Section 8

Section 8
VEGETATION RESOURCES

TABLES

FIGURES

Section 8
VEGETATION RESOURCES

SOURCES OF DATA

The information and summaries presented in this section were derived from a number of sources, including documents and databases. A complete list of references is found at the end of the section; however sources particularly useful include:

- CALVEG habitat mappings GIS layers (U.S. Forest Service, 1999)
- California Natural Diversity Database (CNDDB 2005 version)
- Wildlife Habitats of California (Mayer and Laudenslayer 1988)
- USDA (United States Department of Agriculture) Mendocino National Forest Management Plan, 1995
- Terrestrial Vegetation of California (Barbour and Major 1977)
- Early accounts by settlers and travelers (e.g., Muir 1894)
- Annual Crop Reports (Tehama County Agricultural Commissioner)
- Draft Voluntary Oak Management Plan
- California Department of Conservation Land Mapping Program
- Tehama County Parcel Land Use Information

The primary resource used to characterize vegetation at the watershed scale is the CALVEG data. This data set relies on interpretation of satellite imagery with verification of the images in the field. The CALVEG database was updated in 1998. The minimum mapping unit for this coverage is 2.5 acres. This system classifies the existing plant communities in California. The plant communities are based on one or several dominant plant species or the dominant vegetation form (i.e., meadows or grasslands). CALVEG provides a reasonably accurate assessment of forests and woodland features. Little information is available about the structure of vegetation dominated by shrublands or herbaceous plants. Other sources of information reviewed include Department of Water Resources files pertaining to the water storage projects proposed in the watershed, and information on the Farmland Mapping and Monitoring Program available from the California Department of Conservation, Upper Thomes Creek Watershed Assessment (United States Fish & Wildlife Service [USFWS]) and publications by the California Department of Fish and Game (CDFG) and others. The California Native Plant Society's (CNPS) Inventory of Rare and Endangered Vascular Plants and the California Natural Diversity Database (CNDDB) were searched for the US Geological Survey (USGS) 7.5-minute quadrangles that occur within the boundaries of the watershed for sensitive species.

HISTORICAL CONTEXT

The vegetation of the Tehama West Watershed has changed significantly since the arrival of the first European settlers. These changes include alterations in plant species composition, diversity, and density. Three primary forces have been the driving factors behind these changes:

- Introduction of non-native plant species
- Intensive grazing by imported livestock (prior to regulations)
- Radical alteration of the pre-existing fire regime

To a lesser degree timber management, water management, and agricultural and urban development have also resulted in change. This section summarizes what is known regarding historical vegetation changes and the causes for these changes in western Tehama County.

Historical changes to California's vegetation first began as a by-product of the establishment of missions in coastal areas of California from the Mexican border to just north of San Francisco Bay. Many species of plants were imported intentionally, such as grains to establish an agricultural base. However, there were many other plant species that were introduced unintentionally. These were usually brought in as seed in livestock fodder, animal hair, packing materials, ship ballast, or in soil surrounding fruit cuttings. While the intentionally imported seeds, such as wheat and corn, have been the basis for the highly successful agricultural infrastructure California currently supports, the unintentional species have had major irreversible, and often detrimental, impacts on our wildlands.

Introduced weed seeds primarily came from the Mediterranean region and consisted of species that had evolved in a climate very similar to California. In addition, they were species that had been able to cope with millennia of heavy grazing, overuse of farming land, and severe competition from other aggressive species. Consequently, when these species were released in California, they were pre-adapted to aggressively compete with native grasses and forbs. While the invasion started in the coastal areas near the missions, it quickly extended throughout the Sacramento Valley and adjacent grasslands.

Most of the introduced plants were annuals, forbs, and grasses, including: red brome (*Bromus madritensis* ssp. *rubens*), downy chess (*Bromus tectorum*), false foxtail fescue (*Festucea myuros*), European foxtail (*Festuca bromoides*), foxtail fescue (*Festuca megalura*), hare barley (*Hordeum leporinum*), glaucous barley (*Hordeum glaucum*), nitgrass (*Gastridium ventricosum*), purple falsebrome (*Brachypodium distachyon*), and silver hairgrass (*Aira caryophyllea*). Early Spaniards may have also directly imported wild oats (*Avena fatua*), slender wild oats (*Avena barbata*), annual ryegrass (*Lolium multiflorum*), and soft chess (*Bromus mollis*) and ripgut brome (*Bromus diandrus*). Some annual legumes, such as bur clover (*Medicago polymorpha*) and the filarees (*Erodium* spp.), were also probably imported in this manner.

Additional changes to the state's vegetation came about when appreciable numbers of livestock were imported. Sheep and cattle were originally brought in by the Spaniards but were relatively localized until the Gold Rush and the time of Statehood. Early in the history of Tehama County sheep were the dominant rangeland species. They were seasonally driven into the higher elevations to take advantage of the summer pasturage; consequently, some of the effects noted in the foothill and valley areas also extended into the mountains. The early patterns of sheep use were an asserted factor in the reduction of native perennials and replacement of more aggressive annuals in upper elevation meadows (Muir 1894, Douglass and Bilbao 1975, Rowley 1985, Belsky 1996). John Muir was particularly disenchanted with the effects he saw of sheep grazing.

Sheep populations increased in Tehama County from the Gold Rush/statehood period and peaked in the period from 1890-1930. During this time thousands per year were exported from California to the Midwest, Wyoming, and Idaho (Wagoner 1886). Between 1880 and 1896 from 20,000 to 80,000 sheep per year were driven from the Red Bluff area, north of Mt. Lassen, and through Modoc County. Sheep production peaked in 1930, when Tehama County reported 350,000 head. Since that time numbers have steadily declined while the number of cattle has increased. During the past 40 years, the number of cattle in Tehama County has remained fairly constant (65,000 to 100,000) but sheep populations have declined dramatically and numbered only 5,800 in 2002 (Tehama County 2003). See Figure 2-10 in Section 2, "General Watershed History."

Historical accounts suggested that the sheep usage affected rangeland conditions to a greater degree than cattle. This was likely due to a higher number of concentrated animals over a longer season. The grazing effects were exacerbated by the herders' burning practices that were more frequent and intense than those used by the Native Americans (Wagoner 1886). For areas receiving heavy domestic livestock grazing, the native plants were at a serious disadvantage. Timing of new grazing pressure also contributed to species changes. The result was a very rapid invasion and replacement of many Californian native valley and foothill plants and plant communities with introduced species.

The effects of early-day, unrestrained livestock use of rangelands led to increased federal actions to address the problems. In the 1930s the U.S. Forest Service (USFS) adopted new policies for federal land grazing with the intent to balance range use with their conditions. Grazing permits were issued and some areas were closed to allow for rangeland recovery. During that time predator control and poisonous plant reduction programs were initiated. The 1934 passage of the Taylor Act challenged the USFS's control of rangelands by creating the rival Grazing Service of the U.S. Department of Interior. This competition resulted in longer grazing lease periods and an increased number of permits.

Many range improvement programs were initiated during the period from 1934 to 1944. Additional water sources were developed in dry areas, which allowed greater dispersal of livestock. Seeding and planting efforts were widespread; however, because little attention was given to the use of native seeds, many of the projects actually spread additional exotic species. A common seed mix that was used included wheat grass, common timothy (*Phleum pratense*) and smooth brome (*Bromus inermis*), all introduced species (Menke, et al 1996).

The nineteenth and twentieth centuries were also a time of significant expansion of agriculture in Tehama County, which resulted in significant changes to native grassland and riparian areas. The earliest farming occurred on the large scattered Mexican Land Grants. Farming then spread onto homesteaded valley land due to the demand for food prompted by a rapidly expanding population during the Gold Rush. Cereal farming was first to make its appearance, followed by more diversified and extensive agriculture. In the late 1800s the number of farms in Tehama County ranged from 600 to 800 and increased to 1,900 by 1945. Since then the number of farms have fluctuated, but with a general decline, with 1,679 farms reported in 1997. The farming was concentrated initially along the quality soils in the flat valley areas and rolling foothills. Annual dryland crops were dominant through the 1940s (Tehama County Department of Agriculture 2003). However, these were replaced with orchards following flood control and irrigation supply systems associated with the construction of Shasta Dam. Grazing and agricultural land use reduced the areas of native riparian forest reported to have existed during this period.

The settlers' early and extensive use of fire and heavy grazing has been blamed for exacerbating changes in foothill grassland communities. By 1900 there was a strong sentiment within America that fires in forests needed to be stopped. These fires, whether set by hunters, livestock owners, or by lightning, were viewed to be extremely detrimental to forests and watersheds. Consequently, very effective steps were taken to prohibit intentionally set fires and suppress accidental or natural fires. While well intentioned, halting of fire has had a number of serious consequences.

The forests in the Tehama West Watershed were likely a product of frequent fires. Native Americans set fires and others were ignited by lightning. Because the fires burned frequently, fuel loading (including limbs, downed logs, scattered brush, and litter) was limited. Therefore, when fires burned they produced relatively low amounts of heat and had short durations. The larger trees could endure such fires and an open, "park-like" condition developed (Muir 1901). Suppressing fires has allowed more time for debris and undergrowth to accumulate. After many decades of fire suppression, forests now are much denser, with much higher amounts of forest floor level fuels. The result is that when fires now start, they are very difficult to control and the intensity and severity of the fires tend to kill all or nearly all of the trees.

FOREST MANAGEMENT

Active forest management and harvesting began in the timber portions of the watershed in the later 1940s and early 1950s (Barron 2005, Schoendienst 2005). Up until that point most of the access into the steep country was along game trails via horseback (Barron 2005). The steeper rough topography of the area limited access until the development of larger earthmoving equipment after World War II (Schoendienst 2005). The first entries into the forest and private timberlands were generally correlated to the development of milling facilities in the 1940s. The Crane Mill in Paskenta was constructed in 1946 and the first access roads into the forest were constructed in the same year (Barron 2005). Logging began in late 1948 (Barron 2005).

The first cutting cycle through the timberlands occurred between 1948 and 1960, and included the removal and salvage of high risk trees (Barron 2005, Schoendienst 2005). It is likely that these initial removals favored pine. Local mills were generally pine mills, as pine had the most value of the species at that time.

Subsequent entries into the timberlands began about 1960. The period of 1960 to around 1970 reflected a period of selective harvesting. Larger trees were removed in the more accessible areas to allow regeneration in the understory. Topography continued to limit access to certain areas (Schoendienst 2005). This period resulted in the creation of early seral stage habitat conditions that have continued through today. The period of 1970 through the current period resulted in numerous subsequent reentries to the timbered areas for resource removal. Since 1970 cutting practices have varied by owner. Crane Mills, the largest private land owner in the watershed, has continued to practice a conservative, uneven-aged, selective management strategy, while other private land owners employed more aggressive harvesting practices. The USFS conducted harvesting activities through the late 1980s, when harvesting was greatly reduced due to concern over the spotted owl, and has generally maintained harvesting levels significantly below those prior to the spotted owl management requirements and the Northwest Forest Plan.

The harvesting activities have created significant acres of early seral habitat condition and, when coupled with the fire suppression management strategies of the last century, resulted in significant changes in stand composition. Chuck Schoendienst of the California Department of Forestry and Fire Protection (2005) compared tree inventory data from the western portion of Glenn and Tehama Counties for his upcoming book. The comparison was based predominately on the inventories for the private tracks of land once known as the Commander (or L-P) tract, most recently owned by Pioneer, and divided recently between the USFS and Crane Mills. The initial Commander inventory in 1945 showed that the private forests contained as much as 20,000 board feet per acre. Recent numbers for the same holding indicate that the current stocking is largely in smaller trees (hence the smaller board feet per acre volume) and in a non-climax condition of 2,000 board feet per acre or higher (Schoendienst 2005). The analysis was based on the original 1945 Lolo and Forest inventory and the recent 2003 Pioneer inventory data. This analysis showed that the volume of ponderosa pine had decreased throughout the ownership by 33 percent. In the same time period (1945 to 2003) Douglass fir had increased by 16 percent and white fir/red fir and cedar volumes had increased by 17 percent. The increase of more shade tolerant species is likely a result of the combination of silvicultural techniques not resulting in sufficient stand opening to allow the establishment of ponderosa pine, as well as the continuous strategy of fire suppression. These changes in stand dynamic and species composition to smaller, more shade tolerant species are common throughout California and the western United States. Both Crane Mills and the USFS are reported to carry more volume per acre than the Commander tract residual volumes. It also should be noted that "the private forest land in the western watershed has more early seral stage forest on a percentage basis than does the Mendocino National Forest, but the private land is by no means all early seral stage forest or lacking stand characteristics of more mature forests. Successful regeneration in the watershed requires open canopies because of soil types and precipitation" (Barron, 2005).

EXISTING PLANT COMMUNITIES

Vegetation patterns are shaped by the ecological forces at work in a region. Climate, topography, soil, the frequency of natural disturbance such as fire, and human management are all driving factors that affect how vegetation is distributed on the landscape. Unfortunately, patterns in nature are rarely an unchanging picture. Individual trees grow and die. Fires and other natural calamities periodically result in instantaneous change to entire forests. In this sense, the mosaic of vegetation types (e.g., conifer forest, sagebrush, aspen, etc.) constantly changes with time. To give an example, a mere 12,000 years ago glacial ice covered great portions of California. On a time scale closer to one in which we live, we can use ecology to describe the range of variability in vegetation patterns, and the trend of change in place. Tree ring and glacial records show that as recently as 1760 to 1820, California experienced an extensive period of drought unparalleled anywhere in the recent 2,000 years.

