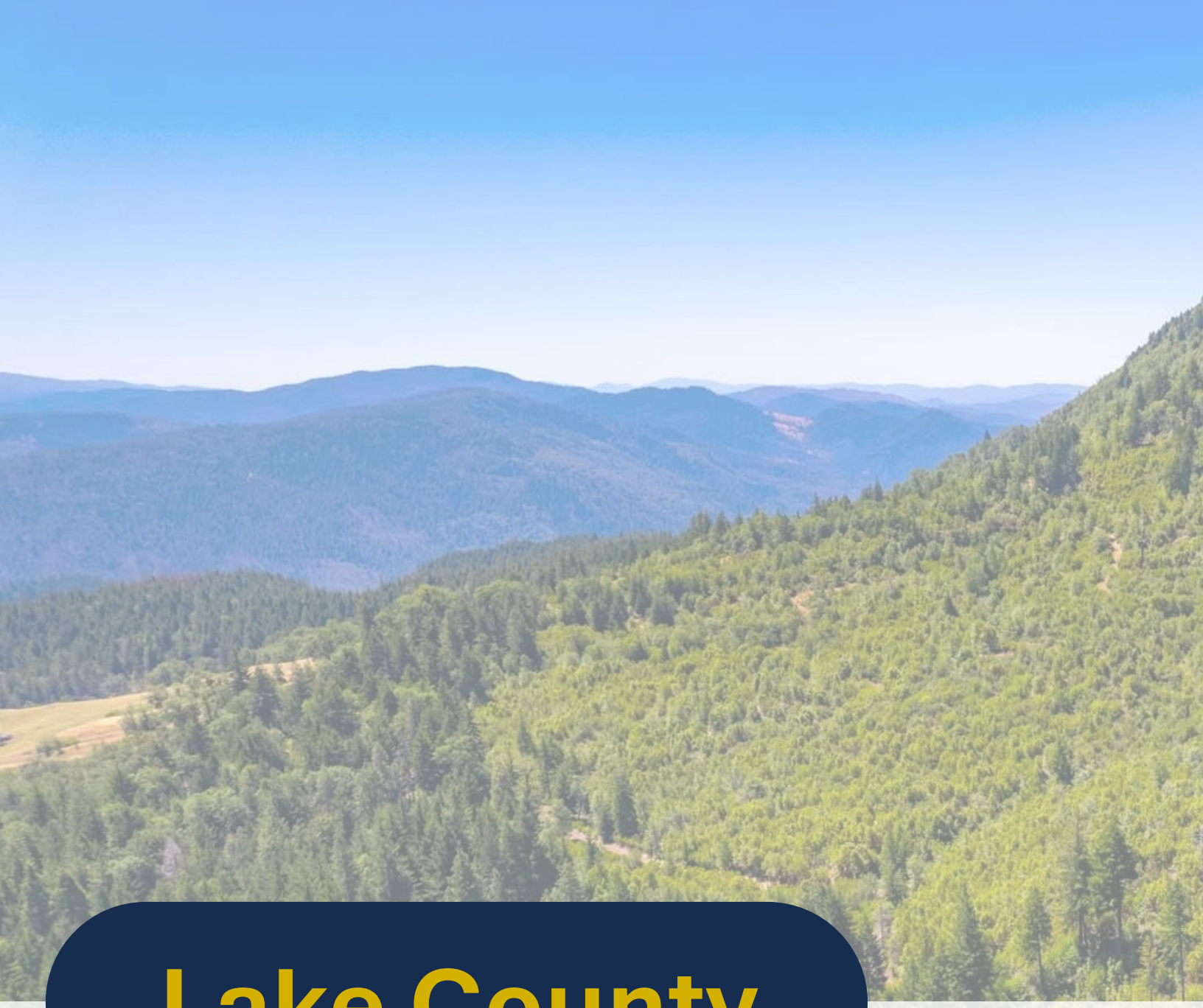


Lake County

Climate Vulnerability Analysis

TABLE OF CONTENTS

TABLES

FIGURES

EXECUTIVE SUMMARY

Lake County's Resilience Journey

Over the past decade, Lake County has faced numerous climate-related challenges that have significantly impacted the local community. Since 2015, devastating wildfires—including the Rocky Fire (2015), Valley Fires (2015), Jerusalem Fire (2015), Clayton Fire (2016), Sulphur Fire (2017), Pawnee Fire (2018), Mendocino Complex Fire (2018), August Complex Fire (2020), LNU Lightning Complex Fires (2020), Cache Fire (2021), Glenhaven Fire (2024), and Boyles Fire (2024)—have burned through approximately 70 percent of the county, causing loss of life and homes, reducing tourism, and harming the local economy.[1] Drought conditions have stressed local water supplies, and severe storms have periodically isolated communities by causing power outages and blocking transportation routes.[2] Flooding of Clear Lake is also an issue, with the lake flooding in both 2017 and 2019. Per the National Flood Insurance Program, flooding on Clear Lake causes Lake County to have the highest number of claims and highest cost of claims in the State of California. These disasters have led to multiple evacuations and property losses, prompting the County, cities of Clearlake and Lakeport, tribal governments, and other stakeholders to collaborate on building a more resilient Lake County.

Definitions

Vulnerability: The degree to which natural, built, and human systems are at risk of exposure to climate change impacts.

Hazard: An event or physical condition that has the potential to cause fatalities, injuries, physical damage, or other types of harm or loss.

Adaptive Capacity: The ability of people and assets to adjust to potential damage from climate change hazards; to take advantage of existing opportunities such as funding, tools, and resources; or to respond to the impacts of climate change.

Impact: The effects (especially the negative effects) of a hazard or other conditions associated with climate change.

Source: California Governor's Office of Emergency Services. 2020. California

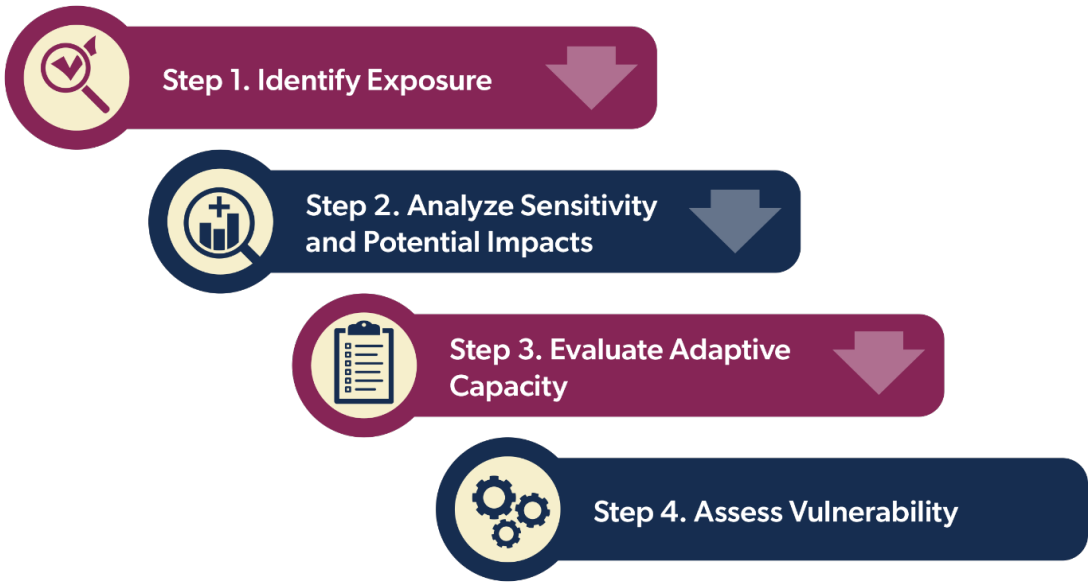
In 2018, Lake County established the Lake County Community Risk Reduction Authority through a joint powers agreement to reduce fire risks, improve community infrastructure, manage funding sources, and develop training tools to enhance resilience. This agreement was updated in 2021 to include the cities of Clearlake and Lakeport, local Tribal Governments, and water districts to foster collaborative resilience planning. In 2022, the County created the Chief Climate Resiliency Officer position to develop a comprehensive local resilience strategy. Through these partnerships, Lake County secured a grant through the California Adaptation Planning Grant Program in 2023 to launch the "Planning for an Equitable Climate-Safe Lake" project, which includes preparation of this Climate Vulnerability Analysis, an evacuation study, and a Climate Adaptation Plan as part of the Lake County 2050 General Plan Update.

Climate Vulnerability Analysis

The Lake County Climate Vulnerability Analysis evaluates how climate change hazards may affect Lake County's community members, built environment, services, infrastructure, and natural systems. Prepared with guidance from the California Adaptation Planning Guide,[3] this analysis follows the four-step process

in **Figure E-1** to evaluate the degree to which people and community assets are susceptible to harm from climate change and associated hazards.

Figure E-1 Vulnerability Analysis Process



The Lake County Climate Vulnerability Analysis examined the vulnerability of 18 different population groups, 19 types of buildings and infrastructure, 7 economic drivers, 6 ecosystems, and 8 key services to 8 climate hazards. The analysis found that wildfire and smoke present the greatest vulnerabilities countywide, followed by severe weather, flooding, and drought. The populations facing the highest climate risks are people of color and immigrant communities, people with high outdoor exposure, households in poverty, persons in tribal communities, and persons with chronic illnesses and/or disabilities. The most vulnerable community assets are energy and communication infrastructure, homes, transportation systems, and the agriculture industry. The findings will inform the development of the countywide Climate Adaptation Plan and the Lake County Health and Safety Element update, helping to safeguard Lake County against current and future climate-related hazards.

Climate Stressors

Climate change is causing shifts in long-term weather patterns that are increasing the frequency and intensity of natural hazards in Lake County. Climate stressors fall into two categories: primary climate stressors and secondary climate stressors. Primary climate stressors are direct effects of rising global temperatures—changes in temperature and precipitation patterns. These primary stressors lead to secondary climate stressors or hazards, which are events or physical conditions that can cause harm to people, property, and natural systems.[4]

Cascading and Compounding Effects

Cascading Effects: When an extreme event causes a series of secondary events that are larger than the initial impact.

Compounding Effects: When multiple hazards or drivers occur simultaneously, amplifying their collective impact.

Source: IPCC. 2019. Extremes, Abrupt Changes and Managing Risk.

The Climate Vulnerability Analysis evaluates the following secondary climate stressors resulting from changing temperatures and precipitation patterns. **Table E-1** describes each of the primary and secondary climate stressors; the past and projected future occurrences of each climate stressor; the impacts of each climate stressor on the built and natural environment; and the impacts of each climate stressor on vulnerable populations.


Agriculture and forestry pests and diseases


Drought


Extreme temperatures


Flooding


Human health hazards


Landslides and debris flow


Severe weather


Wildfire and smoke

Table E-1 Primary and Secondary Climate Stressors

Climate Stressor	Past, Present, Future	Impact on Built and Natural Environment	Impact on Vulnerable Populations
Primary Climate Stressors			
 Changes in Temperature	**Past**: Historical (1961 to 1990) annual average minimum temperature was 37.9°F countywide. The annual average maximum temperature was 67.7°F countywide. **Present and Future**: Annual average minimum temperatures are projected to increase to 40.9°F by 2030, 42.3°F by midcentury (2035 to 2064), and 45.9°F by late century (2070 to 2099). Annual average maximum temperatures are projected to increase to 70.8°F by 2030, 72.4°F by midcentury, and 75.8°F by late century.		
 Changes in Precipitation Patterns	**Past**: Historical annual average precipitation was approximately 42 inches countywide. **Present and Future**: Precipitation is projected to increase to 47 inches by midcentury and 51 inches by late century. Though overall rainfall will increase, it is likely to occur during fewer, intense storm events with longer dry periods between storms.		

Climate Stressor	Past, Present, Future	Impact on Built and Natural Environment	Impact on Vulnerable Populations
Secondary Climate Stressors (Hazards)			
Agriculture and Forestry Pests and Diseases	**Past**: Tree mortality increased from 3,000 dead trees in 2019 to over 1,000,00 by 2024. Sudden oak death was identified in southwestern portions of the county and Mediterranean Oak Borer detected in 2022 in Middletown moving northward into the Mendocino National Forest by 2024 **Present and Future**: Warmer temperatures and changing precipitation patterns will create more favorable conditions for agricultural and forestry pests and diseases.	Agricultural Productivity Decline Habitat Loss Power Delivery Disruption Structure & Property Damage	Income Loss Food & Water Insecurity Mental & Behavioral Health
Drought	**Past**: Significant droughts in 1976–1977, 2014, and 2020–2021. **Present and Future**: More frequent and severe droughts likely, with longer durations and shorter recovery periods. County reached D3 level (Extreme Drought) in 2020 and fluctuated between D3 and D4 (Exceptional Drought) through 2021.	Water Supply/Quality Reduction Agricultural Productivity Decline Habitat Loss	Food & Water Insecurity Income Loss Mental & Behavioral Health Public Health Risks

Climate Stressor	Past, Present, Future	Impact on Built and Natural Environment	Impact on Vulnerable Populations
 Extreme Temperatures	**Past**: Multiple heat events included June 2019 (record-breaking temperatures), July 2021 (100°F+ temperatures), September 2022 (prolonged heat wave), July 2023 (temperatures over 100°F) and July 2024, the hottest month ever recorded in California **Present and Future**: Extreme heat days projected to increase from 4 days annually to 12 days by 2030, 20 days by midcentury, and 42 days by late century. Warm nights projected to increase from 5 to 77 days annually by late century.	 Power Delivery Disruption  Agricultural Productivity Decline  Structure & Property Damage  Emergency Services Strain	 Physical Injury  Public Health Risks  Mental & Behavioral Health
 Flooding	**Past**: • February 1998 (60+ homes flooded, $5 million in damages) • January 2006 (federal disaster declaration) • December 2014 (state of emergency) • February 2017 (forced evacuations, $5 to 7 million in road damage) **Present and Future**: More intense precipitation events likely to cause more frequent and severe flooding, particularly around Clear Lake and along waterways.	 Structure & Property Damage  Transportation Disruption  Water Supply/Quality Reduction  Emergency Services Strain	 Displacement  Income Loss  Access to Services Reduction  Physical Injury

Climate Stressor	Past, Present, Future	Impact on Built and Natural Environment	Impact on Vulnerable Populations
 Human Health Hazards	**Past**: West Nile virus first detected in 2004; COVID-19 pandemic (2020–present) with 13,860 total cases and 192 deaths in Lake County as of February 2024. **Present and Future**: Ongoing concerns with vector-borne diseases and harmful algal blooms in Clear Lake. Warmer temperatures expected to expand ranges and seasons for disease vectors.	 Emergency Services Strain  Water Supply/Quality Reduction  Agricultural Productivity Decline	 Physical Injury  Public Health Risks  Access to Services Reduction
 Landslides and Debris Flows	**Past**: Spring Valley Landslide (Cache Creek Slide) showed considerable movement between 1993 and 1999. Anderson Springs landslide (~4 acres) and Ettawa Springs landslide (~2 acres) discovered during 2017 winter storms. **Present and Future**: More frequent landslides and debris flows likely due to increased wildfire activity followed by intense precipitation events.	 Structure & Property Damage  Transportation Disruption  Power Delivery Disruption  Emergency Services Strain	 Displacement  Physical Injury  Access to Services Reduction  Income Loss

Climate Stressor	Past, Present, Future	Impact on Built and Natural Environment	Impact on Vulnerable Populations
 Severe weather	**Past:** Lake County has received 13 federal disaster declarations for severe winter storms since 1950. Notable events include winter storms in 1986, 1998 El Niño floods, 2005 to 2006 winter storms ($5 million in damages), 2017 winter storms (two separate federal disaster declarations), 2019 atmospheric river events, and 2022 to 2023 winter storms. **Present and Future:** More extreme precipitation events are expected, with increased frequency and intensity of atmospheric rivers. Though damage directly associated with severe weather has historically been limited, secondary hazards like floods, landslides, and power outages will become more significant.	 Structure & Property Damage  Power Delivery Disruption  Transportation Disruption  Emergency Services Strain	 Displacement  Physical Injury  Access to Services Reduction  Mental & Behavioral Health
 Wildfires	**Past**: • 2015 Rocky Fire and Jerusalem Fire (69,438 acres, 43 homes destroyed) • 2015 Valley Fire (76,067 acres, 1,280 homes destroyed, 4 deaths) • 2016 Clayton Fire (3,929 acres, 189 homes destroyed) • 2017 Sulphur Fire (2,200 acres, 138 homes destroyed) • 2018 Pawnee Fire (15,185 acres, 12 homes destroyed) • 2018 Mendocino Complex (459,123 acres, 157 homes destroyed in Lake County) • 2020 August Complex (1,032,648 acres) • 2021 Cache Fire (83 acres, 100+ structures destroyed) • 2024 Boyles Fire (81 acres, 33 structures destroyed)	 Structure & Property Damage  Power Delivery Disruption  Habitat Loss  Emergency Services Strain	 Displacement  Mental & Behavioral Health  Physical Injury  Income Loss

Climate Stressor	Past, Present, Future	Impact on Built and Natural Environment	Impact on Vulnerable Populations
	Present and Future: Annual average acres burned projected to increase by 35 percent by midcentury and 50 percent by late century. More extreme fire behavior expected.	 Transportation Disruption  Water Supply/Quality Reduction	 Public Health Risks  Access to Services Reduction

Sources:

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- U.S. Forest Service. 2022. Aerial Detection Survey: 2022 Summary Report. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd1088611.pdf.
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- U.S. Drought Monitor. 2023. "Time Series–County–Lake County (CA)." https://droughtmonitor.unl.edu/DmData/TimeSeries.aspx.
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- California's Fourth Climate Change Assessment. North Coast Regional Summary Report. 2018. https://www.energy.ca.gov/sites/default/files/2019-11/Reg_Report-SUM-CCCA4-2018-001_NorthCoast_ADA.pdf.
- Lake County General Health Department COVID-19 Dashboard. 2023. https://www.lcghd.org/covid19/.
- California Office of Environmental Health Hazard Assessment. 2024. Vector-Borne Diseases Report. https://oehha.ca.gov/climate-change/epic-2022/impacts-human-health/vector-borne-diseases.

Key Findings

The key findings of the Climate Vulnerability Analysis are the identification of the people and community features that are highly vulnerable to natural and human-made hazards. A population or a community asset in these key findings reflects the severity of climate change impacts and level of harm, but also considers other factors, such as the size of the population, the role that the asset plays in maintaining community-wide well-being, and the potential of the population or asset to be impacted by compounding or cascading effects of interacting hazards.

Wildfire and smoke are responsible for the greatest number of high vulnerabilities countywide, followed by severe weather, flooding, and drought. Countywide, the populations facing the greatest risk from climate change are people of color and immigrant communities, people with high outdoor exposure, households in poverty, persons in tribal communities, and persons with chronic illnesses and/or disabilities. The most vulnerable community assets are energy and communication infrastructure and services, homes, transportation infrastructure, and agriculture as an economic driver. The following paragraphs give additional detail about each identified key finding.

People of Color and Immigrant Communities: These communities face disproportionate impacts from all climate hazards due to historical marginalization, language barriers, and economic constraints.[5] Many work in outdoor occupations directly exposed to extreme heat, wildfire smoke, and agricultural pests. They often live in areas with limited infrastructure and may distrust or lack awareness of government services, making it difficult to access critical resources during emergencies.

People with High Outdoor Exposure: Agricultural, forestry, landscaping, and construction workers face increased health risks from extreme heat, vector-borne diseases, and wildfire smoke due to direct exposure from outdoor occupations. Those experiencing homelessness (approximately 290 individuals countywide) lack adequate shelter from hazards and have limited access to water, sanitation, and healthcare.[6]

Households in Poverty: Approximately 17 percent of unincorporated county residents, 11 percent of Lakeport residents, and 25 percent of Clearlake residents live in poverty.[7] These households typically lack resources to invest in home repairs, weatherization improvements, and disaster preparedness. They often have inadequate insurance coverage, making recovery from disasters particularly challenging. Rising utility costs during drought or extreme heat disproportionately impact their limited budgets.

Persons in Tribal Communities: Tribal communities face significant disruptions to cultural practices and resources from climate hazards. Drought and extreme heat threaten traditional food sources, and wildfires damage culturally significant sites.[8] Water quality issues in Clear Lake, a vital cultural and subsistence resource, disproportionately impact tribal members, and housing insecurity among tribal members limits adaptation options.

Persons with Chronic Illnesses and/or Disabilities: Approximately 21percent of residents in both unincorporated Lake County and Clearlake, and 17 percent in Lakeport, have some type of disability.[9] These individuals face heightened risks during emergencies due to mobility challenges, medical dependencies, and evacuation difficulties. Extreme heat, poor air quality, and vector-borne diseases can exacerbate existing health conditions.

Energy and Communication Infrastructure and Services: These systems are highly vulnerable to flooding, landslides, severe weather, and wildfire, particularly in remote areas with limited redundancy. Damage to power lines or communication towers can disrupt essential services for extended periods. Power outages during extreme heat or winter storms create cascading impacts on other critical systems and vulnerable populations.

Homes: Residential structures throughout the county face multiple hazards, including wildfires, flooding, landslides, and severe weather. Even minor initial damage can lead to mold, mildew, and foundation failures that render homes uninhabitable. Extreme heat and wildfire smoke create dangerous indoor temperature and air quality conditions, particularly for residents without adequate cooling systems or air filtration.

Transportation Infrastructure: Roads, highways, bridges, and transit networks are vulnerable to flooding, landslides, severe weather, and wildfire, especially given the county's challenging geography. Damage to critical routes like SR-20, SR-29, SR-53, and SR-175 can isolate communities, block evacuations, delay emergency response, and disrupt supply chains.[10] Many rural areas depend on single-access roads with few or no alternatives.

Agriculture and Timber Industries: These economic drivers face substantial harm from agricultural pests, drought, extreme temperatures, flooding, severe weather, and wildfire. Climate-related hazards threaten crop yields, timber harvests, and the livelihoods of agricultural workers. The wine grape industry, pear production, and other key crops are particularly sensitive to changing climate conditions.[11]

Forests and Woodland Habitat: These ecosystems are highly vulnerable due to their overlap with high fire severity zones and susceptibility to drought, extreme heat, and pest infestations. Weakened forest and woodland habitats can ignite more easily during wildfires, creating devastating crown fires. Oak woodlands face threats from sudden oak death and high-intensity wildfires that prevent natural regeneration.[12]

Water and Wastewater Treatment, Delivery, and Collection: Water infrastructure is vulnerable to drought, flooding, landslides, and wildfires. Reduced groundwater supply during drought threatens the security of domestic and agricultural water supply. Infrastructure damage can disrupt service delivery and potentially contaminate drinking water. Harmful algal blooms in Clear Lake during drought and extreme heat conditions pose additional water quality challenges.[13]

Other Significant Findings:

- **Older adults** face unique vulnerabilities due to physical limitations, fixed incomes, and social isolation.
- **Persons living in manufactured homes** are particularly vulnerable due to existing financial burdens, resiliency of the home structure, and few adaptive capacity options.
- **Isolated communities** face challenges accessing emergency services and evacuating during disasters.
- **Outdoor recreation and tourism**, which are vital economic drivers, are threatened by multiple climate hazards.

- **Aquatic habitats** face degradation from warming temperatures, altered precipitation patterns, and harmful algal blooms.
- **Emergency services** may be overwhelmed by increasing demand and disruptions during hazard events.
- **Public transit access** can be severely limited during and after climate hazard events, isolating transit-dependent populations.

Pillars of Landscape Resilience

The Lake County Office of Climate Resiliency has developed a resilience framework, the "Pillars of Landscape Resilience," to guide resilience planning efforts that interlink ecology and resilience. This framework recognizes the interdependence of ecological, economic, built, and social systems to address the comprehensive and interdependent climate vulnerabilities identified in this analysis.

These pillars focus on enhancing community capacity, fostering sustainable economic opportunities, and improving ecosystem health—all essential for supporting those most at risk from climate change. The Climate Adaptation Plan will use these findings and the Pillars of Landscape Resilience framework to develop strategies that address Lake County's most significant vulnerabilities while building on existing strengths and opportunities for a more resilient future.

The framework comprises ten pillars:

Air Quality

Biodiversity Conservation

Carbon Sequestration

Economic Diversity

Fire-Adapted Communities

Fire Dynamics

Forest Resilience

Social and Cultural Well-Being

Water Security

Wetland Integrity

INTRODUCTION

Lake County's Resilience Journey

Over the past decade, wildfires, drought, severe storms, and other natural hazards have devastated the Lake County community. In 2015, the Rocky Fire, Jerusalem Fire, and Valley Fires burned through the southern portions of the county; followed by the Clayton Fire in 2016; Sulphur Fire in 2017; Pawnee Fire in 2018; Mendocino Complex Fire in 2018; and most recently, the August Complex Fire and LNU Lightning Complex Fires in 2020. Since 2011, more than 60 percent of the county has burned, contributing to loss of homes, reduction in tourism, and economic harm to those residing in both the county and incorporated cities.[14] Recent drought has also shocked the county due to the reliance on local surface water (Clear Lake) and groundwater sources for domestic, agricultural, and firefighting supply. The rural nature of the county and dispersed water systems have created both water quality and quantity challenges since the 1970s for homes, businesses, agriculture, and sensitive species, like the Clear Lake hitch (*Lavinia exilicauda chi*). Most recently, severe storms have isolated the county from the surrounding region by causing power shutoffs, debris to block roadways, and stormwater to wash out major transportation routes. These disasters have led to multiple evacuations and property loss over the years, leading the County, City of Clearlake, City of Lakeport, tribal governments, and other service providers and land managers to come together to plan for a more resilient Lake County.

