Preliminary Resiliency Framework

Forest & Water Resources

A Sound Investment to Safeguard Tehama County

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RESOURCE CONSERVATION DISTRICT OF TEHAMA COUNTY

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Forward

In 2014, the Model Forest Policy Program (MFPP), Climate Solutions University (CSU), and the Resource Conservation District of Tehama County (RCDTC) came together to create a climate adaptation framework specifically for the forest and water systems in Tehama County. Development of the plan came about because all parties recognized the critical need for local community resilience against the impacts of climate change by protecting forest and water resources. This climate adaptation framework for Tehama County's resources presents the results of information gathering, critical analysis and thoughtful planning. The RCDTC took the local leadership role to engage with the CSU's: Forest and Water Strategies program to initiate the discussion of local climate resilience. The adaptation framework addresses specific climate risks and fits their local conditions and culture.

This achievement was made possible by the guidance and coaching of CSU, created by the MFPP in partnership with the Cumberland River Compact. The goal of CSU is to empower rural, underserved communities to become leaders in climate resilience using a cost effective distance-learning program. The result of this collaborative effort is a powerful plan that local stakeholders can support and implement in coming years. The outcome will be a community that can better withstand impacts of climate upon their natural resources, economy and social structures in the decades to come.

Acknowledgments

The Resource Conservation District of Tehama County extends gratitude to those who provided insight and resources to jumpstart this initial framework: Allan Fulton (Tehama County Cooperative Extension), Dawn Pederson and Don Owen (CAL FIRE), Deputy Kert Rulofson (Tehama County Sheriff Department), Chris O'Brien (USFS), Dave Schlom (science journalist), California Department of Water Resources staff to include Tito Cervantes, Mary Randall, Peter Coombs, Michelle Dooley, and Aric Lester as well as William Patzert (NASA's Jet Propulsion Laboratory, Oceanographer and Climatologist).

The Kresge Foundation and other funders allowed for Climate Solutions University (CSU) to develop the in-depth curriculum and coaching support to a community of participants to include representatives of Tehama County, California, Siskiyou County, California, Nisqually Watershed, Washington, Menominee County, Wisconsin, and the Red Lake Indian Reservation, Minnesota. The CSU staff that facilitated the program include: Nancy Gilliam, Gwen Griffith, Todd Crossett, Toby Thaler, Margaret Hall, Alyx Perry, Deb Kleinman, Vanitha Sivarajan, Josh Dye, and Spencer Phillips.

Contents

Table of Figures

Table of Tables

Executive Summary

Conditions are changing in Tehama County and it's imperative to assess the risks and identify strategies to thrive in the face of rapid transition. Alarmingly, no sector is immune from the ramifications of variable climate conditions and citizens most vulnerable to impacts are not limited to lower socioeconomic status. Projected climate conditions directly impact the economy, public health, social well-being, and ecological vigor, locally, regionally, and throughout downstream communities.

Agriculture and forestry are particularly sensitive to the consequences of a variety of climate conditions because of their immediate dependence on the natural environment. Tehama County is already experiencing the effects of climate change, including longer fire seasons and shifts in precipitation. Forest suppression management practices and heightened groundwater demand are non-climate stressors that compound the severity of climate impacts. Investments must be made to ensure that agriculture and timber remain staples in the local economy and contribute to climate readiness protections. It is of utmost importance to identify a balance to maintain agricultural viability without extracting groundwater to a point where water supply is jeopardized. At the current rate of orchard development and the significant drop in groundwater elevation, agricultural is at risk of substantial loss. Of equal importance is identifying a balance to sustain timber harvest production while optimizing ecosystem processes to safeguard forest and water resources. Without investing in resource resiliency, losses to these vital industries will have a substantial ripple effect throughout the local economy.

The expected impacts of climate change will also increase demand upon the social services sector as extended heat waves incite wildfire activity, polluting air with ash particulates, and increase the risk of heat stroke- particularly to sensitive populations. In addition, food production and distribution will be impacted by climate variability and will place further strain on services to the lower socioeconomic populace. Adaptation to the climatic situation requires a greater demand for firefighting personnel and associated infrastructure and water supply. In addition, there is the growing challenge of addressing of unsuitable water quality disrupting domestic, municipal, agricultural, and industrial uses.

The rich natural resources of Tehama County are the foundation of a vanishing rural lifestyle in California. The county's key natural resources include forested and agricultural lands, surface and ground water, and public access to open space, all of which will be impacted by climate change outcomes. The forest and waters of Tehama County are also vital sources of water, food, fiber and recreation to locals and millions of people living downstream.

Tehama County sits atop significant groundwater resources whereby its foothill streams deliver important volumes of runoff from precipitation events and snowmelt for surface water use and groundwater recharge. In the county's mid- elevations and valley floor, geologic recharge areas are vulnerable to development, and oak woodlands are mainly privately owned, with few protective measures in place. These woodlands and the adjoining timberlands provide food, fiber, fuel, recreational opportunities and scenic beauty. These are among the benefits of natural capital or "ecosystem benefits" that come from ecosystem processes, like the water, carbon, and nutrient cycles, the formation of diverse wildlife habitats, as well as cleaning the air and the growth of plants. Increased awareness and focus on these ecosystem services and on the significant role that these landscapes play in regulating water quantity and quality are necessary to resiliency.

The Earth has historically undergone natural climatic fluctuations for thousands of years, however, the rapid pace of change and extreme weather events over the past few decades are cause for alarm. Changes in climate such as rising global average temperatures, altered precipitation patterns, as well as the increased intensity, frequency, and unpredictability of extreme weather events, are already having disruptive effects. The impacts are evident on local agricultural and forest productivity, the availability of clean, potable water, the life cycles of plants and wildlife, and ultimately, on the means by which many individuals and communities, particularly rural communities, make a living.

Based upon historical data and modeling, researcher at Scripps Institution of Oceanography suggests that under current trends, by 2100, the Sierra snowpack will be reduced by 48 to 65 percent from its average amount in the year 2000. Warmer air temperatures and snowpack reduction will increase water temperature, resulting in stress to fisheries, and a reduction of coldwater habitat for species of concern. Sea level is projected to continue to rise along California's coast and San Francisco Bay; the latter is of importance as saltwater intrusion will advance from the San Francisco Bay to the Delta region, requiring more freshwater from the Central Valley Project and Sacramento Valley communities (DWR, Update 2013).

With a feeble El Niño developing in the eastern Pacific this year, California is the midst of its fourth consecutive dry winter. This unfavorable position extends the dry spell and may quite possibly classify it as the worst drought in centuries.

Setting aside any science based climate change disagreements that may arise, a community that is prepared for various short term and long term climate conditions is one that protects the livelihoods of its current citizens and of those to come. Under adverse conditions, it is vital to ensure a community-based forest and water climate resilience strategy is established for the long term health and vitality of Tehama County's citizens, economy, and natural resources.

In spite of serious threats, there are practical strategies to bring resilience to the landscape and to the people of Tehama County. Investing in natural assets through ecosystem services optimization is a principle step to ensuring the ongoing productivity of ecosystems for multiple beneficiaries. For example, in Tehama County's public forestlands, continuous application of fuel treatments (mechanical and low intensity prescribed burning) may achieve multiple management objectives, including the reduction of wildfire risk and associated carbon emissions and the creation of more diverse forest structure and composition.

A majority of the forested lands are held under private ownership. In developing a small-scale landowner forest stewardship program focused on providing sound forest management knowledge and necessary resources for local property owners to make informed decisions about their forested land. Such a program could target properties in high elevation conifer and mixed conifer zones, as well as, native oak woodlands, and riparian forests. Connecting property owners with certified foresters and natural resource managers would be mutually advantageous investment for all parties involved to safeguard the beneficial natural processes that occur on these landscapes.

The structure and composition of natural areas and working landscapes play an important role in securing water supply locally and for the entire Sacramento River watershed. As water from the local water table naturally flows into the Sacramento River at specific locations, it is important to retain precipitation that falls in Tehama County for local use as long as possible. In exploring green infrastructure options, such as modified wetland, is oftentimes a more cost effective method of filtering surface water and storage as groundwater than conventional grey infrastructures. This is not only a local resilience strategy, but a regional approach as downstream communities will also benefit from wetland filtering in receiving high quality, potable water.

Excessive groundwater extraction has caused overdraft, failed wells, deteriorated water quality in some communities, as well as, infrastructure damage and extensive environmental damage. When properly managed, groundwater resources will help protect the economy of rural communities and its natural capital against the impacts of changing climate conditions, preserving water supplies for existing and potential beneficial use. In addition, failure to manage groundwater to prevent long-term overdraft infringes on existing groundwater rights (Sustainable Groundwater Management Act, 2014).

As a living document, this initial Framework is a starting point for integrating climate risks and resiliency responses to various climate conditions that place our forest and water resources in jeopardy. This Framework proposes a number of goals that when achieved will make significant progress toward natural resource protection and economic vigor for the people of the region.

Goal 1	Ensure the availability of and access to clean water through conservation and enhancement of existing water resources for multiple beneficiaries.
Goal 2	Conserve, enhance and restore functional forest, oak woodland, rangeland, and riparian ecosystems to safeguard economic viability through ecosystem services optimization: water quality, quantity, and storage, as well as habitat and recreational opportunities.
Goal 3	Reduce the risk of catastrophic wildfire to safeguard human life, infrastructure, industry, habitat, and ecosystem services in Tehama County.
Goal 4	Explore downstream beneficiaries to provide an opportunity to support vital ecosystem services in Tehama County.
Goal 5	Foster a collaborative resiliency effort through rigorous stakeholder engagement program.
Goal 6	Secure funding to establish a climate coordinator position for the mutual benefit of multiple agencies, organizations, and decision makers.

Modifications to the Framework and implementation of actionable items will be pursued in collaboration with diverse stakeholders both locally and in downstream urban areas. Achieving these goals will result in a wide range of beneficial outcomes for rural communities, downstream urban cities, and the natural ecosystems that are vital to the region.

Tehama County is poised for optimizing its landscapes. Land use practices can be managed for resiliency so that even under the projected climate conditions, the County's natural systems are capable of providing services on which the local economic system depends. Preservation of the variety of lands helps to maintain a more functional ecosystem that complements and enhances the riparian system.

A greater likelihood in achieving resiliency throughout the County's forest, rangeland, grassland, and oak savanna is based on management practices that correspond with ecological processes as in the 'way things work' principle, as opposed to solely engineering ourselves out of unfavorable conditions. The way society relates to the ecosystem must be re-examined in order to foster solutions for enhanced water quantity and quality now and for future consumers.

Introduction

Tehama County is renowned for rural splendor as very few places in California have been able to uphold the rugged beauty of the frontier west and the humble lifestyle of yesteryear with access to present day conveniences, accommodations, and services. Locals and visitors alike value the open space and wide vistas of diverse landscapes.

The Sacramento River is a major element of natural capital that bisects the county into west and east. As the longest river in California, the Sacramento River serves as the lifeline of invaluable water that plays a significant role in the state's water supply affecting over 39 million Californians on a daily basis. As a prolonged drought seems inevitable, many throughout the state recognize the Sacramento River as salvation: the reliable water source of northern California.

Typical of rural communities, Tehama County faces limited economic diversity and socioeconomic challenges, increasing the vulnerability to climate change risks. The county's economic foundation of agriculture, forestry, limited light industry, and recreation activities are influenced by the services provided by its natural systems, all of which are vulnerable to climate change impacts. In the face of climate change, community stability will be challenged due in large part to the county's reliance on natural assets and limited economic depth.

The capacity for downstream urban areas to cope with the impacts are also challenging as they depend on the ecosystem services provided by rural, upstream communities such as Tehama County. Despite the fact that the Sacramento Metropolitan Area is geographically divided by the state's largest waterway, the Sacramento River, the metro area's half-a-million people rely on the Folsom Lake reservoir for their water supply. As of February 2014, the lake was only at 30% of its total capacity with a historical average for this date of 54%. With little rain and a record low snowpack, it is likely drought conditions will intensify requiring many downstream consumers to tap into new sources. As the effects of climate change become more prominent downstream, urban support for maintaining and improving a healthy ecosystem in upstream rural areas is gaining momentum.

Recognizing that Tehama County had yet to comprehensively address the effects on water and forest resources in relation to economic, social and environmental vulnerabilities of a changing climate, the Resource Conservation District of Tehama County (RCDTC) began the facilitation process in early 2014 to develop a forest and water resource resiliency framework. Under guidance from the Model Forest Policy Program's Climate Solutions University (CSU), the RCDTC was able to take the lead in developing the framework on behalf of the community. Without such an effort, Tehama County faces threats to the resources that supply water for drinking, agricultural and industrial uses; provide important fish and wildlife habitat for state and federally listed species; maintain economic stability; and cultivate the way of life locally as well as for downstream communities. This framework advocates coordinated approaches to protect productive farmland, well-managed forests, ample outdoor recreation, and access to quality drinking water; all significant economic drivers that cultivate the rural lifestyle of great value to many who call Tehama County home.

The RCDTC connected with key community leaders from a wide range of organizations, with a variety of expertise and skills to participate in planning the community's first climate-based resiliency framework, see Table 1. Regardless of the causes of climate change, this group found common ground and identified mutually desirable outcomes pertaining to forest and water resources. Considered the first step toward resiliency, the document serves as a living resource and talking point to delve into pressing issues pertaining to forest and water resource vitality and its ripple effect, impacting the economy, public health, social well-being, and ecological vigor. There is a dual focus to this Framework; build resilience to climate impacts and improve greenhouse gas emissions through natural asset management. For instance, Tehama County can improve its working range and pasture lands by using innovative management practices to increase soil moisture capacity for flood protection and enhance surface water infiltration as well as increase vegetation for carbon sequestration.

Forest & Water Resources Resiliency Framework Preliminary Participants			
Name	Role on Team/Expertise	**Entity**	Title
Alan Abbs	Air quality and GHG emissions insight	Tehama County Air Pollution Control District	Director
Allan Fulton	Agricultural production	Tehama County Cooperative Extension	Irrigation and Water Resources Advisor
Aric Lester	Environmental Assessment	California Department of Water Resources; Northern Region	Branch Chief
Chris O'Brien	Public forestlands	Lassen Nat'l Forest/Almanor	Public Services and Ecosystems Staff Officer
Dave Schlom	Science journalist - communication specialist	Corning Union High School and KCHO	Educator
Dawn Pederson	State Responsibility Area (SRA) Specialist	CAL FIRE	Forester
Dennis Garton	Local government insight	Tehama County Board of Supervisors	Supervisor District 3
Don Owen	Pest and Disease Specialist	CAL FIRE	Entomologist
Kathy Garcia	Work force and economic status	Job Training Center	Director
Kif Sheuer	Urban downstream partner	Local Government Commission	Climate Change Program Director
Lisa Callaway	Office of Emergency Services	Tehama County Sheriff Department	Staff
Mary Randall	Public Relations Specialist	California Department of Water Resources; Northern Region	Northern Regional Coordinator

Forest & Water Resources Resiliency Framework Preliminary Participants			
Name	Role on Team/Expertise	**Entity**	Title
Michelle Dooley	Drought Specialist	California Department of Water Resources; Northern Region	Engineering Geologist
Mike Marvier	Private timber industry	Crain Mills	Forester
Peter Coombs	Climate Change Specialist	California Department of Water Resources; Northern Region	Senior Environmental Scientist
Sergeant Rod Daugherty	Office of Emergency Services	Tehama County Sheriff Department	Deputy
Tito Cervantes	Senior Land and Water Use Section in the Division of Planning and Local Assistance's Northern District (RB)	California Department of Water Resources; Northern Region	Chief

Table 1: Participants Involved in the Preliminary Framework for Forest and Water Resource Resiliency in Tehama County.

The stage is set. With endorsement from two County Supervisors and the ongoing recruitment of stakeholders, Tehama County has arrived at a defining moment: carrying out a collective, proactive response toward local climate resilience to uphold our forest and water resources for generations to come. Despite the various models projecting climate conditions of prolonged drought, extreme 'flashy' rainfall, and diminished snowpack, there is committed interest in our community to advantageously position Tehama County to face these challenges with minimal loss of property and livelihood.

Tehama County Terrain

Tehama County is rural in nature, hosting isolated pockets of population primarily concentrated along the major transportation corridor of Interstate 5 in the valley and Highway 99 skirting the eastern edge of the valley along the Sierra Nevada foothills. A majority of the incorporated (city) and unincorporated developed areas are adjacent to Interstate 5 and Highway 99 where commercial and residential land uses are in line with major transportation networks. Sparse populations are located along Highway 36, the route connecting the western and eastern ranges of our region. Ascending from the populated areas of the valley floor to the west and east boundaries of the county, large private lands and ranches, the forest products industry, and government land holdings dominate the terrain (Figure 1).

The Sacramento River bi-sects the county, creating watersheds on the east and west sides that all flow directly into the river. Topography and geology form two distinct regions in the county: the Coast Range Geomorphic Province to the west and the Great Valley Geomorphic Province in the east. The western portion has high erosion potential due to steep elevations, abrupt slopes, and heavy rain. Underlain by rocks, the west has a relatively poor fractured groundwater reservoir. Groundwater recharge on the east slope of the Coast Range is dismal as it is situated within the rain shadow and has relatively little drainage area with significant snowpack. Significant groundwater recharge occurs in the alluvial deposits associated with the transition zone between the two geomorphic provinces. This transition serves as the western boundary of the Sacramento Groundwater Basin.

The northern Sierra Nevada and southern Cascades that make up the eastern portion has a lower erosion potential due to moderately gentle topography and lower quantities of rain precipitation and more snowfall events. The significant groundwater aquifer serves as the sole water source for a majority of Tehama County relies on relatively predictable and significant snowpack, snow melt and run-off (VESTRA Resources, Inc., 2006).

Tehama County experiences a typical meditereanian climate characterized by warm to hot, dry summers and cool wet winters. In summer months high pressure moves north and sits over much of the Eastern United States. As the storms move east across the Pacific, the blocking ridge of high pressure diverts storm systems well north of Tehama County. In the winter months the high pressure shifts south where easterly winds and the subpolar lows advance. These air masses blend with the easterly winds and winter rains. In addtion, a historic fire regime characterizes California's meditereanian climate.

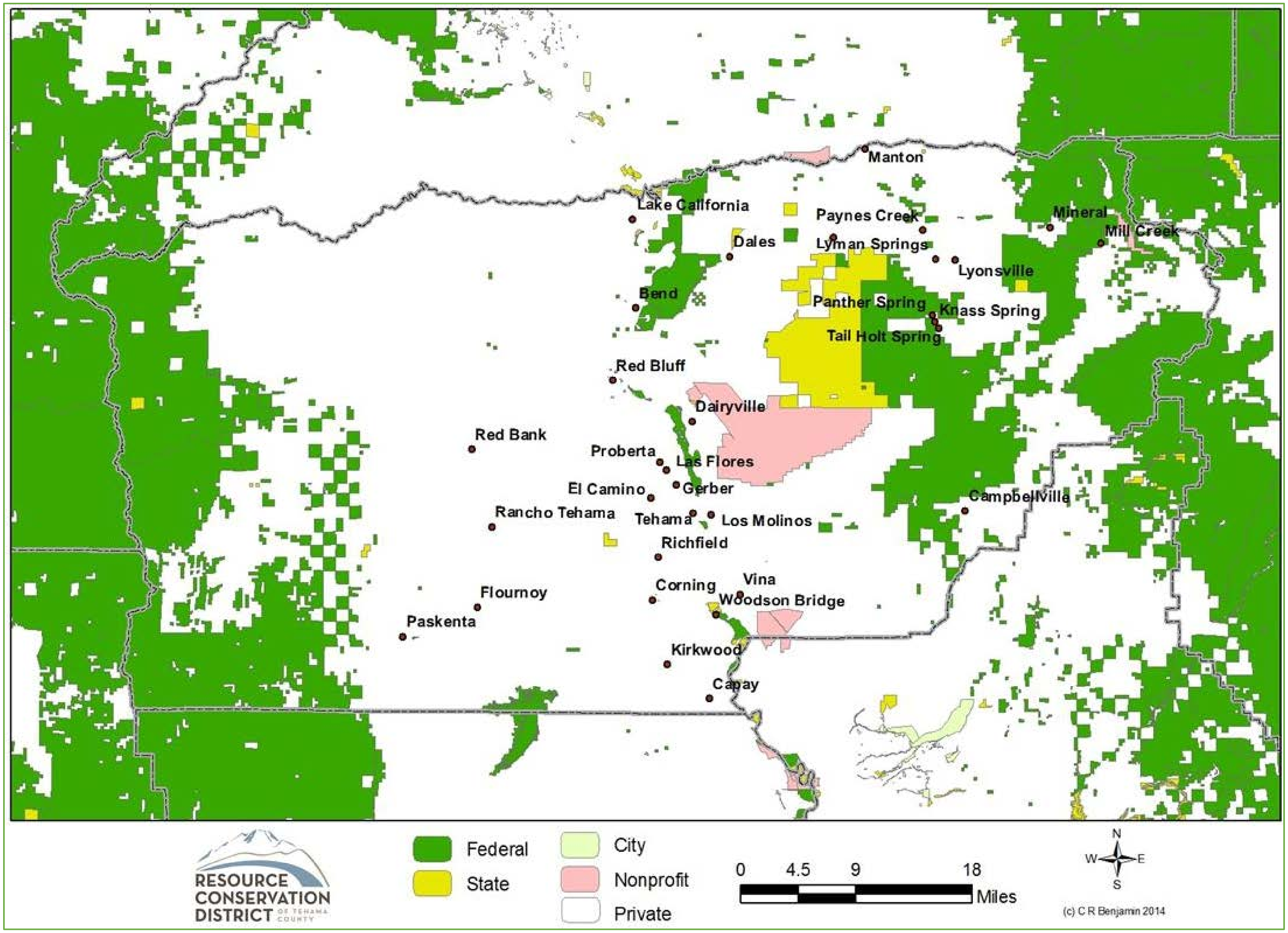
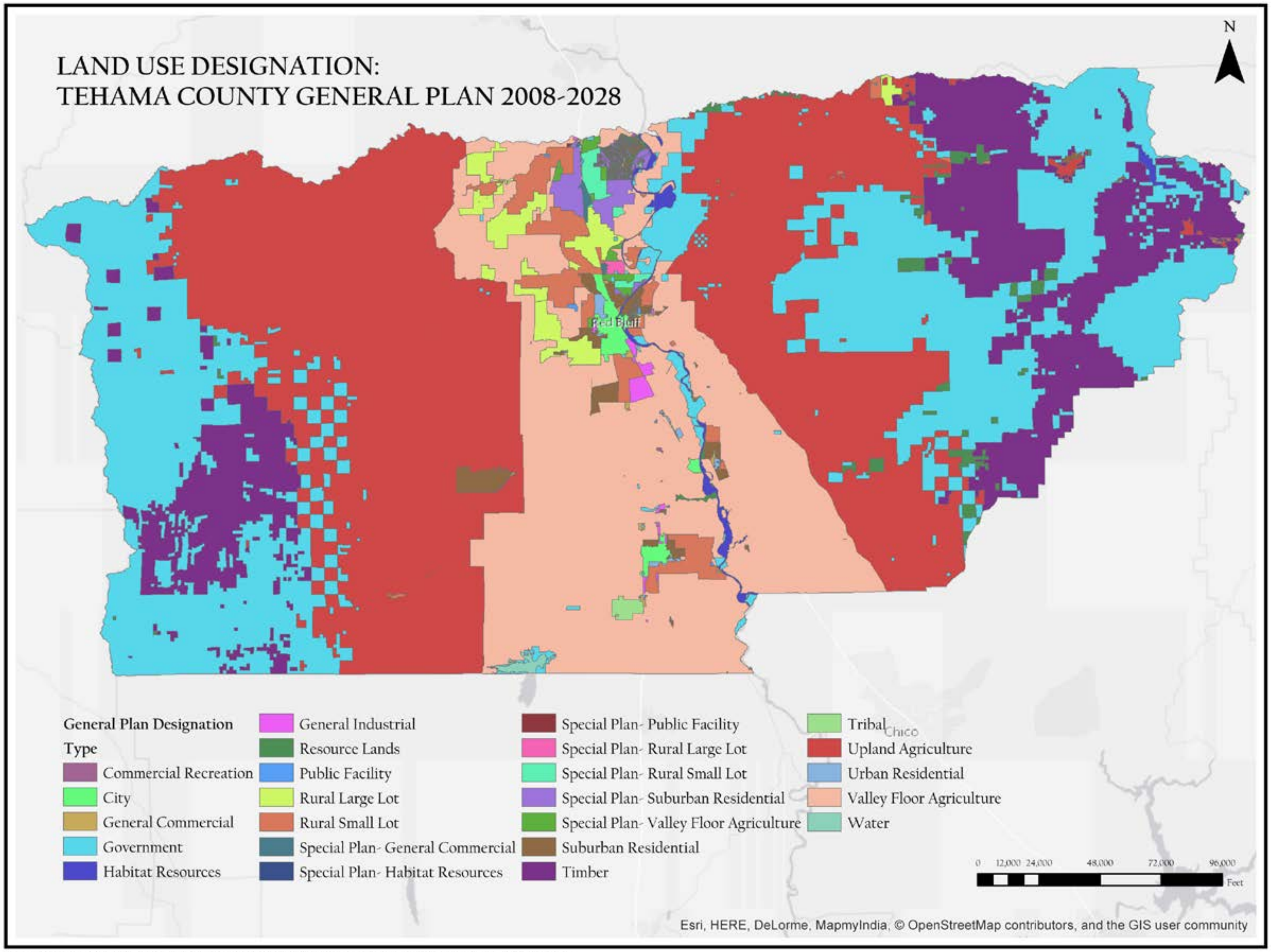


*Figure 1: **Tehama County Landownership.** Source: Resource Conservation District of Tehama County.*



Prepared by A. Dan, Resource Conservation District of Tehama County, November 17, 2014 / Source: General Plan Data from County of Tehama

Figure 2: Land Use Designation According to the Tehama County General Plan 2008 – 2028.

The General Plan for Tehama County is a highly refined document which projects land development several hundred years into the future that is based on current population growth trajectories. The entire county is zoned as indicated in Figure 2, allowing commercial growth to occur along the Interstate 5 corridor, and it is predicted based on currently approved projects that a sizeable portion of this development will occur northward of the city of Red Bluff.

South of the city of Red Bluff, there are tracts of land zoned for industrial use clustered around the Sierra Pacific Industries lumber mill and the Walmart Distribution Center, both large area employers and harbingers of likely future development.

The ease of access, coupled with the low cost of land, clear zoning, lack of architectural review or development fees, and efficient, inexpensive project review process by the County's Planning Department position the region for a future influx of industry.

Natural Assets

The scenic vistas and beauty in natural landscapes throughout the county offer more than just a collection of aesthetic hotspots or prime venues for a multitude of outdoor recreation activities (Figure 3). Though these places appear idle and pleasing, these lands are in fact working landscapes (forests, foothills, rangelands, waterways and adjacent lands, wetlands, etc.) providing beneficial water regulating services, incognito. Under ideal scenarios these landscapes are capable of processing water and carbon efficiently. The high elevation forestland functions in safeguarding limited snowpack and its streams offer canopy cover keeping water temperatures cool and decreasing evaporative water loss. Well managed forests also have the potential to balance carbon emissions and sequestration. Savannah grasslands and oak woodlands function as filters, removing contaminants to improve water quality and play a role in moderating stream flow. The soils in range and pasturelands have impressive potential water and carbon storage capabilities. Since pasturelands and floodplains are often one and the same, the landscape offers large-scale water storage from 'flashy' rain events. Riparian areas, the green vegetated areas adjacent to a waterway, regulate water timing and quality through flood, erosion, sediment, and temperature control. Under proper conditions, these landscapes including vernal pools can provide high levels of biodiversity. All of these valuable functions performed by our landscapes for our benefit is not only worth protecting from development and ecological harm, but are vital to lessening the impact of climate variability.

Figure 3: Images of Tehama County's Natural Capital. *Clockwise from top left, peaks of Lassen National Volcanic Park, Mill Creek, Lassen National Forest, almond orchard on the valley floor in full bloom, natural riparian corridor along Antelope Creek, and grass oak woodland at Jelly's Ferry. Source: Resource Conservation District of Tehama County.*

Bonanza to the Bottom

Despite the abundance of innate beauty, there is a critical issue that all citizens, business owners, and decision makers in Tehama County must face: current groundwater extraction rates exceed nature's capacity to recharge the aquifer in select areas and have a high probability of occurring throughout the county. We must avoid a 'race to the last drop' where there can be no winners at a finish line with a severely depleted water supply. Without reasonable water use limitations, this bonanza to the bottom would reshape the county's agricultural core and could place citizen against citizen, resident against agricultural producer and vice versa. Of immediate concern are the effects of the current drought; loss in groundwater elevation in the Antelope District and the communities of Paskenta and Lowrey whereby citizens have had to rely on drilling a deeper well or intra-county purchased water. In addition, the current extraction rate cannot sustain limitless expansion of orchard production, particularly in the southern portion of the county. Aside from irrigation pump costs, currently access to water is free without restrictions for agricultural use of groundwater and there are no foreseeable restrictions on new orchards in Tehama County.

In order to preserve our rural heritage and avoid the devastating downfall of the once agriculturally rich San Joaquin Valley, agricultural producers, businesses, residential and rural citizens alike will need to implement groundwater conservation measures and participate in water use restrictions. Groundwater use restrictions will need to be developed and enforced by local government in a timely manner not only to comply with the Sustainable Groundwater Management Act, but to preserve our rural lifestyle and livelihoods. Without attention to groundwater protection and conservation, a larger portion of the community risks losing access to quality water and the rural culture that defines Tehama County is threatened.

Consider Climate

Life on earth depends on the naturally-occurring Greenhouse Effect of Earth's atmosphere to warm our local environment, allowing plants to grow and contribute to the very oxygen we breathe (Figure 4). Solar radiation warms the surface of the Earth as short wave radiation easily penetrates the atmosphere. Some of this heat is absorbed by matter—soil, plants, water, rocks and other objects, which reradiates heat, much like the metal body of a car on a hot summer day. This long wave reradiated heat is absorbed by carbon dioxide, methane, water vapor and other naturally occurring gases, in which some of that heat is re-reflected back to the Earth's surface. Trapping the heat in a warming cycle is called the Greenhouse Effect and the gases that trap this heat are called greenhouse gases—GHGs—and are released from human activities (cars, planes, buses, factories, etc.) and other sources. As these released gases build up, the ocean and atmosphere increase in temperature creating a new thermodynamic equilibrium with global implications.

While climatologists have been observing an increase in the amount of heat that is trapped near the Earth's surface over the past several decades, scientists have also been observing fundamental changes in the way air and ocean currents circulate around the planet. These currents are responsible, in large part, for the weather patterns that we have come to consider typical of certain places in certain seasons. With a continuing increase in global average surface temperature, interruptions to historic weather trends are certain to grow in frequency and severity. Between 1906 and 2005, global average surface temperatures rose 0.6 to 0.9°C (1.1 to 1.6°F) and the rate of temperature increase has nearly doubled in the last 50 years as displayed in Figure 4.

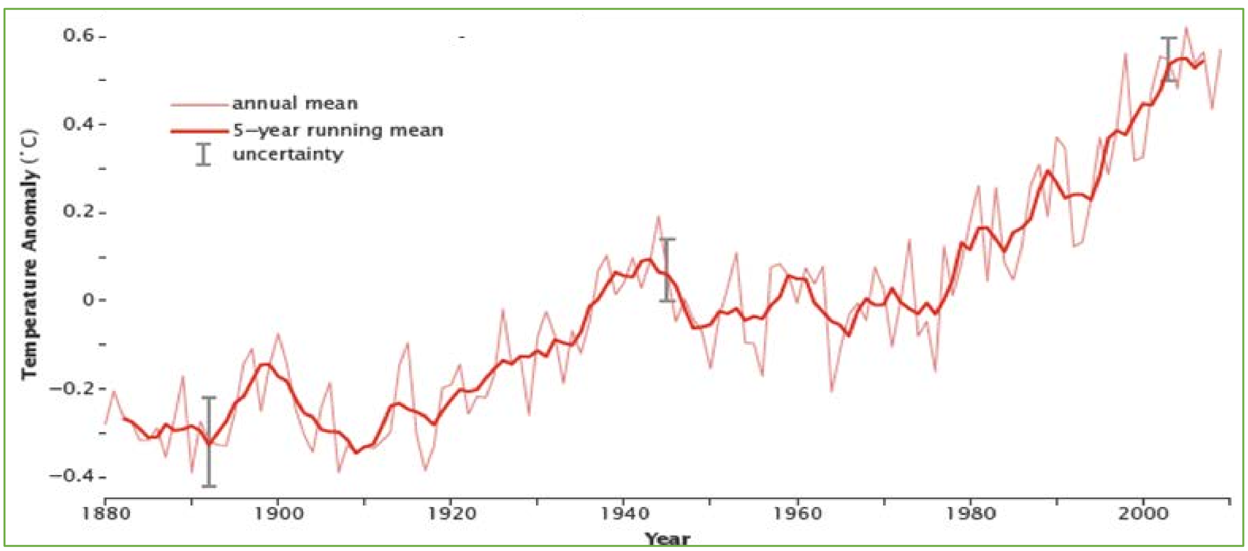


Figure 4: Global Average (Mean) Temperature. *The rise in temperature, particularly over the last 50 years has been accompanied by shifts in snowmelt timing, spring bloom dates, pest productivity, and habitat ranges. Source: NASA Earth Observatory, Global Warming.*

Current Conditions

An increase in carbon dioxide and other greenhouse gases that have been released since the Industrial Revolution trap additional heat in the lower atmosphere and affect climate at the global scale (Figure 5). California had its warmest consecutive months on record occurring in 2014 from January – August, surpassing the previous record by 1.1°F. Forecasters averaged high and low temperatures from January to July of 2014 for the entire state and recorded an average temperature of 60.2 ° F revealing that the first seven months of the year have been the warmest on record for California. California's 1970s drought had an average temperature of 57° F, well below the current high (National Weather Service).