Plants tend to grow in areas where climate and soil are favorable to their specific needs. There are often a wide number of plants that have similar preferences or requirements and consequently are often found together. This mixture of species commonly existing together is known as a plant community. Existing plant communities within the Tehama West Watershed have been classified by CALVEG and cross-walked to Wildlife Habitat Relationship (WHR) habitat types (Mayer and Laudenslayer 1988). The plant communities existing in the Tehama West Watershed are shown in Figure 8-1 and their approximate acreage is summarized in Table 8-1. Although numerous vegetation mapping systems exist, the CALVEG system was selected for this watershed assessment because of the level of detail that it provides, its correlation to databases available with coverage on a statewide basis, and because of the relationship between these vegetation types and wildlife habitat functions.

A description of Tehama West Watershed plant communities beginning with those found in the highest elevations and working downslope follows in this section. USDA (1995), Mayer and Laudenslayer (1988), and Barbour and Major (1977) were used heavily for this section.

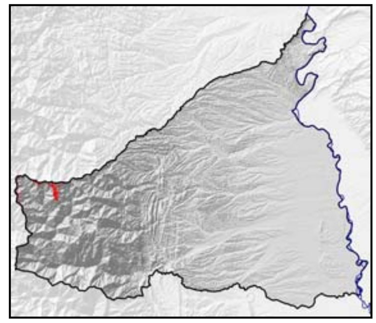
Table 8-1
VEGETATION TYPES (CALVEG WHR) IN THE TEHAMA WEST WATERSHED

WHR Type	Acres	Percent of Tehama West Watershed
Conifer-Dominated Habitats		
Red Fir	1,301	0.19%
White Fir	11,904	1.78%
Klamath Mixed Conifer	47,508	7.11%
Douglas Fir	38,293	5.72%
Ponderosa Pine	5,023	0.75%
Jeffrey Pine	20	0.01%
Montane Hardwoods-Conifer	17,673	2.64%
Closed-Cone Pine-Cypress	725	0.11%
Total	**122,447**	18.33%
Hardwood-Dominated Habitats		
Montane Hardwood	18,228	2.73%
Montane Riparian	83	0.01%
Blue Oak-Foothill Pine	19,931	2.98%
Blue Oak Woodland	110,923	16.60%
Valley Oak Woodland	6,739	1.01%
Eucalyptus	7,746	1.16%
Total	**163,650**	24.49%
Shrub-Dominated Habitats		
Montane Chaparral	3,084	0.46%
Mixed Chaparral	31,632	4.73%
Chamise-Redshank Chaparral	11,256	1.68%
Total	**45,972**	6.88%
Herbaceous-Dominated Habitats		
Wet Meadow	81	0.01%
Annual Grassland	207,668	31.08%
Total	**207,749**	31.09%
Agriculture-Crop-Dominated Habitats	**32,926**	4.93%
Urban-Dominated Habitats	**3,596**	0.54%
Barren Habitats	**2,870**	0.43%
Water/Aquatic Habitats	**1,028**	0.15%
Unclassified Areas	87,930	13.16%
TOTAL	**668,168**	**100.00%**

Note: No data for area east of Interstate 5 (unclassified)

Conifer-Dominated Habitats

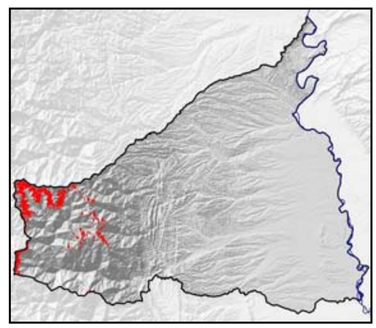
Red Fir



Conifer-dominated habitats extend over 122,000 acres of the Tehama West Watershed, or almost 18 percent of the total area. Red Fir (WHR:RFR) habitats exist on approximately 1,300 acres (<1 percent) of the Tehama West Watershed. This type is located on the highest slopes of the Coast Range, generally above 6,000 feet elevation. Higher elevations are generally sub-alpine or barren. This RFR type tends to have open to moderately open forests with relatively scant undergrowth. The dominant species is red fir (*Abies magnifica*), occasionally with mountain hemlock (*Tsuga heterophylla*) or white fir (*Abies concolor*).

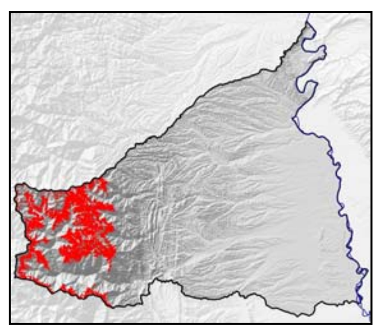
Wet meadows (WHR:WTM) are frequently associated with this habitat because of the occurrence of springs and glacial lakes or bogs at this elevation.

White Fir



White Fir type (WHR:WFR) occurs slightly lower in elevation than RFR habitats and are more widely spread. Almost 2 percent of Tehama West Watershed (11,904 acres) consists of this habitat. In Tehama County this type lies in the 5,000 to 6,000 feet zone, although it can extend lower on north-facing slopes. White fir (*Abies concolor*) is the dominant tree species but it may be mixed with red fir, sugar pine (*Pinus lambertiana*), and Jeffrey pine (*Pinus jeffreyii*). White fir stands, like red fir, tend to be relatively open habitat, however, following fire exclusion policies, occasionally dense understories comprised of trees from seedling to sapling in height exist. WFR stands can also be associated with wet meadows or with narrow riparian stringers (WHR:MRP) along headwater streams. Both RFR and WFR stands have often developed from wildfire-caused brushfields that the shade tolerant conifers eventually overtopped.

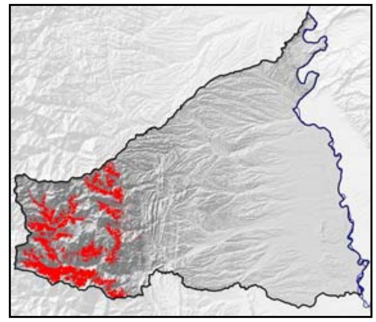
Klamath Mixed Conifer



The most abundant conifer-dominated habitat in Tehama West Watershed is Klamath Mixed Conifer (WHR:KMC) type. KMC covers approximately 47,500 acres or about 7 percent of the watershed. The type extends from approximately 5,000 feet downslope to approximately 2,500 feet elevation, depending upon slope aspect. It is comprised of a mixture of conifer species, including ponderosa pine (*Pinus ponderosa*), Douglas fir (*Pseudtsuga menziesii*), incense cedar (*Libocedrus decurrens*), white fir and sugar pine, along with California black oak (*Quercus kelloggii*). This type is considered to be the most valuable and intensely managed of the commercial conifer forest types in this region.

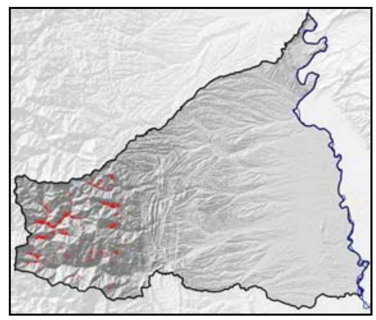
While originally an open forest type, fire suppression and timber management has tended to result in dense KMC stands with relatively high amounts of dead and down logs and litter. Small openings often have shrub and sub-tree species, including deerbrush (*Ceanothus integerrimus)* and Nuttall's dogwood (*Cornus nuttallii*). Species composition is also strongly associated with aspect and south facing slopes are dominated by ponderosa pine and north slopes dominated by Douglas fir within the mixed conifer type.

Douglas Fir



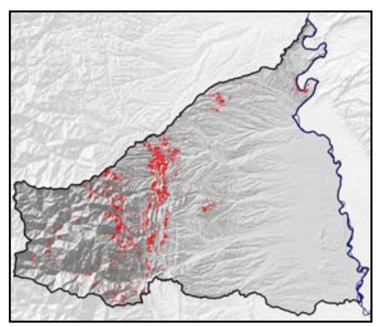
Occasionally, mixed in the KMC type elevation belt, three other conifer-dominated types Douglas Fir (DFR), Ponderosa Pine (PPN), and Montane Hardwood (MHC) are found. They have strong similarities to the KMC type but have slightly different conifer makeup: due to soil characteristics or past fire history. The first example are the stands dominated by Douglas Fir (WHR:DFR). Tree associates include California black oak and canyon live oak (*Quercus chrysolepis*). The understory can be quite variable in composition and density. It is usually found at mid- or lower elevations within the conifer zone and on north-facing slopes. Approximately 38,300 acres of dry fir forests exist in Tehama West Watershed, or slightly more than 5 percent of the total area.

Ponderosa Pine and Jeffrey Pine



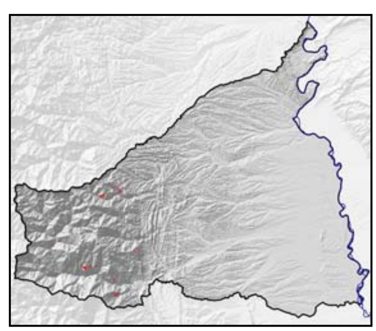
Stands dominated by Ponderosa Pine (WHR:PPN) occur on southern aspects at mid- or lower conifer zone. While sometimes growing as a monoculture, these stands often include a number of the other tree species found in KMC habitats. Undergrowth tends to be light. This habitat covers only about 5,000 acres. Jeffrey Pine (WHR:JFP) habitat types are rare and only found on 20 acres of the watershed. The type is dominated by Jeffrey pine and is often associated with soils high in magnesium and iron (ultra-mafic).

Montane Hardwood-Conifer



Montane Hardwood-Conifer habitats (WHR:MHC) exist in the same elevation zone as the KMC habitat. These stands have a mix of conifers and hardwood species in their overstory, especially Douglas fir, canyon live oak and California black oak. They appear to be a gradation in all manners between conifer- and hardwood-dominated habitats. This habitat tends to form near the lower elevations of the conifer-dominated habitats on relatively poor and rocky soils, and is estimated to cover 17,673 acres (almost 3 percent of the watershed).

Closed-Cone Pine-Cypress

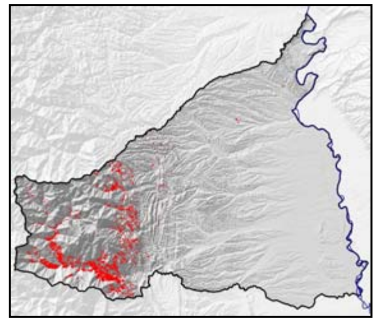


Closed-cone pine-Cypress habitats (WHR:CPC) cover 725 acres and are generally dominated by knobcone pine. In many ways this conifer type is much more like a chaparral habitat than a conifer type, as it is highly dependent upon high severity fires to regenerate its stands, is relatively short-lived, and tends to exist on harsh sites with poor soils. Knobcone pine's serotinous cones hold seeds tightly enclosed until heat pops them open. These stands often are densely covered with the pine, but heavy shrub islands can also occur, comprised of several species of manzanita and other chaparral. These habitats can be found from 3,000 feet down to 1,000 feet elevation, often on south-facing slopes.

Hardwood-Dominated Habitats

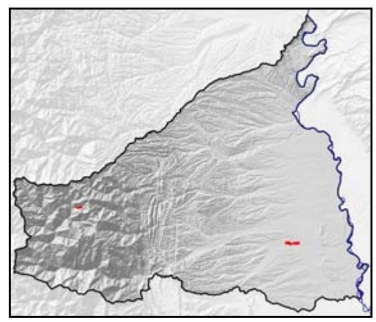
Hardwood-dominated habitats cover approximately 25 percent of the Tehama West Watershed (about 164,000 acres).

Montane Hardwood



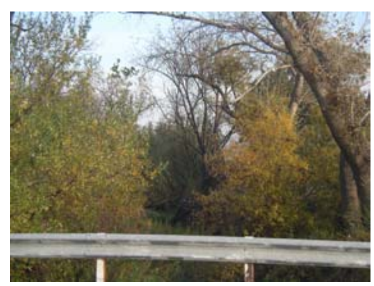
Montane hardwood habitats (WHR:MHW) can be found from 3,000 down to 1,000 feet elevation. Dominant trees include California black oak, coast (*Quercus agrfolia nee*) and interior live oak (*Quercus wislizeni*), and California bay-laurel (*Umbellularia californica*). Stands of this type are frequently found adjacent to conifer (e.g., KMC) or chaparral communities. Typically, soils are shallow and rocky, probably one reason why conifers do not dominate the sites. Chaparral species such as deerbrush, buckbrush, and manzanita often form a shrubby understory. This habitat exists on 18,228 acres of the watershed (almost 3 percent of the watershed area).

Montane Riparian



Montane riparian habitats (WHR:MRP) generally exist as narrow streamside buffers from 6,000 down to 2,500 feet elevation. Primary overstory trees include black cottonwood (*Populus balsamifera ssp trichocarpa)* and white alder (*Alnus rhombifolia*), with a willow (*Salix lasiandra*) and dogwood understory. In many cases this habitat is a very narrow swath on either side of streams, because the floodplain is constrained by the steep canyon slopes that support upland conifer- or hardwood-dominated habitats. Only 83 acres of this habitat has been typed (see Table 8-1).

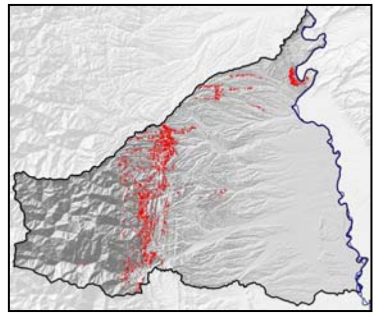
Valley Foothill Riparian



Valley Foothill Riparian Habitat, Houghton Creek

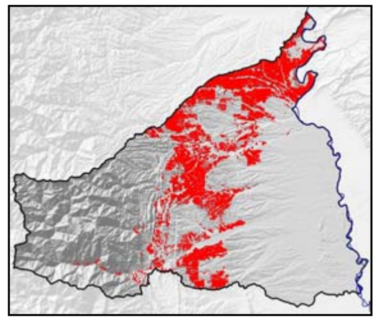
As Tehama West Watershed streams flow out of the Coast Range, the montane riparian habitat (MRP) gradually transitions into Valley Foothill Riparian (WHR:VFR) habitats. Dominant tree species include Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), white alder, and valley oak (*Quercus lobata nee*). Understory shrubs include wild grape, wild rose, California blackberry, poison oak, and willows. Lianas (hanging vines) such as wild grapes are a common feature of this habitat type. Because this habitat exists along streams that are unconstrained by canyon topography, the VFR riparian zone can be relatively wide. In prehistoric times it was likely up to 20 miles wide in the lower Sacramento and San Joaquin River reaches (World Wildlife 2005). In cases where disturbances such as floods or gravel mining occur in valley streamside zones, shrub willows are often the first species to be established in this type, followed by the taller growing tree species. There is no available estimate of the amount of VFR in the watershed.