Pillars of Landscape Resilience

In 2024, the County of Lake Office of Climate Resiliency adapted the Tahoe-Central Sierra Initiative's Pillars of Landscape Resilience as a framework for resilience that recognizes the interdependence of ecological and social systems. Each of the 10 pillars provides a measurable metric for ecosystem and social resilience. These pillars are:

- Air quality
- Water security
- Wetland integrity
- Biodiversity conservation
- Forest resilience
- Carbon sequestration
- Fire dynamics
- Fire-adapted communities
- Economic diversity
- Social and cultural well-being

In 2018 and 2019, the County of Lake, the Lake County Watershed Protection District, and the county's Fire Protection Districts formed the Lake County Community Risk Reduction Authority through a Joint Powers Agreement. The primary goals of the Community Risk Reduction Authority include:

- Development of resources to reduce fire risks
- Development of community infrastructure improvements
- Management of funding sources to support program implementation
- Development of training tools to improve the resilience of local forests and the overall community.

In 2021, the Lake County Community Risk Reduction Authority (RRA) updated the Joint Powers Agreement to add the cities of Clearlake and Lakeport, local tribal governments, and County water districts to foster a collaborative process for resilience funding and program management. Several community partners support the Risk Reduction Authority. In 2022, the County of Lake received a grant from the California Office of Emergency Services to fund a staff position of Chief Climate Resiliency Officer to focus on the development of a comprehensive local resilience strategy, interlinking ecology and resilience, and working with a broad spectrum of collaborators to identify challenges and capabilities, while making plans to address the gaps between the two.

Lake County Community Risk Reduction Authority Members

- County of Lake
- Lake County Watershed Protection District
- Lakeport Fire Protection District
- Northshore Fire Protection District
- South Lake County Fire Protection District
- Kelseyville Fire Protection District
- Lake County Fire Protection District
- City of Clearlake
- City of Lakeport
- Callayomi County Water District
- Clearlake Oaks County Water District
- Cobb Area County Water District
- Lower Lake County Water District
- Habematolel Pomo of Upper Lake Indians
- Middletown Rancheria of Pomo Indians
- Robinson Rancheria of Pomo Indians
- Scotts Valley Band of Pomo Indians

Through the creation of the Chief Climate Resiliency Officer position, the partnership created by the Lake County Community Risk Reduction Authority Joint Powers Authority, and collaboration with the Lake County Resource Conservation District and Lake County Fire Safe Council, Lake County was able to secure a grant through the Governor's Office of Land Use and Climate Innovation's Adaptation Planning Grant Program in 2023 to launch countywide resilience efforts through the *Planning for an Equitable Climate-Safe Lake (Climate Safe Lake)* project. The work program for the *Climate-Safe Lake* project includes the development of a countywide Climate Vulnerability Analysis, evacuation study, and climate adaptation plan.

Countywide Climate Vulnerability Analysis

The County of Lake, the City of Clearlake, and the City of Lakeport conducted a comprehensive Climate Vulnerability Analysis to evaluate how climate change hazards may harm the community. This Climate Vulnerability Analysis, prepared with guidance from the California Adaptation Planning Guide, analyzes climate vulnerability, which is the degree to which people, nature, the built environment, and other systems are susceptible to harm from climate change and associated hazards. This includes physical and mental injuries, property damage or destruction, environmental harm, economic damage, and other factors.

The Climate Vulnerability Analysis helps community members, County and City staff, special districts, and decision makers understand how climate change hazards may alter community conditions and what parts of the countywide community (people and places) should be prioritized for adaptation and resilience in the Climate Adaptation Plan. The County will use this analysis to make recommendations that will improve resiliency in Lake County in an equitable, integrated, and tailored manner. The findings from the Climate

Vulnerability Analysis will be used to inform the goals, strategies, and actions in the countywide Climate Adaptation Plan and the Lake County General Plan (specifically the Safety Element). This Vulnerability Analysis can also inform future updates to the City of Clearlake and City of Lakeport General Plans, the Community Wildfire Protection Plan, and Lake County Multijurisdictional Local Hazard Mitigation Plan. Integration of the results across multiple countywide and citywide plans will help safeguard Lake County against both current and future hazard conditions, including the changes in hazard events from climate change.

COMMUNITY PROFILE

Lake County is centrally located in the north-central part of California, directly north of the San Francisco Bay Area. It is surrounded by the counties of Glenn, Colusa, Yolo Napa, Sonoma, and Mendocino. Access to the county is primarily provided by State Route (SR-) 29 traveling north from Napa County, SR-175 and SR-20 traveling east from Mendocino County, and SR-20 traveling west from Colusa County. The county covers an area of approximately 1,329 square miles, 73 square miles of which consists of water, most notably Clear Lake, which is the largest natural lake wholly within California. The county is home to a diverse set of ecosystems and habitats due to the diverse topography ranging from Snow Mountain East, a 7,055-foot peak in the Berryessa Snow Mountain Wilderness National Monument, to Cache Creek and Putah Creek that flow into the Sacramento River. Volcanic features, such as the Clear Lake Volcanic Field have shaped the topography into a series of mountains and valleys, forming numerous lakes and forests throughout the landscape.

Tribal Lands in Lake County

Lake County is home to seven federally recognized tribes, which directly descend from the Pomo people that have historically inhabited the Clear Lake area for over 11,800 years. These tribes include Big Valley Band of Pomo Indians, Elem Indian Colony, Habematolel Pomo of Upper Lake, Koi Nation of Northern California, Middletown Rancheria of Pomo Indians, Robinson Rancheria Pomo Indians, and Scotts Valley Band of Pomo Indians. Many of these tribes have developed economic ventures to achieve self-sufficiency and the Lake County Tribal Health consortium provides medical services to both the tribal and non-tribal Lake County community. More information is available online: https://www.lakecountyca.gov/1524/History-of-Lake-County-Pomo-Indians.

The land in Lake County is owned and managed by a mix of federal, tribal, state, nonprofit, local governments, and private individuals and organizations. The U.S. Forest Service owns the largest portion of land through the Mendocino National Forest, and co-managed the Berryessa Snow Mountain National Monument with the Bureau of Land Management. The federal Bureau of Land Management and State of California own and manage several open space areas, such as South Cow Mountain Off-Highway Vehicle Recreation Area, Boggs Mountain Demonstration State Forest, and Clear Lake State Park. While not a government entity, the Lake County Land Trust manages public lands throughout the county, including over six preserves, Monitor Island, and the Rodman Nature Center. Locally, Lake County, the City of Clearlake, and the City of Lakeport own and manage land in the unincorporated and incorporated areas of the county. The following sections provide community profiles of each of these three local jurisdictions.

Clear Lake

Clear Lake is the largest natural freshwater lake entirely in California, covering approximately 68 square miles. It is also one of the oldest lakes in North America, estimated to be around 2.5 million years old. This unique geologic and ecologic setting supports diverse wildlife, including large populations of endemic fish, such as the Clear Lake hitch (*Lavinia exilicauda chi*). The lake's shallow waters promote rich plant life, which in turn sustains various species of birds and other wildlife. The Clear Lake watershed also includes wetlands that filter sediments and nutrients, thus enhancing water quality and supporting biodiversity.

Clear Lake is a cornerstone of the local economy, particularly through tourism. The lake attracts thousands of visitors annually for activities such as fishing, boating, swimming, and hiking. In peak seasons, especially during summer fishing events, the influx of tourists significantly boosts local businesses in hospitality and retail, as well as agritourism activities in the surrounding areas. Clear Lake also provides much of the county with drinking water, including the City of Lakeport, City of Clearlake, and several unincorporated communities along the shoreline of the lake.

Unincorporated Lake County

The unincorporated areas of Lake County are scattered throughout the county. The unincorporated county is connected by SR-20, SR-53, SR-29, SR-175, and SR-281, with other major roads such as Butts Canyon Road, Morgan Valley Road, and Scotts Valley Road connecting the more rural areas of the unincorporated county. Transit service is limited in the county, with Lake Transit providing bus service around Clear Lake and between unincorporated communities in southern Lake County.

Land uses in the unincorporated county are rural in nature but vary widely from agricultural lands outside of communities; to parks and open spaces surrounding Clear Lake, Lake Pillsbury, and Indian Valley Reservoir; to residential and commercial areas in communities such as Cobb, Lucerne, and North Lakeport. The agricultural land uses support the thriving agriculture economy, with major crops including wine grapes and pears, cannabis, livestock such as poultry, and timber.[15] The parks and open space areas provide a foundation for a robust outdoor recreation and tourism economic sector, especially in the summer months. Visitors travel to the county to participate in water recreation activities on Clear Lake, hiking and bicycling on the nearby State and federal lands, and camping at the dozens of tent and recreation vehicle campsites across the county. Agricultural lands and the geothermal areas of southern Lake County also support agritourism and resort activities. The commercial and residential areas of the unincorporated county host local businesses and services for both residents and visitors.

The socioeconomic and demographic profile of Lake County presents a diverse population with unique social and economic characteristics. According to the 2022 American Community Survey, unincorporated Lake County is home to 46,398 people with a median age of 44 years and a median household income of approximately $56,260.[16] The population includes a significant proportion of older adults, who make up 25 percent of the community, while children under the age of 18 account for 21 percent. Despite the thriving agriculture and tourism economy, the unincorporated county faces notable challenges, including a poverty rate of 17 percent and 21 percent of the population living with a disability. Transportation and

connectivity issues are also prominent, with 9 percent of residents lacking access to a vehicle and 19 percent of households without internet access. Housing insecurity is also evident, with 290 individuals experiencing homelessness and 26 percent of households living in rental accommodations.

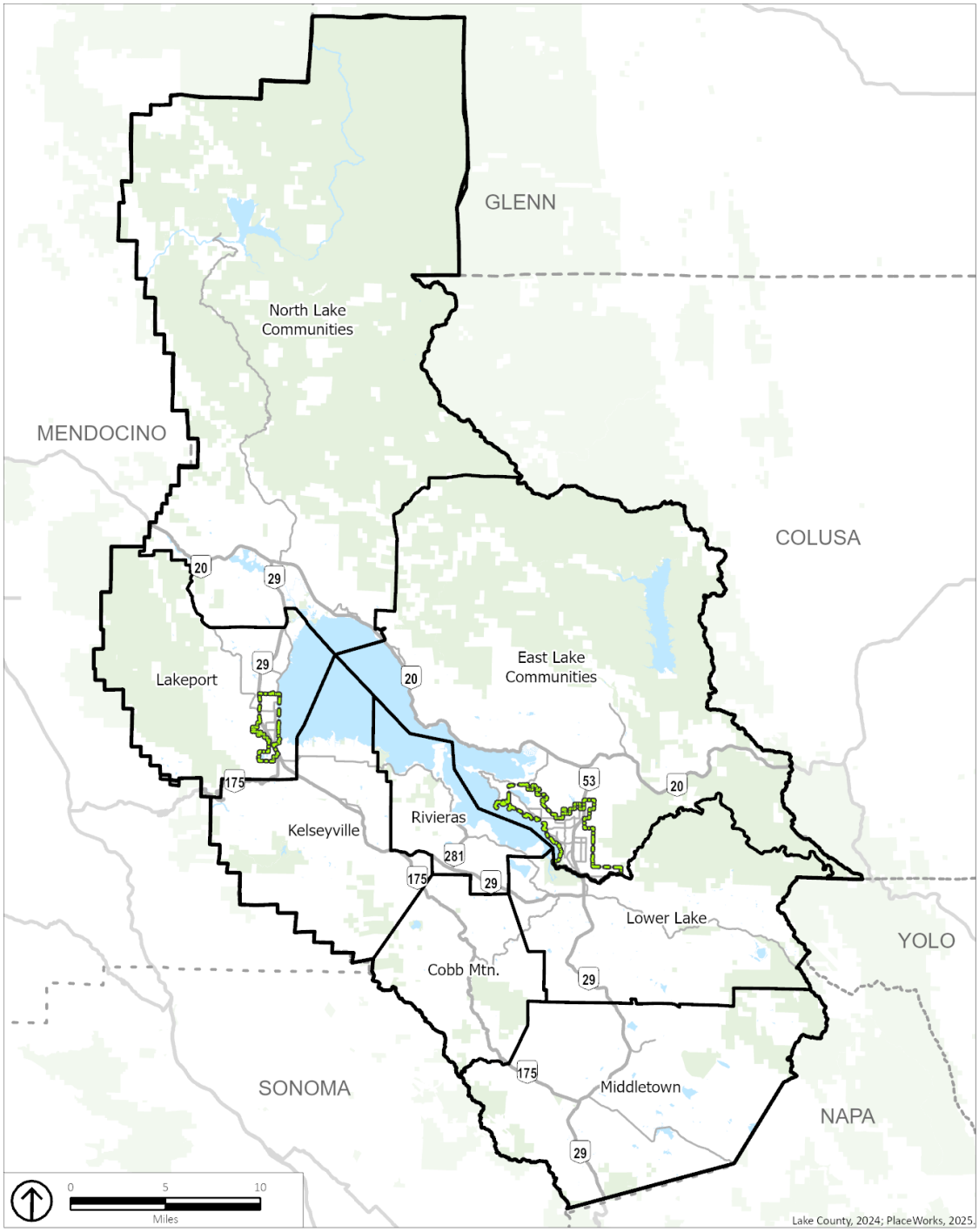
As shown in **Figure 1**, the County divides up the unincorporated areas into eight planning areas:

- **Cobb Mountain Area.** The Cobb Mountain Area encompasses 47,388 acres within the mountainous territory in southwestern Lake County, with vehicle access to the area provided by SR-175. The unincorporated communities of Cobb, Loch Lomond, and Pine Grove are the primary population centers, hosting various mountain resorts, hot springs, geothermal steam fields, and Cobb Mountain.
- **Kelseyville Area.** The Kelseyville Area covers 48,192 acres in western Lake County, with vehicle access provided by SR-29 and Soda Bay Road. The unincorporated communities of Finley and Kelseyville are the primary population centers, providing housing and commercial areas that support the rural agricultural lands. The area is known for producing walnuts and wine grape agricultural products. The Kelseyville community is home to numerous retail shops and is near Clear Lake State Park, which includes a visitor's center, camping, boating, hiking, and swimming facilities.
- **Lakeport Area.** The Lakeport Area covers 52,472 acres of land stretching from the city limits of Lakeport to the Mendocino County line. SR-29, SR-175, and Scotts Valley Road provide vehicle access to the area. This area is home to the County seat in the City of Lakeport, as well as the unincorporated community of North Lakeport. North Lakeport consists of primarily residential subdivisions, several mobile home parks, and scattered commercial development. Sutter Lakeside Hospital, along with several medical offices provide medical services to the countywide community.
- **Lower Lake Area.** The Lower Lake Area is in the southeastern portion of Lake County, covering 77,162 acres of land. SR-29, SR-53, and Morgan Valley Road provide vehicle access to the area. The unincorporated communities of Lower Lake and Seigler Springs are the primary population centers, hosting some of the County's prime historic structures, residences, resorts, and the Anderson State Historic Park, providing thousands of acres of open space.
- **Middletown Area.** The Middletown Area is in the southernmost portion of Lake County, covering 94,175 acres of land with vehicle access provided by SR-29, SR-175, and Butts Canyon Road. The primary population center is the unincorporated community of Middletown. Other unincorporated communities in this area include Anderson Springs, a set of hot springs and a resort; Hidden Valley, a residential and recreation area adjacent to Hidden Valey Lake; Harbin Springs, a set of three springs turned into a resort in the late 1800s; and Whispering Pines, a family resort. This area is also home to livestock ranches, vineyards, and the Geysers Geothermal Field.

- **Rivieras Area.**[1] The Rivieras Area is along the western shores of Clear Lake, covering 26,390 acres of land. SR-29, SR-281, Soda Bay Road, and Point Lakeview Road provide vehicle access to the area. This local planning area primarily supports residential and scattered commercial uses, as well as recreation such as boating, fishing, picnicking, and swimming associated with Clear Lake. Unincorporated communities in the Rivieras Area include Buckingham, Clearlake Riviera, Riviera Heights, Riviera West, and Soda Bay.
- **East Lake Communities Area.** The East Lake Communities Area covers 201,300 acres of land in the north and eastern portions of the county. SR-20 and SR-53 provide primary vehicle access to the area, including the City of Clearlake. Unincorporated communities in this area include Clearlake Oaks, Double Eagle Ranch, Glenhaven, Kono Tayee, Lucerne, Paradise Valley, and Spring Valley. Many of these communities support housing in the unincorporated county, as well as lodging and retail for tourism and county parks and campgrounds for outdoor recreation.
- **North Lake Communities Area.** The North Lake Communities Area is the largest planning area, covering 302,792 acres of land, much of which is in the Mendocino National Forest. SR-20 and SR-29 provide primary vehicle access to the area. Unincorporated communities in this area include Blue Lakes, Lake Pillsbury Ranch, Nice, Saratoga Springs, and Upper Lake. Many of these communities consist of resorts, campgrounds, and lodges due to natural springs and the formation of Scott Dam in northern Lake County. The unincorporated communities of Nice and Upper Lake are the main population centers, providing homes, retail and commercial areas, and parks for both residents and visitors.

[1] Although the Rivieras Area shares a ZIP code and supervisorial district with Kelseyville, the Lake County 2050 General Plan identifies it as a separate planning area to reflect its distinct identity and development characteristics.

Figure 1 Lake County Area Plan Boundaries



City of Clearlake

The City of Clearlake is a community of approximately 16,500 people along the southeastern shore of Clear Lake bordered by the unincorporated communities of Clearlake Oaks to the north, Lower Lake to the south, and rural unincorporated Lake County to the east. SR-53 provides vehicle access through the city, connecting the agricultural lands in southern Clearlake with residential areas in the center of the city, and agricultural and low-density residential areas in the northern portion of the city. Lake Transit Authority operates four routes through the city, connecting education centers, healthcare facilities, government offices, and retail centers. The lakeshore areas of the city consist primarily of homes, lodging, and parks, such as Redbud Park and Austin Park. The northwestern portion of the city contains Borax Lake, which is a National Historic Landmark. Other important ecosystems in the city include aquatic and wetland habitats along the Clear Lake lakeshore, riparian areas along Cache Creek, forested areas covered in oak-madrone forests and chaparral, and grasslands and shrublands scattered throughout the city.

Borax Lake

Borax Lake is a National Historic Landmark and is thought to be home to one of the first major lakeshore dwelling communities in North America, with artifacts found dating back to 12,000 years ago. During the California Gold Rush, the California Borax Company harvested borax from the lake to help in the gold extraction process in the region.

Clearlake has a diverse economy centered on outdoor recreation and tourism, but supported by education, healthcare, and government services. The tourism and recreation industry is driven primarily by the proximity of Clear Lake, which draws visitors for fishing, boating, and water sports. This supports the large retail establishments such as Safeway and Ray's Food Place, as well as recreational vehicle (RV) parks and other lodging near the lakeshore. Healthcare and social assistance through the St. Helena Hospital, Lake County Tribal Health Consortium facility, and the Veteran's Clinic are the largest economic industries in the city, which also provide essential services to the community. Yuba College provides both employment opportunities and workforce development for residents in the area.

Although a vibrant recreation and tourism destination, Clearlake faces many socioeconomic challenges. According to the 2022 American Community Survey, the city has a median household income of $41,047, which is less than the surrounding unincorporated county, and an unemployment rate of 8 percent, which is 3 percent higher than the county's unemployment rate. Over 24 percent of people in Clearlake are in poverty, which is much higher than the rest of Lake County. The median age in Clearlake is 39 years old, indicating a younger population, although 21 percent of the population identifies as having at least one disability. However, due to the more urban nature of the city compared to the rest of the county, only 11 percent of the population does not have access to internet, compared to 19 percent of the county's population.

City of Lakeport

The City of Lakeport, the county seat of Lake County, is a small community of approximately 5,000 people along the western shore of Clear Lake. The city is bounded by unincorporated North Lakeport to the north, Clear Lake to the east, unincorporated Finley to the south, and agricultural lands and Scotts Creek to the west. SR-29 and SR-175 provide vehicle access to the city, and Lake Transit Authority provides transit via four routes that connect residents to other areas of the county, as well as Ukiah in Mendocino County.

Lakeport features a mix of residential, commercial, agricultural, recreational, and public land uses that reflect its rural and community-centered nature. Residential areas, mainly consisting of single-family homes, dominate the city, with lakefront properties offering access to Clear Lake. The central commercial district, located along Main Street, includes local shops and services, while larger businesses are found along SR-29. Lakeport is also rich in biological resources, with Clear Lake hosting abundant fish species and surrounding areas featuring diverse ecosystems, such as wetlands, oak savannah woodlands, chaparral, conifer and deciduous forests, grasslands, oak woodland, and riparian areas.

Lakeport supports approximately 45 percent of all jobs in Lake County, with most Lake County government offices located in the city. Agriculture and viticulture are key components of the local economy, with extensive vineyards alongside diverse crops such as grapes, fruits, nuts, and livestock, all integral to the community. Healthcare is also a major contributor to the local economy, with facilities like Sutter Lakeside Hospital and Lake County Tribal Health Consortium providing employment and essential services. The commercial base is spread throughout multiple shopping centers, small nodes, and standalone businesses, with six main business centers, including the historic downtown area. Tourism is vital due to the city's location on Clear Lake, attracting visitors for outdoor activities like boating and fishing.

According to the 2022 American Community Survey, Lakeport has a median household income of $61,100, which is higher than that of the surrounding unincorporated areas of Lake County and the City of Clearlake. The city's unemployment rate is 2 percent, which is 4 percent lower than the county's unemployment rate. Approximately 11 percent of Lakeport residents live in poverty, significantly lower than the rest of Lake County. The median age in Lakeport is 43, indicating a relatively younger population compared to the surrounding unincorporated areas of Lake County. About 17 percent of the population reports having at least one disability, which is also lower than the county average. Due to its more urban nature, only 10 percent of Lakeport's population lacks internet access, compared to 19 percent in the rest of Lake County.

CLIMATE HAZARDS

Climate change is the long-term shift in average weather patterns, including significant alterations in temperature and precipitation patterns over an extended period, typically decades or longer. Rising global temperatures continue to cause more frequent and intense heatwaves, storms, floods, droughts, wildfires, and other hazards. These events are frequently concurrent, resulting in cascading hazards and compounding impacts that are progressively more difficult to manage, such as droughts amplifying wildfire risk or extreme heat exacerbating water scarcity. This section lays out the primary and secondary climate stressors affected by climate change in the unincorporated areas of Lake County and the cities of Clearlake and Lakeport, and how these stressors are expected to change in the coming years and decades.

Cascading and Compounding Effects

Cascading Effects: When an extreme event causes a series of secondary events that are larger than the initial impact.

Compounding Effects: When multiple hazards or drivers occur simultaneously, amplifying their collective impact.

Source: IPCC. 2019. Extremes, Abrupt Changes and Managing Risk.

Climate Stressors

Climate stressors are a condition or trend related to climate variability and change—such as decreased precipitation or warmer temperatures—that can exacerbate natural hazards.[17] Climate stressors fall into two categories: primary climate stressors and secondary climate stressors. Primary climate stressors result in secondary climate stressors, or hazards, which are events or physical conditions that have the potential to cause harm. This harm may include fatalities, injuries, property damage, infrastructure damage, agricultural losses, damage to the environment, and interruption of business, among other types of harm or loss.

In unincorporated Lake County, Clearlake, and Lakeport, the two primary climate stressors are (1) air temperature changes and (2) precipitation pattern changes. These stressors are direct effects of a rise in global temperatures due to increases in greenhouse gas emission levels in the atmosphere. This Climate Vulnerability Analysis evaluates the following secondary climate stressors, or hazards, resulting from changing temperatures and precipitation patterns:

- Agriculture and forestry pests and diseases
- Drought
- Extreme temperatures
- Human health hazards
- Flooding
- Landslides and debris flow
- Severe weather
- Wildfire and smoke

Other hazards, such as earthquakes, are not included in this analysis because they are geophysical in nature and not directly influenced by changing climatic conditions. This report focuses exclusively on climate-driven hazards resulting from temperature and precipitation changes.

Primary Climate Stressors

Changes in Temperature

Projected air temperature changes in Lake County show a substantial rise compared to historical levels as global temperatures continue to increase. Historically, Lake County's countywide annual average minimum temperature was 37.9 degrees Fahrenheit. Projections show an increase of 3 degrees in the near term, 4.4 degrees by midcentury, and 8 degrees by late century.[18] Projections show a similar upward trend in the countywide maximum temperature, with a historical annual average maximum temperature of 67.7 degrees Fahrenheit projected to increase 3.1 degrees in the near term, 4.7 degrees by midcentury, and 8.1 degrees by late century.[19] **Table 1** shows the annual average minimum temperature change in the county and two cities, and **Table 2** shows the annual average maximum temperature change. Note that these projections are averages and do not illustrate extreme heat days.

Table 1 Historical and Projected Annual Average Minimum Temperature

Locations	Observed (1961–1990)	Near Term (2025–2035)	Midcentury (2035–2064)	Late Century (2070–2099)
Countywide	37.9	40.9	42.3	45.9
Clearlake	40.5	43.4	44.8	48.5
Lakeport	41.2	44.0	45.5	49.1

Source: Cal-Adapt. 2024. Annual Averages.
Note: Projections are an average of the four State-recommended climate models (HadGEM2-ES, CNRM-CM5, CanESM2, MIROC5), averaged for near term (2025-2035), midcentury (2035-2064), and late century (2070-2099).

Table 2 Historical and Projected Annual Average Maximum Temperature

Locations	Observed (1961–1990)	Near Term (2025–2035)	Midcentury (2035–2064)	Late Century (2070–2099)
Countywide	67.7	70.8	72.4	75.8
Clearlake	71.0	74.1	75.7	79.1
Lakeport	71.5	74.5	76.0	79.4

Source: Cal-Adapt. 2024. Annual Averages.
Note: Projections are an average of the four State-recommended climate models (HadGEM2-ES, CNRM-CM5, CanESM2, MIROC5), averaged for near term (2025-2035), midcentury (2035-2064), and late-century (2070-2099).