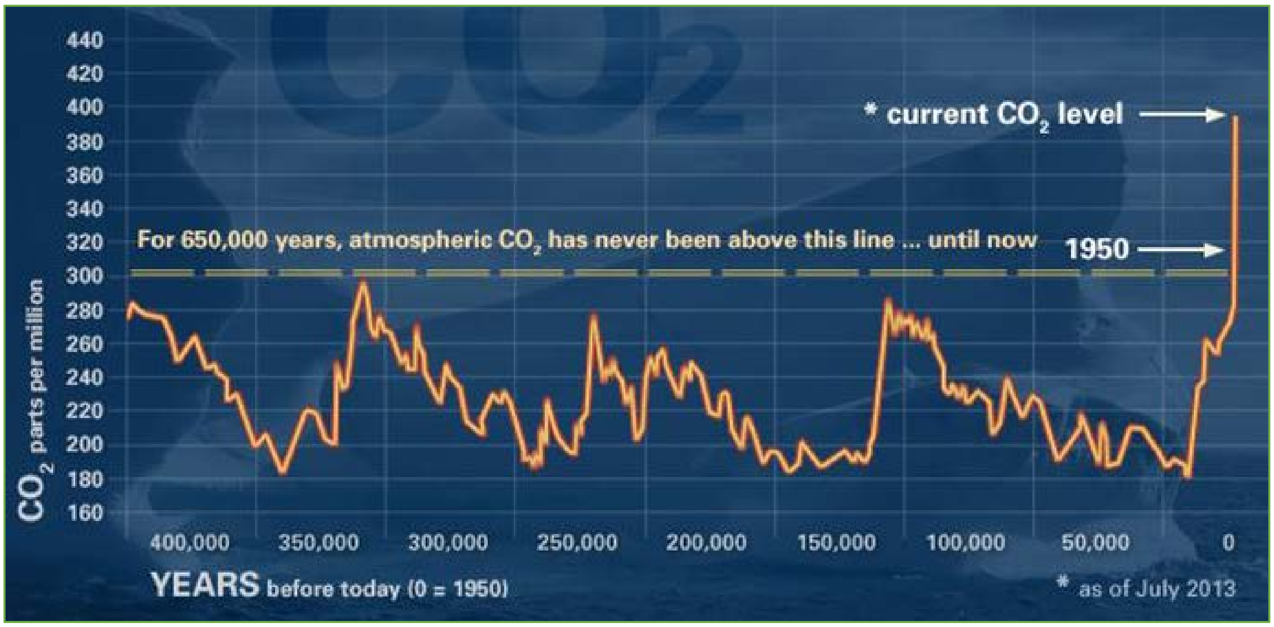


Figure 5: Atmospheric Carbon Dioxide Timeline. *This graph based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric CO2 has increased since the Industrial Revolution. Source: NOAA.*

Since the early 1960's, temperature has been steadily creeping up by 0.27° F each decade, and over roughly the same time span, a decrease in spring snowpack has been observed in the western United States with northern California among the most significant losses (Mote, 2013). The satellite image in Figure 6 shows the drastic loss in snowpack throughout the Sierra Nevada range between 2013 and 2014. As of March of 2013, the snowpack was at 52 percent of historic average levels, continuing a trend that has severe consequences for forest health as well as the state's water supply and electricity generation.

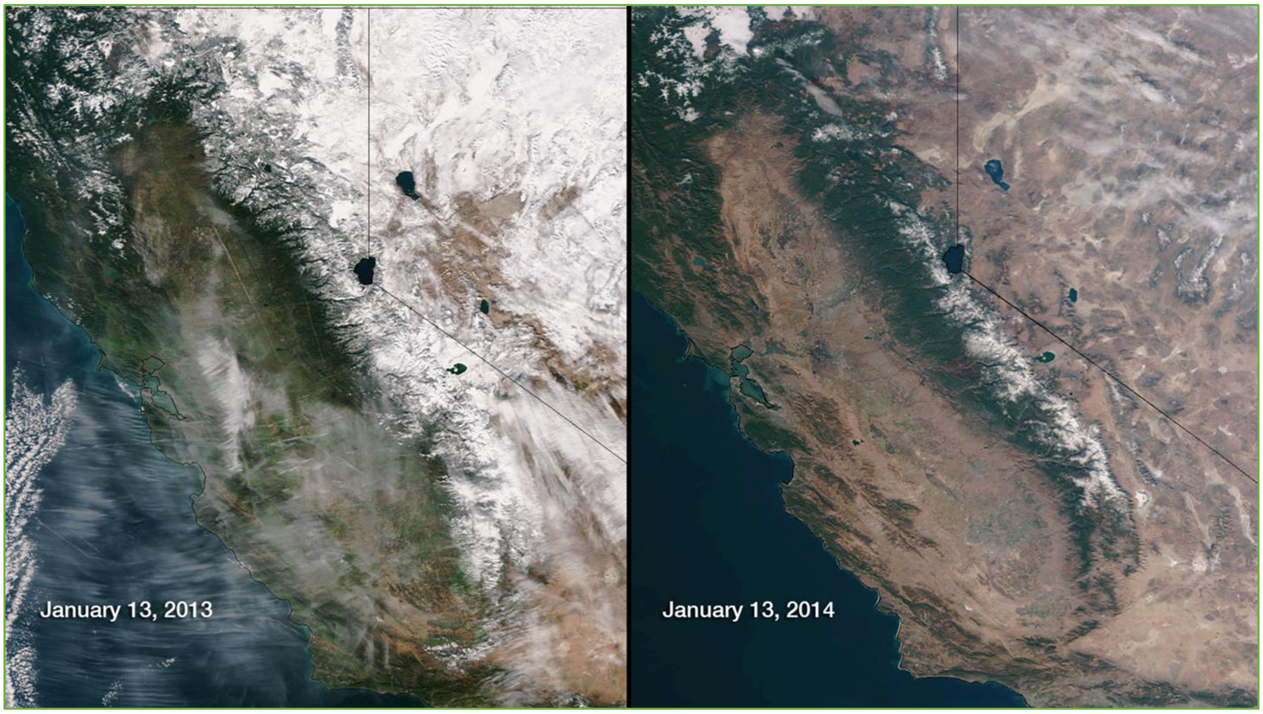


Figure 6: Sierra Nevada Snowpack Comparison. *Source: NOAA.*

During the summer of 2014, the state experienced extreme summer heat ranking within the top five hottest on record. Having experienced the third consecutive year of drought, California's largest reservoirs are at or below 40% of average, see Figure 7 (NOAA, 2014). There are no signs of a reversal of these patterns as the average annual air temperature is projected to continue rising 5-9° F by 2100 throughout the country compared to 2000 (Preparing for Climate Change, 2007).

While the national average of precipitation has increased by an average of 5-10% annually over the past 100 years, year-to-year precipitation has become more speculative, and punctuated by extended periods of drought as depicted in Figure 8 (Feng and Hu, 2004; IPCC, 2001a). The frequency of extreme weather events has intensified, accounting for much of the precipitation increase, yet drought trends across the Southwest and Interior West have seen a menacing uptick (Andreadis and Lettenmaler 2006; Easterling et al. 2000).

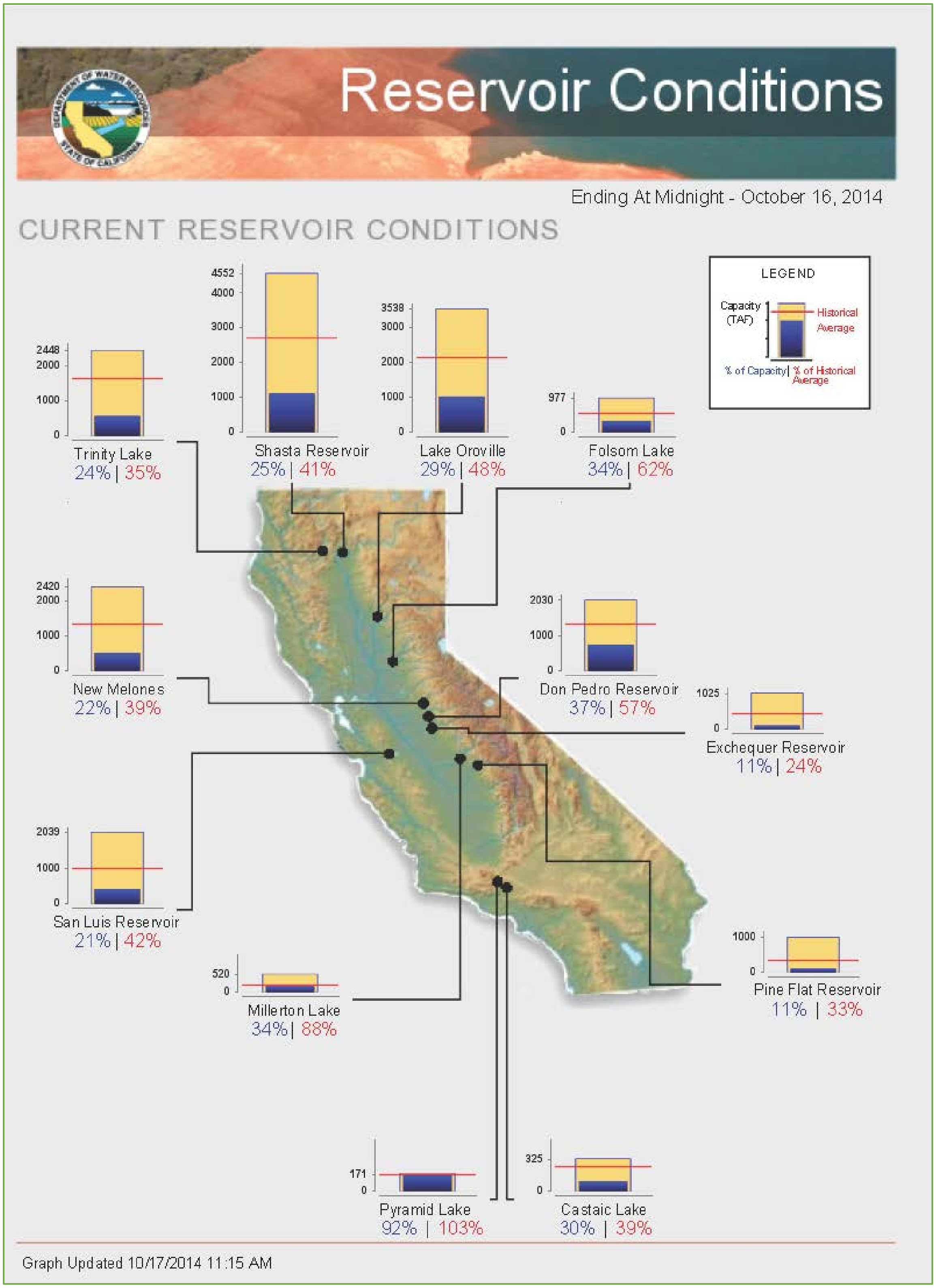


Figure 7: California Reservoir Conditions as of October 17, 2014.
Source: California Data Exchange Center, Department of Water Resources.

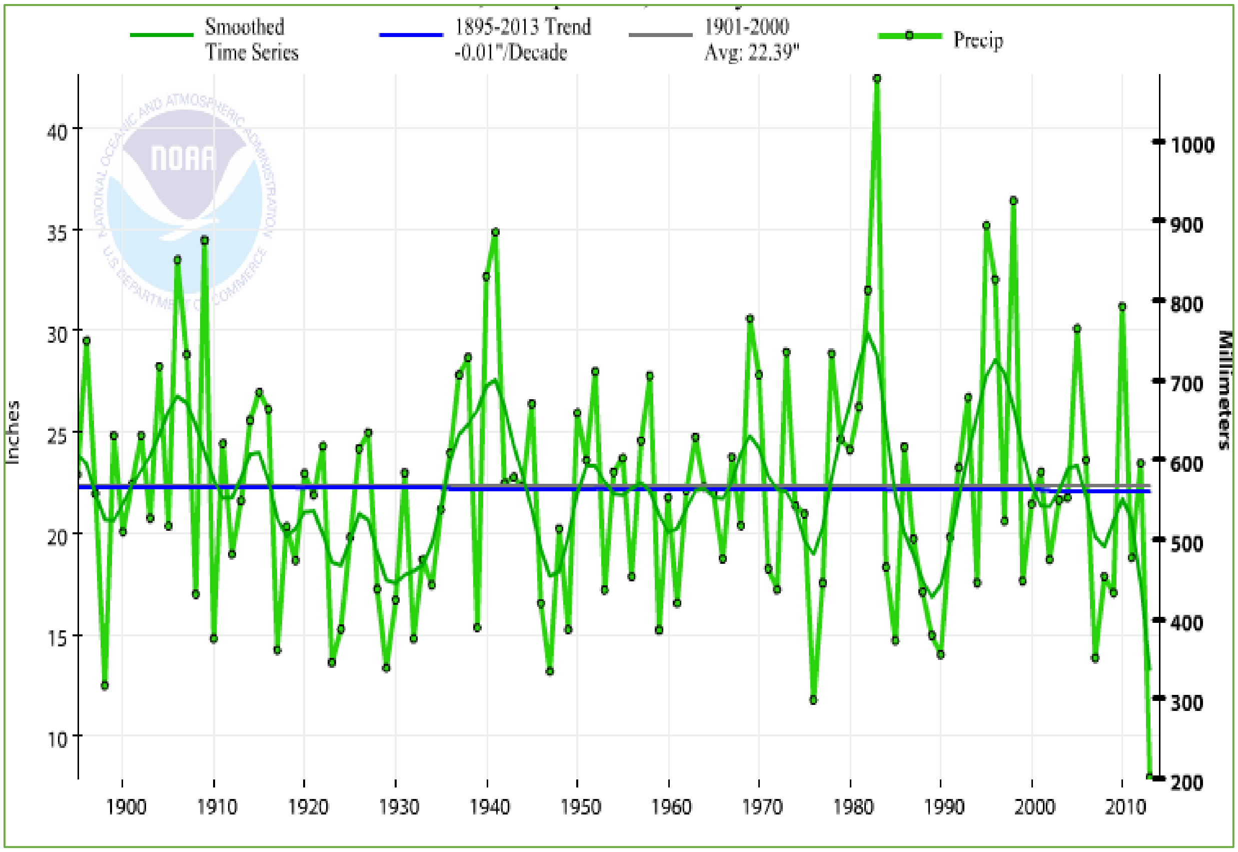


Figure 8: Historical Precipitation in California, January – December 1900 - 2010. *The high rainfall of the early 1980s was associated with a strong El Niño event followed by severe drought in the late 1980s. As history shows, the wet weather - drought sequencing are not unique events. Source: USGS.*

In California, the combination of prolonged drought and higher heat days are factors contributing to water deficits.

The volume of water that fills the ocean basins is increasing, however, Earth isn't generating or receiving greater quantities of water. Higher global temperatures accelerate ice sheet and glacier melting adding more water to the sea. Combine the basic law of physics that warm water expands, the fact that water retains heat at a greater rate than land, and warming average air temperatures, one can begin to understand how the waters of the ocean will take up more space and claim additional shoreline. The rate of sea-level rise has been occurring at a higher rate than the average over last several thousand years, and has been accelerating since the late 1970s. New methods of satellite altimetry (the measurement of elevation or altitude) indicate a rate of sea level rise of 0.12 inches per year (NOAA, Ocean Facts).

The current climatic condition will likely create perennial droughts and flashy rain increasing the likelihood of flooding. As temperatures rise in the lower atmosphere, more water vapor will be produced, as in precipitation events, in the form of rain rather than snow. The current climate has altered the type and quantity of precipitation available through our ecosystem. Precipitation is a direct beneficial outcome of an ecosystem process via the water cycle providing water.

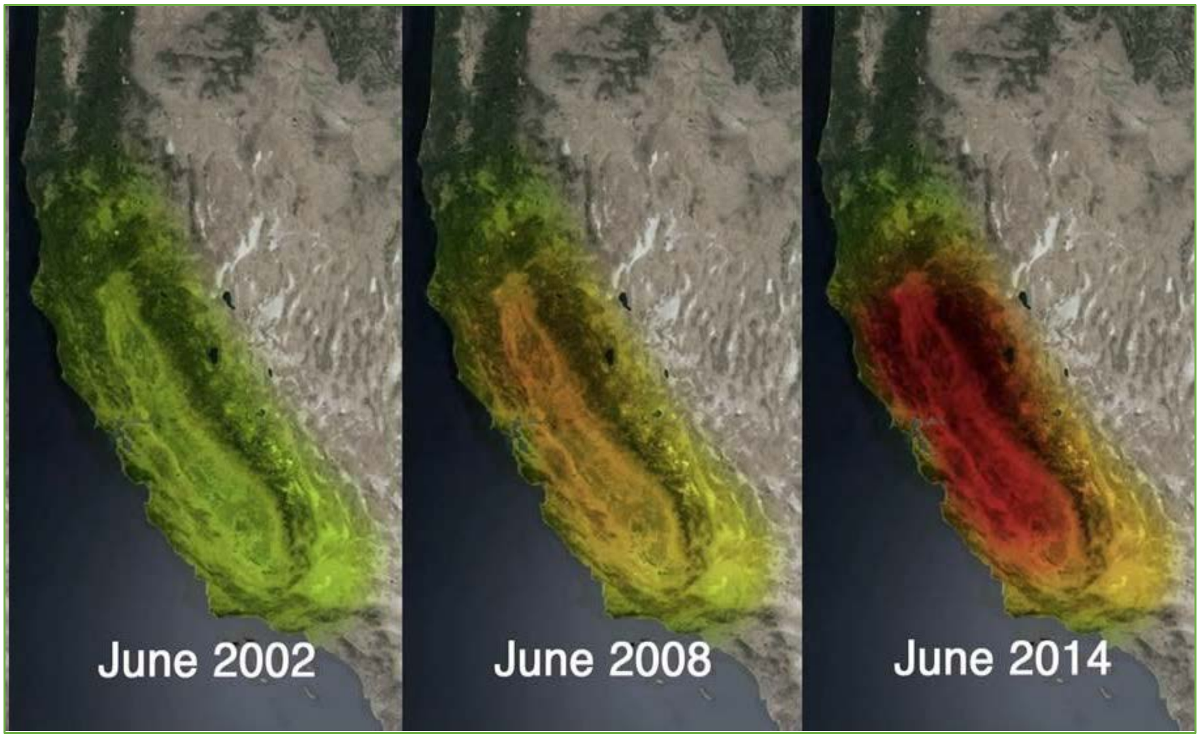


Figure 9: Declining Water Storage in California. *The trio of maps depict satellite observations of declining water storage in California as seen by NASA's Gravity Recovery and Climate Experiment satellites in June 2002 (left), June 2008 (center) and June 2014 (right). Colors progressing from green to orange to red represent greater accumulated water loss between April 2002 and June 2014. Source: NASA/JPL-Caltech and University of California, Irvine.*

Warmer temperatures and early arrival of Spring allows for a longer growing season. Research has been done to suggest that snowmelt runoff could occur up to two months earlier than it does under current averages (Rauscher, S. Western US. Geophysical Research Letters) and is infact the case. The current lack of rainfall in late Spring experienced in Tehama County from 2011-2014 has increased demand for irrigation earlier in the growing season and will likely heighten competition for water between urban, agricultural and environmental uses, particularly along the residential/agricultural fringe. Additional applications of pesticides and herbicides are highly likely as pests and pathogens flourish during an extended growing season.

Ridiculously Resilient Ridge

Pacific storms carrying much needed precipitation are currently being deflected and shifted northward by a high-pressure ridge that is settled over much of North America's West Coast. This is the same atmospheric phenomonon that caused the infamous dry winter of 1933/34 and ultimately triggered a decade of drought and hardship throughout nearly three-quarters of the western states known as the Dust Bowl. This weather feature is associated with the ridge-trough sequence that typically brings persistent record-breaking warmth and drought to California and other western states and severe cold temperatures and unrelenting precipitation to eastern North America. Coined the "Ridiculously Resilient Ridge" by the California Weather Blog, it has largely contributed to the dry winters and the following drought years of 1976/1977, 1988/1989, and the current three year statewide drought (Cook & Seager, 2014).

Great Wet Hope

The El Niño is a key indicator forecasters use to decipher what will happen during the winter months. As of November 2014, the temperature of the Pacific Ocean has failed to warm to the levels necessary for significant winter precipitation. Models indicate the 2014/15 winter will provide a weak to moderate El Niño event, not enough relief for the drought stricken west (JPL News, 2014).

Projected Conditions

Historic and real-time data are powerful measures indicating the climate is changing, though; they cannot project future conditions under various GHG emission scenarios. To do so, various modeling scenarios must be examined to allow scientists to simulate future climate projections. It is projected that human-induced climate change is to accelerate significantly if global emissions of heat-trapping gases continue to increase.

The National Weather Service forecasts the drought impacting the Central Valley of California and much of the Western U.S. is to continue into 2015. Below normal rain and snow is predicted for the 2014/15 winter with temperatures above average for this time of year. Models suggest a trend in maximum mean temperatures will occur whereby temperatures will be consistently warmer in all months.

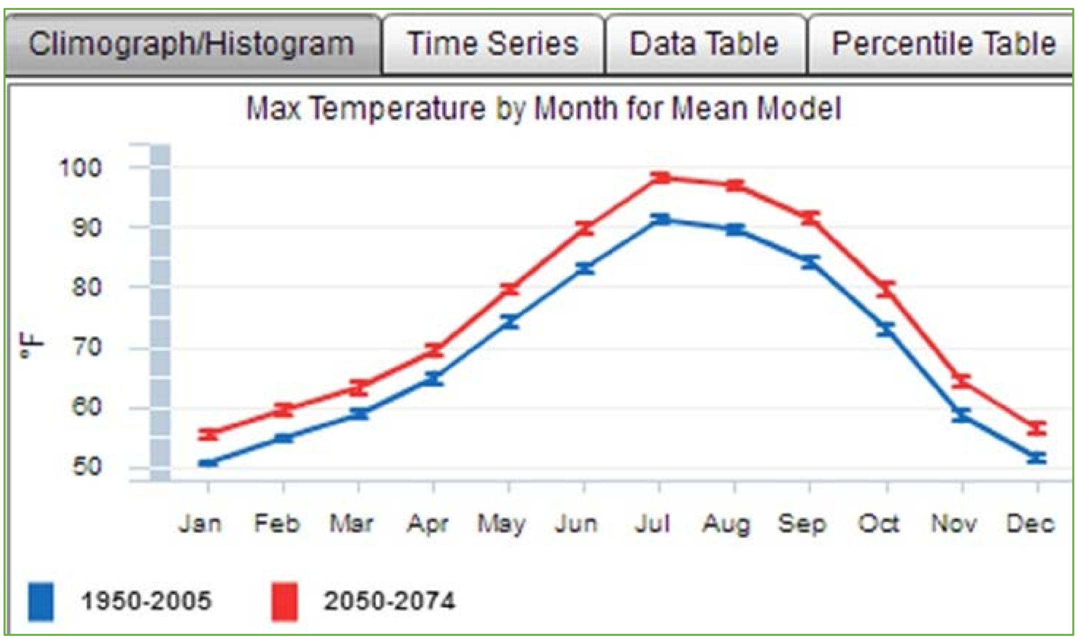


Figure 10: A Comparison in Maximum Mean Temperatures in Tehama County from 1950-2005 and 2050-2074. *Given that the bar representing past years in blue does not overlap with the red bar of years 2050-2074 suggests that the changes are statistically significant. IMPACT: stress on crops and livestock with yet another mechanism driving greater water requirement. Source: USGS National Climate Change Viewer, May 2014.*

Climate plays an important role in the global distribution of freshwater resources. Changing precipitation patterns and temperature conditions will alter the distribution and availability of freshwater resources, reducing reliable access to water for many consumers. Winter snowpack and mountain glaciers that provide water are declining as a result of higher global temperatures.

Natural Capital

Tehama County is located in an area rich in natural capital. Its economy is heavily reliant on natural goods and services that occur within the jurisdiction and region. There is an intimate relationship between we the consumer of goods and services and the ecosystem provider as one cannot thrive without the other. The image in Figure 11 displays valuable provisioning, regulating, cultural, and supportive services received without a fee from ecosystems.

Figure 11: Natural Assets / Ecosystem Services. *Source: MetroVancouver.*

Take for instance the unique characteristics of the set of attributes that provides for a diversion of water to supply agriculture. For a diversion to be utilized the water needs to arrive at a certain time, in the case of agriculture during the irrigation season. An appropriate quantity of water must be available to irrigate the intended acreage. The water must also be of a minimum quality, free of pathogens, nutrient rich and of appropriate salinity to support crops. Lastly, the water needs to be in a suitable location in order to be diverted. All four of the attributes in the above example are regulated by ecosystem processes and altered by climate change (Brauman, Daily, & Duarte, 2007).

As gathered by the example above, ecosystem services are the benefits we receive from a biological process, by-product or final product from nature that we cannot create ourselves such as air, soil, water, minerals, wood, and the like. Figure 12 shows the flow of benefits received from ecosystems. Ecosystem goods and services are products we gain from natural functions where core processes such as the nutrient and water cycles provide beneficial ecosystem processes (water purification, soil building, etc.) that ultimately supply valuable end products such as fresh water, raw materials, and other benefits we receive from ecosystems. Integrating human needs and requirements, the ecological potential of a landscape, and economic considerations are vital components in ecosystem management. Sustaining the integrity of ecosystem function, composition, and structure is necessary to provide for future generations while supplying immediate goods and services to an increasingly diverse demand (Collins & Larry, 2007).

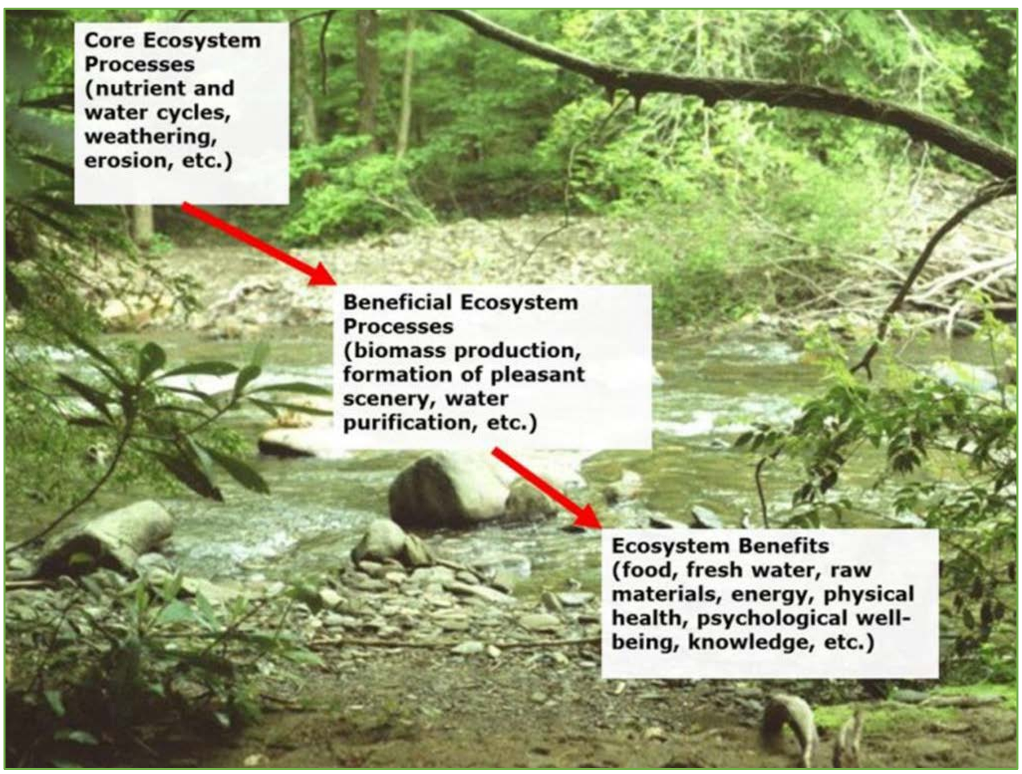


Figure 12: Core Processes and Benefits from Natural Assets/Ecosystem Services.
Source: User's Guide to Ecosystem Services, Phillips 2013.

In examining the benefits received from snowpack, it primarily serves as a freshwater reservoir that slowly releases snowmelt into our streams providing surface water as well as replenishing the aquifer. As climate models indicate, the decrease in snowpack will diminish the amount of surface water, causing greater reliance on groundwater supply, which is already heavily tapped.

Rangelands are natural assets that generate provision, regulating, cultural, and supporting services for multiple beneficiaries. As much as one third of the surplus CO_2 in the atmosphere driving climate change today has come from land management practices that cause loss of carbon, as CO_2, from our working lands. One way CO_2 returns to the atmosphere is through common agricultural practices such as driving a tractor, the use of fossil fuel based products, tilling the soil, and over grazing.

In addition to valuable water storage, soils have the capacity to hold carbon in a process called "soil carbon sequestration." This long-term (decades to centuries or more) 'carbon storage' service allows agriculture to transform from being a net emitter of carbon to a net sequester of carbon. Though carbon sequestration models are in their infancy, compost application on California's livestock grazing land is a relatively inexpensive, low tech approach to absorbing carbon emissions. A recent five-year Marin Carbon Project model suggests greenhouse gas mitigation rates over a 30-year time frame can produce more than 13 tons of CO_2 equivalency for each acre of rangeland treated with ½ inch of compost., Applying compost to rangelands improves soil structure, increases soil water holding capacity by 17 – 25%, and boosts resiliency towards changes in precipitation patterns, particularly drought and higher temperatures (Carbon Farming, 2014).

While orchard land is a prime land use that also sequesters carbon, it requires a significant amount of groundwater for crop production and carbon management. Tehama County's range and pasture lands are ideal for carbon farming and are less water intensive than orchard production. These land uses not only safeguard the desirable 'open space' aspect of the county, but also contributes resolve to a larger necessity, carbon sequestration. The practice involves implementing practices that are known to improve the rate at which CO2 is removed from the atmosphere and converted to plant material and/or soil organic matter. Carbon farming is successful when carbon gains resulting from enhanced land management and/or conservation practices exceed carbon losses. In 2013, 922,500 acres of rangeland, 22,000 acres of irrigated acres, and 6,322 acres of stubble (barley, wheat, etc.) were harvested in Tehama County (Tehama County Department of Agriculture Weights and Measures, 2013). Currently, these lands are being converted to water intensive perennial orchard crops, a land use practice that is not well suited for the ever increasing demand of water in the north Sacramento Valley. With nearly 1 million acres in pasture and rangeland use, Tehama County can likely play a role in carbon sequestration and enter the Cap and Trade arena with strength.

The fate of rangelands to continue to provide three critical ecosystem services (soil carbon, critical habitat, and water availability) in the face of integrated climate variables is based on land practices. The trio of maps (Figure 13) represents land use – land cover change scenarios based on three storylines (A1B, A2, and B1) of the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emission Scenarios (SRES). The A1B – Wealth and Technology scenario reflects low density development, high value perennial commodity crops, and 500,000 acres protected by 2100, near urban centers. The A2 – Population Pressures scenario includes low density development, intensive agriculture, and a lack of active conservation planning. The B1 – Sustainability scenario features high density development, moderate agriculture, and 1,000,000 acres protected by 2100 in high biodiversity areas. The sub-watersheds in green indicate enhanced ecosystem services whereas the grey show diminished ecosystem services by 0.15% to 5%, and the deepest shade of red have a detrimental effect on ecosystem services by a change of over 50%. The ecosystem services occurring throughout the county's rangelands are threatened with the Lower Clear Creek and the Lower Thomes Creek sub-watersheds of critical concern. Clearly it would be a worthwhile effort for Tehama County to engage in sustainable land management as suggested in scenario map B1 to help secure water availability, critical habitat, and contribute to carbon sequestration.

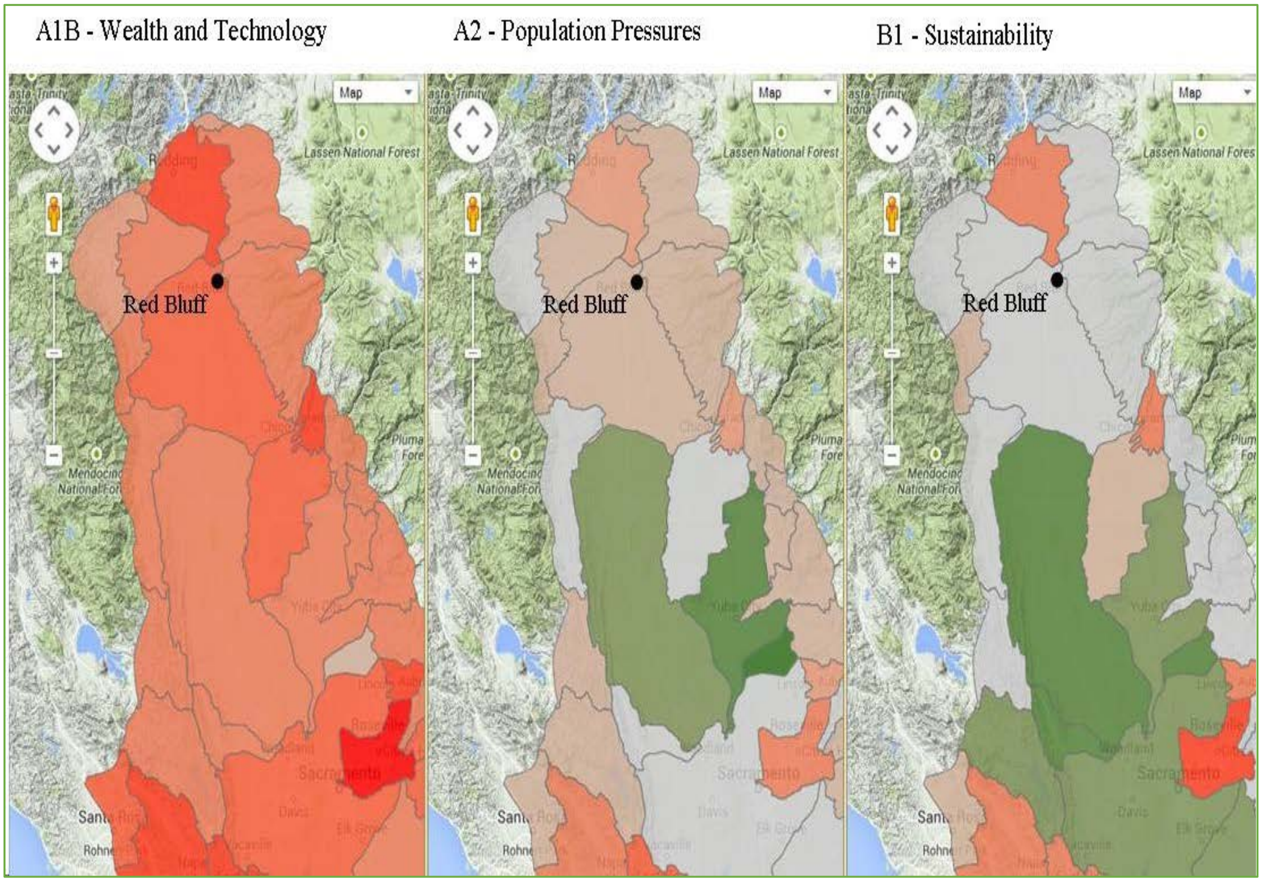


Figure 13: Average Changes to Multiple Ecosystem Services (Carbon, Habitat, and Water) from 2010 to 2040 Occurring on Rangeland under Hot, Dry Climate Scenarios. *Source: USGS and the California Landscape Conservation Cooperative, Climate Threat Assessment on California Rangelands.*

Land used for commodity production such as food, wood, and fiber productions also provides vital ecosystem goods and services; therefore it is essential that these working landscapes are managed for co-production. Numerous ancillary benefits are provided by responsible forest and rangeland management practices including carbon sequestration, enhanced water supply, recreation opportunities, and support for species abundance. These lands also provide vital water regulation services that control quality, quantity, and timing.