Blue Oak-Foothill Pine



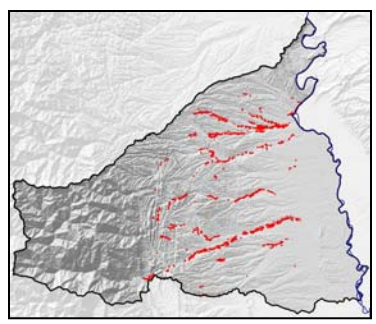
The eastern foothills of the Coast Range are commonly covered by Blue Oak-Foothill Pine (WHR:BOP) habitats. This habitat often occurs on rocky and thin-soiled slopes below 2,000 feet elevation. Blue oak (*Quercus douglasii*) and foothill pine (*Pinus sabiniana*) typically comprise the overstory of this type, with scattered pockets of interior live oak. The understory can have significant amounts of chaparral shrub species (see later description of Mixed Chaparral habitat) or annual grasslands. Over 19,000 acres of the Tehama West Watershed consists of this type.

Blue Oak Woodland



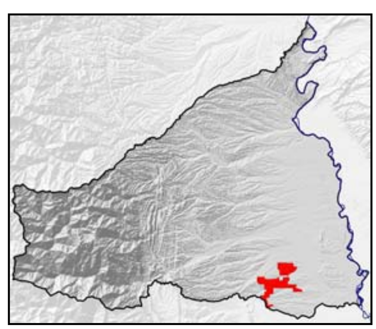
Blue Oak Woodlands (WHR:BOW) are similar to BOP habitats but lack the scattered overstory of foothill pine and have less chaparral understory. The BOW habitat typically occurs lower in elevation, generally below 1,500 feet elevation. This is the most common tree-dominated habitat in Tehama West Watershed, extending over almost 111,000 acres or 16 percent of the entire watershed. The type forms a discontinuous ring in the foothills around the Central Valley. It is dominated by open-grown blue oak over an annual grass and forb understory but there may be occasional pockets of chaparral. Characteristically, blue oak communities occur on dry, rocky slopes in infertile soils. This community gradually thins out and is replaced by annual grasslands below 500 feet elevation. Cattle grazing, low seedling recruitment, and land conversions are contributing to the gradual loss of blue oak woodland throughout the state. Extensive areas of this type were converted to grasslands through the 1950s to improve cattle range.

Valley Oak Woodland



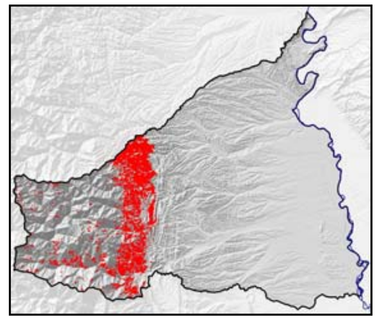
Valley oak are among the tallest growing of all California's oaks and provide the dominant overstory tree in the Valley Oak Woodland (WHR:VOW) community. Mature valley oaks can reach a height of 115 feet. These stands occur in the Sacramento Valley floor along natural drainages. VOW stands with little or no grazing and those in riparian areas tend to develop a partial shrub understory of poison-oak, toyon, wild grape, and coffeeberry. In other situations the tree cover is open-grown with an annual grass and forb understory. Common associates of the valley oak include California sycamore, Hinds black walnut, interior live oak, and boxelder. This type covers over 6,700 acres in the watershed.

Eucalyptus



Eucalyptus woodlands (WHR:EUC) exist within the hardwood habitat covering almost 8,000 acres in the lower elevations of the Sacramento Valley, close to Interstate 5. Eucalyptus (*Eucalyptus globulus*) was originally introduced a century ago to provide wood lots for fire wood, as well as for fuel to power steam engines (Schoendienst 2005). Eucalyptus cuttings were initiated several decades ago to provide a wood chip base for the pulp industry in northern California. The trees are irrigated by drip-hoses and grow very rapidly. Management consists of periodic whole-tree shearing and chipping, allowing the sprouting tree to regrow. Because the pulp mill that was to use this product has closed, the final product coming from the EUC stands now goes to garden mulch, but the plantations are still being managed and maintained in a manner similar to that originally planned. Very little, if any, competing trees or shrubs exist in these plantations, but annual grasses and forbs exist in openings.

Shrub-Dominated Habitats

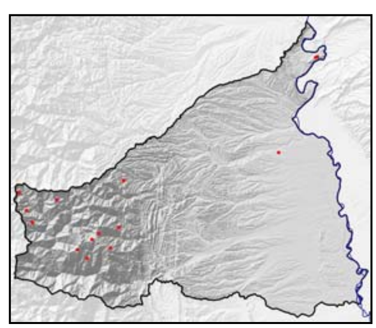


About 8 percent of the Tehama West Watershed area is dominated by shrub communities (about 46,000 acres). Three chaparral-dominated habitats constitute these shrub types, including: Montane Chaparral (WHR:MCP), Mixed Chaparral (WHR:MCH), and Chamise-Redshank Chamise (WHR:CRC). These habitats tend to form dense canopies comprised of relatively few chaparral species. Generally speaking, MCP habitats exist at the highest elevations and are often associated with conifer-dominated stands. Common shrub species include manzanita species, chinquapin (*Chrysolepis* spp.), deerbrush (*Ceanothus integerrimus*) or wedgeleaf ceanothus (*Ceanothus cunneatus*) and silk-tassels (*Garrya* spp.). MCH stands are found at intermediate elevations at or near the lower limits of the KMC zone and include several manzanita, Ceanothus species, and birch-leafed mahogany (*Cercocarpus betuloides*). CRC habitats are found the lowest elevation of the chaparral habitats and are dominated by nearly pure stands of chamise (*Adenostoma fasciculatum*). The MCH and CRC habitats exist on poor, rocky soils, often with severe, southerly aspects, while MCP stands may represent the result of recent fires and ultimately may evolve into conifer stands.

Mature chaparral-dominated habitats have little herbaceous growth, due to nearly total canopy cover by the shrub's foliage. However, these types are well adapted to periodic wildfires and respond by both resprouting (e.g., chamise and some manzanitas) and rapid reseeding (some *Ceanothus* and some manzanita species). For several years following wildfire, where reduced shrub canopy cover allows sunlight on the soil, annual forbs growth can be very abundant. This likely stems from seed that persisted in the soil for long periods of time. These three chaparral habitats cover approximately 46,000 acres or about 6 percent of the Tehama West Watershed.

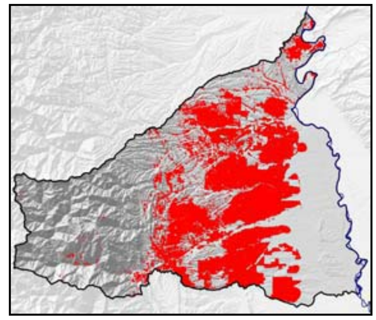
Herbaceous-Dominated Habitats

Wet Meadow



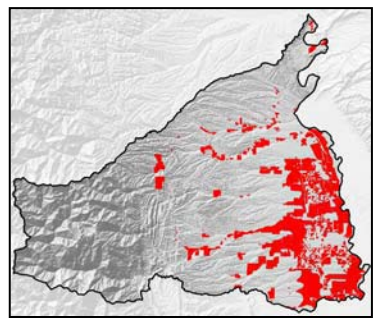
Wet Meadows (WHR:WTM) are uncommon and scattered in the Tehama West Watershed, comprising only 81 acres. Because they tend to be small in size, CALVEG typing likely failed to detect many of these meadows and their true extent may be greater. They can be found at any elevation within the watershed. Wet meadows consist of herbaceous species (grass and forbs) that require or tolerate saturation of soils all, or nearly all, of the year. The saturated soil conditions that create this habitat can be attributed to adjacent springs or streams or local sub-surface soil conditions that prevent surface water from infiltrating the ground. Scattered patches of shrubs, such as willow (*Salix spp.*) or dogwoods (*Cornus spp.*) can exist along the edges or within these meadows. Likewise, moist-soil-tolerant conifer species, such as lodgepole pine (*Pinus contorta*), can be associated with WTM margins. These habitats can be spectacular in early summer with their colorful show of wildflowers.

Annual Grassland



Annual Grasslands (WHR:AGS) are by far the most common habitat existing within the watershed, covering almost 208,000 acres, or about 30 percent of the Tehama West Watershed. These annual grasslands are generally made up of introduced annual grasses and both native and introduced forbs. They exist in elevations below blue oak woodlands, where soil conditions do not favor other hardwood growth, or as openings in blue oak woodlands. Decades of ranching, agricultural use, and extended drought periods have nearly converted the state's dry upland from perennial bunchgrass-dominated grasslands to an annual system dominated by grasses, forbs, and broad leaf. A unique sub-set of the remaining native grassland community is comprised of nodding needlegrass (*Nasella cernua*), found at its northern limit in Tehama County, just north of Black Butte Reservoir (CNDDB 2005).

Agricultural-Crop-Dominated Habitats



For the purpose of this discussion, the term "agricultural-crop-dominated habitats" refers to orchard, field crops, and row crops (WHR:AGC). In some cases pastures may also be included, but not rangelands seasonally-used for grazing, which are generally termed annual grasslands (AGS). Typically, agricultural lands are monotypic; however, trees and shrub rows often exist as windbreaks at field edges or fence lines and some weedy vegetation is found along field edges and roads. There are approximately 80,500 acres of agricultural land in the Tehama West Watershed (almost 5 percent of the total area), with grain, rice, orchards, and hay making up the majority of the acreage. Table 8-2 contains acreage statistics for the agricultural land uses in the watershed based on Tehama County parcel data. These are discussed in more detail in Section 3, "Demographics, Land Use, and Economic Activity" and Section 7, "Water Quality."

Urban-Dominated Habitats

Scattered metropolitan areas and suburban and rural communities constitute urban habitats (WHR:URB). These habitats are characterized by human modifications to allow year-round habitation. Plant composition is highly variable and includes high concentrations of exotic ornamental shade trees and shrubs, as well as small inclusions of habitat dominated by native vegetation (e.g., riparian areas). Within western Tehama County the largest urban areas are Red Bluff and Corning, with smaller urban areas including Paskenta, Flournoy, Richfield, Tehama, Gerber, and Proberta. Urban habitats take up almost 3,600 acres of land (< 1 percent) of the watershed area. These urban habitats are a source of exotic species that pose a continuous threat to wildlands.

Table 8-2 AGRICULTURE LAND USE IN THE TEHAMA WEST WATERSHED		
Land Use Code	**Land Use Description**	**Acreage**
30X: 300-306	Irrigated Prune Orchard	9,140
31X: 310-316	Irrigated Walnut Orchard	7,160
32X: 320-326	Irrigated Almond Orchard	7,053
33X: 330-336	Irrigated Olive Orchard	7,665
34X: 340-346	Irrigated Miscellaneous Orchard	1,278
35X: 350-356	Irrigated Vine & Bush Fruits	53
36X: 360-366	Irrigated Row Crops	3,301
37X: 370-376	Irrigated Field Crops	10,433
40X: 400-408	Irrigated Pasture	23, 883
50X: 500-506	Dry Land Orchard	19
52X: 520-526	Dry Land Field Crops	10,517
TOTAL		**80,502**
Source: Tehama County Parcel Data		

Barren Habitats

Serpentine Soils (Barren Habitats)

Barren areas (WHR:BAR) can be found scattered throughout the Tehama West Watershed at virtually any elevation. These sites have little or no vegetation due to adverse soil conditions or recurring soil movement. Examples include shear rock faces and cliffs and areas with serpentine soils that have excess levels of magnesium and iron. The plants living on these areas are highly adapted for dealing with the significant moisture retention and chemical-imbalance challenges associated with these barren sites. These soil types support unique assemblages of plant species with many endemic and rare species. These will be discussed in the following section.

Water/Aquatic Habitats

Both perennial and seasonal aquatic habitats exist within the Tehama West Watershed. Perennial aquatic habitats are those existing in reservoirs, streams, and ponds (WHR:LAC). Emergent vegetations, such as tule are typical. Seasonal aquatic habitats include vernal pools, which have water during the wet season and quickly dry in the spring. The vernal pools and marshes are sensitive botanical resources that have limited distribution in Tehama County. Marshes tend to be very effective at filtering water of sediment and contaminants, and are therefore valuable for water quality. The vernal pools are well-known for providing habitat for rare plant and animal species, which will be described in the following section as well as in Section 3, "Demographics, Land Use, and Economic Activity" and Section 9, "Wildlife Resources." Aquatic habitats cover approximately 1,000 acres of land in the Tehama West Watershed.