Figure 2 and **Figure 3** show the projected annual average maximum temperatures for midcentury and late century, respectively. As shown in **Figure 2,** average annual maximum temperatures in most of the county are likely to reach 70 degrees, with the highest temperatures exceeding 75 degrees in the Lakeport, Kelseyville, Middletown, Lower Lake, and East Lake Communities Areas. As shown in **Figure 3**, average annual maximum temperatures in most of the county are likely to reach 75 degrees, with the highest temperatures exceeding 80 degrees in the Lakeport, Kelseyville, Middletown, Lower Lake, and East Lake Communities Areas. This increase in annual average maximum temperature will worsen hazards throughout the county, such as agricultural pests and diseases, extreme heat, human health hazards, and wildfire.

Figure 2 Projected Annual Average High Temperatures (Midcentury)

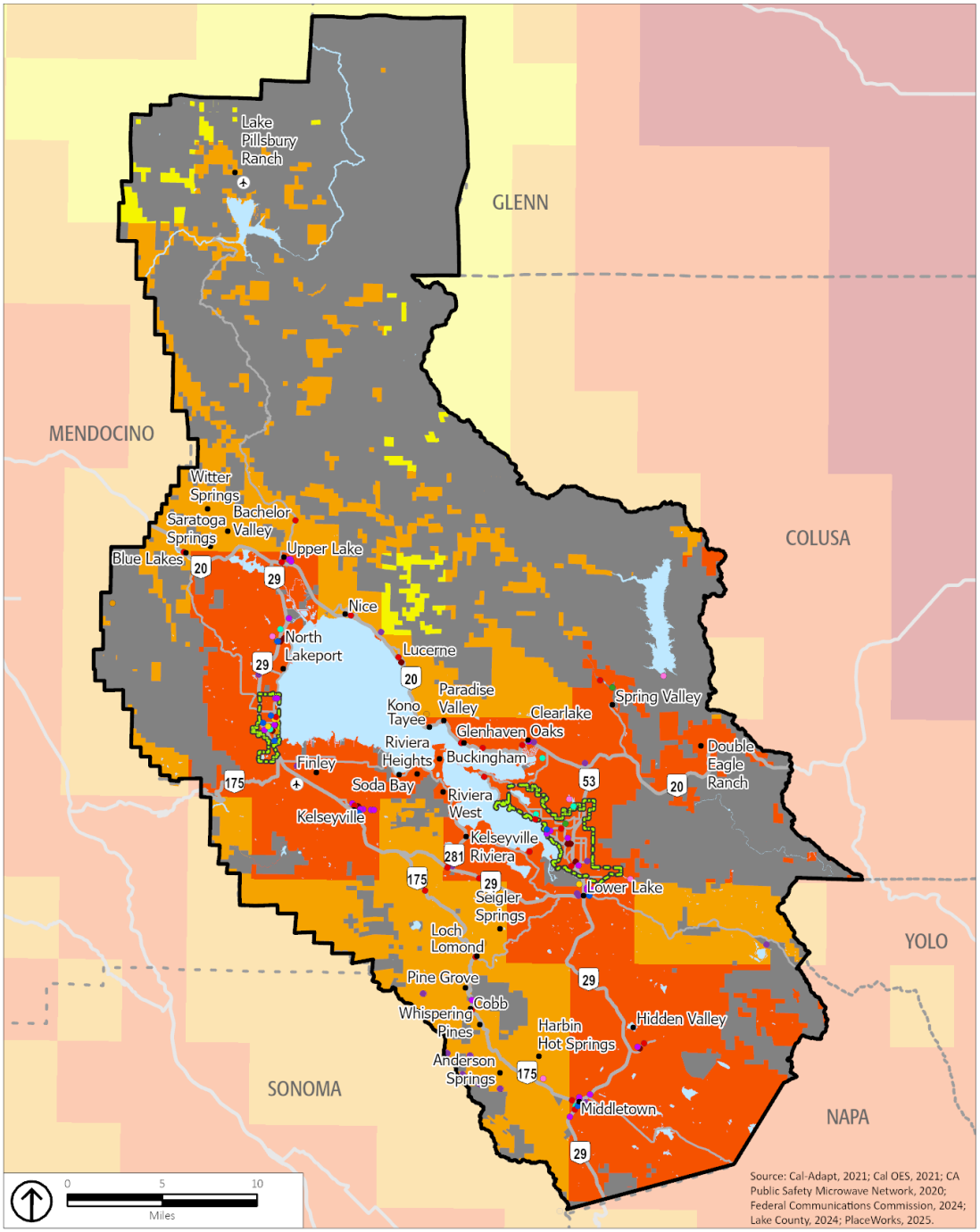
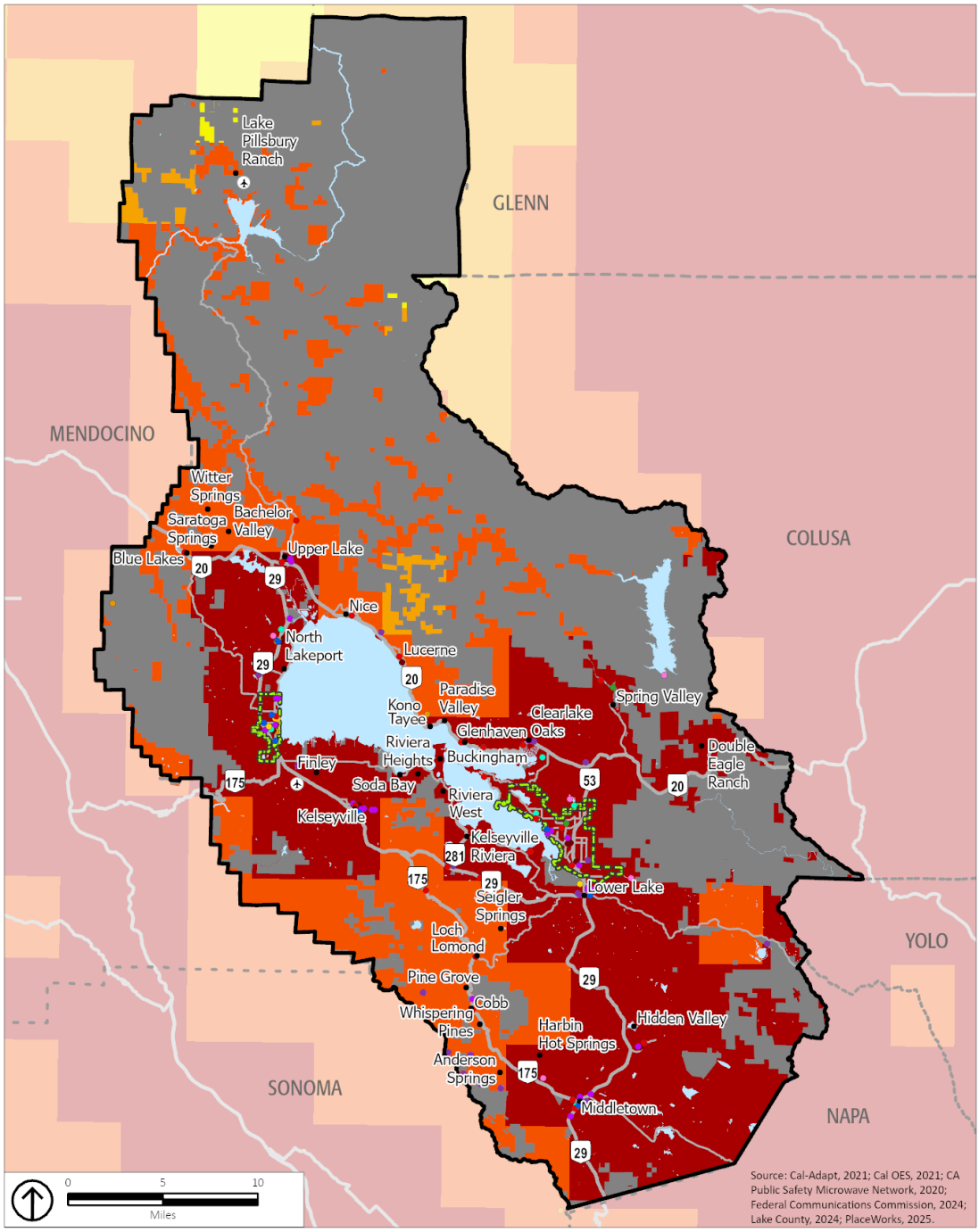


Figure 3 Projected Annual Average High Temperatures (Late Century)



Changes in Precipitation Patterns

Countywide historic annual average precipitation from 1961 to 1990 was approximately 42 inches per year.[20] **Table 3** shows the expected annual average precipitation change countywide and in the cities of Clearlake and Lakeport. Although there will be a slight increase in rainfall throughout the twenty-first century, the seasonality may change (i.e., timing during a given year). There will likely be more rain during periods of precipitation (e.g., storms with higher rainfall totals), fewer total days with precipitation, and an increase in year-to-year variability. This means that more rain may fall during fewer storms throughout the year.

Figure 4 and **Figure 5** show the projected precipitation levels for midcentury and late century, respectively. These figures align with **Table 3**, showing an increase in average annual precipitation in most of the areas immediately surrounding Clear Lake, with larger increases in annual average precipitation in the southern and northern portions of the county reaching at least 45 inches per year. Changes in precipitation patterns can directly and indirectly cause or worsen hazards in both the unincorporated areas of Lake County and incorporated cities, such as drought, flooding, landslides, severe weather, and wildfire.

Table 3 Historical and Projected Annual Average Precipitation (inches per year)

Locations	Observed (1961–1990)	Near Term (2025–2035)	Midcentury (2035–2064)	Late Century (2070–2099)
Countywide	41.9	47.5	46.8	51.3
Clearlake	33.2	38.3	37.9	41.9
Lakeport	30.7	34.8	34.1	37.3

Source: Cal-Adapt. 2024. Annual Averages.

Note: Projections are an average of the four State-recommended climate models (HadGEM2-ES, CNRM-CM5, CanESM2, MIROC5), averaged for near term (2025-2035), midcentury (2035-2064), and late century (2070-2099).

Figure 4 Project Precipitation Levels (Midcentury)

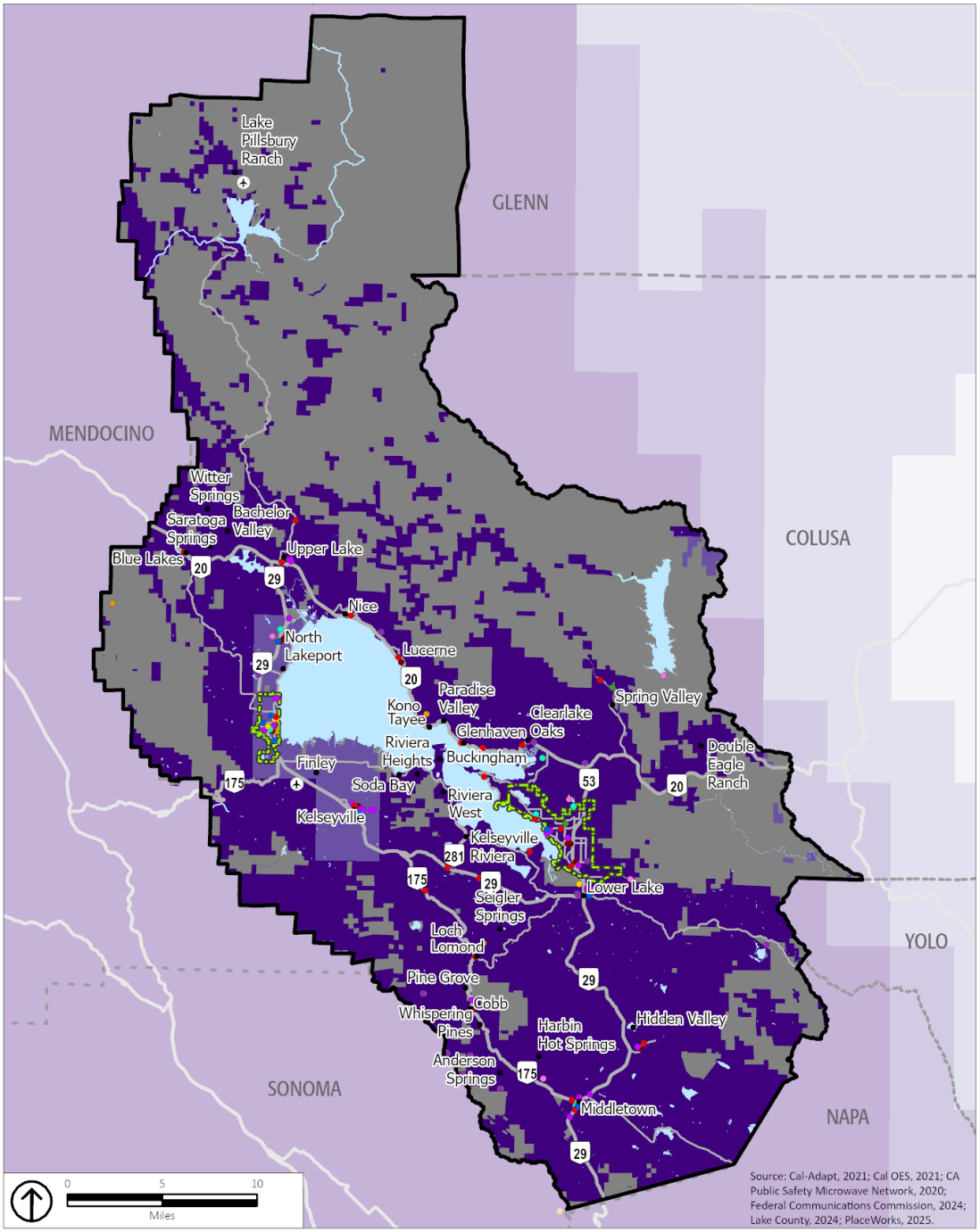
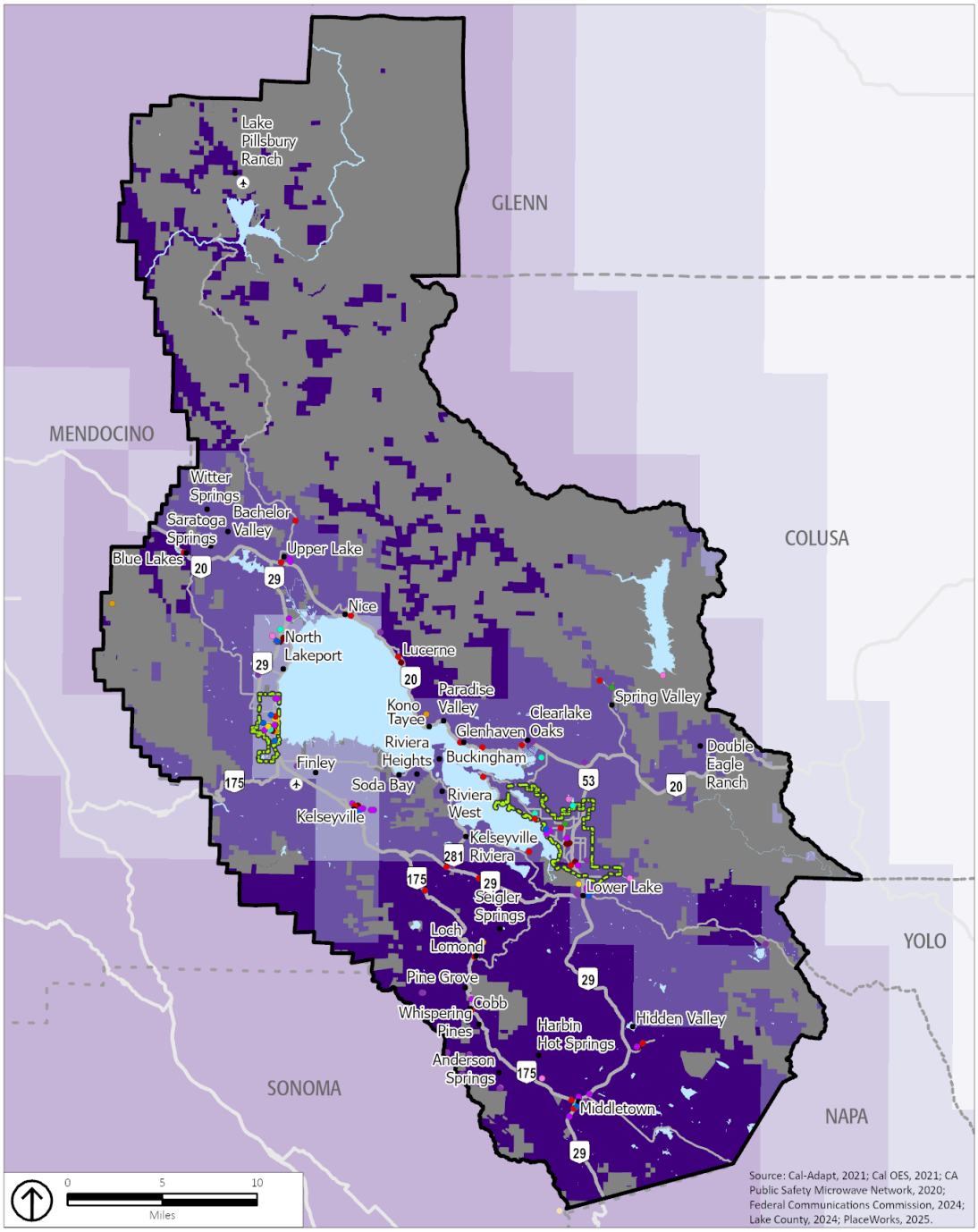


Figure 5 Project Precipitation Levels (Late Century)



Secondary Climate Stressors

Agriculture and Forestry Pests and Diseases

Agricultural and forestry pests and diseases are plant and animal species that can harm Lake County's natural environment and agricultural areas. They pose significant challenges countywide, affecting not just outdoor workers but also the health and productivity of agricultural areas. Climate change is expected to worsen pests and diseases by increasing the abundance and range of both native and non-native pests. Invasive plant species threaten local ecosystems by outcompeting native flora, disrupting habitats, and reducing biodiversity. They also harm agriculture by degrading soil quality and competing with crops. Forestry pests and diseases, such as bark beetles, ambrosia beetles, Sudden Oak Death, and other insect species, can severely damage tree populations, leading to large-scale forest die-offs, which in turn affect wildlife habitat, carbon sequestration, and water availability.

Agriculture Stakeholders

The County hosted an agriculture stakeholder meeting on December 19, 2024, to discuss Lake County 2050, the County's General Plan Update. Community members listed drought and groundwater resources as the largest climate hazard and least prepared to address, followed by wildfire and smoke, flooding, and agricultural pests and diseases. Other major concerns included farmworker exposure to wildfire smoke, high water use crops and lack of sustainable supply, and evacuation of livestock in an emergency.

On May 3, 2022, the County proclaimed a Local State of Emergency due to pervasive tree mortality after extreme drought, groundwater depletion, and multispecies bark beetle infestation across the county.[21] Lake County is also currently listed as a Sudden Oak Death quarantine location due to occurrences in the southwest portion of the county. Additionally, the Mediterranean Oak Borer (*Xyleborus monographus*) is an ambrosia beetle that moved into Lake County from Napa County and has been detected in Middletown, Cobb, and the South Lakeport area. The Mediterranean Oak Borer targets oak trees, primarily valley oaks and blue oaks.

As a result, the County is required to conduct monthly inspections at nurseries that ship plants out of the county.[22] According to the Lake County Department of Agriculture, several insect pests were detected countywide in 2022. These pests include the Mediterranean Fruit Fly, Asian Citrus Psyllid, European Grapevine Moth, Glassy-winged Sharpshooter, Japanese Beetle, Melon Fruit Fly, Oriental Fruit Fly, Spongy Moth, and Vine Mealybug.[23] The European Grapevine Moth and Glassy-winged Sharpshooter pose particular risks to wine grapes, one of Lake County's top crops, by damaging vines and spreading diseases such as Pierce's disease, which can severely limit grape yields and quality.

Warmer temperatures and shifting precipitation patterns caused by climate change can weaken crops, forests, and livestock, making them more susceptible to infestations and infections. Climate change also creates favorable conditions for invasive species to establish themselves because extreme weather events disrupt native communities. Weakened trees in forests provide ideal conditions for pests to spread, reducing forest health and resilience to other hazards. In aquatic environments, rising temperatures and drought conditions decrease dissolved oxygen levels, causing harmful algal blooms and allowing invasive species to thrive, complicating management efforts.

The economic consequences of crop losses and increased pest control efforts triggered by elevated pest activity can increase food costs because smaller crop yields lead to a smaller supply and higher prices, and the additional costs of pest management are often passed on to community members. Increased pesticide use can contaminate soil and water, harm non-target species such as pollinators, and disrupt natural predator-prey relationships, resulting in lasting damage to the natural environment.[24] Runoff from pesticide applications can flow into nearby water bodies, including Clear Lake, where it may contribute to water quality degradation and pose risks to aquatic ecosystems and drinking water sources. Additionally, exposure to pesticides can pose health risks to agricultural and outdoor workers, particularly if safety protocols are not followed, leading to acute or chronic health effects. These changes can degrade crucial ecosystem services like pollination, water purification, and soil stabilization, which are essential for agriculture and biodiversity. Such damage diminishes the unique natural character of the county and lands surrounding Clearlake and Lakeport and can negatively impact the local economy and overall quality of life.

Drought

A drought is where conditions are drier than normal for an extended period, making less water available for people and ecosystems. While drought is a normal occurrence in California, prolonged drought conditions can harm ecosystems, people, and the regional economy. Drought can lead to critical environmental and economic harm, including crop loss, increased water costs, habitat degradation, and heightened wildfire risks. Increasing water demands, such as population growth and increased use of irrigation for agriculture and landscaped areas, exacerbate these impacts, potentially leading to restrictions and quality issues.

Water and wastewater services in Lake County are managed by a combination of over 80 public and private entities, each responsible for specific geographic areas and functions ranging from communitywide systems to small resort-only systems. Lake County, Lakeport, and Clearlake primarily rely on local surface water and groundwater sources, including Clear Lake and local rivers and streams. Approximately 60 percent of residents countywide depend on Clear Lake as their source of drinking water.[25] The county also relies on groundwater primarily to support agricultural water supplies, which are vital for sustaining local farming operations. Groundwater is one of Lake County's greatest natural resources. In an

Drought Impacts to Clear Lake

Clear Lake faced significant impacts from recent drought conditions, which caused harmful algal blooms that threatened wildlife and recreational activities. These blooms, exacerbated by higher temperatures and concentrated nutrients such as phosphorus due to lower water levels, have contributed to declining water quality and eutrophication. The native Clear Lake hitch (*Lavinia exilicauda chi*) fish species has been particularly affected, as insufficient water flow in creeks hinders their spawning and rearing processes, threatening their survival. In response to these challenges, State officials are evaluating minimum in-stream flows and considering emergency regulations to protect local aquatic species, highlighting the need for collaborative management strategies among land managers, local tribes, scientists, and water users.

Sources:
Lake County. 2022. Climate Change and Water Quality.

State Water Resources Control Board. 2024, November 22 (accessed). Clear Lake Hitch.

Los Angeles Times. 2024. Shocking before-and-after photos show California's famed Clear Lake turn bright green.

average year, groundwater meets about 60 percent of domestic, visitor-serving, and agricultural water demands.[26]

Water and wastewater infrastructure is extensive throughout the county. Several water and wastewater treatment and distribution systems serve the unincorporated county, including the Kelseyville Wastewater Collection and Treatment System, the Northwest Regional Wastewater System, the Southeast Regional Wastewater System, and septic systems throughout the county. In the City of Clearlake, water services are provided by the Clearlake Water System, which includes the Konocti Water District, Highlands Water District, Golden State Water, Lake County Special District, and Golden State Water's Sonoma Water Treatment Plant. Wastewater services for Clearlake are handled by the Southeast Regional Wastewater System. In the City of Lakeport, water is supplied by the Lakeport Water System, which features the City of Lakeport Water Treatment Plant. Wastewater services in Lakeport are managed by the Northwest Regional Wastewater System.

California Water Service Drought Programs

California Water Service, the water purveyor for Lucerne, offers several rebate programs to encourage water conservation and mitigate the impacts of limited water supplies. These programs provide financial incentives for converting water-intensive lawns to drought-resistant landscapes, promoting more sustainable landscaping. Rebates are also available for upgrading irrigation systems with efficient sprinkler nozzles and smart irrigation controllers, which help reduce water waste by optimizing watering schedules and ensuring precise delivery. Additionally, California Water Service supports the use of high-efficiency clothes washers and toilets, which significantly reduce indoor water consumption. These initiatives are aimed at helping residents adapt to drought conditions by using water more efficiently and responsibly.

During a drought, groundwater reserves deplete faster from increased pumping and less replenishment from precipitation. This can lead to lower groundwater levels and issues like diminished pumping capacity, meaning less water is available for users such as farmers who need it for irrigation, municipalities for public water systems, and households for daily consumption. Decreased groundwater negatively impacts stream flows —reducing water available for aquatic habitats, causing habitat loss and fish die-offs, harming wildlife that depend on these ecosystems, and limiting water supplies for downstream users such as farmers, municipalities, and households— and prolonged drought conditions increase wildfire susceptibility due to dried vegetation and pest vulnerability.

California regularly experiences droughts, but scientists predict climate change will result in more frequent and severe droughts across the state. Overall, precipitation levels are expected to increase across the county, as shown in **Table 3**. However, more years with extreme levels of precipitation, both high and low, are likely due to climate change. More intense droughts are expected to harden soil and cause aquifer levels to drop due to reduced groundwater recharge. When rains return, more water will run off rather than infiltrate into soils and percolate into groundwater basins, potentially causing downstream flooding. Higher temperatures will further increase evaporation, worsening drought conditions.