Supporting the longevity of limited snowpack also optimizes the process of groundwater recharge. The majority of domestic, agricultural, industrial, water districts and municipalities rely solely on groundwater and clearly benefit from ecosystem processes. Given that the Sacramento River is a gaining waterway south of Red Bluff (see Water: Tehama's Treasure section), downstream communities also directly benefit from the groundwater recharge process that occurs in Tehama County.

The Eco's: Economics & Ecosystem Services

Economics and ecosystems are two quite different concepts whereby the former is a social science based on supply and demand in relation to production and consumption of goods or services, and the latter is based on biological science. Similarities among the terms can be bridged when examining the concept of an ecosystem, the interacting and interdependent elements as part of an integrated whole. Given the two share the root 'eco' referring to 'home' or 'environment,' economics and ecosystems share a foundation in the principle of cause and effect occurring throughout interdependent relationships.

Root Word Review

Root	Meaning	Origin
Eco -	home	Greek 'oikos'
		Latin 'oeco'
- ology	study of	
- nomics	law of	Greek

In utilizing the tools of economics, climate adaptation efforts can be effective and far reaching for community climate readiness planning.

Similar to any sound financial investment, a diverse adaptation portfolio reduces risk and supports rebound from disturbances brought on by climate variability. A geographically diverse portfolio of ecological systems management (lands, resources, and species interactions) is a worthwhile investment for economic well-being through climate resilience. An adaptation portfolio that ensures economic and ecologic viability may include expanding protected areas, new investments in corridor connectivity, restoration, and new land use restrictions.

Investments in restoration and management of natural assets such as riparian corridor buffers, wetlands, and native plant species are measures to hedge against the loss of economic and ecologic wealth due to climate variability (Boyd, 2001). Land use practices should be managed for resiliency so that even under the projected climate conditions, the County's natural systems are capable of providing services on which the local economic system and downstream communities depend.

Certain species may be able to adapt to elevated temperatures by relocating to areas with lower temperatures, such as higher altitude or latitude, given migratory resources. For species adaptation to occur the natural landscape must provide suitable migratory pathways with critical forage and connected habitat must exist within those ranges. Connectivity of natural vegetation linking vital areas will increase the success of species movements. Investing in area networks resilient to climate variability can serve as migratory refuges that also preserve economic values. Refuges are not only vital to plant and animal species, but safeguard human welfare as well by optimizing beneficial ecosystem services that occur on these lands.

Restoration and corridor connectivity projects have the most potential in addressing both the needs of ecosystems and employment. According to a recent University of Oregon study, for every $1 million invested in forest and watershed contracting created 15-24 jobs, relative to the type of work involved. The economic benefits of restoration, for example, extend far beyond the jobs for the men and women working on the project. Those jobs create a ripple effect through the community, multiplying the benefits. The study estimated that same $1 million investment generated an additional 1.4 to 2.4 times the amount of economic output, contributing to economic growth. It also found that an average of 90 cents of every dollar spent on restoration stays in the state, and 80 cents of every dollar spent stays in the county where a project is located. Habitat restoration jobs pay dividends twice: upfront, in creating the local jobs, and then, through increased benefits of enhanced ecosystem services as well as tourism and community resiliency for many decades to come (University of Oregon, 2012).

To develop a comprehensive adaptation portfolio, an economic analysis of Tehama County's resources with an ecosystem services overlay and cost of failing to prepare for climate variability is clearly of value. Using the High Conservation Value approach common in sustainable land management would be a beneficial starting point to safeguard ecosystems and species. Connecting county and city administrators with natural resource specialists, scientists, and policy professionals will strengthen the portfolio. In addition, communicating the economic and social ramifications of ecosystem mismanagement may recruit public support for community preparation initiatives.

As a starting point, a prioritization exercise was conducted with input from various stakeholders to analyze climate change stressors with associated ecosystem services and benefits as provided in Figures 14 and 15.

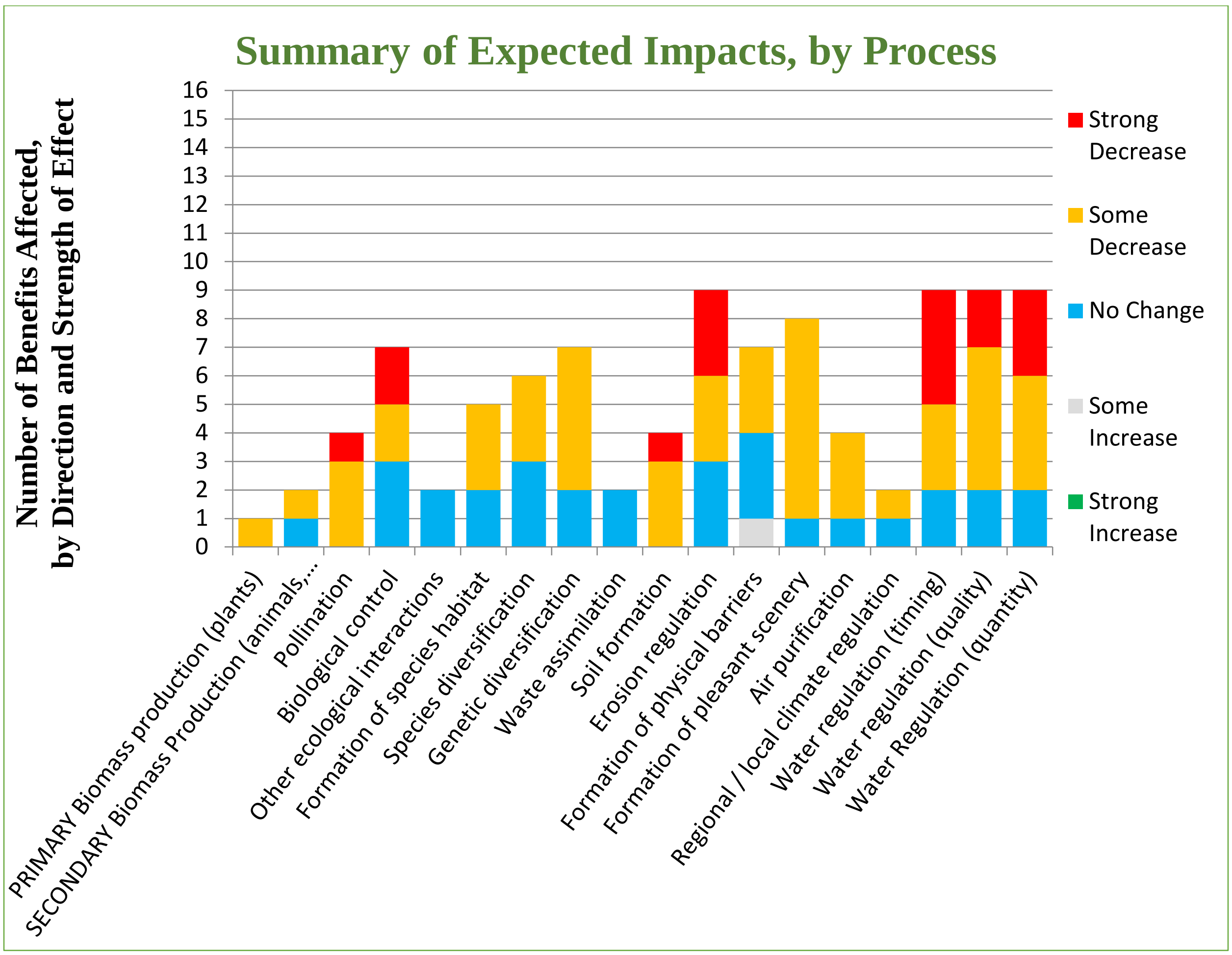


Figure 14: Summary Chart of Expected Impacts per Natural Process and Affected Natural Assets (Benefits). *Source: S. Phillips & B. Greer.*

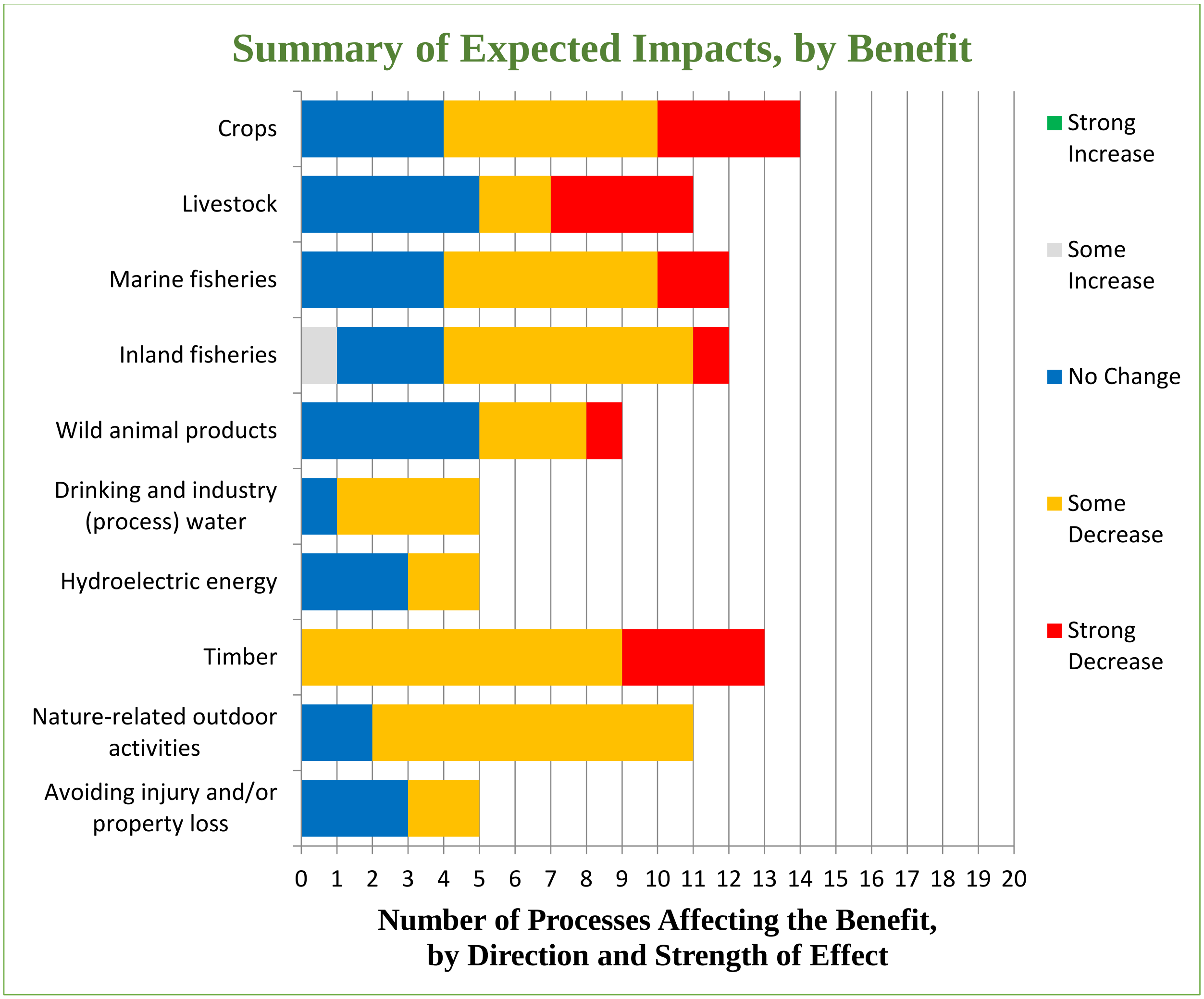


Figure 15: Summary Chart of Expected Impacts per Natural Asset/Benefit and Affected Processes.
Source: S. Phillips & B. Greer.

Forest Landscape

There are five distinctive natural vegetation zones within the county's watershed that are directly associated with elevation. Elevations range from a few hundred feet above mean sea level at creek confluences with the Sacramento River to over 9,000 feet at Brokeoff Mountain in the Sierra Nevada in the east side of the county and over 8,000 feet in the southern Yolla Bolly located in the Coast Range. This elevation range influences precipitation, which historically varies from 25 to nearly 80 inches, and results in a vegetation continuum from valley grasslands through oak woodland, Ponderosa Pine (historically), mixed conifer to white fir and sparse red fir at the highest elevations. Figure 16 depicts the broad vegetation types located in eastern Tehama County.

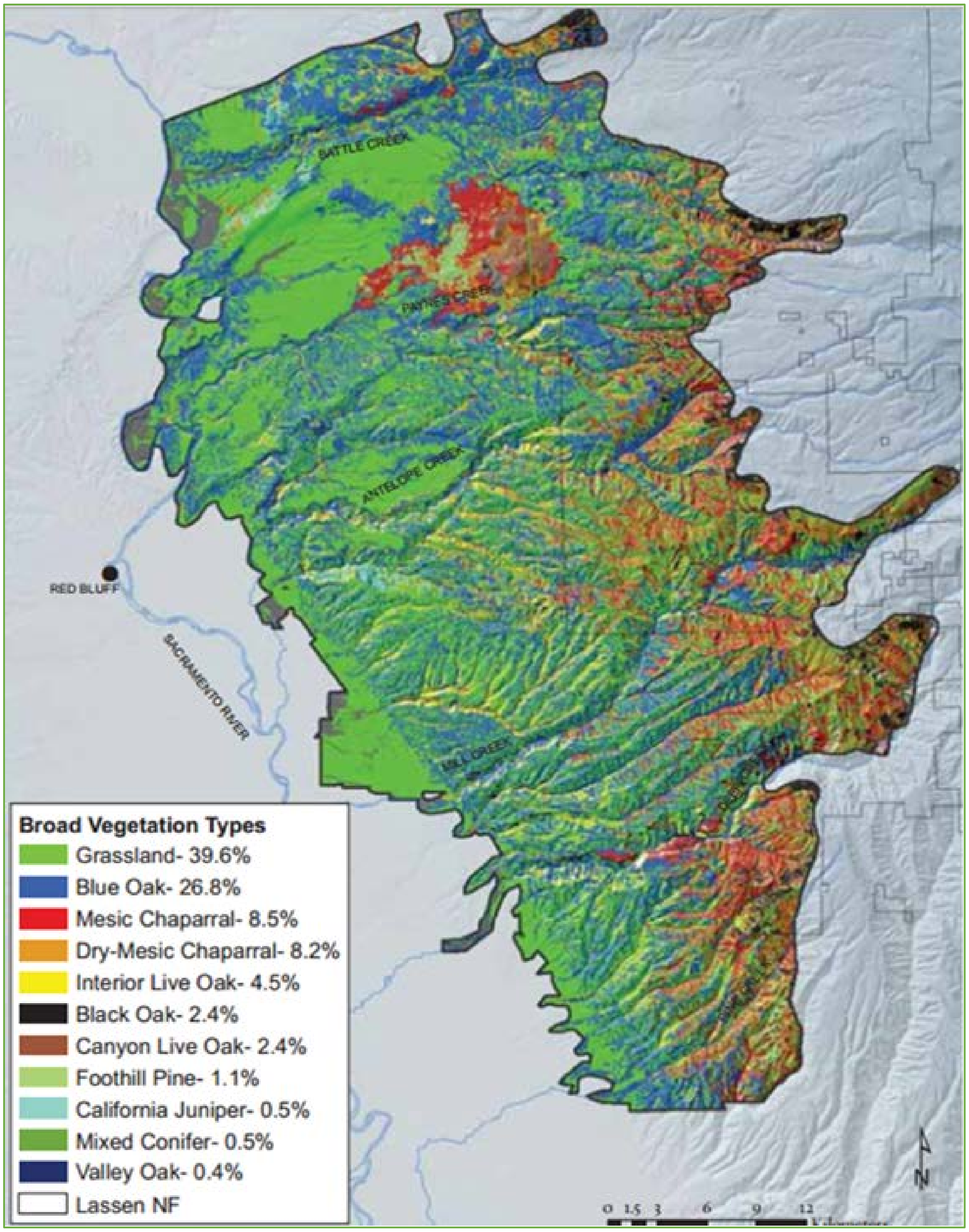


Figure 16: Vegetation Types in Eastern Tehama County. *Aggregated vegetation types ordered by decreasing presence in Tehama County's eastern watershed. Source: Resource Conservation District of Tehama County.*

The county's lowest elevation occurs in the Sacramento Valley within a range of 270 feet to 380 feet. Connectivity of riparian habitat has been fragmented due to urban and agricultural land uses largely along the Sacramento River corridor. Agricultural uses have severely reduced riparian vegetation to thin, disjointed thickets of willow, sycamore, cottonwood, and valley oak, as well as forbs and grasses. There are areas of intensive agricultural use with production extending to the river bank. The sparse native riparian vegetation provides few remaining places for wildlife to exist. The foothill zone is generally below 2500 feet elevation. Scattered oak species such as blue, interior live, white and black as well as, to a lesser degree gray pine, comprise roughly one-third of this landscape. Extensive patches of chaparral, grass, rock outcropping, and less frequently, Douglas-fir contribute to the open, park-like woodland of the foothills. There are limited areas in the higher reaches of the foothills with enough moisture to support Ponderosa pine.

Above the foothills, extending to 4800 to 5000 feet elevation is the low elevation mixed conifer forest. Ponderosa pine, Douglas-fir, and incense cedar are the most prevalent conifers. White fir is a common species above 4,000 feet. Though sugar pine and incense cedar occur throughout this zone, they are generally sub-dominant species. Black oak is common, especially on drier, productive sites. Canyon live oak dominate steep, rocky slopes on the larger canyon walls.

At higher elevations white fir mixed conifer forests generally occur from 5,000 to 6,000 feet and occasionally extend in elevation on very xeric ("dry") sites with shallow soils. Here, white fir is the dominant species with a mixture of ponderosa pine and/or Jeffrey pine occurring in varying amounts depending upon aspect and soil depth. Pine is most prevalent on drier sites or those with shallow soils. This zone inter-grades gradually and indistinctly with the white fir and red fir zones that occur in the higher elevation band.

Above 6,000 feet the upper montane zone encompasses mixed red fir and white fir, pure red fir, and lodgepole pine forests. Small natural openings of rock outcrops or meadows are most prevalent in this zone.

Forest Structure

Forest structure provides the natural infrastructure for regulating snowpack and wildfire, water yield and water quality for human and habitat needs as well as biodiversity. It is also a major component in ecosystem function and directly impacts the water, nutrient, and carbon cycles. The size and distribution of live trees, dead wood, vertical foliage distributions, horizontal variation in canopy density, coarse woody debris, and below ground assemblages characterize the structure of forestlands. Though natural forces such as wind, fire, and succession play a role in shaping forest structure, forest management practices that modify and restrict variation also highly influence the overall forest structure at the stand and landscape levels (Thomas A. Spies, 1998).

Fire has been an integral force within many North California ecosystems since the Pleistocene. Tree ring studies and charcoal analysis indicate that fires passed through many of the pine and mixed conifer forests found in the county's southern Cascades every six to thirty-two years. Continuous, low intensity fires reduce competition between rapidly growing brush species and seedlings of timber species reducing their rate of survival. Overcrowding tends to weaken large pines, making them more susceptible to insect attack.

In some instances, fire is the dominant factor controlling ecological change within many local landscapes. There is indication that natural fire regimes are catalysts for the reorganization of vegetation during periods of dramatic climate change. Fire in grassland, oak woodland, and chaparral landscapes improves brush stands as forage for large mammals by replacing woody, unpalatable vegetation of low nutrient value with new, more palatable root sprouts having somewhat higher nutritional value (Resource Conservation District of Tehama County ,2008).

In examining pre-European settlement vegetation conditions, upland conifer forests tended to be more open in structure as a result of the thinning effects from low-intensity fires as shown in the historical pictorial comparison of the central Sierra Nevada range Figure 17. Species that are resilient to low severity fires such as pines were favored under these conditions (Resource Conservation District of Tehama County, 2005). Gaps in the canopy and lack of ladder fuels in the earlier forest are in stark contrast to the dense forest thickets present today.

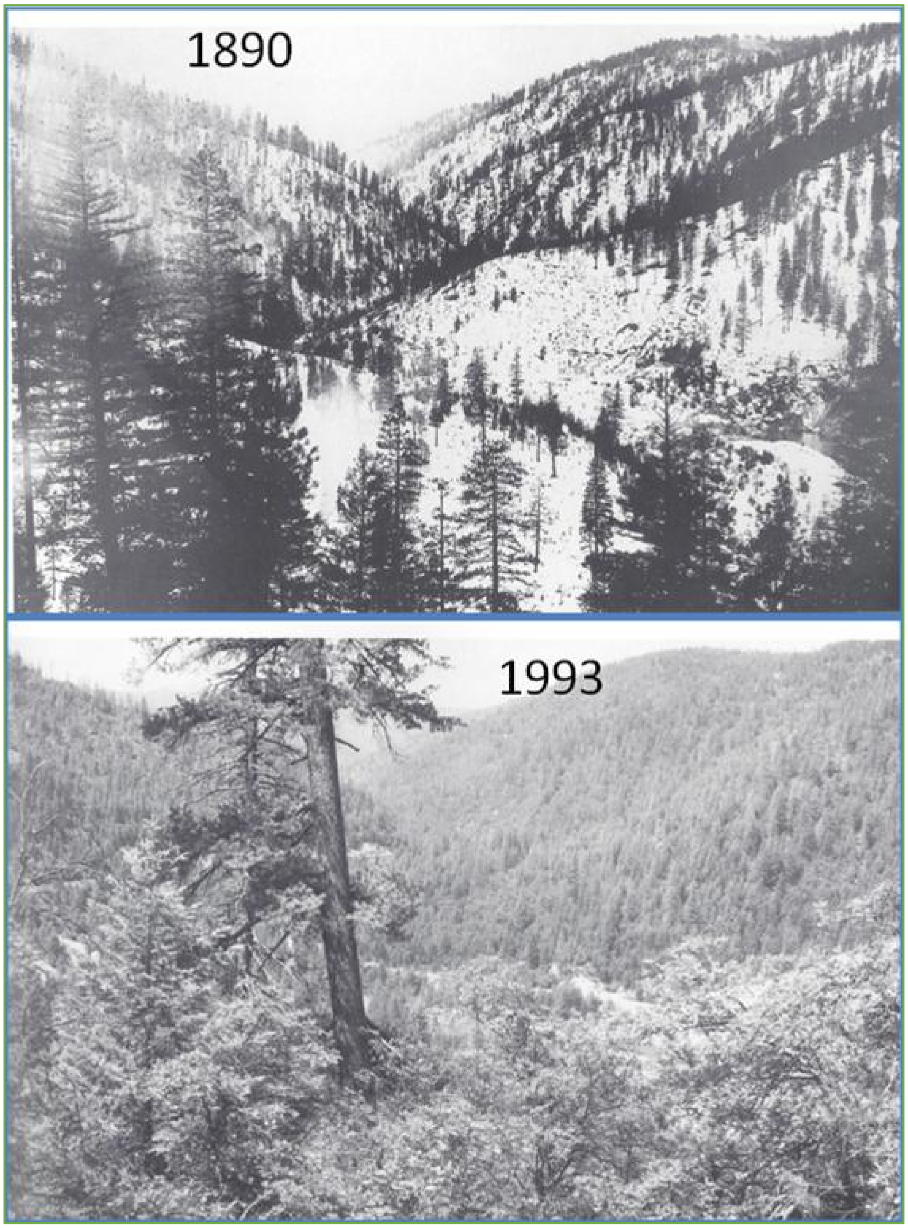


Figure 17: Historical Comparison Forest Density at 3,400 Feet in Elevation; Sierra Nevada Range, North Fork of the Feather River, East Branch. *Source: G.Gruell.*

Land Ownership and Uses

Conifers, hardwoods, and grassland habitat that blanket the foothills are challenged by land use practices. Patterns of land use such as agricultural clearing, timber harvesting, and urban expansion are stressors upon the forest, particularly among the riparian and oak woodland communities found in lower elevations. Historically, the valley was rich in biodiversity with a dense riparian canopy and expanses of open grasslands. Valley hardwoods have been largely replaced by urban encroachment, orchard crops, and to a lesser degree grazing and hay production.

Conversion of wild areas into urban and residential uses is an ongoing trend within the county's grasslands and oak woodlands that skirt the foothills (Figure 18). Rural development is also occurring within the area's chaparral and forested wildlands at the urban fringe of communities such as Bend, Manton, Paynes Creek, and Ponderosa Sky Ranch in eastern county, as well as the Red Bank area to the west.

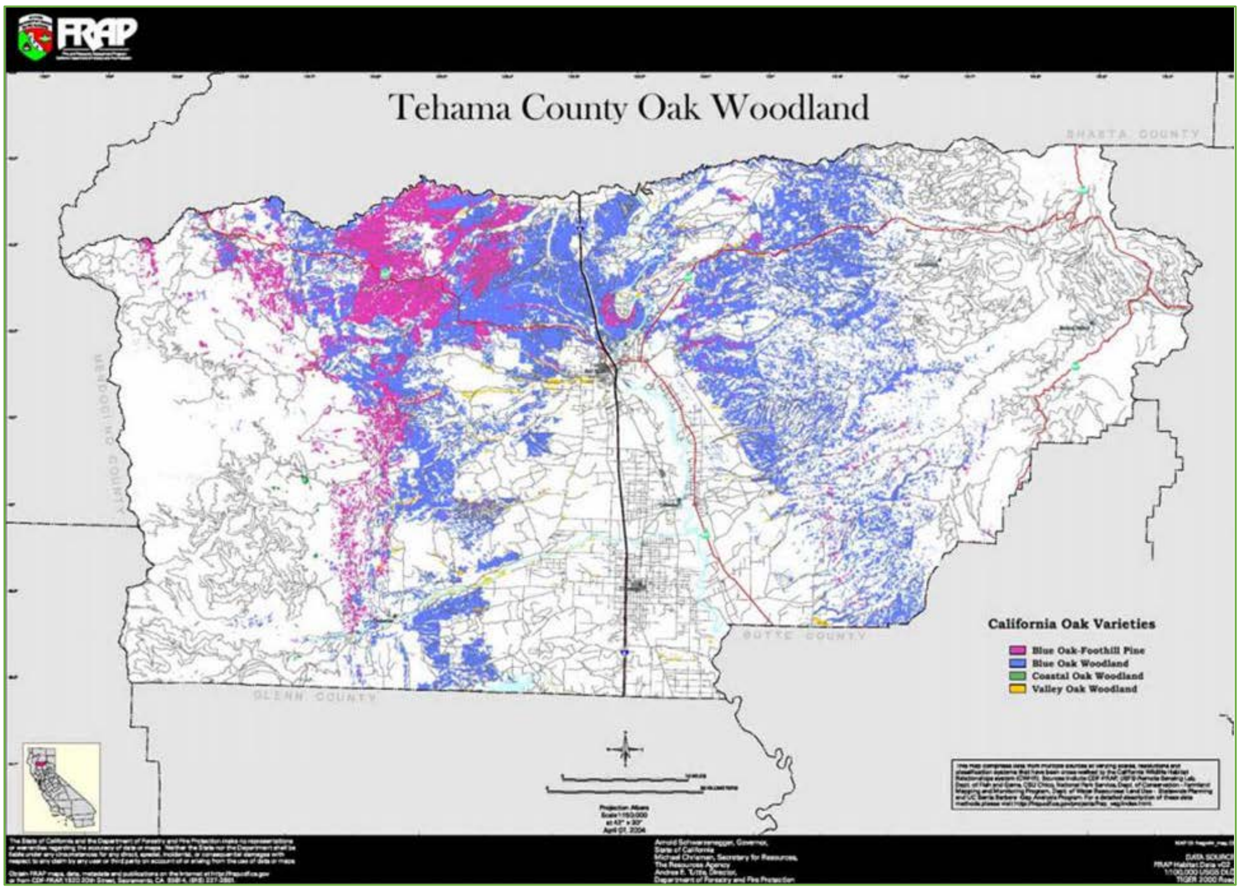


Figure 18: Tehama County Oak Woodland. *The middle elevations of Tehama County contain valuable hardwood stands of blue oak, valley oak, and other montane hardwoods. Upland mixed pine forests are categorized as biofuel and timber resources by CAL FIRE in its annual forest and range assessment. Source: The Department of Forestry and Fire Protection (CAL FIRE).*

Existing land use patterns consist of a combination of upland grazing, exclusive agricultural, as well as public and private lands. Portions of Lassen, Mendocino, and Shasta-Trinity National Forests fall within the county lines and are largely comprised of lower mixed conifer to montane habitats with the Mendocino National Forest as a unique situation managing both high elevation conifer and riparian oak woodlands. The significance of these different forest types provide critical habitat for list species to include the spotted owl, yellow-billed cuckoo bird, and elderberry beetle.

The timber industry has been an important component of the economic base in Tehama County. High periods of lumber demand ranged from the Gold Rush era through the 1970's when selective harvesting practices were employed per the Forest Practice Act of 1973. Though restrictions on public lands significantly decreased timber harvesting, the industry remains productive on private, particularly large-scale, landownership. In 2013, approximately 92,774,000 board feet were harvested, a nearly 39% increase from the previous year. Timber Harvesting Plans submitted to CAL FIRE in 2014 reveal that over 1100 acres in Tehama County are currently under the review process for harvest. Timber harvesting practices follow rigorous California Forest Practice Rules restricting industrial clear-cut extraction to a maximum of 30 acre tracts. Industrial clear-cutting, the preferred extraction method of large scale timber companies, which is a time-efficient and cost-effective harvesting method that removes virtually all trees within a designated tract and oftentimes requires repeated application of herbicide to maintain stand homogeny. It leaves forest cover highly fragmented with high levels of edge habitat that fundamentally changes the species composition of the forest flora and fauna. In contrast, selective harvesting is a less impactful extraction technique that removes specific trees in a tract with the intention of managing for continued growth and harvest of various ages and species over time. It is a great improvement upon the clear-cut method and maintains species diversity and ecological functions. Preliminary studies suggest that over time uneven age, selective harvesting also has the same profit potential since harvesting can occur more frequently and with less expensive inputs and management required.

Non-Climate Stressors on Forest Resources

Fire suppression and timber harvesting practices are major land management practices challenging the capacity of forests to remain resilient through various climate conditions. Fire suppression programs employed over the last century have lead to heavy fuel loads, particularly throughout public national forest lands. During this period, U.S. federal fire policy aimed to exclude fire from wildlands with the intention to protect human life, timber, and forest habitat by snuffing out all wildfires. Decades of suppression programs have altered the ecological imprint of wildland fire and ultimately contributed to a forest condition in which high frequency, high intensity forest fire regimes have become the norm due to unnaturally dense forests. Public forest land management, particularly regarding fire protection and fuel reduction, is wholly inadequate and has been a deadlock issue for several years due to significant lack of funds and an extensive NEPA process. This comes at the cost of greater catastrophic wildfire susceptibility, thereby threatening lives and destroying an array of natural assets along with millions of dollars' worth of public and private property. A majority of higher elevation federal lands are plagued with widespread over-accumulation of fuels increasing the likelihood of high-intensity, fast-moving catastrophic burns. Additionally, the federal timber harvest decline since the late 1980s has exacerbated the local fire problem. In turn, increases in disturbance or perturbation with subsequent impacts on water quality will occur at a greater rate than pre-suppression wildfires that burned in more open forest stands with much lighter fuel loads. Other harmful secondary environmental effects of catastrophic burns include impacted habitats of sensitive wildlife species throughout the watershed and diminished air quality with increased air pollutants and greenhouse gas emissions.

From a wildfire management perspective, overstocked forests are of concern as they contain far more flammable material within dense stands of trees of various heights, fostering prime conditions for catastrophic conditions for plant and animal species and to human communities. Overstocked forests are prone to the spread of tree diseases and pests placing more stress on trees, thus heightening the probability of catastrophic wildfire with the additional fuel as shown in Figure 19. Overall tree health is at risk due to overcrowded forests as each tree competes for scarce water, sunlight, and nutrients.

Figure 19: Image of Overstocked Forest in the Sierra Nevada Range. *Portions of the southern Cascade and northern Sierra Nevada forests have not burned for almost a century, largely due to historic mismanagement by public land managers and to misunderstanding of forest ecology by private landowners and to protect private property. In the absence of natural disturbance, overstocking, the accumulation of young and old trees into unnaturally dense thickets, leads to the deterioration of open, park like, mixed forests into crowded, brushy understory conditions with dead wood build-up on and near the floor. Since so much fuel is available, fire will burn hotter and move more slowly setting the stage for catastrophic, ecologically devastating wildfires. Overstocked forests are also very difficult and dangerous for fire crews and emergency personnel to operate in. Source: University of California Agriculture and Natural Resources.*

Valued recreational use of state and federal parcels is jeopardized by the threat of wildfire on public lands as well as adjacent private parcels. Consider the recent Bald and Eiler wildfires of 2014 in the Shasta County portion of Lassen National Forest. The two lightening-ignited incidents burned 39,926 and 31,085 acres of public land, respectively (as of print date) and will likely drastically impact tourism opportunities, endangering the economy of rural mountain towns as well as a loss in property values throughout the community.

Driven by the desire to sustain a viable timber operation in the years to come, large scale private forests, in general, adopt rather aggressive fuels reduction practices. The forest structure within these timber lands tends to have younger trees throughout the homogenous stand profile, particularly in lands harvested using industrial clear-cut methods.

The two silvicultural practices of clear-cutting and selective harvesting directly affect forest structure and valuable ecosystem processes. Removing large contiguous sections of forest by employing the clear-cut method compounds the severity of wildfire and challenges the forest's ability to generate and sustain beneficial services. The loss of the canopy structure within the clear-cut zone and along its periphery ultimately dries out the understory by exposing the forest floor to a greater amount of sunlight. Stunted and dead trees as well as dry vegetation lie in the wake of clear-cutting, contributing tinder for wildfire. It is common to have an increase of soil erosion and instream nitrate levels in the clear-cut harvest zones that contribute to algal bloom formations and soil erosion. Fragmented habitat, reduced biodiversity, and prominent monoculture stands resulting in a less complex food web and a greater susceptibility of tree species to disease are common clear-cut side-effects that ultimately affect the quality and quantity of water.

The concept behind selective harvesting allows the forest to regenerate at a natural rate while maintaining biodiversity and lessens the probability of soil erosion. With the minimal removal of trees by strategic selection, this type of harvesting is time and labor intensive. Similar to clear-cut methods, selective harvesting involves tractors, log docks, skid tracks, and access road(s) that severely alter the forest floor and increase water quality degradation. A selection system based on forest stewardship and biodiversity is necessary to ensure the ecosystem functions for all beneficiaries.

Federal and state forest land management are not the only obstruction in the removal of hazardous fuel loads in forestlands. Private, small scale property owners also hinder fuel load reduction as many owners are resistant to cut trees due to various reasons including aesthetic, spiritual, and privacy reasons. Ranchettes and rural development as a whole frequently abut large tracts of timber and public lands compounding the probability of catastrophic fire events.