SENSITIVE BOTANICAL RESOURCES

Freshwater Marsh, Central Valley

Sensitive botanical resources are defined to be Tehama West Watershed plant communities that are limited in extent, contain a variety of rare species, or are at significant risk of reduction due to human activities or other factors. In some cases a given plant community may have all of these attributes. The sensitive botanical resources identified for the Tehama West Watershed includes those listed by the California Natural Diversity Database (2005) and others known to have environmental sensitivities or outstanding attributes:

- Great Valley (Central Valley) mixed riparian forests
- Great Valley oak riparian forests
- Great Valley cottonwood riparian forests
- Great Valley willow shrub habitats
- Great Valley freshwater marshes
- Great Valley needlegrass grasslands
- Northern hardpan vernal pools
- Plant communities on serpentine soils
- Oak woodlands

Great Valley Riparian and Related Habitats

The Great Valley habitats delineated (including mixed, cottonwood, and oak riparian forests), have been greatly reduced during historical times due to conversion of croplands, flood control and stream channelization, and urbanization. These habitats occurred in low-lying areas, near the Sacramento River or major tributaries that are now considered prime for either agricultural development or urbanization. There are likely remnants of these habitats in scattered locations along the eastern edge of the watershed.

Great Valley needlegrass habitats represent what portions of the Central Valley might have been like prior to settlement. Only a few examples of this community still exist, with a site just north of Black Butte Reservoir being the northern representative.

Great Valley freshwater marshes have been greatly affected by gravel mining, stream channel modifications, and water flow management, including the diversion of water from streams. At one time the rivers and low-lying areas of the Central Valley supported vast freshwater marshlands and it is estimated that less than 6 percent remains today of what originally existed (World Wildlife 2005).

Vernal Pool Habitats

One significant example of sensitive wetlands is the hardpan vernal pools found in a band from Red Bluff in the north to the Glenn County line in the south (see Figure 8-2). Vernal pools are habitats that are inundated for a few days to a few months during the spring. They typically form in small depressions that are underlain by impermeable sub-soils (see Section 4, "Geology and Soils"). They provide a unique habitat for both plant and animal species, particularly invertebrates. Some of these species are endemic, not being found anywhere else on the earth.

Vernal pools in the Sacramento Valley are essentially islands of native vegetation in non-native grasslands; only about 20 of the 200 species known to exist in them are non-native (Holland and Jain 1984). The water relations in these pools and their landscapes can be easily altered by plowing, paving, road construction, ripping the subsoils, flood control activities or simply by altering the landscape that lies upstream of existing pools. It is generally in landscapes that have unaltered hydrologic regimes that vernal pools and their associated flora are found to persist.

Vernal Pool, Central Valley

Because of their importance, vernal pools were mapped by CDFG in 1998. This mapping provides the sources of Figure 8-2. CDFG is also responsible for managing a vernal pool reserve located northwest of Corning. Ongoing studies include the effects of grazing on the vegetation and ecological function; the habitat values of the pools; and techniques of managing vernal pool landscapes to maintain diversity. Through the past decade efforts have been placed into creation of vernal pool habitats.

Vernal pool landscapes evolved under the impacts of grazing from native herbivores. One management decision that may indirectly affect hydrology is the cessation of livestock grazing. Although vernal pools may not have evolved under extensive grazing practices common today, the current hydrology and ecology of most vernal pool landscapes in the Sacramento Valley have been influenced by a livestock grazing regime. Observations of vernal pool sites where livestock were excluded for fifteen years indicate that removal of livestock favors exotic annual species around the margin of vernal pools. Complete rest from livestock grazing may also alter the hydrology of the vernal pool landscape by increasing residual dead plant material and altering the soil structure (Barry 1996; UCAE 2005).

Numerous studies have been conducted on vernal pool habitats in California by The Nature Conservancy (TNC), CDFG, Natural Resources Conservation Service (NRCS) and others showing that grazing can help reduce the cover of invasive non-native species (DiTomaso 2000, Marty 2004). Locally in Tehama County (eastern portion), CDFG biologists are evaluating community interaction and grazing effects on vernal pool plants and macroinvertebrates (Lis and Eggeman 1999) however, the results of grazing trials have not been published. In areas where native herbivores have been eliminated, livestock grazing may replicate ecological disturbance processes vital to local ecosystems (Marty 2004, Collins 1998). In 2000, researchers in TNC Consumnes River Preserve began an experiment examining the role cattle grazing plays in the maintenance of plant and animal wetlands. A summary of the results from 2004 are as follows.

TNC tested the impact of four grazing treatments on two soil types. After just 3 years, the ungrazed vernal pools became overgrown with non-native vegetation following grazing, and the small species composition of the pools shifted to non-native grass. The hydrology of the ungrazed pools also changed significantly over the 3 years of the experiment. In 2003, the pools that were ungrazed had an average maximum inundation period of 65 days, whereas the continuously grazed pools were inundated for a maximum of 115 days. In addition to this reduction in the inundation period, the ungrazed pools dried and refilled an average of twice per season, while the continuously grazed pools dried fewer than once per season on average. Invertebrate taxa richness was negatively affected by these hydrologic changes. By the third year, taxa richness was approximately 20 percent lower in the ungrazed treatment group than in the continuously grazed control group. The research found that livestock grazing plays an important role in maintaining species diversity in the vernal pool grasslands studied. Grazing removal resulted in significant negative effects on the pools native plant communities, hydrology, and aquatic invertebrate communities. Researchers concluded that grazing should be considered a potentially positive force for the maintenance of biodiversity in some situations.

On the other hand, improperly managed grazing can negatively impact vernal pools. Disturbance can include the compaction of soils, particularly when they are wet, and excessive loss of native vegetation. In planning for grazing livestock, managers should consider the effects of grazing different livestock, season of grazing, and grazing intensity (Barry 1996; UCAE 2005).

Ultra-Mafic Habitats

The Coast Range contains significant acreage of temperate forest and Mediterranean scrub (chaparral) and savanna. The temperate coniferous forests of northwestern California contain significant expressions of biodiversity due to the area's complex terrain, geology, climate, and biogeographic history. Although well-known among biologists, few Americans realize the uniqueness of these coniferous forests (Rickets 1999). Plant communities located in this area, whether dominated by conifer, shrub, or herbaceous cover are particularly rich in endemic plants and these plants support endemic invertebrates (Rickets 1999). Rare species located in these habitats of the Tehama West Watershed will be described later in this section.

The main reason for the high number of rare, endemic plants in the Coast Range is the presence of outcrops of ultra-mafic soil that are rich in magnesium and iron. Many species of plants cannot grow in these conditions and others can survive but appear stunted. These areas have an unusual appearance, as if they had been burned, greatly reducing the density of vegetation. Because of the chemical imbalances inhibiting many species and the patchy nature of these geologic formations, many rare plant species that are tolerant of the chemical anomalies have evolved. A list of the rare plants known to exist in the Tehama West Watershed (many of which live exclusively or frequently on serpentine soils) is presented in the next section.

THREATENED AND ENDANGERED SPECIES

The United States Congress passed the Federal Endangered Species Act (FESA) in 1973 with the goal of protecting species that were endangered or threatened with extinction. The State of California enacted a similar law, the California Endangered Species Act (CESA) in 1984 and Native Plant Protection Act. Both regulatory entities have processes by which species are nominated and reviewed for suitability to be considered and placed on a list as either threatened or endangered. California also has a list of animal species that are not included under CESA but potentially could be at-risk, called "Species of Special Concern." Lists of federal- and state-listed species can be found in Section 9, "Wildlife Resources." Any project that could affect the habitat or individual species on any of these lists requires species assessments, permits, and mitigation.

For plants, an additional entity, the California Native Plant Society (CNPS), maintains a list of species that have low numbers, limited distribution, or are otherwise threatened with extinction. The USFS and Bureau of Land Management (BLM) also maintain special species listings and should be continued for projects on federal land. This information is published in the Inventory of Rare and Endangered Vascular Plants of California (CNPS 1994). The categories used by CNPS to describe individual species' conditions are:

- 1A-Plants presumed extinct
- 1B-Plants rare, threatened, or endangered in California and elsewhere
- 2-Plants rare, threatened, or endangered in California, but more common elsewhere
- 3-Plants for which more information is needed to determine status
- 4-Plants with limited distribution

Table 8-3 lists the rare, threatened and endangered plants known to occur in western Tehama County. It is important to appreciate that of the 28 species shown, 11 (39 percent) are known to be strongly associated with serpentine soils, 6 (21 percent) occur only in vernal pools, and two (7 percent) are found in marshes and other wetlands. In other words, 19 of 28 rare plant species (68 percent) exist in habitats that are represented in only a very small percent of the watershed's lands, and in the case of wetlands and marshes, habitats that have been greatly reduced through historical development.

Table 8-3
ENDANGERED, THREATENED, AND RARE PLANT SPECIES

Common Name	Latin Name	Status	Preferred Habitats	Records for Tehama West
Hendersons' bent grass	*Agrostis hendersonii*	CNPS 3	Wetlands	1
Scabrid alpine tarplant	*Anisocarpus scabridus*	CNPS 1B	Sub-alpine	5
Sonoma manzanita	*Arctostaphylos canescens ssp. sonomensis*	CNPS 1B	Serpentine/Forest	1
Konocti manzanita	*Arctostaphylos manzanita ssp. elegans*	CNPS 1B	Mixed Conifer	1
Jepson's milk-vetch	*Astragalus rattanii ssp. jepsonianus*	CNPS 1B	Serpentine/Oak Woodlands	1
Big-scale balsamroot	*Balsamorhiza macrolepis* var. *macrolepis*	CNPS 1B	Serpentine/Chaparral	3
Indian Valley brodiaea	*Brodiaea coronaria* ssp. *rosea*	State Endangered CNPS 1B	Serpentine/Closed Pine and Chaparral	2
Stony Creek spurge	*Chamaesyce ocellata* ssp. *rattanii*	CNPS 1B	Valley and Foothill Grasslands	18
Dwarf soaproot	*Chlorogalum pomeridianum* var. *minus*	CNPS 1B	Serpentine/Grasslands and Chaparral	11
Silky cryptantha	*Cryptantha crinita*	CNPS 1B	Gravelly Streambeds	2
Dwarf downingia	*Downingia pusilla*	CNPS 2	Vernal Pools	11
Four-angled spikerush	*Eleocharis quadrangulata*	CNPS 2	Marshes/Ponds	4
Oregon fireweed	*Epilobium oreganum*	CNPS IB	Serpentine/Forest Bogs	1
Brandagee's eriastrum	*Eriastrum brandageeae*	CNPS 1B	Barren Volcanic Chaparral	26
Tracy's eriastrum	*Eriastrum tracyi*	State Rare CNPS 1B	Chaparral	1

Table 8-3 (cont.) ENDANGERED, THREATENED, AND RARE PLANT SPECIES				
Common Name	**Latin Name**	**Status**	**Preferred Habitats**	**Records for Tehama West**
Adobe-lily	*Fritillaria pluriflora*	CNPS 1B	Chaparral/Adobe Soil	1
Boggs Lake hedge-hyssop	*Gratiola heterosepala*	State Endangered CNPS 1B	Vernal Pool	2
Nile's harmonia	*Harmonia doris-nilesiae*	CNPS 1B	Serpentine/Chaparral	1
Stebbin's harmonia	*Harmonia stebbinsii*	CNPS 1B	Serpentine/Chaparral	5
Tehama County western flax	*Hesperolinon tehamense*	CNPS 1B	Serpentine/Chaparral	9
Red Bluff dwarf rush	*Juncus leiospermus* var. *leiospermus*	CNPS 1B	Vernal Pools	5
Colusa layia	*Layia septentrionalis*	CNPS 1B	Serpentine/Chaparral	1
Mt. Tedoc leptosiphon	*Leptosiphon nuttallii ssp. Howellii*	CNPS 1B	Serpentine/Lower Forest	4
Anthony Peak lupine	*Lupinus antoninus*	CNPS 1B	Sub-alpine	1
Leafy-stemmed miterwort	*Mitella caulescens*	CNPS 1B	Conifer Forest/Seeps	1
Baker's navarretia	*Navarretia leucocephala* ssp. *bakeri*	CNPS 1B	Vernal Pools	1
Pincushion navarretia	*Navarretia myersii* var. *myersii*	CNPS 1B	Vernal Pools	1
Ahart's paronychia	*Paronychia ahartii*	CNPS 1B	Vernal Pools	10
Source: CNDDB, 2005				

Endangered plants within the watershed area are found in six major habitat types. Figure 8-3 displays occurrences of rare plants in the watershed. Habitat types and number of species per type are included in Table 8-4.

Table 8-4 HABITAT TYPES AND NUMBER OF SPECIES IN THE WATERSHED	
Type	**Number of Species**
Vernal pool	12
Serpentine soils	31
Chaparral (non-serpentine soil)	15
Conifer forest	12
Mesic (bogs, riparian areas, meadows, etc, but not vernal pools)	23
Grasslands	6
Miscellaneous (rock outcrops, rocky streams, etc)	6

Although vernal pool habitats discussed previously have received, by far, the greatest regulatory attention, other habitat types such as serpentine soil areas (both chaparral conifer and grassland) also harbor populations of species narrowly adapted to the specific habitat.

Serpentine soils are derived from deep ocean rock formations that were metamorphosed, pushed up to the surface, and weathered. While relatively rare on the surface of the earth, they are common in California and the watershed's Coastal Range Mountains. These soils have high levels of magnesium and iron but relatively low amounts of other essential minerals, such as calcium. In addition, the soils are often thin and retain little moisture. These conditions create a physical environment that severely challenges most plant species. While some taxa cannot endure the conditions, other species can. For this reason, the vegetation growing on serpentine soils often looks relatively stunted (Raven 1977).

Serpentine soils tend to be patchy in distribution; consequently, the species that can endure these soils are often surrounded by vegetation communities where they cannot compete as well. This isolation of populations resulted in the evolution of a large number of rare, endemic plant species with very limited geographic distribution. There are approximately 282 rare plant species existing in California that are primarily associated with serpentine soils and Tehama West Watershed supports some of these species.