Extreme Temperatures

Extreme temperatures are an increasingly serious issue countywide, threatening public health, infrastructure, and the environment. Extreme temperatures include both extreme heat and extreme cold, as well as warm nights that can exacerbate temperature impacts on communities. California Public Resources Code Section 71410 defines extreme heat as increasing temperatures or other meteorological conditions that could result in any of the following: extreme heat wave, heat health event, or heat watch, warning, or advisory from the National Weather Service, the Office of Emergency Services, or a county health officer, or a proclamation of a state of emergency by the Governor pursuant to Section 8625 of the Government Code.[27,28] Extreme heat days are defined as temperatures exceeding 98 percent of historical highs, and these events are becoming more frequent and intense due to climate change.[29] Extended periods of extreme heat, known as heat events or waves, threaten community safety, drive up energy costs, and exacerbate the risks of wildfires and water shortages. When the daily minimum temperatures remain significantly above normal, warm nights can worsen an extreme heat day because people and community assets may not get relief from high temperatures. Additionally, warm nights can negatively impact key crops, as some crops are sensitive to elevated nighttime temperatures and rely on cooler evening conditions for optimal growth and productive yields. Warm nights are when minimum temperatures remain above normal levels during nighttime hours. Extreme cold is when temperatures fall below the normal levels.

California's 2022 Extreme Heat Action Plan

The 2022 Action Plan outlines California's all-of-government approach to mitigating the health, economic, cultural, ecological, and social impacts of increasing average temperatures and heat waves. This plan outlines a strategic and comprehensive set of state actions to address extreme heat and constitutes California's response to what has become known as “extreme heat” and accompanying “extreme heat events”.

On an extreme heat day in Lake County, temperatures reach at least 97.1 degrees countywide, 101.9 degrees in Clearlake, and 103.1 degrees in Lakeport. The warmer temperatures brought on by climate change are likely to cause an increase in the number of extreme heat events throughout the county. **Table 4** shows how climate change is expected to increase extreme heat days in the county, Clearlake, and Lakeport.

Table 4 Projected Number of Annual Extreme Heat Days

Locations	Observed (1961–1990)	Near Term (2025–2035)	Midcentury (2035–2064)	Late Century (2070–2099)
Countywide	4	12	20	42
Clearlake	3	10	16	35
Lakeport	3	10	16	34

Source: Cal-Adapt. 2024. Extreme Heat Days & Warm Nights.

Note: Projections are an average of the four State-recommended climate models (HadGEM2-ES, CNRM-CM5, CanESM2, MIROC5), averaged for near term (2025-2035), midcentury (2035-2064), and late century (2070-2099).

On a warm night, temperatures remain above at least 55.6 degrees countywide, 59.5 degrees in Clearlake, and 60.5 degrees in Lakeport. **Table 5** shows the number of warm nights projected in the county, Clearlake, and Lakeport.

Table 5 Projected Number of Annual Warm Nights

Locations	Observed (1961–1990)	Near Term (2025–2035)	Midcentury (2035–2064)	Late Century (2070–2099)
Countywide	5	19	32	77
Clearlake	5	16	26	65
Lakeport	4	14	23	60

Source: Cal-Adapt. 2024. Extreme Heat Days & Warm Nights.

Note: Projections are an average of the four State-recommended climate models (HadGEM2-ES, CNRM-CM5, CanESM2, MIROC5), averaged for near term (2025-2035), midcentury (2035-2064), and late century (2070-2099).

Extreme heat is one of the deadliest climate-related hazards nationwide, with the Centers for Disease Control and Prevention noting a rise in heat-related deaths—from 297 in 2004 to over 2,300 in 2023.[30,31] The rising frequency and intensity of extreme heat events pose significant public health concerns, especially in Lake County, which has historically experienced milder temperatures and is home to residents without access to climate-controlled environments. Warmer temperatures and the urban heat island effect can exacerbate extreme heat impacts in densely populated areas, such as Clearlake and Lakeport. Even slight increases in temperature can overwhelm a community's adaptive capacity, straining public health systems and infrastructure, including emergency response capabilities to address heat-related incidents. This leads to heightened risks of dehydration, heat-related illnesses, and respiratory issues, disrupting daily life and economic activity.[32]

Extreme heat also stresses energy infrastructure, as heightened air conditioning demand risks overloading the power grid and causing outages, and very high heat can degrade transportation systems leading to delays and damage. Additionally, rising temperatures harm local ecosystems by increasing water temperatures in local lakes and streams, harming fish and plant species.

On an extreme cold day, temperatures fall below and do not exceed 37.9 degrees countywide, 40.5 degrees in Clearlake, and 41.2 degrees in Lakeport.[33] Extreme cold can decrease electrical conductivity and cause conductor sag and ice buildup.[34] Cold temperatures can decrease the electrical conductivity of the transmission line materials, reducing the efficiency of power transmission. In rare cases, extreme cold can also cause power outages and equipment damage. Heating fuels, such as wood burning and propane, are commonly relied upon in Lake County, as the Pacific Gas and Electric Company (PG&E) does not have natural gas transmission lines in the county, but their performance and availability may also be affected by extreme cold temperatures. Wood burning may provide consistent heat but can worsen air quality, while propane systems may experience reduced efficiency or delivery delays.

Floodplains and Flood Recurrence

According to the Federal Emergency Management Agency, a floodplain is any area of land that could be flooded by water from any source, but are often next to creeks, lakes, oceans, and ponds. The 100-year floodplain is the area that has a 1 percent (1 in 100) chance of being flooded in any given year. This would also be the area that would flood during a 100-year storm. The 500-year floodplain is the area that has a 0.2 percent (1 in 500) chance of being flooded in any given year due to a 500-year storm.

Flooding

Flooding occurs when normally dry land is covered by water. This can include creeks and streams overtopping their banks and heavy rainfall that surpasses the capacity of drains to carry the water away. It can also result from dam failure, water or wastewater infrastructure failure, or tsunamis. Flooding occurs throughout the county during the rainy season from November through April.[35]

Floods are among the costliest natural disasters in terms of human hardship and economic loss nationwide, significantly threatening the health and life of community members and causing substantial damage to structures, landscapes, and utilities in the region. Standing water can weaken structural foundations, damage electrical systems, and create breeding grounds for vector-borne illnesses. Flooding also accelerates soil erosion, reduces water quality, and leads to the loss of important environmental resources, making ecosystems more vulnerable. The impacts of increased flooding go beyond immediate property damage. Flooding can lead to long-term public health problems if mold and mildew grow in buildings, displace communities if homes are destroyed or become uninhabitable, and increase economic burdens, such as rising home insurance costs.

Climate change is expected to make flood events worse due to fewer yet more intense precipitation events in the form of atmospheric rivers.[36] For example, what is currently a 200-year storm, or one that has a 1 in 200 chance of occurring each year, by 2100 could increase in frequency by 40 to 50 years (to a 1 in 150/160 chance each year).[37] This means that the 100- and 500-year floodplains may expand, and the current floodplains may become 40- to 50-year floodplains. One such scenario is known as ARKstorm 2.0, which simulates flooding across California due to two intense storms: one comparable to the “Great Flood” of 1862 that killed an estimated 4,000 people and destroyed a quarter of all property in the state, and another even more extreme future scenario resulting in 30 to 45 inches of rain along the coast during a month-long period. ARKstorm highlights the risks posed by prolonged, high-intensity precipitation events. Extensive flooding could overwhelm flood protection systems designed for lower thresholds. Winds reaching hurricane force, hundreds of landslides, and widespread infrastructure damage, including disruptions to power, water, and transportation systems are key concerns. Experts estimate total direct property losses of nearly

Frequently Flooded Areas

- Nice/Lucerne Cutoff
- Scotts Valley Road
- Hill Road
- New Long Valley Road
- Island Drive
- Keys Boulevard
- Lake Street
- St. Francis Drive
- Soda Bay Road
- Lands End Drive
- Clearlake Keys Community
- Lands End Community
- Corinthian Bay Community

Source: Lake County. 2023. Lake County Local Hazard Mitigation Plan.

$400 billion across California.[38] Climate change is also likely to increase the frequency and severity of droughts that cause soil to dry out and become hard. When precipitation does return, more water runs off the surface than is absorbed into the ground, which can increase flooding downstream.

Among the streams in the county, tributaries to Clear Lake, including Scotts Creek near Lakeport, Cole Creek and Kelsey Creek south of Kelseyville, and Adobe Creek west of Kelseyville experience the most significant flooding issues. These streams also contribute significantly to high lake stages and lakeshore flooding. Localized flooding can occur whenever rainfall exceeds the drainage system's capacity. As shown in **Figure 6**, flood-prone areas across the county include areas around the shoreline of Clearlake; the unincorporated communities of Upper Lake, North Lakeport, Finley, Kelseyville, Clearlake Oaks, and Lower Lake; and the cities of Clearlake and Lakeport.

Atmospheric Rivers

An atmospheric river is a long, narrow band of moisture in the atmosphere moving from the tropics that can cause heavy rain or snow when it moves over land. These storms are responsible for over half of California's water supply, but also most of the flooding and mudslide events across the state.

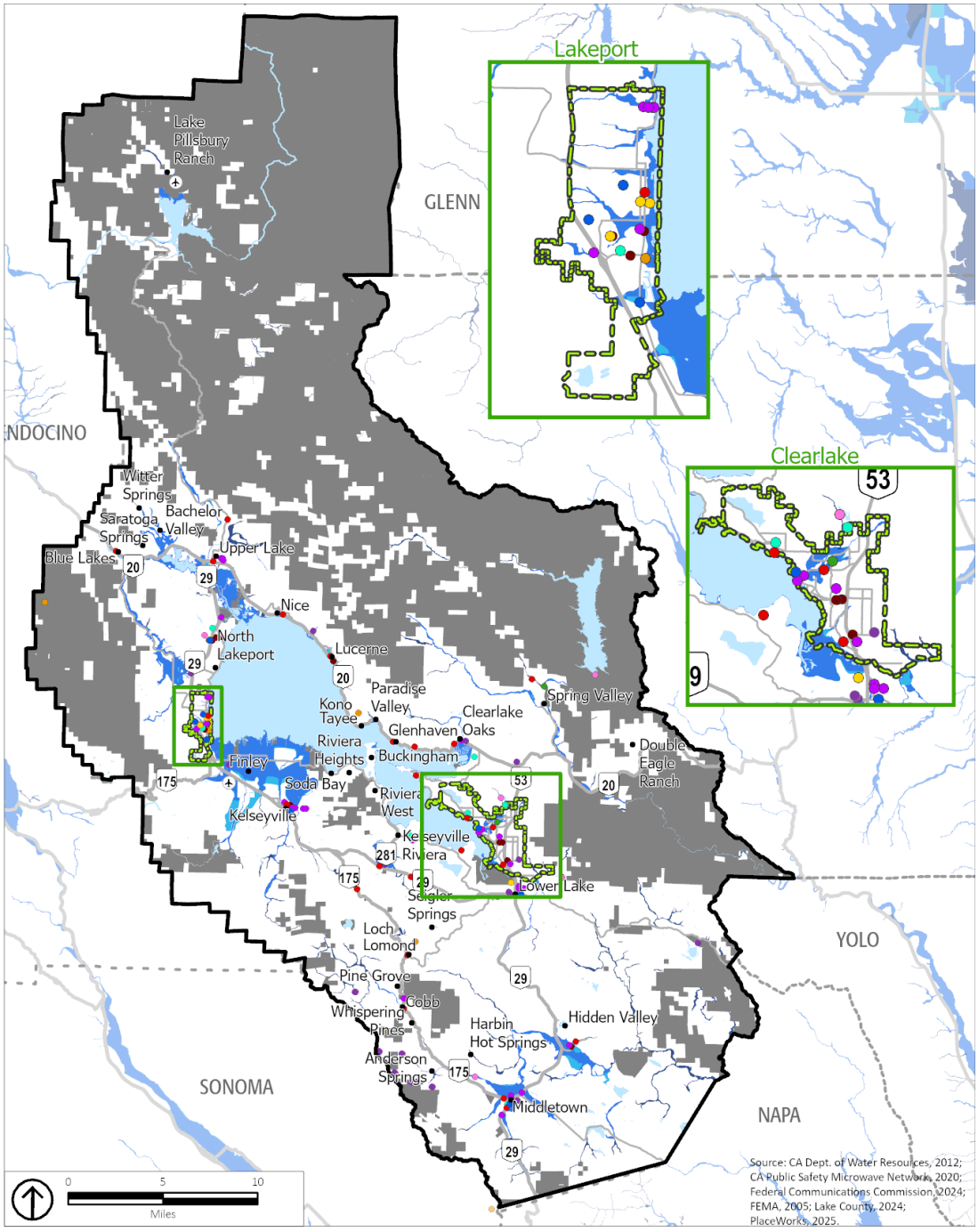
Source: Emily Mendez. 2024. *A Climate Expert Explains Why Atmospheric Rivers Are Causing Historic Rainfall in California*. Lamont-Doherty Earth Observatory: Columbia Climate School.

Human Health Hazards

Human health hazards, including bacteria, viruses, parasites, and other pathogens, pose significant concerns across Lake County. These conditions can result in physical injuries, fatalities, mental health issues, and exacerbate pre-existing conditions like asthma and allergies. Rats, mice, ticks, and mosquitos are common vectors, meaning that they often spread the pathogens that can cause illness. Rising temperatures and changing precipitation patterns due to climate change promote the proliferation of disease-carrying vectors. Warmer, wetter conditions allow for increased populations of mosquitoes and ticks, extending their geographic range and spreading diseases like West Nile virus and Lyme disease.[39] As temperatures rise and extreme weather events, such as heavy rainfall, become more frequent, these vectors can spread more broadly, transmitting diseases that threaten public health.[40]

Heatwaves, another increasing hazard due to climate change, can directly impact human health by causing heat-related illnesses and deaths, while also worsening respiratory conditions due to increased air pollution. The combination of these factors suggests that human health hazards will become more prevalent and severe as climate change progresses, making proactive public health measures even more critical. The implications of these health hazards extend beyond individual well-being, placing strain on healthcare systems, increasing economic burdens, and affecting mental health.

Figure 6 Flood Hazard Zones



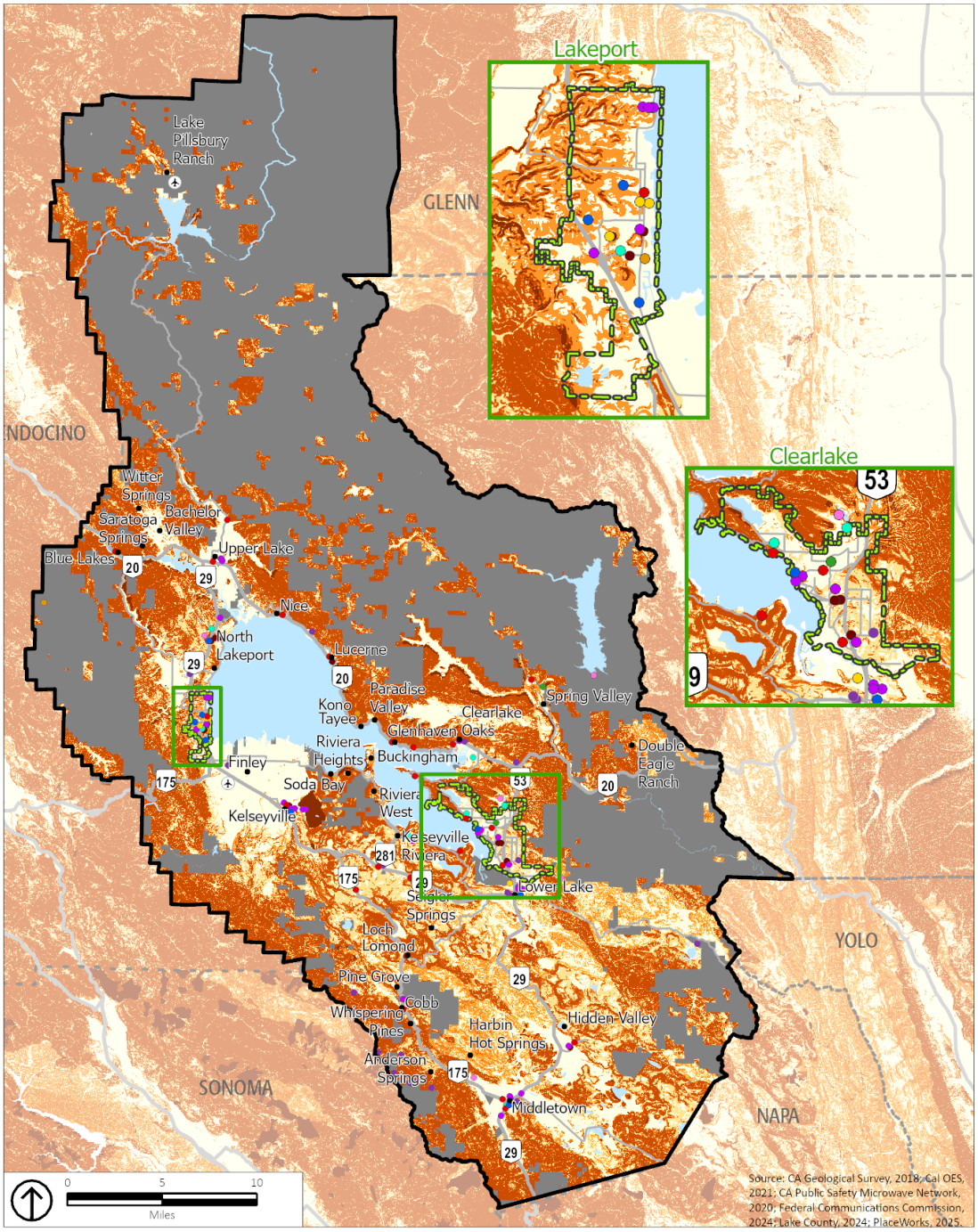
Landslides and Debris Flows

A landslide, defined as the movement of rock, soil, or debris down a slope, is often triggered by natural events such as heavy rainfall, floods, or wildfires. In the county, landslides commonly occur during or after intense rainfall, particularly in areas previously affected by wildfires where vegetation loss destabilizes slopes. The mountainous terrain of the unincorporated county and the City of Clearlake, which rises sharply to higher elevations, creates challenging conditions where much of the remote, high-relief landscape is prone to landslides. These events threaten homes and infrastructure, disrupt transportation networks, and contribute to downslope erosion. Landslides can travel significant distances, accumulating debris and amplifying their destructive impact as they move downslope.

Areas throughout the unincorporated county that have historically experienced landslides include Clearlake Oaks, Lucerne, Kelseyville, Riviera, Cobb Mountain, and Bartlett Springs.[41] As shown in **Figure 7**, a majority of the county is at high risk of landslides occurring, especially in the hillsides. However, landslide risk is generally low to moderate near the shoreline of Clear Lake. Unincorporated areas with little to no risk include agricultural areas in Upper Lake, North Lakeport, Kelseyville, and Hidden Valley. Despite these varying levels of risk, the overall annual probability of landslides in the county remains high due to these recurring conditions that contribute to slope instability. Clearlake contains several hillside regions that exhibit moderate to high susceptibility to landslides, whereas most of the city lies in areas of low susceptibility. In contrast, Lakeport predominantly consists of areas categorized as having moderate to high landslide susceptibility.

Climate change is expected to exacerbate landslide hazards by increasing frequency of wildfires and severe storms. Wildfires remove stabilizing vegetation and alter soil properties, making slopes more vulnerable to erosion during and after subsequent storms. As the climate becomes drier, with occasional extreme rainfall events, the county will experience more landslides and mudslides, which pose significant challenges to regional safety. Landslides can displace residents, block emergency routes, and damage critical infrastructure, disrupting daily life and requiring costly repairs.

Figure 7 Landslide Susceptibility



Severe Weather

Severe weather poses a significant threat across Lake County, disrupting daily life, compromising safety, and affecting infrastructure and ecosystems. Severe weather is usually caused by intense storm systems, although types of strong winds can occur without a storm. The types of dangers posed by severe weather vary widely and may include injuries or deaths, damage to buildings and structures, fallen trees and roads blocked by debris, and fires sparked by lightning. Severe weather often produces high winds and lightning that can damage structures and cause power outages. Lightning from these storms can ignite wildfires and structure fires that can cause damage to buildings and endanger people. Objects such as vehicles, unprotected structures like bus stops or carports, fences, telephone poles, or trees can also be struck directly by lightning, which may cause an explosion or fire. The most common severe weather events that have historically impacted Lake County are heavy rains (usually a result of atmospheric rivers), thunderstorms, and windstorms.

While average annual rainfall is projected to increase steadily over the coming decades in unincorporated Lake County, Clearlake, and Lakeport, climate change is also expected to cause an increase in the number of years with intense levels of precipitation.[42] Heavy rainfall can increase the frequency and severity of other hazards, including flooding.

Public safety power shutoff events are used as a preventive strategy to reduce wildfire risk during severe weather, especially during high winds and dry conditions. Utility companies like PG&E may shut off power lines during high winds, especially during hot and dry conditions, to prevent them from sparking fires causing power outages that may last for extended periods. Without backup power, communication networks may be disrupted, making it harder for residents to receive emergency notifications and for first responders to coordinate effectively. People who depend on medical devices, such as oxygen concentrators or ventilators, are at greater risk during power outages, as are those who need electricity for climate control to keep indoor temperatures safe. The existing limited redundancy of communication and energy infrastructure due to the remoteness of the county exacerbates these risks. The loss of power to communications and other critical infrastructure disrupts access to goods and services.

Wildfire and Smoke

The county's Mediterranean climate, steep topography, and diverse plant communities create ideal conditions for wildfire development. Historically, the fire season extended from early summer through late fall of each year during the hotter, drier months, although it is increasingly a hazard that can occur year-round due to higher temperatures, lower moisture content in air and plant matter, accumulation of vegetation, and high winds. Rising temperatures and prolonged droughts dry out vegetation, creating abundant fuel for fires. Pest outbreaks, such as bark beetle infestations and Sudden Oak Death, leave behind weakened and dead trees that serve as additional fuel, while extreme heat and erratic wind conditions make wildfires more unpredictable and harder to control. The fire season is extending beyond historical norms, leaving communities vulnerable for much longer periods.

Wildland-Urban Interface

The wildland-urban interface is an area where buildings (e.g., housing) and infrastructure (e.g., cell towers and water supply facilities) mix with flammable wildland vegetation, allowing wildland fires to spread to buildings and structures easily.

Figure 8 illustrates very high, high, and moderate fire hazard severity zones in the State Responsibility Areas of the county. Wildfire-prone areas in the county are generally in Lake County's wildland areas and the communities of Nice, Lucerne, Glenhaven, Soda Bay, the Rivieras, Cobb, and Lake Pillsbury, which are mapped within Very High Fire Hazard Severity Zones.[43] Nearly all county residents reside in moderate to Very High Fire Hazard Severity Zones.[44] The City of Clearlake also contains Very High Fire Hazard Severity Zones in Clearlake Highlands. In addition to the fire hazard severity zones, the county contains areas designated as a wildland-urban interface. **Figure 9** identifies the wildland-urban interface in the county. The communities most at risk are those surrounded by extensive open spaces and forested lands, often located along hillsides, which heightens their vulnerability to wildfires.

Wildfires occur on mountains, hillsides, and grasslands. In and around Lake County, the habitats provide highly flammable fuel that is conducive to wildfires. These plant species are capable of regeneration after a fire, making periodic wildfires a natural part of the ecology of these areas. A combination of factors, including weather, topography, and vegetation, create a higher risk of wildfire hazards, particularly in High and Very High Fire Hazard Severity Zones.

Residential development in the wildland-urban interface, the introduction and proliferation of exotic plant species, accumulated fuel because of wildfire-suppression efforts, and climate change-driven compression of the historic rainy season exacerbates the fire problem. Taken together, these factors result in more people, property, critical infrastructure, and natural resources more frequently in harm's way. While large-scale wildfires do not occur every year, wildfire incidents driven by extreme weather conditions have repeatedly been difficult to contain.

Increasing statewide fire frequency can create recurring air quality degradation events, leading to respiratory health effects. Wildfire smoke consists of a mix of gases and fine particulate matter from burning vegetation and materials; it is usually no bigger than a few microns and can travel for hundreds of miles. The pollutant of most concern from wildfire smoke is fine particulate matter, which is damaging to human health due to its ability to deeply penetrate lung tissue and affect the heart and circulatory system. Although wildfire smoke presents a health risk to everyone, sensitive

Historic Wildfires

Lake County has experienced several major wildfires throughout its history. Notable incidents include the 1961 Cobb Mountain fire (9,000+ acres), the 1964 Hanley Fire (52,000 acres), and the 1981 Lang Peak Fire (11,000 acres). From 2015 to 2018, over 60 percent of Lake County's landmass burned, including significant fires like the 2015 Rocky Fire (69,438 acres), 2015 Valley Fire (76,067 acres), and the 2018 Mendocino Complex (459,123 acres across four counties). More recent fires, including the 2020 August Complex and 2020 LNU Lightning Complex Fires, have further underscored the ongoing wildfire risks in the region.

Source: Lake County. 2023. *Lake County Local Hazard Mitigation Plan*.

groups may experience more severe acute and chronic symptoms from exposure to wildfire smoke, such as children (particularly younger children), older adults, people with chronic respiratory or cardiovascular disease, and low-resourced persons.

In addition to public health risks, wildfire smoke poses significant economic threats to the agriculture and outdoor recreation industries.[45] Much of the County's agricultural land lies in wildfire-prone areas, where smoke and ash can damage crops, alter soil nutrients, and reduce yield quality. Wine grape growers face heightened vulnerability, as smoke exposure during and after the ripening phase can cause "smoke taint," where grapes absorb smoke compounds, negatively affecting wine quality, which can lead to lost contracts and financial hardship for vineyards and wineries. The outdoor recreation and tourism industry may also suffer from repeated smoke events, as poor air quality limits outdoor activities and deters visitors from traveling to the county, further compounding economic losses.

