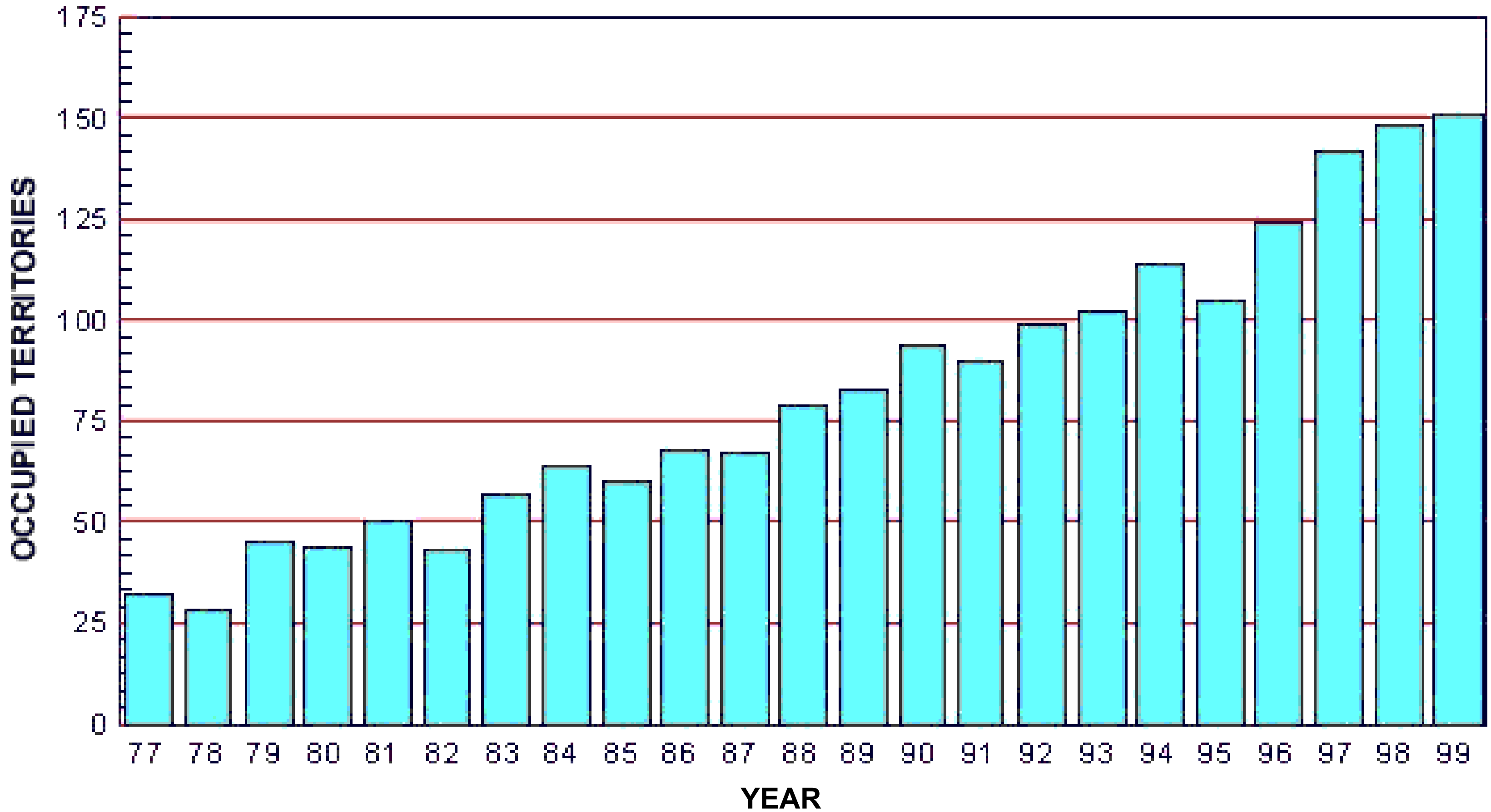
Uncreditted

Mountain Yellow-Legged Frog

Uncreditted

FIGURE 7-4
PICTURES OF THREATENED AND ENDANGERED ANIMALS THAT OCCUR OR POTENTIALLY OCCUR
SIERRA VALLEY WATERSHED

VESTRA



Occupied territories are the number of areas where eagle nests are found and where the outcome of breeding success was known.

FIGURE 7-5

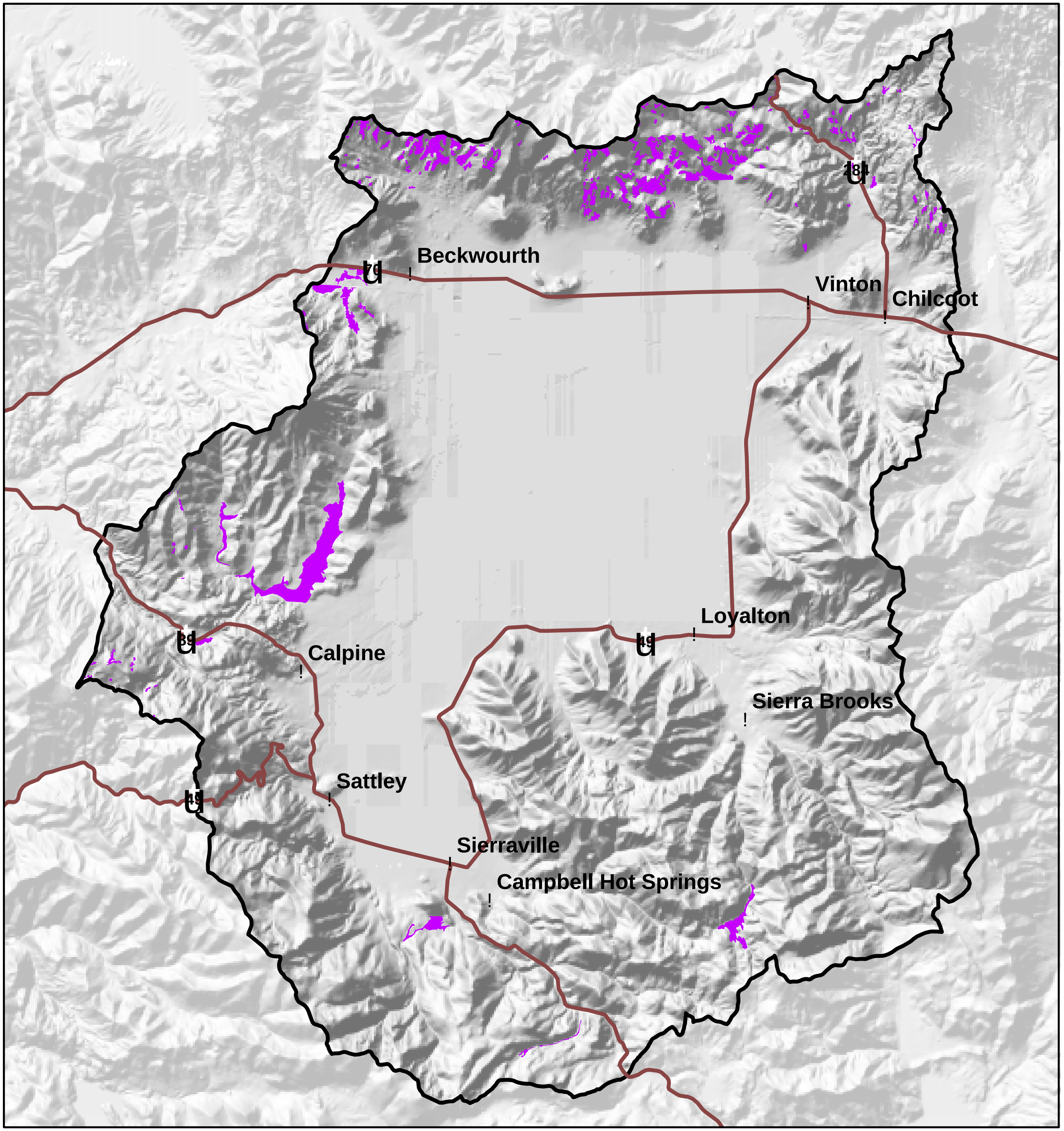
BALD EAGLE BREEDING POPULATION TREND
IN CALIFORNIA, 1977-1999

SOURCE: CALIFORNIA DEPARTMENT OF FISH AND GAME, 2004

SIERRA VALLEY WATERSHED

VESTRA

Figure 7-6
Predictive Modeling of Potential Willow Flycatcher Habitat
Sierra Valley Watershed



Legend

- Sierra Valley Watershed
- State Highways
- Potential Willow Flycatcher Habitat

SOURCE: CALIFORNIA DEPARTMENT OF FISH AND GAME

0 1.25 2.5 5 Miles

VESTRA

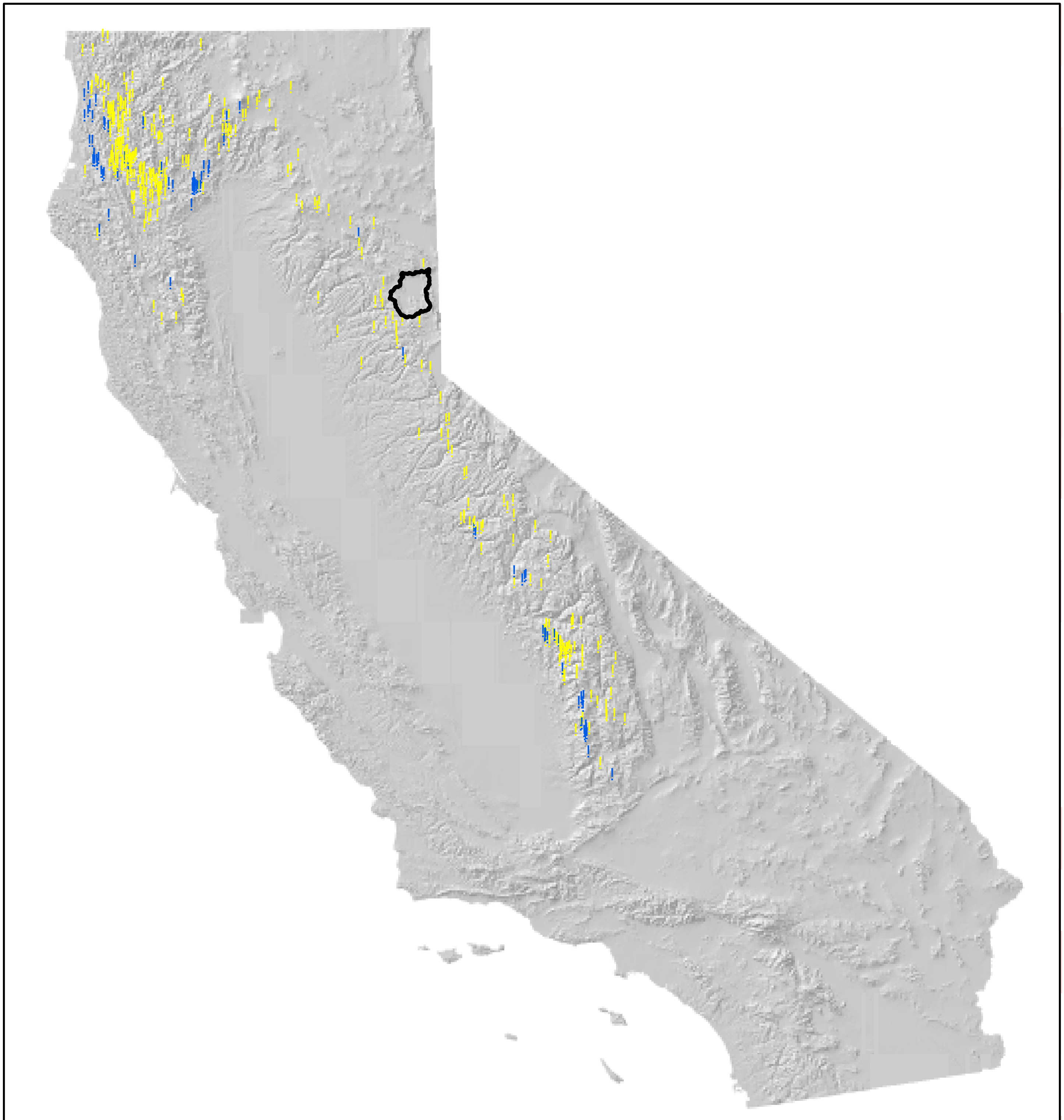


Figure 7-7
Historic and Recent Occurences of Fisher in California
Sierra Valley Watershed

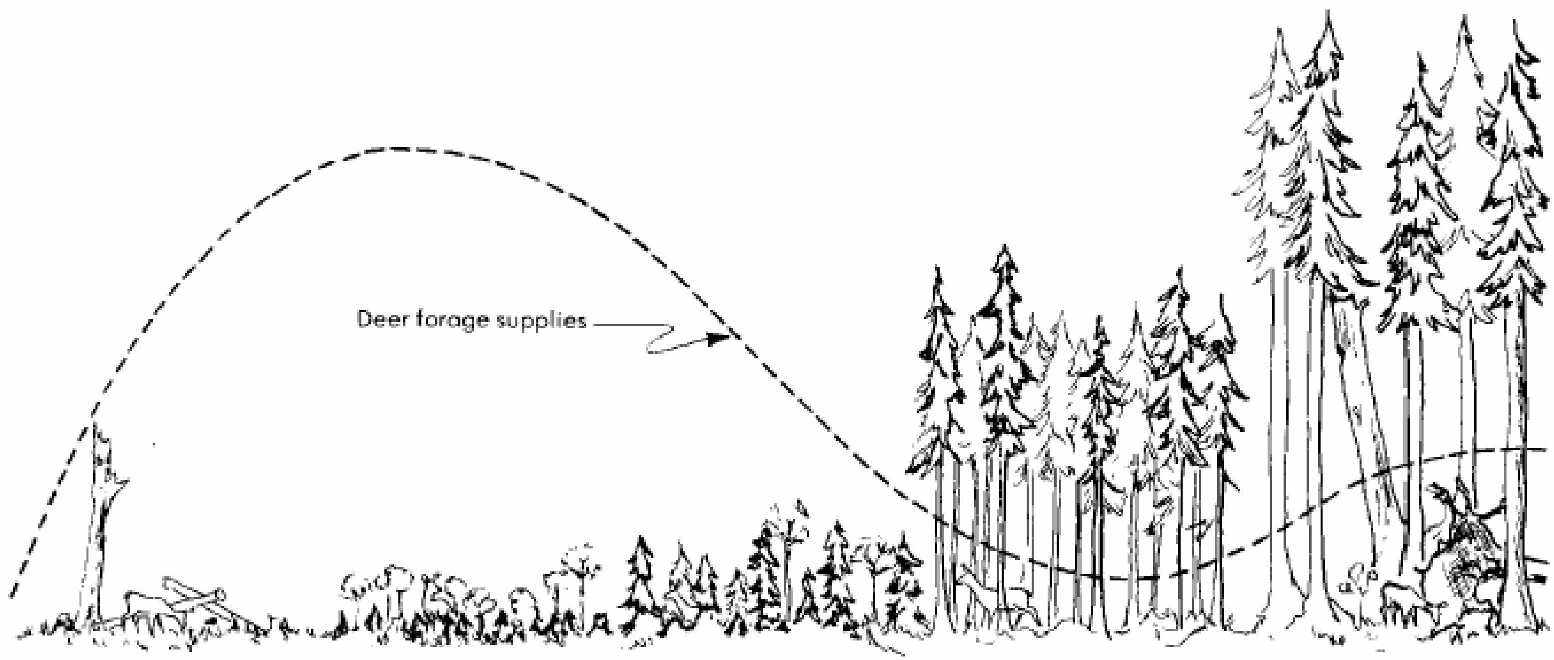
Legend

Sierra Valley Watershed
1911 - 1989 Occurences
1990 - 2003 Occurences

SOURCE: CALIFORNIA NATURAL DIVERSITY DATABASE

0 25 50 100 Miles

VESTRA



New clearcut	Seedling conifer	Advanced regeneration	Second growth timber	Old growth forest
Forb - grass - sedge	Shrub - herb	Young tree - shrub	Minimum undergrowth	Moderate undergrowth
1-5 years	6-10	10-20	20-200	200 +

Generalized representation of the relationship between deer forage supplies and the successional process as influenced by timber harvest and plant succession. Graphic from Wallmo and Schoen (1981). Forest management for deer. Pages 434-457 *in* O.C. Wallmo, Ed. Mule and black-tailed deer of North America. Wildlife Management Institute, Univ. of Nebraska Press.

FIGURE 7-8

THE RELATIONSHIP BETWEEN DEER FORAGE AND FOREST SUCCESSION

SIERRA VALLEY WATERSHED

VESTRA

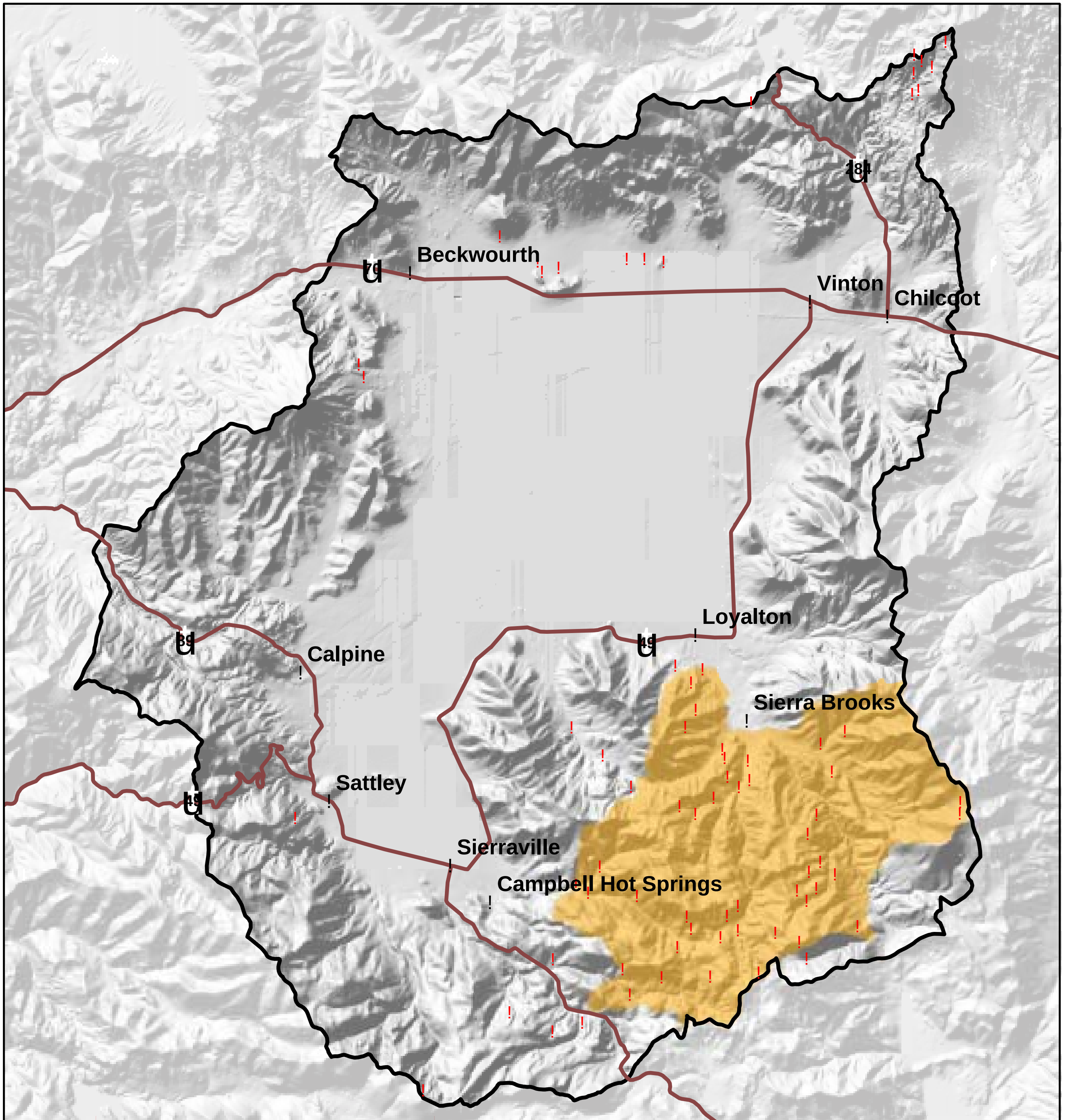


Figure 7-9
Deer Harvest Locations - 2002
Sierra Valley Watershed

Legend

- State Highways
- Sierra Valley Watershed
- Deer Harvest Locations - 2002
- Cottonwood Fire Boundary

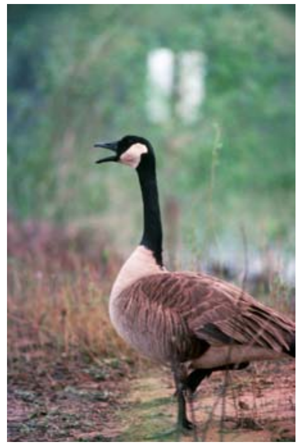
SOURCE: WILDLIFE MANAGEMENT DEEP SPOTKILL MAPS: CALIFORNIA DEPARTMENT OF FISH AND GAME SACRAMENT VALLEY CENTRAL SIERRA REGION WEBSITE; CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION

0 1.5 3 6 Miles

VESTRA

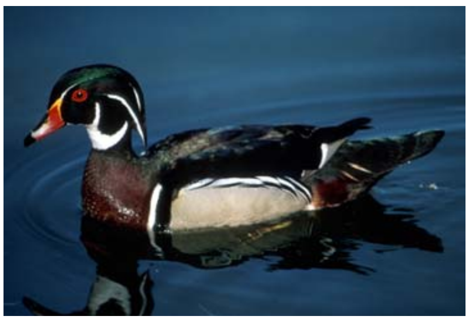
Tundra Swan

Canada Goose



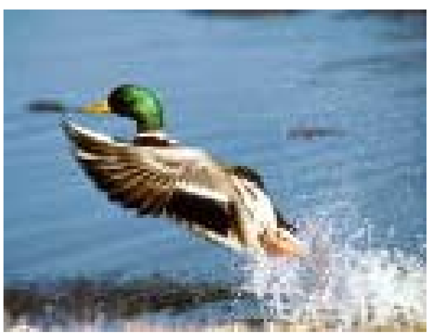
Pintail

Wood Duck



Cinnamon Teal

Mallard



American Wigeon

Lesser Scaup

Ruddy Duck

All pictures from National Image Library, U.S. Fish and Wildlife Service

FIGURE 7-10
PICTURES OF SELECTED WATERFOWL SPECIES THAT OCCUR
SIERRA VALLEY WATERSHED

VESTRA

Section 8

Section 8
LAND USE

TABLES

FIGURES

Section 8
LAND USE

INTRODUCTION

This section examines human use of lands within the Sierra Valley Watershed including development patterns, resource production, and growth policies. More than any other factor, human land use activities have a profound affect on the physical and biological characteristics of a watershed. As the human population or human activity in the watershed grows, decisions by land use authorities such as the US Forest Service (USFS), County of Plumas, and County of Sierra will have a significant influence on the health of the watershed and public sentiment for conservation of natural resources within the watershed.

Land use is generally characterized by incremental intensities of human use by various types such as residential, commercial, industrial, agricultural, mineral resources, recreational, or natural resources. Demographics provide spatial information about population patterns in specific areas for factors such as density, race, age, and income. Demographics are reflective of current land use while land use plans, such as general plans, represent a desired blueprint for future development. Land use is controlled directly by local regulations and indirectly by other state and federal laws intended for public safety, public welfare, or to protect natural resources.

DATA SOURCES

A list of primary information sources used to construct this section include:

- Plumas County General Plan
- Sierra County General Plan
- Bureau of Land Management (BLM) Resource Management Plan
- United States Census Bureau, 1990 and 2000 Census
- Status of Sierra Nevada
- Sierra Nevada Forest Plan Record of Decision (2001 and 2004)
- Land and Resource Management Plans Plumas and Tahoe National Forests
- Data from California Department of Food and Agriculture (CDFA)

A detailed list of references is provided at the end of this section.

GENERAL INFORMATION

Demographics

Demographics refer to the distribution of people and population characteristics by area. The United States Census Bureau conducts a census every ten years to provide data, allocate funds, and set election areas. Detailed information is available for distinct geographical areas broken into census tracts, block groups, and blocks. Types of data discussed include: population density, race, gender, income, home ownership, education, and transportation. For the purpose of this section total population and population density data were collected to determine population distribution in Sierra and Plumas Counties. Data specific to the Sierra Valley Watershed are not available. Figure 8-1 shows the 2000 Census Population data. The legend was broken into seven blocks to determine population location and correlate with population density (Figure 8-2). By comparing census population distribution to allowable growth areas under the general plan, areas that may face greater development pressure can be identified.

While generalizations regarding demographics in the watershed are made, specific comparisons or trends in census data over time cannot as census boundaries do not correspond with watershed boundaries and tract and block boundaries are changed with each decennial census. As examples tracts and blocks vary in land area, generally increasing in size as population density decreases.

The population change taken place in the watershed is somewhat typical of the mountain valleys where resident population increased during the 1930s and 1940s when mining and timber activities were much greater than today. The growth rate has declined since then. The population does show signs of increasing. There was an increase in population in the immediate post war years of World War II for the category of persons over 65 and under 16 years of age. People between the ages of 20 to 35 left the mountain areas beginning in the 1950s for urban communities of the state due to changes in the agricultural sector and the forest industry. This trend continues today as the 2000 census revealed the population is dropping most dramatically in the 25 to 45 year age group. A reason for this decline is attributed to the lack of an economic base in the area. Census numbers show that retail trade positions top the list of occupations. Retail positions pay minimum wage and have very high turn over rates. Even with increased numbers of construction and manufacturing positions, overall lack of good paying jobs available in the area also contributes to the decline of the 25 to 45 year age group. Unemployment for the nation averages approximately 5 to 6 percent with Plumas and Sierra Counties consistently above that at levels as high as 12 percent. Population of Sierra and Plumas Counties from 1860 to 2000 is shown in Table 8-1.

Table 8-1
HISTORICAL POPULATION DATA

Decade	Population (by County)	
	Sierra	Plumas
1860	11,378	4,354
1870	5,619	4,489
1880	6,623	6,180
1890	5,051	4,933
1900	4,017	4,657
1910	4,098	5,259
1920	1,783	5,681
1930	2,422	7,913
1940	3,025	11,548
1950	2,410	13,519
1960	2,247	11,620
1970	2,365	11,707
1980	3,073	17,340
1990	3,318	19,739
2000	3,555	20,824

Source: University of Virginia Geospatial and Statistical Data Center

Transportation

There are approximately 845 miles of road in the Sierra Valley Watershed (Table 8-2). The majority of miles are local roads and state Highways. Other local thoroughfares are identified from the United States Census Bureau's Topologically Integrated Geographic Encoding and Referencing (Tiger) Transportation Layer (California Spatial Information Library).

Table 8-2
MILES OF ROAD IN THE SIERRA VALLEY WATERSHED

Type	Miles
Railroad	32.4
State Highways	77.4
US. Highways	2.3
Vehicular Trails	1.5
Local Roads	712.8
Other Thoroughfares	18.4
Total	**844.8**

The 1994 Regional Transit Plan (RTP) was prepared and adopted by Plumas County Transportation Commission in response to California State Law (Government Code Title 7, Chapter 2.5, Sections 65080-65082). The plans describe proposed transportation development in Plumas County through the year 2014 with improvements scheduled over the next seven years. As with most rural settings, public transportation is limited in nature. Public transportation for Plumas County is limited in areas that it serves. Plumas County Transit System has an "inner-city" transportation system for Quincy with stops at Feather River College, the local athletic center, post office, hospital, courthouse including the annex, and several stops in the surrounding outer limits of Quincy. Service by Plumas Transit System in the county of Plumas and outer areas includes Chester, Greenville, Meadow Valley, Portola, and includes Chico and Reno (Plumas County Transit System).

There is currently no public transportation in Sierra County. One public airport is located outside Sierraville. The Sierraville Dearwater Airport is owned by Sierra County but is a public airport with operations averaging 83 aircraft per month with 50% local general aviation and 50% transient aircraft.

Ownership

Current ownership within the watershed is shown in Figure 8-3. Land ownership in the Sierra Valley Watershed is approximately 50 percent public and 50 percent private. The number of acres in each ownership classification is shown in Table 8-3.

The USFS, BLM, California Department of Fish and Game (CDFG), and State Lands Commission hold approximately 58 percent of the watershed. Of the 50 percent of the land held by federal agencies, the USFS is the biggest landholder with approximately 43 percent. There are three national forests in the Sierra Valley Watershed. Approximately 32 percent of the USFS is in the Tahoe National Forest; 11 percent is in the Plumas National Forest, and less the one percent is in the

Toiyabe National Forest. Total acres in the national forest are approximately 127,350. Figure 8-3 shows locations of the national forests in relation to the Sierra Valley Watershed.