INVASIVE PLANTS AND OTHER 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 with "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). Plant pests are defined by law, regulation, and technical organizations, and regulated by many different sources, which include the California Department of Food and Agriculture (CDFA), United States Department of Agriculture (USDA), and the California Invasive Plant Council (CalIPC). 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 California Invasive Plant Council has developed a list of plant pests specific to California wildlands. The "CalIPC" list is based on information submitted by land managers, botanists, and researchers throughout the state and 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, 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 CalIPC list categories are explained in more detail in Table 8-5

The Tehama County Agricultural Commissioner maintains a list of the CDFA-rated invasive plants known to occur in the county. This list and the CDFA and CalIPC designations of these plants are provided in Table 8-6. Table 8-7 provides a list of the CalIPC invasive pests.

Table 8-5 CDFA AND CALIPC 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.
CalIPC 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 includes widespread pests that are invasive in more than three Jepson regions, and List A-2 includes 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 CalIPC, County Agricultural Commissioner, or California Department of Food and Agriculture.

Additional information on common invaders is included on Table 8-8. Weed Management Areas (WMA) are local organizations that bring together various private and government officials to cooperatively coordinate efforts for controlling the spread of common invasive plants. The Tehama WMA is participating in a multi-county effort with Glenn and Colusa Counties to map and control invasive plants.

Once invasive plants have spread into native vegetative communities, such as riparian areas or annual grassland, it is very difficult to eradicate them. Weed control methods include physical control (e.g., burning, hand pulling), chemical control (e.g., selective or non-selective herbicides), and biological control (e.g., insects that eat the pest). A group of sixteen state and federal agencies called the California Interagency Noxious Weed Coordinating Committee created the Calweed database that provides information on weed control projects underway in California counties. According to the database there are presently nine weed control projects in Tehama County, including focused efforts against seven of the species listed in Table 8-8. These projects include the county agricultural commissioner, conservation groups, and the Tehama County Resource Conservation District (TCRCD).

In 2002 stream restoration projects for Reeds Creek and Red Bank Creek were initiated through a partnership with the TCRCD, CSU Chico, Chico's Non-Native Eradication Team, and the Tehama County Agriculture Department. During the first season, 12 acres of Red Bank Creek and 8 acres of Reeds Creek were treated with the EPA aquatically approved herbicide, Rodeo™. This project has been successful, involving over 100 landowners.

Table 8-6 CDFA NOXIOUS WEEDS FOUND IN TEHAMA WEST WATERSHED					
Rank	**Latin Name**	**Common Name**	**Found in Tehama County**	**Verified in Tehama West Watershed**	**Target for Eradication**
A					
	Centaurea diffusa	Diffuse knapweed	X	X	X
	Centaurea maculosa	Spotted knapweed	X	X	X
	Chondrilla juncea	Skeletonweed	X		X
	Linaria genistifolia ssp *dalmatica*	Dalmation toadflax	X	X	X
	Hydrochoris morsus-ranae	European frogbit	X		X
B and C					
	Allium vineale	Wild garlic	X		
	Cardaria draba	Heart-podded hoarycress	X		X
	Cirsium arvense	Canada thistle	X	X	X
	Elytrigia repens	Quackgrass	X		
	Isatis tinctoria	Dyer's woad	X		X
	Lepidium latifolium	Perennial peppercress	X		
	Euphorbia oblongata	Oblong spurge	X		X
	Carduus pycnocephalus	Italian thistle	X	X	
	Centaurea solstitialis	Yellow starthistle	X	X	
	Convolvulus arvensis	Field bindweed	X	X	
	Cuscuta spp.except *C. reflexa*	Dodder	X	X	
	Cynodon spp and *hybrids*	Bermudagrass	X	X	
	Cytisus scoparius	Scotch broom	X	X	
	Genista monspessulana	French broom	X		
	Hypericum perforatum	Klamath weed	X	X	
	Salsola tragus	Common Russian thistle	X		
	Sorghum halepense	Johnston grass	X	X	
	Taeniatherum caput-medusae	Medusahead	X	X	
	Cenchrus echinatus	Southern sandbar grass	X	X	X
	Cyperus esculentus	Yellow nutsedge	X	X	
	Eichhornia crassipes	Common water hyacinth	X		
	Senecio jacobaea	Tangy ragwort	X		
	Solanum elaeagnifollim	White horsenettle	X		

In 2003 tamarisk was treated by cutting and planting native vegetation on Red Bank Creek. Cutting and leaving the exotic root-wads in place provides stabilization for the stream bank, and the opportunity for native plant growth. Additional work on arundo (*Arundo donax*) in Reeds Creek was completed in 2003.

Additional information on these and other invasive plants can be found at:

- http://www.nps.gov/plants/alien/factmain.htm
- http://www.cdfa.ca.gov/phpps/ipc/weedinfo/winfo_photogal-fameset.htm

Table 8-7 CALIPC LIST OF INVASIVE PESTS					
Rank	**Latin Name**	**Common Name**	**Found in Tehama County**	**Found in Tehama West Watershed**	**Target for Eradication**
Red Alert: Species with potential to spread explosively; infestations currently restricted					
	Centaurea maculosa	Spotted knapweed	X	X	
	Hydrilla verticillata	Hydrilla	X		
	Lythrum salicaria	Purple loosestrife	X		
List A-1 – Most invasive wildland pest plants; widespread					
	Arundo donax	Giant reed, arundo	X	X	
	Bromus tectorum	Cheat grass, downy brome	X	X	
	Centaurea solstitialis	Yellow starthistle	X	X	
	Cortaderia selloana	Pampas grass	X	X	
	Cytisus scoparius	Scotch broom	X	X	
	Genista monspessulana	French broom	X		
	Lepidium latifolium	Perennial pepperweed, tall whitetop	X		
	Rubus discolor	Himalayan blackberry	X	X	
	Taeniatherum	Medusahead	X	X	
	Tamarisk chinensis, T. gallica, T. parviflora & T. ramosissima	Tamarisk, salt cedar	X	X	
List A-2 – Most invasive wildland pest plants; regional					
	Ailanthus altissima	Tree of heaven	X	X	
	Cardaria draba	White-top, hoary cress	X		
	Elaeagnus angustifolia	Russian olive			
	Ficus carica	Edible fig	X	X	
	Mentha pulegium	Pennyroyal			
List B – Wildland pest plants of lesser invasiveness					
	Carduus pycnocephalus	Italian thistle	X		
	Centaurea melitensis	Tocalote, Malta starthistle			
	Cirsium arvense	Canada thistle	X	X	
	Cirsium vulgare	Bull thistle	X	X	
	Conium maculatum	Poison hemlock			
	Hypericum perforatum	Klamath weed, St. John's wort	X	X	
	Myriophyllum aquaticum	Parrot's feather	X		
	Phalaris aquatica	Harding grass	X	X	
	Robinia pseudoacacia	Black locust	X		
	Spartium junceum	Spanish broom	X		
	Vinca major	Periwinkle	X	X	
Need more information					
	Descurainia sophia	Flixweed, tansy mustard	X		
	Isatis tinctoria	Dyers' woad	X		
	Ludwigia uruguayensis	Water primrose	X		
	Pinus radiata cultivars	Monterey pine			
	Pyracantha angustifolia	Pyracantha			
	Salsola tragus	Russian thistle, tumbleweed	X	X	
	Salvia aethiopis	Mediterranean sage			
Annual grasses					
	Aegilops triuncialis	Barbed goatgrass	X		
	Avena fatua	Wild oat	X		
	Bromus diandrus	Ripgut brome	X		

Table 8-7 (cont) CALIPC LIST OF INVASIVE PESTS					
Rank	**Latin Name**	**Common Name**	**Found in Tehama County**	**Found in Tehama West Watershed**	**Target for Eradication**
Considered, but not listed					
	Dipsacus sativus, D. fullonum	Wild teasel, Fuller's teasel	X		
	Medicago polymorpha	California bur clover	X	X	
	Melilotus officinalis	Yellow sweet clover	X	X	
	Nerium oleander	Oleander	X	X	
	Silybum marianum	Milk thistle	X	X	
	Xanthium spinosum	Spiny cocklebur	X	X	

Yellow Starthistle

Yellow starthistle is one of the most invasive weeds in Tehama County. It is usually found in moderately dry fields, roadsides, and rangelands. It does not compete well with dense vegetation in fields that are well watered. Insect species have been introduced in the past, collected from the weed's originating country, to help control this species, including: hairy weevil (*Eustenopus villosus*), seedhead weevil (*Bangasternus orientalis*), gall fly (*Urophora sirunaseva*), and the flower weevil (*Larinus curtis*) (Tehama County 2003).

Tamarisk

Thicket-forming members of the genus tamarisk or saltcedar, were originally introduced to North America from Eurasia for windbreaks and ornamentals, or to assist with erosion control. Since their introduction around 1950, seven species have spread through 23 states, and dominate 1.2 million acres of riparian and shrub habitats (Zavaleta 2000). The tamarisk group has many of the classic characteristics of weedy invasive plants, including rapid reproduction and the ability to dominate a site where it becomes established. In addition, it can alter the ecosystem to its own advantage and to the disadvantage of native species. Tamarisk can produce as many as 80 seeds per square inch, per year, which germinate quickly and easily in a wide range of conditions. After germination, the plants can grow up to 2 inches per day, consuming tremendous quantities of water and drawing salts up to the surface from deep in the soil. These salts are secreted on the foliage, and when the foliage drops onto the soil each year, the salinity increases until it reaches up to 20 times the tolerance level of willow and cottonwood (Zavaleta 2000).

Table 8-8
SIGNIFICANT INVASIVE PLANTS KNOWN TO EXIST BY WILDLAND COMMUNITY

Plant Species	Type	Location	Reproduction	Risk	Control Strategy	Source
Riparian Invaders						
Arundo donax Giant Reed	Reed	Isolated in main-stem Cow Creek	Vegetative rhizome or parts	High, voracious competitor	Herbicide on method – do not burn	Sub-Indian continent – In LA by 1820 – Spreading north major problem.
Ailanthus altissima Tree of Heaven	Tree	Isolated locations mainstem and in LCC and Tributaries – in developed areas	Seeds and root sprouts	Moderate	Herbicide or grazing – burning not effective	Eastern China. Introduced as shade tree. Planted in 1890. Ubiquitous.
Cortaderia selloana Pampas grass	Shrub/ grass	Isolated in developed areas near Palo Cedro and along MS Cow Creek and Lower Cow Creek	Seeds, but sprouts after fire and by plant parts	Low to moderate. Isolated populations	Herbicide. Following burning will sprout, grazing effective in N.Z.	Native to Argentina and Brazil. Introduced to CA in 1874. Planted in SCS in LA in 1946 for vegetation control.
Rubus discolor Himalayan blackberry	Vine	Ubiquitous throughout the watershed	Seeds spread by bird and mammals and vegetatively	Serious problem. Invades pasture area; inhibits wildlife access to streams; replaces native plants, low water yield	Difficult to control. Manual removal and repeated herbicide and burning and grazing	Introduced to North America by Luther Burbank in 1885 as cultivar from native Western Europe.
Fiscus carica Edible fig	Tree	Lower reaches of watershed; maybe elsewhere	Seeds and vegetatively	Moderate	Difficult to control; basal treatment Herbicide effective	Native to Arabia. Introduced to LA by missionaries in 1769.
Tamarisk Salt Cedar	Woody shrub	Isolated in lower reaches of watershed	Seeds and vegetatively	Moderate	Herbicide or grazing	Central Asia and near east. Planted widely for erosion control in LA.
Vinca major Periwinkle	Vine	In isolated areas and near historic residences	Vegetatively	Low	Herbicide	Northern Africa; imported as ornamental and medicinal herb.

Table 8-8 (cont.)
SIGNIFICANT INVASIVE PLANTS KNOWN TO EXIST BY WILDLAND COMMUNITY

Plant Species	Type	Location	Reproduction	Risk	Control Strategy	Source
Grassland and Meadows						
Bromus tectorum Cheat grass	Grass	Ubiquitous in watershed	Seeds	High	Herbicides, plant competition, spring burning, mechanical	Native to North Africa. Introduced to LA in 1860s. Ubiquitous – has significantly displaced native plants.
Centaurea solstitialis Yellow starthistle	Forb	Ubiquitous below 6,000 ft.	Seeds	High	Herbicide, burning, grazing, biological limited success	Significant competitor and invader; significantly lowers forage quality and yield in pastures and range condition.
Cirsium vulgare Bull thistle	Forb	Isolated to disturbed areas	Seeds	Moderate	Easily controlled with herbicide; bio tried, but no success	Introduced from Europe and North Africa. Common in forest areas and clear cuts; displaces native forage. Common in disturbed areas.
Cirsium arvense Canada thistle	Forb	Isolated to disturbed areas	Seeds	Moderate	Herbicide	Introduced from SW Europe. Serious pest to cultivated agriculture. Usually found in disturbed areas and along roads.
Hypericum perforatum Klamath Weed	Forb	Isolated individual	Seeds	Moderate	Herbicide	Introduced from Europe. Ingestion by livestock can cause serious illness and death.
Phalaris aquatica Harding grass	Grass	Numerous locations in grasslands	Seeds	Moderate	Herbicide	Field planting forage crop.
Taeniatherum caput-medusae Medusahead	Grass	Everywhere – has resulted in losses of <40-75% carrying capacity	Seeds	High – serious problem throughout watershed	Herbicide, burning prior to seed dispersal, in early spring grazing (sheep)	Introduced from the Mediterranean in the late 1800s. Has reduced grazing capacity on some ranches from 40 to 75% (Whiston 2000).

Mature tamarisk is drought-tolerant and can survive flood conditions in which native species have difficulty. In addition, fire may enhance this species, as it rapidly re-sprouts from below-ground parts and can quickly overtop other post-fire vegetation. When tamarisk invades and dominates a riparian area it can cause dramatic impacts. Because it consumes water 35 percent more rapidly on average than native vegetation, it has been known to draw down water tables, dry up springs, and decrease the volume of flows in waterways. Finally, tamarisk provides little habitat value for either fish or wildlife resources (Zavaleta 2000), while out-competing high value native riparian habitat.