Forests Role in Carbon Balance

Trees remove carbon dioxide, the primary greenhouse gas of concern, from the air and store it within as carbon as they grow. This valuable function that healthy forests provide is an important component in addressing resiliency to climate conditions. Conversely, carbon dioxide is released back into the atmosphere as a result of tree death. The rate of carbon emitted corresponds with the scale of forest damage ranging from basic tree decomposition to landscape level wildfires, insect and disease outbreaks, or development. CAL FIRE has identified five forestry strategies for reducing or mitigating greenhouse gas emissions that align with the Scoping Plan for AB 32, the California Global Warming Solutions Act as follows:

- Reforestation to sequester more carbon
- Forestland conservation to avoid forest loss to development
- Fuels reduction to reduce wildfire emissions and utilization of those materials for renewable energy

- Urban forestry to reduce energy demand through shading, increase sequestration, and contribute biomass for energy generation
- Improved management to increase carbon sequestration benefits and protect forest health

Source: CAL FIRE Climate Change, 2012

Forest Susceptibility

Weather, climate, and associated hydrology are critical drivers of forest dynamics. High elevation forests, foothill oak woodlands, and rangelands provide watershed protection, economic benefits, and social wellbeing through water quality and quantity regulation, nutrient cycle management, recreation opportunities, and wildlife habitat. The projected increase in average air temperature as well as altered precipitation and hydrology will challenge the resiliency of Tehama County's forestlands throughout the elevation continuum. The interaction of land use practices and the variability of climate conditions compound stress upon these working landscapes and may reduce or alter the range of benefits received from forestlands. Susceptible local forestlands lead to a susceptible economy in Tehama County. The quality of life for local citizens and the standard ability to continue 'business as usual' for industry, and municipalities, as well as downstream counterparts, will likely be impacted.

Increased Average Air Temperatures

As a result of rising average temperatures, tree mortality has occurred at a faster rate in recent decades throughout the southwestern United States (California Adaptation Strategy, 2009) as depicted in Figure 20. It is unclear whether the warming-related mortality rate increases are driven by increasing drought stress in trees, more favorable conditions for tree-killing organisms, or a combination of the two. In examining the central Sierra Nevada, evidence suggests that drought stress on trees in water-limited, low-elevation forests (dry areas with prolonged high heat days where water is scarce) tend to dominate changes in mortality rate, while tree-killing organisms play a key role in energy-limited, high-elevation forests characterized as cold and wet areas with a shorter growing season (Das, 2013).

The high elevation southern Cascade and western slope of the northern Sierra Nevada offer prime conditions for white fir to thrive, however, it is sensitive to spring and fall frosts. Developing buds as well as foliage can be damaged due to spring frost. The majority of established trees are not susceptible to cold damage, however, it can take the form of frost cracks and ring shake. Frost cracks are associated with some rot and decay loss. Conversely, sudden rises in temperature during May and early June can cause damage nearly identical to that of spring frosts (Glend, 2001). Climate models indicate the decline of chill hours will drive shifts in habitat impacting the composition of forest species. This rapid decrease in chilling hours ranging from 30% to 60% by 2050 will likely accelerate the spread of pest and disease and alter reproductive cycles (National Climate Assessment, 2014).

The forecasted increase in tree mortality rates throughout the coniferous and hardwood forests could have dramatic effects on forest productivity, structure, and habitat for various forest species. Seed production and establishment as well as plant growth and vigor are development processes affected by temperature rise. Warmer temperatures reduce moisture available to plants further threatening seedling and plant survival and increasing the risk of wildfire. Continuous high heat days accelerate snow melt leading to earlier water deficits for forest vegetation.

Figure 20: Image of Weakened Stand in the Sierra Nevada Range. *Young trees succumb to disease, pest infestation and drought stress at a significantly higher rate than in past decades. Old growth stands are also weakened by the prolonged changes in annual temperatures and precipitation patterns. Source: N. Stephenson/USGS*

Warm temperatures will fundamentally impact water supplies in forestlands as evapotranspiration rates are projected to increase. The evapotranspiration process requires a tremendous amount of energy from trees to transfer moisture from the earth (surface and/or groundwater) to the atmosphere through evaporation and transpiration processes. Projected extended high heat days, prolonged drought, and high wind events exacerbate rising evapotranspiration rates leading to an even greater loss of water to the atmosphere.

In response to increased temperatures and given favorable soil conditions tree species will likely migrate north and to higher elevations altering forest and range communities and overall species composition. A sequence of upslope relocation is projected in which grass savanna lands migrate upward to occupy historic oak woodlands, oaks may inhibit mixed pine forest, and mixed pine advance into conifer stands, confining such evergreens to a limited band of high altitude habitat. Since there is inadequate room to ascend in elevation primarily due to soil and atmospheric conditions, alpine forests and associated plant species are particularly vulnerable to increases in average air temperatures.

The structure and function of meadows not only provide habitat for a diversity of species, but also serves as water storage. Meadows are highly sensitive to drying and potential extreme temperatures, in addition to non-climate stressors.

Altered Precipitation and Hydrology

In California, winter snowpack provides more than 80 percent of the moisture available at high elevations. Projected climate models indicate a decline of snowpack as well as an altered length and arrival of winter precipitation and temperatures. Less precipitation falling as snow, earlier snowmelt, and earlier arrival of most of the year's streamflow not only challenges high elevation forest production, but also timber production and the ecosystem process that will affect many beneficiaries (human and species habitat).

Changing precipitation patterns result in a change in snowmelt timing in that runoff is occurring earlier now than the mid20th Century (Cayan et al. 2001; Stewart et al. 2004). Plants and animal species have attuned to the shift as flowering dates for plants and breeding seasons for animals have occurred earlier in the year. In addition, many species are seen colonizing higher elevations or more northerly latitudes than their historic range due to non-ideal temperatures or resource shortages (Cayan et al. 2001; Parmesan and Galbraith 2004; Logan and Powell 2005).

Taxing on Tree Health

As tree defenses are weakened in drought and extended periods of consecutive high heat days and warmer nights, vulnerability to infestation increases. The frequency, concentration, and range of insect pest, pathogen, and disease outbreaks are a response to the combination of warmer temperatures and drought as well as a symptom of the larger management problem of overstocked fuel loads. High fuel stock results in greater forest density, which increases competition (water, solar energy, and space availability) and promotes damage from pests. Fire suppression practices offer trees an opportunity to flourish (especially white fir, due to shade tolerance) accumulating to current hazardous stand densities.

Fire scars, commonly found in older stands, offer entry for a variety of disease and decay organisms. Tree borer's, such as the Bark Beetle, are present throughout the eastern forestlands and are major drivers of interior forest deterioration. In time, trees succumb more readily to infestation as weak or dead trees serve as hubs accelerating the borer population and range, ultimately destroying more trees than would have been affected had trees not been stressed by drought. During the substantial droughts of the late 80's and early 90's, large die-offs of true fir occurred with up to 60% mortality by stand. The sheer number of beetles can, however, overwhelm the tree's defenses, and the results can be disastrous.

Warming induced drought stress may make trees more vulnerable to the negative effects of mistletoe. Mistletoe, a parasitic perennial plant that also carries out photosynthesis, relies on a host tree for water and mineral nutrients. This suggests that mistletoe increases the risk of drought induced mortality of its host making trees more susceptible to drought stress and compromising the carbon balance of the host. Studies indicate the parasite can adversely affect long-term tree growth and vigor in areas with pronounced water deficit (Sanguesa-B). Mistletoe is increasingly common throughout Tehama County's mid-elevation hardwood forests and could threaten forest health and timber productivity as prolonged periods of drought are projected.

Wildfire

Large wildfires are generally the result of several factors; development in Wildland-Urban Interface zones (WUI), an increase in the amount of biomass fuels, and changing climatic conditions. Forestlands throughout the region are prime for catastrophic wildfire due to non-climate stressors such as overstocked fuels as well as various climate related stressors. Widespread drought, higher average air temperatures, extended high heat days, earlier snowmelt and spring growth, delayed winters, expanded insect and disease infestations, and the shift of precipitation from snowpack to variable rainfall are climate conditions that have extended the fire season that gives way to a highly susceptible landscape to the risk of wildfire.

Rising average summer temperatures are associated with an increase in acres burned. Research in the Sierra Nevada range found an annual increase in average summer temperature of 1°F is associated with a 35% expansion in burn area (Headwaters Economics , 2014). In keeping pace with temperature rise, models project up to a 74% increase of burned areas in California with northern California potentially experiencing a doubling under a high emissions scenario toward the end of the century (National Climate Assessment, 2014).

Fire is an important natural process for sustaining ecological health throughout the watershed. Fire suppression forest management practices on federal forestlands pose a great risk to the ecological function of the forest. In lower elevations, a lack of low to moderately intense fire has allowed invasive species such as medusa-head grass to dramatically alter the composition of the grasslands matrix among oak woodlands and foothills chaparral on a significant spatial scale (Resource Conservation District of Tehama County, 2008).

Wildland Urban Interface

The Wildland Urban Interface (WUI) is roughly defined as a zone where natural areas and development intersect. There is a greater risk for wildfire in WUI zones as more residential developments occur on rural lands adjacent to natural areas and public lands. Roughly 16 percent of the WUI in the West is developed with the remaining 84 percent open to potential development (Headwaters Economics, 2014). Roughly 25,852 acres in the county are vacant suggesting development may expand despite the General Plan's firm open space and agricultural land protections and inaccessibility due to physical constraints (County). Residential growth on these lands is primarily a local responsibility, however, state and federal governments bear the costs of wildfire protection. Homeowner insurance fees will likely increase to assist in covering the cost of wildfire protections.

Communities adjacent to and within the state's wildlands have experienced growth in the last decade. Development in these areas has taken a number of forms. In addition to the simple expansion of the urban fringe, rural hamlets are established far from urban centers, and lot splits have allowed homes and small ranches to be built on individual parcels. In some instances, such as Lake California and Rancho Tehama Reserve this has created residential densities that approach urban areas. Development in these remote areas is often created without many of the infrastructure components and fire safety features that are integral to fire protection. Significant among these deficiencies are insufficient access on two lane roads for ingress and egress of firefighting equipment, inadequate water supply systems, and the presence of mobile homes as residences on many small rural parcels. Considering that mobile homes are often installed with little or no vegetation removal, this type of residence is more susceptible to flash fires.

The conversion of wild areas into agricultural, urban, and rural residential uses is currently taking place within the county's foothill grasslands and oak woodlands. Rural development is also occurring within the area’s chaparral and forested wildlands at the urban fringe of communities such as Bend, Manton, Paynes Creek, and Ponderosa Sky Ranch. A portion of wildland fire threat to fringe communities comes from federal lands, as in the US Forest Service and Bureau of Land Management. These areas of rural development have been described as a point where the fuel feeding a wildfire changes from natural (wildland) to manmade fuel, such as structures, crops, and urban debris. This intermingling of natural and manmade fuel in the WUI has made the control of wildland fires more difficult and costly. It has also dramatically increased the danger and potential destruction caused by wildfire.

Scattered development of individual homes and structures is also found near rural population centers such as Lyonsville, Panther Spring, and Lyman Springs. This physical characteristic of the eastside has focused much of the current development on areas that are relatively flat and are already being utilized for urban development. Some outlying areas such as Forward Valley (the area immediately east of the Manton Community) and scattered parcels along the Sacramento River already have sites suitable for construction (VESTRA Resources, Inc., 2006).

According to the Tehama County Planning Department’s Draft Housing Element (2013), the most significant housing project currently holding entitlements for construction within the unincorporated county is Sun City Tehama. This project proposes to create approximately 3,450 age-restricted (55 years of age and older) housing units and 250 non age-restricted housing units, and establish approximately 67 acres as General Commercial and 108 acres as Commercial Recreation west of I-5 between the Hooker Creek Road and Sunset Hills Drive interchanges. This proposed project lies in the northern portion of the county’s WUI zone with a Very High and High classification according to the CAL FIRE Fire Hazard Severity Zone Map (Figure 21). The proposed community largely targets out of town retirees who likely are unaware of the area’s fire susceptibility. In addition, the proposed resident population requires substantial assistance in the event of a fire.

The wildfire factors mentioned above are of concern throughout the elevation continuum and particularly in populated forested areas. In an effort to reduce the effects of wildfire upon developing areas, federal fire managers authorized State Foresters and CAL FIRE to determine communities exposed to a greater threat of wildland fire. A majority of the communities identified as an at-risk fire threatened community are adjacent to federal lands. Table 2 lists the officially recognized communities within eastern Tehama County, where a majority of the population resides. A Hazard Level Code 3 denotes the highest level of threat and a 2 indicates a moderate threat. In addition, the community of Ponderosa Sky Ranch is a community with significant risk within the eastern fire plan project area (Resource Conservation District of Tehama County, 2008).

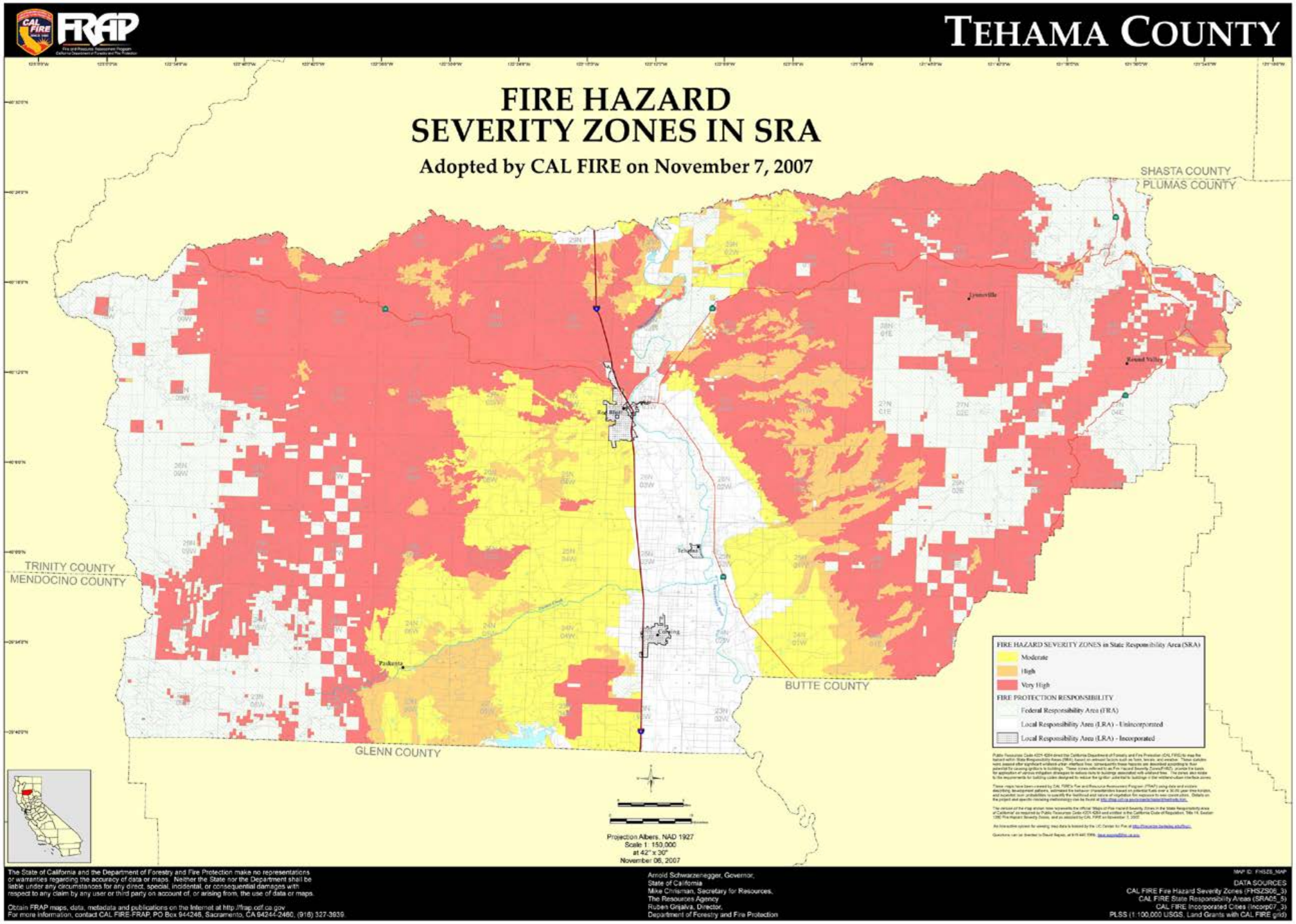


Figure 21: Fire Hazard Severity Zones in State Responsible Areas (SRA). *Source: CAL FIRE 2007.*

Officially Recognized Communities at Risk within Eastern Tehama County[1]			
Community Number	**Community Name**	**Federal Threat[2]**	**Hazard Level[3]**
85	Bend	X	2
283	Dairyville		2
656	Los Molinos	X	2
678	Manton	X	3
840	Paynes Creek	X	3
920	Red Bluff	X	3

Table 2: Communities at Risk of Wildfire, Eastern Tehama County. *Source: Resource Conservation District of Tehama County, 2008.*

Forest Findings

In order to foster resiliency in the county's forested lands, the stakeholders developed a qualitative forest resources matrix (Table 3) to prioritize risks from non-climate related and climate related stressors. The risk rating was established based on current conditions, impacts, probability of such consequences occurring, and the habitat's natural ability to respond independent of human influence. The risk evaluation findings suggest that agricultural and timber harvest practices followed by urban encroachment are non-climate based stressors upon Tehama County's native grasslands, native oak woodlands and riparian woodlands. The function of these ecosystems are further at risk due to current and projected higher temperatures, extended dry seasons, and catastrophic fire events. Though there are native species in these communities fit for drought tolerance, adaptive capacity has its limits where many species will not be able to adjust to extremes in a short period of time. The analysis also suggests that inadequate land management of public and private forested lands as well as human activity in the WUI zone pose great loss of forest productivity and community resilience. The impacts are compounded in light of climate projections.

A unified approach of best management practice across forest property boundaries at various elevations is of value to educate rural property owners of forestlands regarding the components of a "healthy forest"; what it looks like, why it is important, how activities and practices on private land impact neighbors as well as the larger community, and what they can do to be part of the solution. An experimental, on the ground, demonstration site would be of value to serve as a local example of optimized forestland.

Tehama County FOREST RESOURCES RISK MATRIX QUALITATIVE ANALYSIS H=High | M=Medium | L=Low						
Stressee	**Stressor**	**Conditions/Comments**	**Impacts/ Consequences**	**Probability**	**Ability to Respond**	**Risk Rating**
NON-CLIMATE RELATED						
Grass savanna (native grasses)	Agriculture	Perennial native grasses and flora challenged by invasive annuals from grazing ungulates. Perennial plant species acclimated to low intensity fire.	H - as grasslands are limited.	HA4:G28A4A 4:G28	L	H
	Urban encroachment	Development expansion within already limited habitat.	H - as grasslands are limited	M	L	M
	Wildfire	Habitat has under gone prescribed burning prior to European arrival.	Fire aids productivity of perennials. However, annuals are problematic - shorter fire return interval and an increasing grass fire cycle.	H	M	M
Native oak woodlands	Agriculture	Seedlings challenged by poor grazing practices and invasive grass species introduced via cattle.	H	M	M	M
		Extensive clearing in habitat for orchard and vineyard crop cultivation.	H	H	L	H
	Urban encroachment	Development expansion particularly within foothill habitat.	H	H	L	H
		Clearing on private lands.	H	H	L	H

Tehama County
FORREST RESOURCES RISK MATRIX QUALITATIVE ANALYSIS

H=High | M=Medium | L=Low

Stressee	Stressor	Conditions/Comments	Impacts/ Consequences	Probability	Ability to Respond	Risk Rating
Riparian woodland (mixed species)	Agriculture	Extensive clearing in riparian corridor for orchard crop cultivation. Riparian vegetation zone is a vital buffer to flood surges, bank stabilization, and threatens water quality downstream.	H	H	L	H
	Urban encroachment	Development expansion within valley floor riparian habitat.	H	H	L	H
High elevation forestland (Conifers)	Pests and pathogens	Waves of pests damage select stands of species. Bark Beetle.	M	M	M	M
	Harvesting practices	Clearing on private lands.	H	H	L	H
Wet meadows	Land use practices	Grazing/ allotments and timber practices main impacts. Culvert drainage for water use downstream.	M	M	M	M
CLIMATE CHANGE RELATED						
Grass savanna (native grasses)	Precipitation	Less rain therefore may lead to less soil capacity.	Loss of grass species and habitat destruction. H	H	M	M
	Temperature	Extended periods of consecutive high heat days.		H	L	
	Wildfire	Perennials may not be able to overcome reoccurring high intensity fires.		H	M	
Native oak woodlands	Precipitation	Extended dry season challenges the adaptive capacity of this native drought-tolerant species.	Loss of oak species and destruction of traditional habitat.	M	M	M

Tehama County FOREST RESOURCES RISK MATRIX QUALITATIVE ANALYSIS H=High | M=Medium | L=Low						
Stressee	**Stressor**	**Conditions/Comments**	**Impacts/ Consequences**	**Probability**	**Ability to Respond**	**Risk Rating**
	Temperature	Extended periods of consecutive high heat days.	H	H	M	M
	Wildfire	Prolonged high intensity fires incinerate oak shoots and established trees beyond recovery. Loss of mineral nutrients within habitat.		H	L	H
Riparian woodland (mixed species)	Precipitation	Projected 'flashy' precipitous events may dislodge vegetation along waterways. Extended drought conditions may weaken trees.	M	L	M	L
	Temperature	Extended periods of consecutive high heat days in drought conditions may weaken older trees or those with shallow tap roots.	M	M	M	M
	Wildfire	Unusual for vegetation along waterways to burn due to high moisture content.	M	L	M	L
High elevation forestland (Conifers)	Precipitation	More precipitation received as rain, less as snowfall leading to species retracting to higher elevations.	Overall decline of production and reduced to a limited band/range of habitat leading to moderate probability of mortality due to increase stressors. H	H	M	M
	Temperature	Accelerated snow melt due to higher low temps, and extended periods of consecutive high heat days.		H	L	H

Tehama County FOREST RESOURCES RISK MATRIX QUALITATIVE ANALYSIS H=High | M=Medium | L=Low						
Stressee	**Stressor**	**Conditions/Comments**	**Impacts/ Consequences**	**Probability**	**Ability to Respond**	**Risk Rating**
	Wildfire	Prolonged high intensity fires incinerate oak shoots and established trees beyond recovery. Loss of mineral nutrients within habitat.	Loss conifer species and habitat destruction. H	H	L	H
Wet meadows	Precipitation	Precipitation received as rainfall over snowpack, therefore lacking strategic time release of water into wetland ecosystem. Indicator biome of changes in water quantity and quality and species composition.	Altered water flow regimes; lack of flood control and water purification with invasion of woody plants. Ecosystem Services - loss of water and carbon storage functions. H	H	L	H
	Temperature	Shortened life span; evaporation.	H	H	L	H

Table 3: Forest Resources Risk Matrix.

Competition for limited forest and water resources runs high in our community and those downstream. Finding ways to meet all of these needs despite the various stressors upon these resources is not going to be easy; however, efforts are in motion for local resilience. Of highlight is Antelope Creek (Figure 22 and adjoining box *Antelope Adaptation*) and the community involvement to safeguard this sub-watershed as a critical connection between groundwater and surface water as well as ecosystem function and beneficiaries; wildland habitat and agricultural production, and ultimately rural and urban communities.

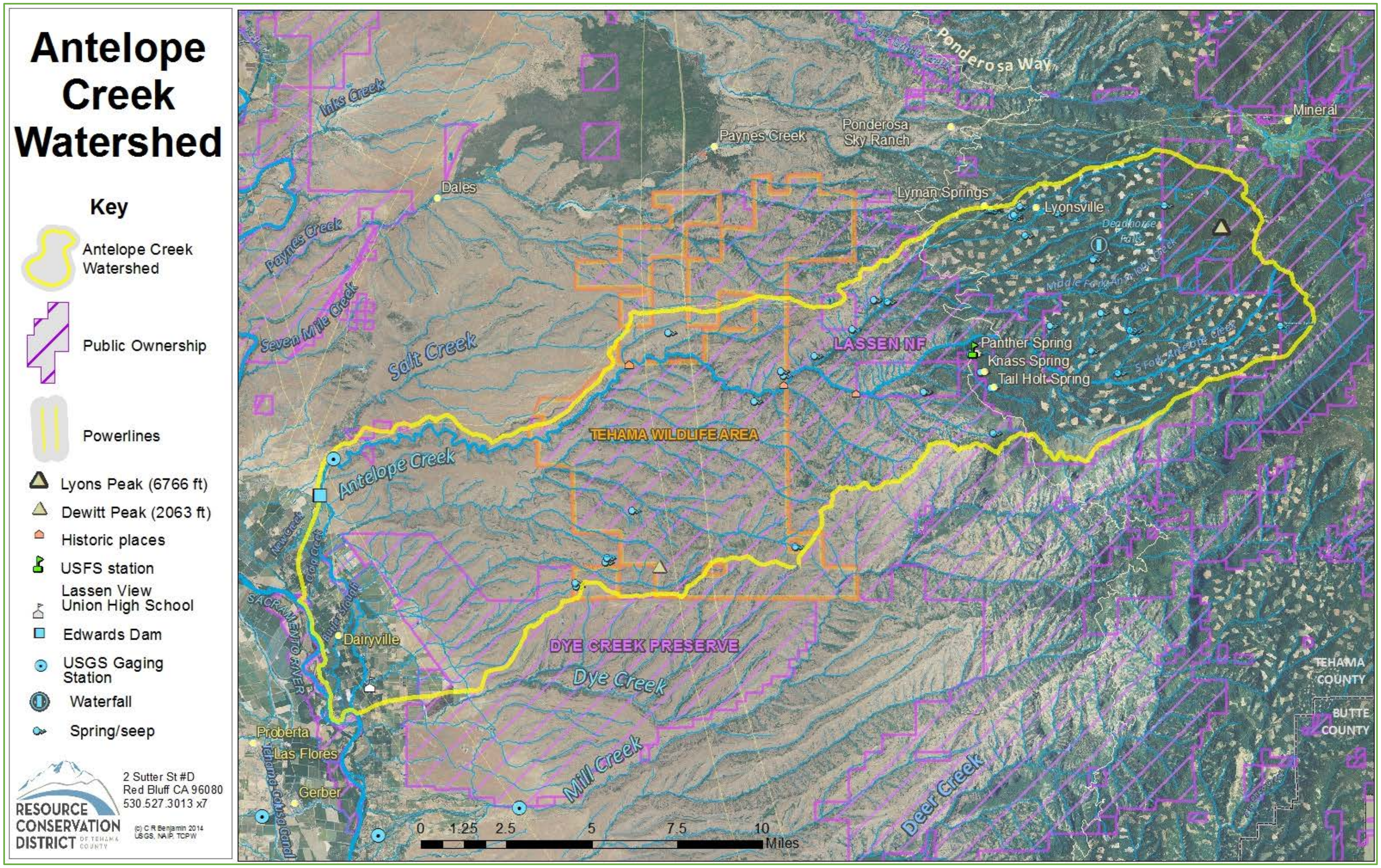


Figure 22: Antelope Creek Watershed. *At 123 square miles, the Antelope Creek watershed is the largest on the eastside and varies in elevation from 210 to 6,766 feet. Roughly half of the watershed is privately owned, with the other half owned equally between federal and state agencies, with 7% owned by The Nature Conservancy. The major conservation goals are to ensure viable spawning habitat to maintain populations of spring-run Chinook salmon and steelhead and to provide suitable habitat for native wildlife species. Source: Resource Conservation District of Tehama County.*

Antelope Adaptation

At the juncture of the Sierra Nevada Mountains and the Cascade Range, flowing westward from its forested headwaters on Lyon Peak, Antelope Creek is bounded tightly by canyon walls for roughly 32 miles until it spills onto the valley floor. There, it splits into several channels and travels through agricultural lands for a few more miles, meeting the Sacramento River near the town of Dairyville in Tehama County. At least 47 springs feed and sustain its waters throughout the summer months, providing habitat for native species of fish and wildlife. Federally endangered spring run Chinook and steelhead return to the creek to spawn, and the winter range of the Tehama deer herd is located in the middle elevations.

Historically, copious amounts of timber were harvested from the upper watershed, with lumber camps located at Lyonsville and Paynes Creek. Skeletons of elaborate flumes leading downhill to the confluence with the Sacramento River can still be found. Drinking water was provided to Red Bluff at the site of the Cone Dam, and the Cone Grove Park stands as a remnant of those times.

Water from Antelope Creek is now diverted southward for agricultural and urban uses at the Edwards Dam. In the rainy season, the diverging channels and alluvial fan of lower Antelope Creek are subject to sudden flooding, causing havoc for the human residents.

Nearly half the watershed is held in public ownership by the Lassen National Forest and Tehama Wildlife Area and is available for hunting and recreational uses. The five largest landowners are the federal government, Sierra Pacific Industries, State of California, James Edwards, and The Nature Conservancy. The watershed provides 32 miles of anadromous fish habitat and would potentially support a population of 3,000 spring-run Chinook salmon. However:

"The 1992-2007 average escapement for spring-run was 33 with as few as zero returning in 1994, 1997, and 2009 and as many as 154 in 1998." http://www.fws.gov/stockton/afrp/ws_projects.cfm?code=ANTEC

Thus, Antelope Creek has captured the attention of natural resource managers and has been the focus of cooperative effort between public and private interests. A list of many of the various legislative acts and project activities occurring in the watershed appears below.

- 1973. Forest Practice Act (Timber Harvesting Plans)
- 1981. Edwards Dam installation of fish ladder (CDFG)
- 1983. A survey of spring-run salmon and habitat in Antelope Creek, Tehama County. Lassen National Forest, Chester Ranger District. Chester CA. 11 p. (Airola, D.A.)
- 1989 to present. Monitoring Study Group formed (CalFire/BOF)
- 1992. Central Valley Project Improvement Act, Anadromous Fish Restoration Program formed (USFWS lead agency)

"Section 3406(b)(1) of the CVPIA directs the Secretary of the Interior to develop and implement a program that makes all reasonable efforts to at least double natural production of anadromous fish in California's Central Valley streams on a long-term, sustainable basis." --http://www.fws.gov/stockton/afrp/overview.cfm

Antelope Adaptation

- 1993. Restoring California Streams: A Plan for Action (CDFG)
- 1995-present. Sacramento River Spring-Run Chinook Salmon Annual Reports (CDFG)
- 2000. Watershed Analysis for Mill, Deer, and Antelope Creeks. (United States Forest Service, Lassen National Forest)
- 2001. Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California (USFWS lead agency)
- 2001. Inland Fishes of California (Peter Moyle)
- 2001. Central Valley Project Improvement Act (CVPIA) Instream Flow and Fisheries Investigations
- 2003. Tehama County Water Inventory and Analysis (Tehama County Flood Control and Water Conservation District)
- 2004-2010. Judd Creek Cooperative Instream Monitoring Project (Cajun James, PhD)
- 2007. New fish ladder constructed at Edwards Dam (CDFG Red Bluff Screen Shop, AFRP)
- 2007. Underwater videography (Edwards Dam)
- 2009. Antelope Creek/Edwards Ditch/Los Molinos Ditch Juvenile Fish Passage
- 2009. Public Draft Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter -Run Ch
  Distinct Population Segment of Central Valley Spring -Run Chino
- 2010. Habitat Expansion Agreement for Central Valley Spring-Run Chinook Salmon and California Central Valley Steelhead (American Rivers, California Department of Fish and Game, California Department of Water Resources, Pacific Gas & Electric Company, State Water Contractors, USDA Forest Service, USDC National Marine Fisheries Service, US Fish and Wildlife Service)
- 2011. Biological Assessment for Threatened, Endangered, and Proposed Species that May be Affected by the Tehama Wildlife Area Crossing Repair Project, Antelope Creek Watershed (USFWS and CA DFG)
- 2012. Tehama Wildlife Area Road Crossing Project (USFWS, AFRP, CDFG)
- 2014. Antelope Creek Juvenile Fish Passage Improvement Project at Edwards Diversion Dam (USFWS<, AFRP, CDFG)

Water: Tehama's Treasure

"Aridity, and aridity alone, makes the various West one…And what do you do about aridity if you are a nation accustomed to plenty and impatient of restrictions and led westward by pillars of fire and cloud? You may deny it for a while. Then you must either try to engineer it out of existence or adapt to it."

- Wallace Stegner

For centuries society has interacted with waterways and water sources as integral components of our local environment on which we depend for food, shelter, and basic survival. Water source areas promote a sense of tranquility and inner peace for local citizens and tourists alike. Precipitation that falls on our forests, foothills, orchards, rangelands, pastures, streets, and yards accumulate for local and regional use and also contribute to the state's water supply. The story of water in California is based on a historic sequence of alternating extremes: decades of precipitous years followed by dry decades. The extensive water infrastructure within the state is a remarkable feat; the state's economy would not have given rise to the lifestyle nearly 40 million Californians enjoy today. The elaborate statewide water transfer system was developed from the mid-1930s through late 1940s to largely capitalize on snowpack melt and consists of the Central Valley Project (source waters from Shasta Dam), the State Water Project (source water from Oroville Dam), and a series of smaller dams, canals, aqueducts, and pump plants. Much of the development in subsequent years correlates with wet years when water resource constraints were less evident and is reflected in the culture of short-sighted and unsustainable consumption.

California's complex water conveyance system transports the resource from sparsely inhabited source areas in the northern regions of the state to parched populations throughout the state. Although the nature of drought in California has not changed, the population density has nearly quadrupled in the last 65 years with greater industry, and agriculture, as well as urban and rural growth all demanding more water than nature can provide. Populations are expanding in urban and suburban areas where water is limited. California's current drought (2011-present day)has led to water scarcity in 2014 that is so alarming, it triggered a series of rapid responses from the Capital: Governor Jerry Brown declared a drought State of Emergency as early as January, issued a second executive order in April in an effort to secure water to combat wildfires and assist cities and farmers, challenged all Californians to prevent water waste and reduce water use by 20%, and signed historic legislation requiring sustainable groundwater management for the first time in California. In July, the State Water Board approved emergency regulation mandating minimum actions from agencies and residents to conserve water supplies for both 2014 and 2015. Under the regulation, agencies could ask courts to fine water users up to $500 a day for failure to implement the conservation requirements. See Appendix A for legislative timeline and policy information.

Scarce surface and groundwater are a mutual concern among local governments throughout the western United States. The county's municipal, domestic, agricultural, and industrial water supplies are largely supported by extracted groundwater due to unreliable quantities from local creek water diversions (Table 4). Since the 1970s, a steady shift to groundwater extraction from surface water use occurred in Tehama County for various reasons. Free of sedimentation and readily available, tapping into the aquifer is a relatively convenient, user friendly water source. In addition, water allocations from downstream consumers increased the demand and cost of water received through the Central Valley Project. A land and water use analysis from 2005 by the CA DWR Northern Region showed that Tehama County acquires 69% of its total, annual water demand from groundwater. As the state is approaching a fourth dry winter, that percentage is sure to increase. Over the last two decades there has been a continuous shift to water intensive orchard crops contributing to an increasing reliance on groundwater. A majority of these orchards have been and will be developed on previously non-irrigated lands. Of importance to note, the spring 2010 groundwater flow indicates the Red Bluff area and lands to its south through Colusa contribute flow into the Sacramento River and serves as the main corridor of groundwater discharge in the entire Sacramento Valley (DWR, 2013). This finding that the Sacramento River is a gaining river in the Red Bluff area suggests a natural loss of water from the local water table within the most populated area and agriculturally dense core in the county.