Table 8-3
LAND OWNERSHIP ACREAGE BY LAND USE IN THE SIERRA VALLEY WATERSHED

Owner	Total Acres	Percent of Watershed
Bureau of Land Management	11,733	3.9
California Department of Fish and Game	8,389	2.8
State Lands Commission	591	0.2
United States Forest Service	127,351	42.8
Plumas National Forest	*31,681*	*10.6*
Tahoe National Forest	*95,418*	*32.1*
Toiyabe National Forest	*252*	*0.1*
Subtotal Federal Acres	**148,064**	**49.7**
Unclassified Private Ownership	142,751	48.0
Sierra Pacific Industries	6,841	2.3
Subtotal Other Acres	**149,592**	**50.3**
Total	**297,656**	**100%**

Source: California Spatial Information Library, The Legacy Project, 2003
California Forestry Association, Private Timber Company Land Holdings Data, 1995

Private individuals and companies hold approximately 142,750 acres, or 50 percent of the watershed. Sierra Pacific Industries, a private timber company, holds approximately 6,840 acres or roughly 2 percent of the total Sierra Valley Watershed (CFA 1995).

Subdivisions

County Boundaries
The Sierra Valley Watershed is spread across three counties including: Plumas, Sierra, and a small portion in Lassen. Current county boundaries are shown in Figure 8-4. Historical county boundaries are shown in Figure 8-5.

Legislative Boundaries
The Sierra Valley Watershed has one legislative district for the Assembly and the Congressional. Sierra Valley Watershed is located in District 3 for the Assembly and District 4 for the Congressional.

Public Utilities District Boundaries
There are three public utilities districts located in the Sierra Valley Watershed. The companies are the Plumas-Sierra Rural Electric Cooperative, the Sierraville Public Utility District, and the Last Chance Creek Water District. The Plumas-Sierra Rural Electric Cooperative was founded in 1937 to bring power to Plumas, Lassen, and Sierra counties. The company continues to provide power,

satellite, and telecommunication services to residents of the Sierra Valley Watershed. Sierraville Public Utility District is a private water districts. Its location and boundaries are shown in Figure 8-6.

The Last Chance Creek Water District is a private water district established in 1956 following the construction of Frenchman Dam and Reservoir. Originally, the boundary of the district was a strictly political subdivision, drawn to incorporate the private lands of ranches which were in operation at that time. Since then, portions of some ranches have been sold or divided in some manner and the boundary currently contains lands which have little or no relationship to the activities of the Last Chance Creek Water District. The district manages lands to which water from Frenchman Reservoir has been adjudicated to form an intricate network of ditches and diversions used for irrigation water, which also results in a recharge to the area's water table. The specific lands to which irrigation water from Frenchman Reservoir can legally be applied by members of the district holding adjudicated water rights are identified in the Middle Fork of the Feather River Decree available at the Plumas County Courthouse.

Recreation

Recreational use of the Sierra Nevada increased rapidly as most major trans-Sierra roads were competed during the 1950s and Interstate 80 was completed in the 1960s (Figure 8-7). The development of ski resorts allowed year round recreation throughout the Sierra Nevada, though the Lake Tahoe region and Yosemite National Park remain the prime destinations. The physical impact of developed recreation led conservation groups such as the Sierra Club to begin to question National Park Service and USFS policies in the 1950s. By the early 1970s, urban growth in the Lake Tahoe Basin eventually instigated the largest cooperative program in the Sierra Nevada between the federal, state, and local governments to reduce the impacts on the lake's ecosystem.

In the late 1960s, after two decades of rapid growth, the governors and lawmakers in California and Nevada approved a bi-state compact, which created a regional planning agency to oversee development at Lake Tahoe. In 1969, the United States Congress ratified the agreement and created the Tahoe Regional Planning Agency (TRPA). The agencies compact as revised in 1980, gave TRPA authority to adopt environmental quality standards, called thresholds, and to enforce ordinances designed to achieve the thresholds. The main objectives of the TRPA are to protect Lake Tahoe and other resources of the region from being threatened with deterioration or degeneration, which endangers the natural beauty and economic productivity of the region.

The majority of the following was taken from the California Department of Water Resources report entitled *Natural Resources of the Sierra Valley Study Area* (October 1973). Sierra Valley Watershed affords a selection of recreational activities in a scenic area which is rich in historic and geologic sites and which supports a variety of unique wildlife habitat. Figure 8-7 generally shows areas used for three intensities of recreational use in the study area, whether water associated, land use associated, or other. The criterion used to establish the areas was general comparison with the use at other recreation areas. The Tahoe Basin was considered a high use area and values compared on a declining basis.

Lake Davis is the most intensively used recreational facility in the study area. There are 125 camp units provided at two campgrounds and Frenchman Lake has 116 camp units at three campgrounds.

Additional recreational facilities are provided at summer campgrounds located in the lower part of the study area within the Tahoe National Forest.

Little Last Chance Creek that drains into Frenchman Lake is a tributary of the Middle Fork of the Feather River. The Middle Fork is a component of the National System of Wild and Scenic Rivers, and a portion that traverses the Sierra Valley Watershed is designated as a recreational river zone.

In 1997, after numerous studies, DFG concluded that eradication of the predatory pike was necessary in order to protect the native salmon and steelhead populations found downstream in the Sacramento-San Joaquin river systems and Delta. Meanwhile, in response to what was happening at Lake Davis, the local community began to organize an action group (DFG 2000). The Save Lake Davis Committee (originally called Victims of Lake Davis) was formed by a group of local Lake Davis area residents in early 1995. Shortly after its inception, officials from Plumas County and the City of Portola joined the group actively. Later, the name was changed to Save Lake Davis Coalition to better reflect the makeup of the group.

The majority of the data found for the watershed is from public lands (USFS and BLM), specifically the Plumas, Tahoe, and Toiyabe National Forests. Recreational activity is either local in origin and involves tourism, a subset of all activity related to the travel industry. Unfortunately, there is very limited data from private opportunities.

Large areas of open space that are publicly and privately owned accompany relatively low density of human settlement in the Sierra Valley Watershed. Much of the land remains generally accessible for informal public recreational activities of a dispersed, low-intensity nature. These activities include camping, hunting, fishing, running, walking, mountain biking, cross-country skiing, snowmobiling, and nature study. Recreational users often cross between public and private lands on a single trail without even knowing whether they are on federal, state, local, or private land at a given time. Additional recreational activities occur on private lands and the potential for conflicts over trespass are highest at the public-private land interface. Reduction in informal public access to privately owned open spaces are also likely as human settlement increases parcelization and population density on large blocks of private land.

Recreational activity is a function of many factors. For most types of recreation ecological conditions are not the dominant factor. The availability of developed facilities and a wide range of behavioral considerations including cultural factors are equally important. The institutional arrangements for provision of recreational opportunities (e.g., whether they are public or private and whether or not there is a fee for the activity) also influence recreational activity. Finally, aesthetic considerations are important for many types of outdoor recreation.

Current recreational activities are directed toward "developed" and "front-country" activities than many of the traditional wilderness-type uses that were so important in the past three decades. Increased affluence together with decreased access to other open space could change those patterns within a single generation.

Recreational use is commonly measured in Recreational Visitor Days (RVD). One RVD equals one 12-hour visit to a site or 12 hours of recreational activity. Statewide, the USFS classifies its non-wilderness recreational activities using the following activity classes: (1) camping; (2) picnicking, swimming; (3) travel; (4) hiking, horseback riding, water travel; (5) winter sports; (6) resorts; (7) hunting; (8) fishing; and (9) other activities (Duane 1996).

The most popular recreational activities in the nine forests of the Sierra Nevada as presented in the Sierra Nevada Ecosystem Project (SNEP) were activity classes of "automobile travel" (32 percent) and "camping, picnicking, and swimming" (29 percent) (Duane 1996). Together with resorts (11 percent), these three general classes of recreational activity accounted for nearly three-quarters (72 percent) of all RVDs on USFS units in the Sierra Nevada (Duane 1996). Distribution of mean annual RVDs by USFS classes in the Sierra for the period 1987–1993 showed:

- Camping/Picnicking/Swimming 29 percent
- Travel 32 percent
- Hiking/Horseback Riding/Water Travel 6 percent
- Winter Sports 9 percent
- Resorts 11 percent
- Hunting 2 percent
- Fishing 6 percent
- Nature Study/Interpretive Activities 2 percent
- Other Activities 3 percent

Between 1986 and 1993, there was an overall decrease in total number of fishing and hunting licenses issued in the Sierra Nevada counties. During the 1986 to 1987 fishing season, 293,939 fishing licenses were issued, dropping 4 percent in the 1992 to 1993 season to 282,939. Hunting licenses decreased 15 percent from 73,712 in the 1986 to 1987 season to 62,955 in the 1992 to 1993 season. Fishing is affected by annual weather variations. Besides variations in weather, the increase cost of the fishing license has significantly impacted the number of licenses issued. The prolonged drought of 1986 through 1994 impacted the amount of fishing licenses purchased. Hunting licenses issued statewide declined 18 percent during 1992 to 1993. This drop is part of the continuing urbanization of California's population and changing social values regarding hunting. Less than one percent of Californians now hunt (Duane 1996).

FEMA Issues

The Sierra Valley Watershed is located in Federal Emergency Management Agency's (FEMA) Region IX, which covers the states of California, Arizona, Nevada, Hawaii, and the United States Territory of Guam. FEMA conducts flood-mapping services and emergency services. Flood mapping for the watershed is included on Figure 8-8.

FEMA conducted flood hazard mapping of Plumas County in 1993. Within the next five years, Water Concepts, Inc will complete a revised flood hazard map for all FEMA data. DWR conducted "potential" flood hazard mapping of Sierra County from 2002 to 2003. The intent of DWR is to provide the community as well as the individual citizen an additional tool in understanding potential flood hazards currently not mapped as a regulated floodplain. This will enable each community to provide better protection for its citizens against loss of life and loss of property damages during a flood event as well as reduce community costs for emergency response needs.

LAND USE

Agriculture/Cropland

Wide varieties of crops are grown throughout Sierra Valley Watershed. These range from alfalfa, improved pasture, meadow pasture, grain, Christmas tree farms, and specialty crops, although the majority of crops are pasture or production of hay. The top five crops in Plumas and Sierra County for 2002 listed by value were timber products, cattle, irrigated and dryland pasture and rangeland pasture, alfalfa hay, and other hay (CFBF 2004).

Table 8-4 shows a summary for Plumas and Sierra County for 2001 and 2002 for current livestock value. Acreage and crops grown in Plumas and Sierra County are located in Table 8-5.

Table 8-4
CURRENT LIVESTOCK VALUE SUMMARY – PLUMAS AND SIERRA COUNTIES

Livestock	Year	Number of Head	Total cwt	*Price per cwt$	Total $
Plumas County					
Beef	2002	15,385	117,891	67	9,297,929
	2001	18,590	147,810	80	11,824,800
Other Livestock	2002	----	----	----	137,600
	2001	----	----	----	118,500
Sierra County					
Beef	2002	4,837	35,622	67	2,823,203
	2001	8,200	57,000	80	4,560,000
Other Livestock	2002	-----	----	----	20,000
	2001	-----	----	----	31,500

Source: Plumas and Sierra County Annual Crop Report, 2001 & 2002
*Price averaged does not include breeding cows or pairs; and bulls. CWT = cost per thousand pounds

Grazing

The vegetation in national forests has undergone significant change since European settlement. Livestock grazing resulted in the loss of native perennial grasses, sagebrush communities, and increases in alien annual grasses, especially cheatgrass. Although Menke and others showed systems are stable from any number of perspectives, they continue to be invaded by new weed species and increased fire frequency. The increased frequency of fire tends to provide additional sagebrush removal, exacerbating problems. Replacement of brush species with grasses is evident in Table 8-6, detailing a general increase in percentage of big sagebrush and other non-native annual grasses.

A key indicator of declining conditions in national forests is an increase in cheatgrass (Menke et al 1996). Cheatgrass negatively affects surface soil erosion and cover percentages as cheatgrass litter is much less influential in protecting soils from surface erosion than native perennial grasses or sage canopy, which protects against raindrop erosion (Menke et al 1996). As indicated in Table 8-7, cheatgrass is present but not increased over the past 40 years.

Table 8-5
ACREAGE AND VALUE OF CROPS GROWN – PLUMAS AND SIERRA COUNTIES

Crop	Year	Harvested Acres/ Production	Per Acre	Total	Unit	Avg/Unit (dollars)	Total (dollars)
Plumas County							
Alfalfa Hay	2002 2001	4,756 5,150	4.00 3.00	19,024 15,450	Ton	100.00 120.00	1,902,400 1,854,000
Meadow Hay	2002 2001	2,697 6,250	1.09 1.00	2,940 6,250	Ton	120.00 110.00	352,768 687,500
Grain Hay	2002 2001	663 1,500	1.50 1.40	995 2,100	Ton	80.00 15.00	79,560 119,500
Pasture (irrigated)	2002 2001	35,000 23,000	---- ----	---- ----	Acre	60.00 50.00	2,100,000 1,700,000
Pasture (dryland)	2002 2001	52,000 51,000	---- ----	---- ----	Acre	10.00 16.00	520,000 816,000
Range Pasture	2002 2001	65,000 65,000	---- ----	---- ----	Acre	2.00 3.50	130,000 227,500
Sierra County							
Alfalfa Hay	2002 2001	875 1,600	3.20 3.70	2,800 5,920	Ton	100.00 115.00	280,000 680,800
Meadow Hay	2002 2001	1,400 2,400	1.75 2.00	2,450 4,800	Ton	120.00 110.00	294,000 528,000
Grain Hay	2002 2001	446 500	1.50 2.00	669 1,000	Ton	70.00 70.00	53,520 95,000
Pasture (irrigated)	2002 2001	11,445 11,000	---- ----	---- ----	Acre	60.00 50.00	686,700 550,000
Pasture (dryland)	2002 2001	20,000 21,000	---- ----	---- ----	Acre	8.00 16.00	160,000 336,000
Range Pasture	2002 2001	24,000 20,000	---- ----	---- ----	Acre	2.00 4.00	48,000 80,000

Note: Source: California Farm Bureau Crop Reports 2002/Plumas and Sierra County
Miscellaneous Timber Products = Christmas trees, cull logs, fuel logs, fuel chips, etc.

Table 8-6
BIG SAGEBRUSH, NATIVE PERENNIAL GRASS, AND FORB COMPOSITION (%) IN SAGEBRUSH-STEPPE COMMUNITIES OVER FIVE DECADES FROM PARKER TRANSECT

Forest	Before 1956	1956–1965	1966–1975	1976–1985	1986–1995
Plumas	(0)	(11)	(3)	(3)	(3)
Big sagebrush	---	23.7	9.7	17.7	30.0
Perennial grasses	---	2.9	5.0	5.3	3.0
Forbs	---	35.0	19.7	22.3	38.0
Tahoe	(3)	(5)	(11)	(3)	(0)
Big sagebrush	1.7	20.8	14.3	16.7	---
Perennial grasses	1.7	2.8	3.0	1.7	---
Forbs	8.7	29.6	21.7	19.3	---
Toiyabe	(0)	(10)	(2)	(10)	(2)
Big sagebrush	---	24.4	32.0	20.4	21.0
Perennial grasses	---	2.8	2.0	5.2	0.5
Forbs	---	29.3	25.3	28.1	43.0

Note: Cheatgrass (*Bromus tectorum*), medusahead (*Taeniatherum caput-medusae*), filaree (*Erodium* spp.), dandelion (*Taraxacum officinale*), wheatgrass (*Agropyron* spp.), plantain (*Plantago* spp.), and bull thistle (*Cirsium* spp.)

Table 8-7 NON-NATIVE SPECIES COMPOSITION (%) IN WET AND MESIC MEADOWS OVER FIVE DECADES FROM PARKER TRANSECT					
Forest	**Before 1956**	**1956–1965**	**1966–1975**	**1976–1985**	**1986–1995**
Plumas	(0)	(14)	(13)	(5)	(13)
Bluegrass	---	2.0	4.6	1.8	1.8
Redtop	---	0	3.0	0.4	2.6
Dandelion	---	0.2	0.5	0.4	0.1
Cheatgrass	---	0	0	0.2	0.1
Wheatgrass	---	0	0	0.4	0
Buttercup	---	0	0	0	0.1
Tahoe	(1)	(16)	(12)	(11)	(7)
Bluegrass	0	2.0	1.0	3.6	5.7
Redtop	0	0.4	0.2	0.5	1.6
Dandelion	0	0	0	0	1.6
Cheatgrass	0	0	0.2	0	0
Toiyabe	(0)	(10)	(1)	(10)	(0)
Bluegrass	---	0	0	0	---
Dandelion	---	1.4	0	0	---
Wheatgrass	---	0	0	0	---
Borago officinalis	---	0	0	0	---

The non-native species Kentucky bluegrass is the primary invader of mountain meadows on national forests in Northern California (Menke et al 1996). Bluegrass is increasing on mountain meadows in the Tahoe National Forest. Redtop grasses are the second most common non-native component of meadows. Increases in composition of redtop are occurring in Plumas and Tahoe National Forests. Common dandelion is the third-most common non-native species occurring on mountain meadows and population of this species remains constant. Meadow and riparian ecosystems have greater potential for response to management and recovery than any other range ecosystem type. By their very nature, they are well-watered systems. Plant growth is rapid and species composition is diverse.

Grazing impacts vary significantly with both season and timing of grazing and species of livestock. Livestock grazing of mountain meadow areas remains controversial. Livestock grazing affects are positive, neutral, or negative depending on the level and timing of use. Ecosystem improvement occurs when appropriate grazing strategies are followed.

Prior to 1934, most livestock grazing in California was unregulated. Before the establishment of National Forests, the Sierra Nevadas were subject to intense transient grazing by cattle and sheep. The high sheep populations in the Sierra Nevada jeopardized the range allotments and the local livestock economy (Menke et al 1996). Historic grazing practices are discussed further in the "Agriculture" subsection of Section 2, "General Watershed History."

Moderate livestock grazing increases the diversity of native plant species in both wet and mesic meadows but can depress diversity in dry meadows (Ratliff 1985). Particularly where grass like plants (*Carex* spp. especially) dominate wet parts of meadows, livestock grazing reduces dominance and litter accumulations and allows more species to inhabit a site. These species are usually native. Heavy grazing diminishes foliage density and increases bare ground in the community thereby making sites available to invasion of exotic species if they are present on a grazing unit. Many "increasers" in mountain meadow rangelands are native forbs that substantially increase with frequent grazing (Ratliff 1985).

Trampling impacts from grazing also indirectly affect plant species diversity. Trampling reduces soil porosity, especially when soils are wet and of high clay content. Repeatedly trampled wet or mesic meadows become drier. Drier meadows reduce productivity due to lowered water infiltration and water holding capacity and increased runoff. It is imperative that meadows are managed carefully since they often provide the bulk of an allotment's forage productivity.

In certain situations, livestock use restores and improves certain ecotypes. Many scientists and range managers concede that livestock use in vernal pool ecosystems assists in controlling the invasion of non-native grasses. Trampling actually increases site diversity through soil disturbance thereby increasing micro-site differences.

In the 1990s, impairment of riparian ecosystem function was a primary issue in range management. Natural meandering keeps water on meadows longer thereby creating or maintaining water tables and more mesic or wet meadow conditions. A common meadow riparian problem is lost meanders, and streams that are straighter with steeper gradients and downcut due to faster-moving water. Loss of meanders is caused by the overgrazing of livestock which creates a deficiency of woody plants; or reduced vigor of graminoids that provide armoring of bends in meanders. As a result much of the undercut bank structure and other features contributing to aquatic habitat quality are lost. Meadow productivity is depressed due to lowered water tables. Many streams become degraded due to a combination of grazing disturbance and flood events.

Loss of riparian vegetation and trampling of stream banks caused by overgrazing allows stream banks to widen and become shallower. This increases the impacts of solar radiation on water and results in higher temperatures.

Public Land Allotments

Public land plays a vital role in the watershed's livestock industry. Most cattle ranchers use public lands for three to six-month periods when it is necessary to have irrigated lands in hay production for winter-feeding. Current allotments for USFS land total 30 with 133,259 acres, approximately 89 percent of the total USFS land. Current BLM allotments totals are 20 with 9,743 acres, approximately 83 percent of the total BLM land. A map of the current allotments is shown on Figure 8-9. Ranchers pay grazing fees to the USFS and BLM. In turn, the county is paid approximately 25 percent of the grazing fee in the form of a possessor's tax. A majority of the fees collected for grazing are reinvested by the various agencies in the form of range betterment and advisory services.

Grazing legislation and allotment issues are a major concern in the Sierra Valley Watershed. There was a controversy in the mid-1970s over the grazing of public lands. BLM was charged with failing to consider the environmental impacts of their grazing program and failed to inform the ranchers of the proposed reductions. These actions resulted in many lawsuits filed by ranchers and an intense mistrust of the BLM.

Responding to the turmoil, Congress passed the 1978 Public Rangelands Improvement Act (PRIA). Section 12(a) directs the secretaries of the Interior and Agriculture to develop and implement an experimental program that would explore innovative grazing management policies and practices, and provide incentives to permittees whose management style improves range conditions. The program also includes collaboration on large watershed health issues such as forest and fuel management.

Federal statute mandates that counties and management agencies coordinate actions concerning public lands. The Federal Land Policy and Management Act, the National Environmental Policy Act, and the Endangered Species Act are just a few of the policies shaping the management practices in the Sierra Valley Watershed. Current livestock summary numbers for Plumas and Sierra Counties are summarized in Table 8-4 on page 8-8.

Farmland Mapping and Monitoring

In 1980, the California Department of Conservation (CDC), Division of Land Resource Protection, began work to supplement the Soil Conservation Service (SCS) conservation programs through a Farmland Mapping and Monitoring Program (CDC 2001). This program (designed to inventory important farm and grazing lands in the form of important Farmland Series maps) became California Law in 1982. Its purpose is to monitor conversion of the state's agricultural land to and from agricultural work to supplement the SCS (now the NRCS, Natural Resources Conservation Service) conservation programs. The categories are grazing land, farmland of local importance, prime farmland, farmland of statewide importance, and unique farmland. All five designations of land use are found in Sierra Valley Watershed. Important farmland in the Sierra Valley Watershed is located in Table 8-8. Included in the table is data on urban and built-up land, water, and other lands.

Table 8-8
IMPORTANT FARMLAND – SIERRA VALLEY WATERSHED

Type of Farmland	Acres	% of Watershed
Urban and Built-Up land	783	0.26
Grazing Land	35,845	12.04
Farmland of Local Importance	90,187	30.30
Prime Farmland	8,515	2.86
Farmland of Statewide Importance	4,718	1.59
Unique Farmland	2,642	0.89
Water	45	0.02
Other land	3,281	1.10

A map showing important farmland is located in Figure 8-10. As shown on the figure, approximately 146,016 acres or 48 percent of the Sierra Valley Watershed has not yet been inventoried.

According to the CDC, the state's total agricultural land use acreage inventoried (Table 8-9) decreased by approximately three percent from 1996 to 2000. The CDC defines these five categories as described in the following sections.

Table 8-9 STATE OF CALIFORNIA: CHANGE BY LAND USE					
Land Use Category	Total Acreage Inventoried				
	1992	1994	1996	1998	2000
Prime Farmland	3,279	3,239	3,337	9,692	9,014
Farmland of Statewide Importance	4,389	4,072	4,071	4,671	4,814
Unique Farmland	3,185	3,135	3,146	2,644	2,640
Farmland of Local Importance	75,064	75,471	75,358	91,832	92,494
Important Farmland Subtotal	85,917	85,917	85,912	108,839	108,962
Grazing Land	108,558	108,558	108,066	80,706	80,100
Agricultural Land Subtotal	194,475	194,475	193,978	189,545	189,062
Urban and Built-Up Land	745	745	745	745	832
Other Land	2,977	2,977	2,975	7,406	7,803
Water Area	80	80	74	75	75
Total Area Inventoried	198,277	198,277	197,772	197,771	197,772
Note: Information not available for the entire watershed					

Prime Farmland

"Prime Farmland" is farmland used for production of irrigated crops in the four years prior to the mapping date and meets a strict set of criteria concerning physical and chemical soil properties such as moisture content.

Farmland of Statewide Importance

"Farmland of Statewide Importance" is land other than "Prime Farmland" that has a good combination of physical and chemical characteristics for the production of crops and is used for the production of irrigated crops within the last three years. It does not include publicly owned lands for which there is an adopted policy preventing agricultural use.

Unique Farmland

"Unique Farmland" is land that does not meet the criteria for "Prime Farmland" or "Farmland of Statewide Importance" and currently used for the production of specific high economic value crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to produce sustainable high quality or high yields of a specific crop when treated and managed according to current farming methods. Examples of such crops may include oranges, olives, avocados, rice, grapes, and cut flowers. It does not include publicly owned lands for which there is an adopted policy preventing agricultural use.

Farmland of Local Importance

"Farmland of Local Importance" is land currently producing crops or has the capability of production. "Farmland of Local Importance" is land other than "Prime Farmland," "Farmland of Statewide Importance," and "Unique Farmland." This land is important to the local economy due to its productivity. It does not include publicly owned lands for which there is an adopted policy preventing agricultural use.

Grazing Land

"Grazing Land" is land defined in Section 65570(b)(2) of the Government Code as "land on which the existing vegetation whether grown naturally or through management is suitable for grazing or browsing of livestock." The minimum mapping unit for "Grazing Land" is 40 acres.

Water Issues

The quantity, quality, and availability of water resources are vital to the natural and human activities within Sierra Valley Watershed. Water is essential to the viability and most notably to agriculture. Wise and prudent planning combined with management of surface and groundwater resources is fundamental to providing a substantial economic base for its residents. Water is discussed in detail in Section 4, "Hydrology."

Agriculture is the largest developed water using industry in the Sierra Valley Watershed. Although changes in future irrigation practices will result in better water resource management, the predominant use of water in the area will continue to be for agriculture.

The residents of Sierra Valley obtain irrigation water from many sources. These include Last Chance Creek, Fletcher Creek, West Wide Canal, Hamlin Creek, Miller Creek Turner Creek, Smithneck Creek, Adams Neck, Frenchman Creek, Cold Creek, Webber Creek, Perry Creek, and the Sierra Valley Water Company, all of which deliver water to agricultural lands in addition to water supplies developed by individual farmers and ranchers. Water use for crops range from 2.1 acre-feet/acre/year to 4.8 acre-feet/acre/year. The estimates for applied water per crop in the watershed provided by DWR are shown in Table 8-10 (DWR 2000).

Table 8-10
APPLIED WATER DEMAND BY CROP TYPE

Crop	Unit ET of Applied Water	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage (1,000's of acres)			ET of Applied Water (1,000's of acre-feet)			Applied Water (1,000's of acre-feet)		
Grain	1.0	1.4	1.3	0.0	0.5	0.5	0.0	0.5	0.5	0.0	0.7	0.7
Alfalfa	2.0	2.7	2.6	3.5	1.8	5.3	7.0	3.6	10.6	9.5	4.7	14.2
Pasture	2.3	3.3	3.0	0.0	0.1	0.1	0.0	0.2	0.2	0.0	0.3	0.3
Meadow Pasture	2.1	3.0	2.9	20.9	0.0	20.9	43.9	0.0	43.9	62.7	0.0	62.7
Meadow Pasture - X	1.0	1.4	1.4	6.0	0.0	6.0	6.0	0.0	6.0	8.4	0.0	8.4

Source: California Department of Water Resources, 2000

Commercial Timberlands

Comprising just over two percent of the land base in the watershed, private industrial timberlands are a significant commercial activity. The major private landowner, Sierra Pacific Industries, has an individual land management-planning document that outline goals and objectives for the various properties. This plan specifies timber harvest levels, vegetation and stocking plans, wildlife management plans, and limited public uses. The plan must conform to the requirements for commercial timberlands outlined by the State Board of Forestry, administered through the California Department of Forestry and Fire Protection. Table 8-11 lists wood products by county including value.

Table 8-11 WOOD PRODUCTS BY COUNTY				
Wood Product	**Year**	**Volume**		**Value**
Plumas County				
Gross Timber Products	2002 2001	79,802 99,241	Million Bd. Ft. Million Bd. Ft.	17,507,215 29,136,282
Miscellaneous Timber Products	2002 2001	--- ---	Million Bd. Ft. Million Bd. Ft.	660,000 1,100,000
Sierra County				
Saw Timber	2002 2001	33,342 24,533	Million Bd. Ft. Million Bd. Ft.	6,591,583 5,729,742
Miscellaneous Timber Products	2002 2001	--- ---		53,130 46,200
Source: Plumas and Sierra Counties 2002 Crop Reports.				

Land dedicated to commercial forest management provides not only building materials, energy for industrial processes, firewood, county revenue for roads and schools, and employment opportunities, but also wildlife habitat, recreational opportunities, aesthetic enjoyment, and watershed protection. Maintaining timber operations and preservation of valuable timberlands are important to the economic base and the natural resource values of the watershed.