Arundo

Another very significant threat to California's dwindling riparian resources is the non-native grass species known as *Arundo donax*. This species was introduced approximately 25 years ago, and once established along a stream channel, root parts are readily spread downstream by high water. It can form dense stands up to 30 feet tall, but, like tamarisk, provides little in the way of fish or wildlife habitat. Arundo dramatically alters the ecological and successional processes in riparian areas and ultimately dominates the near-stream areas to the detriment of native species. Also, like tamarisk, arundo survives fire and rapidly re-sprouts, quickly becoming reestablished after being burned.

The California Invasive Plant Council included arundo as one of the top five species of concern. In some areas, arundo infestation is the greatest risk to dwindling riparian habitats. Furthermore, arundo and tamarisk are frequently found together.

***Arundo*, Stony Creek**

Arundo can dramatically change channel morphology by retaining sediments and constricting flow. Its shallow rhizomes provide little structural integrity to streambanks resulting in undercutting, bank slumping, and sedimentation of the stream. Arundo rapidly and catastrophically alters ecological processes in riparian systems, ultimately moving formerly diverse ecosystems toward pure stands of arundo through a regime of intensified flooding and fire (Bell 1997).

Lessons learned from southern California, where thousands of acres are infested by this species, suggest that early prevention of spread is the most cost-effective approach. Once arundo becomes heavily established and habitat value is destroyed, its elimination is very problematic and costly (Bell 1997). The most effective control appears to be systemic herbicides such as Rodeo, licensed for use near water. Follow-up treatments to kill missed or re-sprouting plants may be necessary for 1 to 5 years following initial treatment. Following eradication, a short-term spike in downstream fine sediment has been noticed before native vegetation becomes reestablished or restoration efforts become effective. However, the potential increase in riparian habitat values of restored streamside zones is considered to greatly outweigh the short-term effects (Bell 1997).

Because the short-term environmental damage and expense of arundo eradication becomes greater if infestations get larger, it is imperative that control efforts proceed immediately after detection. Projects should be encouraged to:

- Include multiple stakeholders with significant local landowner involvement, including using local volunteer and/or landowner labor
- Foster riparian zone health as a preventive measure against arundo invasion or re-invasion
- Proceed with eradication efforts from the top of the watershed down, cognizant of the rapid downstream spread capabilities of the species
- Work with downstream agencies or landowners to assist with eradication of propagule sources located upstream (Bell 1997)

If continued re-introductions of arundo are to be prevented, broad-based action is necessary. Individual landowners along waterways need to be aware of the plant and its dangers. Nurseries need to be prevented from selling arundo for use along streams. CDFG is producing educational materials with the Sonoma Ecology Center to reach landowners, the general public, and local organizations building eradication programs.

CHANGES IN COMMUNITIES OVER TIME

Vegetative communities change over time. Some changes are influenced by natural causes such as fill, landslides, and floods. Man-induced changes are caused by invasive plants, fire suppression, water diversion, grazing, and development. In general no one factor is responsible for large scale changes in vegetative communities. The earth's climate has changed drastically in the last 10,000 years (see Section 5, "Climate"). Historical climate records are constructed from tree rings, glacial cores, and sediments. Historical population dynamics are reconstructed from fossils and pollen analysis.

Table 8-9
CLIMATE SUMMARY VEGETATIVE RESPONSE

Historical Time Frame	Responses
> 8,500 years ago	Much cooler
8,500-2,500 years ago	Mild winters, warmer dry summers
2,500-400 years ago	Moist and cooler
400-100 years ago	Abnormally dry and cold
120 years ago to present	Warmer with more precipitation

Even prolonged short term changes such as the droughts of the 1920s and 1970s can significantly affect species diversity and composition. Many changes in vegetation commonly associated in European settlements after 1860 may in fact be associated with climate change. In a *Watershed Analysis Report for the Middle Fork Eel River Watershed* (USDA 1994) a pollen analysis study done at an unnamed lake just south of the Yolla Bolly-Middle Eel Wilderness (located at approximately latitude

(39 °57'45" N by longitude 123 °2' E at an elevation of 3,320 feet which the author calls A-M Lake), the author concludes:

> The A-M Lake pollen record reconfirms that North Coast Range plant communities are dynamic ecosystems with ever changing compositions and relationships. While some taxa appear to have long histories of association, the notion of regional stable communities with unchanged composition, structure, and functional relationships over long periods of time must be rejected. With little exception, the current plant communities in the North Coast Ranges are the result of multiple trajectories of vegetation succession in response to climatic variability.

The USFS presented the following example in the Thomes Creek Watershed Assessment (USDA 1997). Extreme weather fluctuations can lead to floods, droughts, or windstorms. Droughts, especially those lasting several years, can lead to an increase in insect damage to conifer stands. The degree of damage or disturbance is related to stand density. During periods of above-average rainfall, forests stand densities increase to utilize the higher site potential. But when multi-year wet periods are followed by a drought, these stands are suddenly overstocked for the reduced site conditions. When this happens, large numbers of trees are unable to get the amount of water they need to stay vigorous. These trees become weakened by moisture stress, which increases the likelihood of large-scale insect epidemics. There may also be more large-scale fires in drought years.

Windstorm can damage forest stands over entire regions; however, their impacts are usually more localized. The damage from windstorms is normally most severe on ridge tops and in natural wind funnels. Damage is also related to logging practices. Large conifer trees recently deprived of the support and protection of their neighbors due to partial cutting, or along the edges of clearcuts, are vulnerable to windthrow for many years after logging. Trees, both hardwood and conifer, whose roots are damaged by grazing, logging, road building, or recreation activities (as campgrounds) are also more vulnerable to windthrow. Heavily stocked stands of young conifers that have not been adequately thinned (often called dog-hair thickets) are sometimes blown down in blocks (USFS 1997).

Fire suppression activities beginning in 1920 have resulted in denser stands with significantly different species composition than those of 100 years ago. The Thomes Creek Watershed Assessment by the USFS (1997) compared average conifer stand characteristics determined from data collected during a 1913 inventory with current (1991) old-growth inventory plot statistics from the same area. The comparison shows that in 1991 conifer stands had an average of over 5 times more trees per acre, and over 50 percent more basal area than in 1913. Stocking density relative to normal basal area was twice as high in 1991, while annual conifer mortality is over 12 times as high. Average conifer stand age and diameter are both less today. Board foot volume per acre is also slightly higher today.

Another factor which has influenced vegetation since 1850 has been the amount, intensity, and duration of grazing. Table 8-11 shows how grazing has declined in the Mendocino Forest since 1912. Native herbivores have grazed the watershed for thousands of years, but the introduction of domestic livestock has changed the intensity, seasonality and duration of grazing.

Table 8-10 AVERAGE CONIFER STAND CHARACTERISTICS ON FEDERAL LAND IN THE THOMES CREEK UNIT IN 1913 AND 1991		
Average Stand Characteristics	**1913**	**1991**
Number of trees per acre	20	106
Conifer diameter (in.)	28	16
Conifer basal area (ft ^{2}/ac.)	89	141
Conifer volume (bd. ft./ac.)	18,400	20,900
Stand age (years) (est. for 1913)	300	182
Relative stand density (% normal BA)	31	62
Annual mortality (per 10,000 conifers)	4	52
Source: USFS 1997		

Table 8-11 LIVESTOCK GRAZED IN THE MENDOCINO NATIONAL FOREST BY FISCAL YEAR					
Stock Type	**Number of Animals**				
	1912	**1922**	**1935**	**1960**	**1996**
Sheep and goats	61,000	50,900	19,542	0	0
Cattle and horses	3,500	11,600	7,363	1,586	1,949

Coniferous Forest Habitats

As stated earlier in this section, both wildfire suppression and commercial timber management have caused changes in the composition, density, and mean tree size in the Tehama West Watersheds as well as the entire American West. The extent or degree of change has not been well-quantified because there are little data pertaining to forest stands prior to the period when fire suppression was well established. However, anecdotal accounts of the early days and photographic analyses of historical photos support the notion of the following general structural and compositional changes. Fire exclusion allowed conifer seedlings and saplings in the understory to grow into trees, resulting in much denser stands than existed previously. Because of stands developing in a more dense condition, shade-tolerant species were often favored, including white fir and incense cedar, rather than shade-intolerant species such as the pines and black oak

These changes have had significant effects on wildfire behavior, as the results lead to burns with much greater intensity and severity than the stands likely to have existed 150 years ago. These are due both to greater fuel loading and development of ladder fuels.

The California Land Cover Mapping and Monitoring Program (LCMMP), a collaboration between USFS and the California Department of Forestry and Fire Protection (CDF), uses Landsat Thematic Mapper (TM) satellite imagery to derive land cover change (losses and gains) within 5-year time periods. The Northeastern California area, including Tehama County, was completed last in 1997 and addressed change from 1991-1996. The LCMMP quantifies changes in habitat at a landscape scale to provide regional level assessments.

Table 8-12 AREAS OF HARDWOOD CHANGE, CONIFER CHANGE, AND CHAPARRAL CHANGE			
	Hardwood	**Conifer**	**Chaparral**
Decrease in Vegetation	10,634	11,208	1,403
% Decrease	2	8	1
Increase in Vegetation	9,394	16,743	12,884
% Increase	2	11	12
Total change	20,028	27,951	14,287
Total % change	4	19	13
Wildfire	9,136	6,049	12,339
Prescribed fire	0	0	0
Harvest	231	8,204	58
Mortality	0	0	0
Development	415	2	18
Regeneration	0	5,288	326
Total	9,782	19,543	12,741

Chaparral Habitats

Chaparral habitats are highly adapted to wildfire and reproduce quickly following a burn. Wildfire suppression has widened the time between these events; therefore, chaparral stands may be older, more decadent and less palatable for wildlife than prior to fire suppression actions. The conifer habitat suppression actions lead to more severe and intense fires than typically occurred prior to the policy of fire suppression. Wildlife species requiring younger and more palatable plant growth, with higher amounts of protein and minerals, such as black-tailed deer, have likely been impacted by this change. Recent deer herd numbers reflect this decline (see Section 9, "Wildlife Resources"). Fire suppression may also have diminished the mosaic of dipping age classes of chaparral.

Riparian Habitats

It is likely that montane riparian habitats have been affected by fire suppression. These narrow corridors are comprised primarily of hardwoods that are regenerated by a disturbance, such as floods or fires. Because of the fewer and wider spaced timing of wildfires, the opportunity to reproduce has been changed, leading to older trees along the streams. Forest management may have affected the riparian areas by removing the largest conifers and leaving smaller trees. This has become an issue in many areas due to the importance of riparian areas to provide large wood debris recruitment to streams and the importance of these large pieces to fisheries habitat. However, on Thomes Creek, below the confluence with Fish Creek, large wood debris plays a very limited role in channel development as more control is exerted by geomorphology.

Riparian habitats in the foothill and valley stream reaches have likely had much greater historical impacts than of those in the mountain regions, but have not been quantified for the Tehama West Watershed. Livestock grazing has likely affected hardwood regeneration; aggressive non-native weeds have been introduced that have likely reduced the extent of many of these habitats. Constructing dikes and channels for flood control and gravel mining likely eliminated entire riparian areas or predisposed the systems to colonization by non-native invaders.

Hardwood Habitats

Harvest for firewood, range improvement, and subdivision development has affected large acreage within the watershed, resulting in reduced habitat area. This has resulted in reducing the number of acres covered by this species and reducing the amount of canopy cover of oak woodlands. There has also been concern regarding whether blue oaks are adequately regenerating to replace dying trees. Failure to regenerate may also be influenced by changes in climate since 1850.

Valley oaks were more restricted in distribution than blue oak because of the lowland habitat preference of this species and the good soil it requires. Valley oaks generally live in areas with deeper soils near streams. All the factors responsible for reducing valley riparian habitats also would potentially have affected this oak. The State of California has recognized valley oak habitat as a special concern (CDFG 2005). Recent amendments to the California Environmental Quality Act to protect the habitat of oak woodlands reveal a rising concern over oak species.

Tehama County has produced a plan to help in management of its oak resources (Tehama County 2004). Guidelines presented in the 2004 Draft pertain to fuel wood and range management projects. Some specific practices include:

- Retain at least 30 percent canopy cover in a variety of sizes and species originally present
- Educate landowners regarding the economic benefits of maintaining oaks
- Retain old trees with hollow limbs and boles for wildlife habitat
- Seek management assistance from U.C. Extension and other local experts
- Protect oaks during construction and avoid summertime watering
- Cluster housing to preserve wildlife corridors and habitats

The county encourages the voluntary protection of oak woodlands through partnerships and conservation easements with government and non-profit groups, developing sustainable ranching and farming operations, and establishing Williamson Act contracts.

Annual Grassland and Vernal Pool Habitats

Human activities such as wildfire suppression, grazing, and the introduction of aggressive grass and forbs have been responsible for effects to the ecology and composition of the Tehama West Watershed's grasslands. Nearly all other annual grassland in the watershed is dominated by species known or suspected to be alien. A unique needlegrass habitat is known to occur north of Black Butte Reservoir.

CDFG biologists believe that the vernal pool landscape we see today is completely changed from its appearance prior to invasion and settlement by Europeans (Lis and Eggeman 1999). Even those landscapes remaining are not isolated pristine habitats (Pollack and Kan 1998). For the remaining vernal pool landscape, the primary changes have been in the composition of plant species and in the large herbivores that used to inhabit the region. Vernal pools remaining in Tehama County are located generally in annual grassland and blue oak woodland plan communities, which in turn are dominated by non-native plant species that have established themselves (Pollack and Kan 1998).