Human activities are the leading cause of wildfires, and increased development near wildland areas has amplified the likelihood and risk of wildfire events.[46] Wildfires not only destroy homes and infrastructure but can also displace entire communities and degrade critical wildlife habitats. The economic consequences are significant, ranging from property damage and fire suppression costs to long-term business disruptions. Moreover, the loss of natural spaces impacts recreation, tourism, and local biodiversity.

Historically (1961 to 1990), an annual average of 7,849 acres burned in Lake County; however, this is projected to increase by 35 percent to 10,632 acres by midcentury (2035 to 2064) and by 50 percent to 11,912 acres compared to historic levels by late century (2070 to 2099).[47] As this is an annual average, some years are likely to see little or no wildfires, and other years are likely to see much larger fires. **Figure 10** and **Figure 11** show the future annual average acres burned in Lake County for midcentury and late century, respectively.

Figure 8 Fire Hazard Severity Zones

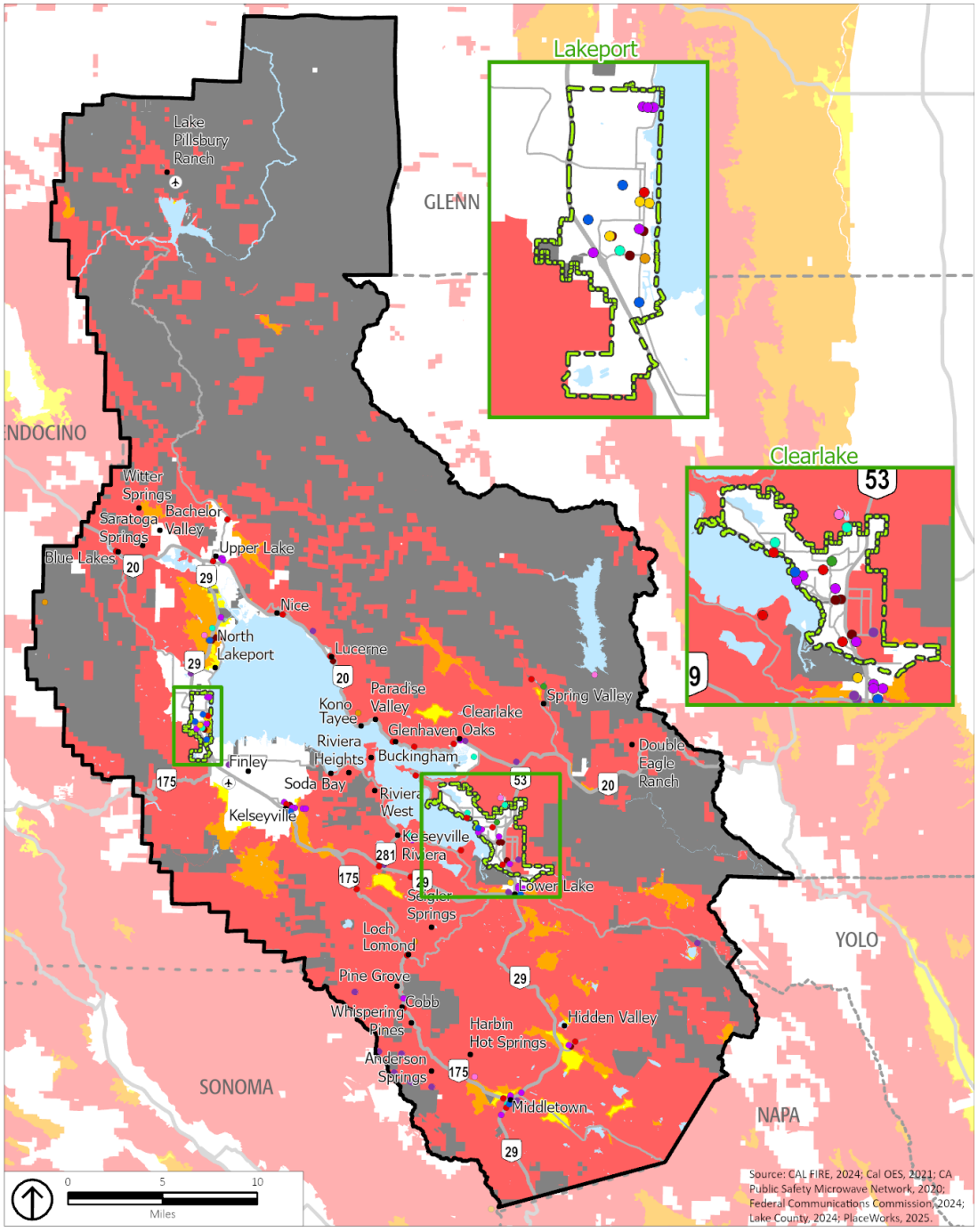


Figure 9 Wildland-Urban Interface Areas

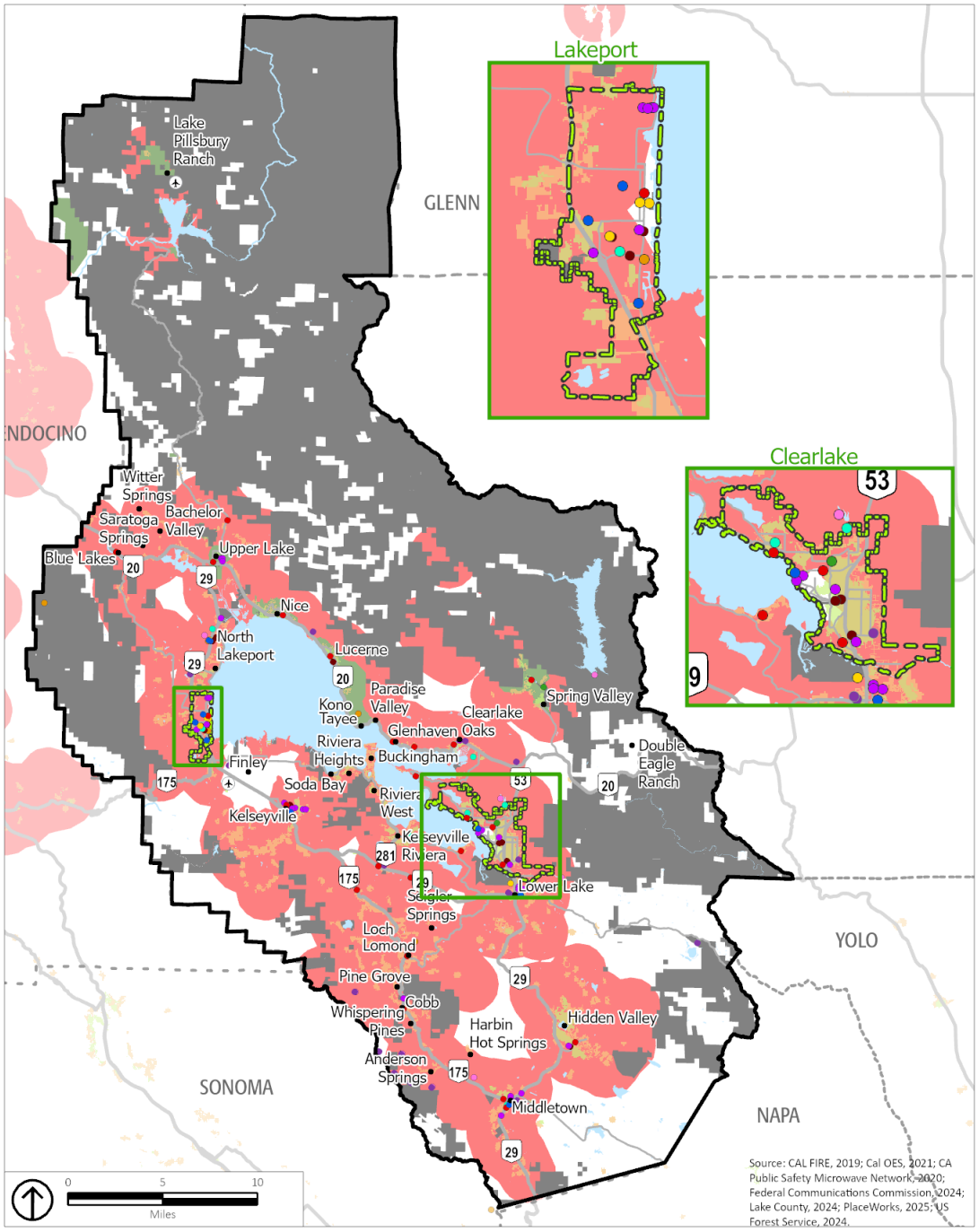


Figure 10 Future Annual Average Acres Burned (Mid-Century)

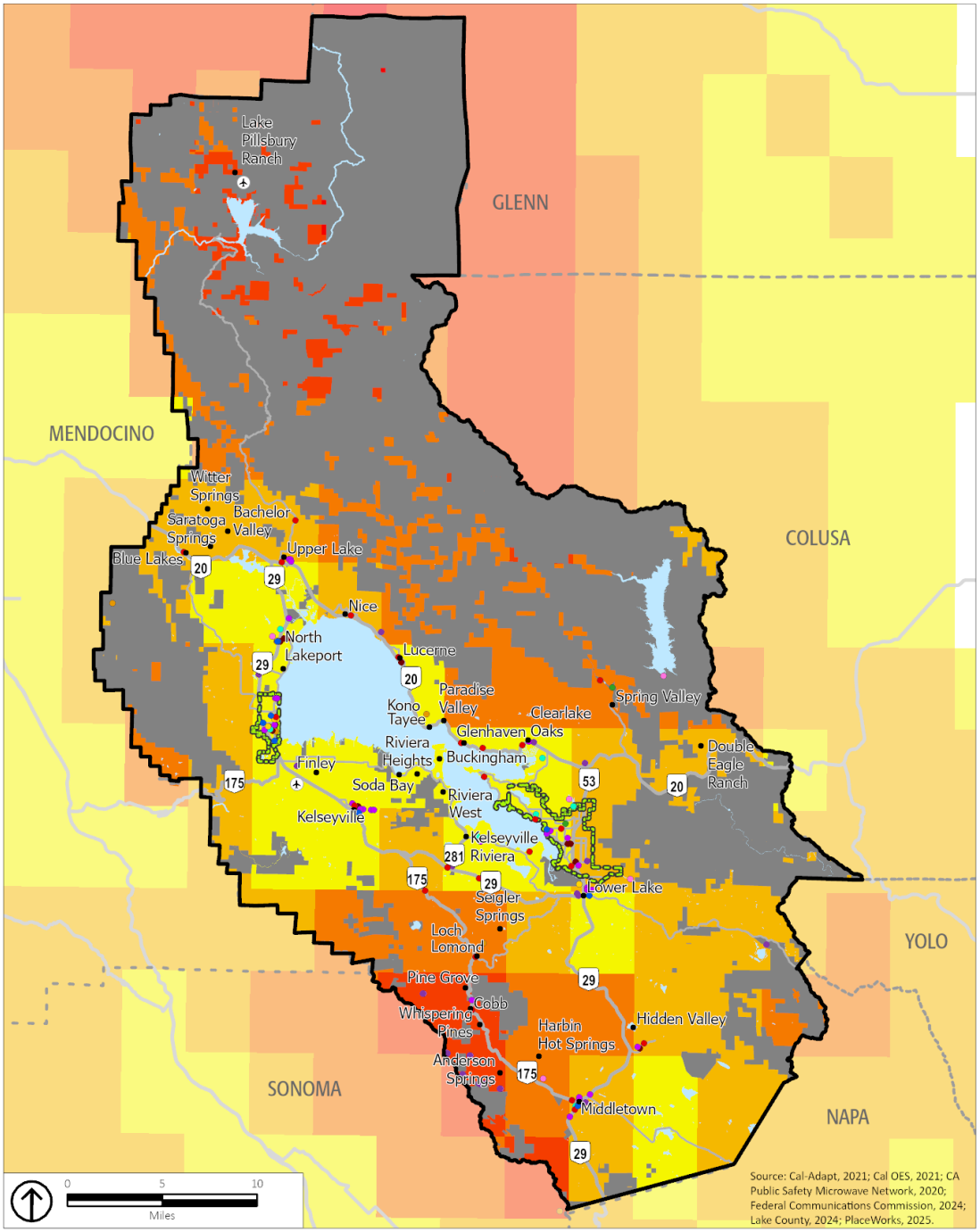
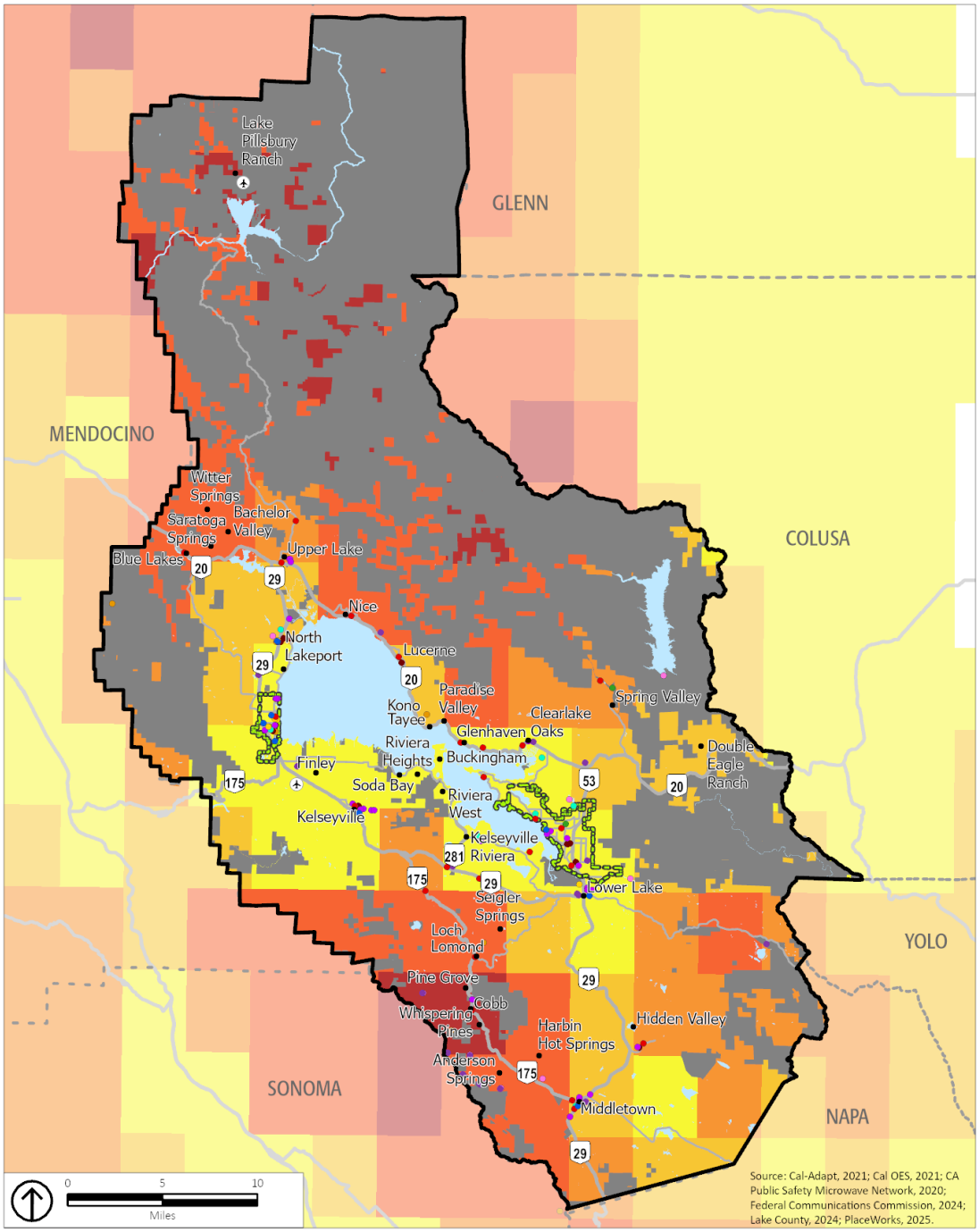


Figure 11 Future Annual Average Acres Burned (Late Century)



KEY FINDINGS

The following section presents the key findings of the Climate Vulnerability Analysis for Lake County and the cities of Clearlake and Lakeport, highlighting the people and community features that are identified as highly vulnerable. This includes people, buildings, infrastructure, economic drivers, ecosystems and natural resources, and key services that should be considered priorities in adaptation and resilience planning. Identifying a population or a community asset in these key findings reflects the severity of climate change impacts and level of harm but also considers other factors such as the size of the population, the role that the asset plays in maintaining community-wide well-being, and the potential of the population or asset to be impacted by compounding or cascading effects of interacting hazards.

Wildfire and smoke are responsible for the greatest number of high vulnerabilities countywide, followed by severe weather, flooding, and drought. Countywide, the populations facing the greatest risk from climate change include people of color and immigrant communities, people with high outdoor exposure, households in poverty, persons in tribal communities, and persons with chronic illnesses and/or disabilities. The most vulnerable community assets include energy and communication infrastructure and services, homes, transportation infrastructure, and agriculture as an economic driver.

The Lake County Office of Climate Resiliency has adapted a resilience framework, the Pillars of Resilience, based on the Tahoe-Central Sierra Initiative, which also was adopted by the California Wildfire and Forest Resilience Task Force to guide resilience planning efforts that interlink ecology and resilience. The framework recognizes the interdependence of ecological, economic, built, and social systems making it well suited for presenting the comprehensive and interdependent climate stressors, climate vulnerabilities, and adaptation and resilience strategies that help vulnerable populations and community assets adapt to climate change hazards. This framework is comprised of ten pillars: forest resilience, fire dynamics, carbon sequestration, biodiversity conservation, wetland integrity, air quality, water security, fire-adapted communities, economic diversity, and social and cultural well-being. These pillars focus on enhancing community capacity, fostering sustainable economic opportunities, and improving ecosystem health—all of which are essential for supporting those most at risk. Each of the following key findings includes a description of relevant pillars and explanation of how they contribute to enhancing the resilience of vulnerable populations and community assets.

Climate change is expected to affect everyone and all locations in Lake County, Clearlake, Lakeport, and tribal lands to some degree. This section does not describe all impacts from climate change and associated hazards. Rather, it identifies the populations and assets who are most vulnerable and how the Pillars of Resilience can be integrated to create a cohesive resilience approach. Each of the key findings has a table with icons listing out which hazards create high vulnerabilities for the three jurisdictions

included in this analysis. Populations and assets not listed here may still face significant harm from climate change.

People of Color and Immigrant Communities

	Most Vulnerable To:							
Unincorporated Lake County, City of Clearlake, City of Lakeport	 Agricultural and Forestry Pests and Diseases	 Drought	 Extreme Temps.	 Human Health Hazards	 Flooding	 Landslides	 Severe Weather	 Wildfire and Smoke

People of color and immigrant communities are susceptible to severe outcomes from climate change hazards, owing to historical and ongoing marginalization and discrimination, and in some cases distrust of government services, lack of awareness of government and community services, and lack of a social support network.[48] Immigrant communities and people of color often encounter significant barriers when accessing vital resources before, during, and after natural disasters. While they may seek out cooling centers and health services, concerns about citizenship status, racial discrimination, and language barriers can make them feel unsafe or unwelcome.[49] Linguistic isolation is a major challenge, as many individuals in these communities may be unaware of health and emergency alerts due to limited proficiency in English. Countywide, for example, Spanish, German, and other Pacific Island languages are the primary languages among households that are not fluent in English, while Spanish, Arabic, and German are common in Lakeport, and Spanish, Hindi, and Chinese are prevalent in Clearlake.[50,51,52] These language barriers can significantly hinder effective communication during emergencies. Additionally, many people in these communities work in agriculture, landscaping, and other outdoor recreation occupations, which expose them directly to poor air quality from wildfire smoke, extreme heat, and vector-borne illnesses. Some of this population may also work in visitor-serving jobs supporting hotels and lodging, food service, and facilities maintenance. These industries can be harmed if visitors are deterred from traveling to the county due to hazard events.

Immigrant communities working in agriculture and forestry may face economic hardships if crops or timber areas are damaged by pests and diseases. These hardships can lead to job losses when farms or forestry operations struggle financially. Low-resourced people of color are more likely to have chronic health conditions that can be worsened by human health hazards. Low-resourced people of color and immigrant communities often lack adequate access to health services or may not be able to afford care when affected by illness.

Many of these populations frequently face disparities in living conditions and systemic biases that limit access to high-quality housing, forcing many to live in substandard homes more vulnerable to flooding, landslides, and severe weather. As a result, they are often less able to recover and rebuild their quality of life if their property is damaged or their health is impacted by such events. These inequities, along with

institutional biases, often prevent them from having the financial means or support services necessary to prepare for or recover from disasters.[53] As a result, they are often less able to recover and rebuild their

quality of life if their property is damaged or their health is impacted by such events. People of color and immigrants are more likely to live in neighborhoods with limited shade and tree cover and park spaces, which further exacerbates their vulnerability to extreme heat and high levels of stormwater runoff.

Pillars of Landscape Resilience

The pillars of resilience such as social and cultural well-being, economic diversity, air quality, water security, and fire-adapted communities are highly relevant in addressing the challenges faced by people of color and immigrant communities in the face of climate change hazards. The ***social and cultural well-being*** pillar reduces systemic barriers by building community support networks, improving access to resources, and reducing distrust of services, which are critical for marginalized groups during emergencies. The ***economic diversity*** pillar aims to create sustainable economic opportunities, helping alleviate financial instability that often affects these communities, especially outdoor workers vulnerable to economic shocks. Managing ***air quality*** and ***fire dynamics*** ensures reduced exposure to hazards such as smoke and extreme heat, which disproportionately impacts these populations if they work outdoors. The ***water security*** pillar focuses on equitable access to clean water, reducing the strain on vulnerable populations during droughts. Lastly, ***fire-adapted communities*** emphasizes preparedness for fire threats, ensuring that marginalized populations are informed and able to take appropriate measures. Together, these pillars aim to reduce social inequities, enhance resilience, and improve adaptive capacity for people of color and immigrants.

People with High Outdoor Exposure

	Most Vulnerable To:						
Unincorporated Lake County, City of Clearlake, City of Lakeport	 Agricultural and Forestry Pests and Diseases	 Drought	 Extreme Temps.	 Human Health Hazards	 Landslides	 Severe Weather	 Wildfire and Smoke

Outdoor workers and individuals experiencing homelessness spend significant time outdoors, which means they are disproportionately exposed directly to several climate change hazards. Individuals experiencing homelessness throughout the county face severe challenges due to a lack of permanent, and often temporary, shelter. The 2023 Point In Time count reported 290 unsheltered individuals countywide. The absence of stable housing leaves these individuals highly vulnerable to a range of health and safety risks. Limited access to water and sanitation contributes to dehydration, poor hygiene, and increased susceptibility to illnesses, including respiratory infections and skin conditions. Without proper sanitation

facilities and limited finance for healthcare, unhoused individuals are more likely to experience health complications that further compromise their well-being.

Exposure to extreme weather conditions, such as extreme heat, extreme cold, flooding, and wildfires poses significant health risks for those without shelter. Extreme heat can lead to dehydration, heat exhaustion, and worsen pre-existing medical conditions, while extreme cold increases the risk of hypothermia and cold-related stress. Severe weather events, such as storms and floods, can cause physical harm, destroy temporary shelters, and damage the few possessions that unhoused individuals have, creating added hardships. Wildfires also pose a serious threat, as they can expose individuals to hazardous smoke and lead to respiratory issues. Additionally, many individuals experiencing homelessness may not receive adequate evacuation warnings due to a lack of communication systems, leaving them at further risk during emergencies. The lack of permanent shelter leaves homeless individuals directly exposed not only to extreme weather but also to pathogens, pollen, allergens, and other health hazards. This constant exposure increases their vulnerability to respiratory infections, allergies, and other health complications. Limited access to healthcare services also exacerbates these health challenges, as untreated medical conditions can quickly escalate without proper care.

CalWORKs Homeless Assistance Program

The CalWORKs Homeless Assistance Program supports families in the CalWORKs program who are homeless or at risk of homelessness. It offers two types of assistance, including **Temporary Homeless Assistance**, which provides up to 16 days of shelter, including hotel or motel costs, to address immediate housing needs, and **Permanent Homeless Assistance**, which offers financial aid for securing or maintaining permanent housing, such as covering security deposits, last month's rent, or up

Outdoor workers countywide are most closely tied to agriculture, forestry, landscaping, construction, and outdoor recreation. Many outdoor workers are from low-resourced households, including immigrant communities or households in poverty, and may face economic hardships if these industries are harmed. These workers are often concentrated in physically demanding, low-paying jobs with limited protection or health insurance, making them particularly vulnerable to disruptions. The seasonal or temporary nature of many outdoor jobs further contributes to their economic insecurity, especially in the face of hazards such as flooding, landslides, and wildfires. These jobs often have fewer educational requirements, making them accessible to those facing challenges such as a lack of legal status, language barriers, or the need to support their families. Additionally, systemic barriers limit access for many people of color to higher-paying, safer jobs, leading to a concentration in low-wage, physically demanding work.[54]

The physical demands of their outdoor work often require wearing heavy gear and performing manual labor, which increases their susceptibility to heat-related illnesses during heat waves. Vector-borne illnesses and diseases could harm the outdoor workers supporting agriculture and forestry, therefore preventing crops from being planted or harvested. Natural disasters, such as wildfires or severe weather, can disrupt their ability to work and flooding conditions can block roadways and prevent outdoor workers from reaching worksites, leading to economic instability. This financial strain can limit their access to timely medical care, creating a cycle of vulnerability that is difficult to break. Individuals experiencing homelessness face even greater challenges. Without consistent access to adequate shelter, they are left

exposed to extreme weather events and hazardous conditions, putting their health and safety at significant risk.