Timber production in the watershed declined over the last several years. In 2002, Plumas County's total gross for timber products was approximately $18 million down from approximately $30 million in 2001 and down from $51 million in 2000. Sierra County dropped to almost no harvesting in the county since Sierra Pacific Industries closed its sawmill in Loyalton.

In 1976, the California State Legislature enacted the Forest Taxation Reform Act. The Act restructured the taxation of timber and timberlands by replacing the annual ad valorem property tax on timber and timberland with yield tax on harvested timber. This reduced the immediate demand on standing timber and the high grading that accompanied the need to cut larger trees on private holdings to reduce tax liability.

LAND USE PLANNING

Public Lands

Each federal and state agency has its own policies concerning land use and management. Legislation dictating public land use by agency is summarized in the following section. Land management activities on public lands traditionally focus on timber management, livestock grazing, mining, and water production. In recent years, the various land management plans for these public agencies de-emphasized timber and livestock production and focused more closely on watershed management and preservation of wildlife habitats. This "ecosystem approach" to management significantly reduced the amounts of timber harvested from public lands, increased scrutiny on livestock grazing, and emphasized research and development of conservation techniques.

Resource management on public lands is generally designed to:

- Improve rangeland conditions, with permitted grazing and forage capacity in balance
- Provide timberlands with a diversity of age and size classes
- Provide a full range of recreation opportunities, ranging from primitive to modern recreation settings
- Improve water quality and riparian areas
- Increase populations of threatened and endangered species, snag dependent species, and early successional wildlife, and improved fisheries production

While at the same time resource management can:

- Protect significant cultural resources
- Provide mineral and energy resources development
- Continue to offer firewood commensurate with public demand
- Maintain soil productivity
- Ensure scenic attractiveness from major public use areas
- Continue wetland development
- Maintain viable populations of all native and non-native desirable vertebrate species

United States Forest Service (USFS)
The USFS, which oversees the Plumas, Tahoe, and Toiyabe National Forests is required by the Rangeland Renewable Resource Planning Act of 1974 (RPA), as amended by the National Forest Management Act of 1976 (NFMA), to prepare individual forest plans. The RPA requires the USFS to conduct an assessment of the nation's renewable resources and to develop a program of use. The assessment determines the capability of all national forest lands to provide goods and services, as well as a forecast of demands for them.

NFMA requires the USFS to develop an integrated land management plan for each national forest. Each region distributes its share of national production targets to each of its forests. The share each forest receives is based on detailed information gathered at the forest level.

Assessment of the plan's environmental impacts is required by the National Environmental Policy Act (NEPA) and contained in an accompanying environmental impact statement (EIS). The EIS describes in detail the existing forest environment and management, supply-and-demand factors, and the environmental effects of implementing the proposed forest plan. Reasonable alternatives are also presented. The plan summarizes demand and supply potential, amplifies the preferred alternative, and applies its management direction to each management area.

District rangers and their staff administer these plans along with the changes and improvements made to other programs in the forest plan.

In January 2004, the Sierra Nevada Framework amended the land and resources management plans of 11 national forests in the Sierra Nevada region. Additional goals and standards included:

- Adopts an approach for modifying wildland fire behavior across broad landscapes through the strategic placement of area treatments, including direction to avoid California spotted owl protected activity centers (PACs) and northern goshawk PACs wherever possible

- Requires a landscape level assessment of opportunities and constraints to be completed as a first step in designing the pattern of fuels treatments needed to implement the fire and fuels strategy

- Provides mechanisms for more efficiently using appropriated funds

- Provides opportunities to reduce stand density and improve tree vigor and overall forest health

- Provides for ecosystem restoration following catastrophic disturbance events

- Allows for salvage of dead and dying trees for both economic value and fuels reduction purposes

- Incorporates new fuels and vegetation management standards and guidelines

- Re-establishes the Herger-Feinstein Quincy Library Group (HFQLG) Forest Recovery Act Pilot Project consistent with the HFQLG Forest Recovery Act

- Adopts an active and focused adaptive management and monitoring strategy

The Sierra Nevada Framework allows for the thinning of forests to prevent the devastation from fires. This has been referred to as "double logging" by the California environmentalists. In a speech in April of 2003, Forest Service Chief Bosworth referred to:

> [the bogus debate over logging] and said there's a misperception that the Forest Service is eagerly chopping down trees to make money. He said the amount of timber cut in the United States has dropped from 12 billion board feet a year two decades ago to 2 billion board feet a year now. It takes about 10,000 board feet to build an average house. (Locke 2003).

Sierra Nevada Framework

In January 2001, the USFS issued the Sierra Nevada Forest Plan Amendment (SNFPA), Record of Decision. This amendment supersedes the land and resource management plans of Plumas, Sierra and Toiyabe National Forests within the Sierra Valley Watershed and nine other national forests in the Sierra Nevada region. The decision is in accordance with the 1982 NFMA planning regulations (36 CFR 219). These regulations were recently changed (65 FR 67513), however, transitional language in the new regulations permits this decision to be made under the 1982 regulations.

The plan is designed to focus on providing an integrated, collaborative framework of concepts, principles, and goals for the Sierra Nevada region used to help guide future land-use decisions. The effort integrates recent science into natural resource management through a variety of approaches and at a variety of geographic scales. It also works toward more effective means of coordination, cooperation, and collaboration among the various parties.

The 2001 and amended 2004 Sierra Nevada Forest Plan focuses on five problem areas:

- Old forest ecosystems and associated species
- Aquatic, riparian, and meadow ecosystems and associated species
- Fire and fuels
- Noxious weeds
- Lower Westside hardwoods ecosystems

The principal focus of each area, strategy, risks, uncertainties, and likely trade-offs required to achieve desired future conditions are all addressed in the plan.

The newest Record of Decision (ROD), adopted in January 2004 includes an integrated strategy for vegetation management that is aggressive enough to reduce the risk of wildfire to communities in the urban-wildland interface while modifying fire behavior over the broader landscape. The amended ROD incorporates thinning projects that may significantly reduce the threat of catastrophic fires to wildlife and watersheds.

Bureau of Land Management
The BLM, a department within the United States Department of Interior, is directed under Title II, section 202 [43 U.S.C. 1712], of the Federal Land Policy and Management Act of 1976 to develop, maintain, and periodically update land use plans for all tracts or areas for the use of the public. When land use plans are prepared or revised, they must observe the principles of multiple use and sustained yield set forth by the Multiple Use-Sustained Yield Act of 1960. The BLM is currently updating their Resource Management Plan. Resource Management Plans represent the BLM's preferred management plans that use alternatives for minimizing environmental impact, and provide guidelines public land uses in the planning area. Alternatives attempt to meet the BLM's statutory mission under the Federal Land Policy and Management Act to provide for multiple uses of the public lands and identify actions to protect resources and avoid or minimize environmental harm.

California Department of Fish And Game
The CDFG is directed under the California Public Resources Code, Section 515, to produce and submit a general plan for each land acquisition classified or reclassified by the State Park and Recreation Commission. Effective January 2002, Bill AB1414 amended the current laws. Now CDFG is required to submit land management plans to better address resource, habitat, and species for state-held lands. The management plans will address the goals and strategies for managing the land, and identify and describe both ongoing and any necessary restoration, rehabilitation, and improvement projects for the land. These goals and strategies also include enforcement of the Federal Endangered Species Act and the California Endangered Species Act.

County Plans

The primary land users on private property, excluding urban areas, are those associated with timber production, recreation, and agriculture (ranching, hay, alfalfa, and wild rice). The passage of the California Land Conservation Act of 1965, commonly known as the Williamson Act, enables local governments to enter into 10 or 20-year contracts with private landowners for the purpose of restricting specific parcels of land to agricultural or related open space use. In exchange, landowners receive lower property tax assessments based upon farming and open space designation rather than current market value. The local government receives the lost property tax revenues from the state via the Open Space Subvention Act of 1971.

All cities and counties are required by State law to prepare and periodically update general plans. General plans are intended to guide growth in light of sensitive resources—both human and natural—and available services. Specifically, Government Code Section 65031.1 provides growth be guided by a general plan with goals and policies directed to land use, population growth and distribution, open space, resource preservation and utilization, air and water quality, and other physical, social, and economic factors.

Sierra Valley Watershed is subject to county general plans, except the federally owned lands within the Sierra Valley Watershed. The process to update general plans involved extensive public review and environmental review under the California Environmental Quality Act (CEQA).

Plumas County
Plumas County's General Plan objectives are to identify and protect for present and future utilization of commercially viable resource production areas with safeguards for the surrounding lands and the environment. It is also used to establish land use patterns based on constraints and opportunities with intensity and density of development tied largely to the availability of public facilities and services.

Sierra County
Sierra County's General Plan objective is to protect existing qualities and address local concerns as Sierra County grows. Plan objectives and fundamental goals of the General Plan are as follows:

- It is the county's most fundamental goal to maintain its culture, heritage, and rural character and preserve its rural quality of life

- It is the county's goal to defend its important natural features and functions; these have included and always will include scenic beauty, pristine lakes and rivers, tall mountain peaks and rugged forested canyons, abundant and diverse plants and animals, and clean air, water, and watershed values

- It is the county's goal to foster compatible and historic land uses and activities which are rural and which contribute to a stable economy

- It is the county's goal to direct development toward those areas already developed, where there are necessary public facilities, and where a minimum of growth inducement and environmental damage will occur. The pattern of land uses sought by the county is a system of distinct and cohesive rural clusters amid open land

- It is the county's goal to provide a comprehensive plan for all lands and uses within the county regardless of ownership or governmental jurisdiction

The previous mentioned objectives are carried out in detailed policies, implementation measures, land use diagram, and the overall theme of the General Plan, which is as follows:

- Direct growth of the community influence and community core areas
- Discourage development outside these communities
- Create Special Treatment Areas where a more detailed level of planning is needed due to resources or constraints in these areas
- Utilize optional general plan elements to emphasize protection of the environment and economic value of the County's resources
- Protect the county's natural resource based industries
- Limit extension of county services outside the Community Core and Community Influences Areas to reduce fiscal impacts and protect the environment and economic value of the county's resources

LAND USE REGULATIONS

Many laws and regulations govern the manner in which both public and private lands are managed on the federal, state, and county level. This section will discuss some of the laws most relevant to the watershed and its citizens. This is not an all-inclusive list and the reader is cautioned to not use the following as legal or regulatory advice.

Federal

- **The Forest Reserve Act of 1891.** The Forest Reserve Act gave the President the authority to deem any or all public lands with forest or undergrowth a public reserve.
- **The Taylor Grazing Act of 1934.** The Taylor Grazing Act provides a way to regulate the occupancy and use of public land, preserve the land from destruction or unnecessary injury, and provide for orderly use, improvement, and development.
- **The Wild Horse Annie Act of 1959.** This law prohibits the use of motorized vehicles to hunt wild horses and burros on all public lands.
- **The Multiple Use-Sustained Yield Act of 1960.** Congress stated that the national forests are established and administered for a variety of uses such as outdoor recreation, range, timber, watershed, and wildlife and fish purposes. The management of all the various

renewable surface resources of the national forests to best satisfy the needs of the American people.

- **The National Environmental Policy Act (NEPA) of 1969.** The purposes of this act are to declare a national policy which will encourage productive and enjoyable harmony between man and his environment; promote efforts which will prevent or eliminate damage to the environment and biosphere, and stimulate the health and welfare of man; enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality.

- **Clean Water Act (Federal Water Pollution Control Act Amendments) of 1972.** The primary purpose of the 1972 Clean Water Act was to "restore and maintain the chemical, physical, and biological integrity of the nation's waters." To achieve that goal the law prohibits the discharge of pollutants into "navigable waters," defined in the act as "waters of the United States," without a permit. The law historically is understood to protect traditionally navigable waters, tributaries of navigable waters, wetlands adjacent to these waters, and other wetlands, streams, and ponds that if destroyed or degraded could affect interstate commerce.

- **The Endangered Species Act of 1973.** The Endangered Species Act recognizes that various species of fish, wildlife, and plants in the United States rendered extinct because of economic growth and development, and that other species of fish, wildlife, and plants are so depleted in numbers that they are in danger of, or threatened with, extinction. The United States pledged to conserve to the extent practicable the various species of fish or wildlife and plants facing extinction.

- **The Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974.** This act directs the Secretary of Agriculture to prepare a Renewable Resources Assessment every 10 years. These assessments include "an analysis of present and anticipated uses, demand for, and supply of the renewable resources with consideration of the international resource situation, and an emphasis of pertinent supply, demand, and price relationships trends."

- **The Federal Land Policy and Management Act of 1976.** This law deemed that public lands must be managed in a manner to protect their quality and value. In certain cases, the preservation and protection of certain public lands in their natural condition will provide food and habitat for fish, wildlife and domestic animals, and provide for outdoor recreation and human occupancy and use.

- **The Public Rangelands Improvement Act of 1978.** This law gave public land administrators the authority to charge a fee for livestock grazing permits and leases on public lands based on a formula reflecting annual changes in the costs of production and enabled formation of ESIP.

- **The Government Performance and Results Act of 1993 (GPRA).** The GPRA directs all government agencies to develop a strategic plan that covers three to five years. Four major themes of the USFS RPA are to: (1) enhance recreation, wildlife, and fisheries resources, (2) ensure environmentally acceptable commodity production, (3) improve scientific knowledge about natural resources, and (4) respond to global resource issues.

State

- **Porter-Cologne Water Quality Act of 1969.** This law passed by the legislature deemed the state and Regional Water Quality Control Boards (RWQCB) the primary governing bodies responsible for the coordination and control of water quality. Coordination of their respective activities is to achieve a unified and affective water quality control program in California.

- **California Environmental Quality Act (CEQA) of 1970.** CEQA is closely modeled on the NEPA. Unlike NEPA, CEQA imposes an obligation to implement mitigation measures, or project alternatives to mitigate significant adverse environmental effects, if these measures or alternatives are feasible. CEQA establishes both a procedural obligation to analyze and make public adverse physical environmental effects and a substantive obligation to mitigate significant impacts.

- **California Endangered Species Act (CESA) of 1984.** CESA generally parallels the main provisions of the Federal Endangered Species Act, which is administered by the CDFG. Under CESA, the term "endangered species" is defined as a species of plant, fish, or wildlife, which is "in serious danger of becoming extinct throughout all or a significant portion of its range," and is limited to species or subspecies native to California.

- **California Land Conservation Act (Williamson Act) of 1965.** The law enables local governments to enter into contracts with private landowners to restrict specific parcels of land to agricultural or related open space use. In return, landowners receive property tax assessments, which are much lower than normal because they are based upon farming and open space uses, as opposed to full market value. Local governments receive an annual subvention of forgone property tax revenues from the state via the Open Space Subvention Act of 1971.

- **Z'berg-Nejedly Forest Practices Act of 1973.** The Z'berg-Nejedly Forest Practices Act (Forest Practices Act) was enacted in 1973 to create a comprehensive regulatory act to protect timberlands with the intent to restore, enhance, and maintain forest productivity, and to sustain high-quality timber products while taking into account "recreation, watershed, wildlife, range and forage, fisheries, regional economic vitality, employment, and aesthetic enjoyment." This is an all-encompassing law enacted to involve timber, loggers, and environmentalists alike in forest management decisions.

Typical Permit Requirements

The numerous statutory requirements that apply to lands in the watershed generate volumes of regulations to manage how actions occur on both state and federal properties. Although not an inclusive listing below is an example of the types of permits and administrative actions required to conduct activities, such as restoration projects. Typical permit requirements in the watershed are summarized below.

A permit is an authorization or other control document issued by a federal, state, or local agency to implement the requirements of a law or regulation. The type of permits required for a project depend on the

- Source of project funding (private, state, or federal)
- Type of project and resources affected
- Ownership of land on which the project occurs
- Physical location of the project

Most permits require a fee. The permitting process for any project can be complicated and difficult to understand. This section is not intended as a comprehensive guide for project permitting. Since it is the responsibility of the permit applicant to ensure they have applied for all the right permits, the goal of this section is to present enough information to assist project managers in asking the correct questions and searching out appropriate sources for assistance. Some permits apply to specific project types. Others, like CEQA compliance, apply to all projects. There is significant distinction in permit requirements between projects on public and private lands. Most permits are resource use specific. For example, the preparation of a timber harvest plan and submittal of the plan to the California Department of Fire and Forestry Protection (CDF) is required to remove timber. Any project which disrupts a stream channel or waterway requires a 1600 (stream bed alteration) permit from the CDFG. Cinder pits require compliance with the Surface Mining and Reclamation Act of 1975. Water re-use projects that may impact water quality will require review by the RWQCB or DWR. Most all projects will require NEPA or CEQA review as no permit may be issued without the primary agency completing this process.

Brief descriptions of regulatory agencies that may be involved in the project are found in Table 8-12. A possible project matrix and likely permit requirements for private lands is included as Table 8-13. This table is provided *only* to present areas where permits may be required.

In general, project permitting will take a minimum of 120–180 days. It is important in all project planning and permit operations to:

- Prepare a well-defined project description that minimizes disturbance
- Prepare clear and concise plans
- Contact agencies early
- Maintain a positive attitude

REFERENCES

CDC (California Department of Conservation, Department of Land Resource Protection). *Farmland Mapping and Monitoring Program* [online]. Sacramento, CA [cited January 14, 2004]. Available from the World Wide Web: http://www.consrv.ca.gov/DLRP/fmmp/

California Farm Bureau Federation. *Values of agricultural production by county, 2001* [online]. Sacramento, CA [cited March 10, 2004]. Available from the World Wide Web: http://www.cfbf.com

Table 8-12 PERMIT-ISSUING AGENCIES		
Agency	**Function**	**Area**
Local:		
City/County Planning Department	Many city or county planning departments have local ordinances pertaining to grading creeks and wetlands, and depending on the nature of the project, several other permits/exceptions/approvals may be required as well. Planning departments are commonly the lead agency for CEQA documentation. County planning department are commonly the lead agency for mine applications	Sierra, Plumas Counties
City/County Environmental Health Department	Local Environmental Health Departments provide monitoring and enforcement relating to food and hazardous materials handling. This agency may be involved if work on the stream, or discharge into the stream pose a pubic health hazard, such as with water re-use. Health departments commonly are lead agency for well permits, water re-use and reclamation, and underground storage tank contamination limited to soil.	Sierra, Plumas Counties
Local Irrigation, Water, or Flood Control District	Irrigation, Water, or Flood Control Districts are empowered to protect water resources within their jurisdiction which may require a permit for certain projects	Sierra, Plumas Counties
State:		
California Department of Fish and Game	The California Department of Fish and Game requires a Stream Alteration Agreement (1600 permit) for projects that will divert or obstruct the natural flow of water, change the bed, channel or bank of any stream, or use any material from a streambed. The 1600 permit is a contract between the applicant and the CDFG stating what can be done in the riparian zone and stream course. The permit is required for removal of vegetation and such activities, as placement of culverts requires independent CEQA review for all 1600 permits and will serve as lead agency if the review is not considered previously. CDFG can also be expected to provide input to projects through the CEQA and NEPA review process.	Region 1 (Northern California & North Coast Region) 601 Locust Street Redding, CA 96001 (530) 225-2300
California Regional Water Quality Control Boards	There are nine Regional Water Quality Control Boards. Regional Boards engage in a number of water quality functions. One of the most important is preparing and periodically updating Basin Plans, which set water quality standards. Regional Boards regulate all pollutant discharges that may affect either surface water or groundwater. Private, state, and federal projects require RWQCB permits. The permits obtained from the RWQCB would include: Waste Discharge Requirements The discharge of waste or waste water to land that may impact water quality National Pollution Discharge Elimination System (NPDES) Permit – This permit is required when proposing to, or discharging of waste into any surface water. For discharges to surface waters, these requirements become a federal National Pollution Discharge Elimination System (NPDES) issued by the RWQCB. Federal Clean Water Act (CWA) Section 401 Water Quality Certification – This certificate is required for every federal permit or license or for any activity, which may result in a discharge into any waters in the United States. Activities include flood control channelization, channel clearing, and placement of fill. Federal CWA Section 401 requires that every applicant for a US Army Corps of Engineers CWA Section 401 permit or Rivers and Harbors Act Section 10 permit must request a state certification from the RWQCB that the proposed activity will not violate state and federal water quality standards. The RWQCB reviews the request for certification and may waive certification, or may recommend either certification or denial of certification to the State Board Executive Director.	Redding Branch Office (5R) Redding, CA (530) 224-4845
State Water Resources Control Board Division of Water Rights	Anyone wanting to divert water from a stream or river not adjacent to his or her property must first apply for a water rights permit from the State Board. The State Board issues permits for water rights specifying amounts, conditions, and construction timetables for diversion and storage. Any persons or agencies intending to take water from a creek for storage or direct use on non-riparian land must first obtain a Water Rights Permit. The goal of the Board is to assure that California's water resources are put to a maximum beneficial use and that the best interests of the public are served. CDFG also must concur on the permit.	Division of Water Rights 1001 "I" Street, 14th Floor Sacramento, CA 95814 (916) 341-5300

Table 8-12 (cont.) PERMIT ISSUING AGENCIES		
Federal:		
United States Army Corps of Engineers	Federal and state projects planning work in a river, stream, or wetland may require a Corps permit. The regulatory authority of the Corps for riparian projects is based on Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. Section 404 of the Clean Water Act requires Corps authorization for work involving intentional or unintentional placement of fill or discharge of dredged materials into any "waters of the United States." This applies even if there is a chance the winter rains may cause erosion leading to sediment discharges into the "waters." Section 10 of the Rivers and Harbors Act requires Corps authorization for work or instructions in or affecting "navigable waters." Corps jurisdiction extends up to the ordinary high water line for non-tidal waters. Corps review can be shortened through the use of General Permit categories. These are areas where the AOC has determined with SWRCB concurrence that a special permit is not required and published BMPs or General Permit conditions are acceptable	Sacramento District – (916) 557-5250 New Redding Office
United States Fish and Wildlife Service	The US Fish and Wildlife Service (USFWS) is the principal federal agency for conserving, protecting, and enhancing fish, wildlife, plants, and their habitats. USFWS and National Marine Fisheries Service share responsibility for administration of the Endangered Species Act. USFWS enforces the federal Endangered Species Act, ensures compliance with the National Environmental Policy Act, and reviews and comments on all water resource projects. The Fish and Wildlife Coordination act requires that all federal agencies consult with the USFWS, the National Marine Fisheries Service, and state wildlife agencies for activities that affect, control, or modify waters of any stream or bodies of water. Under the Act, the USFWS and NMFS have responsibility for project review. In addition, the USFWS functions in an advisory capacity to the Corps of Engineers under the provisions of the Fish and Wildlife Coordination Act and other legislation. <u>Incidental Take Permits</u> – If a project may result in "incidental take" of a listed species, an incidental take permit is required. An incidental take permit allows a non-federal landowner to proceed with an activity that is legal in all other respects, but that results in "incidental taking" of a listed species. <u>Habitat Conservation Plan</u> – A Habitat Conservation Plan must accompany an application for an incidental take permit. The purpose of an HCP is to ensure that the effects of the permitted action on listed species are adequately minimized and mitigated. The incidental take permit authorizes the take, not the activity that results in the take. The activity itself must comply with other applicable laws and regulations.	2800 Cottage Way, Room W-2606 Sacramento, CA 95825-1846 (916) 414-6464
National Marine Fisheries Service	The National Marine Fisheries Service (NMFS) is the federal agency responsible for the conservation and management of the nation's living marine resources. Projects or activities that may affect marine fish and related habitat within NMFS jurisdiction are reviewed for any potentially harmful effects. The purpose of reviews conducted by NMFS is to ensure that sensitive populations of marine and anadromous fish (such as salmon and steelhead), as well as the aquatic and riparian habitat that support these fish, can survive and recover in the presence of human activities. The types of projects and activities of interest to NMFS include streambank stabilization, streambed alteration, habitat restoration, flood control, urban and industrial development, and water resource utilization. When projects or activities require a federal permit, such as a Clean Water Act section 404 permit from the Army Corps of Engineers, then NMFS conducts a consultation with the federal agency under section 7 of the ESA. When there is no federal involvement, then for projects that incidentally "take" a listed species a permit under section 10 of the ESA is required.	N/a
Tribal Review		
Tribal Review	For projects on federal and state lands, tribal review is required. For projects on private lands with federal money, review would apply. Private land projects with private money do not require tribal review.	

Table 8-13
PROJECT PERMIT EXAMPLES – COUNTY OR OTHER LEAD AGENCY

Is Your Project:	City/County Planning Dept Grading, Mining, etc	City - County Health Dept	Water/Irrigation Flood Control District	California Dept of Fish & Game		State Water Resources Control Board/Division of Water Rights	Regional Water Quality Control Board			US Army Corps of Engineers	County or Other Agency (CEQA)	National Environmental Policy Act (Federal Lead Agency)	Tribal Review	US Fish and Wildlife Service
				1600	Other		WDR	NPDES	401 Cert					
On federal land with federal funding?												×	×	
On private land with private funding?	×				×						×			
On private land with federal funding?									×	×	×	×	×	×
On private land with state funding?											×			
Result in stormwater discharge into the creek?					×				×					
Divert or obstruct the natural flow; or change the natural bed or bank of the creek?				×		×					×			
Involve repair, rehabilitation, or replacement of any structure or fill adjacent to creek?				×					×	×	×			
Involve fish and wildlife enhancement, attraction, or harvesting devices and activities?				×	×						×			×
Use materials from a streambed including but not limited to boulders, rocks, gravel, sand, and wood debris?	×		×	×	×		×		×	×	×			
Require the disposal or deposition of debris, waste, or any material containing crumbled, flaked, or ground pavement with a possibility that such material could pass into the stream?				×	×		×		×	×	×			×
Involve grading or fill near the creek?														
Involve a bridge or culvert?														
Involve water re-use?		×	×				×							
Involve a septic or leach field?		×					×							
Require a water well?		×												
Involve work within historic or archaeological area?											×	×	×	
Remove water from creek for storage or direct use on non-riparian land?						×								
Require that hazardous materials be generated and/or stored on site?		×					×	×						
Involve a land disturbance of five acres or more?	×					×			×	×				
Involve a project with species listed as endangered or threatened?					×									×

Source: Portions for CARCD Guide to Watershed Project Permitting

CFA (California Forestry Association). 1995 private timber company land holdings data.

California Spatial Information Library. *Frequently accessed data* [online]. Sacramento: California Spatial Information Library [cited January 2003]. Available from the World Wide Web: http://gis.ca.gov/BrowseCatalog.epl

DFG (California Department of Fish and Game). 2000. *Managing northern pike at Lake Davis: A plan for Y2000*. Save Lake Davis Task Force Steering Committee and Department of Fish and Game, 2000.

Duane, T.P. 1996. *Sierra Nevada ecosystem project: Final report to Congress, vol. II. Assessments and scientific basis for management options. Chapter 19: Recreation in the Sierra*. Davis: University of California, Centers for Water and Wildland Resources.

DWR (California Department of Water Resources). 1973. *Natural resources of the Sierra Valley study area.* A Cooperative Study by Federal, State, and local Agencies, issued by DWR-Central District CPA/ 1020.10.

—. 2000. *Agricultural Land and Water Use for 2000*.

Locke, Michelle. 2003. *Forest Service chief says debate focuses on wrong issues.* [online]. San Francisco: [cited July 27, 2004]. Available from the World Wide Web: http://sfgate.com/article.cgi?file=/news/archive/2003/04/22/

Menke, et al. 1996. *Rangeland assessment. Sierra Nevada Ecosystem Project: Final Report to Congress, vol. III, Assessments, Commissioned Reports, and Background Information*. Davis: University of California, Centers for Water and Wildland Resources.

Plumas County. 2004. Plumas County General Plan.

Plumas County, Department of Agriculture. 2001. 2001 Crop Report.

Ratliff, R. D. 1985. *Meadows in the Sierra Nevada of California: State of knowledge*. General Technical Report PSW-84. Berkeley: United States Department of Agriculture, Forest Service, Pacific Southwest Forest, and Range Experiment Station.

Sierra County, 1996. Sierra County General Plan.

Sierra County, Department of Agriculture. 2001. 2001 crop report.