The vernal pool ecosystem is maintained through several factors including: water cycle, soil type, seasonal patterns, nutrient cycles, and animal impacts. Animal impacts from deer, pigs, ground squirrels, birds, insects, earthworms, nematodes, and many others through their interactions with the environment play a role influencing the plant community (Lis and Eggeman 1998). In the late Pleistocene a wide variety of grazing and browsing animals shaped the plant community (Edwards 1996). These animals include: *Mammuthus* (mastodons), *Glossotherium* (ground sloths), *Camelops* (camels), *Cervus* (elk), *Bison antiquus* (bison), *Euceratherium* (shrub ox), and *Symbos* (woodland musk ox) (Edwards 1996). DFG stated that even the predators that are now absent, wolves and predatory cats, played an important role in the development of the plant community by keeping the grazing and browsing animals moving (Lis and Eggeman 1998). Since the late Pleistocene there has been a reduction in the number of large herbivores and their predators (Van Devender 1995).

The reasons for the declines are speculative, particularly for the Pleistocene extinctions, which have been variously attributed to dramatic climatic changes and to hunting pressure from early Native American peoples. The changes brought about with the arrival of Europeans are more clearly documented, and include increased hunting pressures, importation of livestock and establishment of ranches, clearing and draining land, and controlling natural hydrologic cycles. These activities resulted in disruptions to the landscape that disturbed migration patterns, summer and winter feeding grounds and breeding territories. With the invasion of Europeans came the seeds of non-native plants, which found the new lands to be suitable habitat. They have spread rampantly during the past 50 years (Lis and Eggeman 1998).

Three significant impacts to the vernal pool plant communities: 1) loss of large herbivores and their predators, 2) invasion and establishment of non-native plants, and 3) invasion and settlement of Europeans. The loss of large herbivores and their predators changed the dynamics that maintained the native plant communities. The settlement of Europeans was in direct competition with the large herbivores and predators and resulted in their decline through direct removal and habitat loss. In addition, Europeans replaced the native herbivores with domestic livestock, which were managed in ways that were not conducive to the native plants and the grazing patterns with which they had evolved. The result was overgrazing and land degradation (Lis and Eggeman 1998).

Overgrazed, disturbed lands were perfect sites for the non-native species to colonize. As they invaded and displaced the native species, the entire community structure changed. The change in plant species composition changed the community type as well as its response to fire. The large influx of non-native annual grasses resulted in the community burning more easily and frequently than it probably did in the past. The fire return interval can be dramatically increased by the presence of dense stands of both cheat grass (*Bromus tectorum*) and medusa-head (*Taeniatherum caput-medusae*). In areas of dense cheat grass or medusa-head, the fire return interval has declined to 5 years or less because the continuity of fine textured fuels promotes larger, more frequent fires (Moseley et al. 1999).

Vernal pool ecosystems evolved under grazing pressure from a variety of large and small herbivores and had a periodicity of fire in the evolution of the vernal pool ecosystem (Lis and Eggeman 1998). With the invasion of many non-native plant species, the loss of the herbivore grazing patterns,and changes in fire cycles, the communities of the vernal pool ecosystem have undergone varying degrees of compositional changes. The uplands have gone through such extensive species compositional changes that the original composition is now unknown. Flats and swales have a greater percentage of native species, but some non-natives are quite dominant and may be increasing. The vernal pool ecosystem appears not to be of an equilibrium that will be self sustaining over time. Rather it appears to be one where non-equilibrium determines the biological community structure, whereby disturbance and heterogeneity, generate and maintain biodiversity of the communities within the ecosystem (Lis and Eggeman 1998).

As stated previously, two forms of grazing effects are being monitored by CDFG: 1) controlled experimental grazing, where a high density of cattle graze in pastures for periods ranging from 1-3 weeks in the late spring; and 2) less controlled grazing, where cattle are grazed at a much lower density during a longer period from late fall until late spring. The vernal pools and surrounding uplands are affected very differently by these two forms of grazing. One of the objectives in the CDFG study is to determine how varying grazing pressure influences vegetation composition. Preliminary results provided for this report by CDFG state that water quality measurements (temperature, pH, dissolved oxygen, conductivity, and salinity) have been recorded at bimonthly intervals during the 1999-2005 vernal pool seasons. Temperature has also been recorded hourly within the pools during the time they contain water. Preliminary observations show water quality variables do not vary dramatically between grazed and ungrazed pools. In some cases dissolved oxygen is slightly higher in lightly grazed pools and this benefit may be due to three possible grazing effects: 1) reduced previous season plant matter standing in the pool water column during early pool season, 2) reduced levels of filamentous green algae in the pool water column, and 3) cooler water temperatures during early pool season due to increased adiabatic cooling effects.

Vernal pool branchiopods (*Branchinecta lynchi*, *Linderiella occidentalis*, and *Lepidurus packardi*) have been quantitatively sampled at bimonthly intervals in the pools for four vernal pool seasons. Preliminary results suggest that branchiopods are not randomly distributed throughout an individual pool, but have preferred habitat locations within the pool as well as in the water column. Pool habitat for branchiopods does not equate to pool dimensions. Pools may be grouped by branchiopod density differences and these may be related to vegetation mosaic patterns which exist in the pool. With light to moderate grazing, vernal pool branchiopods may also benefit from the grazing effects listed above under water quality. These preliminary observations remain to be confirmed or refuted through data analysis.

Vegetation is being monitored using permanent transects and quadrats in the pools and in the surrounding habitat including upland mounds and flats. Over 1,300 permanent quadrats were established in 1999 and have been monitored for 4 years. Native, non-native, and special status plant species (primarily *Orcuttia tenuis*, *Sagittaria sanfordii*, and *Paronychia ahartii*) are being monitored within the permanent plots. In the controlled-grazing pastures the goal of grazing was to reduce and control the non-native grass, medusa-head (*Taeniatherum caputmedusae*). Grazing has significantly reduced medusa-head as well as less aggressive non-native grasses that colonized the upland sites. Data analysis is currently underway on the vegetation composition and changes over time of the native species and special status species.

In conclusion, grazing may be important in developing and maintaining vegetation mosaics in vernal pools and in the uplands, and will be more accurately defined during data analysis. These mosaics may in turn be important in maintaining plant species diversity and are speculated to have some relationship to observed differences in branchiopod densities (Lis and Eggeman 2000.

DATA GAPS

The following data gaps exist for information, on vegetative resources assessment:

- Quantitative trends regarding historical and ongoing habitat changes (vernal pools, riparian, and noxious plants)
- Hardwood reproduction rates in the various habitats
- Amount of protected habitat in each “at risk” habitat
- Inventory of noxious weeds, including GIS mapping by region, and a noxious weed management plan and monitoring the effectiveness of current control methods
- Vernal pool management BMPs for aquatic and terrestrial species
- Inventories of fuel loading and size classes

CONCLUSIONS AND RECOMMENDATIONS

The issues that should be addressed from a watershed perspective to manage vegetation on a sustainable basis include:

Development

Development of commercial and residential properties, roads, utilities, and other infrastructure is likely to occur in and near existing communities and along the Interstate 5 corridor. In some cases, sensitive botanical resources lie in the path of this development. These resources include riparian plant communities, oak woodlands, vernal pool landscapes, and prime agricultural lands.

- Support planning processes that sustain the natural resources, agriculture, and rural environment of western Tehama County
- Policies should be developed, and practices encouraged, that preserve and protect sufficient areas of these sensitive botanical resources so that they can continue to thrive and provide ecologic diversity in the landscape
- Develop plans to include practice that discourages exotic species invasion

Grazing and Grasslands

How grazing is managed can affect watershed systems in various ways. In many cases grazing contributes to open space and the maintenance of annual grassland and vernal pool landscapes. Grazing of livestock can be done in a manner that provides long term protection of Tehama County’s soils, vegetation, and other sensitive resource such as vernal pools.

- Policies and practices should be developed that promote and encourage the continuation of livestock ranching in a sustainable manner. This may be achieved in part by research, education, and demonstrations that provide practical examples of livestock management that build soil fertility and diverse plant communities over time.

- Evaluate the effectiveness of TNC Lassen Foothills Vina Grassbank project to determine if a similar project would assist Westside landowners in improving grassland ecosystem.
- Inventory non-native grassland impacts and develop BMPs for re-establishment of healthy grasslands. Specifically develop control strategies for cheatgrass and medusa-head and provide funding support for control efforts.
- Evaluate additional opportunities to provide offstream water sources for livestock and fencing to protect sensitive riparian areas.

Oak Woodlands

Oak woodland averages have decreased in the last 50 years due to harvesting, range conversion, and development (FRAP, Tehama County 2004). Oak woodland habitat (both valley and blue oak) is important for maintenance of deer winter range as well as habitat for a number of other wildlife species. The following recommended actions were taken from the draft county oak management plan 2004.

- Encourage voluntary education and protection programs that assist private landowners in the management of their productive oak woodlands, by promoting economic studies on the value of alternative and sustainable rangeland products such as fee hunting, ecotourism, wild herb production, and firewood production
- Use the resources and expertise of the County Economic Development Corporations and the Tehama local Development Corporation in order to promote non-traditional low intensity business ventures within the oak woodlands of Tehama County
- Educate county landowners on the economic benefits of maintaining and restoring oak woodlands

    1. When harvesting oaks for fuel or range improvement, encourage land owners to maintain an average leaf canopy of at least 30 percent
    2. Retain trees of all sizes and species represented at the site
    3. When safety permits, leave old hollow trees and those actively being used for nesting, roosting or feeding
    4. Where low fire risk and aesthetics allow, pile limbs and brush to provide wildlife cover
    5. Where commercial or extensive harvest is being contemplated, seek professional advice from such resources as UC Cooperative Extension (Farm Advisor), NRCS, California Department of Forestry and Fire Protection (CDF) and private consultants

- When building within oak woodland encourage landowners to:

1. Consider the impact of construction practices on the long-term management of oaks found on their property.
2. Cluster houses to preserve wildlife corridors and habitats.
3. Protect existing oaks during construction.
4. Avoid root compaction by limiting heavy equipment in the root zone.
5. Carefully plan roads, cuts and fills, building foundation and septic systems to avoid damage to tree roots.
6. Design roads to minimize erosion and sedimentation to downstream resources.
7. Avoid landscaping that requires or allows irrigation within the drip line of oak trees. Consider replacing trees whose removal during construction is unavoidable.
8. Remove dead and rotting trees from areas immediately adjacent to homes and other structures.

- Inform private landowners regarding the value of well-managed oak woodlands. Educate landowners about potential threats to this resource and seek funding that supports outreach to private landowners through the Tehama County RCD, the NRCS, and UC cooperative Extension, Wildlife Conservation Board as well as others.
- Encourage landowners to protect oak woodlands for future generations by conserving large working landscapes with significant oak woodlands.
- Recognize sites according to landscape variables (size, shape, and connectivity to other habitats such as riparian) that support rich sustainable wildlife populations.
- Establish a monitoring program to evaluate the conservation efforts.
- Encourage the Hardwood Advisory Committee to conduct biannual evaluations of the County's oak woodlands, utilizing FRAP and other appropriate data sources.
- Increase communication between land managers, ranchers, and scientists regarding the protection and management of oak woodlands.
- Encourage research on oak woodland habitats.
- Encourage studies that evaluate oak regeneration in Tehama County.
- Encourage studies that evaluate the effects of changing land uses on oak woodland's current values (wildlife, ranching, water, economics, etc.)
- Encourage studies that provide Tehama County ranchers the ability to manage oak woodlands in a sustainable manner.

Vernal Pools

The nature and intensity of the grazing that occurred in vernal pool landscapes prior to the arrival of Europeans and domesticated livestock is unknown. The threat to vernal pool landscapes from development and other changes in land use is one of the largest threats to the Tehama West Watershed. A successful program to protect these resources and limit the losses will require a combination of education, voluntary compliance, property tax and other incentives, land use regulation at the local level, and regulatory compliance under the California Environmental Quality Act, the federal Clean Water Act, and both state and federal Endangered Species Acts. A combination of both protection of existing resource and creation of additional vernal pools is likely to provide the greatest benefit at the lowest overall cost. Careful consideration should be given to the development of goals for managing vernal pool landscapes.

- Landscape management plans should be developed to meet these goals, and to utilize the existing conditions of non-native vegetation and the grazing intensity that may be afforded by domestic livestock.
- Monitoring of success in meeting the landscape management goals can be used to revise and fine tune management strategies, including the timing and intensity of grazing and fire.
- Additional research should be conducted on the benefits of balanced grazing on vernal pool landscapes. Additional information on vernal pools with soils and climatic conditions similar to those found in western Tehama County would be most useful.
- Ranchers and land managers should be encouraged to develop range management plans that protect and enhance vernal pool resources. This may include educational efforts by the Tehama County Resource Conservation District, cost sharing for fencing or watering troughs from the Soils Conservation Service, and other programs.

Agriculture

Agriculture is an important land use for maintaining open space and some types of wildlife habitat.

- Agricultural practices that protect and encourage sensitive botanical resources, particularly wetlands and riparian areas, should be promoted. This can be accomplished through education, demonstration farms, the United States Department of Agriculture (USDA) Wetland Reserve Program, Natural Resources Conservation Service (NRCS) cost-sharing for water quality protection, and property tax incentives for the protection of riparian areas and conservation easements.

Fire Management

Excess fuels and fire hazards exist in all wild habitats within the watershed. Fire management is essential to protecting vegetation resources in the watershed.

- Prescribed fire should be considered in situations that can foster the natural process of succession in chaparral and forest communities and also be considered in grasslands that may benefit from prescribed fire.

Riparian Communities

Riparian communities have been significantly changed over the last 50 years. Overgrazing, introduction of non-native plants and gravel mining reduced original riparian areas. Little historical data is available in the watershed.