Agricultural Pest Programs

The Lake County Department of Agriculture implements two key programs to safeguard the region's agricultural industry and environment which include the Insect Trapping Program and Pest Exclusion Program.

The **Insect Trapping Program** uses strategically placed traps and visual inspections to detect and eliminate invasive insects before they become established, thereby protecting the region's agricultural industry and environment.

The **Pest Exclusion Program** focuses on inspecting incoming shipments of agricultural products and plant materials to prevent exotic pests from entering Lake County, emphasizing proactive measures over costly eradication efforts.

Agricultural and forestry pests and diseases pose significant threats to the job stability and health of outdoor workers. Pest infestations can disrupt their jobs, leading to economic consequences if work is delayed or halted. For low-resourced households employed in these sectors, pest-induced damage to crops or timber can result in severe economic hardship. Agriculture can be affected by fungal pathogens, invasive disease vectors, and pests as temperatures continue to warm, which could affect the quality or viability of crops in the county. Pests and diseases that weaken trees and severe weather can cause trees to fall, harming recreational areas where outdoor workers are employed. This not only creates safety hazards but also discourages tourism and deters visitors, further reducing job prospects and exacerbating economic challenges for these workers. Additionally, the increased use of pesticides and insecticides to manage pest outbreaks can pose health risks to these workers, potentially resulting in both acute and long-term health issues.

The pillars of resilience such as fire dynamics, fire-adapted communities, economic diversity, water security, air quality, and social and cultural well-being are highly relevant in addressing the impacts faced by people with high outdoor exposure, including outdoor workers and individuals experiencing homelessness.

Pillars of Landscape Resilience

The ***forest resilience*** and ***fire dynamics*** pillars reduces exposure to wildfires, creates safer environments for those without adequate shelter, and supports outdoor workers in the timber industry. The ***fire-adapted communities*** pillar promotes community preparedness, helping ensure that individuals, especially those experiencing homelessness, are informed and protected during wildfire emergencies. ***Water security*** is crucial for outdoor workers and homeless individuals who often face limited access to clean water, which affects hydration, sanitation, and overall health. By improving water availability and infrastructure, these individuals can maintain better hygiene and reduce their vulnerability to health hazards.

The ***economic diversity*** pillar is particularly relevant for outdoor workers, many of whom belong to marginalized communities facing job insecurity. Economic diversity encourages the creation of more stable and varied job opportunities, reducing reliance on seasonal and high-risk employment. ***Air quality*** management helps reduce respiratory issues that are common among individuals with high outdoor exposure. People experiencing homelessness and outdoor workers are particularly vulnerable to poor air

quality due to prolonged exposure to wildfire smoke. Lastly, ***social and cultural well-being*** aims to build support networks and ensure that individuals have access to essential resources, such as emergency shelters and healthcare services, ultimately improving their capacity to adapt to environmental hazards and recover from adverse events.

Households in Poverty

Most Vulnerable To:							
Unincorporated Lake County, City of Clearlake, City of Lakeport	 Drought	 Extreme Temps.	 Human Health Hazards	 Flooding	 Landslides	 Severe Weather	 Wildfire and Smoke

Households in poverty are among the populations most at risk of climate change hazards in unincorporated Lake County, where approximately 17 percent of residents earn incomes at or below the poverty level.[55] In Lakeport, about 11 percent of residents are in poverty, while in Clearlake, the figure is as high as 25 percent.[56, 57] These households typically lack sufficient resources to invest in home repairs and weatherization improvements, air conditioning, and water-efficient appliances, health care, and other means to prepare for and recover from hazardous events. Evacuation concerns are significant for these households, as they may lack access to reliable transportation or the financial means to leave during emergencies, making it difficult to comply with evacuation orders. Additionally, households in poverty often lack access to critical lifelines, such as emergency shelters that can accommodate their needs or have the capacity for large families.

These individuals are less likely to have home insurance, or to be underinsured, meaning that they can face a significant financial burden for home repairs or rebuilding. Limited financial resources may prevent these households from affording adequate housing, which means they are more likely to live in older buildings with poor maintenance, structural damage, or inadequate sanitation. These conditions create an ideal environment for pests that can carry harmful pathogens.

FEMA Individuals and Households Program

This program offers critical financial assistance and direct services to individuals and households impacted by disasters. It is designed to support those with uninsured or underinsured expenses and serious needs caused by a disaster. The program provides a range of assistance, including housing support and other needs assistance. Housing assistance covers financial aid for temporary housing, home repairs, and, if needed, temporary housing units when rental options are unavailable. Other assistance includes help for replacing or repairing essential personal property, vehicle repairs, and hazard mitigation to assist homeowners in rebuilding or repairing homes to be more resilient to future disasters.

Pillars of Landscape Resilience

The Lake County Office of Climate Resiliency's Pillars of Resilience that apply to households in poverty include air quality, fire-adapted communities, water security, and social and cultural well-being. The ***air quality*** pillar emphasizes the importance of clean air throughout the county, which households in poverty are highly susceptible to and have limited financial resources to adapt to resulting health outcomes. The ***fire-adapted communities*** pillar aims to protect low-income households that often lack the financial means for evacuation, home repairs, or insurance. The ***water security*** pillar seeks to reduce the burden of increasing water costs, particularly during droughts, which disproportionately impact these communities. The ***social and cultural well-being*** pillar emphasizes the importance of connecting people with the landscape, access to Tribal cultural resources, recreation, and health improvements. For households in poverty, improving public health and providing opportunities for connection to nature is critical, especially in areas with high susceptibility to smoke-induced illnesses and other health vulnerabilities.

Persons in Tribal Communities

	Most Vulnerable To:					
Unincorporated Lake County, City of Clearlake, City of Lakeport	 Agricultural and Forestry Pests and Diseases	 Drought	 Extreme Temps.	 Flooding	 Severe Weather	 Wildfire and Smoke

The tribal communities throughout Lake County continue to maintain their cultural heritage and strong ties to the land. Climate change hazards are already disrupting tribal cultural practices and damaging resources through devastating wildfires that burn culturally significant sites, forestry pests and diseases that damage trees and wildlife, and drought and extreme temperatures that reduce water quality and quantity in Clear Lake. Pests and diseases can severely impact the gathering areas that are vital for providing traditional foods and fibers that are integral to cultural practices and traditions[58]

Drought conditions can profoundly affect the environmental and cultural landscape. Lower water levels in Clear Lake and other water bodies throughout the county can lead to harmful algal blooms that threaten aquatic ecosystems and water quality. Additionally, groundwater depletion exacerbates water scarcity, jeopardizing access to traditional food sources such as fish and wild plants. This disruption can undermine cultural activities tied to these resources and hinder community resilience.[59]

Persons in tribal communities, particularly elders, face heightened risks of heat-related or cold-related illnesses during extreme weather events. Limited financial means often result in homes without adequate cooling or heating systems, leaving individuals vulnerable. Moreover, flooding from severe weather can destroy homes, displace families, and damage tribal cultural sites that hold historical and spiritual significance. Many people in tribal communities live in less-resilient structures that are more susceptible to damage from severe wind events. Utility systems in these areas can also be damaged or destroyed,

leading to extended power outages. Severe weather can block access to communities due to road failures or fallen trees, interrupting vital deliveries of goods and services and causing economic disruption. There is already a significant shortage of housing for tribal members, particularly young adults, who often struggle to find affordable rental options. This lack of housing availability makes it difficult for young adults to establish independence and stability within their communities, which further exacerbates the challenges posed by extreme weather events and economic disruptions.

Wildfires pose a significant threat to tribal communities, destroying homes, cultural sites, and critical vegetation that supports traditional practices.

Pillars of Landscape Resilience

The pillars of resilience, such as forest resilience, biodiversity conservation, water security, carbon sequestration, economic diversity, air quality, wetland integrity, social and cultural well-being, and fire-adapted communities are highly applicable to addressing the challenges faced by persons in tribal communities.

Forest resilience and ***biodiversity conservation*** are critical in maintaining the health of ancestral gathering areas that provide traditional foods and fibers, essential to the cultural practices of tribal communities. The ***water security*** pillar addresses drought-related impacts, including reduced water quantity and quality, and harmful algal blooms that threaten traditional food sources like fish and wild plants***. Forest resilience*** and ***economic diversity*** also help sustain the economic activities tied to forest health, which are crucial for the livelihoods of tribal members. This pillar also supports tribal communities in diversifying their economies to include local businesses and casino operations. ***Social and cultural well-being*** ensures the protection of culturally significant sites that may be at risk due to wildfires, flooding, or severe weather. The ***fire-adapted communities*** pillar supports tribal resilience by enhancing preparedness for wildfires, which threaten homes and cultural sites, and integrating traditional forest management practices into the landscape. ***Air quality management, carbon sequestration,*** and ***wetland integrity*** also contribute to sustaining healthy ecosystems, which support cultural traditions and practices integral to tribal life. Together, these pillars provide a comprehensive approach to maintaining cultural heritage, safeguarding livelihoods, and ensuring the resilience of tribal communities in the face of climate change.

Persons with Chronic Illnesses and/or Disabilities

Most Vulnerable To:							
Unincorporated Lake County, City of Clearlake, City of Lakeport	 Drought	 Extreme Temps.	 Human Health Hazards	 Flooding	 Landslides	 Severe Weather	 Wildfire and Smoke

Persons with chronic illnesses or disabilities are among the most vulnerable populations during emergencies due to physical, medical, and social factors that limit their ability to respond and recover effectively. In the unincorporated county, about 21 percent of residents have some type of disability, such as those affecting hearing, vision, cognition, mobility, self-care, or independent living.[60] In Lakeport, this percentage is slightly lower at 17 percent, while Clearlake has a similar rate to the county, with 21 percent of residents experiencing disabilities.[61, 62] Many of these individuals have weakened immune systems due to pre-existing conditions or medications, making it harder for them to fight off new illnesses from vector-borne illnesses, poor air quality during smoke conditions from wildfire, or extreme heat. Exposure to allergens and vector-borne diseases can also exacerbate existing conditions, complicating treatment and recovery.

Hazards, including flooding, drought, extreme heat, severe weather, and wildfire, pose additional risks, as individuals with chronic conditions or disabilities may be more likely to be injured. They may rely on medications or medical devices that can be lost, damaged, or rendered unusable during power outages and evacuations. Wildfire smoke can exacerbate respiratory conditions, drought can limit access to clean water, and severe weather can disrupt medical care, further impacting health. Loss of power, such as during a public safety power shutoff, can be especially dangerous for those who need electricity to operate medical devices or store medications, a situation that becomes more likely during extreme heat, severe weather, or flooding. Furthermore, people with disabilities often face barriers in preparing their homes for emergencies and evacuating to safety before and during wildfire or flooding events.

Pillars of Landscape Resilience

The pillars of resilience, such as fire dynamics, air quality, fire-adapted communities, social and cultural well-being, and economic diversity are highly relevant in addressing the challenges faced by persons with chronic illnesses or disabilities. ***Air quality*** management is critical to reducing exposure to smoke and pollutants that can worsen respiratory conditions for those with chronic illnesses. ***Fire dynamics*** and ***fire-adapted communities*** help minimize the risk of wildfires, ensuring those who need medical support and mobility challenges have safer living conditions and adequate warning to evacuate. The ***social and cultural well-being*** pillar emphasizes the importance of community connections to nature for enhancing overall health and well-being, in addition to ensuring access to culturally valued resources and recreational opportunities, which contributes to better health outcomes and community resilience. ***Economic diversity*** contributes to financial stability, allowing individuals with disabilities to afford medical care. Together,

these pillars offer a comprehensive framework to address the specific vulnerabilities of individuals with chronic illnesses and disabilities, supporting their health, safety, and overall resilience during climate-related hazards.

Energy and Communication Infrastructure and Services

	Most Vulnerable To:						
Unincorporated Lake County, City of Clearlake, City of Lakeport	 Agricultural and Forestry Pests and Diseases	 Drought	 Extreme Temps.	 Flooding	 Landslides	 Severe Weather	 Wildfire and Smoke

Residents, visitors, and workers rely on energy and communication infrastructure and services to work, play, stay connected, and remain healthy and safe. Energy delivery and communication infrastructure and services are highly vulnerable to hazards that could undermine their foundations or cause damage to the power plants and transmission lines, including flooding, landslides, severe weather, and wildfire. This infrastructure supports electricity, internet, and phone services for residents, visitors, and businesses, but has little redundancy in the county due to its rural nature. These networks are vulnerable throughout the county, but the threat to these systems and the people who depend on them is particularly high in more remote areas, such as Cobb, Middletown, and Hidden Valley Lake.

Power plants, transmission lines, and communication towers are highly susceptible to damage or destruction from various hazards, including pest-infested trees, landslides, wildfires, flooding, high winds, extreme heat, and extreme cold. These hazards can compromise electricity transmission and distribution lines, communication networks, and support structures, leading to widespread power outages and communication failures. Communities in hillside areas, fire-prone zones, and floodplain areas are particularly vulnerable to these risks. Energy generation facilities that rely on water to function, such as the hydroelectric facilities on Clear Lake and Indian Valley Reservoir, and the geothermal areas, could see a reduction in electricity production due to lower water levels during drought conditions. If this occurs statewide, it could lead to increased flex alerts and power outages.

The consequences of damaged infrastructure include power outages, communication breakdowns, and delays in emergency response services, all of which negatively affect residents and businesses. Prolonged power outages can hinder residents' ability to prepare adequately and impair emergency medical responses, disproportionately affecting vulnerable populations such as older adults, low-income households, and individuals with chronic health conditions or disabilities. Communication failures also disrupt essential community support services. These disruptions have significant financial impacts, especially on financially constrained households and small businesses, who are less equipped to absorb the associated losses.

Pillars of Landscape Resilience

The pillars of resilience such as forest resilience, fire dynamics, wetland integrity, and fire-adapted communities are highly relevant to increasing the resilience of energy and communication infrastructure and services. ***Forest resilience*** and ***fire dynamics*** help protect power lines from damage caused by weakened trees and wildfires, which can lead to power outages. ***Fire-adapted communities*** aims to minimize wildfire risks and ensure that infrastructure is more resilient to fire threats. Lack of ***wetland integrity*** reduces the ability of wetlands to absorb stormwater, reducing the impacts of flooding on power lines and communication infrastructure. Together, these pillars support the resilience and reliability of energy and communication services, ensuring that residents, visitors, and workers can stay connected and safe, even during hazardous events.

Homes

	Most Vulnerable To:				
Unincorporated Lake County	 Agricultural and Forestry Pests and Diseases	 Flooding	 Landslides	 Severe Weather	 Wildfire and Smoke
City of Clearlake	 Flooding	 Severe Weather	 Wildfire and Smoke		
City of Lakeport	 Flooding	 Severe Weather	 Wildfire and Smoke		

Homes and residential structures are an essential part of every community, and like in other areas of California, Lake County, Clearlake, and Lakeport face a chronic housing crisis fueled by high costs and a limited supply of housing. Climate change has the potential to make this crisis worse. Houses and multifamily buildings throughout the county can be damaged or destroyed by wildfires, flooding events, landslides during or after heavy rainfall, and severe storms. Homes in forested areas are highly vulnerable to pests and diseases weakening trees, especially combined with heat or drought, increasing the risk of falling branches or trees that can cause severe structural damage. Even if initial damage is minor, standing or retained water from flooding and severe storms can cause mold and mildew to grow, causing homes to become uninhabitable. Since 2015, the county has endured multiple disasters, including wildfires that have destroyed approximately 1,950 housing units, representing about 5.5 percent of its housing stock.[63]

This loss has exacerbated housing shortages and increased the number of residents facing homelessness or housing insecurity.

Although extreme heat events and wildfire smoke may not affect the structural integrity of homes and residential structures, these events can cause unhealthy indoor air temperatures and quality, resulting in dangerous living conditions for occupants. If homes become uninhabitable, residents can be displaced and may face significant challenges in finding alternative housing options, often resulting in prolonged periods of housing instability or even homelessness. This is a critical issue in the county since hundreds of families are housing insecure, with nearly one in six residents living in poverty.[64] Housing shortages may lead to inequitable access to affordable housing options and make it difficult for displaced residents to remain in their community.

These equity considerations underscore the need for targeted support and resources for vulnerable communities, including affordable housing programs, emergency assistance, and community planning efforts, to ensure fair access to safe and affordable housing and to prevent displacement. To help address these issues, the County has established a Coordinated Entry System to ensure that individuals experiencing a housing crisis have fair and equal access to resources through designated access points.[65] Additionally, North Coast Opportunities provides the Building Up Individuals and Local Development program, which is a workforce development initiative that equips individuals facing employment barriers with construction trade skills while actively supporting affordable housing efforts. The program rehabilitates homes, builds tiny home communities, and enhances community infrastructure, directly increasing the availability of safe, affordable housing.

Home Insurance Crisis

Most residents and property owners in Lake County have experienced significant changes in their costs and options for homeowners. Property owners have faced significant increases in home insurance rates or must scramble to find insurance after their insurance providers have either chosen not to renew or to cancel insurance policies in the county. Between 2015 and 2023, the number of home insurance policies written by insurance companies in the county steadily decreased from about 24,500 to 19,900, or about 19 percent. During that same period, an average of 910 home insurance policies were dropped per year by insurance companies. Homeowners are now faced with the choice of going uninsured, being underinsured, or increasing their cost of living and housing costs with adequate insurance to accommodate increased premiums.

Source: California Department of Insurance. 2024. *Residential Data: Annual Insurance Policy County Data. Data and Analysis on Wildfires and Insurance.*

Pillars of Landscape Resilience

The pillars of resilience, such as forest resilience, fire dynamics, and fire-adapted communities are essential in addressing the impacts of climate change on homes and residential structures. ***Forest resilience, fire dynamics,*** and ***fire-adapted communities*** help minimize risks to homes from wildfires, and other hazards by promoting healthier forests, reducing fuel loads, and ensuring proactive management of fire-prone areas. These efforts reduce the likelihood of structural damage from falling branches, fire, or storms, creating a safer environment for residential communities. Together, these pillars provide a comprehensive strategy to protect homes and residential structures from climate change hazards while enhancing community resilience and stability.

Transportation Infrastructure

Most Vulnerable To:					
Unincorporated Lake County, City of Clearlake, City of Lakeport	 Agricultural and Forestry Pests and Diseases	 Flooding	 Landslides	 Severe Weather	 Wildfire and Smoke

Roads and highways, bridges, and transit networks and facilities play a pivotal role in supporting community health, safety, and well-being. The major highways in the county include SR-20, which runs east to west across the northern part of the county, and SR-29, which runs north to south through the center of the county, as well as SR-53 and SR-175, which connect the county with the surrounding region.[66] These highways are critical for the movement of people and goods throughout the county and beyond. In addition to the major highways, there are many local roads that provide access to residential, commercial, recreation, and visitor-serving areas throughout the county. Bridges are also an important component of the transportation infrastructure in the county, as they provide critical connections across rivers and other bodies of water.

These systems span the county and are especially vulnerable to pests and diseases, flooding, landslides, severe weather, and wildfire. Invasive pests weaken trees along transportation corridors, increasing hazard trees that can obstruct roads, damage infrastructure, and destabilize soil, leading to erosion and costly repairs. During normal conditions, damage to transportation infrastructure and services prevents people from going about their daily lives, disrupts visitors from traveling to the county, and interrupts many key services, including vital supply chains that support both businesses and households. Damage to transit networks also significantly impacts mobility for those who rely on public transportation, leading to reduced access to jobs, healthcare, and other essential services. During emergency events, the potential for harm is even greater, as damaged transportation networks can block evacuations, prevent or delay emergency response, and significantly hinder deliveries of vital supplies. Countywide, roads and highways are a priority vulnerability. Roadways can be damaged or blocked by wildfire, landslides, flooding, and debris knocked into the road by severe weather.

In addition to the major routes, many of the local roads are in areas that are susceptible to natural hazards, which can impact the ability of people and goods to move throughout the county. Harm to these routes could isolate the region and be dangerous when evacuations are needed. Even in Lakeport and Clearlake, infrastructure networks such as SR-53 and SR-29 are subject to disruptions. In an extreme scenario, these hazards could block multiple roads throughout the county and cities, significantly limiting evacuation options and delaying access to healthcare and other emergency services.

All major highways, including SR-20, SR-29, SR-175, and SR-53, are in moderate to very high wildfire, landslide susceptibility area, and flood hazard zones. These hazards could damage roadways and bridges, making them impassable, causing expensive repairs, and isolating residents and visitors. This would prevent the delivery of vital goods and services and disrupt regional transportation.

Several bridges in Lake County, including those in Clearlake and Lakeport, are in hazard-prone areas. Wildfires, landslides, and floods can damage supportive infrastructure, such as culverts and vegetation, essential for maintaining the structural integrity of bridges. Landslides could dislodge or damage bridges, while flooding could scour bridge foundations, increasing maintenance needs. These damages could lead to severe structural and environmental impacts, potential fatalities, and isolation of communities.

The City of Lakeport could be isolated if SR-29 and SR-175 are impacted by landslides or large debris flow and the City of Clearlake could be isolated if SR-29 and SR-53 are impacted by landslides or large debris flow.[67, 68] Flooding may also damage pavement, increase maintenance costs, and create unsafe conditions for driving, walking, and biking. Transit services could be disrupted, leading to reduced reliability and longer travel times. Neighborhood access roads with poor drainage could face long-term delays and costly cleanup. Beyond evacuation concerns, highway closures severely disrupt local supply chains. Grocery stores relying on frequent deliveries can run out of essential goods within hours when roads are blocked or closed. There are 25 bridges in the county within a 100-year floodplain, including all three in Clearlake and the single bridge in Lakeport, which face risks of failure during major floods, potentially isolating parts of the county.

Disruptions along major evacuation routes could also hinder evacuation efforts for transit-dependent populations. While roadway improvements could alleviate these risks, they are likely to require substantial funding that could strain local budgets, demand additional resources, and take a significant amount of time to complete. This situation could leave some communities without sufficient evacuation access for extended periods of time, particularly those in more remote areas.

Pillars of Landscape Resilience

The pillars of resilience, such as forest resilience, fire dynamics, fire-adapted communities, and wetland integrity are essential in addressing the impacts on transportation infrastructure in Lake County. ***Forest resilience, fire dynamics,*** and ***fire-adapted communities*** work to minimize risks from wildfires, which can damage roads, bridges, and transit networks, thereby reducing the chances of critical infrastructure failures. These pillars focus on proactive forest management, maintaining healthy ecosystems, and reducing fuel loads, which help protect transportation routes from fire damage and prevent infrastructure from becoming impassable during wildfire events. ***Wetland integrity*** plays a role in managing stormwater damage to roads and bridges. Maintaining wetlands and ensuring effective water management can help

control floodwaters, reducing their impact on vulnerable infrastructure and minimizing disruptions to transportation routes. Together, these pillars offer a comprehensive strategy to protect transportation infrastructure from climate-related hazards, enhance community resilience, and ensure that critical routes remain functional during both normal conditions and emergencies.

Agriculture and Timber Industries

Most Vulnerable To:							
Unincorporated Lake County, City of Clearlake, City of Lakeport	 Agricultural and Forestry Pests and Diseases	 Drought	 Extreme Temps.	 Human Health Hazards	 Flooding	 Severe Weather	 Wildfire and Smoke

Lake County has a diverse agricultural landscape characterized by various types of farming and crops. The primary agriculture practices in the region include viticulture, fruits and nuts, nurseries, livestock, cannabis, and timber. The county's agricultural sector is supported by its unique climate and soil conditions, making it a vital part of the local economy and cultural heritage. As of 2022, Lake County had 581 farms covering approximately 138,030 acres and the estimated total gross production was $107 million.[69] In 2022, wine grapes were the number one crop, with a gross value of $84,756,086 made up of approximately 10,987 acres. Pears were the number two crop, with a gross value of $16,286,443, made up of approximately 1,375 acres.[70]

Agriculture is sensitive to changes in weather and pests, which can lead to lower crop yields and economic losses. Agriculture, one of the primary economic drivers in the county, can be harmed by agricultural pests and diseases that ravage plants and animals, drought and extreme heat that weaken or ruin crops, and severe weather that decimates agricultural products. These can include fungal pathogens, such as powdery mildew and rust fungi, invasive disease vectors such as the glassy-winged sharpshooter, and pests such as aphids and spider mites, which are exacerbated by rising temperatures and threaten agricultural operations. Pests can significantly harm agricultural operations by weakening plants, reducing yields, and spreading diseases across various sectors, including viticulture, fruits and nuts, and nurseries, leading to economic losses and operational challenges. Forestry pests, such as the flatheaded fir borer, Mediterranean oak borer, and western pine beetle can adversely affect tree growth, leading to decreased yields of wood and non-wood products.[71] For instance, pests like bark beetles can cause extensive tree mortality, which directly impacts timber supply and quality.

Wildfire poses a significant economic threat and remains a critical risk to industries within the working lands sector.[72] Much of the county's agricultural land is situated in wildfire-prone areas, where smoke and ash can severely damage crops, farms, and agricultural fields. Even agricultural areas outside fire hazard zones are not immune, as smoke and ash can alter soil nutrients, potentially causing plants to die or yield fewer usable fruits.[73] For wine grape growers, smoke exposure can lead to "smoke taint," a condition where grapes absorb smoke compounds through their skins, particularly during and after the ripening

phase. This can negatively affect the quality of the wine, resulting in lost contracts and economic hardship for growers. These impacts create considerable economic challenges for farmers. Moreover, these hazards affect not only food production but also the financial stability of farmers and outdoor workers.