Summary of Water Supplier and Water Source					
Water Supplier	**Municipal**	**Agricultural**	**Groundwater**	**Surface Water**	**Mixed Source**
City of Red Bluff	X		X		
Proberta Water District		X		X	
El Camino Irrigation District		X	X		
Thomas Creek Water District		X		X	
City of Tehama	X		X		
Gerber-Las Flores CSD	X		X		
City of Corning	X		X		
Corning Water District		X		X	
Stanford Vina Ranch Irrigation Co.		X			X
Deer Creek Irrigation District		X			X
Los Molinos MWC		X		X	
Rio Alto Water District	X				X
Anderson Cottonwood Irrigation District		X		X	
Mineral County Water District	X				X
Golden Meadows Estates CSD	X		X		
Los Molinos CSD	X		X		
Thomas Creek Water Users Assoc.		X		X	

Table 4: Summary of Water Suppliers and Water Sources in Tehama County. *Source: Department of Water Resources, 2013.*

Non-Climate Stressors on Water Resources; Supply & Demand

Heighted water demand to serve expanding agricultural needs and lack of community-wide water use reductions are human induced stressors upon water resources. Groundwater overdraft and subsequent loss in quality of water has been a statewide issue for decades and the current drought has increased pressure to where inaction is no longer acceptable. In Tehama County as many areas of California, drilling for much-needed groundwater has become a 'race to the last drop' favoring those who can drill the deepest, promptly. The status quo is particularly challenging for the least-resourced citizens and farmers, who often cannot afford to invest in well modifications or expensive new wells.

Despite local well monitoring efforts, information gaps impede a greater understanding of how the local aquifer system and groundwater sub-basins function due to its dynamic nature: a series of interconnected underground water reservoirs oftentimes segmented by soil strata with varying soil types.

Since most of the county relies on ground and spring water, understanding groundwater hydrology is essential for evaluating the regions vulnerability to climate impacts. Groundwater levels of the 48 'key wells' are measured throughout the county's twelve groundwater sub-basins on the valley floor, eight of which are heavily monitored, where most of the groundwater extraction occurs for irrigation, domestic, and industrial uses.

Cumulative groundwater elevation levels have significantly declined over the last fifty years in the Central Valley and correlate with dry conditions as illustrated in Figure 23 (Jonathan Mulder, Northern Region Office Data Collection and Management Section, DWR). To use financial banking as a framework, the region's success rides on water reserves where by municipalities, industry, agriculture and residents collectively draw from the same groundwater 'savings account.' This high risk transaction of rapid withdrawal and inadequate deposit will clearly drain the account. Alarmingly, the wet and variably wet years have not sufficiently resupplied groundwater to compensate for the rate of extraction in dry years, thus, a net loss in groundwater supply. Groundwater elevation loss is of critical concern, as shown in Figure 24. Between the early 2000s to present day 2014, the county's Redding groundwater basin in the north experienced an average loss in groundwater elevation of 6 feet and a maximum decrease of over 11 feet elevation at an average well depth of 239 while the groundwater elevation significantly dropped in Sacramento Valley basin of the county with a maximum of over 38 feet and an average loss in elevation of nearly 12 feet with a similar average well depth. As Figure 25 reveals, in one year alone (2013-2014) a maximum loss of over 26 feet of groundwater elevation and an average loss of 3 feet occurred in the Sacramento basin, extracting century's worth of water accumulation.

A tentative objective within the Tehama County Groundwater Management Plan is to address significant loss of groundwater elevation. Spring is the ideal season to monitor water supply to capture peak flow data as precipitation shifts from rainfall to snowpack melt. According to this plan, a Spring Alert Level 2 represents spring groundwater levels observed in a previous drought as occurred in 1977, 1991, or 2007-2009. Spring groundwater levels exceeded the Spring Alert Level 2 in 2012, 2013, and 2014 (Fulton, 2014) triggering "awareness actions" that according to the Tehama County Groundwater Management Plan may involve public notification, information and education, additional monitoring and investigation, and consideration of a variety of possible management actions such as review of the county's approval process regarding water supply for development or additional groundwater pumping projects.

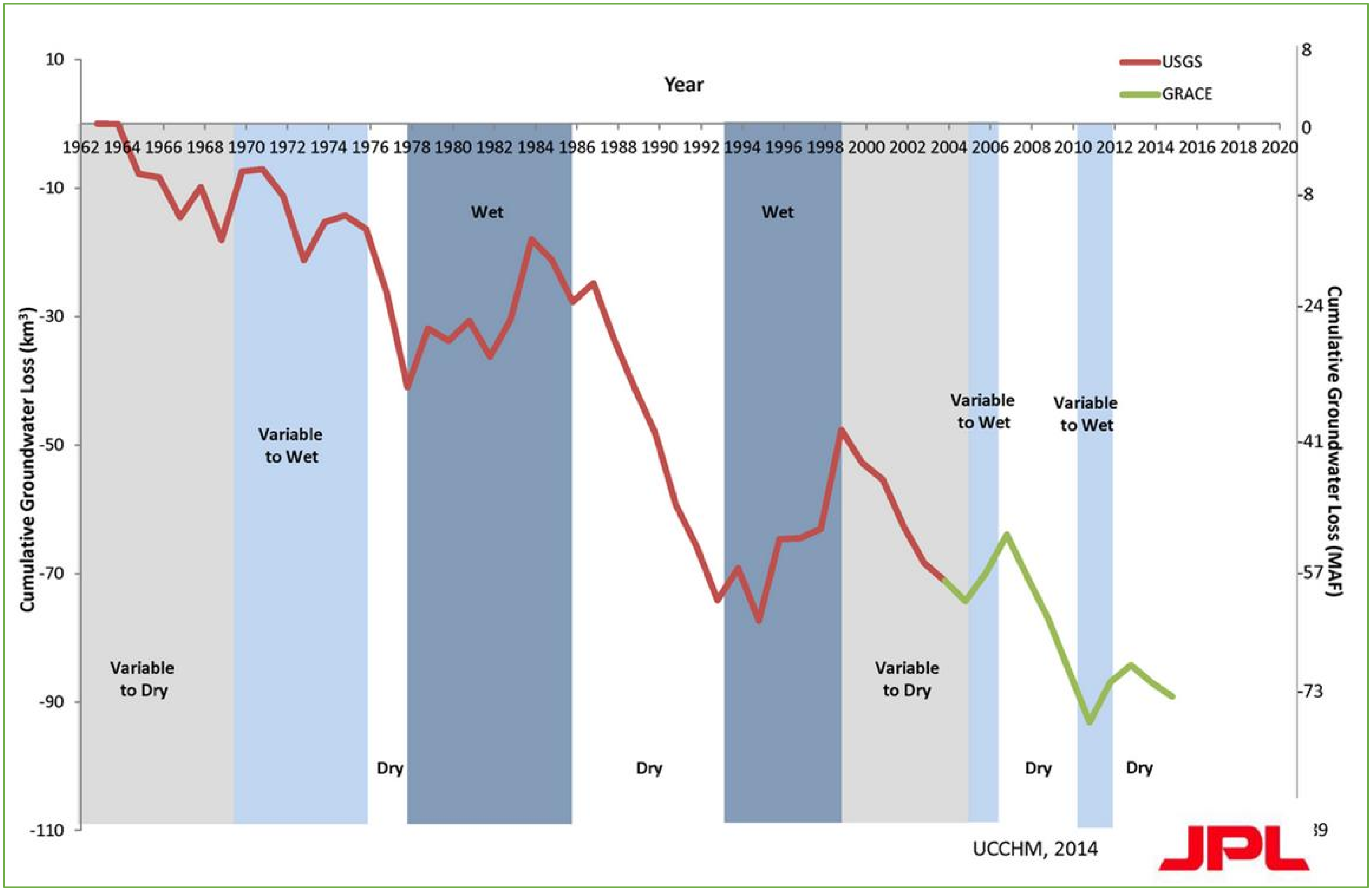


Figure 23: Cumulative Groundwater Loss from 1960 to 2013, Central Valley, California. *The red line in this graph represents USGS model simulations for 1962-2003 and the green line represents NASA's GRACE satellite estimates of groundwater storage loss that occurred between 2003-3013. Significantly dry years are identified by a white background, whereas, significantly wet years are shaded in dark blue. Of importance, this data suggests wet and variable wet years do not provide adequate water to resupply groundwater at the rate of extraction during dry years. Source: National Geographic, 2014.*

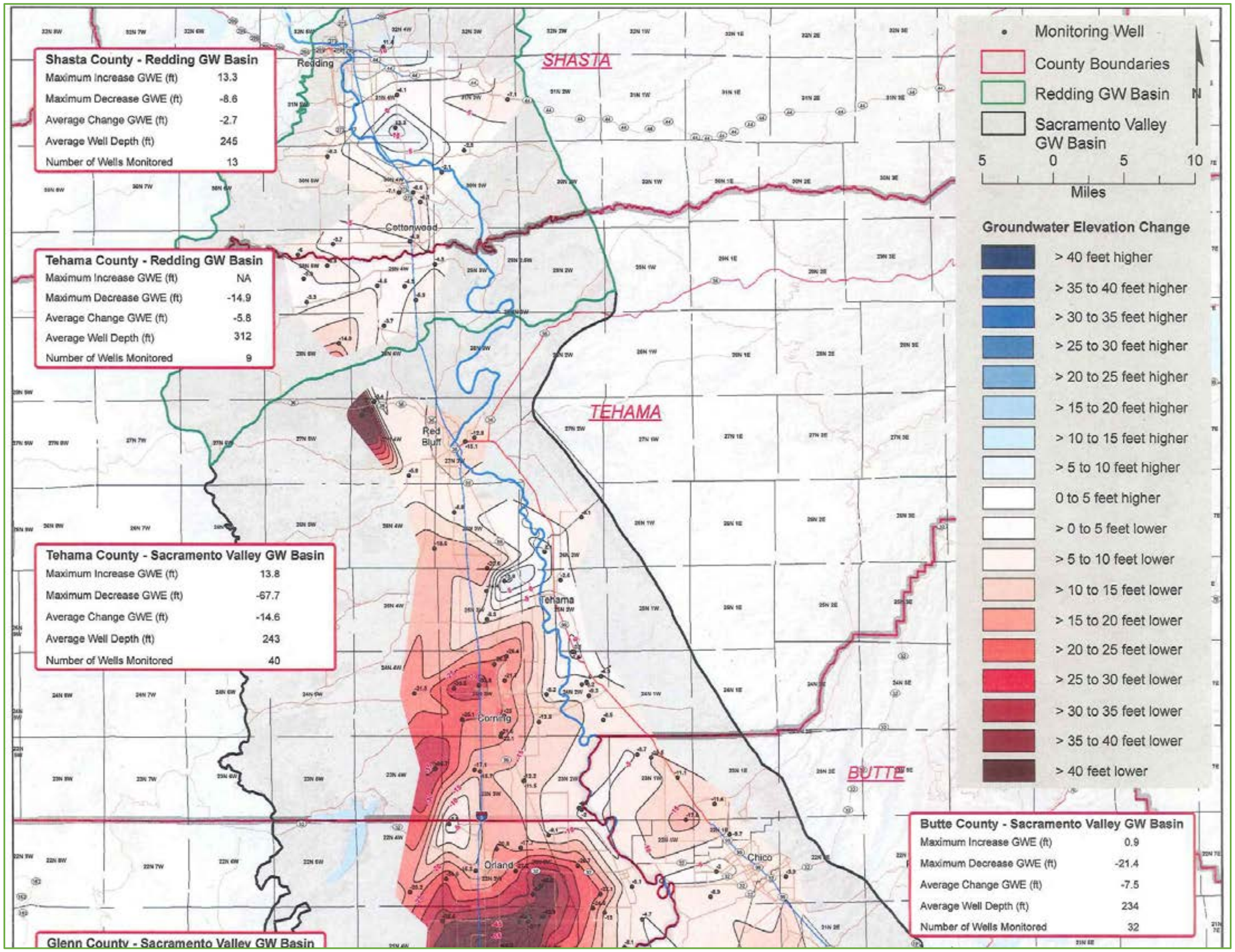


Figure 24: Change in Groundwater Elevation Map Summer 2004 – Summer 2014, Tehama County. *This map indicates groundwater levels in well depths between 100 feet and 450 feet were lower in 2014 than 2004 as negative numbers and deeper shades of red reflect groundwater elevation loss. Groundwater level changes are based on groundwater level measurements taken from wells constructed in the intermediate aquifer zone at similar dates of different years. Source: Department of Water Resources, Northern Regional Office. Modification of Plate 2C-B. September 2014, G. Gordon.*

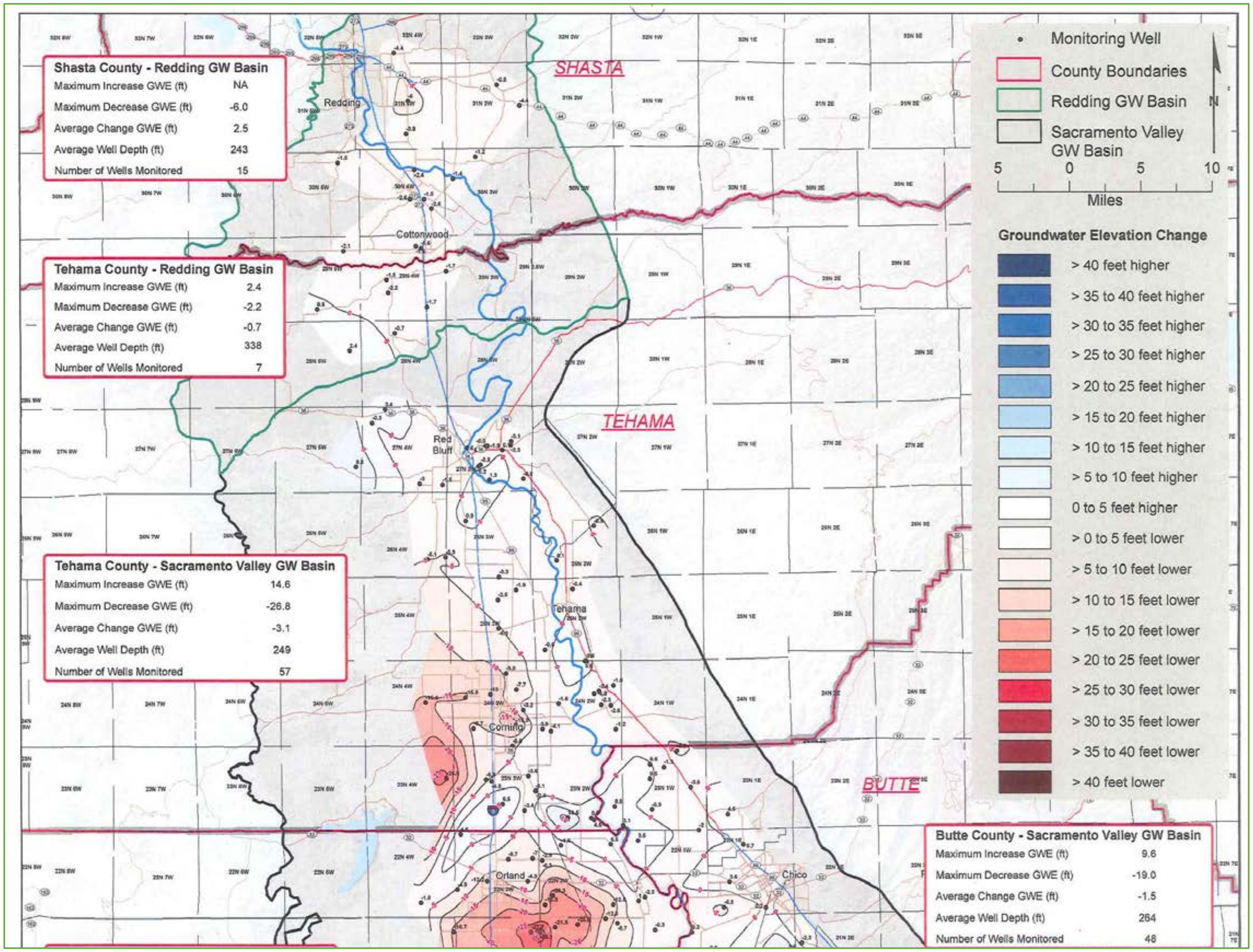


Figure 25: Change in Groundwater Elevation Map Summer 2013 – Summer 2014, Tehama County. *This map indicates groundwater levels in well depths between 100 feet and 450 feet were lower in 2014 than 2013 as negative numbers and deeper shades of red reflect groundwater elevation loss. Source: Department of Water Resources, Northern Regional Office. Modification of Plate 2C-A. August 2014, G. Gordon.*

There is a wide range in spring groundwater levels throughout the county with Antelope, Corning East, and Red Bluff East in drastic decline compared to other sub-basins whereby domestic, municipal, and industrial users all tap into the same source water. The frequency of domestic wells going dry is increasing and users resort to simply drilling a deeper well. Groundwater overdraft is common under drought conditions and drawing from an ever deeper well clearly is not a sustainable response to a threatened water supply. Groundwater use is expected to continue to increase in the future in response to extended dry spells and unreliable surface water. As groundwater overdraft becomes more frequent, changes in crop patterns and irrigation practices for the agricultural industry as well as domestic use will occur.

The communities of Antelope, Paskenta, and Lowry are challenged by critically low groundwater levels. Currently the wastewater disposal in the Antelope District is primarily on-site septic tanks followed by either leach fields or seepage pits. Wells tend to be shallow causing water quality issues despite the underlying alluvial soils that are typically porous with rapid percolation rates. Notably, a water education campaign has commenced whereby Antelope District landowners are gaining insight to improve water management on their properties and to clarify rational behind the reduction in groundwater elevation.

Severely drought stricken Paskenta has implemented voluntary water rationing measures limiting the 65 Paskenta Community services District connections to 50 gallons per day. The Paskenta District now relies on purchased water of up to 20,000 gallons from the City of Corning, about 20 miles to its east. The neighboring community of Lowrey has similar groundwater scarcity issues and will likely purchase water from the City of Red Bluff. Both of these communities are particularly vulnerable to lack of a reliable and potable water supplies in the face of climate variability.

Illegal marijuana cultivation negatively impacts surface and groundwater supplies and causes habitat degradation throughout the watershed on both public and private properties. Such activity largely takes place in the higher elevation forest lands as well as in various valley communities, including Rancho Tehama. Despite the efforts of local cattlemen and strict marijuana laws in Tehama County, the local watershed has succumbed to destruction from the so-called 'Green Rush' with a marked toll on degradation at the landscape level similar to the Gold Rush era. In addition to tons of trash, and reckless application of fertilizers, insecticides and animal poison, illegal cultivation extracts large amounts of illegally diverted water from streams and ponds that impacts the function of ecosystems.

According to the Tehama County Marijuana Ordinance (2014) and the Tehama County Marijuana Suppression program for 2014, approximately 53,528 illegal marijuana plants were removed by law enforcement which represents roughly 10 percent of such operations in the county. It is estimated that over 48 million gallons of water was used to cultivate the seized product in Tehama County. This highlights an additional loss of water supplies and watershed destruction when figuring in the amount of illegal water use for the remaining illegal grows. The California Department of Fish and Wildlife's Marijuana Enforcement Team (MET) estimates unregulated marijuana grows have stolen 1.2 billion gallons of water between 2012 and 2014. The illegal use of local water supplies is problematic for resource managers and surface water rights holders. Local habitat and provisioning services provided by the ecosystem are in peril.

Resource Susceptibility: Water

There is no life without water. The region is already experiencing a decline in snowpack and a subsequent loss in groundwater elevation. Further climate projections suggest greater impacts upon water resources are forthcoming. An insecure water supply will be punishing and dangerous for the health of Californians and its economy. In an effort toward local water resource resiliency, a qualitative resources matrix (Table 5) was developed with input from water resource managers to prioritize risks from non-climate related and climate related stressors. The risk rating was established based on current conditions, impacts, probability of such consequences occurring, and the habitat's natural ability to respond independent of human influence.

Tehama County WATER RESOURCES RISK MATRIX H=High | M=Medium | L=Low						
Water Sector	**Non-Climate Stressor**	**Climate Risk**	**Impacts/ Consequences (HML)**	**Probability (HML)**	**Ability to Respond (HML)**	**Risk Rating (HML)**
Supply (surface and groundwater)	Agriculture - sector expanding in high-value water intensive orchard crops (walnuts) withdrawing mostly gw except for the Los Molinos and Deer Creek areas which utilizes surface water in addition to groundwater.	Lack of snowpack reduces gw recharge that threatens long-term water availability. Surface water supply also threatened by lack of snowpack.	H	H	M	H
	Cultural - There is no campaign to reduce needless water consumption aimed at urban/domestic/municipal users.	Vulnerable populations have the greatest impact exposure to include loss of access to potable water.	M	H	M	M
	Changes in local hydrology due to in part by the decommissioning of the diversion dam for salmon habitat restoration initiative (Antelope district).	Potential for decreased quantity of groundwater due to lack of snowpack recharge. Flashy rain events may alter groundwater availability.	H (socioeconomic vulnerable pop)	H	L	H
	Municipalities - aging infrastructure for water transport, treatment, and storage. Limited water recycling capacity.	Flashy' rain events may overwhelm system causing health concerns and disrupting transportation and utility services.	H	M	L	H
Timing	Land Use - Timber harvesting practices (clear-cut) increase the quantity of run-off per precipitation event and increase the probability of 'flashy' water delivery.	More precipitation as rainfall will accelerate run-off and intensify 'flashy' flooding events.	M	H	M	M

Tehama County WATER RESOURCES RISK MATRIX H=High | M=Medium | L=Low						
Water Sector	**Non-Climate Stressor**	**Climate Risk**	**Impacts/ Consequences (HML)**	**Probability (HML)**	**Ability to Respond (HML)**	**Risk Rating (HML)**
	Land-Use - Urban; impervious surfaces accelerate surface run-off.	More precipitation as rainfall will increase run-off.	M	M	L/M	M
Quality	Overdraw of groundwater can cause greater pollution concentrations in the water source and a loss in water quality.	Greater risk of reliance on contaminated, non-potable, water due to insufficient surface water storage to meet year-around needs of population and agriculture in Northern California. Should precipitation continue to shift from snow to rain, more of the water that is received will "run through" the northern Sacramento Valley for use in central and southern California via reservoirs and water project infrastructure.	H	H	L	H
	Intensive agriculture throughout the valley floor is likely to increase nitrate levels and risk of runoff to waterways.	Greater risk of reliance on contaminated surface and groundwater due to lower dilution of pollutants coupled with a consistent or increased demand for water.	H	M	H	H
	Intensive agricultural land use within riparian corridors have led to an increase in surface water turbidity due to bank destabilization. Contamination from agricultural practices may threaten water quality.	Flashy rain events on poor orchard soils may accelerate run-off and erosion resulting in a loss of quality water and challenging water system delivery.	M	H	H	M
	Clear cut harvesting practices expose forest soil and lead to nutrient and topsoil loss in rainfall events.	More frequent rainfall events will have greater erosional impact.	M	H	M	M

Tehama County WATER RESOURCES RISK MATRIX H=High | M=Medium | L=Low						
Water Sector	**Non-Climate Stressor**	**Climate Risk**	**Impacts/ Consequences (HML)**	**Probability (HML)**	**Ability to Respond (HML)**	**Risk Rating (HML)**
	Wildfires threaten water quality with heavy sediment loads and accelerated run-off.	The probability of catastrophic wildfire increase as lower annual snowpack leads to lower dry-season moisture retention in montane vegetation and soil.	H	H	M	H
Weather	Mediterranean climate of mild wet winters and warm summers.	Climate change projections state more extreme summer heat is expected. Increased evapotranspiration rates under these conditions will increase water demand to support orchard crops, cattle, and urban/residential irrigation. These demands will result in additional groundwater withdrawals, since surface watercourses are largely fully allocated (senior water rights holders or environmental flows). Lower precipitation overall, and the shift away from winter precipitation as snow to rain, decreases the snow-water "reservoir" in the Cascade and Sierra Nevada ranges and increases the incidence of short-term, high-flow rain events.	M	H	L/M	M/H
Economic	Groundwater is not regulated.	Groundwater reliance is likely to increase if surface water availability decreases due to increased precipitation-as-rain, which is largely lost to the region due to inadequate storage capacity. When precipitation is received as snow, the slow release allows surface reservoirs and aquifer to be refilled concurrent with use during the dry season, expanding the window of opportunity for capture and requiring less storage capacity.	M	H	M	H

Tehama County WATER RESOURCES RISK MATRIX H=High | M=Medium | L=Low						
Water Sector	**Non-Climate Stressor**	**Climate Risk**	**Impacts/ Consequences (HML)**	**Probability (HML)**	**Ability to Respond (HML)**	**Risk Rating (HML)**
Habitat	Land-Use: Loss of riparian marsh habitat due to human water demand. Loss of high elevation forest habitat to timber activity. Loss of mid-low elevation mixed-pine-oak woodlands due to rural residential development.	Drought and prolonged high heat will increase water demand and evaporation of surface water. Conifer decline due to drought stress, pest vulnerability and wildfire will exacerbate the loss of habitat being introduced by poor stand management. In-migration of agriculturalists and others seeking greater water resources will result in sprawl and additional development of ranch/ranchette properties in the low foothill rural periphery of Red Bluff and Los Molinos.	M	M	M	M
	Invasive species altering native habitat. Native plants in greater competition with invasives for water and space.	Invasive plants may flourish during longer growing season. Areas left barren after catastrophic wildfire may be inundated with invasive plants.	M	M	M	M
Species	Anadromous fish - stretches of riparian canopy loss increase thermal barriers and lack of instream water fragments migration routes.	Higher stream temperatures and early spring snowmelt increases difficulty of migration, spawning, and risk of fry endangerment due to stranding and predation.	H	M/H	L/M	H

Table 5: Water Resources Risk Matrix.

Combining climate-related stressors such as extended dry spells, higher heat days, and soil moisture deficits with non-climate stressors of heighted demand, expanding agricultural production with a greater reliance on groundwater, a shift to water intensive perennial orchards as well as irrigating previously uncultivated lands, and a lack of community-wide conservation practices has driven greater competition for scarce water supplies. In addition, the climate impacts of rain event variability and limited snowpack are projected to increase the intensity and longevity of drought conditions, severely reducing surface run-off water supplies and ground water availability. This is of particular concern in aquifer recharge areas as a majority of county citizens solely rely on groundwater supply from the Tuscan and Tehama aquifers.

> *"Plans to protect air and water, wilderness and wildlife are in fact, plans to protect Man."*
>
> \- Steward Udall
> Secretary of the Interior
> 1961-1967

Given the lack of regulation or monitoring of groundwater use, very high numbers of new wells are being installed to offset supply for junior water rights holders who are not getting their surface water allocation during the drought, and residents whose wells are going dry. While the supply pinch has brought about some positive behaviors, such as renewed interest in irrigation system efficiency evaluations by orchardists, any water savings gained by improvement are often used to justify crop expansion. There is no incentive for conservation as groundwater is a "commons" in California and will have a negative long term impact on the local economy.

California pumps more groundwater than any other state in the U.S. on an annual basis. With few incentives and few regulations to encourage groundwater conservation, it has historically been the most lax of the western states regarding disclosure requirements for groundwater use. As a result well log data, a key metric necessary for sound water management collection, is sparse. In every western state except California, this data is and is publically available in. This data is critical to understanding the size and geographic distribution of aquifers within a groundwater basin. In addition, a greater awareness of the aquifer system allows managers to identify and protect groundwater recharge areas from unfavorable land use practices as well as target areas for groundwater banking projects to enhance the recharge process. Without this data, the entire community is susceptible to groundwater overdraft. The State has taken a monumental step toward managing groundwater through legislative action in September of 2014

Historically, the number of wells developed correspond with climate variation as revealed in Figure 26 where the steep incline of well development are associated with the drought years of the 1970s, late 1980s, and mid-2000s. This reiterates how important it is to enhance groundwater recharge during wet years and implement extreme conservation measures during drought so we can continue to rely on our aquifers.

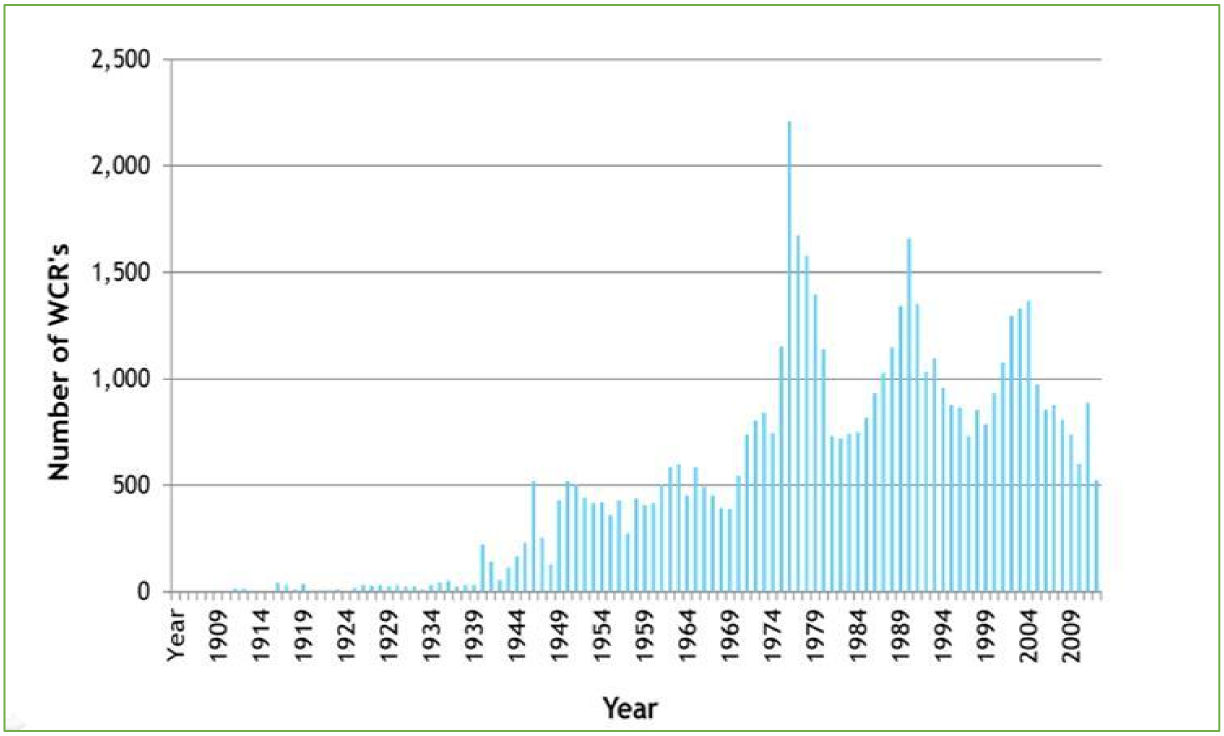


Figure 26: Number of Well Completion Reports in Butte, Colusa, Glenn, Tehama, and Shasta Counties from 1900 – 2013. *Source: Department of Water Resources, North Region, via A. Fulton, University of California Cooperative Extension, Tehama County.*

In response to the 2013/14 drought conditions, the Tehama-Colusa Canal Authority enacted a 0% allocation for its 17 agricultural water districts resulting in 70-80,000 acres being fallowed, roughly half of the 150,000 acres serviced, and expensive water to be purchased to service permanent crop. The impact shall prove to be significant as the service area spanning four counties along the west side of the Sacramento Valley, produces over $250 million in crops per year, and contributes $1 billion to the regional economy annually (Tehama Colusa Canal Authority, 2009).

In addition to those served by the Tehama-Colusa Canal Authority, those served by the Antelope District of eastern Red Bluff, as discussed in the previous section, are also susceptible to loss of access to water as shallow wells, limited infrastructure and greater demand for water has left some residents without potable water. The Los Molinos Water District relies on surface water from Mill and Antelope Creeks to meet the needs for the county's intense walnut production zone and rural residents.

> *And it never failed that during the dry years the people forgot about the rich years, and during the wet years they lost all memory of the dry years. It was always that way.*
>
> – John Steinbeck; *East of Eden*

The sub-basins of South Battle Creek, Bend, and Corning West have limited groundwater level monitoring and the Red Bluff West sub-basin only has one location. Corning West sub-basin has seen a substantial increase in orchard crop development that will only drive further demand of the scarce resource. Ongoing regional monitoring is of the essence particularly in these areas that solely rely on groundwater for water supply. Extraction occurring in other valley communities directly effects groundwater elevation and in time, water quality in Tehama County. Neighboring Glenn County is scheduled to align over 700 new wells, clearly impacting the south county populations of Capay and those within and surrounding the City of Corning. The City of Corning is already trucking drinking water under contract to Paskenta, a hamlet of just over 100 (2010 Census) located roughly 20 miles to its west. Paskenta water supply is at the mercy of Thomes creek, which has been dry. The City of Corning is also trucking its water by contract to the even smaller community of Lowrey and the City of Red Bluff is scheduled to join the relief effort. As for the City of Corning itself, they were the first and only populace to declare a city-wide voluntary water conservation measure in the county.

Accompanying retreating quantities of groundwater, diminished inflows to recharge the aquifer and sustain surface water volumes decrease water quality and lengthen the time pollutants remain in water bodies. High nitrate concentrations are detected in select residential areas related to sewage disposal systems in close proximity to shallow wells threatening drinking water supplies. Though arsenic, chromium, aluminum, iron, manganese, and sulfur are naturally occurring minerals and elements, hazardous levels have been detected within the region and threaten the quality of drinking water.