- Initiate a study of historical riparian habitat trends in the watershed. Develop GIS mapping for the watershed in conjunction with this inventory effort.
- Initiate a detailed study to analyze historical aerial photographs from CDF, Caltrans, NRCS, DWR, and other sources to determine the change in riparian resources over time.
- Promote restoration projects on pubic and private lands focused on improving the understanding of the relationship between ecological health of riparian areas and land management practices.
- Gravel mining provides necessary materials for construction. In Tehama County, much of the gravel mining occurs in or near streams and riparian areas. It can and should be conducted in a manner that protects riparian habitats by avoiding mature stable areas and restoring other riparian areas with native trees and shrubs after mining activities have been completed, and to control and prevent invasive species infestations.
- Encourage the development of riparian buffer zones to maintain native riparian habitat, benefit fish and native plant species, provide buffering benefits, and reduce the potential for damage from floods.

Invasive Plants

Once established, invasive plants are extremely costly and difficult to remove. The control of tamarisk and arundo should be a priority for the watershed. The research and tools that have been developed to deal with these and other noxious weeds should be included in programs to detect and eradicate newly introduced invasive species.

Map the extent and type of noxious weeks in the watershed and work cooperatively with adjacent watersheds in the eradication of these species

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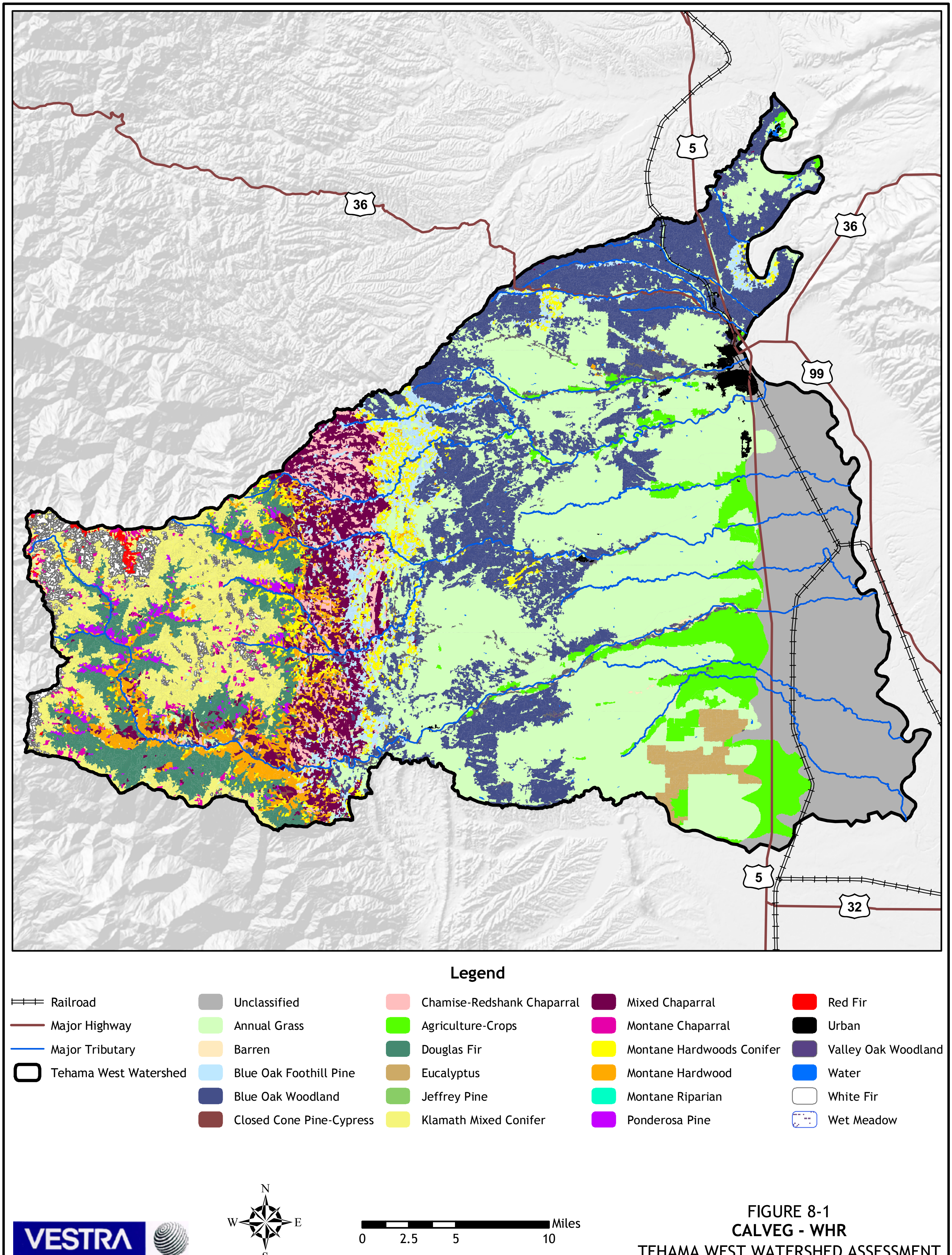


FIGURE 8-1
CALVEG - WHR
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: U.S. FOREST SERVICE

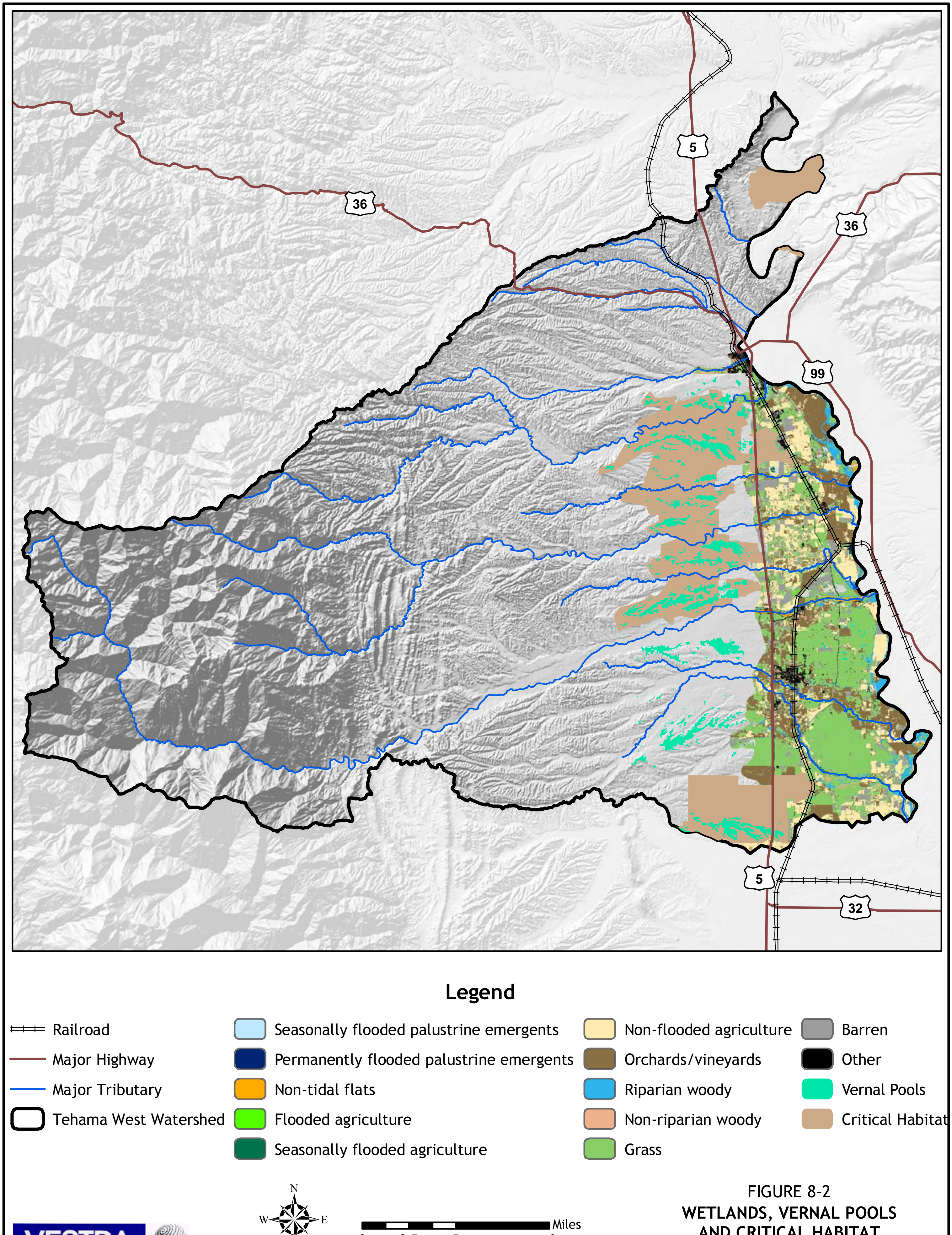
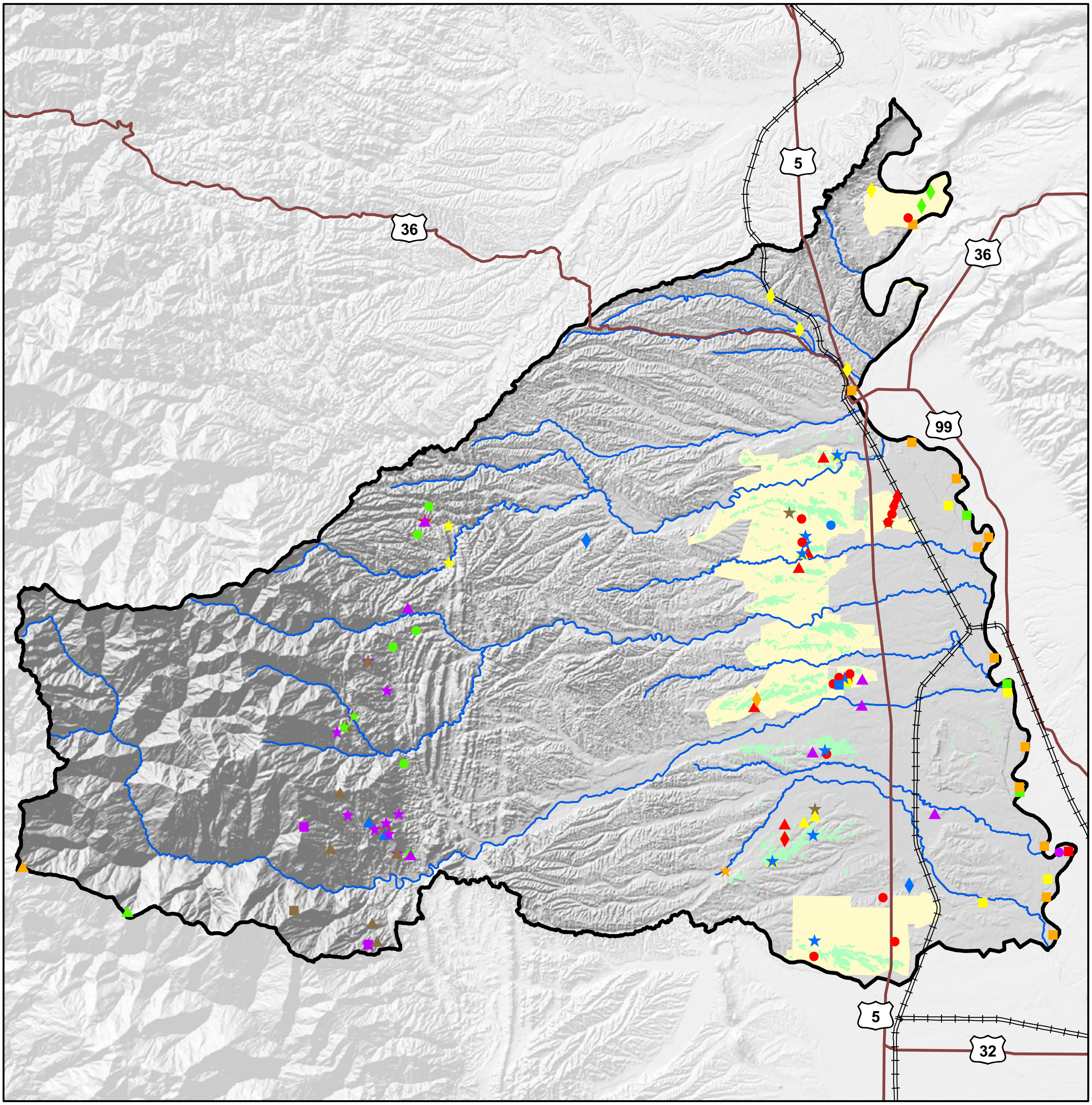


FIGURE 8-2
WETLANDS, VERNAL POOLS AND CRITICAL HABITAT
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA DEPARTMENT OF FISH AND GAME



Legend

- Railroad
- Major Highway
- Major Tributary
- Tehama West Watershed
- DFG Vernal Pool
- USFWS Critical Habitat
- Ahart's paronychia
- Baker's navarretia
- Boggs Lake hedge-hyssop
- Brandegee's eriastrum
- California linderiella
- Coastal and Valley Freshwater Marsh
- Colusa layia
- Great Valley Cottonwood Riparian Forest
- Great Valley Mixed Riparian Forest
- Great Valley Valley Oak Riparian Forest
- Great Valley Willow Scrub
- Henderson's bent grass
- Indian Valley brodiaea
- Konocti manzanita
- Northern Hardpan Vernal Pool
- Oregon fireweed
- Red Bluff dwarf rush
- Sonoma manzanita
- Stebbins's harmonia
- Stony Creek spurge
- Tehama County western flax
- Tracy's eriastrum
- Valley Needlegrass Grassland
- Adobe-lily
- Big-scale balsamroot
- Dwarf downingia
- Dwarf soaproot
- Four-angled spikerush
- Legenere
- Pincushion navarretia
- Silky cryptantha
- Slender orcutt grass
- Western spadefoot

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FIGURE 8-3
CNDDB OCCURRENCES OF RARE PLANTS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA NATURAL DIVERSITY DATABASE, 2004