University of Virginia Geospatial and Statistical Data Center. 1998. *United States historical census data browser* [online]. University of Virginia [cited March 9, 2003]. Available from the World Wide Web: http://fisher.lib.virginia.edu/census/

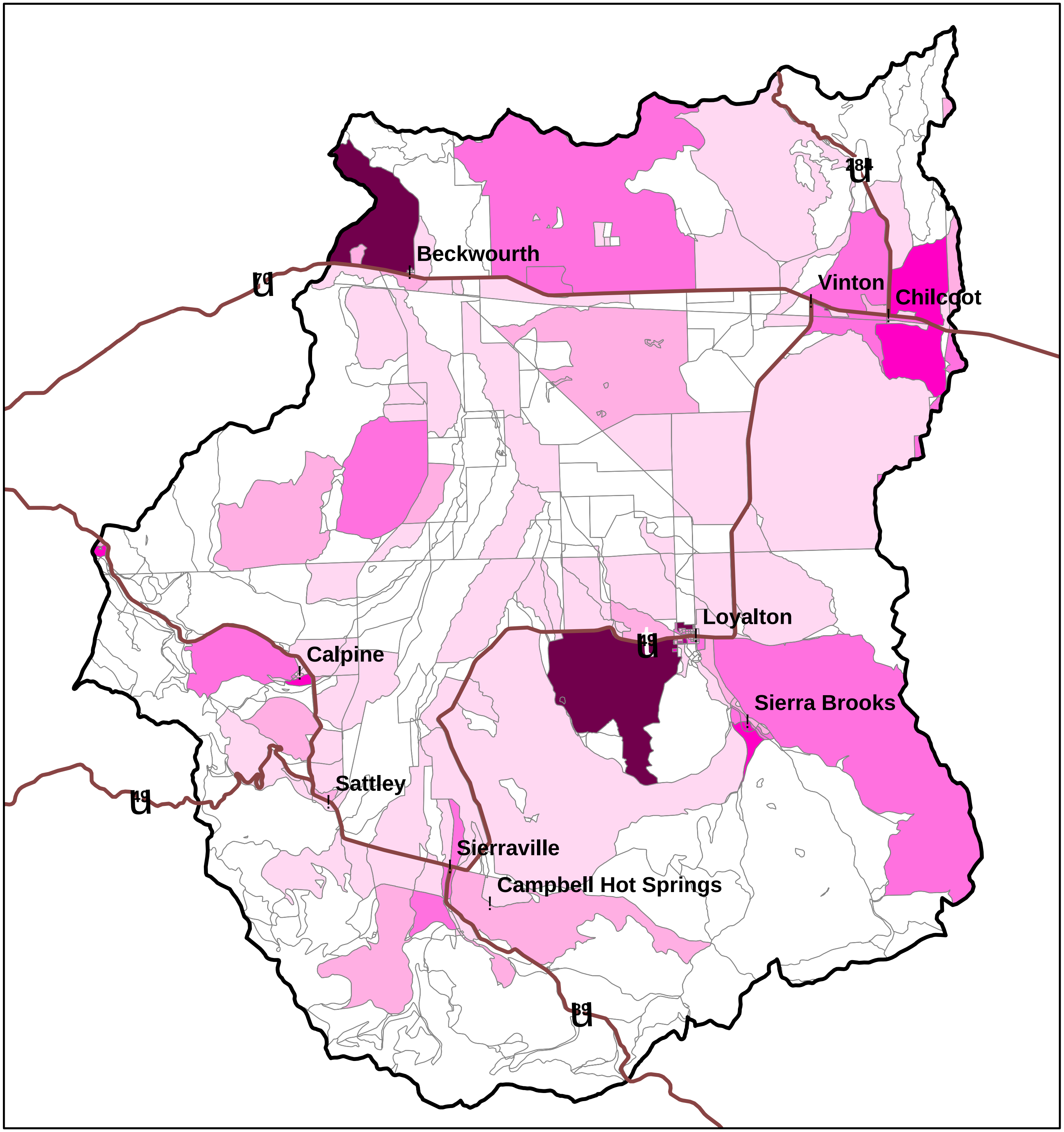


Figure 8-1
2000 Census Population
Sierra Valley Watershed

Legend

- Sierra Valley Watershed
- State Highways
- Census Block
- 0 persons
- 1 - 10 persons
- 11 - 25 persons
- 26 - 50 persons
- 51 - 75 persons
- 76 - 100 persons
- 101 - 175 persons

Figure based on number of persons residing within each census block

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY: CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION, 2002

0 1.25 2.5 5 Miles

VESTRA

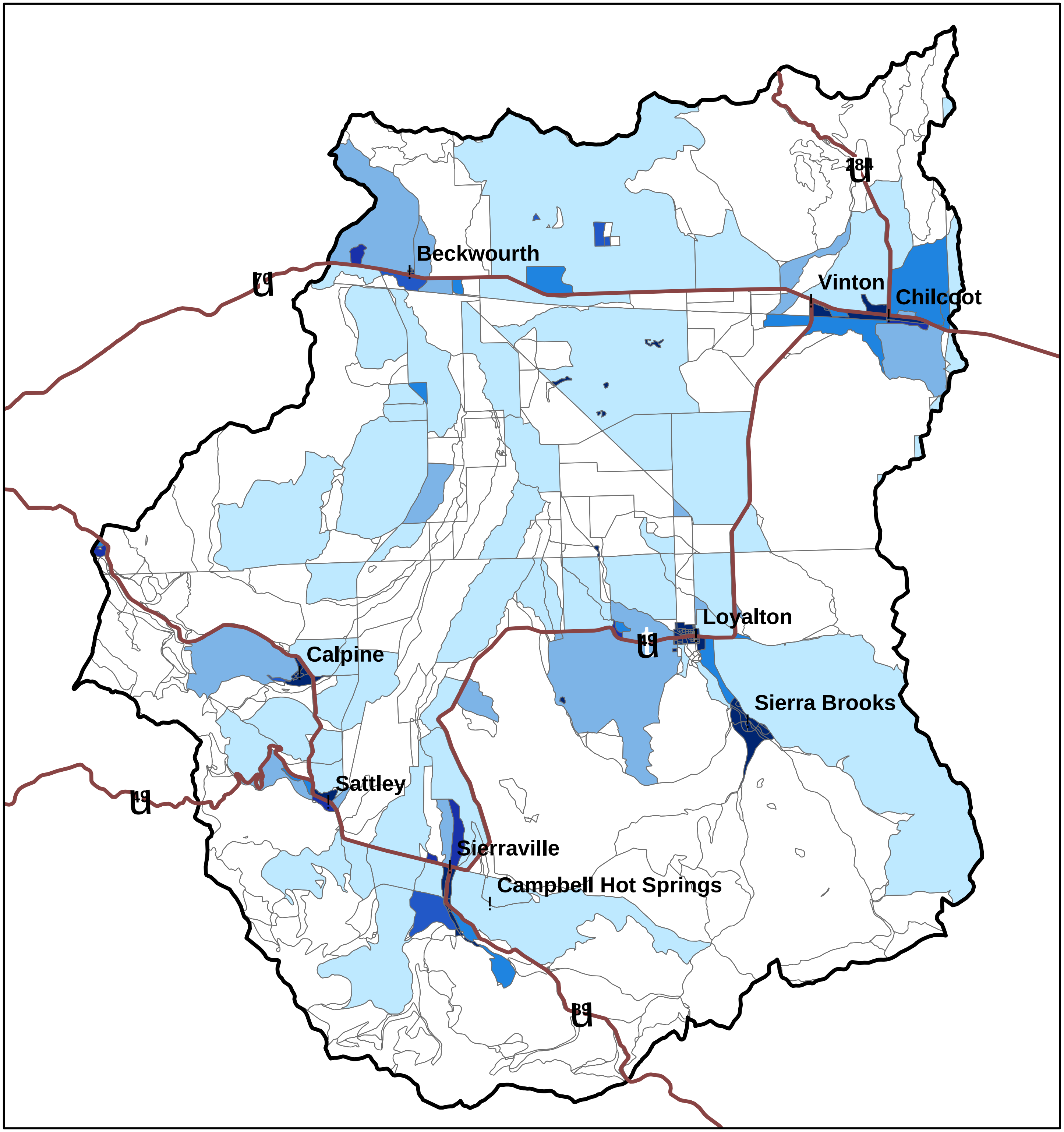


Figure 8-2
2000 Census Population Density
Sierra Valley Watershed

Legend

- Sierra Valley Watershed
- State Highways
- Census Block
- 0
- 1 - 10
- 11 - 25
- 26 - 50
- 51 - 75
- 76 - 100
- > 100

Figure based on persons per square mile

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY: CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION, 2002

0 1.25 2.5 5 Miles

VESTRA

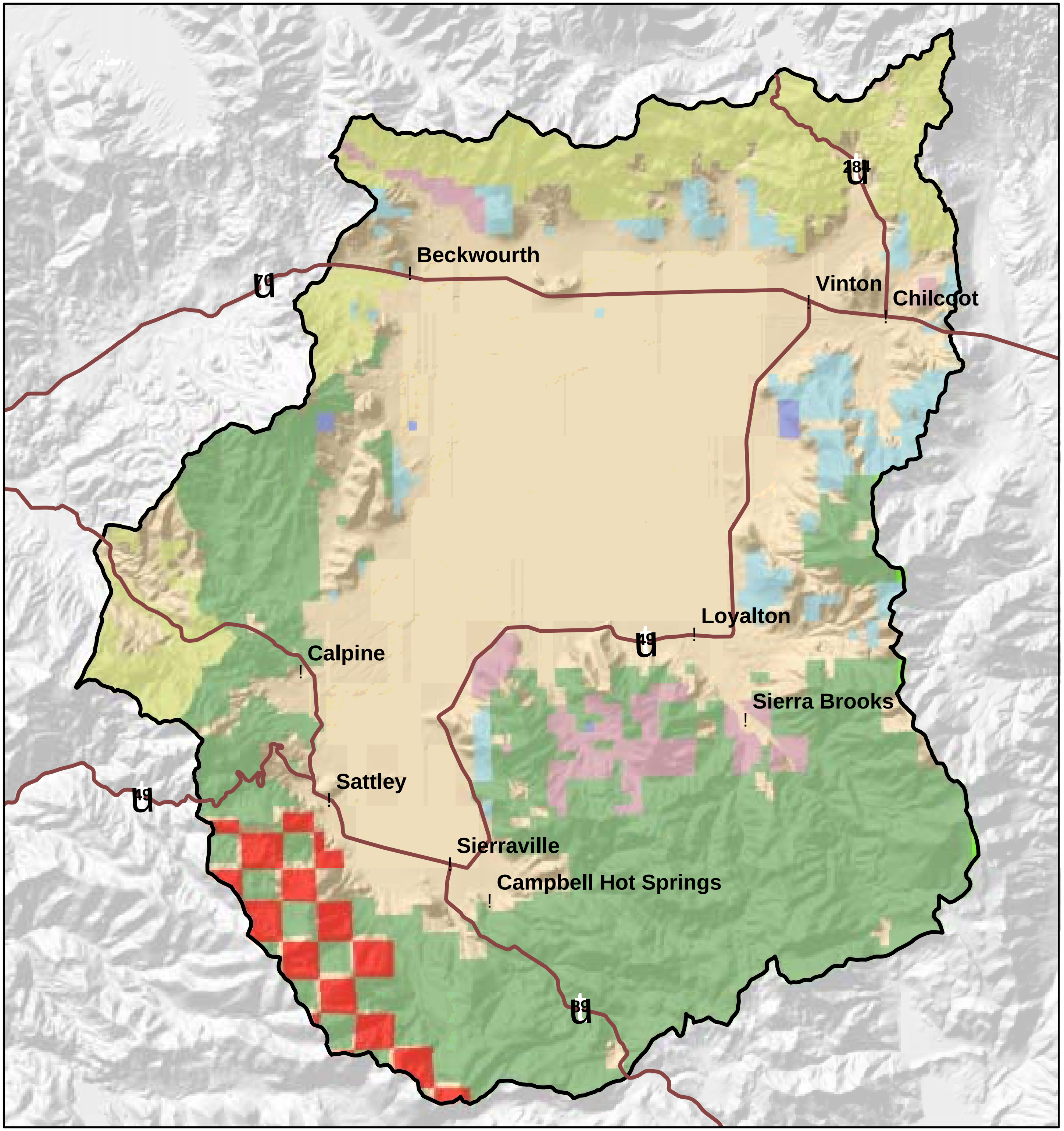


Figure 8-3
Ownership
Sierra Valley Watershed

Legend

- Sierra Valley Watershed
- State Highways
- Sierra Pacific Industries
- Bureau of Land Management
- California Department of Fish and Game
- State Lands Commission
- Plumas National Forest
- Tahoe National Forest
- Toiyabe National Forest
- Other Private Lands

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY, THE LEGACY PROJECT, 2003; CALIFORNIA FORESTRY ASSOCIATION, 1995

0 1.25 2.5 5 Miles

VESTRA

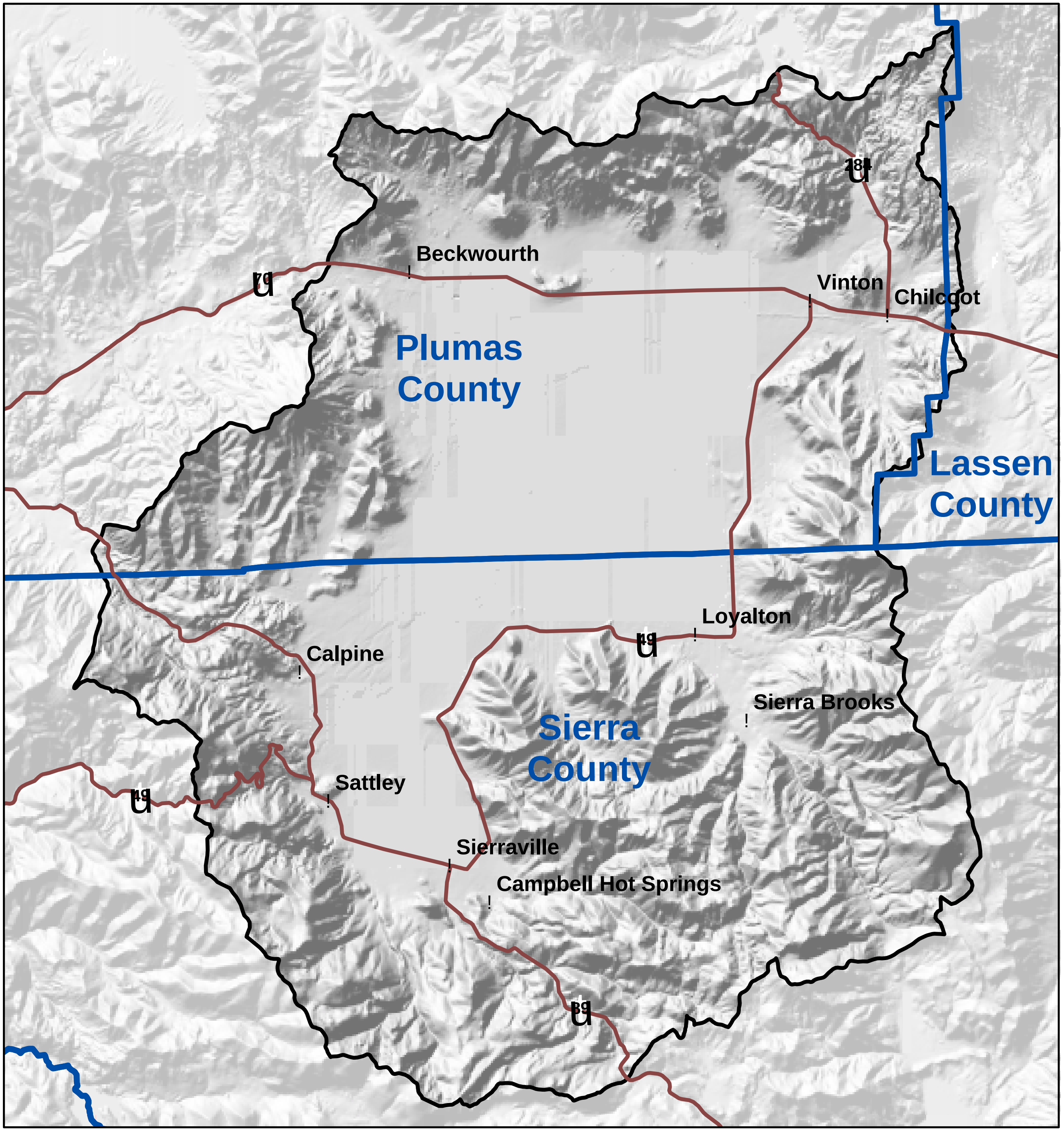


Figure 8-4
County Boundaries
Sierra Valley Watershed

Legend

- Sierra Valley Watershed
- State Highways
- County Boundaries

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY, TEALE GIS SOLUTIONS GROUP, 1997

0 1.25 2.5 5 Miles

VESTRA

1850

1860

1870

FIGURE 8-5

EARLY COUNTY BOUNDARY CHANGES

SOURCE: CALIFORNIA ASSOCIATION OF COUNTIES

SIERRA VALLEY WATERSHED

VESTRA

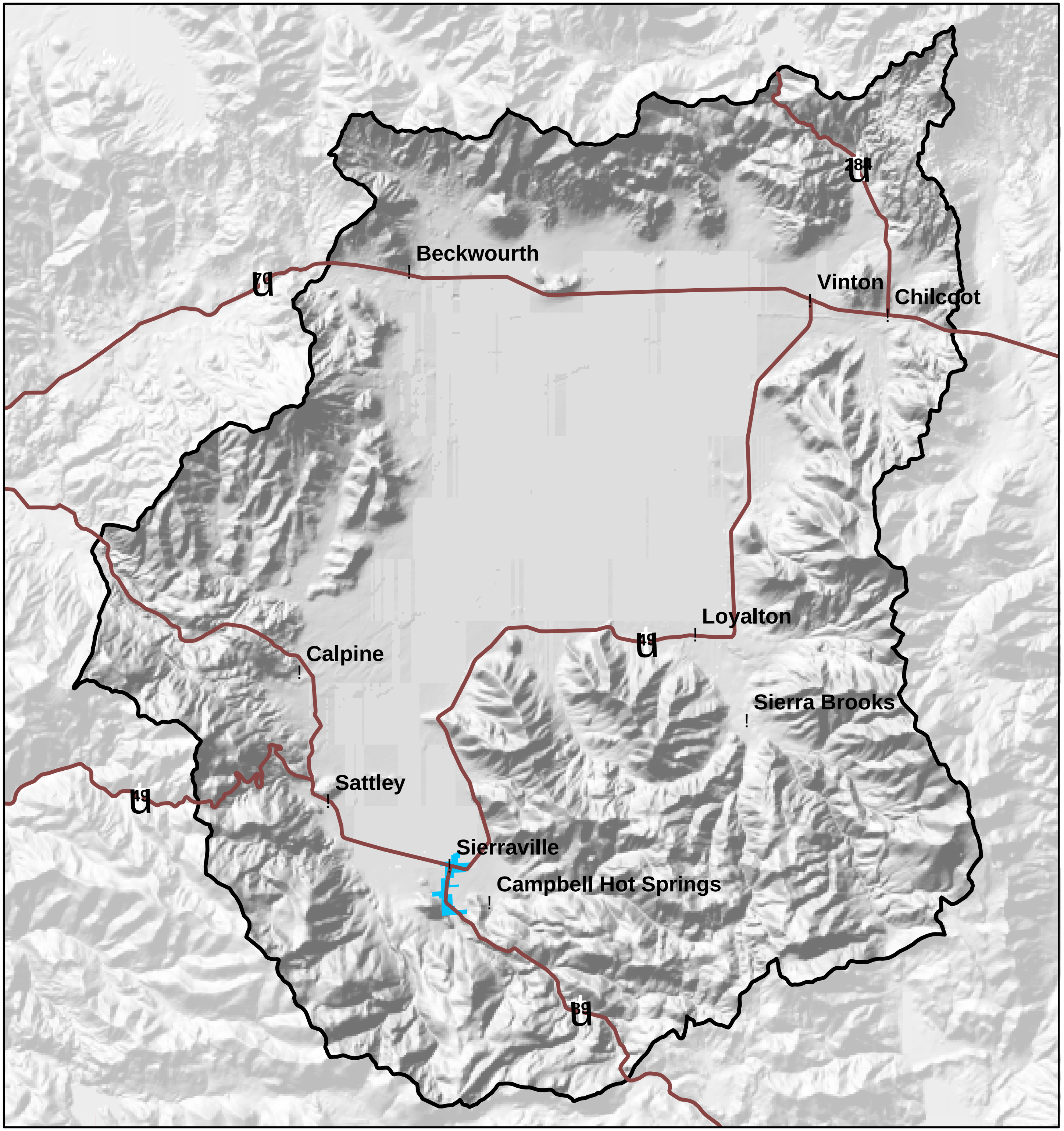


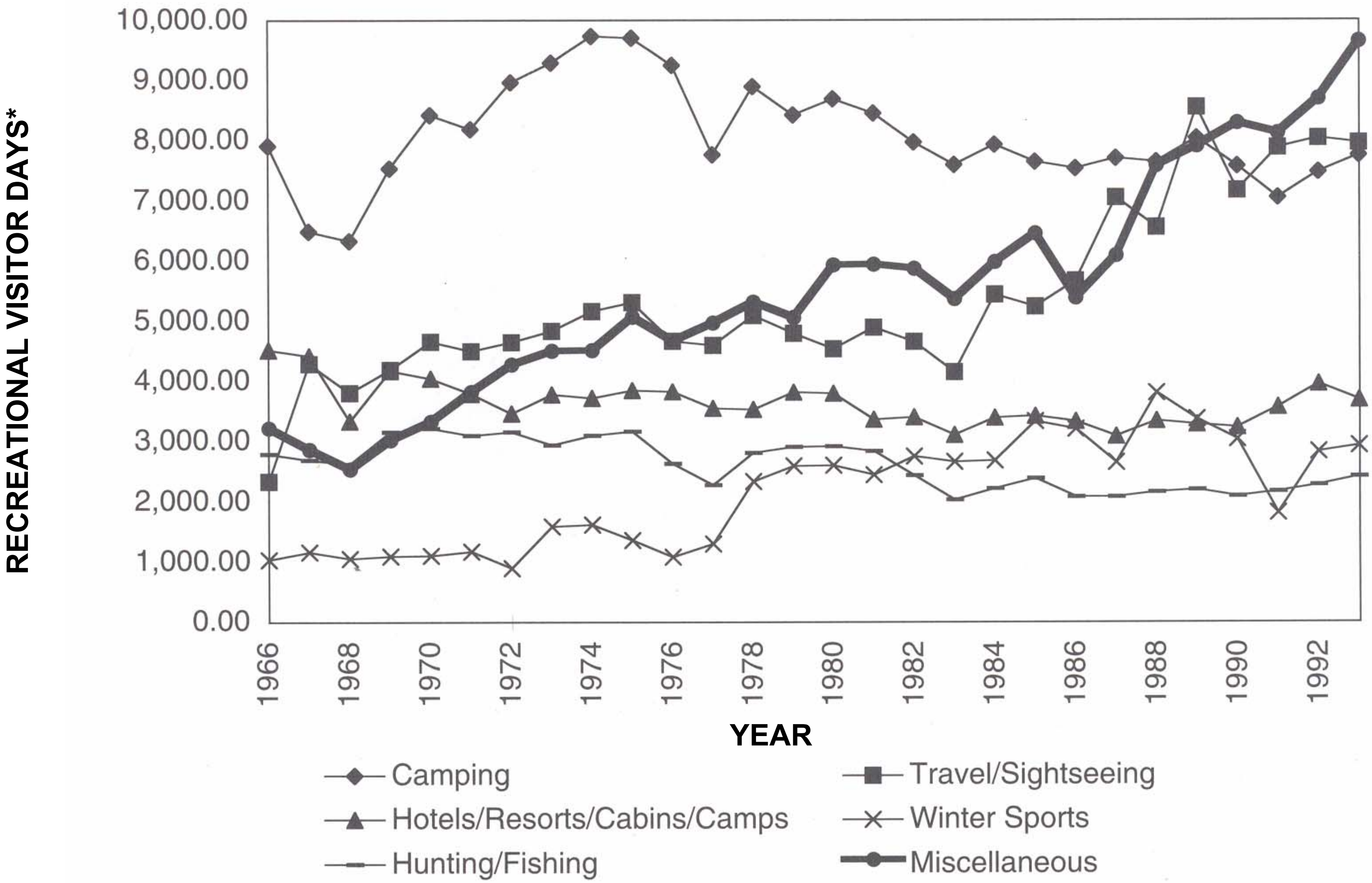
Figure 8-6
Private Water Districts
Sierra Valley Watershed

Legend

- Sierra Valley Watershed
- State Highways
- Sierraville P.U.D.

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY: U.S. BUREAU OF RECLAMATION, 2003

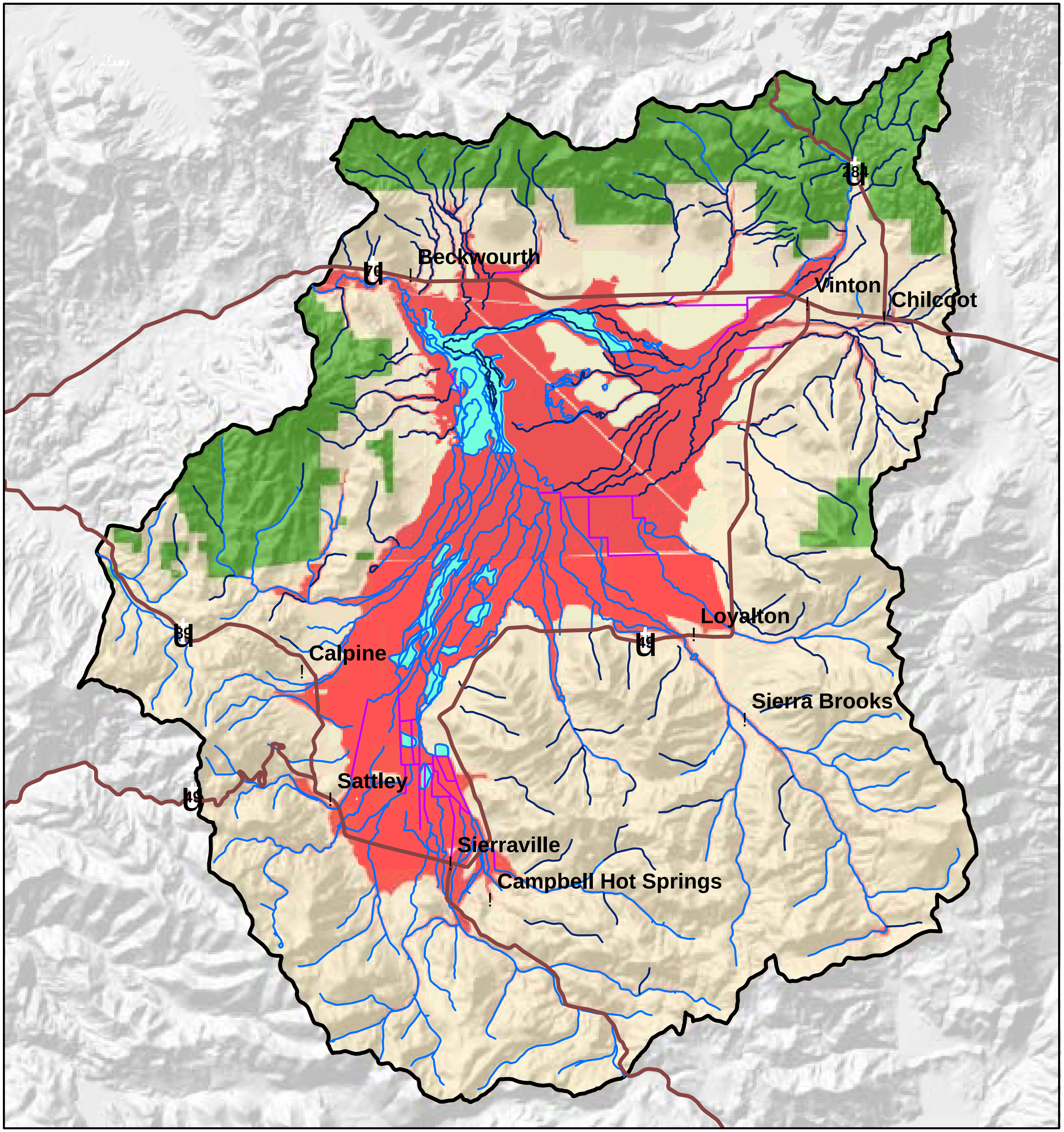
0 1.25 2.5 5 Miles



* Figure represents all US Forest Service units in the Sierra Nevada study area (except Toiyabe National Forest). One Recreational Visitor Day equals one 12-hour visit to a site, or 12 hours of an activity.