Key crops, including wine grapes, pears, walnuts, and nursery products, heavily rely on irrigation from groundwater wells, underscoring the importance of consistent water availability. Drought can drastically reduce both ground and surface water, making it challenging to maintain crop health and yields. Prolonged droughts and extreme heat increase water needs, leading to competition for limited resources and threatening the sustainability of agriculture.

Extreme heat also stresses fruit and nut trees, reduces quality, and accelerates evapotranspiration, depleting soil moisture. This affects plant health in nurseries, while livestock suffer from heat stress, reducing weight gain, milk production, and overall health. In forestry, extreme heat weakens trees, making them more susceptible to pests and diseases, which reduces timber quality and yield. Periods of extreme cold can also render crops unviable, reducing yields. Extreme cold events can significantly affect agricultural productivity by causing crop failure and yield reductions. In viticulture, freezing temperatures can destroy the primary bloom of grapevines, necessitating reliance on secondary blooms, which may produce lower-quality fruit. To protect vines from frost damage, vineyard managers use methods like spraying water over the plants. When the water freezes, it forms a thin ice layer that helps keep the vines from getting too cold and prevents serious damage to the plant cells.

Climate change is projected to shift the types of crops that can thrive in the region due to changes in temperature and precipitation patterns, decreasing the productivity of some crops while boosting others. For instance, warmer temperatures and altered precipitation are expected to reduce wine grape yields and increase water demands for agriculture. Warmer temperatures may also increase water demands for agriculture and reduce plant growth.[74, 75]

Flooding, high winds, hail, and thunderstorms all pose significant threats to agriculture, with each hazard capable of decimating crops and causing severe economic losses. Flooding can lead to significant yield losses, damage grapevines, and cause root diseases in fruits and nuts, while also affecting nurseries through soil compaction and reduced drainage. In timber production, floods can erode soil around tree roots, destabilizing trees and reducing their growth potential. Additionally, floods can delay planting schedules and wash away topsoil, leading to long-term degradation of soil health and productivity.[76, 77] Crops can be flattened by high-velocity winds and food crops can be damaged by hail. These combined hazards create considerable economic challenges, impacting both food production and the financial stability of farmers and outdoor workers.

Pillars of Landscape Resilience

The pillars of resilience, such as forest resilience, fire dynamics, water security, fire-adapted communities, biodiversity conservation, carbon sequestration, and economic diversity are critical in addressing the impacts on agriculture in throughout the county. ***Forest resilience*** and ***biodiversity conservation*** help protect crops, livestock, and timber production by maintaining healthy ecosystems that are less susceptible to pests and diseases, drought, and other hazards. ***Healthy forests*** reduce the spread of pests that can weaken trees and agricultural crops, minimizing economic losses. ***Fire dynamics*** and ***fire-***

adapted communities support proactive fire management, reducing wildfire risks that threaten agricultural areas, agriculture infrastructure, and the residential areas supporting outdoor workers in this industry. ***Water security*** is essential for the agriculture sector, and these measures help ensure that there is enough water for irrigation, even during prolonged dry spells. ***Economic diversity*** stabilizes the agricultural and timber economies by encouraging diversification of crops, livestock, and timber products. This pillar supports farmers' and timber producers' financial resilience, helping buffer against economic shocks due to crop failures, pest outbreaks, or other challenges. ***Carbon sequestration*** supports greenhouse gas-reduction efforts, which helps stabilize weather patterns and reduces the risks of climate change conditions that threaten agriculture. Similarly, ***wetland integrity*** and ***forest resilience*** help maintain soil health and reduce erosion, supporting agricultural and timber productivity. Together, these pillars provide a comprehensive framework for enhancing agricultural resilience in Lake County, protecting crops, livestock, and livelihoods from climate-related hazards.

Forests and Woodland Habitat

Most Vulnerable To:					
Unincorporated Lake County, City of Clearlake, City of Lakeport	 Agricultural and Forestry Pests and Diseases	 Drought	 Extreme Temps.	 Severe Weather	 Wildfire and Smoke

The unincorporated areas of Lake County are predominantly rural, with significant portions of land dedicated to agriculture, natural resources, and open spaces. State and federal lands consist of undeveloped lands which include Boggs Mountain Demonstration State Forest, Clear Lake State Park, Anderson Marsh State Historic Park, Mendocino National Forest, Cache Creek Wilderness Area, Indian Valley Recreation Area, Indian Valley Management Area, Berryessa Snow Mountain National Monument, and North Cow Mountain Recreation Area. While the cities consist of primarily urban, developed land uses, conifer and deciduous forests and oak woodlands are found throughout the unincorporated communities and cities.

Forests and woodlands throughout the county provide a wide range of valuable ecosystem services, including supporting biodiversity, sequestering carbon, offering recreational opportunities, and stabilizing soil. However, these ecosystems are increasingly threatened by climate change hazards, largely due to their significant overlap with high and very high fire severity zones, as well as the potential of cascading effects from drought, extreme heat, and ecosystems pest infestations.[78] Weakened and dead forest and woodland habitats can ignite more quickly during a wildfire, creating devastating wildfires that burn at higher temperatures. These weakened trees can also fall during severe weather events, damaging structures and blocking roadways. These ecosystems struggle to recover from wildfires as wildfire burning at higher temperatures damage trees more severely, preventing regrowth and sprouting of seedlings.

Oak woodlands, though fire-dependent ecosystems, are increasingly at risk from repeated high-intensity fires. Repeated high-intensity fires can kill mature trees that would otherwise survive single low-intensity fires, disrupting the ecosystem's balance.[79, 80] Additionally, sudden oak death can spread during high wind events and devastate oaks woodlands. Once oak trees are infected with sudden oak death, they have no defense against the disease. Loss of these trees can significantly change the ecosystem, harming plants and wildlife that depend on oaks and leading to ecosystem shift to grassland or shrub habitats.

The interaction between urban development in Clearlake and Lakeport and natural habitats complicates efforts to manage and protect forest and woodland ecosystems by creating fragmented landscapes that disrupt natural processes. Urban development often leads to habitat loss, increased human-wildlife conflict, and altered water flows, all of which make it more challenging to maintain ecological balance and resilience. The fragmentation of habitats exacerbates vulnerabilities by disrupting ecological continuity, reducing habitat size, and isolating species populations, limiting the movement of wildlife, reducing genetic diversity, and reducing resilience. As a result, the ecosystem becomes more susceptible to pests, which can spread more easily among weakened plant populations, as well as to drought, which has a greater impact on small, isolated patches.

Pillars of Landscape Resilience

The pillars of resilience such as forest resilience, fire dynamics, water security, air quality, wetland integrity, biodiversity conservation, and carbon sequestration are fundamental in addressing the impacts on forests and woodlands countywide. ***Forest resilience*** and ***biodiversity conservation*** are crucial for maintaining healthy forest and woodland ecosystems that can withstand climate change impacts, such as pests, extreme heat, and drought. These pillars help sustain diverse species, stabilize soil, and promote tree regeneration, thereby reducing vulnerability to high-intensity wildfires and ecosystem collapse. ***Fire dynamics*** and ***fire-adapted communities*** play an essential role in managing wildfire risks that threaten forests and woodlands. Proactive fire management strategies, such as controlled burns and fuel reduction, help reduce the intensity of wildfires, allowing ecosystems like oak woodlands to better withstand fire events. ***Carbon sequestration*** is integral to forests and woodlands as they function as significant carbon sinks, helping reduce greenhouse gas emissions by absorbing carbon dioxide from the atmosphere. Maintaining healthy, resilient forests through sustainable management practices enhances their ability to sequester carbon, which also contributes to climate regulation and reducing greenhouse gas emissions. ***Water security*** and ***wetland integrity*** are vital for forest health, as they help maintain adequate soil moisture and water availability, supporting tree growth and reducing the risk of drought-induced stress. Together, these pillars provide a comprehensive framework for enhancing the resilience of forests and woodlands throughout the county, protecting them from climate change hazards, ensuring their ecological health, and maintaining their role in supporting biodiversity, recreation, and cultural heritage.

Water and Wastewater Treatment, Delivery, and Collection

	Most Vulnerable To:			
Unincorporated Lake County	 Drought	 Human Health Hazards	 Landslides	 Wildfire and Smoke
City of Clearlake	 Drought	 Flooding	 Wildfire and Smoke	
City of Lakeport	 Drought	 Flooding	 Wildfire and Smoke	

Water and wastewater services in Lake County are managed by a combination of public and private entities, each responsible for specific areas and functions ranging from communitywide systems to small resort-only systems.

Water and wastewater infrastructure are at risk from drought, landslides, and wildfires. Drought lowers groundwater levels by reducing the amount of water that percolates into groundwater basins. This reduction can result in dry wells, decreased groundwater availability, and diminished contributions to surface water bodies, such as rivers, streams, and wetlands, which depend on groundwater for flow, especially during dry periods. Lower groundwater levels result in the need to deepen wells, which can be cost prohibitive for both domestic and agriculture well owners.[81] Drought and extreme heat conditions can reduce water levels in Clear Lake and other surface water supplies, causing harmful cyanobacteria or blue-green algae to bloom. These bacteria can cause skin and eye irritation, gastrointestinal symptoms, and neurological symptoms. While standard larger water treatment facilities can filter out this bacteria, smaller residential systems may be unable to do so. Drought conditions can also affect the ability of the water districts serving unincorporated communities and the cities of Clearlake and Lakeport to provide reliable water services, as much of the water supply comes from Clear Lake, leading to water use restrictions and increased water costs for residents and businesses. Drought can reduce sewer flow by decreasing the amount of water entering the system, making wastewater more concentrated and requiring additional treatment to meet water quality standards, which in turn increases energy use. Reduced flow also decreases the flushing of debris from pipes, reducing system efficacy and potentially leading to infrastructure damage or service disruptions.

Flood events can disrupt wastewater services if wet-weather flows from rainfall and stormwater overwhelm the system, impairing operations of treatment plants and the capacity of septic systems. This could cause raw sewage to leak into the surrounding soil and water, creating significant public health risk.

Flooding can also damage the pipelines and pumps going to and from the treatment facilities, compromising service availability. If this infrastructure fails, wastewater services could be unavailable for weeks or months since repairs can be expensive.

Buried water pipelines are also at risk due to changes in soil water content caused by flooding, as fluctuations in moisture levels can lead to soil instability, increasing the likelihood of pipeline shifting, cracking, or even bursting. In areas with expansive clay soils, prolonged drought conditions can cause soil to contract and shift, leading to water pipe failures in both public and private systems. Damage to the water system could increase vulnerability to wildfire because the system is essential for firefighting efforts, though it is not designed to handle major wildfires. Wildfires can contaminate water supplies with ash and fire retardants, which degrades water quality and reduces availability. Wastewater systems are typically unaffected unless the sewer collection lines themselves sustain damage.

Pillars of Landscape Resilience

The pillars of resilience, such as forest resilience, fire dynamics, water security, fire-adapted communities, wetland integrity, and biodiversity conservation are essential in addressing the impacts on water and wastewater treatment, delivery, and collection throughout the county. ***Water security*** and ***wetland integrity*** are critical for maintaining reliable water supplies, especially during droughts that threaten both surface and groundwater availability. These pillars help ensure that water sources, such as Clear Lake and local groundwater, remain viable for drinking water, agriculture, and firefighting. ***Wetland integrity*** also helps manage flood risks, reducing the burden on wastewater treatment plants by controlling stormwater runoff and preventing treatment systems from being overwhelmed. ***Fire dynamics*** and ***fire-adapted communities*** are vital for protecting water and wastewater infrastructure from the risk of wildfires. Ensuring that both water infrastructure and nearby communities are adapted to withstand wildfire threats is crucial for maintaining service continuity. ***Forest resilience*** and ***biodiversity conservation*** contribute to watershed health, maintaining the natural capacity to absorb rainfall, reducing soil erosion, and protecting water quality, which is essential for both drinking water and wastewater management. Together, these pillars provide a comprehensive framework to protect and enhance the resilience of water and wastewater infrastructure throughout the county, ensuring reliable service delivery, minimizing risks from climate-related hazards, and safeguarding community health and well-being.

Other Significant Findings

Although the following populations and assets are not identified as vulnerable to as many hazards as discussed above, they are still significant and important to Lake County, Clearlake, and Lakeport, and represent critical concerns to community members. It is essential that this report recognize these other significant findings for the purpose of community planning and risk assessment efforts. Addressing these vulnerabilities proactively can help to reduce their impacts and support countywide resilience.

Older Adults

Most Vulnerable To:						
Unincorporated Lake County, City of Clearlake, City of Lakeport	 Drought	 Extreme Temps.	 Human Health Hazards	 Flooding	 Landslides	 Wildfire and Smoke

Older adults face a distinct set of vulnerabilities that are exacerbated by climate changes and during emergencies and hazardous events. Many older adults experience reduced mobility, impaired vision, and hearing loss, which can make it difficult for them to respond quickly to sudden threats such as natural disasters. For instance, attempting to evacuate during a wildfire or accessing cooling centers while dealing with mobility impairments or vision issues can be very difficult. Physical limitations often lead to delays in older adults taking protective actions or can cause them to take longer to respond during emergencies, increasing their risk of harm.

In the unincorporated Lake County, approximately 25 percent of residents are older adults, and in Lakeport, 23 percent of residents are older adults, while in Clearlake, this figure is 18 percent.[82, 83, 84] Many of these older adults live alone—18 percent in unincorporated Lake County, 22 percent in Lakeport, and 16 percent in Clearlake—which adds another layer of vulnerability during emergencies due to limited communication and mobility challenges.[85, 86, 87] Furthermore, older adults are more susceptible to injuries from hazardous events and may face a more difficult recovery due to age and fixed incomes. Older adults are also highly susceptible to cascading and compounding impacts from natural hazards, as the interplay of physical limitations, chronic health issues, economic constraints, and limited access to information can converge to place their lives at considerable risk.

Older adults in care homes face additional vulnerabilities, as they may depend on caregivers or institutional protocols for emergency response, which can vary in effectiveness, depending on the availability and capability of caregivers or the adequacy of institutional protocols. During emergencies, such as wildfires or extreme weather events, the adequacy of care can be compromised by limited staff availability, as caregivers may also be affected or unable to reach the facility. This situation is particularly concerning during widespread emergencies, where swift evacuations or emergency care can be severely delayed, increasing the risk of harm faced by these individuals. Additionally, older adults in care homes may have complex medical needs that require specialized attention, and disruptions in care can have severe, potentially life-threatening consequences.

Economic and social factors compound many of these risks. Older adults receive, on average, less income than middle-aged adults. While some continue to work or have ample financial resources due to retirement funds or other investments, many have limited, fixed incomes, which limits their ability to invest in necessary disaster preparedness measures, such as purchasing emergency supplies or making their homes more resilient to natural hazards; this ultimately can increase their vulnerability to hazard events. The digital divide is another key factor given that some older adults may be less familiar with digital

technology, making it difficult for them to receive timely alerts and critical information disseminated through smartphones, social media, or emergency apps.

Pillars of Landscape Resilience

The pillars of resilience, such as fire dynamics, air quality, water security, fire-adapted communities, and social and cultural well-being are highly relevant in addressing the vulnerabilities of older adults. ***Fire dynamics*** and ***fire-adapted communities*** ensure adequate wildfire risk reduction and preparedness, reducing the risks for older adults who may have difficulty evacuating or taking protective actions. ***Air quality*** management reduces exposure to wildfire smoke, which is critical for older adults with respiratory and cardiovascular issues. ***Water security*** ensures that older adults have reliable access to clean water, which is essential for their health, particularly during heatwaves and droughts. The ***social and cultural well-being*** pillar emphasizes the importance of connecting people with the landscape, recreation, and health improvements, which increases the connection of older adults with the community. Together, these pillars provide a framework for protecting older adults by addressing their physical, medical, and social needs, enhancing their safety and well-being during hazardous events.

Persons Living in Manufactured Homes

Most Vulnerable To:						
Unincorporated Lake County, City of Clearlake, City of Lakeport	 Drought	 Extreme Temps.	 Flooding	 Landslides	 Severe Weather	 Wildfire and Smoke

Persons living in manufactured homes face significant vulnerabilities to hazards, structural challenges, and socioeconomic barriers. These homes are particularly susceptible to drought, extreme temperatures, flooding, landslides, severe weather, and wildfires. Unlike other housing types, manufactured home residents are more likely to experience water cut-offs, particularly during periods of water scarcity, which poses a serious risk to their well-being.[88]

Energy efficiency is another critical issue, as older manufactured homes are among the least efficient housing units. These homes often cannot accommodate weatherization improvements, leading to higher energy costs per square foot compared to detached homes. This financial burden is exacerbated during extreme weather, as residents must rely more heavily on air conditioning during heatwaves and heating systems during the winter.[89] During severe storms, manufactured homes are especially vulnerable to damage from strong winds, heavy rainfall, and flying debris. Wildfires also present a grave threat, as manufactured homes, particularly older models, are constructed with easily ignitable, lightweight materials. Their lack of fire resistance, combined with the proximity of homes in manufactured home communities, facilitates rapid fire spread, making containment efforts difficult.[90]

Structurally, manufactured homes lack the resilience of foundation-built houses, making them prone to damage from flooding and other severe weather events. While retrofitting and proper maintenance can improve their durability, many residents face financial constraints that limit their ability to undertake these measures. Additionally, manufactured homes in areas prone to landslides, such as parts of Kelseyville, , Clear Lake Oaks, Lucerne, and North Lakeport, are at risk of foundation damage due to soil erosion or landslide activity, potentially leading to destruction and harm for occupants.

Financial limitations further hinder residents' ability to implement fire mitigation strategies, such as creating defensible spaces or upgrading to fire-resistant materials. Many manufactured home community residents do not own the land beneath their homes, restricting their ability to make substantial safety improvements. These structural vulnerabilities, coupled with socioeconomic challenges and the high-risk locations of many manufactured home communities, leave residents particularly exposed to harm during emergencies like wildfires.

Pillars of Landscape Resilience

The pillars of resilience such as forest resilience, fire dynamics, fire-adapted communities, water security, air quality, economic diversity, and social and cultural well-being are highly relevant in addressing the vulnerabilities of persons living in manufactured homes. ***Forest resilience*** and ***fire dynamics*** are vital for mitigating wildfire risks, which disproportionately threaten manufactured homes due to their lightweight construction and proximity within manufactured home communities. Proactive fire management and improved forest health reduce the likelihood of wildfires reaching these areas, while ***fire-adapted communities*** promote strategies to enhance fire safety, such as defensible space and evacuation planning. ***Water security*** ensures a reliable and equitable water supply, supporting the basic needs of vulnerable populations, helping them cope with water scarcity. ***Air quality*** improvements help protect residents from health risks associated with prolonged smoke exposure and extreme heat. ***Economic diversity*** provides resources for improving the energy efficiency and structural resilience of manufactured homes. Investments in retrofitting programs and energy assistance initiatives help reduce the financial burden on residents while making homes more resistant to climate hazards. ***Social and cultural well-being*** emphasizes the importance of equitable access to resources, such as financial assistance for retrofitting, disaster preparedness education, and community support networks. Strengthening these systems ensures that manufactured home residents are better equipped to handle emergencies and recover more effectively.

Persons Living in Isolated Communities

Most Vulnerable To:						
Unincorporated Lake County, City of Clearlake, City of Lakeport	 Drought	 Extreme Temps.	 Flooding	 Landslides	 Severe Weather	 Wildfire and Smoke

Persons living in isolated communities face heightened risks from various hazards, including drought, extreme temperatures, flooding, landslides, severe weather, and wildfires. These communities often consist of individuals living on single-access roads—routes with only one entry or exit point—or in areas that lack transportation links to larger, more populated regions. Persons living in isolated communities are more likely to rely on groundwater. During prolonged droughts, groundwater levels can drop, and domestic wells, typically shallower than agricultural wells, may run dry. This leaves communities without adequate water supplies, compounding the stress of extreme heat and other hazards.

When roads in isolated areas of the county become impassable due to flooding, wildfires, landslides, or debris, residents may lose access to vital resources such as food and medicine. Emergency services may also find it impossible to reach those in need, leaving them stranded until roads are repaired or alternative routes are established. If roads become impassable due to wildfire or infrastructure damage, residents may be unable to evacuate. Power safety shut-offs due to high wind conditions or extreme heat conditions that stress the electricity grid leave residents without electricity for extended periods, further restricting access to these communities and the ability for residents to receive emergency notifications.

Pillars of Landscape Resilience

The pillars of resilience, such as forest resilience, fire dynamics, water security, air quality, economic diversity, and social and cultural well-being are highly relevant in addressing the vulnerabilities of persons living in isolated communities. ***Forest resilience*** and ***fire dynamics*** play critical roles in reducing wildfire risks, which pose acute dangers to isolated communities. Proactive fire management and healthy forests help prevent wildfires that can block single-access roads, ensuring that residents can evacuate safely and that emergency services can reach affected areas. ***Water security*** ensures sustainable water management helps mitigate the impacts of prolonged droughts that could leave domestic wells dry, providing a more reliable water supply for isolated areas. ***Air quality*** supports the health and well-being of residents, particularly during wildfire events when smoke can exacerbate respiratory issues. Cleaner air ensures that residents can stay safe during prolonged exposure to hazards. ***Economic diversity*** supports the resilience of isolated communities by providing resources for infrastructure improvements and emergency preparedness. Investments in diverse economic activities help fund critical services and create pathways for recovery after disasters. ***Social and cultural well-being*** emphasizes the importance of equitable access to emergency resources and community support networks, ensuring that isolated residents are not left behind during disaster planning or response efforts.

Outdoor Recreation and Tourism

Most Vulnerable To:					
Unincorporated Lake County, City of Clearlake, City of Lakeport	 Drought	 Extreme Temps.	 Human Health Hazards	 Landslides	 Wildfire and Smoke

State and federal lands, including public and Tribal Trust lands, play a vital role in countywide outdoor recreation and tourism industry. Notable areas include Clear Lake State Park, Anderson Marsh State Historic Park, Mendocino National Forest, Cache Creek Wilderness Area, Indian Valley Recreation and Management Areas, Berryessa Snow Mountain National Monument, Knoxville Recreation Area, and North and South Cow Mountain Recreation Areas. Clear Lake, the largest natural lake in California, serves as an important regional destination for tourism and recreation. Additionally, the wine industries in Lake County provide a significant source of tourism. Hazards such as wildfires, extreme heat, and flooding not only affect the safety and accessibility of outdoor recreation but also have broader economic and environmental consequences. Damage to facilities and ecosystems, along with reduced visitor numbers, can lead to significant financial losses for local businesses and governments. Additionally, prolonged closures or environmental degradation can harm the long-term sustainability of these recreational areas.

Major roadways, bridges, trails, parks, and other popular recreational spots can be damaged and become impassable due to flooding, landslides, severe weather, and wildfire. Flooding may wash out roadways, trails, and infrastructure, making it difficult or impossible for visitors to access these locations. This could prevent visitors from traveling to the region, damaging the outdoor recreation industry, rendering recreational areas unusable, and impacting both recreation and local economies reliant on tourism.

The agritourism industry is sensitive to changes in weather and pests, which can lead to lower crop yields and economic losses. Agriculture and related wine tourism, one of the largest economic drivers in the county, can be harmed by agricultural pests and diseases that ravage plants, drought and extreme heat that weaken or ruin crops, and severe weather that decimates agricultural products.

Outdoor recreation locations, such as Clear Lake or the Mendocino National Forest, face flooding, landslides, severe weather, and wildfire which can significantly impact their accessibility, usability, and safety. Wildfires can destroy ecosystems, threaten visitor safety, and lead to the closure of trails, parks, and other facilities. State and federal lands within the county are particularly vulnerable, as they often fall within high and very high fire hazard severity zones. Even when recreational facilities are not directly impacted by flames, poor air quality caused by wildfire smoke can force closures to protect the health of participants. Additionally, local businesses that depend on tourism can experience significant losses during wildfire events. For example, access to popular water recreation destinations like Clear Lake may be restricted or deemed unsafe, prompting potential visitors to choose alternative destinations. These disruptions can have long-term economic consequences for the community.

Extreme heat poses challenges to outdoor recreational activities like running, biking, and hiking, as intense physical exertion in high temperatures increases the risk of heat-related illnesses. Visitors must stay hydrated and avoid overexertion to reduce these risks. Additionally, extreme heat can deter travelers from visiting the county during warmer months, reducing tourism revenue. However, warmer temperatures may also present opportunities for water-based recreation, such as swimming, boating, and other water sports. While these activities may see an increase in participation during hot weather, it is crucial to ensure safe conditions and adequate resources for participants.

Pillars of Landscape Resilience

The pillars of resilience, such as forest resilience, fire dynamics, water security, fire-adapted communities, air quality management, wetland integrity, biodiversity conservation, carbon sequestration, and economic diversity are highly relevant in addressing the impacts on outdoor recreation and tourism across the county. ***Forest resilience and biodiversity*** conservation help maintain the health of state and federal lands, ensuring that ecosystems remain vibrant and accessible for outdoor recreation. Healthy forests are essential for providing scenic beauty, biodiversity, and habitats that support recreational activities like hiking, camping, and wildlife observation. ***Fire dynamics*** and ***fire-adapted communities*** are critical in mitigating wildfire risks to recreational areas. Wildfires threaten not only the natural environment but also visitor-serving facilities and visitor safety, leading to the closure of trails, parks, and other recreational facilities. By promoting proactive fire management, these pillars help minimize the risk of wildfires and ensure that key tourism infrastructure remains accessible and operational after fire events.