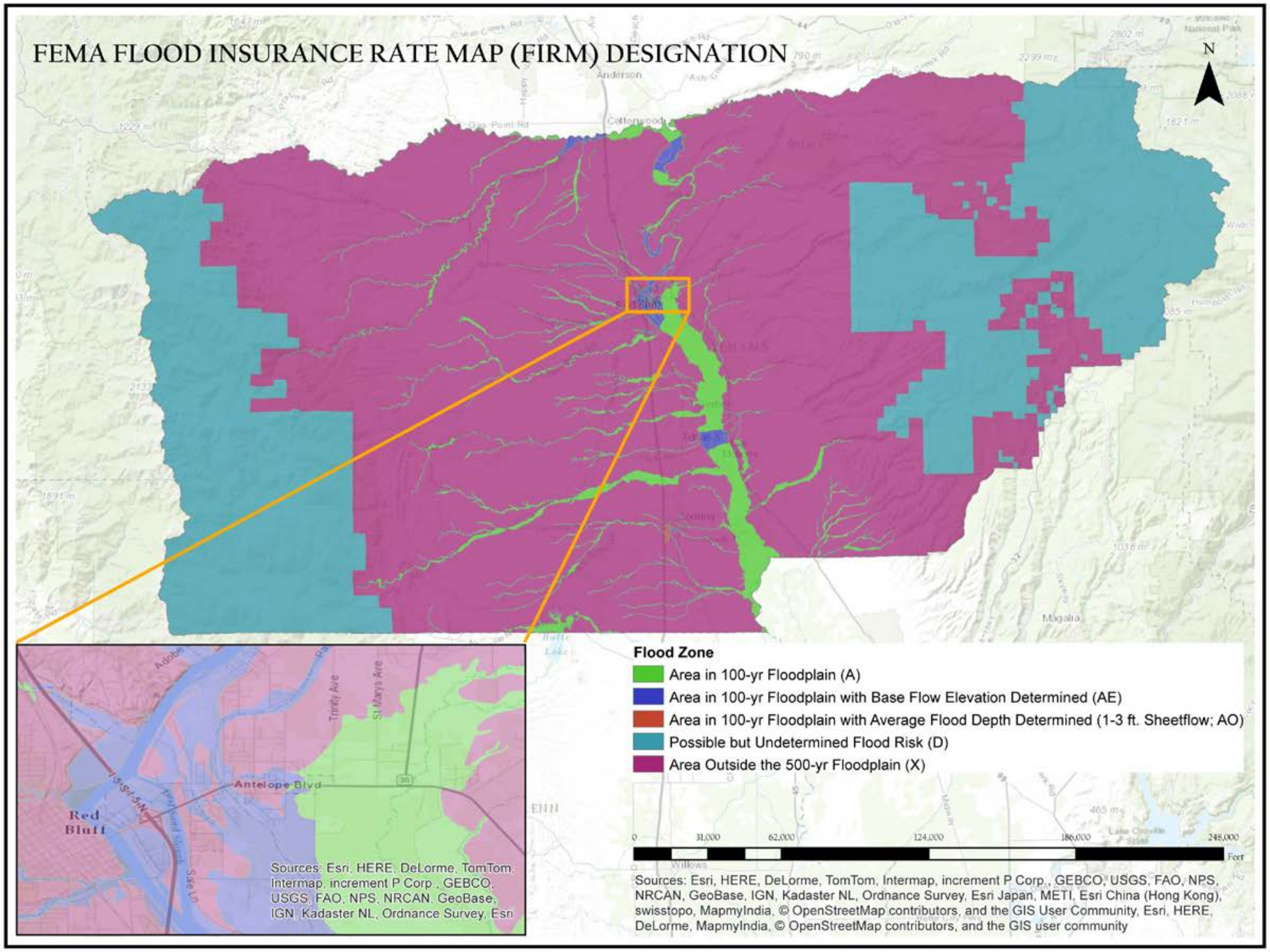
When Tehama County floods, public safety and health is endangered, vital services become isolated or interrupted, water supplies are threatened or impacted, critical infrastructure is damaged, and agricultural areas are rendered unproductive. In large storm events, it is fairly typical for runoff to exceed the capacity of stream channels. High flood stages in the Sacramento River intensify flooding within tributary zones, leading to greater vulnerabilities. The 2011 FEMA flood map in Figure 28 displays zones prone to impacts of the 100 year flood. According to this recent map, the Antelope area is particularly susceptible to flood in this scenario. Of the 19 emergencies proclaimed by the State of California between 1950 to 1997, the county declared nine were related to flooding (four occurred within a 15 year period) and five were storm related (Wood Rodgers, Inc., 2006). Tehama County is at risk of devastating flood events due to existing stressors such as limited and aging infrastructure and a rise in population increase the risk of significant flood damage that will be exacerbated by heavy ‘flashy’ rain events as indicated by various climate models.

Experiencing year three of consecutive drought conditions throughout the state, it is ever more evident that amount of recharge hasn’t and likely will not make up the deficit for water use demands. Years of well monitoring and increased demand suggest urgency to implement water reduction measures in the sub-basins with greatest demand and monitor effects in all sub-basins. Likely impacts on water utilities from source to tap include watershed changes, treatment challenges, distribution impacts, and changes in user demand. In turn, the impacts present risk to water quality and quality as well as facilities and supporting infrastructure both locally and for downstream consumers.

Figure 27: The Junction of the Red Bluff Diversion Dam and the Tehama-Colusa Canal along the Sacramento River in Red Bluff. *Due to fish passage improvement, the Dam gates are now permanently open. The Tehama-Colusa Canal Authority operates and maintains the 140 mile Tehama-Colusa and Corning canals irrigation water supply system. Source: Bureau of Reclamation.*

Water Policy Work and Other Positive Progress

The Flood Control and Water Conservation District is the monitoring agency for groundwater in Tehama County and lead author of the 2013 Coordinated AB3030 Groundwater Management Plan and associated Tehama County Groundwater Management Plan (GWMP). In recognition that there is not an infinite supply of high quality groundwater in Tehama County, the long term goal of the GWMP is to balance extraction and replenishment so that groundwater can be extracted for domestic, industrial, agricultural, and environmental purposes reliably and at affordable costs (Tehama County Flood Control and Water Conservation District, 2012). The TC Flood Control and Water Conservation District adopted a Coordinated (AB3030) Groundwater Management Plan in 1996 with an update in 2013. The Coordinated Plan has been developed in three phases with Phase 1 pertaining to monitoring to understand the water resources. Phases 2 and 3 outline potential active management measures to sustain long-term groundwater supplies.



Prepared by A. Dan, Resource Conservation District of Tehama County, November 17, 2014 / Source: Tehama County FIRM 2011, FEMA

Figure 28: Federal Emergency Management Agency's (FEMA) Federal Insurance Rate Map (FIRM), 2011. *Source: FEMA.gov.*

The export of groundwater from the county has been a reoccurring proposal; however, the Tehama County Board of Supervisors' ordinances prohibited the extraction of groundwater for off-parcel use without a permit granted by the Board, subject to certain restrictions and limitations. Due to recent groundwater elevation loss, the Tehama county Board of Supervisors took action in July of 2014 to authorize water transfers within the county on the basis of public health, safety, and welfare.

> *"The nature of drought in California has not changed, however, the population density has…demanding more water than nature can provide."*
>
> William Pazert, Ph.D.
> Oceanographer
> Cal Tech, NASA JPL

The Sustainable Groundwater Management Plan aims to strengthen local government management and monitoring of groundwater basins most critical to the state's water needs. California's adherence to the 1951 law making well logs and drillers' reports confidential and unavailable for public inspection makes true groundwater management extremely challenging. California is the only western state that keeps groundwater pumping data restricted to select government agencies creating a barrier to access vital water management information.

The $7.5 billion water bond measure (AB 1471) that passed on the November 1st ballot, is intended to bolster the state's systems for water supply and quality through a combination of infrastructure projects, restoration efforts, flood management, and conservation initiatives. In addition, the water bond would provide funds to assist with the implementation of the state's historic package of groundwater regulations (SB 1168, SB 1319, and AB 1739) which for the first time requires local government to monitor and regulate groundwater usage.

Climate and the Community

In California, 11 of the last 16 years have had below normal rainfall. The last 3 years have been severely dry as calendar year 2013 is the driest on historical record dating back to 1895. Climate impacts can be punishing and dangerous for Tehama County's economy, infrastructure, and social well-being.

Over 35 percent of those employed by the county's largest private businesses are directly impacted by climate variations due to work related to natural resource as featured in Table 6 to include Sierra Pacific Industries, Pactiv Corporation, Bell-Carter Foods, Inc., and Louisiana-Pacific Corporation. In reviewing the employment figures from the Tehama County Housing Needs Assessment, over half of major employers (public and private) are directly tied to resource management and are susceptible to climate impacts. The percentage of employed affected is likely much higher as the table and Assessment figures omit mid to small-scale agriculture and related services as well as the supportive services of timber production that will be jeopardized. The table also highlights the largest public employers where the estimated 119 U.S. Fish and Wildlife Service and 100 California Department of Forestry Fire Protection (CAL FIRE) employees will be impacted by climate. Additional public positions that are associated with natural resource management include staff of the California Department of Water Resources, Northern Regional Office.

Largest Employers : Private		
Business Name	**City**	**Employees**
Wal-Mart Stores, Inc.	Red Bluff	1,350
Sierra Pacific Industries	Red Bluff	1,070
Rolling Hills Casino	Corning	515
Pactiv Corporation St Elizabeth Community Hospital	Red Bluff	477
Bell-Carter Foods, Inc.	Corning	350
Raley's Supermarket & Drug Centers	Red Bluff	128
Petro Shopping Centers L.P.	Corning	114
Lassen Medical Group, Inc.	Red Bluff	110
Brentwood Skilled Nursing	Red Bluff	107
Pactiv Corporation	Red Bluff	100
Louisana-Pacific Corporation	Red Bluff	100
Corning Food	Corning	56
TA Operating Corporation	Corning	48

Largest Employers : Public		
Business Name	**City**	**Employees**
County of Tehama	Red Bluff	740
Corning Unified Elementary School District	Corning	315
Red Bluff Elementary School District	Red Bluff	265
Red Bluff Joint Union High School District	Red Bluff	210
City of Red Bluff	Red Bluff	170
U.S. Fish and Wildlife Service	Red Bluff	119
Corning Union High School District	Corning	100
California Department Forestry Fire Protection	Red Bluff	100
City of Corning	Corning	

Table 6: Tehama County's Largest Employers. *Source: Tehama County Economic Development Corporation.*

Industry Type	2000		2011		% Change 2000-2011
	Number*	Percent	Number*	Percent	
Agriculture, Forestry, Fishing, Hunting and Mining	1,260	9.3%	1,477	9.8%	17.2%
Construction	842	6.2%	1,372	9.1%	63.0%
Manufacturing	1,560	11.6%	1,030	6.8%	-34.0%
Wholesale Trade	404	3.0%	360	2.4%	-11.0%
Retail Trade	1,968	14.6%	1,983	13.1%	0.8%
Transportation And Warehousing, and Utilities	821	6.1%	725	4.8%	-11.7%
Information	204	1.5%	191	1.3%	-6.4%
Finance, Insurance, Real Estate, and Rental and Leasing	571	4.2%	773	5.1%	35.8%
Professional, Scientific, Management, Administrative	988	7.3%	996	6.6%	0.8%
Educational, Health and Social Services	2,684	19.9%	3,347	22.2%	24.7%
Arts, Entertainment and Recreation Services	888	6.6%	1,022	6.8%	15.1%
Other Services	725	5.4%	818	5.4%	0.1%
Public Administration	568	4.2%	1,000	6.6%	76.0%
Total	**13,483**	**100.0%**	**15,094**	**100.0%**	**12.0%**

Table 7: Tehama County Employment by Industry- Unincorporated Tehama County. *Source: Tehama County Housing Element May 2014 Public Review Draft.*

Population in Tehama County grew by 115% compared to 53% for the U.S. from 1970 to 2011.

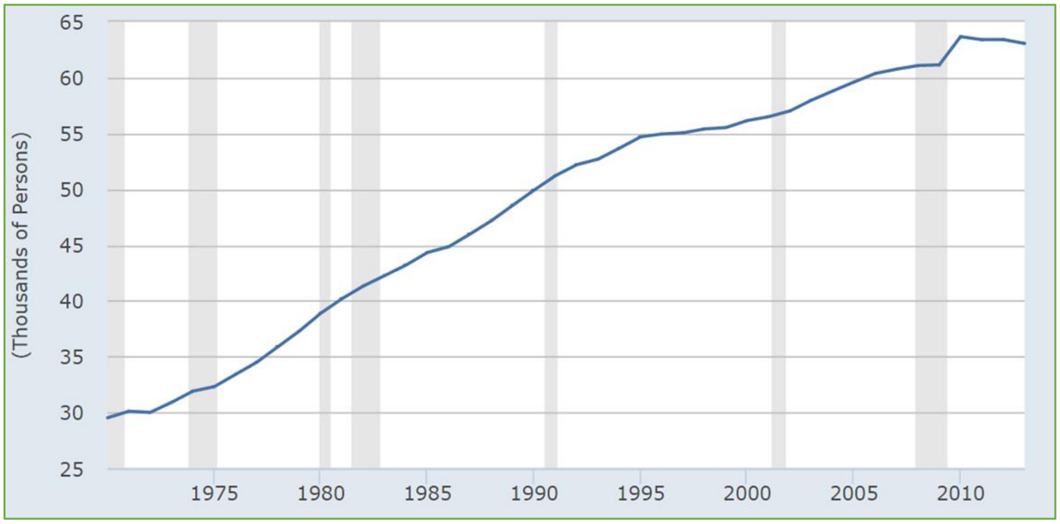


Figure 29: Resident Population in Tehama County From 1970 To 2013. Shaded areas indicate U.S. recessions.
Source: US Bureau of the Census via the Federal Reserve Economic Data (FRED).

The City of Sacramento has two independent water sources. Eighty four percent of the primary water source is river water from the American and Sacramento Rivers with groundwater providing the remaining 16 percent. The City of Sacramento Utilities, Rio Linda Water District, and Fruitridge Vista Water Company are the water purveyors in the City of Sacramento region. The Rio Linda Water District and Fruitridge Vista Water Company supplies constituents exclusively from groundwater sources. There are additional water districts in the Sacramento Metro Area that find themselves in the same predicament; the series of dry winters threatens water supplies (City of Sacramento, 2014).

Infrastructure

California heavily relies on hydropower with 14 percent of U.S. hydro capacity within its borders. California and neighboring western States are particularly vulnerable to loss of electrical power or may receive intermittent service due to reduced flow through hydroelectric dams as a result of diminished snowpack. In addition transmission lines are vulnerable to damage from wildfire and extreme storms can wreak havoc disrupting power to many Californians.

Higher temperatures will likely increase electricity demand due to higher air condition use. Relying on imported power from the Pacific Northwest during peak demand is costly with a great amount of risk. Increased exposure to a variation of non-climate and climate induced events such as landslides and extreme weather can disrupt electrical power generation and transmission throughout the grid.

Electrical transmission lines transecting longitudinally throughout the region are positioned within fire prone areas. Oftentimes, utility lines cause or exacerbate fire by igniting vegetation and/or blocking roads. Employing energy conservation practices and increasing locally produced renewable energy can lessen the areas dependence on the power grid and decrease the risk of intermittent service.

As climate models suggest an increase in 'flashy' heavy rain events and earlier snowmelt, the frequency and extent of flooding will likely increase. The recent FEMA flood map revisions no longer allow roads to be used as flood protection barriers. In the past, roads were considered to function as levees and flood maps were drawn accordingly. Since then, engineers concluded that it was inaccurate as flooding had surpassed roads on occasion. This is the case in the Antelope District along Salt Creek in the vicinity of the Highway 36E interchange with Highway 99E whereby the redrawing of the map increased the area of 100 year flood events triggering new insurance rates.

Public Health

As temperatures rise, Californians will face greater health risks from dehydration, heat stroke, heart attack, and other heat-related illnesses as well as vector borne diseases.

Sensitive populations and socioeconomic factors are two components representing at-risk population to impacts from climate conditions. Rising temperatures and extreme weather events pose a long list of serious health risks. Though citizens that reside in the rural-agricultural interface experience higher exposure rates to pesticides, favorable climate will likely increase pest and pathogen activity requiring modified applications to protect valuable crops. Heat-related illnesses, a rise in mosquito and tick borne diseases, and poor air quality from wildfire smoke, dust from fields gone fallow, or an increase in pesticide and insecticide use will make sensitive groups more susceptible to asthma, allergies, and lung disease see Figure 30. "Flashy" rain events can overtax sewage systems allowing disease-causing bacteria to contaminate drinking water and streams. Rates of depression, anxiety, and pure exhaustion in dealing with ongoing exposure to extreme elements or surviving an extreme event will likely rise, as will the incidence of post-traumatic stress disorder.

Vulnerable Populations

Regional vulnerability is similar to human health in that there are a multitude of factors contributing to complex problems. As a doctor monitors health through indicators such as blood pressure, blood tests or other examinations and considers factors such as family history, obesity, and smoking, the doctor can decipher the most probable health risks. Precise predictive models don't exist, but given a large enough group of people, the probability or likelihood of developing health problems can be determined.

Regional vulnerability can be assessed in much the same way. Sensitivities to particular stressors, those inherent properties that predispose an organism or an ecological system to problems, can be identified by studying places in which similar organisms or systems were affected by those same stressors in the past. Based on this information, the likelihood of future problems can be determined even if we can't precisely predict the exact conditions that will occur in any specific location.

Those vulnerable to the impacts of climate are largely based on geographic and socioeconomic conditions. Planned communities with limited ingress and egress routes exist throughout the incorporated and unincorporated areas of Tehama County and the City of Red Bluff to include Lake California, Bend, Surrey Village, and Rancho Tehama. These rural residential hubs are vulnerable due to geography as they are restricted to only one way in and one way out. These areas are extremely difficult for emergency services in managing evacuations during flood and wildfire events.

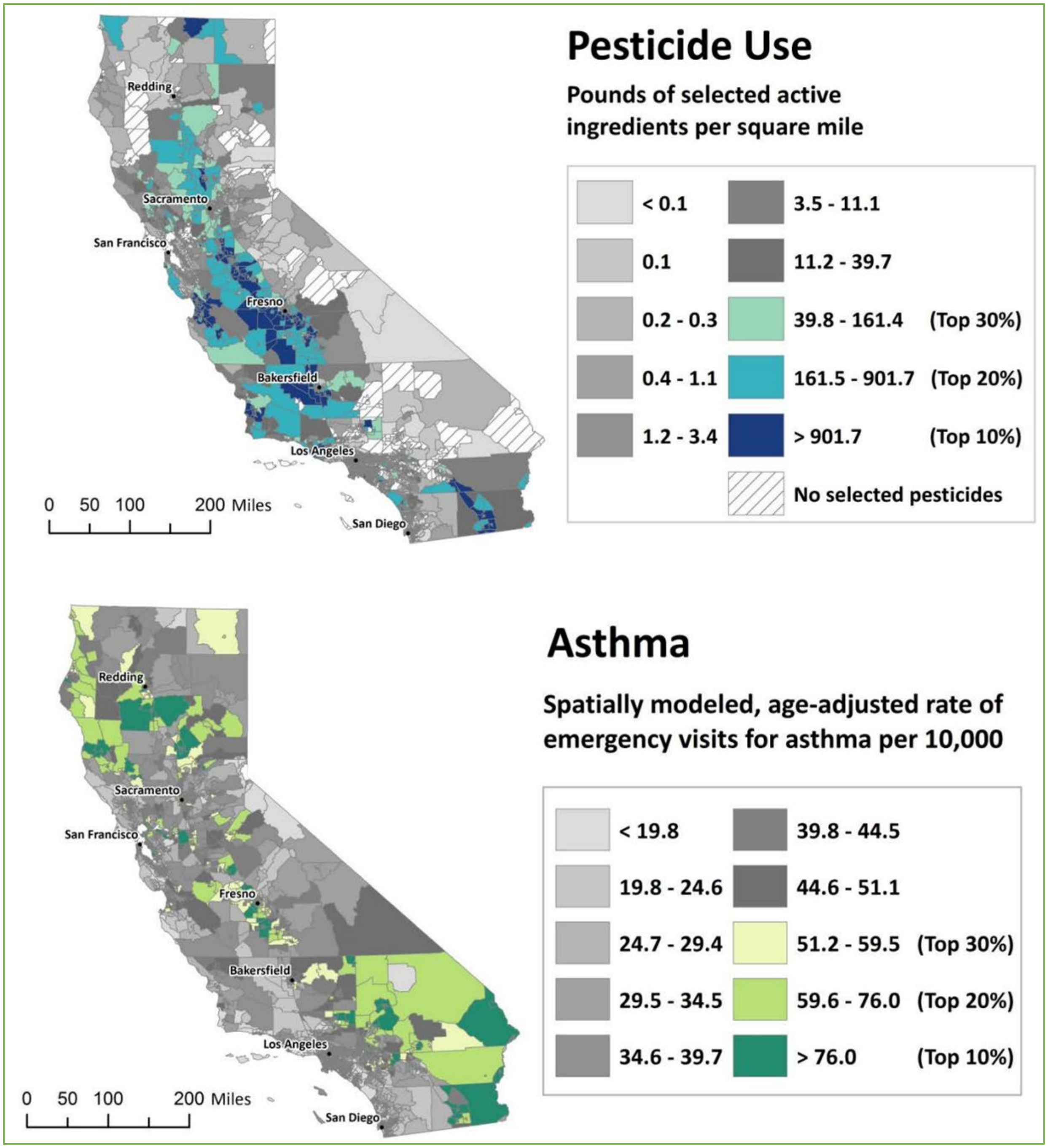


Figure 30: Statewide Pesticide Use and Asthma Occurrence. *Pesticides were detected on over half of Tehama County's Land Mass, a majority of which correlates with population hubs as well as riparian corridors. Production agricultural pesticide use records were obtained for the entire state for the years 2009, 2010, 2011. The list of all registered pesticides in use in CA was narrowed to a subset of 69 chemicals that are filtered for hazard and volatility; indicative of higher likelihood of drift and exposure. Production pesticide use for each census tract was divided by each census tract's area. Pesticides as well as other particulate matter trigger asthma, a prominent health concern in the county ranking in the top 10 percentile of emergency visits statewide. Source: California Office of Environmental Health Hazard Assessment. California Communities Environmental Health Screening Tool, Version 2.0 (CalEnviroScreen).*

People dependent on both jobs and the food supply that local agriculture provides will be most vulnerable without adaptation efforts (refer to Table 7). To be certain, local low income and fixed income populations as well as downstream counterparts are vulnerable to a lack of reliable availability to nutrient-rich foods and potable water.

Between 2008 and 2012, over 20% of Tehama County's population lived at or below the federal poverty level, a 5% increase compared to the rest of the state. Over 25% of the county population are children (0-17 years of age) with Red Bluff alone exceeding the state and nation in female householder without a husband present with children under 18 years of age at roughly 46%, 40%, and 42%, respectively. In addition, roughly 16% are 65 years of age or older (2010 U.S. Census Bureau). These figures imply the aging and low income populations will have the greatest difficulty in overcoming the harsh climate conditions and are the most sensitive populace to climate impacts (Figure 31).

Oftentimes the socioeconomic status of indigenous tribes inhibits the adaptive capacity to climate change leading to vulnerabilities that are exacerbated by land-use policies, political marginalization, and legal issues associated with tribal water rights. With less than 8,000 in population, the Corning-Paskenta Tribal Area is a contiguous three-mile area joining the Paskenta Band of Nomlaki Indians and the City of Corning.

Climate change related impacts including extended drought, an increase in the frequency and intensity of wildfires, and higher temperatures will alter habitat, threatening indigenous tribal access to traditional foods, medicinal properties, and cultural practices providing sustenance to their community for generations.

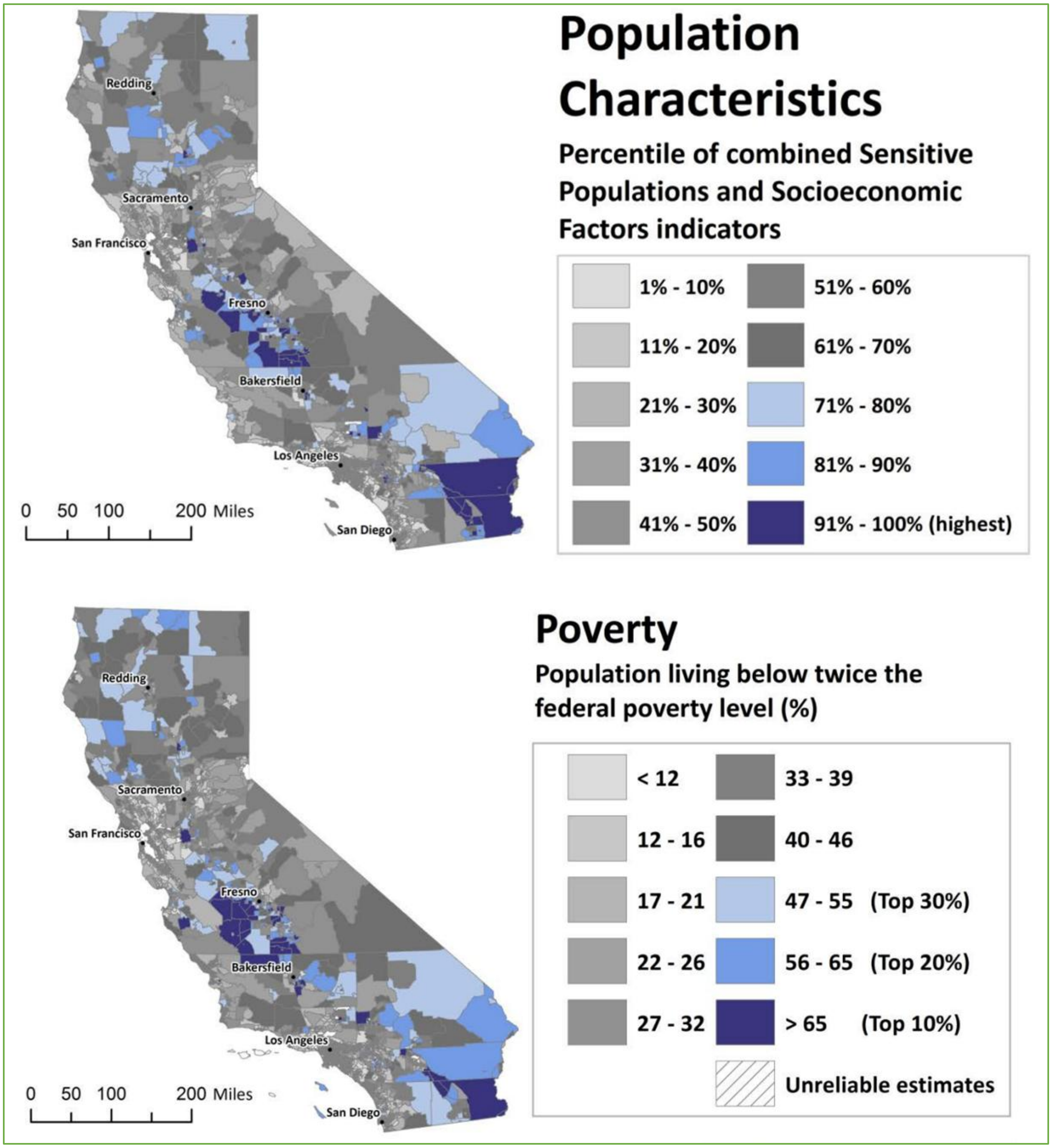


Figure 31: Statewide Population Characteristics and Federal Poverty Level Maps. *Tehama County ranking within the top 20 percentile of combined sensitive populations and socioeconomic factors as well as ranking in the top 30 percentile of population living below federal poverty rate. Source: California Office of Environmental Health Hazard Assessment 2007-2011. California Communities Environmental Health Screening Tool, Version 2.0 (CalEnviroScreen).*

Climate and Agriculture

Agriculturalists tend to have an innate sense in solving crises of various magnitudes that occur in day-to-day field operations. Oftentimes a quick fix solution buys time; however, most conclude the underlying issue remains. In order for agriculture to remain the cultural and economic core of Tehama County, it must be not only cognizant of the underlying resource issues but willing to adapt to the next challenge; there are significantly more water intensive, perennial crops in production and going into production whereby demand for groundwater surpasses the amount nature can resupply. This unfavorable circumstance has made the region and the agricultural industry more vulnerable to considerable water resource depletion and economic loss.

Much of the county has moderately high crop vulnerability (Figure 32) due to the fairly limited spectrum of crops that are produced intensely to include walnut, almond, olive, plum (prunes), and pasture.

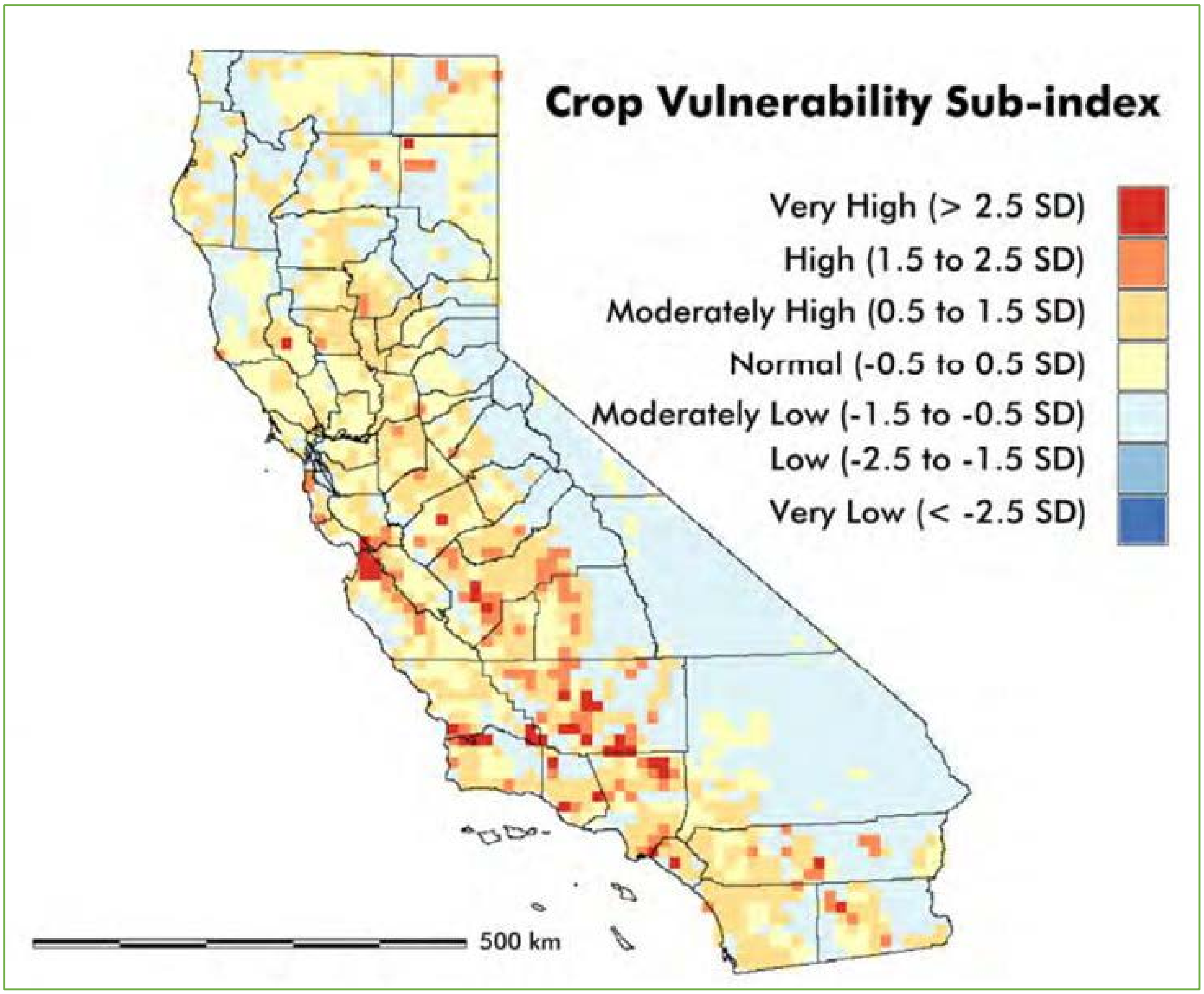


Figure 32: The Crop Vulnerability Sub-Index. *The vulnerability level is assigned based on standard deviation integrates variables for crop sensitivity, crop dominance and pesticide use throughout California. Source: California Energy Commission White Paper, July 2012, UC Davis.*

Climate Variability and Agricultural Impacts

- *Constrained water resources*
- *Yield reductions; crop and livestock stress from heat, pests and disease*
- *Heat stress is taxing on labor*
- *Reduced winter chill hours*
- *Extremes in weather events; prolonged drought and "flashy" precipitation*

There has been a drastic increase in production of higher-revenue-per-acre crops such as walnuts and almonds. Within a 20 year range, bearing acres of walnut increased by nearly 92 percent from 11,116 acres in 1991 to 21,304 in 2013. Within the same time frame, almond production increased by nearly 42 percent from 7,282 acres to 10,313 (Tehama County Department of Agriculture Weights and Measures, 2013). Due to high market demand for these crops, idle lands are actively being converted to nut orchards. These lands were never previously irrigated are further straining groundwater. In the recent past, orchards were flood irrigated and many are proactively modifying irrigation systems for drip irrigation. Walnuts in the northern Sacramento Valley consume just over 1 million gallons per acre on average via drip irrigation per year.

Agriculture is on the front lines of climate change and is already experiencing the impacts of severe droughts and record heat waves. The impacts of climate change threaten to upend agricultural production in much of the country. Crop failures we currently experience less frequently, i.e. once every twenty years would reoccur more than once every two years by the end of the century.

For example, dried plum growers reported a loss of more than 40 percent of their crop in 2013/14 due to drought stress and poor weather at bloom. The increased difficulty in finding access to forage or natural sources of pollen and nectar for honey bees during years with average rainfall and is proving more challenging in years of prolonged dry conditions. Many public lands that would provide blooming plants in typical years are not performing and have greatly impacted honey production (UC Davis).

New temperature regimes brought on by climate change as well as advancing range in pests and disease northward will directly impact crop growth. Nut growers may require low-chill hour varieties or shift to new crops to counter the impacts from reduced chilling hours (Figure 33). The American Geophysical Union (May 20, 2014) described key conditions this way, "the chill of winter dormancy allows crops such as almonds and pistachios a vital rest period for the development of buds, flowers and fruit during the growing season. Historically, tule fog extends winter chill conditions as the thick ground fog descends upon the valley between late fall and early spring. The fog shields buds from the sun contributing to lower winter air temperatures. It also functions as insulation sustaining chill within the valley. Covering 32 consecutive winters, research found a 46 percent drop on average in the number of fog days throughout the Central Valley between the first of November and the end of February. It is highly likely the wet or dry seasonality influences the year-to-year variability as less fog occurs when conditions are too dry or too wet. The dramatic decline of the fog events over the past three decades has impacted crop production as an insufficient dormancy rest period impairs the ability of growers to achieve high quality fruit yields. The lack of moisture during drought conditions and saturation during wet years prevent fog formation. Climate forecast suggest the accumulation of winter chill will continue to decline throughout the Central Valley."

A substantial amount of chilling hours (between 32 and 45 degrees Fahrenheit) are necessary for olive flower bud development, which facilitate the plant's movement out of its vegetative state so fruit can be produced. Walnut, almond, and plum trees must be exposed to chilling temperatures for a sufficient period of time each winter to break dormancy and flower each spring. This process is vital in regulating the life cycle of the plant. Walnuts depend on synchronization between male and female flowering that is regulated by the amount of chilling hours (UC Davis).

Farmers, ranchers, and forest landowners can play a role in addressing climate change, and the USDA is ready to help make that happen.

-- US Department of Agriculture; Strategic Plan for FY 2010-2015

Constrained water resources will be among the most challenging effects of climate change for California agriculture. To reduce risks, grower education on best management practices for rangeland, orchards, and vineyards, is imperative. Expanding the reach of local agricultural organizations and frequently contacting growers to keep them apprised of government regulation may influence their likelihood to adopt mitigation and adaptation practices (Figure 34). Connecting growers to NRCS cost-share programs, RCDTC services, and other organizations are ways to advance the adaptation process.