FIGURE 8-7
RECREATIONAL LAND USE
SOURCE: STATUS OF THE SIERRA NEVADA
SIERRA VALLEY WATERSHED

Figure 8-8
FEMA and DWR Flood Hazards
Sierra Valley Watershed



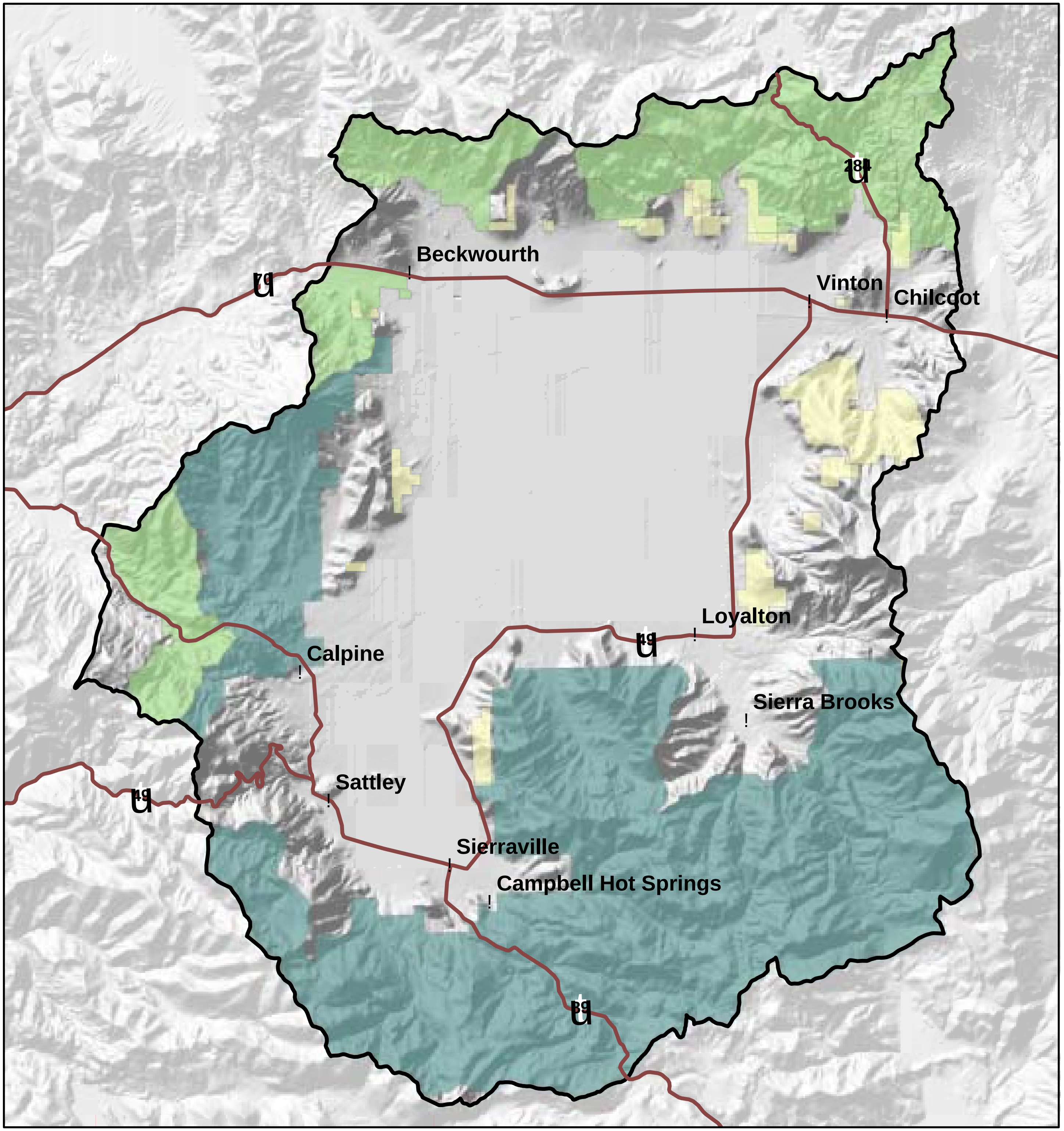
Legend

- State Highway
- Perennial Stream
- Seasonal Stream
- Canal
- Sierra Valley Watershed
- Wetland
- Zone A - Area Subject to Inundation
- Zone D - Unstudied Area
- Zone X - Area Outside of 500-Year Flood

SOURCE FEDERAL EMERGENCY MANAGEMENT AGENCY: NATIONAL FLOOD INSURANCE PROGRAM Q3 FLOOD DATA; CALIFORNIA DEPARTMENT OF WATER RESOURCES

0 1.25 2.5 5 Miles

Figure 8-9
USFS and BLM Grazing Allotments Sierra Valley Watershed



Legend

- Sierra Valley Watershed
- State Highway
- BLM Grazing Allotment
- Plumas National Forest
- Tahoe National Forest
- Toiyabe National Forest

SOURCE: UNITED STATES FOREST SERVICE, REMOTE SENSING LAB, REGION 5; BUREAU OF LAND MANAGEMENT, GEOSPATIAL DATA DOWNLOADS

0 1.25 2.5 5 Miles

VESTRA

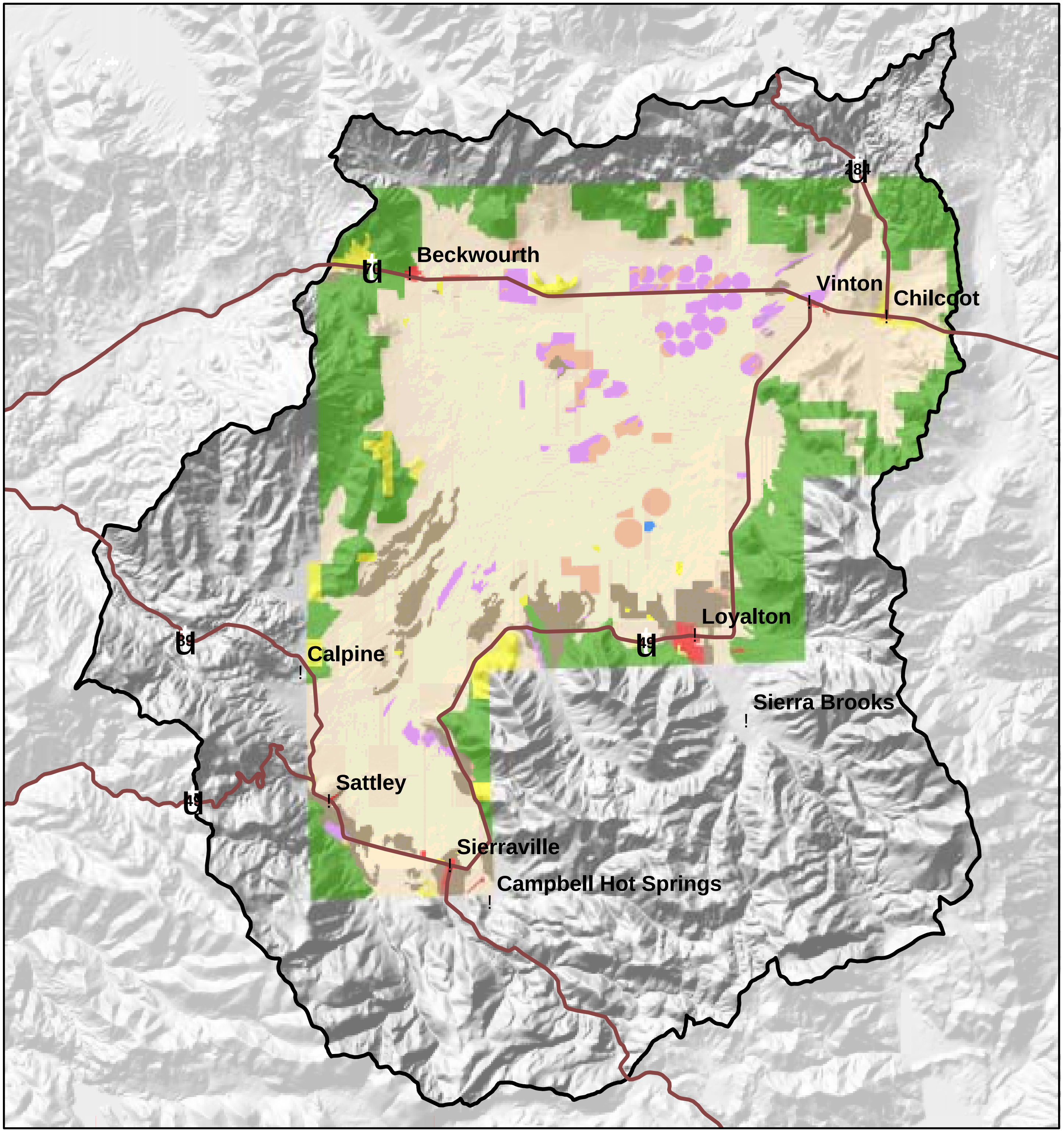


Figure 8-10
Important Farmland
Farmland Mapping and Monitoring Program (FMMP)
Sierra Valley Watershed

Legend

- Sierra Valley Watershed
- State Highways
- FMMP Urban and Built-Up Land - 783 acres
- FMMP Grazing Land - 35,845 acres
- FMMP Farmland of Local Importance - 90,187 acres
- FMMP Prime Farmland - 8,515 acres
- FMMP Farmland of Statewide Importance - 4,718 acres
- FMMP Unique Farmland - 2,642 acres
- FMMP Water - 45 acres
- FMMP Other Land - 3,281 acres

SOURCE: STATE OF CALIFORNIA DEPARTMENT OF CONSERVATION DIVISION OF LAND RESOURCE PROTECTION FARMLAND MAPPING AND MONITORING PROGRAM

0 1.25 2.5 5 Miles

VESTRA

Section 9

Section 9
FORESTRY, FIRE, AND FUEL MANAGEMENT

TABLES

FIGURES

Section 9
FORESTRY, FIRE, AND FUELS MANAGEMENT

DATA SOURCES

Information used in this section was obtained primarily from the following sources:

- Sierra Nevada Ecosystem Project (SNEP)
- The Biswell Symposium
- National Fire Plan
- Desert Research Institute: Western Regional Climate Center
- Vegetation Management Plan (CDF-VMP), 2001, California Department of Forestry and Fire Protection
- California Fire Plan, 1999, California Department of Forestry and Fire Protection (CDF)
- California Department of Forestry and Fire Protection, Fire and Resource Assessment Program (FRAP)

References included at the end of this section provide other sources of information.

FIRE HISTORY

Fire dominates the California landscape as long as there is vegetation to burn. The state's combination of climate, terrain, and vegetation produces one of the most combustible natural fire environments on earth (CDF 1995). A combination of heavy forest floor fuels and dense sapling thickets acting as ladder fuels coupled with normally dry climate, frequent lightning, and human caused ignitions has resulted in a dramatic increase of severe wildfires.

Fire suppression efforts and resource management activities over the last 100 years increased the fire hazard in many of California's ecosystems. These land management practices resulted in extensive forest areas dominated by dense stands of small trees, predominantly shade-tolerant and fire-sensitive species. The result is a significant increase in volume and continuity of live and dead woody fuels near the forest floor, which provide a ladder for connecting surface fuels with the forest canopy (McKelvey et al 1996). The increased competition for available water and sunlight in these dense stands often weakens or kills trees, increasing fire severity.

Simultaneously, fire exclusion practices allowed brush, juniper, and other non-native species to invade lowland and coniferous communities. The risk of catastrophic fire increased dramatically. At the same time, encroaching developments and increasing property values moved human populations into locations that pose ever-increasing risk of loss. Fire suppression activities shifted the fire regime away from numerous smaller fires toward fewer larger fires under more severe weather conditions. Fire suppression activities and historical forest management practices combined to increase fuel loading in conifer forests and develop stands that are younger and denser with a higher risk to loss by fire (CDF 1995).

Prior to European settlement, reports of the forest and woodlands were described as generally open. By the turn of the century they were altered by intense grazing and associated burning patterns in the late 1800s (McKelvey et al 1996). Current forests, when compared to pre-settlement conditions, are younger and denser with smaller trees in diameter and in general more homogenous (McKelvey et al 1996).

Pre-settlement Fire Management

Changes in climate and fire frequency were likely the two most significant contributors to the development of the watershed ecosystems evident today. The 200 or more years of dry, cool weather preceding the arrival of European man coupled with Native American fire use resulted in many frequent low-intensity fires. The hot, dry summer climate provided suitable weather conditions and fuels for burning. Lightning provided a ready ignition source supplemented by Native Americans who used fire for a variety of purposes. Fires spread until weather conditions or fuels, or both, were no longer suitable. Estimates of prehistoric fires in California suggest that 5.5 percent upward to 13 percent of the state was burned on a yearly basis (Martin and Sapsis 1995).

Native Americans in the Sierra Nevada, especially the Maidu, used fire as a way to clear the understory for several reasons: to ease food-gathering, increase game habitat, and, most importantly, provide suitable plants for basket making (Wagtendonk 1995).

Fire-scar records in tree rings show variable fire-return intervals in pre-settlement times. Median values are consistently less than 20 (and as low as 4) years for the ponderosa pine and mixed conifer zones of the Sierra Nevada. Only one study (in high-elevation red fir) found a median fire-return interval greater than 30 years (see Table 9-1).

Table 9-1
HISTORIC FIRE-RETURN INTERVALS COMPARED WITH TWENTIETH CENTURY PATTERNS

Forest Type	Fire-Return Period (Years)	
	Pre-1900	Twentieth Century
Red fir	26	1,644
Mixed conifer–fir	12	644
Mixed conifer–pine	15	185
Ponderosa pine	11	192
Blue oak	8	78

Pre-settlement fire strongly influenced the structure, composition, and dynamics of most Sierra Nevada ecosystems. Many species and most communities show clear evidence of adaptation to recurrent fire, further demonstrating that fire was a regular and frequent occurrence (from SNEP volume 1, chapter 4). Many plant species found in various Sierra Nevada ecosystems adapted traits that help them survive or reproduce after fire. Some brush and shrubs need fire to stimulate germination. Knobcone pine and giant sequoia have serotinous cones that depend on fire to release seeds while ponderosa pine and Douglas fir developed thick, fire-resistant bark (Skinner and Chang 1996).

The variable nature of pre-settlement fire helped create diverse landscapes and unstable forest conditions. In many areas, frequent surface fires minimized fuel accumulation, keeping understories relatively free of trees and other vegetation that could form fuel ladders to carry fire into the main canopy. The effects of frequent surface fires largely explain the reports and photographs of those early observers who described Northern California forests as typically "open and park-like." However, such descriptions must be tempered by other early observations emphasizing dense, impenetrable stands of brush and young trees.

Almost all scientists agree fire played a significant role in shaping the vegetative patterns and systems of California vegetation. There is a significant divergence of views as to fire frequency and vegetative composition of pre-settlement fire. This difference in point of views centers on the belief that many variations in the return frequencies and fire intensity patterns contributed to the mosaic of vegetation patterns on the landscape today.

A second major point of difference relates to the relative "openness" of forests before the disturbances caused by settlers. Alternative views conclude forest conditions were not largely "open or park-like," in the words of John Muir; rather they were a mix of dark, dense, or thick forests in unknown comparative quantities. Select early accounts support an open parklike forest, but there were many similar accounts that describe forest conditions as dark, dense, or thick. J. Goldsborough Bruff, a Forty-Niner who traveled the western slopes of the Feather River drainage between 1849 and 1851, kept a detailed diary. He clearly distinguished between open and dense forest conditions and recorded the dense condition six times more often than the open. Many other accounts of early explorers (e.g. John C. Fremont, Peter Decker, William Brewer) identify dark or impenetrable forest; the pre-settlement forest was far from a continuum of open, parklike stands. From these records, it seems clear that Northern California forests were a mix of different degrees of openness and an unknown proportion of dark dense nearly impenetrable vegetative cover with variations from north to south and foothill to crest.

A third point of departure concerns the frequency of stand-terminating fires in pre-settlement times. One group concluded that such events were rare or uncommon. The alternative view is that stand-threatening fires were probably frequent. They were heavily dependent upon combinations of prolonged drought, an accumulation of dead material resulting from natural causes (e.g., insect mortality, windthrow, snow breakage); and severe fire weather conditions of low humidity and dry east winds coupled with multiple ignitions, possibly from lightning associated with rainless thunderstorms. Such fires were noted during the last half of the nineteenth century by newspaper accounts, official reports, and diaries. Settlers, stockmen, or miners apparently caused most. Fuel loads were obviously sufficient at that time to strongly suggest that similar conditions existed in earlier times with unknown frequencies (discussion from SNEP volume 1, chapter 4).

Fire-Suppression History

Conservationism, since its beginning with Gifford Pinchot in the late 1890s, promotes fire as the bane of the forest (Williams 1999). The national firestorms of 1910 coupled with research published by USFS personnel, S. B. Show and E. I. Kotok, in 1923 stated repeated light fires in the same area caused progressive damage and discouraged effective regeneration of mixed forests. Both of these factors contributed to the debate over complete fire suppression. Show and Kotok went on to state that while fire helped keep forests open and favorable for mature trees (which was good for logging and grazing) it prevented the forest from becoming a sustainable resource. These aspects led to the passing of the Clarke-McNary Act of 1924, thus cementing the exclusion of fire from national forests. Fire should be suppressed and eliminated to allow the forest to grow and thrive. Through the passing of the Clarke-McNary Act, federal money was offered to state agencies that would comply with suppression doctrine. This ideology of absolute suppression formed the basis of USFS and National Park Service (NPS) policy until the 1960s (Beesley 1996). The understanding that humans influenced ecosystems through the use of fire shifted after European settlement in North America when it was believed that fire should and could be controlled to protect both public and private land (Williams 1999).

Because of the indiscriminate use of fire by sheepherders and miners from approximately 1870 to 1900, the idea of suppression was easily argued.. Their use of fire, along with early logging practices in the northern Tahoe area, resulted in significant environmental damage and furthered the developing case for fire suppression (Beesley 1996). However, extensive damage caused by these factors (Leiberg noted in a study conducted at the turn of the century in what is now the Plumas and Tahoe National Forests) that of the 2.8 million acres burned at least once in the preceding 100 years only 214,000 acres burned severely enough to cause tree mortality. In making this assumption, Leiberg also assumed that most meadows and chaparral fields were fire generated. Even if this assumption is true (which is doubtful), total tree mortality occurred on less than 8 percent of the area burned (McKelvey et al 1996).

At the turn of the century, some settlers began to use “light-burn” as a farm management tool. The USFS experimented with the same theory in the 1910s, much like the research conducted by Show and Kotok, but determined that it was too damaging to young seedlings needed for regeneration (Williams 1999). By 1933, with the advent of the California Conservation Corps (CCC), fire fighting evolved and the suppression of wildfires became a full-time occupation. Thousands were trained to fight fire on public and private lands. The primary fire-related mission of land management agencies was to stop fires whenever possible and prevent large fires from developing (Moore 1974).

By the 1950s, controlled burns to reduce fuels and improve habitat for wildlife became commonplace in much of California rangelands, but all other fires were vigorously controlled. In 1963, Leopold and others published a report on the ecological conditions of the national parks in the United States. As a result, managers and the public began to see the benefit of fires in the wildlands (Lyon et al 2000). Leopold’s report stated that wildlife habitat is not a stable entity that persists unchanged, but rather a dynamic entity in which suitable habitat for many wildlife species and communities must be renewed by fire. By 1968, the fire policy of the NPS began to change as managers began adopting the recommendations of the Leopold Report (Lyon et al 2000).

Today wild fire suppression is a full-time occupation. Many agencies are involved coordinating, controlling, and fighting fire including USFS, BLM, NPS, U.S Fish and Wildlife Service (USFWS), Native American tribes, state forestry departments, and many local fire-fighting agencies.

As agencies and the general public attempt to "protect" the forest from fire, increased levels of fuel loads are setting the stage for larger and more devastating wildfires. In recent years, encroachment of urban development in the Sierra Nevada region raised concerns over protection of land and property in the case of wildfire. As the fuel continues to accumulate on the forest floor, fires will continue to present a very real threat to the loss of property.

In order to return the Sierra Nevada to conditions noted during the early days of settlement, the USFS, NPS, and the CDF, along with local fire agencies and fire-safe councils, work with landowners and timber companies to lessen fire danger and try to return the forest to a cycle of frequent low-intensity fires. Acreage burned through planned prescribed fires disposes of logging and thinning slash; prepares areas for timber or range regeneration; reduces dead and woody fuel, improves wildlife habitat, and decreases the occurrence of catastrophic wildfires.

Wildfire History

Fire was a common influence on the structure and function of California's ecosystem in prehistoric times, with as much as 5.5 to 13 million acres burning annually on average (CDF 1999). During the period of 1987 to 1997, California averaged over 300,000 acres burned by wildfire, second only to Alaska (Lyon et al 2000). As a result, many plants exhibit specific fire-adapted traits such as thick bark and fire-simulated flowering, sprouting, seed release, and germination (McKelvey et al 1996).

The relative impact of topography and spatial variations in fuels on fire behavior depends on weather conditions and fuel moisture. At moderate-to-high fuel moisture, variations in vegetation structure and localized landscape fragmentation (due to past fire history) determine burning patterns. When fuel moisture drops below threshold levels and weather conditions are extreme (such as hot, dry winds), fire behavior can be regulated primarily by larger-scale topographic features (Christensen 1994). Figure 9-1 illustrates the historical fire boundaries of California (CDF 2004).

In the years 1910 through 1950, roughly 15 percent of the watershed area burned. The largest percentage was in the years 1931 through 1940. From 1951 to 2002, the percentage of the watershed burned jumped to 25 percent with the years from 1991 through 2002 resulting in the largest percentage. During that decade, 15 percent of the watershed was burned. Table 9-2 shows the percentages by decades for the years 1910 through 2002 (CDF 2004).

FUEL LOADING AND DISTRIBUTION

Fire behavior is a function of fuels, weather, and topography. Of these components, referred to as the fire triangle, only fuel conditions are influenced by human activity. Fuel parameters important to fire behavior that affect intensity, speed of spread, and behavior include loading, size and shape, compactness, horizontal continuity, vertical continuity, and species.

Table 9-2 ACREAGE BURNED SUMMARY (1910–2002)		
Date	**Total Acres Burned**	**% Watershed Burned**
1910–1920	6,354	2
1921–1930	6,750	2
1931–1940	19,867	7
1941–1950	4,014	1
1951–1960	24,315	8
1961–1970	2,125	1
1971–1980	3,861	1
1981–1990	675	<1
1991–2002	45,282	15
TOTALS	**113,243**	

Fuels

Fuel loading, fuel arrangement, and fuel moisture are key characteristics of fuels that can influence fire behavior. The fire intensity is often dictated by the type and amount of fuel available to burn (NWCG 2001). Fuel loading pertains to the amount of fuel over a given area and is a significant factor in determining the fire behavior. Grass vegetation types, which have a fuel loading significantly lower than heavy timber types, ignite more readily and support fires of more rapid spread; but they generally burn with a lower intensity than fuels with a higher load (Anderson 1982). Fuel arrangement pertains to the compactness and continuity of fuels. Less-compact fuels tend to ignite easier than those that are more compact (NWCG 1994). Fuel continuity describes the distribution of fuels. It is further described by both horizontal and vertical continuity. Horizontal continuity pertains to the amount of ground covered by fuel and the distance between surface fuels. Vertical continuity concerns the spatial relationship between surface fuels and aerial fuels as brush and tree canopy (NWCG 2001).

Fuel moisture is another factor that defines fire behavior as based on fuels in a given vegetation community. Fuel moisture pertains to both live and dead fuels and fluctuates slowly over a season for heavier fuels or drastically over just a few hours for fine fuels. Current weather conditions greatly affect fuel moisture of fine dead fuels such as small twigs and leaf litter; this concept is described in more detail below. Vegetation types also dictate the fluctuation of live fuel moisture based on a plant's physiology. Drier fuels burn more quickly than do fuels with higher moistures (Anderson 1982).

Fuel Ranks

In the mediterranean climate of California, rates for decomposition are slow due to low temperatures during the winter and little to no moisture in the summer months. Rates for decomposition may be greater than in the past due to (1) the twentieth century was warmer and wetter, (2) the generally denser stands during the twentieth centure provided more mesoic microclimates that favor decomposition, and (3) more forest floor biomass is available for decomposition because it has not been removed regularly by fire in the twentieth century (Skinner and Chang 1996). Although decomposition possibly increased, it is at a rate not nearly sufficient to compensate for the increasing fuel load due to logging slash and natural (not produced by management activities) fuels (Skinner and Chang 1996). CDF data on fuel ranks is listed below in Table 9-3.

Table 9-3
SIERRA VALLEY WATERSHED ASSESSMENT FUEL RANKS

Value	Description	Acres
–1	Non-Fuel	100,041.60
1	Moderate	69,209.85
2	High	91,842.21
3	Very High	36,563.40

CDF classified the fire risks within the State Responsibility Areas (SRAs). Figure 9-2 shows the SRAs and the fire risks assigned within the Sierra Valley Watershed. A total of 90,053 acres within the watershed fall under CDF responsibility. Of those acres, 51 percent are classified as "Very High" fire risk and while the remaining acres are listed as "High" fire risk areas.

Weather

The weather in the Sierra Valley Watershed is variable by season and elevation. During the fire risk period of summer, the dominant wind condition is usually from the southwest. These winds carry moisture from the Sacramento River Delta and collide with drier air from the north and northwest creating a breeding ground for thunderstorms. Blue Canyon to the south of the valley is the closest area with thunderstorms. The average number of thunderstorms for the northern Sierra Nevada is 12 days per year, one of the highest recordings in California. These thunderstorms, combined with the dry conditions exist during the summer months exacerbate fire conditions in the forests around the edge of the valley.

Precipitation for the Sierra Valley Watershed, recorded at the Sierraville Ranger Station, is approximately 25 inches per year, with an average of 72 inches of snow. Average temperatures for the area during the summer months are 80ºF with a low of 41ºF. Winter-time highs are around 47ºF with average lows of 18ºF. Low precipitation increases wildfire potential during summer months. (Figure 9-3).

Topography

Topography is a key element to the direction, intensity, and rate of speed of fire. Aspect, steepness of slope, elevation, and shape all contribute to fire behavior once ignited. Surface fires are very dependent on topography and generally move more quickly upslope than downslope and may slow significantly over ridges. The Sierra Valley Watershed encompasses a mix of high alpine valley and timbered lands in the higher elevations surrounding the valley. A fire spreads faster with longer flame lengths as the slope becomes steeper during the climb out of the valley. The fire heats and dries fuel above it causing the fuel to burn. For this reason, fire protection agencies commonly use ridges for fuelbreaks and protection areas.

MANAGEMENT METHODS

Prevention, detection, presuppression, suppression, and fuels management are the five programs in fire protection on high fire risk lands. These activities are carried out under separate federal and state fire policies. The policy for federal and state programs is summarized in this section.

Fire Policy

Federal

Prior to 1996, the Forest Land and Resource Management Plan governed fire and fuel management activities. Changes in the Federal Wildland Fire Management Policy established the National Fire Plan (NFP). After the record-breaking wildfire season of 2000, the president requested a national strategy for preventing the loss of life, natural resources, private property, and livelihoods in the wildland/urban interface. Working with Congress, the secretaries of Agriculture and the Interior jointly developed the NFP to respond to severe wildland fires, reduce their impacts on communities, and assure sufficient firefighting capabilities for the future. The NFP includes five key points:

- Firefighting preparedness
- Rehabilitation and restoration of burned areas
- Reduction of hazardous fuels
- Community assistance
- Accountability

The USFS and the BLM are in the second year of the NFP implementation. Significant headway has been made since 2001 to meet both the intent and specific direction from Congress in the 2001 Interior and Related Agencies Appropriations Act. There are also tracking and reporting mechanisms in place. These mechanisms provide accountability as accomplishments are made in firefighting, rehabilitation, and restoration; hazardous fuels reduction; community assistance; and research.

The NFP is a long-term investment that helps protect communities and natural resources, and, most importantly, the lives of firefighters and the public. It is a long-term commitment based on cooperation and communication among federal agencies, states, local governments, tribes, and interested publics.

In addition to the NFP, the Sierra Nevada Forest Plan Amendment, Record of Decision (ROD) jointly amends the planning documents of 19 national forests to implement conservation measures for late successional stage and old growth forests for the purpose of spotted owl management. The ROD consists of extensive standards and guidelines that comprise “a comprehensive ecosystem management strategy” that replace other federal land management plans. To accomplish this, the ROD divides federal lands into land allocation categories with specific “standards and guidelines” for management of each category. The land allocation associated with fire included the following:

- **Inventoried Roadless Area** “Fuel treatments in inventoried roadless areas may be considered stewardship treatments and therefore permissible under the Roadless Rule.”

- **Old Forest Emphasis Area** "Management in old forest emphasis area is to emphasize protecting the highest quality remaining old forest landscapes, increasing old forest conditions, using prescribed fire to reduce hazardous fuel conditions, and re-introducing fire as an ecosystem process. Mechanical treatments will be avoided in old forest emphasis areas except in areas with (1) air quality concerns, (2) high risk of prescribed fire escapes, (3) excessive surface and ladder fuels, (4) unacceptable risks to old forest characteristics, or (5) prohibitive implementation costs."

- **Wildland Urban Intermix (WUI) Zones** "The highest priority has been given to fuel reduction activities in the wildland urban intermix zone. Fuel reduction treatments protect human communities from wildfires as well as minimize the spread of fires that might originate in urban areas." "Management direction for the wildland urban intermix zones is to: (1) design fuel treatments to provide a buffer between developed areas and wildlands; (2) design and distribute treatments to increase the efficiency of firefighting efforts and reduce risks to firefighters, the public, facilities and structures and natural resources; (3) determine the distribution, schedule, and types of fuel reduction treatments through collaboration with local agencies, air regulators, groups, and individuals; and (4) place the highest density and intensity of treatments in developed areas within the wildland urban intermix zone."

- **Strategically Placed Area Treatments (SPLATs)** These are areas that have been treated to reduce fuel loading. "The treatment areas are placed so that a spreading fire does not have a clear path of untreated fuels from the bottom of the slope to the ridge top." "The SPLAT strategy treats a relatively large proportion of the landscape and this strategy facilitates fire reintroduction."

- **General Forest** "Management direction is to reduce hazardous fuels to effectively modify wildland fire behavior to reduce uncharacteristically severe wildland fire effects; and increase the numbers of large trees and the distribution and connectivity of old forests across landscapes."

"The Amended Forest Plan" (page A-10) applies a strategic approach for locating fuels treatments across broad landscapes. WUI zones have the highest priority for fuel treatments. Fuel treatments for landscape fuel management are designed to limit wildland fire extent, modify fire behavior, and improve ecosystems (USDA 2001).

A WUI zone is an area where human habitation is mixed with areas of flammable wildland vegetation. In order to protect human communities from wildland fires and minimize the spread of fires that might originate in the WUI zone. The highest priority is given to fuel reduction treatment activities within the WUI zone. A WUI zone contains an "inner defense zone" that is located within a quarter mile from the inner defense zone outward for 1.25 miles. Fuels are treated less intensively within the threat zone than in the inner defense zone.

The desired condition for the WUI zone is one that fuel conditions allow for safe and efficient suppression of all wildland fires. Fires are controlled through initial attack under all but the most severe weather conditions. Under high weather conditions, wildland fire behavior in treated areas is characterized as follows:

- Flame lengths at the head of the fire are less than 4 feet

- The rate of spread at the head of the fire is reduced to at least 50 percent of pre-treatment level for a minimum of five years

- Hazards to firefighters reduced by keeping snag levels to two per acre and production rates for fireline construction are doubled from pretreatment levels

- Tree density has been reduced to a level consistent with the site's ability to sustain forest health during drought conditions

In general, landscape-level fuel treatment strategies are designed to limit wildland fire extent, modify fire behavior, and improve ecosystems. These strategies allow fire managers to control fires and set priorities that protect firefighters, the public, property, and natural resources. SPLATs are one of these strategies. SPLATs are blocks of land ranging from 50 to 1,000 acres where vegetation is modified to reduce fuel loading. The spatial pattern of treated areas reduces the rates at which fires spread and intensify at the head of the fire. The SPLAT strategy treats a relatively large portion of the landscape that facilitates fire reintroduction. SPLATs are designed to burn at lower intensities and slower rates of spread during wildfires than comparable untreated areas. Wildfires are expected to have lighter impacts and be less damaging in treated areas.

The desired future condition is embodied in the Sierra Nevada Forest Plan mission and goals, forest standards and guidelines, management prescriptions, and land allocation area direction. The desired condition results in integrating fuels objectives with other natural resource objectives that address the role of fire as well as maintaining a level of resource protection commensurate with values.

Fuel management strategies are designed to reintroduce fire, reduce fuels, and mitigate the consequences of large damaging fires. In general, such landscape-level treatment is designed to limit fire extent, modify fire behavior, and improve ecosystems.

Throughout the forest, a strategic approach for fuel treatment is used. Priority for fuel treatment is the areas of urban intermix, old forest emphasis, and general forest. Primary strategies to use include a combination of treatments in strategically placed locations, wildland fire use, defensible fuel profile zones (DFPZs), and priority-setting mechanisms established in the National Fire Strategy. The ROD provides further Standards and Guidelines for fuel treatments. The following discussions display applicable direction from these plans.

Wildland urban intermix zones are designed to protect human communities from wildland fires as well as minimize the spread of fires that might originate in urban areas. The management objective in the wildland urban intermix is to enhance fire suppression capabilities by modifying fire behavior inside the zone and provide a safe and effective area for possible future suppression activity. The intent here is to provide a buffer between developed areas and wildlands. The intermix zones are broken into two categories with differing treatment standards:

- ***Defense Zone*** This is a quarter mile buffer zone around the urban development itself. In this zone where canopy cover is less than 40 percent, desired flame lengths are under 4 feet, crown bulk densities are at 0.05 kg/m^2, and live crown base are at an average of

15 feet high. Snag levels are kept under two snags/acre for firefighter safety. The predicted rate of spread of the fire is 50 percent of pretreatment levels and line construction accomplishment rates are doubled.

- ***Threat Zone*** This is a 1.25-mile buffer zone beyond the defense zone. In this zone where canopy cover is less than 40 percent, desired flame lengths are under 6 feet with crown bulk densities and live crown base levels the same as the defense zone.

The desired condition is to provide for efficient and safe suppression of all wildland fire starts in the hopes of controlling them under even the most severe weather conditions. These zones include not only the sites themselves but also the continuous slopes and fuels that lead directly to the urban sites in need of protection. This requires modification of the fuel profile around them.

Land management objectives for both of these allocations are to focus treatment priorities on areas of high hazard and high risk. Primary locations for treatment of fuels are in lower elevations that are pine/mixed conifer dominant, typified in eastside pine, which are low-intensity regimes historically. Also of prime concern is the upper two-thirds of slopes with south and west aspects as these areas typically burn more often due to exposure and slope. Desired conditions are 75 percent of the area has flame lengths less than 6 feet during weather variables described as 90th percentile conditions. While this flame length is only recommended for old forest emphasis areas, it will apply to general forest as a regionally recognized acceptable fire behavior measurement level.

State

The State Board of Forestry and the CDF drafted a comprehensive update of the fire plan for wildland fire protection in California. The planning process defines a level of service measurement, considers assets at risk, incorporates the cooperative interdependent relationships of wildland fire protection providers, provides for public stakeholder involvement, and creates a fiscal framework for policy analysis.

The overall goal is to reduce total costs and losses from wildland fire in California by protecting assets at risk through focused pre-fire management prescriptions and increasing initial attack success.

The California Fire Plan has five strategic objectives:

- To create wildfire protection zones that reduce the risk to citizens and firefighters.

- To assess all wildlands, not just the SRAs. Analysis will include all wildland fire service providers—federal, state, local government, and private. The analysis will identify high-risk, high-value areas, and develop information on and determine who is responsible, responding, and paying for wildland fire emergencies.

- To identify and analyze key policy issues and develop recommendations for changes in public policy. Analysis will include alternatives to reduce total costs and losses by increasing fire protection system effectiveness.

- To have a strong fiscal policy focus and monitor the wildland fire protection system in fiscal terms. This will include all public and private expenditures and economic losses.

- To translate the analyses into public policies.

Four major components form the basis of an ongoing fire planning process to monitor and assess California's wildland fire environment:

- **Wildfire protection zones** A key product of this fire plan is the development of wildfire safety zones to reduce citizen and firefighter risks from future large wildfires.

- **Initial attack success** The fire plan defines an assessment process for measuring the level of service provided by the fire protection system for wildland fire. This measure is used to assess the department's ability to provide an equal level of protection to lands of similar type, as required by Public Resources Code 4130. This measurement is the percentage of fires successfully controlled before unacceptable costs are incurred. Knowledge of the level of service will help define the risk to wildfire damage faced by public and private assets in the wildlands.

- **Assets protected** The plan will establish a methodology for defining assets protected and their degree of risk from wildfire. The assets addressed in the plan are citizen and firefighter safety, watersheds and water, timber, wildlife and habitat (including rare and endangered species), unique areas (scenic, cultural, and historic), recreation, structures, and air quality. Stakeholders (national, state, local, a private agencies, interest groups, etc.) will be identified for each asset at risk. The assessment defines areas where assets are at risk from wildfire, enabling fire service managers and stakeholders to set priorities for pre-fire management project work.

- **Fiscal framework** The Board of Forestry and CDF are developing a fiscal framework for assessing and monitoring annual and long-term changes in California's wildland fire protection systems. State, local, and federal wildland fire protection agencies, along with the private sector, evolved into an interdependent system of prefire management and suppression forces. As a result, a change to budgeted levels of service of any of the entities directly affects the others and services delivered to the public. Monitoring system changes through this fiscal framework allow the Board and CDF to address public policy issues that maximize the efficiency of local, state, and federal firefighting resources.

Fire Management Tools

In addition to the suppression of fire, many other tools are available to resource managers to reduce wildfire risk and impact.

Defensible Fuel Profile Zones (DFPZs)

DFPZs are strategically located lineal fuel reduction and fire protection areas generally constructed a quarter mile wide along public and private roads that traverse communities, watersheds, and areas of special concern. Within the DFPZ, the hazardous surface, ladder, and canopy fuels are mechanically reduced to historical levels that allow firefighters quicker and safer access to the DFPZ for attacking and suppressing oncoming wildfires. The lineal connectivity of the DFPZ network allows various property owners within a watershed the opportunity to connect fuel reduction projects to adjoining properties through local county fire safe councils. The DFPZ network is the starting point for addressing the scale of the existing hazardous fuel problem at the appropriate pace of annual acres treated.

DFPZ fuel reduction treatments should be designed to address the specific local issues. Examples include establishing a community defense zone, breaking up areas of continuous high-hazard fuels, or designating a strip or block of land to form a zone of defensible space where both live and dead fuels are reduced, also referred to as shaded fuel breaks. Such DFPZs are best initially placed primarily on ridges and upper south and west slopes and along existing roads where possible. They also should be located with respect to urban-wildland intermix and other high-value areas (such as old-growth or wildlife habitat areas), areas of high historical fire occurrence, and/or areas of heavy fuel concentration. Thinning from below and treatment of surface fuels can result in fairly open stands dominated mostly by larger trees of fire-tolerant species. DFPZ locations and national forest boundaries in the Sierra Valley Watershed are shown in Figure 9-4 (USFS 2004).

DFPZs need not be uniform monotonous areas, but should encompass considerable diversity in age, size, and distribution of trees. The key feature should be the general openness and discontinuity of crown fuels, both horizontally and vertically, producing a very low probability of sustained crown fire.

DFPZs should offer multiple benefits by providing not only local protection to treated areas (as with any fuel-management treatment) but also safe zones within which firefighters improve the odds of stopping a fire; interruption of the continuity of hazardous fuels across a landscape; and various benefits not related to fire, including improved forest health, greater landscape diversity, and increased availability of relatively open forest habitats dominated by large trees.

Wildland Urban Intermix (WUI) Zones

WUI zones are areas where human habitation is mixed with areas of flammable wildland vegetation. They extend out from the edge of developed private land into federal, private, and state jurisdictions. The WUI zones comprise two zones: the defense zone and the threat zone (USFS 2004). WUI zones within the watershed are shown in Figure 9-5. Approximately 3,500 acres within the watershed are designated defense zones. Approximately 2,000 acres are designated threat zones.

The WUI defense zone is the buffer in closest proximity to communities, areas with higher densities of residences, commercial buildings, and administrative sites with facilities. Defense zones generally extend one-quarter mile out from these areas; however, actual defense zone boundaries are determined at the project level following national, regional, and forest policy. In particular, the Healthy Forest Restoration Act of 2003 identifies areas to be included in the WUI zone Local fire management specialists determine the extent, treatment orientation, and prescriptions for the WUI zone based on historical fire spread and intensity, historical weather patterns, topography, and access. Defense zones should extend sufficiently so that fuel treatments within them will reduce wildland fire spread and intensity sufficiently for suppression forces to succeed in protecting human life and property (USFS 2004).

The WUI threat zone typically buffers the defense zone. However, a threat zone may be delineated in the absence of a defense zone under certain conditions, including situations where the structure density and location do not provide a reasonable opportunity for direct suppression on public land, but suppression on the private land would be enhanced by fire behavior modification on the adjacent public land (USFS 2004). Threat zone boundaries are determined at the project level following national, regional and forest policy. Threat zones generally extend approximately 1.25 miles out from the defense zone boundary. Actual extents of threat zones are based on fire history, local fuel conditions, weather, topography, existing and proposed fuel treatments, and natural barriers to fire. Fuels treatments in these zones are designed to reduce wildfire spread and intensity. Strategic landscape features, such as roads, changes in fuels types, and topography may be used in delineating the physical boundary of the threat zone (USFS 2004).

Prescribed Fire

Prescribed fire is the controlled application of fire to accomplish specific land management goals. These goals can vary from annual burning around residences to clear grass and weeds; agricultural field burning for preparation of crop planting, burning of brush piles, and landscape burning of forest to remove brush and accumulation of forest fuel. Forestlands can benefit from prescribed fire by attempting to regulate or moderate the frequency and intensity of wildfires. The advantages of using fire and improvement cuttings to restore and maintain seral fire-resistant species include

- Resistance to insect and disease epidemics and severe wildfire
- Continual forest cover for aesthetics and wildlife habitat
- Frequent harvests for timber products
- Stimulation of forage species
- Moderate site disturbance that allow for tree regeneration

By returning to regular burning, we provide forests with a measure of protection from catastrophic loss by reducing the amounts and concentration of brush and other forest fuels.

Historical land-use changes in the watershed make a return to the pre-historical fire regime infeasible. Not only are structures, infrastructures, and managed forest at risk of fire damage too expensive to permit burning at the pre-settlement rate, but regulatory constraints and social costs of fire ands its effects (e.g., low air quality) also prohibit burning at pre-European scales (SAF 1997). Although fire will remain an essential element of these wildland ecosystems, it must be controlled and used in conjunction with other techniques to reduce fuel loads to levels consistent with maintaining healthy forests (McKelvey et al 1996).

Mechanical fuel management reduces fire hazard. Recent studies of the behavior of fires immediately following harvesting found that harvesting or biomass fuel reduction with slash and landscape treatments followed by prescribed burning produced fuel structures that minimize average fire intensities, heat per unit area, rate of spread, area burned, and scorched heights. In contrast, sanitation-salvage harvest without biomass reduction and just lopping and scattering of slash resulted in higher fire intensities. The latter treatments probably result in less-severe fires relative to untreated stands, especially after sufficient time passed to allow the slash to decompose (SAF 1997). In addition, wildfires that burn into areas where fuels are reduced by prescribed burning cause less damage and are much easier to control.

Prescribed fire is also an effective tool for managing fuels. In most forested areas, however, fuel structures are currently too hazardous to safely attempt prescribed ignitions without pre-treating the stand mechanically. Planned nonsuppression fires are fires resulting from unplanned ignitions (caused by either lightning or humans) in areas for which prescribed natural fire plans are adopted specifying conditions under which such fires will be allowed to burn. Following specific fire management activities, prescribed natural fire planning represents an important opportunity to have wildfire help meet watershed management objectives.

A key element to fuel management planning is the initiation of market uses for small trees and biomass removed from wildlands under fuels management programs.

The intensity and temperature of most prescribed fire scenarios are significantly less than catastrophic wildfire and produce positive rather than negative ecosystem impacts. Benefits of prescribed fire include

- ***Reduction of fuel buildup*** of dead wood, overcrowded and unhealthy trees, and thick layers of pine needles and ground vegetation that contribute to larger, high intensity, uncontrollable fires.

- ***Thinning of overcrowded forests*** by fire. These forests are generally healthier and more vigorous and recover faster and more resistant to insect and disease attacks.

- ***Preparation of the site for new growth*** by removing excess vegetation. As the excess vegetation is burned, nitrogen and other nutrients are released making soil receptive for new plants to grow and allowing conifer seeds to germinate. Additionally, some forms of conifers and brush (knobcone pine, lodgepole pine manzanita, deer brush) rely on frequent fire for germination of seeds and new growth development.

- ***Creation of diverse vegetation for wildfire*** by having varying ages and type of plants available for animals to forage on and find shelter in. Wildlife that graze (deer, elk) benefit from new growth as young plants provide more nutrients. Fire creates more open stands that allow predators to be seen and down wood for small mammals and insects.

- ***Increase in water and spring yield*** by removing encroaching chaparral and shade tolerant species and decreasing evapotranspiration. Increases occur in local springs and groundwater discharge to creeks. Significant increased flows are common after fires. Spring yield may increase as much as 200 percent.

- ***Increase in nutrients*** such as phosphorus, potassium, calcium, and magnesium in the ash deposits.

Within the Plumas National Forest, the build-up of highly combustible timber stands made the widespread use of prescribed fire unwise. The first action taken was an aggressive salvage action to remove the rapidly accumulating fuels. Salvage operations could not remove all of the dead and dying material and in many areas less than 30 percent of the boles could be removed. Starting in 1991, the USFS began to slowly reintroduce fire to the ecosystems. By 1995, over 2,000 acres burned. The goal is a target of 3,000 to 5,000 acres burned per year (Hurley 1995). From 1995 to 2003, the USFS in Plumas National Forest has used prescribed burns for 27,000 acres for an average of 3,000 acres per year (USFS 2004).

California Vegetation Management Plan (CVMP)
The CVMP is a cost-sharing program focusing on the use of prescribed fire and mechanical means for addressing wildland fire fuel hazards and other resource management issues on SRA lands. The use of prescribed fire mimics natural processes, restores fire to its historical role in wildland ecosystems, and provides significant fire hazard reduction benefits that enhance public and firefighter safety. The goals of this program are to

- Reduce fuel accumulations
- Prepare seedbeds
- Control competition vegetation
- Improve production of grazing and forest lands
- Manage wildlife habitat
- Thin young trees
- Control pests and disease
- Increase water yield
- Improve fish habitat
- Improve air quality
- Protect irreplaceable soil resources

CVMP allows private landowners to enter into a contract with CDF to use prescribed fire to accomplish a combination of management goals on both forestlands and grasslands. Since 1981, approximately 500,000 acres (an average of 31,000 acres per year) were treated with prescribed fire under CVMP in California. Cost of the prescribed burning averages $25 to $30 per acre but can vary based on the number of acres and resources necessary for the prescribed fire project. This cost-sharing program includes the landowner paying approximately 25 to 30 percent of the total project costs.

ISSUES

Before widespread decisions on ecosystem health can be administered, there are certain issues to consider. These include compliance with USFS policy, the National Environmental Protection Act (NEPA), the California Environmental Quality Act (CEQA), and other state and federal regulations. Communities near areas of high wildland fire risk need to be educated in the risks associated with these areas as well as the precautions that should be taken to ensure against the loss of property and life.

Wildlife

Assessing the economic implication of fire on wildlife without a recognized valuation technique makes quantification problematic. However, wildlife can be generally expressed in terms of the value of a consumptive use (i.e., hunting) or nonconsumptive use (viewing, bird watching). Loss of revenue can be seen in hotels, restaurants, gasoline stations, and grocery stores due to wildland fires and patrons not visiting the area.

The major impact of wildfire on wildlife centers is its influence on vegetation structure and composition. The loss of down and dead woody material during wild and prescribed burns removes essential structural habitat components for a variety of wildlife and reduces species diversity. Loss of brushfields and forestlands restrict the ability of wildlife to forage for food and find shelter. Fire has the potential to accentuate impacts to fish and wildlife associated with other landscape fragmentation and development (timber harvesting, road building, forest management practices). For fish, the primary concerns relative to fire are increases in water temperature, sediment loading, stream cover, and the long-term loss of woody debris from stream channels. This vegetation also decreases the rate of erosion along stream banks.

Change in species composition from intense wildfire favor early successional habitat and its assorted wildlife populations. Significant increase in browsing species population (such as deer) is common following severe fire. Physical movement of animals is also enhanced after wildfire. In chaparral, mountain lions are attracted to the edges of the burned area where deer tend to congregate (Lyon et al 2000). Low-intensity fires do not generally result in significant changes to vegetation composition and resulting wildlife species but have similar benefit by increasing the diversity of vegetation mosaics providing better food and cover border areas.

Bird populations respond to changes in food, cover, and nesting caused by fire. Fire effects on insect and plant-eating bird populations depend on alterations in food and cover. Some species of birds increase in numbers after a fire, such as the swallow, swifts, and flycatchers, allowing greater access to forage. Several species, such as the California gnatcatcher, require structure and cover provided by mature scrub (Lyon et al 2000). For many species, forage increases following a controlled burn. Bird nest site selection, territory establishment, and nesting success are affected by season of fire. Spring burns destroy active nests (Lyon et al 2000).

Direct effects on wildlife population due to wildfires vary depending on body size, mobility of the species, and intensity of the fire. Most animals retreat from wildfires, but some (insectivorous birds, raptors) are attracted to take advantage of available prey (Lyon et al 2000). Large-mammal mortality is higher when fire fronts are wide and fast moving, fires are actively crowning, and thick ground smoke occurs (USFS 2000). Although few studies have been conducted, it is believed that losses of wildlife due to fire are negligible. The large fires of 1988 in the Greater Yellowstone Area killed about 1 percent of the elk population and most of the larger animals died of smoke inhalation (Lyon et al 2000). Like birds, spring fires may impact mammal population due to limited ability of offspring, cover, and the availability of food. Carnivores and omnivores are opportunistic species and although little increase in species occurs, they tend to thrive in areas where their preferred prey or forage is most plentiful, often in recent burn areas (Lyon et al 2000).

Indirect effects on the wildlife population come in the form of preference of certain forest structural attributes characteristic of plant communities indirectly lost through habitat modification. For example, a major concern is fire risk to preferred habitat of the California spotted owl (CDF 1995).

Erosion

The increase of river sediment in rivers is one of the most dramatic responses associated with fire. Loss of ground cover, such as needles and small branches, and the chemical transformation of burned soils make watersheds more susceptible to erosion from precipitation events. Depending upon the amount of precipitation, runoff where at least 75 percent of the vegetation is removed can increase discharge to the basin ranging from 0.1 to 0.8 acre-foot per acre of burned forest. Additional sediment storage can alter a stream's form and function in a deleterious manner. Studies in the Stanislaus National Forest indicate large, intense fires produce an average of 20 to 50 tons per acre per year of erosion for the first two years (CDF 1995).

Sediment transported into local waterways after a precipitation event following a wildfire can be detrimental to aquatic organisms and many fish species. After the rivers and streams settle, sediment fills voids in the streambeds eliminating essential habitat, covering food sources, and spawning sites and smothering bottom-dwelling organisms. Sediment deposition reduces the capacity of stream channels to carry water and reservoirs to hold water. This decreased flow and storage capacity leads to an increase in flooding and decreased water supplies. Sediment entering the stream channels from increased runoff deposits on spawning gravel preventing the emergence of fry and the deposition of eggs. Sediment fills pools, widening and flattening the stream channel removing summer and winter rearing habitat for small fish.

An increase in suspended sediment results in an increase of turbidity, limiting the depth to which light penetrates and adversely affects aquatic vegetation photosynthesis. Suspended sediments damages the gills of some fish species, causing them to suffocate, and limit the ability of sight-feeding fish to find and obtain food. Immediate effects are those that arise directly from the fire, such as changes in water chemistry due to ash deposition and abrupt changes in food quality. In certain instances where severe burns have occurred, elevated levels of manganese and phosphates were detected in surface water up to two years after fires. Changes in water quality due to wildfire are thought to be minimal and short-lived. In some cases increases in ions or pH following fire can cause fish mortality. Large woody debris jams will likely increase postfire because of fire-killed snags, but new recruitment of debris will be reduced in subsequent years. In addition, retention of woody debris (which create pools and habitat for fish) can be decreased postfire because of increased flow.

Turbid waters have higher temperatures and lower dissolved oxygen concentrations. A decrease in dissolved oxygen levels can kill aquatic vegetation, fish, and other aquatic organisms. Increases (or decreases) in water temperature outside the tolerance limits is detrimental to aquatic organisms, especially cold-water fish such as trout and salmon (Brown et al 2000).

Large, intense fires have a much greater effect on stream ecology than smaller, less-intense fires. In addition, the size of the watershed burned and the proportion of the burned area within the watershed will also influence the effects of the fire on stream ecology. Tree removal reduces evapotranspiration, which increases water availability to stream systems. Increased stream flows can scour channels, erode stream banks, increase sedimentation, and increase peak flows. Hoyt and Troxell first documented the effects of wildfire on stream flow in 1932. They found that burning chaparral caused the average annual stream flow of Fish Creek, in California, to increase 29 percent. In addition, they found that peak discharges and sediment loads carried by the streams also increased.

Maintenance

Throughout California there are many local organizations working with federal and state agencies to acquire grants for fuel reductions in wildland-urban intermix zones. In the Sierra Valley area, the Sierra County Fire Safe Council, the Plumas Fire Safe Council and the Sierra Valley Resource Conservation District are taking the initiative to educate local land and homeowners on the benefits of fuel reduction and fire-safe landscaping. Fire safe councils are an outgrowth of the National Fire

Policy Firewise Program. Most are funded through the National Fire Policy grant funds to initiate and develop community based outreach and education programs. By providing monetary and labor support, the Council has helped bridge the gap between communities and the surrounding national forests.

The implementation and maintenance of fuel reduction is expensive and in some areas is impeded by the knowledge and understanding of fire behavior among residents of wildland-urban intermix areas. A survey of residents of a wildland-urban intermix neighborhoods in the Sierra-Cascade foothills near Shingletown and Paradise, California, conducted by Prof. Ronald W. Hodgson, found that while four out of five residents believed that defensible space would help save their property in the event of a wildfire, nearly one-third felt that the upkeep would be harder to maintain than their current landscaping and one in ten felt that it would require more work then their current yards. Hodgson concluded that defensible space has no labor-saving advantage to make it more attractive to wildland-urban intermix residents (Hodgson 1995).

Costs

The reluctance of some homeowners in wildland-urban intermix areas to adopt fire-safe practices is due to a perception of high costs. These costs are minimal when compared to the growing cost of fire suppression over the past 10 years as urban areas encroach upon wildland areas of high fire risk. As costs to fight fire increase, budget cuts are made by state and federal agencies as a way to absorb the additional expenses. For example, the USFS recently made policy changes on the management of its emergency firefighting funds, reduced its initial attack fire suppression budget, and reduced budgets for other resource management programs. To deal with these changes, the USFS proposed to cut engine staffing from five firefighters to three and to staff the engines five days a week instead of seven. Staff reductions in resource management programs mean fewer trained employees available for management positions on large fires.

According to the National Interagency Fire Center's Website, the estimated cost of fire suppression in 2002 for federal agencies was $1.6 billion for 6,937,584 acres, or roughly $231 per acre. Comparatively, in 1999 federal agencies treated 2,240,105 acres with prescribed burns for a cost of $99,104,000 or $44 per acre (NIFC 2004). In 1992, the nation's largest wildland fire loss was the Cleveland Fire in the Eldorado National Forest. For a 24,500-acre fire, the final cost per acre was approximately $10,683.

In 1989, the Layman Fire in the Plumas National Forest burned over 5,800 acres, most of which burned in the first five hours. The estimated cost of suppression, rehabilitation, and reforestation was $8 million approximately. About 30 percent of the area burned was too degraded to replant (Hurley 1995). Local and federal organizations hope that growing costs of suppression will spur taxpayers toward better fuel management programs. These organizations believe that initial costs of these programs will, in the long run, prove to be less expensive than suppression efforts and rehabilitation.

Aesthetics

Another factor for land and homeowner reluctance to take part in fuel management treatments is the concern that different treatments will affect property value, view, and personal comfort. The implementation of fuel management programs requires continuous public education regarding the benefits and limitations of fuel management (Pierpont 1995). Agencies must also take into consideration the community concerns (such as sensitivity to smoke incidents); the risk that prescribed burns could pose to structures; and local environmental issues like erosion, air, and water quality.

TIMBER MANAGEMENT CONSIDERATIONS

Timberland loss can be significant during wildfire. The most noticeable direct effect is loss of timber and its economic value. Catastrophic stand-replacing fires tend to remove much usable wood fiber from the landscape due to the intense fire conditions. Any remaining timber is generally of low quality and value, scattered over the fire area, and has a reduced economic value. Reforestation efforts are expensive and time consuming, generally in excess of $500 per acre. The resulting forests require periods of intensive management with no economic return for up to 60 years. Indirect effects of fire include loss in soil productivity; changed forest successional characteristics; reduced forest health; and increased risk of insect and disease infestation. In recent years, thinning dense stands of the younger and smaller understory trees has become an alternative to full-scale logging as environmental pressures intensified and technological advancements in wood manufacturing provide more uses for smaller diameter timber. Recent legislation known as the Quincy Library Group (HFQLG) implemented thinning, DFPZs, and group selection as components in maintaining a healthy and fire-safe forest. The HGQLG affects 1.5 million acres of national forest, some of which is within the Sierra Valley Watershed.