Conservation of agricultural land provides the opportunity for a series of co-benefits. Examples of these benefits may include, but not be limited to:

- Water conservation, through on site efficiencies, groundwater recharge, or flood control.
- Energy conservation, through on farm practices, local markets or local processing of commodities.
- Nutrient cycling that decreases potential for water pollution.
- Ecosystem services; in support of habitat for species of concern, improved ability of the system to regulate water, and provide pleasant scenery.

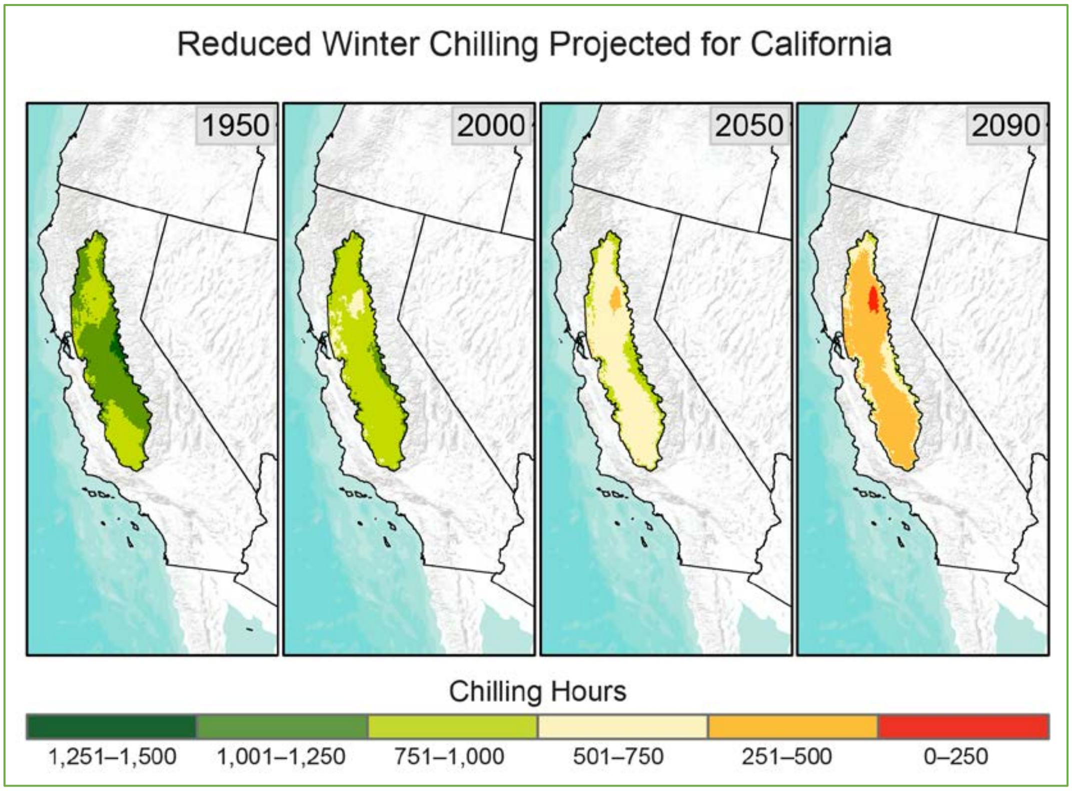


Figure 33: Historical and Projected Reduced Winter Chilling for California. *The projected chilling hours in the Central Valley were produced under the assumption that the observed climate trends in that area continue through 2050 and 2090. Source: National Climate Assessment, 2014.*

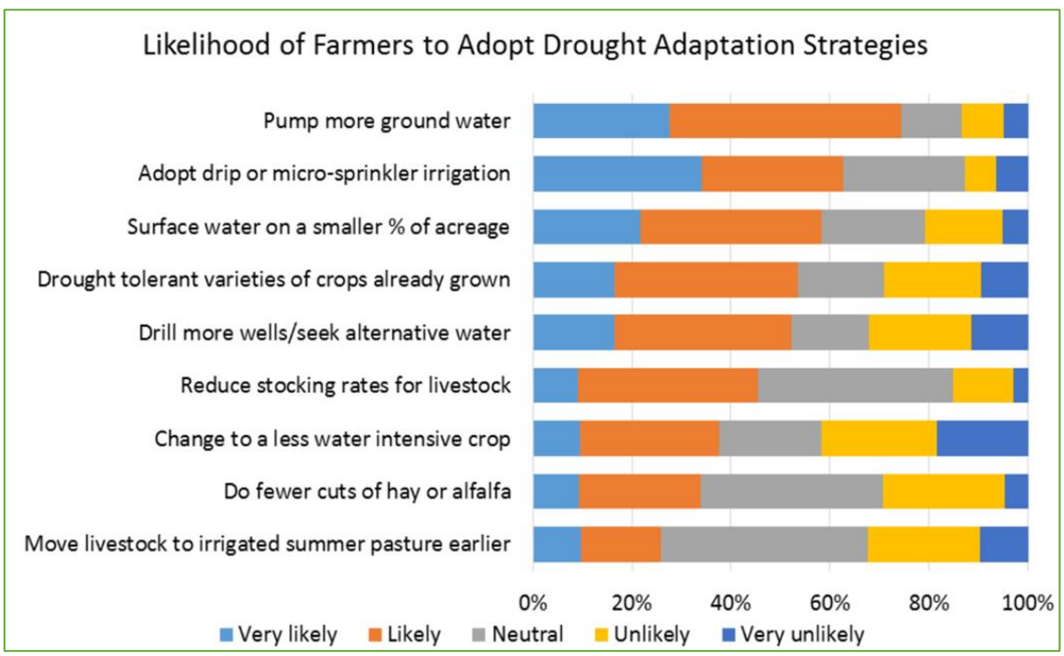


Figure 34: Likelihood of Farmers to Adopt Drought Adaptation Strategies. *Source: Center for Environmental Policy and Behavior, UC Davis.*

Within the last 20 years the number of cow and bull sold decreased by nearly 39 percent, calves by nearly 36 percent, and feeders at nearly 20% (Tehama County Department of Agriculture Weights and Measures, 2013). Despite significant reductions in herd size, the legacy of cattle ranching remains at the cultural core of Tehama County as well as economic. Greater drought stress on rangelands used for grazing and negative impacts on range plant health are climate stressors upon an industry that is challenged by reductions in grazing lands. Climate variability among factors can easily change the fundamental properties of rangeland ecosystems at rates current management systems are not designed to accommodate.

In addition to supporting livelihoods from livestock management, range and pasture lands contribute to three main ecosystem services: wildlife habitat, water quantity, and carbon sequestration. Improving soil health is a resiliency strategy that is mutually beneficial and is discussed in further detail in the Resiliency Response section.

Climate and Watershed Habitat

Tehama County is rich in natural assets, scenic vistas and wildlife diversity. The area supports a wide range of ecosystems and species groups, including native mammals, fish, reptiles, amphibians, invertebrates, and birds. Upland mixed pine forests support wildlife populations especially sensitive to climate change, such as the pika. Despite the multitude of such species, this framework focuses on the habitat of anadromous fish species that are federally listed as threatened or endangered. This includes steelhead trout and spring-run Chinook salmon.

The Creeks

The Delta Reform Act of 2009 requires the State Water Resources Control Board to conduct instream flow studies for high priority rivers and streams by 2018. Over 33% of the streams in the Sacramento Valley that were identified by the SWRCB for instream flow assessments are located in the county to include Cottonwood, Antelope, Battle, Mill, and Deer creeks (DWR, Update 2013).

Select creeks, particularly in the eastern portion of Tehama County, support the few remaining significant spawning populations of spring and fall run Chinook salmon in California, as well as Central Valley steelhead trout. Battle Creek, which flows across county lines (Shasta and Tehama), serves as an important anchor for the recovery of anadromous fish and is likely the highest quality habitat above the Central Valley for these species. Its unique hydrology of significant year round cold water spring flows makes for the only tributary in Tehama County that can consistently provide cold water at temperatures low enough to assure spawning success. Anadromous fish species depend on cold-water channels to maintain the vigor needed to complete their migration: to spawn, to maintain the favorable conditions for their eggs and fry once hatched. This subsurface augmentation of creek flows by springs and fairly intact riparian border increase the resilience of the Battle Creek ecosystem against drought. In an effort for salmon population success, three dams are in various phases of fish passage projects.

Figure 35: Critical Habitat for Sacramento Valley Spring Run Chinook Salmon; Pacific Ocean to Tehama County. *Source: Resource Conservation District of Tehama County, 2014.*

Mill and Deer Creeks also support healthy runs. Since they are dependent solely on snowpack and rain, it is of concern that the flows are fully allocated to water right holders. Nevertheless, both of these foothill streams maintain a level of high water quality, and riparian landowners work with government agencies to understand and accommodate listed fish species.

Antelope Creek has high potential to support a viable population of steelhead and is characterized as having a moderate potential to support a viable population of spring-run Chinook. This creek is considered critical habitat for these two species, especially near its confluence with the Sacramento River where natal rearing areas are found. In addition, stream flows and fish passage have been impaired below agricultural diversion on the valley floor (DWR, Update 2013). The timing of the returning salmon runs is not often favorable as they occur during diminished stream flows during the summer and early fall. The flow in Antelope Creek is also dictated by water rights and has ceased flow below one of the private diversion dams during the summer and early fall. One of its tributaries links salmon from the Antelope sub-watershed to the Sacramento River. Efforts by federal and state agencies to improve fish passage and to balance private water diversions with environmental needs are underway, and several projects have recently been completed (see Antelope Adaptation box in Forest Findings section). Nevertheless, climate mechanisms can cause drastic alter seasonal flow. High turbulent flows during "flashy" winter storms and a meager trickle during drought and summer heat are projected outcomes with profound impact on fish species.

Stressors

Increasing encounters with wildlife as human populations expand outward, together with the associated introduction of domesticized predators into natural communities and conflicts over water and forage, are non-climate stressors that actively impact anadromous fish habitat. Population dynamics also plays a part. Although plentiful salmon populations have adapted to considerable change in climate and the environment in the past, maintaining diversity in now shrinking salmon populations will be key to the long term survival of the species.

Climate related stressors increase challenges for anadromous fish populations as featured in Figure 36. Reduced stream flow resulting from drought conditions is a major issue. The State Water Resources Control Board (SWRCB) has experienced some success in mitigating the current drought impacts by urging voluntary diversion reductions on critical watercourses in 2014, leaving more water in the stream channels for environmental uses. A majority of the 127 water rights holders voluntarily reduced water diversions from Antelope, Mill, and Deer Creeks to protect habitat for endangered fish to comply with the SWRCB's emergency drought order on May 21, 2014. On the other hand, the curtailment incentivized groundwater pumping, an already burdened source of water. The share dedicated to "environmental flows" will likely shrink, particularly in watercourses where critical flow studies have not yet been completed and where the quantity of water required for healthy anadromous fish populations is unknown. If drought conditions continue in this region, it is likely that incidences of fish stranding and die-offs of out-migrants will increase under climate change projections unless a more permanent solution can be reached.

Rising water temperature is a second major concern. Cold, oxygenated streams are of grave importance for the proliferation of anadromous fisheries. Fed less by snowpack and to a greater degree by "flashy" rainfall, in-stream water temperatures in Tehama County are projected to rise as a result of climate change. This will be accelerated by lower flow levels that cause the slower and shallower water to absorb more solar radiation, resulting in warmer water temperatures even at higher altitudes. Under low flow scenarios, in-stream structures and natural barriers will become extreme obstacles to fish passage. In addition, warmer water will allow bacteria to breed at a rapid rate and for a longer period each summer, reducing water quantity and quality for many aquatic species. The loss of a robust riparian canopy to shade the streambed will be an additional challenge for fisheries managers.

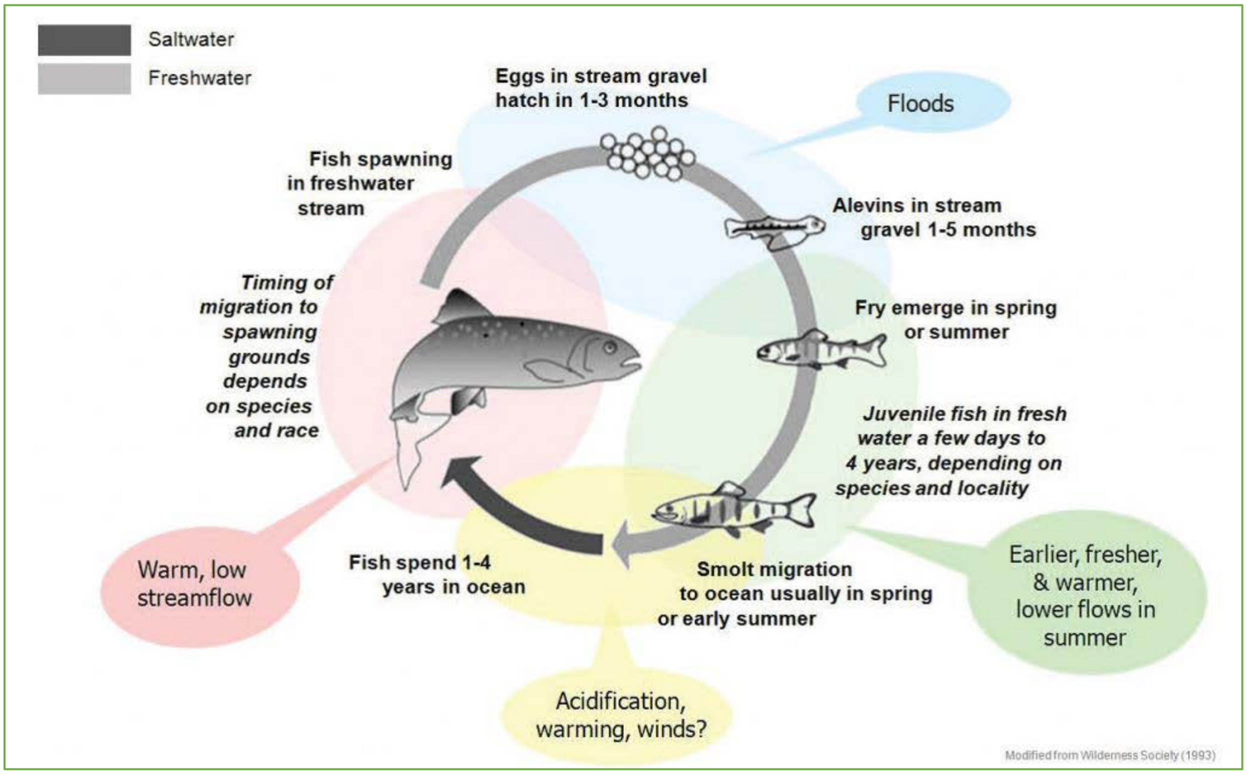


Figure 36: The Salmon Life Cycle and Climate Change. *Salmon have a unique life cycle that exposes them to the effects of climate change across many seasons and habitats. The colored 'call outs' explain how projected hydrologic changes and temperature regimes may impact salmon during various phases of their life cycle. Source: stateofsalmon.wa.gov.*

In Tehama County, critical inland habitat for anadromous fish is located in mountainous watersheds of the Sierra Nevada and Cascade ranges where the risk of fire is at an all-time high. Extended higher heat days and dry conditions lower water content in both the soil and vegetation, elevating the threat of wildfire. With overstocked forests throughout much of the region, the stage is set for high-intensity, devastating fires that would destroy essential habitat for many species. In an intensive fire event, soil stability and carbon retention would be at risk across entire landscapes, and large-scale sedimentation may pose a serious threat to the quality of aquatic habitat in streams and rivers. Ash and fire retardant build up on the surface of the soil, and the loss of vegetation allows large-scale slope erosion. The sudden influx of particulate matter and chemical residues into down-gradient waterways can kill or weaken fish and other aquatic life by depriving them of oxygen, coating food and habitat substrates, or accumulating in their gills.

Under the impact of human induced stressors mentioned above, in combination with projected climate conditions, the viability of anadromous fish habitat is questionable. Land management practices that restore and maintain the structure and function of key ecosystem features would help to ensure the existence of appropriate habitat throughout the watersheds to sustain these migratory fish and other wildlife. Aquatic resources of regional significance rely on creeks throughout the east side's grassland and oak woodland. Development on fertile river floodplains and conversion of wetlands to agricultural and urban uses over the history of the State of California has drastically reduced wildlife habitats in the Sacramento Valley region. While this habitat destruction can never be fully reversed, wildlife habitat is increasingly recognized within the agricultural community as compatible with agricultural production. Practices can be adopted that simultaneously provide wildlife habitat while assisting producers to reduce pesticide use or to establish vegetation buffers that help filter runoff water before it enters waterways, resulting in dual benefits to the environment.

Resiliency Response

> *"Anything else you're interested in is not going to happen if you can't breathe the air and drink the water. Don't sit this one out. Do something. [This] is an absolutely critical moment in the history of our planet."*
>
> \- Carl Sagan

The analysis of ecosystem processes and benefits as well as forest and water risks highlight the need to optimize the county's key natural assets for economic and ecological viability. Land use throughout the county's elevation continuum plays a role in ecosystem processes that contribute to the overall health of the Sacramento River watershed. Sustaining the integrity of ecosystem function, composition, and structure is necessary to provide for future generations while supplying immediate goods and services to an increasingly diverse demand. Optimizing ecosystem processes throughout the county's landscapes is a proactive approach to resource resiliency in the face of a changing climate.

High Elevation Forest:

Forest vegetation and management practices influence mountain hydrology as well as water supply in lower elevations. It is important to optimize the function of high elevation forest lands so they can perform regulative services of water temperature and water quality control, store water in the form of snow, store carbon, and clean the air. Support the function of these lands that provide habitat, biodiversity, as well as aesthetic and recreational opportunities.

- Recreating open park-like setting with gaps in the canopy for snow accumulation particularly in the Mill Creek and Deer Creek sub-watersheds.
- Remove diseased stands
- Thin overstocked fuel loads

The following forest resiliency stakeholder suggestions are economically and ecologically beneficial:

- Standardization of forest health practices for small and large scale private forest landowners that is compatible with public land management practices; monitor forest health, identify outbreaks and vulnerability zones, avoid transporting disease and insects, remove damaged stands and reduce hazardous fuel loads.

Carefully executed mechanical forest thinning and prescribed low intensity burning are two methods to remove dense stands of trees and downed woody debris to restore open forest structure. In doing so, valuable snowpack accumulates on the forest floor as water reserves, storing water as snow for use in warmer months. Additionally, these methods reduce hazard fuels that can contribute to catastrophic wildfire. Research suggests that thinning out dense forest stands and ground vegetation improves tree vigor and ultimately increases its resilience to pests, in addition to fire. Though fuel treatments act to reduce fire severity, its effectiveness decay over time and treatment zones require maintenance.

A recent Sierra Nevada simulation model using five fuel treatment scenarios ranging from light to intensive mechanical forest thinning and two fire regimes indicate fuel treatments were most effective when continuously applied and strategically placed in areas of high ignition associated with the interface between wildfires and treatment areas. Species dynamics within the management units were affected by treatment allowing for a shift in dominance patterns. Treatments created more diversity within the mixed conifer system with a higher proportion of fire-tolerant species.

Balancing the use of fuel treatments for reducing wildfire risk against an alternative goal of carbon sequestration is an important exercise for resource managers. This requires an examination of the net balance between the immediate loss of carbon from live and detrital matter during fuels management such as mechanical thinning and prescribed burning against the goal to increase carbon sequestration. Notably, the study suggests achieving a net carbon gain requires intensive long-term treatment with reliance on wildfire activity. A small amount of wildfire on the landscape resulted in significant changes in the soil carbon pool suggesting that long-term carbon management can be accomplished through fuel treatment applications in key areas (Loudermilk & Stanton, 2014).

The Tehama County 2008-2028 General Plan’s Zoning Code defined private lands protected in perpetuity during a statewide planning effort for timber production as Timber Preserve. Large areas of coniferous forest with minimal to no management occur on private lands as well as state or federal government lands. These account for a wide swath along the eastern and western uplands of the county. Currently, no data exists which would allow an assessment of the acreage under timber production on private land or government parcels which are not zoned Timber Preserve. It is suggested to use LIDAR imagery of the area that would allow for an assessment of coniferous forest area in the county, however, this would be a costly and highly technical task.

Native Oak Woodlands and Savanna:

In grasslands a substantial proportion of photosynthate (sugars produced during photosynthesis) is allocated to roots creating below ground carbon pools. Well managed and protected, these lands have the potential to remove significant amounts of carbon dioxide from the atmosphere. See Working Landscapes to follow.

Riparian Forest:

- Influence instream flow
- Regulate erosion
- Regulate water temperatures for aquatic species

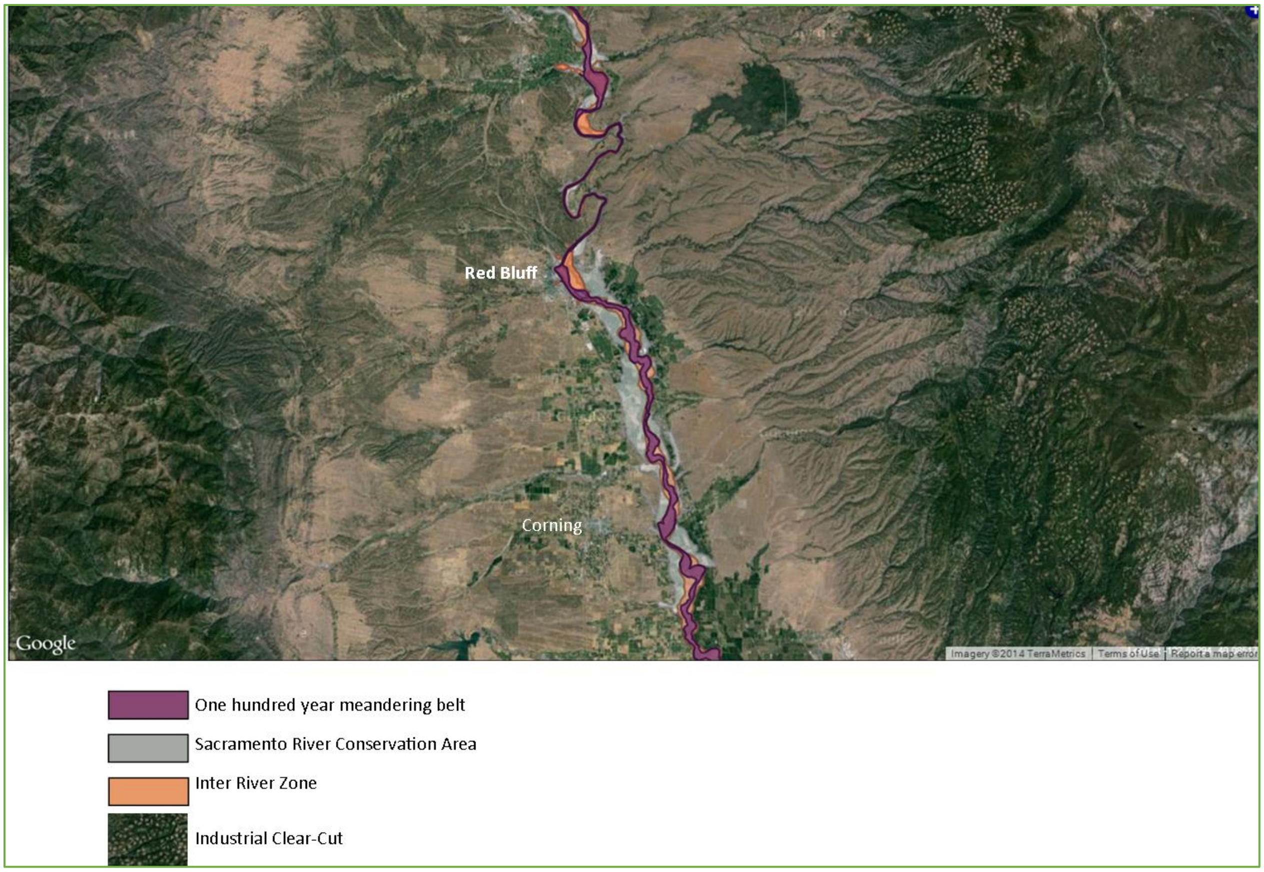


Figure 37: Sacramento River Riparian Corridor within Tehama County. *Source: Sacramento River Area Forum GIS Viewer, 2014.*

Orchards that are planted right along the Sacramento River and its tributaries could benefit from a gray/green economic analysis as well as residential development adjacent to waterways. Establishing a unified development ordinance at the county level that requires ag and urban developers to maintain riparian buffers allows the ecosystem services of flood mitigation, water filtration, and groundwater recharge to be optimized. Additional outcomes would support species diversity and anadromous fish populations and ultimately fish and wild game enthusiasts.

Working Landscapes

Range and Pasture Lands:

Range and pasture lands provide valuable flood protection, filter contaminant for water quality improvements, and ground water recharge. In addition, these lands have the potential to remove significant amounts of carbon dioxide from the atmosphere. Carbon storage on grass and range lands tend to increase with improved grazing practices. Managing these lands for increased carbon storage many co-benefits including improved water holding capacity, soil respiration, soil stability, and plant and forage productivity above ground. A majority of these landscapes are privately owned with few protections. Working with the ranching community to optimizing the ecosystem services that take place on their lands is important to safeguard water resources. Promoting intensive grazing methods, applying compost, and maintaining a balance between the maximum amount of soil capacity and yield are elements of rangeland resiliency.

Tehama County has the potential to significantly reduce greenhouse gas emissions and sequester carbon in marrying waste management with carbon farming. The Tehama County/Red Bluff Sanitary Landfill Agency is required by State law to divert as much material as possible from the "grave" including green waste such as food scraps and vegetative matter to reduce methane emissions, which is another extremely potent greenhouse gas. Assembly Bill 1594 was developed in recognition of the positive impact in processing green waste as compost rather than being disposed of or used as alternative daily cover. Collecting and processing unwanted green material from the landfill to fit the resource needs for carbon farming on local agricultural lands not only assists with waste compliance and improve soil structure, but helps the region adapt to climate change. It is a unique opportunity to redirect the local waste stream and reduce local greenhouse gas emissions for the mutual benefit of two industries and the well-being of many.

Orchard Crop:

Acres of adjacent lands to the river are zoned for agriculture. Since landowners are taxed at agricultural land rates for riparian acreages, they are compelled to maximize production on their lands to support the higher tax. A strategy to conserve the riparian corridor is to reduce taxes on lands that maintain native vegetation that serve as a buffer zone.

Urban Landscapes

Land use change or inadequate management is the main non-climate stressor that will impact the function of select ecosystem services. At the same time, land use management practices that protect ecosystem services and optimize Tehama County's native landscapes can increase groundwater recharge, reduce invasive vegetation water demand, and complement the functionality of the built infrastructure by helping to reduce overall filtration operation costs for municipalities. Impervious surfaces common throughout urban landscapes directly impact water conveyance processes. Concrete and asphalt prohibit infiltration for groundwater recharge and increase water loss as surface run-off, thus, accelerating the deposit of valuable water as well as pollutants into the river.

Impervious surfaces also increase evaporation and greatly contribute to the urban heat island effect causing higher temperature microclimates in built environments. Tree canopies in urban areas significantly reduce surface temperatures by casting shade on hardscapes and impermeable and dry surfaces. The urban heat-island effect occurs in urban areas whereby pavement, roofs, and other hardscapes retain and radiate heat from the sun whereby its own microclimate is generate that is warmer than rural surroundings. Permeable surfaces that have moisture retaining vegetative matter and have shaded tree canopies can help withstand the higher temperatures locally.

What is a Bioswale?

A bioswale is a ditch that reduces surface water run-off by allowing rainwater to soak into the soil slowly. Native plants that line the bioswale serve as the first filter to remove pollutants. The water percolates through a secondary filtration of sand, rock or gravel before slowly making its way to the aquifer.

The major urban zones throughout the City of Red Bluff, City of Corning, and Los Molinos as well as populated pockets of Gerber, Proberta, and Lake California, can play a role in keeping precipitation that falls in Tehama County for local use. When impervious urban surfaces that hasten run-off are modified by investing in natural infrastructure such as pervious surfaces and bioswales, then population centers instead can contribute to quality groundwater recharge. In addition to recharge, these urban zones can play a role in reducing the intensity of high temperatures.

Water

In tandem with optimizing ecosystem services, water security can be gained by enforcing water conservation practices, restricting agricultural expansion, regulating groundwater extraction, and enhancing groundwater recharge.

Figure 38: Image Trio of Pervious Concrete. *Water infiltrates small gaps in specialized concrete reducing surface water and pollution run-off while increasing groundwater recharge. Source: Resource Conservation District of Tehama County, 2014.*

There is no getting around the reality that regulating groundwater extraction at the sub-basin level is a near term response to improved water management of a scarce resource. Modifying the well permitting process to include evidence of adequate groundwater supply, reassessing specific well design parameters including spacing and screen depths, suspending well drilling, and possibly denying permits are proactive management concepts to consider implementing. In addition, expansion of municipalities and water service districts and an all-out well drilling moratorium are proactive steps to safeguard supplies.

The recent groundwater legislation prioritizes groundwater basins that are currently over drafted whereby Tehama County is classified as a medium priority zone. The following is the legislative timeline for implementation:

- By 2017, local groundwater management agencies must be identified:
- By 2020, over drafted groundwater basins must have sustainability plans;
- By 2022, other high and medium priority basins not currently in overdraft must have sustainability plans; and
- By 2040, all high and medium priority groundwater basins must achieve sustainability.

This legislative action does not reflect the urgency of the local water issues. It is crucial that resource planners and local government proactively address the current need to reduce the amount of water consumed in Tehama County well in advance of the 2020 deadline.

Since Tehama County largely relies on groundwater, it is imperative to ensure precipitation that accumulates in Tehama County remains in Tehama County as long as possible. Groundwater recharge facilities include stream beds, spreading grounds, percolation basins, injection wells, and surface delivery systems. Snowpack and rainfall dictate the extent of groundwater recovery each spring. With the current and projected decrease in snowpack and expected 'flashy' rain events, surface water storage is a worthwhile resiliency strategy to explore. Strategically located, groundwater recharge zones can also serve as wetland habitat. One such catchment location may be within the Thomes Creek watershed in the southwestern portion of the county. Here, a green infrastructure such as a modified wetland can store and filter surface water for groundwater banking. The Mill Creek and Deer Creek sub-watersheds of eastern county are of topographic significance as their high altitude serves as snowfall catchments and play a role in the timing of water supply for use in the valley. With further examination, this area may also serve as a recharge zone. Clearly, optimizing recharge zones is a powerful strategy toward climate readiness that not only has a positive impact locally, but for downstream communities as well.

In drought conditions, the sheer volume of water available for local use and as a contribution to the Sacramento River (CVP) is reduced. It is vital to manage the depletion in such a way that all water consumers can adapt to it.

Surface Water

The focus on protecting the quality of surface water includes nonpoint and point pollution. Livestock grazing in riparian areas has been identified as a source of nonpoint pollution. The impacts of livestock grazing in riparian areas include manure and urine deposited directly into or near surface waters where leaching and runoff can transport nutrients and pathogens into the water. Unmanaged grazing may accelerate erosion and sedimentation into surface water, change stream flow, and destroy aquatic habitats. Improper grazing can reduce the capacity of riparian areas to filter contaminates, shade aquatic habitats, and stabilize streambanks.

> *"We have a choice; dealing with lower levels of smoke from prescribed fires that may only be needed every 15 years or so, and which can be timed for optimum weather conditions, or acute levels of smoke from catastrophic fires that can last for months when they hit"*
>
> Scott Stephens, UC Berkeley
> Associate Professor of Fire Science

The negative impacts of livestock grazing in riparian areas can be prevented, minimized, or improved by controlling when, where, how long, and with what intensity livestock graze the forages in the riparian area. Riparian buffers offer many benefits depending on their design and location. A buffer zone or riparian area would be an area of protection between the grazing area and the stream. Some of the benefits of buffers include:

- Protect air and water quality.
- Reduce soil erosion caused by wind and rain.

- Stabilize the banks of streams, rivers, and lakes.
- Trap water-borne sediment that pollutes streams, rivers, and lakes (can reduce up to 80% of sediment).
- Trap manure, fertilizer, pesticides, and other contaminants that pollute surface water (reduce 40% of phosphorous and significant levels of nitrate).
- Trap bacteria and other pathogens that cause waterborne diseases in people, livestock, and wildlife (up to 60% of pathogens removed in runoff).
- Provide habitat for fish and wildlife.
- Cool streams and rivers, creating good conditions for cold-water species.
- Help prevent flooding.
- Increase outdoor recreational opportunities.
- Make the landscape more beautiful and properties more valuable (Source: Shasta Tehama Watershed Education Coalition, 2012).

Resiliency strategies such as increasing water supply reliability, establishing meander zones to allow rivers to move through widening floodways, conserving farmland and riparian corridors, and restoring ecosystems are also beneficial to flood and public health safety.

Antelope District

The City of Red Bluff and County are engaged in a collaborative effort to improve the groundwater quality and quantity conditions in the Antelope District. The collaborative project intends to reduce the impact of on-site wastewater systems on the local groundwater quality and consist of constructing a conventional gravity sewage collection system and connection to the existing City of Red Bluff Wastewater Reclamation Plant (Pace Engineering, 2010).

Wildfire and WUI

There are three major components affecting the threat of wildland fire: weather, topography, and fuel. Potential solutions for reducing the risk of catastrophic wildfire are based on managing fuels, the only fire factor that can be controlled.

Prescribed burning in California's fire-adapted landscapes was practiced by indigenous tribes as a proactive forest resource management tool. The technique intentionally uses fire in controlled conditions to reduce the accumulation of hazard fuels. Additional beneficial outcomes are invigorating new plant growth, ecosystem restoration, enhanced wildlife habitat, and forest and rangeland improvement by reducing competition for water, nutrients, and space from invasives and vulnerable plants on the forest floor. As a low or moderate intensity burn, prescribed burns lead to greater resiliency to extreme events such as catastrophic wildfire from lightning strikes or human ignition. A caveat is this technique must be executed when the wind conditions are favorable during cool months with a permit.

Topography, forest structure, and weather conditions often times prevent prescribed burning. Fire-prone forest material can be mechanically removed to thin stands or shredded on site. This practice accelerates the decomposition process while reducing fuel loads. Of the fuel reduction treatments in the western States, two-thirds rely on the more costly mechanical thinning than prescribed burns to scale up. The use of prescribed burns is the dominant treatment in much of the southeast region of the United States (BioScience June 2012).

Providing quality water for nearly 40 million Californians requires an 'all lands' approach to watershed conservation.

Improving fuels management is a primary factor to safeguarding residents in the WUI zone, however, it doesn't remove the looming threat of wildland fire in fire prone landscapes. Without doubt, implementing smart growth principles such as avoiding future development in high fire hazard areas significantly reduce the risk of catastrophic wildfire. Land use zoning can reduce fuels by restricting human-impact densities in WUI zones. Rural subdivisions located far from urban centers, as well as mobile homes, standard residential homes, and small ranches built on individual parcels, have developed from lot splits which create residential densities.