While cuttings are effective in breaking up the continuity of live fuels in lower canopy layers and in pretreating a stand to facilitate the introduction of prescribed fire, cuttings can add fuels and otherwise increase wildfire hazards. Also, small trees damaged by harvest activities and not removed from the forest often add to the fuel load. This component of the total fuel complex tends to increase the probability of a more intense, more damaging, and perhaps more extensive wildfire. These fire "surrogates" are not the total answer to the problem of how to deal with increased stand density yet neither are prescribed or controlled fires. The current fuel load in many areas is prohibitive to justify the use of fire as a way to return forests to their presuppression density levels. Currently, there is no universal answer to the problem of fuel density that plagues the Sierra Nevada (Skinner and Chang 1996).

REFERENCES

Anderson, H.E. 1982. *Aids to determining fuel models for estimating fire behavior*. Ogden, Utah: USDA Forest Service, Intermountain Forest and Range Experiment Station, Gen. Tech. Rpt. INT-122.

Beesley, David. 1996. *Status of the Sierra Nevada. Vol II. Reconstructing the landscape: An environmental history, 1820-1960.* In: *Assessments and scientific basis for management options.* Davis: University of California, Davis Wildland Resources Center Report No. 37.

Brown, James K. and Jane Kapler Smith (editors). 2000. *Wildland fire in ecosystems: Effects of fire on flora.* General Technical Report RMRS-GTR-42 Vol. 2. Ogden: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

CDF (California Department of Forestry and Fire Protection). 1999. *California fire plan.* Sacramento: State of California.

——. 1995. *Fire management for California ecosystems.* Sacramento: State of California.

——. 2004. Data. *Fire and resource assessment program* [online]. Sacramento: Fire and Resource Assessment Program, California Department of Forestry and Fire, 2003 [cited December 2003]. Available from the World Wide Web: http://frap.cdf.ca.gov/data/frapgisdata/select.asp

Christensen, Norman L. 1994. *The role of fire in Mediterranean type ecosystem: The effects of fire on physical and chemical properties of soils in Mediterranean-climate shrublands.* New York.

Hodgson, Ronald W. 1995. *The Biswell symposium: Fire issues and solutions in urban interface and wildland ecosystems, strategies for and barriers to public adoption of fire safe behavior.* Albany: Pacific Southwest Research Station.

Hurley, Jerry. 1995. *The Biswell symposium: Fire issues and solutions in urban interface and wildland ecosystems, panel discussion: Prescribed burning in the 21st century.* Albany: Pacific Southwest Research Station.

Lyon, Jack L., James K. Brown, Mark H. Huff, Jane Kapler Smith. 2000. *Wildland fire in ecosystems: Effects of fire on fauna.* Missoula: United States Department of Agriculture Rocky Mountain Research Station.

Martin, Robert E. and David B. Sapsis. 1995. *The Biswell symposium: Fire issues and solutions in urban interface and wildland ecosystems: A synopsis of large or disastrous wildland fires.* Albany: Pacific Southwest Research Station.

McKelvey, K.S., et al 1996. *Status of the Sierra Nevada, Vol II. In: Assessments and scientific basis for management options.* Wildland Resources Center Report No. 37. Davis: University of California.

Moore, W. R. 1974. From fire control to management. *Western Wildlands* Vol. I.

NIFC (National Interagency Fire Center). 2004. *Fire statistics, prescribed fire acreage, and cost.* [Cited 2004]. Available from the World Wide Web: http://www.nifc.gov/stats/prescribedfirestats.html and http://www.nifc.gov/fireinfo

NWCG (National Wildfire Coordinating Group). 2001. *National wildlife coordinating group, fire use working team.* [Cited September 11, 2003]. Available from World Wide Web: http://fire.r9.fws.gov/ifcc/monitor/EFGuide/index.htm

——. 1994. *Intermediate wildland fire behavior, S-290.* Pub NFES 2378.

Pierpont, Donald A. 1995. *The Biswell symposium: fire issues and solutions in urban interface and wildland ecosystems, panel discussion: Prescribed fire: Why aren't we doing more?* Albany: Pacific Southwest Research Station.

Skinner, Carl N. and Chi-ru Chang. 1996. *Status of the Sierra Nevada. Vol II. Fire regimes: Past and present.* In: *Assessments and scientific basis for management options.* Wildland Resources Center Report No. 37. University of California, Davis.

SAF (Society of American Foresters). 1997. *Need for expanded wildland fuel management in California.*

USDA (United States Department of Agriculture). 2001. *South Warner Wilderness fire management plan and Warner Mountain rangeland project.* Pacific Southwest Region, Modoc National Forest, Warner Mountain Ranger District.

USFS (United States Forest Service). 2004. R*ecord of decision: Sierra Nevada forest plan amendment: Final supplemental environmental impact statement.*

——. 2000. *Effects of fire in the northern Great Plains, effects of burning on livestock.*

Wagtendonk, Jan W. van. 1995. *The Biswell symposium: fire issues and solutions in urban interface and wildland ecosystems, Dr. Biswell's influence on the development of prescribed burning in California*. Albany: Pacific Southwest Research Station.

Weatherspoon, C.P. 1996. *Status of the Sierra Nevada. Vol II. Fire-silviculture relationships in Sierra Forests.* In: *Asessments and scientific basis for management options.* Wildland Resources Center Report No. 37. University of California, Davis.

Williams, Gerald W. 1999. *Aboriginal use of fire: Are there any "natural" plant communities.* Washington, D.C: United States Department of Agriculture National Office, Washington D.C.

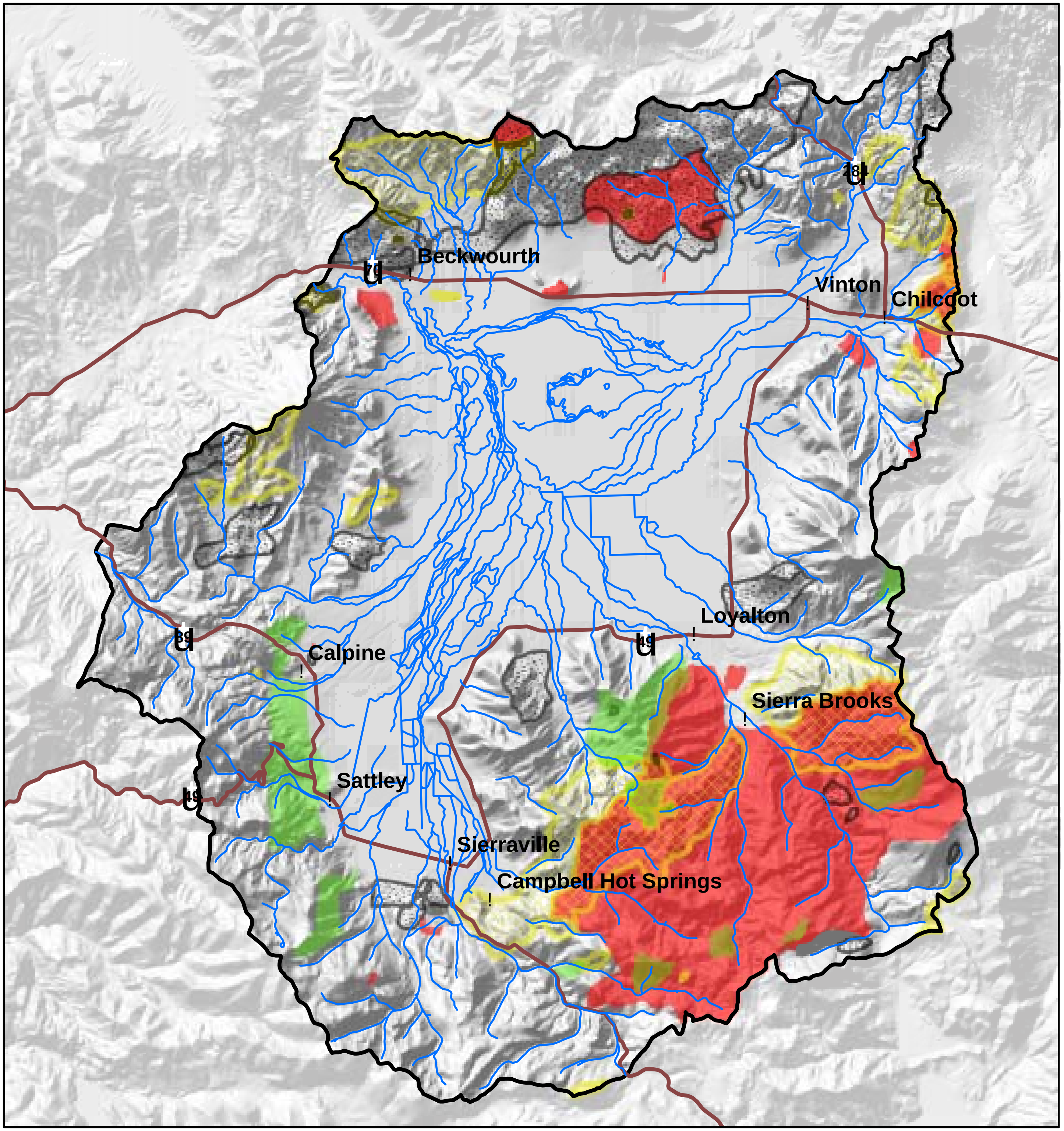


Figure 9-1
Fire History: 1910 - 2001
Sierra Valley Watershed

Legend

- Rivers and Streams
- State Highways
- Sierra Valley Watershed
- 1910 - 1925
- 1926 - 1950
- 1951 - 1975
- 1976 - 2001

SOURCE: CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION AND USFS FIRE AND RESOURCE ASSESSMENT PROGRAM

0 1.25 2.5 5 Miles

VESTRA

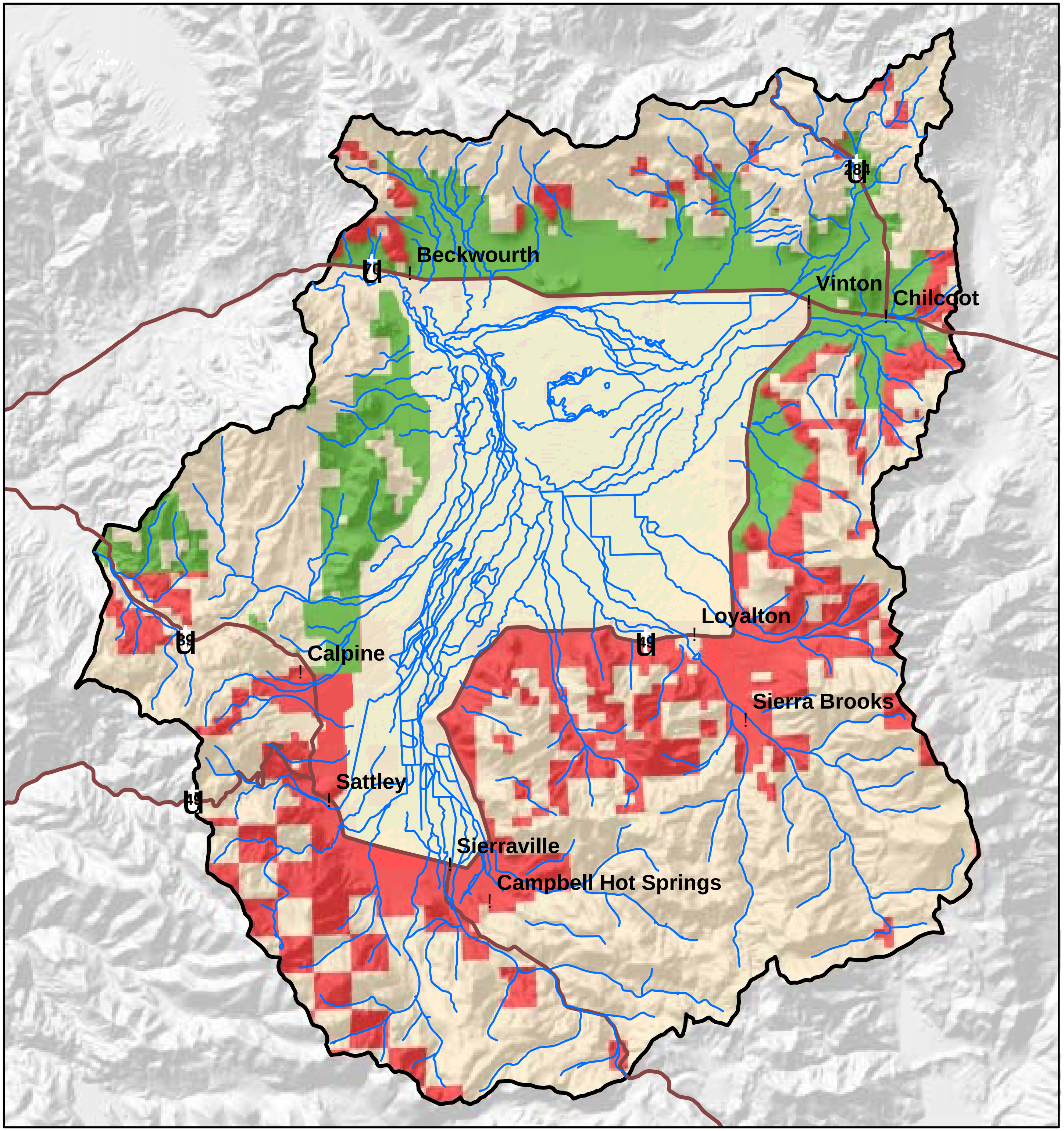


Figure 9-2
Fire Severity Zones
Sierra Valley Watershed

Legend

- Rivers and Streams
- Sierra Valley Watershed
- State Highways
- Very High
- High
- Not State Responsibility

SOURCE: CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION, FIRE AND RESOURCE ASSESSMENT PROGRAM

0 1.25 2.5 5 Miles

VESTRA

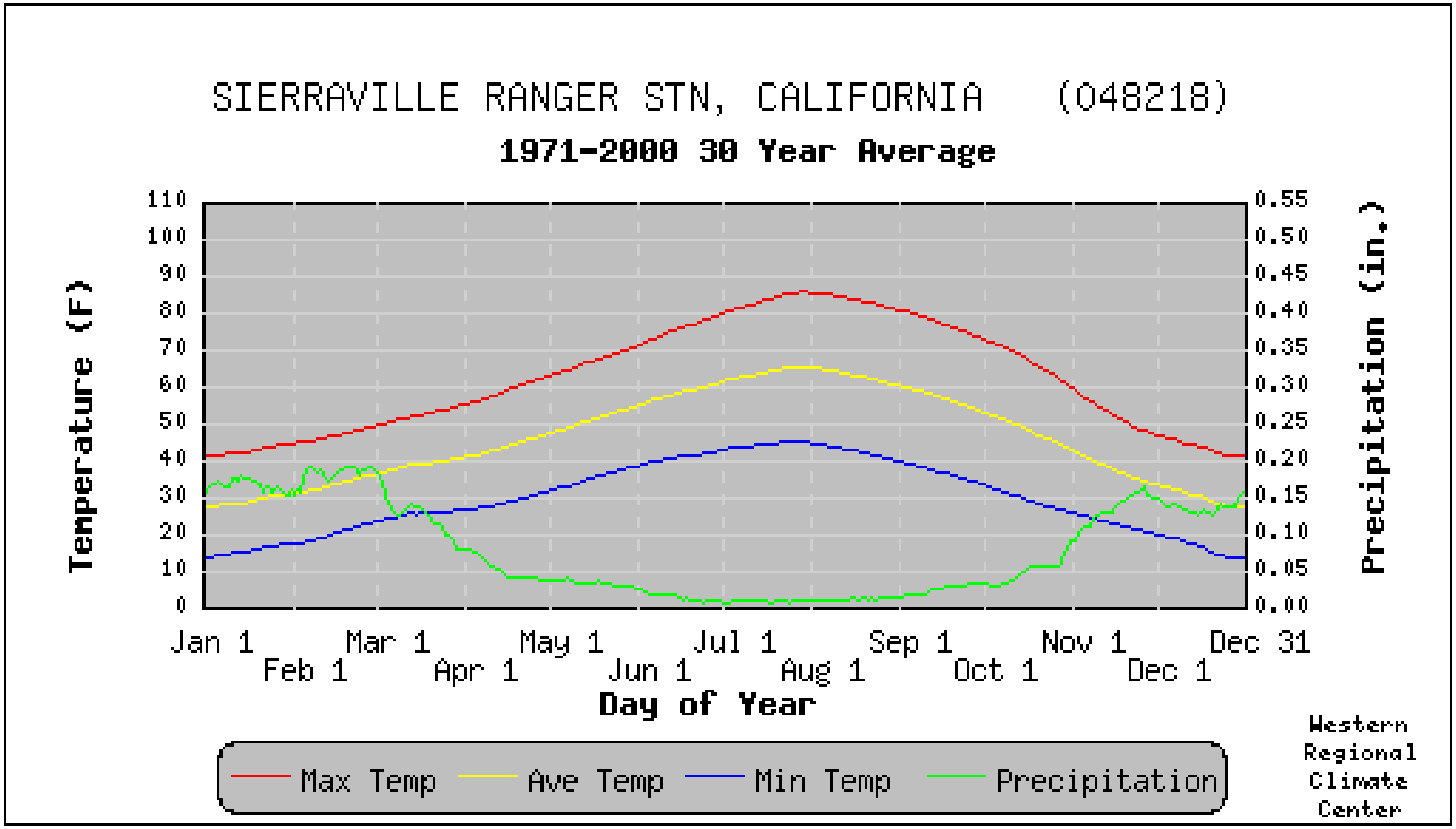


FIGURE 9-3
PRECIPITATION AT SIERRAVILLE RANGER STATION
SOURCE: DESERT RESEARCH INSTITUTE
SIERRA VALLEY WATERSHED

VESTRA

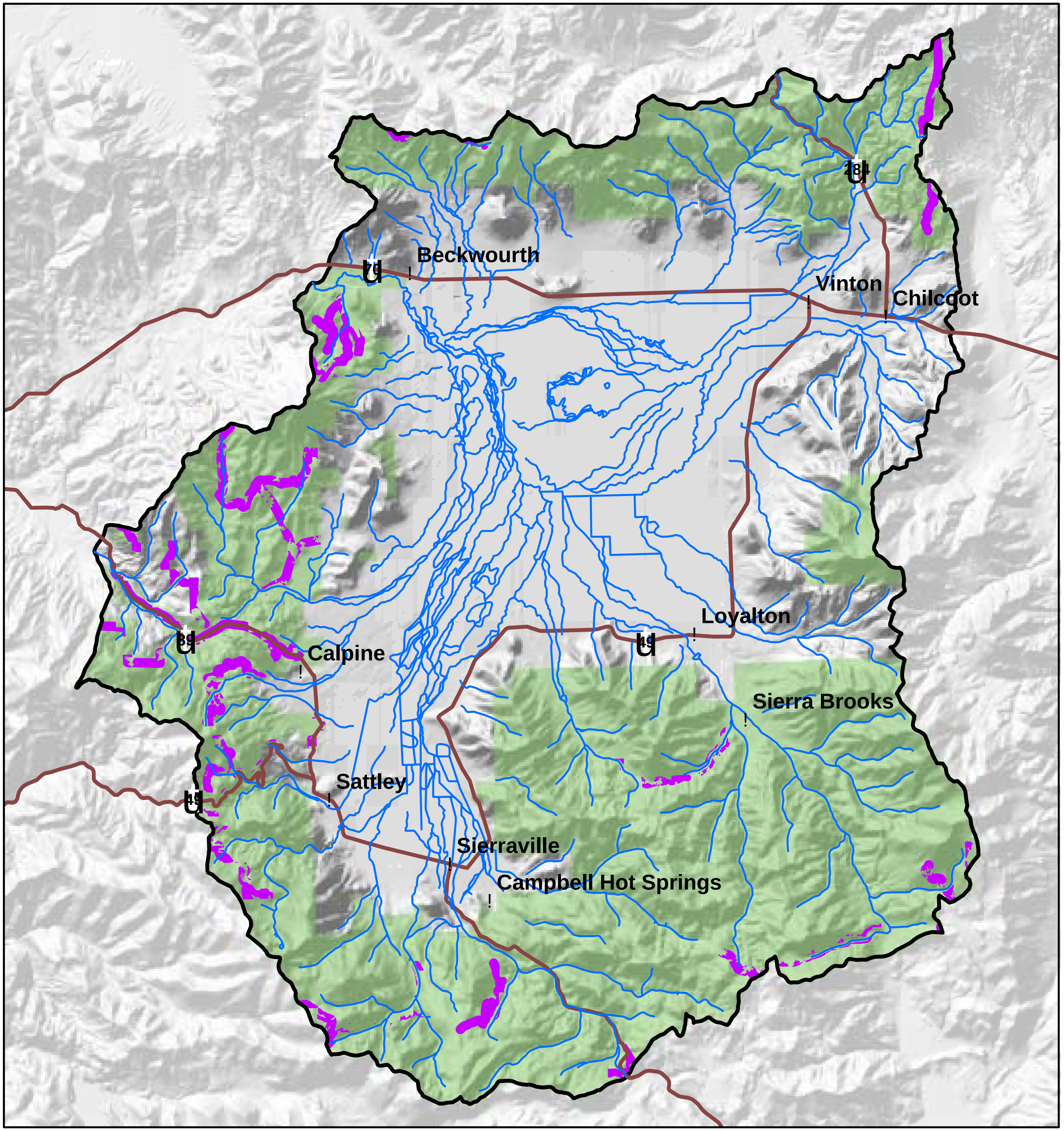


Figure 9-4
Defensible Fuel Profile Zones (DFPZs)
Sierra Valley Watershed

Legend

- Rivers and Streams
- State Highways
- Sierra Valley Watershed
- DFPZs
- National Forest Boundaries

SOURCE: USFS REMOTE SENSING LAB, REGION 5

0 1.25 2.5 5 Miles

VESTRA

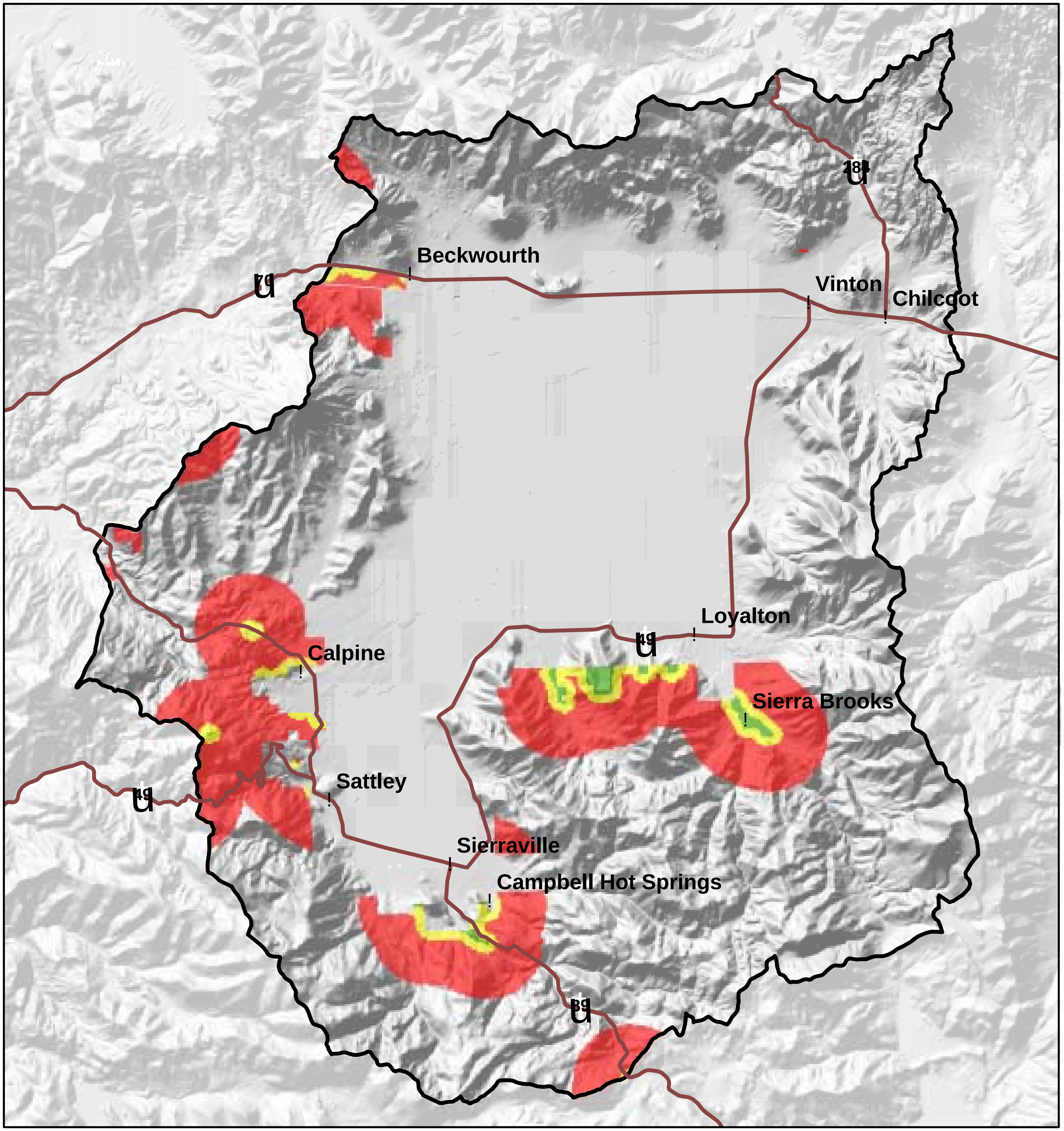


Figure 9-5
Wildland Urban Intermix Zones
Sierra Valley Watershed

Legend

- Sierra Valley Watershed
- State Highways
- Urban Core
- Defense Zone
- Threat Zone

SOURCE: USFS REMOTE SENSING LAB REGION 5

0 1.25 2.5 5 Miles

VESTRA

Section 10

Section 10
CULTURAL CHARACTERISTICS

TABLES

Section 10
CULTURAL CHARACTERISTICS

Much of the historic culture of the early inhabitants in the Sierra Valley Watershed is addressed previously in other sections of this report. Historic Native American resource management techniques and general history will not be repeated. This section will focus on current population demographics, employment and income trends, and significant archeological data.

DATA SOURCES

Cultural resource data on tribal information and organization was not readily available. Rancherias were contacted, but they were unable to provide other digital or nondigital data on boundaries, plans, and related resources. In addition, much of the information concerning the archeological resources is confidential and site locations cannot be revealed. There is also significant concern that the identification of specific sites in the assessment will encourage site disruption. Individuals from the U. S. Forest Service (USFS), Bureau of Land Management (BLM), California Department of Forestry and Fire Protection (CDF), State Office of Historic Preservation, U.S. Environmental Protection Agency (USEPA), the Washoe and Maidu Tribes, the National Park Service, and California Department of Transportation were contacted to assist in contributing to issues relevant to the cultural resources of the watershed.

DEMOGRAPHICS

Historic watershed demographics were discussed in Section 2, "General Watershed History." The highest population densities in the watershed are found in the small towns scattered throughout the area.

Population

The population change that has taken place in the watershed is somewhat typical of the mountain valleys where resident population increased during the 1930s and 1940s when mining and timber activities were much greater than today. There has been a decline in the growth rate since then, but the population currently shows signs of recovery.

There was an increase in population in the immediate postwar years of World War II for the category of persons over 65 and under 16 years of age. People between the ages of 20 and 35 left the mountain areas beginning in the 1950s for urban communities of the state due to changes in the agricultural sector and the forest industry. This trend continues today, as the 2000 census revealed the population dropped most dramatically in the 25- to 45-year age group. Some of the reasons for this decline can be contributed to the lack of an economic base in the area. Census numbers show that retail trade positions top the list of occupations. Retail positions pay minimum wage and have very high turnover rates. Even with the increased numbers of construction and manufacturing positions, overall lack of sustainable paying jobs available in the area contributes to the decline in the 25- to 45-year age group. Unemployment for the nation averages approximately 5 to 6 percent, with Plumas and Sierra Counties consistently above that with levels as high as 12 percent. Population of Sierra and Plumas Counties from 1860 to 2000 is shown in Table 10-1.

Table 10-1 HISTORICAL POPULATION DATA		
Decade	Population (by County)	
	Sierra	Plumas
1860	11,378	4,354
1870	5,619	4,489
1880	6,623	6,180
1890	5,051	4,933
1900	4,017	4,657
1910	4,098	5,259
1920	1,783	5,681
1930	2,422	7,913
1940	3,025	11,548
1950	2,410	13,519
1960	2,247	11,620
1970	2,365	11,707
1980	3,073	17,340
1990	3,318	19,739
2000	3,555	20,824
Source: University of Virginia Geospatial and Statistical Data Center		

Employment and Income

The Sierra Valley Watershed region has supported a wide range of economic activities for more than 150 years. Timber harvesting, grazing, irrigated agriculture, and mineral extraction occurred continually since the Gold Rush in 1849.