Preparing communities for wildfire is an important exercise for economic and social stability. It will take a two pronged approach involving planners and private landowners to reduce the vulnerability of developed structures. It is vital that planning decisions are not made in haste at the cost of positioning residents for wildfire loss. Planning decisions that minimize the spread of fires reduce costs and losses associated with wildfire in the WUI. For example, prohibiting the development of structures in gullies, the hillside 'saddle,' and on at the edge of incline will reduce direct heat. Providing multiple evacuation and entry routes, water storage exclusively for extinguishing, a building code that reduces structural ignitability as well as residential landscape following defensible space protocols are additional strategies to safeguard new development in the WUI.

Private landowners tend to give little thought to wildfire hazards, particularly as the urban populace migrates to rural areas. Fuels reduction activities, invasive plant management and educating property owners about home ignition zones are fundamental strategies for WUI communities.

According to the 2008 Tehama East Community Wildfire Protection Plan and Risk Assessment, the management objective is to enhance fire suppression capabilities by modifying fire behavior inside the WUI zone and to provide a safe and effective area from which possible future fire suppression activities might be carried out. Fire education for property owners provides valuable fire prevention information that reduces the risk of catastrophic wildfire. Some residents of Tehama County received the public outreach and public information efforts of the Tehama–Glenn Fire Safe Council and its member organizations. Fire education has been sporadic due to the nature of grant funding.

Firewise Communities/USA® is a National Fire Protection Association recognition program engaging neighborhoods to protecting themselves and each other from the risk of wildfire. The organization provides comprehensive resources that teach property owners how to adapt to living within WUI zones and encourages neighbors to proactively work together to prevent losses. Clearly, there is need for such an organized approach with a unified message in deploying fire education at the local scale. The

California Department of Insurance has acknowledge the importance of fire prevention as a means of decreasing property damage by approving a filing by USAA to give homeowners insurance discounts to USAA members living in communities recognized by the program. USAA is the first large insurance company to provide a specific discount (5%) to residents of California Firewise Communities/USA® sites. There is a large population in Tehama County with direct ties to men and woman in service. USAA serves current and former members of the U.S. military and their families.

Rural – Urban Conservation Connectivity

Eighty-four percent of the State's developed surface water supply originates on watershed lands within rural California counties. The detrimental effects of wildfire and inadequate land management on public and private forests, oak woodlands, and grass savanna affect Tehama County and all of California, including downstream communities. Providing quality water to local and downstream users requires an all lands approach to watershed conservation. The Tehama County portion of the Sacramento River watershed drains lands that include highly protected areas, including the Tehama Wildlife Preserve and Ishi Wilderness Area, as well as privately owned property lacking protection and urbanscapes. Safeguarding and restoring the county's headwaters and riparian corridors, preserving instream flow, and optimizing source groundwater recharge zones throughout the County would lead to a greater resiliency to climate variability locally and serve to reduce statewide impacts.

Climate Variability and Forest Management

Higher fire risk is projected in the county's WUI zone and higher elevation forestlands due to hotter, drier summer weather patterns, characteristic summer dry lighting events, and, increasing winds. The uncertainties of precipitation patterns and intensities also impacts landscape conditions and timber production.

Managing forests for climate variability may prove beneficial for long-term economic viability and ecological well-being for the region. Practices include:

- Establish larger diameter trees to withstand variable stresses as preferential logging of large diameter trees have left forests vulnerable to more destructive wildfires
- Increase tree spacing to maximize growth and reduce competition for resources
- Remove understory via prescribed burn to reduce destructive ladder fuels, amend soil nutrients, and optimize water holding capacity.
- Develop and maintain shaded fuel breaks to reduce fire progression and ease fire personnel ingress and egress
- Identify drought tolerant species and support growth
- Reduce water quality degradation and sediment generation by identifying roads no longer of use to restore to forest habitat and enhancing road surfacing with rock
- Decrease the quantity of water drafted from streams by utilizing wells or construct off-stream water storage tanks
- Sustain low instream water temperatures by maintaining a high tree canopy along streambeds.

(CA Natural Resource Agency, 2014)

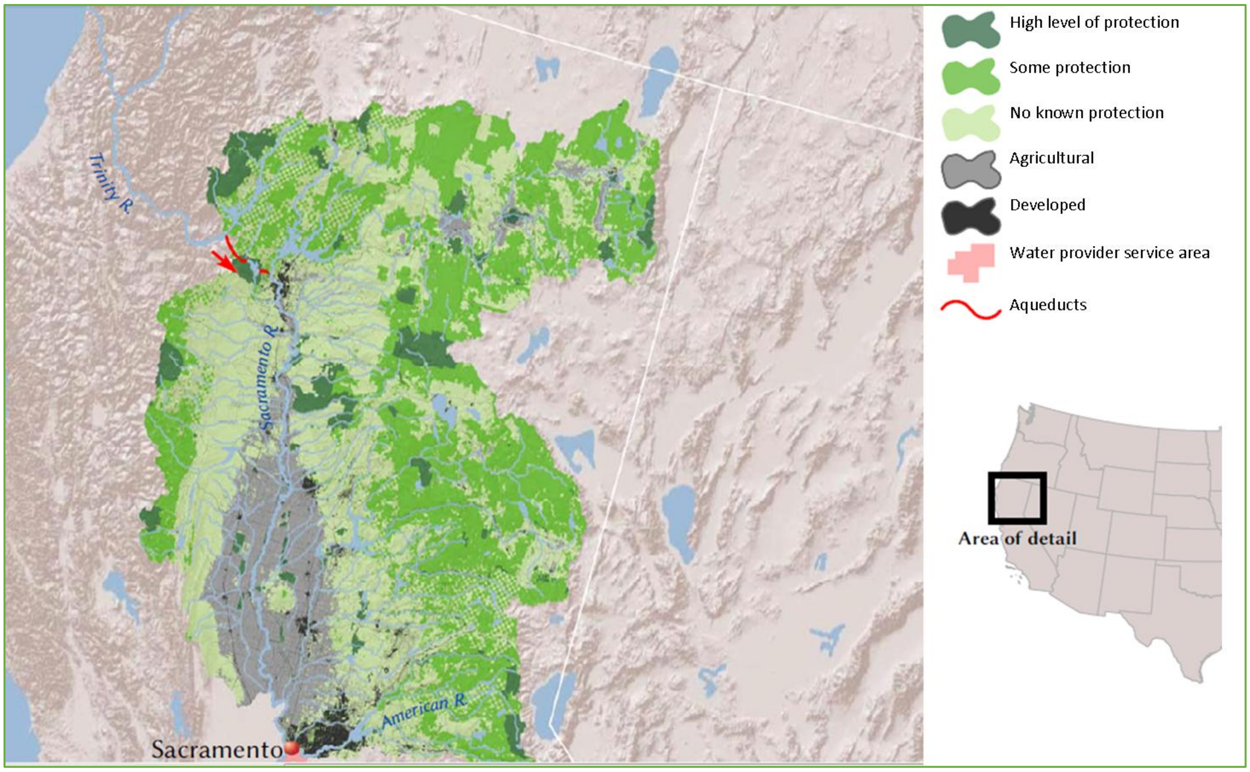


Figure 39: Surface Drinking Water Sources for Sacramento, CA. *This map connects water source areas of rural northern California with downstream urban water consumers. It shows areas of high level protection are scarce in premier water source jurisdictions. Source: The Nature Conservancy, October 2012.*

Payments for Ecosystem Services

The interdependent relationship between rural and urban communities was established thousands of years ago whereby the countryside provided products and people to the city in exchange for the city's products, services and governance. Unfortunately, this traditional relationship is hampered as rural areas are increasingly marginalized, urban areas are at risk of unreliable resources, and the ecosystem benefits all Californians received from the natural environment are threatened by non-climate related and climate related stressors. Many resource rich rural communities throughout the state express concern regarding a lack of water source awareness within urban communities. Far removed from the source, urban Californians need guidance from rural neighbors in making the connection between rural resource supply and urban demand. This is a critical link in protecting ecosystem services as the costs of maintaining and conserving these lands fall disproportionately on rural communities with limited economic means and do not consume the full benefits produced in their region. The relationship needs to be rejuvenated whereby rural communities receive more employment opportunities and income while

What are Payments for Ecosystem Services (PES)?

PES refers to exchanging something of economic value to maintain the flow of specified natural (ecosystem) processes (services) such as clean water. The key to a PES transaction is that the payment causes the benefit to occur where it would not have otherwise.

(Forest Trends & the Katoomba Group, 2008)

urban areas benefit from a sustainable supply of rural products and services through restored rural ecosystems. A new compact between rural and urban communities can be mutually beneficial where cities acknowledge and pay for ecosystem services and rural areas ensure ecosystem function is optimized (Gutman, 2007).

Responsible landowners in Tehama County can be equated to modern day purveyors of ecosystem services. With assistance, they can become land stewards meeting their own needs whil e optimizing natural assets that occur on their property that is of value to many beneficiaries, locally and downstream.

As carbon dioxide is building up in the atmosphere with each ton contributing to altered global temperatures, sea level rise, and other changes, it will likely cost significantly more to address these impacts in the future. In placing a price tag on actions that harm common provisions such as clean water and air, society would be more inclined to preserve resources.

The concept of investing now for future benefit is akin to retirement planning on a personal level or investing in youth education and growth activities at the community scale. This Santa Clara County Open Space Authority has embraced this notion and released a report in the fall of 2014 estimating the value of ecosystem services in the county is between $1.6 and $3.9 billion annually (Santa Clara County Open Space Authority, 2014). Return on investments for ecosystem restoration and conservation accrue year after year at 300% or more. Examples of municipalities avoiding costs many times greater than their investments into watershed protection are highlighted in Table 8. Although there are uncertainties when accounting for ecosystem services, it should be clear that these benefits add up to substantial amounts of money.

Metropolitan Area	Population *(Thousands)*	Avoided Costs Through Watershed Protection
New York City	9,000	$1.5 billion spent on watershed protection over 10 years to avoid at least $6 billion in capital costs and $300 million in annual operating costs.
Boston, Massachusetts	2,300	$180 million (gross) avoided cost.
Seattle, Washington	1,300	$150-$200 million (gross) avoided cost.
Portland, Oregon	825	$920,000 spent annually to protect watershed is avoiding a $200 million capital cost.
Portland, Maine	160	$729,000 spent annually to protect watershed has avoided $25 million in capital costs and $725,000 in operating costs.
Syracuse, New York	150	$10 million watershed plan is avoiding $45-$60 million in capital costs.
Auburn, Maine	23	$570,000 spent to acquire watershed land is avoiding $30 million capital costs and $750,000 in annual operating costs.

Table 8: Avoided Costs through Watershed Protection. *Source: Postel and Thompson, 2005.*

To follow the previous scenario at the local level, a specific buyer would likely be downstream water district(s), facilitated by the Local Government Commission. The providers involved in water quantity might be a coalition of orchard owners who do not consume the rest of their water right and already utilize drip irrigation. In terms of water quality, the suppliers may be upper watershed ranchers who implement intensive holistic grazing management plans on their land to prevent denuding, erosion, stream sedimentation and attachment of pesticides and bacteria which adhere to small soil/organic matter particles. Table 9 provides potential strategies for incentivizing economic and ecosystem interactions.

Incentive Strategies for Ecosystem-Economy Enhancement	
Strategy	**Defined as…**
BMP (Best Management Practices)	Voluntary or mandated land and resource management practices designed (and generally proven) to protect or enhance certain ecosystem processes and/or ensure ecosystem benefits. For example, clearing ladder fuels protect valuable timber from catastrophic wildfire events and reduce negative impacts on air and water quality. Planting native buffer strips helps to prevent nutrient run-off into streams, erosion control, and reduces impact of flooding events.
Certification and labeling program	Goods produced from local resources (using ecosystem processes) that are managed in ways compatible with resiliency needs are labeled as such, providing a purchase preference or price premium (or both), with a share of sales revenue returned to stewardship efforts. Criteria for obtaining the label should cover the ecosystem processes of concern in the region and, especially, those with the greatest impact on the affected ecosystem benefits such as using BMP for orchard products and beef production.
Cost Share	Property owners take actions to supplement or supplant targeted ecosystem processes (i.e., those at risk due to climate change or other stressors) and receive a payment for a portion of the cost of taking the action (e.g., reducing fuels in fire-prone areas). Funding can come from a combination of federal, state and private entities to include NRCS' EQIP assistance program for farms, ranches, and forests.
Differential insurance rates	Work with insurance companies to establish discounts (or additional premiums) tied to risk of loss due to wildfire and/or flooding for specific properties. Costs saved by the insurers can help fund the program. For example, the California Department of Insurance has approved a filing by USAA to give homeowners' insurance discounts to USAA members living in communities recognized by the Firewise Communities/USA® program. This discount applies to policies issuing or renewing on or after October 1st 2014.
Education	Public and/or targeted education about how changes in ecological processes affect stakeholders' interests. Use GIS analysis to target neighborhoods and individual homes for contact.

Impact Fees	**Similar to a Cost Share, however, instead of subsidizing a desired action, a fee is assessed for actions that damage ecosystem processes (i.e. stormwater fees).**
Marketing Partnerships	Develop relationships with direct users of ecosystem goods and services provided upstream that brand and market the product as coming from local, well-managed areas. Marketing is based on the approval or endorsement of the land/resource manager upstream.
Payment for Ecosystem Services	Any system that provides a payment to an individual, firm or other entity in exchange for either the delivery of specified ecosystem benefit and/or the establishment and stewardship of an ecosystem process can be called a "payment for ecosystem services" or PES strategy. Several of the other approaches listed here are, at their core, PES strategies.
Permit or User Fees	A fee charged for the direct use of the outputs of one or more ecosystem processes. A fishing license fees, a fee to park at a trailhead, or a user fee included in water, electricity and other utility bills are good examples. Revenue from the fee is then used to improve, protect and manage the relevant ecosystem processes, like species diversity for anglers or to stabilize trails (reducing erosion) for hikers, or incentives for protecting streambanks. These fees can be used to fund Payment for Ecosystem Services programs, Cost Shares, education and other strategies.
Recognition program	Property owners are publicly recognized for taking ecosystem processes, such as erosion control or establishing species habitat. Signage or other means of recognizing those efforts are provided by NGO or governmental agencies, with the cost of the program supported by downstream users -- those who benefit directly from pollination, species habitat, erosion control, etc.

Table 9: Incentive Strategies for Ecosystem – Economy Enhancement. *Source: Phillips, 2013.*

Goals for Resiliency

Fortunately, the community can capitalize on its shared strengths and opportunities to carry out resiliency approaches in a collaborative effort as outlined in Table 10. A SWOT analysis is an effective technique for community planning on a complex set of issues such as resource resiliency. By identifying human and resource capacities as strengths, weaknesses, opportunities, and threats a community can gauge favorable conditions and barriers to navigate through desirable outcomes. The SWOT matrix was compiled from individual conversations, stakeholder engagement, and Resource Conservation District of Tehama County insight.

SWOT Analysis for Tehama County Resilience Planning

Strengths	Weaknesses	Opportunities	Threats
Inter-agency support among natural resource management entities (NRCS, BLM, TNC, DF&W, DWR, etc.)	• Impacts of climate variability are already occurring	• Coordinate resource and land use plans for joint resiliency efforts	• Local culture reluctant to change
Depth of forest and agriculture knowledge through local resource management entities	• Limited time for personnel to participate in plan and implementation development	• Engage the County Planning department	• Wasteful water use. Lack of citizen will and support of water conservation.
Groundwater Management Plan and large aquifers	• Lack of enforcement	• Take advantage of water bond funds and grant opportunities to advance water conservation and reuse/recycling infrastructure	• Perceived low political will/urgency to meet requirements
Watershed Assessment Plan	• Lack of funds to implement recommended actions	• Take advantage of water bond funds and grant opportunities to advance water conservation and reuse/recycling infrastructure	• Water consumptive culture of "use it lose it"
Proactive Fire Safe Council	• Lack of funding to maintain established shaded fuel breaks and defensible space outreach to landowners	• Connect fuel break projects on private and public lands. • Implement Community Wildfire Protection Plans	• Resistance to outreach engagement as in " how dare you tell me how to operate my business"

SWOT Analysis for Tehama County Resilience Planning			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
Established watershed advocacy groups	• Fragmented interest in resource conservation measures	• Utilize relationships with established resource groups	
Strong grant writing skills	• Lack of pressure from citizens upon local government	• Tap into engaged high school students	
Local Northstate Pride	• Disconnect between altruistic land management practices and ag viability/yields	• Tap into Northstate pride by connecting landowners as purveyors of ecosystem services for local and downstream beneficiaries	
	• Unsuccessful at engaging local specialist to inventory and address needs of vulnerable populations	• Develop citizen scientist events where citizens can speak with resource specialists	
	• Limited volunteer base		
	• Limited recognition that climate change is not only real, but happening now		

Table 10: SWOT Analysis Table.

Safeguarding Tehama County's natural assets (infrastructure, people, landscapes, and habitat) is crucial in maintaining economic stability and ecological well-being as well as preserving the local way of life. The following approaches to forest and water resource resiliency serve as a proposed template intended for ongoing stakeholder engagement. The goals, objectives, strategies, and actions will require modifications over time to reflect the Framework, a living document, and the essentials of natural resource management at the local and regional scale.

GOAL I. Ensure the availability of and access to clean water through conservation and enhancement of existing water resources for multiple beneficiaries							
Objective A. Engage with the Tehama County Flood Control and Water Conservation District to support implementation of the 2012 Tehama County Groundwater Management Plan (GWMP)							
Strategy i. Advance the water conservation educational outreach identified in Phase 1 of the GWMP and required by California state law							
Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Partner with conservation groups to hold educational workshops on water conservation							
b. Secure funding to sustain educational workshop programming through private foundations, state, or federal sources (i.e. Doris Duke Foundation, Western SARE, CA LCC)							
c. Organize and host workshop series							
Objective B. Increase the capacity of the Tehama County Flood Control and Water Conservation District to develop and complete the Tehama County Water Management Plan as identified in the GWMP							
Strategy i. Develop a framework for data gathering and monitoring							
Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Network and engage with partners to assess existing data, etc.							
b. Develop a protocol to obtain and utilize existing information for needed analysis							
c. Contact Civic Spark or other higher education student-based organizations for assistance							

Strategy ii. Partner with stakeholders and other resource management entities to develop a complete Water Management Plan							
Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Utilize working group formed for data collection to serve as an advisory committee to the Tehama County Flood Control and Water Conservation District in preparation of the Water Management Plan							

Objective C: Increase citizen capacity for water conservation and storm water pollution prevention

Strategy i. Conduct an educational outreach program throughout the community on residential water use reduction, water-wise landscaping, and waterway pollution prevention							
Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Create a multi-media outreach package; website featuring infographics; curriculum for primarily for middle school and high school teachers on residential and school campus water use, water-wise landscaping and waterway pollution prevention							
c. Create and coordinate an annual event celebrating the region’s natural resources through the arts							
d. Secure drought grant funding to offer free or low-cost residential or business landscape water audits to county residents							

Objective D. Advance water management to ensure the availability of high-quality water for agricultural use							
Strategy i. Update current well monitoring stations for enhanced data collection							
Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Secure funding for installation of additional monitoring wells in Tehama County to augment or replace nearby stations and provide more accurate assessment of effluent quality							
Strategy ii. Seek collaborative opportunities to handle degraded water quality due to agricultural discharge into waterways							
Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Promote Shasta Tehama watershed Education Coalition's collaborative approach to comply with the Irrigated Lands Regulatory Program requirements							
Objective E. Define the range of sustainable ground water levels in the aquifer(s) utilized within the county and implement landscape-level measures to secure groundwater recharge							
Strategy i. Determine existing baseline groundwater levels and assess threats							
Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Identify communities or areas which will approach the risk threshold for well overdraft in the next 5, 10 or 25 years							
b. Confirm recharge areas and prioritize according to projected aquifer overdraft							

Strategy ii. Optimize in-stream base flow in recharge areas with a co-benefit to local and downstream communities surface water supply							
Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Identify landowners and land use practices within identified recharge area(s)							
b. Develop a financial mechanism to incentivize reduced groundwater withdrawals with regional partners and downstream consumers							
c. Secure funding for installation of recharge infrastructure projects and negotiation of landowner contracts							

Objective F. Assess the capacity of current water infrastructure to handle the projected increase in 'flashy' rainfall and recommend adaptation alternatives

Strategy i. Evaluate the design specifications, age, condition, efficiency, and operational capacity of existing County-wide water infrastructure							
Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a.							

Strategy ii. Assess the feasibility and expense of retrofitting, expanding or replacing existing water infrastructure to meet projected future demands and serve the population efficiently							
Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a.							

Strategy iii. Assess the feasibility of expanding or developing water reclamation, treatment and distribution infrastructure in urban centers of Tehama County							
Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Conduct a cost-benefit analysis of investing in water reclamation infrastructure accounting for the future regulation of groundwater use							
b. Identify available funding for such water reclamation as a drought mitigation measure							
c. Identify feasible locations for water reclamation infrastructure							
Strategy iv. Analyze the costs and benefits of supporting greater individual or cooperative water collection and storage capacity							
Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Evaluate rainwater collection, greywater collection and re-use, on site storage and localized storage farms							
Objective G: Form a joint local groundwater management authority by June 30, 2017 as required by the State Water Regional Water Quality Control Board; Groundwater Sustainability Act, September 2014							
Strategy i. Solicit stakeholders (water districts, special districts, public trust interest groups, integrated water management groups, etc.) to coordinate plan development							
a. Develop goals and objectives for the process to arrive at mutually agreed upon outcomes in accordance with state regulations							

Goal II. Conserve, enhance and restore functional forest, oak woodland, rangeland, and riparian ecosystems to safeguard economic viability through ecosystem services optimization: water quality, quantity, and storage, as well as habitat and recreational opportunities.

Objective A. Establish a coordinated forest management body comprised of public and private stakeholders to provide education, incentives, and a platform to align management practices for community benefit

Strategy i. Solicit the support and endorsement of a community forestry guild from the Tehama County Board of Supervisors

Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Identify and recruit forest resource agency personnel, public fire management personnel, and private timber companies as stakeholders in the forestry guild							
b. Develop direct or indirect (branding) financial incentives for membership in the guild							
c. Solicit public investment in forested watershed protection							
d. Conduct analysis to quantify the impact of overstocked forests upon water yield							
e. Develop a set of uniform practice standards recognizing the importance of reducing overstocked ladder fuels and restoring forest diversity on public and privately-held lands, and supporting the perception of frequent, low-intensity fire as a restoration tool for optimizing ecosystem processes, including carbon sequestration							
f. Develop a “forest landowners guide” to best management practices for healthy forest ecosystems and conduct educational outreach to disseminate this information to small-holders							

Objective B. Implement measures to protect oak woodlands from future development, urban encroachment, and land-use changes							
Strategy i. Develop a Tehama County Hardwood Advisory Committee to assist the county with long term conservation plans on oak woodlands							
Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Advance the Oak Woodland Management Plan from voluntary status to countywide ordinance for new residential construction							
b. Partner with resource agencies to implement educational outreach and to secure funding to develop a 'Managing Your Oak Woodland' guide for Tehama County landowners, promoting invasive species reduction, best practices to support oak woodland health, and grazing management							
c. Conduct an assessment of county oak woodland using GIS technology							
d. Establish an oak reforestation and grassland restoration project to result in a net gain of oak trees within the county							
Strategy ii. Support enforcement of county and city (Red Bluff, Corning, Tehama) open space and rangeland designation and zoning							
Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Provide comments on proposed development projects in native oak woodland when solicited by the City of Red Bluff or Tehama County Planning Departments							

b. Ensure that General Plan 2008-2028 amendments reflect the ecological importance of oak woodlands and offer appropriate protection							
c. Promote sound rangeland management practices through collaboration with local and regional cattle associations, the California Rangeland Coalition, and NRCS							
d. Support the establishment of carbon sequestration plots on rangeland to encourage multiple adaptation benefits of enhanced water storage capacity (benefitting plant communities) and reduced greenhouse gas emissions							

Objective C. Maintain or restore healthy riparian corridors to protect water quality and quantity

Strategy i. Survey and assess current county riparian habitat conditions and restoration needs

Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Identify non-native invasive species presence in the County's watersheds and prioritize removal efforts							
b. Identify climatic refugia for endangered and threatened species by mapping migratory corridors and resilient sub-watershed areas							

c. Participate in regional wildlife conservation planning efforts, including development of a reserve network to facilitate adaptation of important species through conservation of refugia or design of migration corridors							
d. Support the multi-agency Battle Creek Restoration Project for the protection of anadromous fish refugia							
Strategy ii. Participate in land use planning and development processes to establish riparian buffer conservation							
Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Ensure that General Plan 2008-2028 amendments reflect the ecological importance of riparian forests and floodplain zones and offer appropriate protection							
b. Provide comments on proposed development projects in or impacting riparian zones when solicited by the City of Red Bluff or Tehama County Planning Departments							

Strategy iii. Support individual, small-scale riparian restoration, enhancement or protection projects							
Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Solicit willing landowners who would like to enhance or restore the natural function of their riparian and floodplain property							
b. Prepare a series of workshops, press releases and website updates highlighting best management practices for climate adaptation of watersheds							
c. Support the development of a streamlined environmental permitting process for riparian restoration projects							

Goal III. Reduce the risk of catastrophic wildfire to safeguard human life, infrastructure, industry, habitat, and ecosystem services in Tehama County

Objective A. Implement community planning and protection efforts

Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Update the Community Wildfire Protection Plan (2006) through funding sought under the Fire Safe Council framework and other sources							
b. Collaborate with CAL FIRE and private timber companies to advance the connectivity of fuel break projects as addressed in the Tehama West and Tehama East Fire Plans							

Objective B. Develop a forest stewardship program to educate private landowners on fire-wise landscape management							
Strategy i. Partner with the Fire Safe Council, CAL FIRE and the forestry guild to develop the program							
Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Identify areas with the greatest need for fire-wise practices and opportunity for fuel break connectivity							
b. Develop a 'Managing Your Forested Land' guide for Tehama County landowners to assist them in making informed forest management decisions on their property.							
c. Create a workshop series targeting small land-holders in forested watersheds, including classes on WUI risks; the benefits of frequent, low-intensity fire; disease and pest management; impacts of drought; and ways to increase soil water holding capacity							
Strategy ii. Participate in land use planning or development processes to promote sound forest management and conservation of forested watersheds							
Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Provide comments on proposed development projects at the WUI areas to ensure defensible space, fuel breaks, and emergency evacuation routes are addressed when solicited by the City of Red Bluff or Tehama County Planning Department							

b. Ensure that the General Plan amendments reflect the increased risks to structures, property and life of development along the Wildlife-Urban Interface, and presents sound zoning to minimize expansion along the boundary							

Goal IV. Establish a long-range framework for strategic planning and implementation of climate adaptation measures in Tehama County

Objective A. Create and sustainably fund a designated Tehama County Climate Coordinator position

Strategy i. Work with County Government to secure a funding stream to support this position at the Resource Conservation District of Tehama County

Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes
a. Educate the Board of Supervisors on the importance of designating funds for a permanent coordinator and the proposed activities to be undertaken							
b. Submit a funding petition to the County CAO during the annual budget cycle							
c. Recruit a Climate Coordinator to serve Tehama County							

Objective B. Identify downstream communities with direct and indirect access to Sacramento River water

Strategy i.

Action	Timing (S/M/L)	Start/Finish	Resources Needed	Responsible Parties	Deliverable	Success Indicator(s)	Outcomes/Notes

Identify downstream communities with direct and indirect access to Sacramento River water							
Educate identified communities on ecosystem processes that occur in Tehama County and the value product received							
a. Quantify ecosystem services for a payment scenario by leveraging state resources locally							

Framework Implementation

There is danger in planning in isolation and the new climate condition poses challenges too big to be ignored or approached by a single entity. The wellbeing of natural and human systems is at risk, and the resources on which we all rely will suffer many changes if resiliency measures are not taken. Tehama County is already experiencing projected outcomes related to climate change. In 2014 alone the county was exposed to a variety of events ranging from wildfire, flooding, and drought. In January the Campbell fire burned 865 acres of the Ishi Wilderness in Lassen National Forest (inciweb.nwcg.gov), extreme drought through the summer months triggered mandated water conservation measures in the City of Corning, and the high volume of rainfall in December inundated the Salt Creek sub-watershed causing widespread flooding in eastern Red Bluff. In the same year the county faced water quality and quantity issues in the Antelope district, complete loss of drinking water in the communities of Paskenta and Lowrey, and significant groundwater elevation loss throughout the county.

The repercussions from such events affect the local economy, social welfare, and ecosystems. Human activity such as land use patterns, infrastructure, ground and surface water consumption, and forest management practices are non-climate based stressors that compound impacts from climate events. This means we have the responsibility to minimize negative impacts wherever possible. The development—and more importantly, implementation—of this resource resiliency framework will ensure that the people, plants, and animals of Tehama County do not face the unknown unprepared or uninformed. This community has the unique advantage of living in an area that is much healthier and more resilient than many statewide. We cannot lose that momentum.

Successful implementation requires short term and long range strategies compatible with local and regional adaptation efforts in various stages of development. This is a vital step ensuring the Framework functions as intended, as a living document. To do so, input from resource management agencies and community stakeholders is necessary to develop a cohesive forest and water resources approach to resiliency throughout Tehama County while allowing for flexibility in the Framework. As new knowledge is gained, goals are achieved and resiliency increases whereby it may be necessary to add, remove or change certain priorities and actions. At the time of writing this plan, the proposed short-term implementation priorities are:

- **Coordinate an engaged stakeholder project partner team**. It is essential to understand current resiliency needs and activities already underway (monitoring, outreach, etc.) to establish climate readiness strategies. This team would peer review the Framework and associated outline of goals, provide recommendations and prioritize strategic implementation action items.
- **Identify funding for initial implementation actions.** This includes applying for grants to increase resiliency collaboration among agencies, to advance resource conservation and climate education outreach programs, and to increase resource monitoring as needed.
- **Identify adaptation opportunities for landowners.** Safeguarding the county's water resources requires an all lands approach. Urban landscapes or those rich in native plant species as well as range, farm, and forest lands are integral in ecosystem processes. This implementation priority includes connecting landowners with cost-share programs that optimize the economic and

ecologic function as well as lessen the impact extreme climate events on various property types. This includes exploring Payments for Ecosystem Services (PES) that would provide additional income for working lands that follow sustainable management practices.

- **Increase educational outreach regarding natural resources and climate-related impacts within Tehama County and downstream communities.** Citizens, the business community, and decision makers play a vital role in safeguarding the legacy of Tehama County, its natural capital. Providing the community with accessible science-based climate information and how ecosystems function would in turn foster a greater awareness in relating these elements to economic and social welfare locally. Likewise, establishing a strong partnership with the downstream communities will ensure that ecosystem services that occur in Tehama County do not go unappreciated at the regional level.

Long-term climate resilience priorities will keep implementation on track in the years to come. To build upon the short-term priorities, proposed long-range priorities are:

- **Sustainable funding supports adaptation activities on an annual basis.** Funding sources include grant, non-grant, and non-conventional sources such as fee for services (PES).

- **Project partners meet bi-annually to report on implementation progress, review lessons learned and develop new Work Plans.** By keeping each partner accountable, implementation remains at the forefront of actions.

- **Community awareness of and actively engaged in increasing climate resiliency.** Continual outreach efforts and education opportunities can lead to stewardship activities at the landscape level whereby existing developments are prepared for and resilient against natural disasters like fires and flooding.

- **Optimize usable water supply by enhancing in-stream base flow and groundwater recharge**. It is imperative project partners are engaged in the Water Management Plan development and formation of the joint groundwater management authority as required by the State Water Regional Water Quality Control Board; Groundwater Sustainability Act, September 2014.

    - This long-range priority also includes climate ready infrastructure to meet projected future demand and serve the population efficiently, forest land use practices geared to stream stabilization, erosion control, and snowpack storage. In addition, increasing citizen capacity for water conservation and storm water pollution prevention will benefit local and downstream communities' water supply as well as various species.

- **Optimize functional forest, oak woodland, rangeland, and riparian ecosystems to safeguard economic viability**. This is based on land use practices that enhance ecosystem services: water quality, quantity, and storage, as well as habitat and recreational opportunities. In doing so, new development would no longer occur in sensitive areas, including riparian areas, critical habitats or the WUI.

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Appendix

California Groundwater Legislation Timeline

January 31, 2015	DWR sets initial priority for groundwater basins based on current basin prioritization programs. (§ 10722.4)
January 1, 2016	DWR adopts regulations on criteria for modifying groundwater basin boundaries. (§ 10722.2 (b).)
April 1, 2016	First reports due from exempt adjudicated basins (§ 10720.8, sub (f).) Annual reporting thereafter.
June 1, 2016	DWR adopts regulations for evaluating groundwater sustainability plans, coordination agreements, and alternatives. (§ 10733.2.)
January 1, 2017	Local agency submission for DWR approval of an alternative to a groundwater sustainability plan if the local agency believes the alternative satisfies the objectives of the Act. (§ 10733.6.)
June 30, 2017	A local agency or collection of local agencies elects to be a sustainability agency for a basin. (§ 10735.2 (a)(1).)
July 1, 2017	If there is an area within a basin that is not within the management area of any groundwater sustainability agency, and the county does not assume responsibility, extractions must be reported to the State Water Resources Control Board ((§55202 (a)(2), 10724 (b).)
January 31, 2020	Groundwater sustainability plans required for medium- and high-priority basins that are in critical overdraft. (§ 10720.7, 10735.2 (a)(2).)
January 31, 2022	Groundwater sustainability plans required for medium- and high-priority basins that are not in critical overdraft. (§ 10720.7, 10735.2(a)(4).)
April 1st following completion of GSP, annually thereafter	Groundwater sustainability agencies required to report to DWR on basin conditions including elevation data, aggregated extractions for prior year, and change in storage. (§ 10728)
20 years after plan adoption	Groundwater management plans achieve the sustainability goal. (§ 10727.2(b).)
Deadlines vary	If no local agency elects to be the groundwater sustainability agency, if a plan is not adopted, or DWR determines that the plan is not adequate or the plan is not being adequately implemented, the State Water Resources Control Board may designate a basin as probationary. (§ 10735.2.)
Deadlines vary	If the deficiencies that led to designation of a basin as probationary are not corrected, the State Water Resources Control Board may adopt an interim plan. (§ 10735.4, 10735.6, 10735.8.)

(California Groundwater Legislation Timeline. Source: California State Association of Counties, October 2014.)

At-A-Glance Agricultural Specific Legislation

FY 2014-15 Budget: New cap-and-trade funded programs:

- Sustainable Communities Strategies: Program to protect farmland
- Emergency drought relief program to increase ag water use efficiency and reduce GHGs

2014 Water-Related Legislation:

- Water bond: $100 million for water conservation, ag and urban
- Groundwater management bills signed by Governor Brown

On-Farm Renewable Energy Legislation:

- SB 489 – Signed by Governor Brown – 2011
- SB 594 – Signed by Governor Brown – 2012

Resources for Farmers to Address Climate Change:

- AB 2174 – Signed by Governor Brown – 2012
- AB 1532 – Signed by Governor Brown – 2012