Income levels throughout the watershed have been below state levels for decades. Over the past 15 years, income in Plumas and Sierra Counties has been approximately 80 percent of state levels (CCSCE 1996). Much of the personal income in the watershed shifted away from local wage income because of the relatively fast growth of commute wages, interest and dividends, and government transfer payments. The overall share of total personal income from local wages dropped from 67 percent in 1972 to 49 percent in 1992. A significant implication of this trend is that local economic conditions are now more related to national and state economic conditions than 20 years ago. This shift provided economic stability when local employment such as seasonal recreation and commodity production are highly variable.

In addition to the changes in the overall sources of personal income, types of jobs also changed. The distribution of jobs in the watershed (between commodity-producing and service-producing jobs) is the same now as it was in 1970. Diversification occurs within the sector and the number of jobs is more than doubled, but the relative proportion of commodity and service jobs remains constant. Within the goods-producing sectors, agricultural and mining employment dropped while manufacturing employment increased. The most noticeable change in service-producing employment is a reduction in public administration employment and an increase in high-wage service jobs in areas such as health, business, and legal services. Diversification through the growth of less-seasonal industries is crucial for reducing approximately 12 percent unemployment rate in the watershed. During the winter months, unemployment rates are as high as 20 percent, with yearly averages between 8 and 10 percent. Agriculture, timber, and tourism employment remain major components of total employment, even though seasonal in nature. Regional patterns suggest lower overall unemployment rates will only come with greater diversification of employment opportunities.

Over the past two decades, the most significant economic changes in the area are the large inflow of new residents attracted by environmental and social amenities available in the region. The new residential and commercial construction provided the largest impact to the total financial assets of the area. In Sierra County the number of residents employed in construction doubled from 1990 to 2000, while in Plumas County there was a 10 percent increase.

Household income levels in the watershed are lower than those of California as a whole. The median household income in Plumas County rose from $24,299 in 1990 to $36,351 in 2000 and in Sierra County from $23,657 to $35,827. In addition to the large faction of retired households, another major factor reducing income levels is the number of households with children and no identified wage earner.

According to U. S. Census data, approximately 10 to 13 percent of the residents in the watershed lived in poverty for the last 10 years. There are many variables used by the U. S. Census when calculating poverty levels or the poverty threshold. These variables include household size, income, medical expenses, utilities, and other expenditures such as rent. An example of the poverty threshold in 2002 for a family of four with the father present was $18,244.

In December 2000, the Federal Emergency Management Agency (FEMA) gave California's Emergency Food and Shelter Plan $21 million. Various amounts were given to counties in the state. Plumas County received $19,964, but no funds were distributed to Sierra County. These funds are used to support programs that provide food for the hungry, shelter to the homeless, and to prevention of homelessness. Other ongoing family maintenance programs are the family group and unemployed parent programs within Aid to Families with Children (AFDC) now called Temporary Assistance for Need Families (TANF). Over the past 20 years, the ratio of AFDC/TANF cases to the total population has always been below the state average. AFDC/TANF numbers cannot be used as an exact measure of poverty.

ARCHAEOLOGICAL RESOURCES

Archaeology is the study of human past. Around the world, this study is usually divided into either prehistoric archaeology or historic archaeology, depending upon the time period involved. In California, historic archaeology generally begins in 1542, and incorporates only the last 400 to 500 years. Prehistoric archaeology incorporates everything earlier and extends backward in time for at least 12,000 years, believed to be the time of earliest human arrival within what is now California (McGuire and Saechter 2001).

Archaeological science, discussion, and writing relates either to archaeological evidence or to archaeological interpretation. Archaeological evidence is the physical remains of past activities, while archaeological interpretation is the explanation of such physical evidence in the attempt of reconstructing past life ways. It is difficult to put a dollar value on an archaeological site. It is equally hard to assess the value of other cultural intangibles such as art and music, but these are things that enrich our lives in modern society. The understanding of the past is priceless. Archaeological sites contain irreplaceable evidence to reconstruct the past. Without archaeological sites, it would be difficult or impossible to develop the long and diverse archaeological record that helps write California prehistory.

California's archaeological record is unique, varied, and as old as anywhere else in North America. Hundreds of different prehistoric cultures were found within the state through archaeological methods. Many of the archaeological records are fragile traces left behind by earlier peoples and require steps to protect and preserve their information.

ARCHAEOLOGICAL RESOURCE INVENTORY AND EVALUATION

Private Land

The Natural Resources Conservation Service (NRCS) is responsible for the inventory, description, and evaluation of the prehistoric and historic cultural resources on private land. In the watershed, NRCS works in association with range management and agricultural programs located on private property. The NRCS considers cultural resources in its conservation planning along with the soil, water, air, plants, and animals on private property.

Archaeological review is required prior to harvest of timber on private lands through the California Forest Practice rules.

Several federal, state, and local laws were enacted to preserve cultural resources. The most important of these is the National Historic Preservation Act of 1966. Under this and other legislation, federal agencies, including the NRCS, are required to protect cultural resources. If potential cultural resources are located on private property, the California Cultural Resource Specialists are listed in the contacts of this section for your convenience.

Public Land

The USFS and BLM are in the process of inventorying, describing, and evaluating prehistoric and historic cultural resources located on federal property within the watershed. The California Department of Transportation is currently conducting excavations in the Sierra Valley Watershed. Their report will be completed in late 2004. The Bureau of Reclamation and the Army Corps of Engineers inventory and evaluate cultural resources encountered during planned projects or existing facilities. Direction for these activities is outlined in the National Historic Preservation Act of 1966 and Executive Order 11593. All state and federal representatives consult with the State Historic Preservation Officer and the Advisory Council on Historic Preservation and review state and federal registers when applicable.

Cultural resource sites are managed in several ways. The level or intensity of management has the following range:

- Preservation—excluding incompatible land management activities protects sites.

- Conservation—When preservation is not feasible, scientific information is recovered from sites so that other land use activities can occur.

- Interpretation—Sites are developed for public enjoyment and education through signs, trails, and public information kiosks.

- No Management—Sites are not preserved in any way. These sites are not the quality suitable for nomination to the National Register. They contain little scientific information or Native American cultural heritage value.

Tahoe National Forest

In the eastern section of the watershed, Loyalton Rock Shelter is considered a significant archaeological site. It was first excavated in 1958 and 1959 by graduate student Norm Wilson and described in an unpublished master's thesis at Sacramento State University.

This large rock shelter situated high above Sierra Valley yielded a varied and interesting artifact assemblage. Fire hearths and cache pits were encountered frequently in the midden deposit. The remnants of two stone walls were identified that apparently served to partially enclose the shelter. The cache pits contained a number of artifacts (bone pins, pipe bowl, and charmstone), which suggests the occurrence of ritual activity related to hunting.

Of particular interest were numerous skulls of bighorn sheep found in several of the cache pits. Bighorn sheep were not known to reside in this area of the northern Sierra in historic times. Thus, evidence from Loyalton Rock Shelter suggests a much larger range for these animals in prehistoric times.

The site contained numerous bone artifacts and bone refuse. Since most Martis period sites (2,000 B. C. to A. D. 500) are open, bone preservation is poor. The assemblage represents one of the few opportunities to study a broader range of Martis material culture. The collection from Loyalton Rock Shelter has the potential to yield further information if restudied using both analytical techniques and the current hypothesis regarding northern Sierra prehistory.

Many smaller sites are identified in the national forest, but none with the scientific significance of Loyalton Rock Shelter.

Previous Studies

Most of the archaeological work in and around Sierra Valley is in the form of surface inventories by the Plumas National Forest and by Caltrans. Excavation reports are available for areas to the west and east of Sierra Valley in Mohawk Valley, Long Valley, and the Honey Lake Basin. As a group, these studies have helped to build sizeable information database on the prehistory and history of northeastern California (Waechter and Mikesell 2002).

There are no previous archaeological excavations in Sierra Valley itself. However, the Chilcoot Rock Shelter and Loyalton Rock Shelter were excavated long before the advent of modern analytical tools like obsidian and basalt sourcing, obsidian hydration, and paleobotanical studies, and only a few years after radiocarbon dating began to be widely used by archaeologists. Thus, there is very little information available beyond the survey level on chronology, technology, subsistence, exchange, or regional/ethnic affiliation of the people who inhabited the valley in prehistoric times. The two rock shelter studies do provide illustrations of diagnostic artifacts. Included are a profile of toolstone raw material by depth (basalt dominates all tool categories and nearly every provenience), and a detailed description of the cultural and natural strata within the rock shelter (Waechter and Mikesell 2002).

Artifacts documented include "blades" (bifaces), "scrapers" (flake tools), drills, cores, handstones, milling stones, hammerstones, unmodified stream cobbles, remains of freshwater clam *(Margaretifera margaretifera),* available in Little Last Chance Creek, and fragments of bone from bighorn sheep, marmot, squirrel, chipmunk, along with some unidentified large and small mammals. Many of the bone fragments showed butchering marks. In contrast to the Loyalton shelter, most of the flaked stone at Chilcoot was red, yellow, or dark-brown "jasper" with some obsidian and basalt. This abundance of stone almost certainly reflects the proximity of the site to major quarries in the Fort Sage Mountains and Petersen Mountains just east of Beckwourth Pass (Waechter and Mikesell 2002).

A semi-circular stacked-rock wall (two courses high at the time of the excavation) was constructed across the entrance to Chilcoot Rock Shelter. Two hearth features were noted: one lined with small angular stones and the other a cup-shaped pit defined by a thin lens of charcoal. The main cultural stratum was in the top 2 feet of deposit. The lack of midden and the small assemblage suggests the shelter was an intermittent seasonal campsite probably part of a summer hunting, fishing, and foraging pattern. The shelter's small size also implies a family group and the cave's location affords some natural concealment of its occupants from possible hostile groups (Waechter and Mikesell 2002).

At Loyalton Rock Shelter, the large number of projectile points and thousands of fragments of animal bone are evidence the site was primarily a hunting station when in pursuit of large game. Several unlined cache pits contained mountain sheep skulls and specific artifacts (including lemon-shaped charmstones) indicating possible secondary use by shamans for storage and hunting-magic rituals. The points include specimens of basalt, chert, and obsidian. The basalt was of at least two types: an ultra-fine-grained black (probably Gold Lake), and the more typical granular grey basalt, which is the most common tool material in the area (Siegfried Canyon Ridge vicinity). The collection also includes abraders, bone awls, "blades" (bifaces), drills, gravers, "flake knives" (formed flake tools), simple flake tools, cobble core tools, debitage, handstones, anvils, and grinding slabs (Waechter and Mikesell 2002).

The minor use of milling tools suggests a reduced emphasis on seeds and other plants—though 49 modified slabs (metates, anvils, etc.) imply a substantial amount of plant-food processing (Wilson 1963). A great many of the slabs were incorporated into one of the two rock walls in the shelter and Wilson's (1963) interpretation probably applies to the later occupants responsible for constructing the walls. The excavations also identified two cache pits containing a stone pipe bowl; perforated bone pin; a bipointed pin; and a red jasper ovate projectile point. Two other pits had no artifacts or bone but were covered with large flat slabs. Twelve fire hearths were found, all basin-shaped and 12 to 14 inches in diameter. All contained lenses of fine, loose ash, bits of charcoal, and small fragments of burnt bone (Waechter and Mikesell 2002).

Wilson's (1963) research was directed at, among other things, the differentiation of Martis from Kings Beach assemblages; the issue of whether both complexes could be attributed to the same people(s); and why there had been no Kings Beach sites identified in Sierra, Martis, or Sardine Valleys at that time. The rock shelter excavations did not help to clarify these issues. For one thing, projectile points provided the only temporal data and they were stratigraphically mixed. Wilson classifies his points into five numbered categories rather than with reference to an established typology, although he does note similarities with points from Carson Valley, Honey Lake, the Sierran foothills, and the Great Basin. The illustrations in the report show large-stemmed, corner-notched, side-notched, contracting base, split-stem, leaf-shaped, side-notched leaf, shouldered leaf, and eared forms among the larger specimens; and Rose Spring, Gunther-oid, and Desert side-notched (mostly basally notched) among the arrow-sized points. Wilson remarks that the variety of point types implies a long period of occupation, but types are so stratigraphically mixed that they do not help to differentiate between Martis (Middle Archaic) and Kings Beach (Late Archaic/Terminal Prehistoric) assemblages (Waechter and Mikesell 2002).

In the mountains along the southern rim of Sierra Valley in the Tahoe and Toiyabe National Forests, Waechter and Costello (1995) tested 10 sites to assess damages from recent wildfires and fire-suppression activities. Testing included six prehistoric components and seven historic components, often at the same site. Three of the prehistoric investigations took place along Bear Valley Creek (elevation 6,300–6,600 feet above mean sea level), which drains northward through the mountains to join with Smithneck Creek and flows past the Loyalton Rock Shelter out into the broad alluvial marshland of Sierra Valley. All three sites were surface and shallow subsurface deposits with flaked stone tools and debitage of basalt, stone, and obsidian, few grinding slab fragments, and handstones. The soil in this area is volcanic in origin and somewhat shallow. Sites tend to be at or near the surface. Data from the sites indicated they served as periodic short-term residential camps or task stations during the Middle Archaic period. Two of them were used during the Late Archaic probably as task-specific hunting camps. No prehistoric features were found. Projectile points from the sites included one reworked wide-stemmed specimen; two Desert side-notches; one Rose Spring; seven from the Martis/Elko series; and several others that were not identified to type (Waechter and Mikesell 2002).

Toolstone at the Tahoe/Toiyabe sites was dominated by basalt with secondary use of stone. As is typical of the Tahoe Sierra, obsidian was rare. The basalt toolstone recovered from the six prehistoric components showed a very different source profile from sites in Sierra and Mohawk Valleys (Waechter and Mikesell 2002).

Summary and Conclusions of Studies

Sierra Valley holds a unique position both culturally and geographically. Beckwourth Pass, at the eastern end of the valley, separates the headwaters of the Feather River that drains west through the Sierra Nevada and foothills; and the Long Valley Creek system, which drains east into the Great Basin. The valley lies near the Sierran crest zone at the interface of the California and Great Basin culture areas with Beckwourth Pass as a passageway between the two. This intermediary position meant that prehistoric occupants of Sierra Valley had access to and were influenced by the subsistence adaptations and material cultures of both regions. These people were major participants in trade between the two regions perhaps helping to move items like obsidian and pinyon to the western slope, and acorns and Sierran basalt to the eastern front. In ethnographic times, at least, Sierra Valley was a meeting ground for groups from both sides: the Mountain Maidu from the west and the Washoe from the east (Waechter and Mikesell 2002).

This situation presents both opportunities and complications for interpretation of the archaeological record. Sierran archaeologists recognized the mixture of California and Great Basin traits in regional assemblages and speculated on what this may mean in terms of cultural origins, migration, trade networks, and foraging mobility. Kowta's (1988) hypothesized movement of Hokan speakers (ancestral Washoe) out of the Central Valley into the mountains of Plumas County into the Great Basin is one model of how this cultural mixing could have occurred: the migrants brought Central Valley and foothill traits with them into the mountains and the Basin and once there adapted their technology and subsistence strategies to the new environments. This model has yet to be fully tested (Waechter and Mikesell 2002).

However people arrived in the northern Sierra and from whatever direction(s), the mixture of traits makes it very difficult for archaeologists to identify coherent culturally meaningful components and assemblages. This is further complicated by the fact that many, if not most, sites investigated so far are temporally mixed. Heizer and Elsasser (1953) originally reported that Martis and Kings Beach complexes were "geographically exclusive—i.e., distinctive traits of one rarely occur in the same site with those of the other." The Martis (Middle Archaic) sites were supposed to be located in good hunting and seed-gathering areas and the Kings Beach (Late Archaic, Terminal Prehistoric) sites in good fishing areas. Unfortunately, this is not the case. Instead, sites from all time periods are located to those with dependable sources of water, plant foods, game, fuel, and shelter. More specific prehistoric settlement and subsistence adaptations in the region remain to be defined (Waechter and Mikesell 2002).

While clear progress has been made toward an understanding of northern Sierran prehistory, there are still a great many gaps in the data available. Sierra Valley still has many relatively untouched sites and datable processing features. The valley's location at the interface of two great culture areas is an excellent testing ground for existing models, yielding the kinds of data that may help fill gaps. Three of the four sites investigated for this project can contribute substantially to this effort. These sites need to be preserved and protected or unavoidable effects to the sites mitigated through additional study (Waechter and Mikesell 2002).

REFERENCES

Heizer, R. F., and A. B. Elsasser. 1954. *Notes on the Utah Utes by Edward Palmer, 1866-1877*. Salt Lake City: University of Utah Anthropological Papers17:1-8.

Kowta, M. 1988. *The archaeology and prehistory of Plumas and Butte Counties, California: An introduction and interpretive model*. Chico: California Archaeological Site Inventory, Northeast Information Center, CSU Chico.

McGuire, K. and S. A. Saechter. 2001. *"Place of many soldiers": Archaeological investigations at Crooks Canyon*. Far Western Anthropological Research Group, Inc.

Waechter, Sharon A., and J. G. Costello, with S. G. Linstrom and W. W. Bloomer. 1995. *Final report on the assessment of damages from the Cottonwood, Crystal, and Hirschdale fires at Ten Sites on the Tahoe and Toiyabe National Forests (CRR #05-17-1129)*. Report prepared for EA Engineering, Science, and Technology, Inc., Lafayette, California, at the request of the U.S. Forest Service, Region 5.

Waechter, Sharon A. and Stephen D. Mikesell. 2002. *Phase-II report for excavations at sites CA-PLU-1487/H (Plumas National Forest #05-11-51-825), CA-PLU-1486 (Plumas National Forest #05-11-51-919), CA-PLU-1484/H, and CA-PLU-1485, Plumas County, California*. Prepared for California Department of Transportation.

Wilson, N.L. 1963. *The archaeology of the Loyalton rock shelter*. Sacramento: Master's Thesis, Sacramento State College.

Section 11

Section 11
SIGNIFICANT FINDINGS, CONCLUSIONS, AND ACTION OPTIONS

Section 11
SIGNIFICANT FINDINGS, CONCLUSIONS, AND ACTION OPTIONS

SECTION 3 GEOLOGY AND SOILS

Significant Findings and Conclusions

- A detailed soil survey is not available for the entire watershed study area.
- Sierra Valley is one of the most faulted regions in California and is largely composed of recent pyroclastic eruptions and volcanic flows.
- Soils within the watershed vary considerably in productivity, depth, and use due to the diverse parent material, topography, and precipitation levels of the watershed area.
- The soils of the Sierra Valley are classified primarily as "slight" or "moderate" risk of erosion on the valley floor, and "high" risk of erosion in the mountains.

Action Options

- Perform a road inventory and analysis that surveys culverts, stream crossings, road design, construction, soil type, and type of road use to better evaluate sedimentation from upland areas.
- Perform an erosion potential analysis by combining the Natural Resources Conservation Service soils layer with a topographic slope layer generated by 10-meter digital elevation models developed by the United States Geological Survey. This will be used to develop or review best management practices for areas identified as having high erosion potential and site suitability.

SECTION 4 HYDROLOGY

Significant Findings and Conclusions

- Hydrologic data by tributary are not available. Where data are available, they are of short duration.
- The Sierra Valley Watershed is a subset of the Middle Fork Feather River Hydrologic Unit (HUC 18020123).
- The average annual precipitation across the watershed is approximately 25.9 inches (642,900 acre-feet) and varies dramatically from over 55 inches per year in the southwest to under 12 inches per year in the northeastern section of Sierra Valley.

- The lowest recorded annual flow on the Middle Fork Feather River was 54 cubic feet per second in 1961. Seasonally, the Middle Fork Feather River at Beckwourth goes dry almost every year.

- Widespread flooding has not been documented in Sierra Valley and data concerning flood control problems are minimal.

- Approximately 98 percent of the surface water and groundwater used in the Middle Fork Feather River Hydrologic Unit was for irrigation.

- The hydrologic conditions in the watershed have not changed significantly since 1950.

Action Options

- Evaluate water conservation measures for existing diversions to increase stream flows.

- Evaluate the possibility of vegetation management to augment stream flows to improve habitat for wildlife.

SECTION 5 WATER QUALITY

Significant Findings and Conclusions

- Designated beneficial uses of the surface waters of the Sierra Valley are agriculture, recreation, freshwater habitat, spawning, and wildlife habitat.

- Very little data exists for water quality within the Sierra Valley Watershed. Studies include the United States Geological Survey water quality survey of the Middle Fork Feather River conducted from 1970 to 1971, a California Department of Water Resources and United States Forest Service joint study from 1972 to 1973, and a continuous monitoring station installed by the California Department of Water Resources in the Middle Fork Feather River above Portola in 1972. The only recent study is the Feather River Coordinated Resource Management Watershed Monitoring Program conducted intermittently from October 2000 to December 2003. These irregular sampling periods and varying locations make it difficult to construct direct correlations in data collected in the 1970s and more recent water quality data from 2003.

- The limited data available from the Middle Fork Feather River at Beckwourth shows elevated levels of bacteria, temperature, nutrients, total dissolved solids, and evaporation, and depressed levels of dissolved oxygen relative to other sites throughout the Upper Feather River Watershed where water quality monitoring has recently been performed.

- Water temperatures during warmer weather have reached as high as 78ºF in the Middle Fork Feather River.

- The Sierra Valley supports over 40,000 acres in irrigated agricultural production with the majority of surface water being used for flood-irrigated pastures. The majority of the watershed's groundwater is used in sprinkler irrigation.

- Pesticide use in the Sierra Valley is limited and has dropped substantially over the years. The primary chemicals used in alfalfa production are glyphosate, hexazinone, paraquat, and imazethapyr. The majority of chemicals in the watershed is used for forest management, primarily for brush control, and include glyphosate, triclopyr and phenoxy.

- Urbanization is steadily rising in Sierra Valley and may be increasing the variety and amount of pollutants carried into watershed streams and rivers.

Action Options

- Develop a baseline monitoring program to evaluate water quality throughout the watershed to identify areas of concern.

- Develop a plan to identify controllable factors that may exacerbate conditions such as elevated water temperatures, irrigation return flows, riparian community vegetation changes, or diversion of stream flows.

- Offer livestock and farm operators increased opportunities to participate in voluntary cooperative water quality short courses. These courses are designed to help livestock operators understand the possible sources of livestock and farm impacts to water quality and identify alternatives to reduce water quality impacts.

- Pursue grant funding or cost-share payments for landowners to inventory, prepare plans, and implement best management practices that reduce water quality impacts.

SECTION 6 BOTANICAL RESOURCES

Significant Findings and Conclusions

- The composition of ecological communities found within the watershed has changed notably since the early days of California statehood due to changes in climate, exclusion of fire, invasive exotic plants, agriculture, timber harvest, and livestock grazing.

- Although general vegetative mapping is available from many sources, the resolution is insufficient to address vegetation management issues. A better inventory is needed for non-native invasive plants, riparian health and mapping, and fuel density.

- Coniferous forest comprises approximately one-third of the watershed. Agricultural lands and other grasslands cover approximately one-quarter of the watershed. One-fifth of the watershed is covered by sagebrush scrub. Other vegetation types include chaparral, wetlands, grasslands, and deciduous riparian and other hardwoods.

- There are at least 5,000 acres of flooded and seasonally flooded wetlands on the valley floor.

- There are 10 special status plants and 22 invasive plants known to occur in the watershed.

Action Options

- Inventory the watershed for riparian health and mapping, non-native invasive plants, brush density, and fuel density to better address conditions and vegetation changes over time.

- Inventory the watershed for invasive non-native plant species and noxious weeds to assist in developing management strategies for either eradication or management.

- Create strategies for preventing other exotic species from entering the watershed, including educational programs.

- Develop educational awareness programs for the public on identifying non-native invasive plants with recommended control plans.

- Develop a riparian vegetation mapping and inventory program to identify riparian communities and areas where native communities could be reestablished.

- Utilize the California Department of Forestry and Fire Protection's Vegetation Management Program and Range Improvement process to increase the use of prescribed fire as a vegetation management tool.

SECTION 7 FISH AND WILDLIFE RESOURCES

Significant Findings and Conclusions

- The California Wildlife Habitat Relationships model has predicted that over 250 species of terrestrial vertebrates may potentially occur in the watershed, with 40 percent being present only during the summer months and 10 percent during the winter months.

- The Sierra Valley wetland and agricultural life forms provide high-quality habitat to migrating waterfowl species.

- Wildlife populations in the Sierra Valley Watershed have been modified by changes in vegetation management and diversity, development, introduction of non-native species, and statewide policy decisions since the arrival of European settlers in the 1850 and 1860s.

- The Sierra Valley Watershed is host to over 120 butterfly species and multitudes of other insect life.

- The watershed provides aquatic habitat for at least 15 species of fish, half of which are non-native fish either planted as game or introduced accidentally. Four of these species use upland cold-water streams and lakes and ten use warm water streams, channels, and sloughs found on the valley floor. Eight of these fish species are game fishes.

- Rainbow trout is the most widely distributed fish in the watershed.

- There are ten species of threatened or endangered animals and two candidate species for listing that occur in the watershed.

- Watershed deer populations have decreased due to the exclusion of fire and a loss of available forage.

Action Options

- Work with and encourage the California Department of Fish and Game and other biological information resources to expand comprehensive monitoring programs for populations of selected wildlife and fish populations within the watershed to monitor trends over time.

- Prepare a riparian habitat assessment inventory.

- Prepare a fuels assessment plan for the watershed to identify concentrations of residences, strategic locations for fire suppression efforts, and high-priority areas for management of existing fuels.

- Protect and enhance summer and winter range deer habitat in the watershed by using fire as a tool for habitat enhancement. Evaluate the effects of prescribed burning on the watershed deer populations by assessing changes in habitat usage and population trends of deer herds following vegetation management practices implemented to increase forage and stream flow, and determine the effects of predation from cougars and bears on the watershed's deer herds.

- Encourage landowner participation in government cost-share programs that enhance or restore wildlife habitat.

- Investigate and encourage implementation of measures to increase flows in the Middle Fork Feather River and its tributaries.

- Conduct annual fish population evaluations of identified reaches to set a baseline and evaluate success of restoration programs.

- Obtain landowner easements and cooperation around key habitat areas.

SECTION 8 LAND USE

Significant Findings and Conclusions

- Land use has emphasized agriculture and timber resources as the predominant land use in the watershed.

- There are approximately 845 miles of road in the watershed with the majority being local roads and state highways.

- The human population trend has steadily increased since the 1960s. However, the 25- to 45-year age group population has been decreasing. This is attributed to the lack of an economic base in the watershed area.

- Land ownership in the watershed is approximately 50 percent public and 50 percent private. The United States Forest Service is the biggest landholder with approximately 43 percent of the watershed.

- Recreational use has increased significantly since the 1950s, especially within the Plumas National Forest, Tahoe National Forest, and Toiyabe National Forest.

- A wide variety of crops is grown in the watershed with timber, cattle, pasture, and hay having the highest value.

- There is little information available on grazing impacts for the watershed area.

- Public land plays a vital role in the watershed's livestock industry as most cattle ranches use public land allotments for grazing on United States Forest Service and Bureau of Land Management lands.

Action Options

- Encourage retention of large ownerships to enhance stewardship and management efficiency for agricultural resources, fuels management, and preservation of open space.

- Emphasize habitat restoration in areas associated with agricultural lands.

- Encourage the concept of the working watershed aspect of land use—managing and producing natural resources as a land use goal.

SECTION 9 FORESTRY, FIRE, AND FUEL MANAGEMENT

Significant Findings and Conclusions

- The past 100 years of fire exclusion have resulted in significant fuel loading and potential for catastrophic fire.

- Although it is widely known that current fuel loading is unacceptably high, no detailed local fuel inventory is available.

- The California Department of Forestry and Fire Protection has designated approximately 3,500 acres within the watershed as defense zones, and 2,000 acres as threat zones.

Action Options

- Conduct a watershed-specific fuel inventory and identify the most effective methods of fire management.

- Develop a strategic fuels management plan emphasizing ecological and hazardous components.

- Increase local public awareness of the need for expanded fuel management and of the catastrophic consequences of continued ignorance of vegetation management activities.

- Construct and maintain strategically designed and located, large-scale networks of fuel reduction zones through extensive public/private sector coordination.

- Expand the application of prescribed fire practices where they can be used safely and effectively.

- Lobby or petition for resource allocations for fuel management and reduction in permit conditions.

- Develop plans to reintroduce fire into the ecosystem to control fuel density and structure and improve vegetation density.

SECTION 10 CULTURAL CHARACTERISTICS

Significant Findings and Conclusions

- There is a lack of data pertaining to cultural resources, tribal information, and archaeological resources for the watershed area leaving gaps in data for cultural risk and natural resource assessments.

Action Options

- Work with agencies and landowners to promote and support educational and volunteer initiatives that enhance public awareness and increase direct participation in watershed stewardship.

- Collaborate with agencies and organizations to perform comprehensive cultural resource surveys and document newly discovered resources. Work to bring the cultural documentation into a centralized and consolidated database of cultural resources that would aid future urban development in locating and protecting cultural heritage.

- Collaborate with agencies and organizations to locate and preserve historical natural resource data.