Water security is essential for maintaining recreational water bodies such as Clear Lake and Lake Pillsbury, which support activities like boating, fishing, and swimming. Ensuring a stable water supply and mitigating drought impacts are crucial for keeping these areas viable for residents and tourists. ***Wetland integrity*** also contributes to maintaining water quality, reducing the risk of harmful algal blooms that could make water recreation unsafe. ***Air quality management*** is particularly relevant to outdoor recreation, as wildfire smoke can force the closure of recreational areas to protect the health of visitors and workers. Maintaining good air quality helps ensure that outdoor activities can proceed safely, contributing to a positive tourism experience. ***Economic diversity*** supports the resilience of the tourism industry by promoting varied recreational offerings and visitor-serving uses, such as outdoor activities, agritourism, and cultural tourism. This diversity helps buffer against economic shocks caused by natural hazards that might temporarily limit access for visitors. Supporting local businesses that depend on tourism can also help maintain a stable economic foundation for the community. ***Carbon sequestration*** and ***forest resilience*** also help mitigate climate change impacts, reducing the severity and frequency of extreme weather events that can damage recreational areas and disrupt tourism. Maintaining healthy forests and woodlands contributes to the long-term sustainability of these natural attractions, ensuring they continue to provide ecological, recreational, and economic benefits. Together, these pillars provide a comprehensive framework for enhancing the resilience of the countywide outdoor recreation and tourism sector, protecting natural and recreational resources, and ensuring that these areas remain accessible and enjoyable for residents and visitors alike.

Aquatic Habitat

Most Vulnerable To:			
Unincorporated Lake County, City of Clearlake, City of Lakeport	 Drought	 Extreme Temps.	 Severe Weather

Aquatic habitats throughout the county include riparian areas, lakes, and wetlands. Unincorporated Lake County, Clearlake, and Lakeport all have access to Clear Lake, which represents the largest aquatic habitat countywide. In unincorporated Lake County, aquatic ecosystems consist of Lake Pillsbury, Indian Valley Reservoir, Blue Lakes, Kuulanapo Wetland Preserve, Rodman Slough, and riparian corridors along Kelsey Creek, Scotts Creek, Middle Creek, Copsey Creek, Putah Creek, Adobe Creek, and Cole Creek. In Clearlake, aquatic habitats include Borax Lake and riparian corridors along Burns Valley Creek. In Lakeport, aquatic habitats consist of riparian areas along Forbes Creek.

Clear Lake Hitch

The Clear Lake hitch (*Lavinia exilicauda chi*) is a freshwater fish species endemic to Clear Lake. This fish plays an important ecological role in the lake's ecosystem and is culturally significant to the local Pomo tribes. Once abundant, the population of Clear Lake hitch has been in sharp decline in recent decades due to habitat loss, water diversion, and predation by non-native species. In 2014, the species was listed as threatened under the California Endangered Species Act. Efforts are currently underway to protect and restore this species through habitat restoration projects, improved water management, and collaborative work with local communities.

Wetlands serve as natural buffers that absorb and slow floodwaters because the dense vegetation in wetlands physically slows the movement of water, allowing for gradual absorption and infiltration into the soil. This reduces the speed and intensity of floodwaters, protecting communities from damage from flooding. They also play a crucial role in water filtration, removing pollutants and improving water quality for both human and ecological needs. Additionally, wetlands offer critical habitat for diverse wildlife, providing essential breeding, feeding, and shelter areas for birds, fish, and other wildlife. Furthermore, these habitats offer recreational opportunities, such as birdwatching, hiking, and educational activities, contributing to the well-being of the community. Riparian areas play a key role in maintaining water quality, stabilizing stream banks, and providing shade that helps regulate water temperatures, which is vital for aquatic species. Lakes, such as Clear Lake, support a variety of aquatic life and provide important resources for recreation, water supply, and habitat connectivity. One notable species is the Clear Lake hitch (*lavinia exilicauda chi*), a native fish that relies on these aquatic habitats for its lifecycle, including migration and spawning. These habitats are also among the most vulnerable habitats in the county. Several existing factors play a role in the sensitivity of these ecosystems to changing conditions, such as fragmentation, existing pollution levels, and built structures that may impede the natural adaptive migration of the ecosystems as drought intensifies and temperatures increase.

An increase in extreme heat days could result in higher rates of evapotranspiration, leading to an earlier, more rapid seasonal drying down of riparian communities. Higher air temperatures lead to elevated water temperatures in Clear Lake and other water bodies, which can disrupt the physical, chemical, and biological processes in the lakes. Warmer water can exacerbate thermal stratification and reduce oxygen levels in deeper waters, affecting aquatic life and nutrient cycling.[91] Elevated temperatures contribute to the growth of harmful algal blooms, particularly cyanobacteria, which thrive in warm conditions and can produce toxins that pose risks to human health and wildlife. Warmer water temperatures allow cyanobacteria to grow faster and outcompete other algae. The decomposition of dead algae further depletes oxygen levels, leading to hypoxic conditions detrimental to fish and other aquatic organisms.[92] Extreme heat can also reduce water flow and mixing in wetlands, creating stagnant conditions ideal for cyanobacteria to form blooms.[93]

During drought conditions, riparian areas can also dry up, substantially changing the ecosystem's character. Lower water levels in creeks can result in higher water temperatures and lower dissolved oxygen levels, both potentially dangerous conditions for aquatic species. Riparian areas may be overwhelmed by floodwaters and damaged by debris. The absence of adequate freshwater input during droughts can lead to sections of the wetlands drying out and breaking apart, resulting in a loss of habitat continuity and decreased ecological stability. During long-lasting droughts, parts of the wetlands may transition to other ecosystems, causing permanent loss of an ecosystem that has already been destroyed in much of the state. Drought can also contribute to algal blooms, low streamflow, degraded water quality, elevated temperatures, and increased erosion in riparian habitat.

Severe weather can lead to excessive flooding, inundating wetlands for extended periods. This prolonged saturation can stress wetland vegetation, disrupt plant communities, and alter the hydrology of the area. Severe storms can cause trees to fall in riparian areas, which can disrupt the flow of water through the systems and impact aquatic wildlife in the streams.

Pillars of Landscape Resilience

The pillars of resilience, such as water security, wetland integrity, and biodiversity conservation are highly relevant in addressing the impacts on aquatic habitats across the county. ***Wetland integrity*** is crucial for maintaining the health and stability of aquatic habitats, as wetlands act as natural buffers that absorb floodwaters, filter pollutants, and provide essential habitat for a wide range of species. ***Water security*** plays a significant role in maintaining adequate water flow to riparian areas, lakes, and wetlands, especially during periods of drought. Ensuring consistent water availability is vital for preventing the drying out of riparian habitats, maintaining water quality, and reducing the risk of harmful algal blooms. ***Biodiversity conservation*** helps protect aquatic species and their habitats from fragmentation, pollution, and other stressors, ensuring that ecosystems remain resilient and capable of adapting to changing conditions. Together, these pillars provide a comprehensive framework for protecting and enhancing the resilience of aquatic habitats in Lake County, ensuring their continued role in supporting biodiversity and improving water quality.

Emergency Services

	Most Vulnerable To:				
Unincorporated Lake County	 Agricultural and Forestry Pests and Diseases	 Extreme Temps.	 Human Health Hazards	 Severe Weather	 Wildfire and Smoke
City of Clearlake	 Human Health Hazards				
City of Lakeport	 Human Health Hazards				

Emergency services throughout the county include emergency medical response, fire protection services, and law enforcement response. Several climate hazards can disrupt these services, putting community members at risk. Wildfire smoke, severe weather, and extreme heat can significantly increase the number of calls for emergency response, putting stress on the emergency medical response and potentially leading to a shortage of care providers. During major public health emergencies, the availability of emergency medical response can be further compromised due to increased demand and impacts to the health of responders, causing staffing shortages. Disruptions in supply chains can result in shortages of medical equipment, pharmaceuticals, and healthcare personnel, leaving the community's needs unmet. Since these are often regional events, cities such as Clearlake and Lakeport and their emergency providers may not be able to rely on mutual aid to compensate for shortages.

Trees weakened by pests or diseases are at a higher risk of falling during severe weather events, which can block critical transportation routes, preventing emergency services from reaching incidents such as fires, medical emergencies, or natural disasters, leading to delays in response times. Emergency services may also need to divert resources to clear fallen trees and debris, further straining their capacity to handle other emergencies, especially during peak demand periods. These risks are particularly concerning for rural, unincorporated communities with limited roadway connections, such as Cobb, Middletown, and Hidden Valley Lake.

Wildfire poses a significant threat to emergency service providers and public safety infrastructure. The communications systems used by federal, state, and local agencies are vulnerable to damage or destruction from wildland fires, which can severely disrupt coordinated response efforts. Additionally, roadways may become impassable due to active flames or be closed off to prioritize access for emergency personnel, complicating mobility and response logistics.

Pillars of Landscape Resilience

The pillars of resilience such as forest resilience, fire dynamics, water security, fire-adapted communities, air quality, and biodiversity conservation are highly relevant in addressing the impacts on emergency services throughout the county. ***Forest resilience*** and ***biodiversity conservation*** help maintain healthy forests, reducing the likelihood of trees weakened by pests or disease falling and blocking critical emergency routes. This ensures that emergency services can reach affected areas without significant delays, especially in rural and unincorporated communities. ***Fire dynamics*** and ***fire-adapted communities*** play a crucial role in reducing wildfire risks that threaten emergency services and public safety infrastructure. Proactive fire management reduces the risk of wildfires that can make roads impassable, damage communication systems, and complicate response logistics. Ensuring that communities are prepared for fire hazards also helps maintain access for emergency responders during fire events. ***Air quality*** is essential for human health and wellness. By reducing smoke from wildfires through prescribed burns and maintaining healthy forests, this pillar helps ensure safer air quality, thereby supporting the health of the community and emergency responders, reducing the risk of staff shortages during peak demand periods. ***Water security*** is critical for ensuring there is enough water available for firefighting efforts, particularly during droughts conditions. Maintaining adequate water supplies supports effective fire suppression and reduces the risk of fires spreading to critical infrastructure. Together, these pillars provide a comprehensive framework for enhancing the resilience of emergency services across the county, ensuring that they can continue to protect community health and safety during climate-related hazards.

Public Transit Access

Most Vulnerable To:				
Unincorporated Lake County, City of Clearlake, City of Lakeport	 Extreme Temps.	 Flooding	 Severe Weather	 Wildfire and Smoke

Residents throughout the county rely on public transit services to conduct their daily activities and reach jobs, friends, and vital health and support services. Lake County Transit Authority routes are most vulnerable to extreme temperatures, flooding, severe weather, and wildfire. These challenges extend to transit accessibility, as many bus stops and transit facilities in the county will face increased risk of disruption, reducing access to public transportation services.

Extreme heat or cold can make waiting for public transit uncomfortable, leading to a decrease in ridership. During periods of severe storms, fewer residents may choose to use public transit due to the difficulty of waiting outdoors, which ultimately reduces the overall ridership of the Lake Transit system and impacts service efficiency. Many roads and transit facilities are in flood-prone areas, and when these transportation networks are compromised due to rising waters, the consequences extend throughout the region, resulting in widespread disruptions to transit. Public transit access may be delayed or rerouted if roadways become impassable due to storms, heavy rain, snow, or other severe weather. In cases where roadways are significantly damaged or completely fail, transit services could be suspended for extended

periods, potentially lasting days or even weeks. This can lead to significant disruptions in daily activities, including commuting to work, accessing healthcare, or obtaining essential supplies, especially for those who rely heavily on public transportation.

Wildfires can lead to road closures due to fire damage or safety concerns, directly impacting public transit routes and leading to service interruptions. These disruptions can prevent residents from accessing essential services and reaching evacuation points during emergencies. The presence of wildfires may also deter individuals from using public transit because of safety risks or altered travel patterns. Additionally, outdoor transit stops become significantly less appealing during periods of heavy wildfire smoke exposure, potentially causing a further decrease in ridership and increasing the risk to those waiting for transit services in affected areas.

Pillars of Landscape Resilience

The pillars of resilience such as forest resilience, fire dynamics, fire-adapted communities, air quality, and wetland integrity are highly relevant in addressing the impacts on public transit access throughout the county. ***Forest resilience*** and ***fire dynamics*** promote ***healthy forests***, and ***proactive fire management*** reduce the likelihood of wildfires damaging roads and disrupting transit services. Ensuring that ***fire-adapted communities*** are prepared also helps reduce the impact of wildfires on transportation infrastructure, thereby maintaining access to public transit. ***Wetland integrity*** is critical in managing the effects of flooding on transit routes and facilities. Wetlands can help absorb floodwaters and reduce the intensity of flooding. ***Air quality*** is essential for maintaining comfortable and safe conditions for transit users. By improving air quality and reducing emissions from fires, this pillar helps maintain ridership and protects the health of residents waiting for transit services. Together, these pillars provide a comprehensive framework for enhancing the resilience of public transit access across the county, ensuring that transportation services remain reliable and accessible, even in the face of climate change challenges.

NEXT STEPS

The Climate Vulnerability Analysis is a key technical study that provides a foundation for preparation of the county's first Climate Adaptation Plan and the update of the Lake County Health and Safety Element. The Climate Vulnerability Analysis helps community members, County and City staff, and decision makers understand how climate change hazards may alter community conditions and what parts of the community (people and places) should be prioritized for adaptation and resilience. The findings from the Climate Vulnerability Analysis process will be used to inform adaptation strategies in the Climate Adaptation Plan and goals, policies, and actions in the Lake County Health and Safety Element.

GLOSSARY

Adaptation: Making changes in response to current or future conditions (such as the increased frequency and intensity of climate-related hazards), usually to reduce harm and to take advantage of new opportunities.[94, 95]

Adaptive Capacity: The combination of the strengths, attributes, and resources available to an individual, community, society, or organization that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities.[96]

Cascading or Compounding Effects: Extreme events that link together hazards over days, weeks, or months, resulting in multiplied effects that cause secondary and sometimes tertiary damage, exceeding the damage of the initial hazard event.

Climate Change: A change in the state of the climate that can be identified by changes in the mean, and/or the variability, of its properties, and that persists for an extended period, typically decades or longer.

Community Asset: A valued feature of a community that may be harmed by climate change. Community assets may include buildings, infrastructure, community services, ecosystems, and economic drivers.

Exposure: The presence of people; infrastructure; natural systems; and economic, cultural, and social resources in areas that are subject to harm.[97]

Goal: An ideal future end state related to public health, safety, or general welfare.

Hazard: An event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, damage to the environment, interruption of business, or other types of harm or loss.[98]

Impact: The effects (especially the negative effects) of a hazard or other conditions associated with climate change.

Policy: A specific statement that guides decision making, indicating a commitment of the local legislative body to a particular course of action.

Program: An action, procedure, program, or technique that carries out a General Plan policy.

Resilience: The capacity of any entity—an individual, a community, an organization, or a natural system—to prepare for disruptions, to recover from shocks and stresses, and to adapt and change from a disruptive experience. Community resilience is the ability of communities to withstand, recover, and learn from past disasters to strengthen future response and recovery efforts.

Risk: The potential for damage or loss created by the interaction of hazards with assets such as buildings, infrastructure, or natural and cultural resources.

Vulnerability: The degree to which natural, built, and human systems are susceptible to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt.[99]

Vulnerability Analysis: An assessment of how a changing climate may harm a community and which elements—people, buildings and structures, resources, and other assets—are most vulnerable to its effects based on an assessment of exposure, sensitivity, potential impact(s), and the community's adaptive capacity.

ATTACHMENT A: METHODS

The Climate Vulnerability Analysis considers the threats from all relevant natural hazards, which are events or physical conditions that have the potential to cause harm or loss and will emphasize changes to hazard frequency and severity due to climate change. While the Lake County Health and Safety Element will address natural and human-caused hazards, such as seismic hazards and hazardous materials, these hazards will not be included in the Climate Vulnerability Analysis, as climate change does not substantially change their frequency or severity. The Climate Vulnerability Analysis also assesses populations and assets facing potential harm from the hazards. This includes the risk of physical damage to buildings and infrastructure, social vulnerability of persons likely to be disproportionately harmed by hazards, potential disruption to the economic engines of unincorporated Lake County and the cities of Lakeport and Clearlake, and loss of important services.

The Climate Vulnerability Analysis will be based on accurate and up-to-date information, including the Cal-Adapt database, the *California Adaptation Planning Guide* (2020), the *Lake County Local Hazard Mitigation Plan* (2023), *the City of Lakeport Local Hazard Mitigation Plan* (2019), and the *City of Clearlake Local Hazard Mitigation Plan* (2019). As outlined in the *California Adaptation Planning Guide*, the Climate Vulnerability Analysis will follow a four-step process:

1. **Identify Exposure.** In a Climate Vulnerability Analysis, *exposure* is the presence of people, infrastructure, natural systems, and resources (economic, cultural, and social) in areas subject to harm. A *hazard*, in this context also called a climate change hazard, is an event or physical condition that has the potential to cause types of harm or loss. This step includes confirming applicable hazards in unincorporated Lake County and the cities of Lakeport and Clearlake, describing historical hazards, describing how hazards are expected to change, and mapping the hazard-prone areas.
2. **Analyze Sensitivity and Potential Impacts**. *Sensitivity* is the level to which changing climate conditions affect a population or community, species, natural system, government, asset, or resource. Potential *impacts* are the effects of a climate change hazard, the combination of exposure to the hazard and sensitivity of the population or asset to it. For example, suppose an increase in extreme heat events is the hazard. In that case, the greater risk of heat-related illness in susceptible persons is the exposure, and the sensitivity is the degree of the impact from the exposure. Each population and asset in unincorporated Lake County and the cities of Lakeport and Clearlake is likely to experience different impacts. The project team will assess the sensitivities and potential impacts to each population or asset from each applicable climate change hazard.
3. **Evaluate Adaptive Capacity.** *Adaptive capacity* is the ability of people and assets to adjust to potential damage from climate change hazards, to take advantage of existing resources and opportunities, such as funding or tools, and to respond to the impacts of climate change. The project team will assess the adaptive capacity of each population and asset for each applicable identified hazard. Lake County and the cities of Lakeport and Clearlake are already implementing several measures to increase adaptive capacity, including the Municipal Code requirements, Capital Improvement Programs, the Local Hazard Mitigation Plan, and others.

4. **Conduct Vulnerability Scoring**. *Vulnerability* is defined as the combination of impact and adaptive capacity as affected by the level of exposure to changing climate conditions. Following the process in the *California Adaptation Planning Guide*, the project team will score impact and adaptive capacity for each population and asset affected by each hazard on a scale of low, medium, and high, to identify vulnerability on a scale of one to five and prioritize the most vulnerable populations and assets in unincorporated Lake County and the cities of Lakeport and Clearlake.

ATTACHMENT B: POPULATIONS AND ASSETS

Populations

Population data was collected from the U.S. Census, the California Healthy Places Index, and the Lake County Homeless Point-in-Time Count. There were 18 vulnerable populations identified:

1. Children (under 18).
   - Approximately 21 percent of Lake County residents are under the age of 18.[100]
   - Approximately 21 percent of Lakeport residents are under the age of 18.[101]
   - Approximately 26 percent of Clearlake residents are under the age of 18.[102]
2. Cost-burdened/low-income/overcrowded households:
   - Cost-burdened households are those paying 30 percent or more of their income towards housing expenses.[103]
   - The State identifies $65,950 as the low-income threshold for a household of four people in Lake County in 2023.[104]
   - Overcrowded households include housing units that have more than 1.0 person per room (excluding bathrooms and kitchens).
     - Approximately 4 percent of households in Lake County are overcrowded.[105]
     - Approximately 3 percent of households in Lakeport are overcrowded.[106]
     - Approximately 8 percent of households in Clearlake are overcrowded.[107]
3. Households in poverty: households with an income below the poverty line, which is $27,750 for a household of four.
   - Approximately 17 percent of Lake County residents earn incomes at or below poverty level.[108]
   - Approximately 11 percent of Lakeport residents earn incomes at or below poverty level.[109]
   - Approximately 25 percent of Clearlake residents earn incomes at or below poverty level.[110]
4. Immigrant communities/linguistically isolated persons: Communities consisting of foreign-born populations, including refugees, undocumented persons, and other immigrants. Linguistically isolated persons include households without a member who is fluent in English.
   - Spanish, German, and Other Pacific Island languages are the primary languages in Lake County among households that are not fluent in English.[111]
   - Spanish, Arabic, and German are the primary languages in Lakeport among households that are not fluent in English.[112]
   - Spanish, Hindi, and Chinese are the primary languages in Clearlake among households that are not fluent in English.[113]
5. Low-resourced people of color: Persons identifying as a member of a racial and/or ethnic group and facing limited access to resources, such as financial, social, healthcare, or educational assistance.[114,115]
6. Outdoor workers: workers in agriculture, forestry, landscaping, construction, outdoor recreation, etc.

7. Persons experiencing homelessness: The 2023 Point-in-Time count reported 290 total persons experiencing homelessness (all unsheltered) in Lake County.[116]
8. Persons living in manufactured homes.
9. Persons in tribal communities.
10. Persons living in isolated communities: This includes persons living on single-access roads (roads with only a single entry or exit point), as well as those living in communities that lack transportation links to more populated areas.
11. Persons with chronic illnesses and/or disabilities.
    - Approximately 21 percent of residents in Lake County have a disability of some type, including hearing, vision, cognitive, ambulatory, self-care, or independent living disabilities.[117]
    - Approximately 17 percent of residents in Lakeport have a disability of some type, including hearing, vision, cognitive, ambulatory, self-care, or independent living disabilities.[118]
    - Approximately 21 percent of residents in Clearlake have a disability of some type, including hearing, vision, cognitive, ambulatory, self-care, or independent living disabilities.[119]
12. Persons without a high school degree.
    - Approximately 11 percent of Lake County residents at least 25 years old do not have a high school degree.[120]
    - Approximately 5 percent of Lakeport residents at least 25 years old do not have a high school degree.[121]
    - Approximately 21 percent of Clearlake residents at least 25 years old do not have a high school degree.[122]
13. Persons without access to lifelines: Persons without reliable access to a car, transit, or communication systems.
    - Approximately 9 percent of households in Lake County lack access to a personal vehicle and approximately 19 percent of households do not have internet access.[123, 124]
    - Approximately 10 percent of households in Lakeport lack access to a personal vehicle and approximately 8 percent of households do not have internet access.[125, 126]
    - Approximately 11 percent of households in Clearlake lack access to a personal vehicle and approximately 11 percent of households do not have internet access.[127, 128]
14. Renters.
    - Approximately 26 percent of Lake County households are rental households.[129]
    - Approximately 27 percent of Lakeport households are rental households.[130]
    - Approximately 41 percent of Clearlake households are rental households.[131]

15. Older adults (age 65 and older).
    - Approximately 25 percent of Lake County residents are at least 65 years of age.[132] Approximately 18 percent of senior citizens in Lake County live alone.[133]
    - Approximately 23 percent of Lakeport residents are at least 65 years of age.[134] Approximately 22 percent of senior citizens in Lakeport live alone.[135]
    - Approximately 18 percent of Clearlake residents are at least 65 years of age.[136] Approximately 16 percent of senior citizens in Clearlake live alone.[137]
16. Short-term visitors.
17. Students (K-12 public schools, private schools, and junior colleges).
18. Unemployed persons. As of November 2023, the unemployment rate in Lake County was 6.1 percent.[138]

Infrastructure

Details on infrastructure were gathered from state and local geographic information system (GIS) data, and the *2023 Lake County Local Hazard Mitigation Plan,* the *2019 City of Lakeport Local Hazard Mitigation Plan* (2019), and the *2019 City of Clearlake Local Hazard Mitigation Plan*. These 11 asset groups are:

1. Bicycling and pedestrian trails.[139]
2. Bridges (as mapped by the California Office of Emergency Service and the California Department of Transportation).
    - County: 79 bridges.
    - Clearlake: Two bridges.
    - Lakeport: One Bridge.
3. Energy and communication infrastructure:
    - Transmission Lines: Pacific Gas and Electric Company (PG&E).
    - Cell towers, radio sites, fiber-optic lines, and internet lines.
4. Dams/Reservoirs:
    - County: Adobe Creek, Allen, Bar X Ranch Reservoir #2, Bordeaux Lake, Bottoms, Burgundy Lake, Clear Lake, Cache Creek, Coyote Creek, Graham, Guenoc Lake, Highland Creek, Homestake Tailings, Indian Valley, Lake County Sanitation District, Lake County Sanitation District 2, Langtry, McCreary, Peters, Lake Pillsbury, Scott, Spring Valley, as well as any relevant dams located outside of Lake County.
5. Flood control and stormwater infrastructure:
    - Lake County Flood Control and Water Conservation District: The District is responsible for maintaining 10.5 miles of levees along Middle Creek, Scotts Creek, Alley Creek, Clover Creek, and the Clover Creek Diversion Channel.
    - Hidden Valley Lake Community Services Department: maintains levees on Putah Creek.
    - U.S. Army Corp of Engineers: maintains one levee (Maintenance Area 17).

6. Vehicle fuel stations
    - Electric vehicle charging stations[140]
        - County: Five charging stations.
        - Clearlake: One charging station.
        - Lakeport: Three charging stations.
    - Gas stations

7. Hazardous materials sites:
    - 14 sites identified in the Department of Toxic Substances Control's EnviroStor database.[141]
        - County: Five sites (one active cleanup site in Upper Lake).
        - Clearlake: One active cleanup site
        - Lakeport: Eight sites (one active cleanup site)
    - Several sites throughout the county (many of which are closed) identified in the State Water Control Board's Geotracker database.[142] Below are currently open and/or active sites.
        - County: 12 active sites
        - Clearlake: One open remediation cleanup site
        - Lakeport: Two open sites

8. Transportation infrastructure
    - Highways: State Route 20, State Route 29, State Route 175, and State Route 53.
    - County and local roads
    - Transit facilities: stops and other facilities provided by Lake Transit Authority.

9. Parks:
    - Local Parks:
        - County: Alpine Park (Lucerne), Clark's Island (Clearlake Oaks), Clearlake Oaks Beach (Clearlake Oaks), Clearlake Oaks Plaza (Clearlake Oaks), Davis Beach (Lucerne), Hammond Park (Nice), Highland Springs Park (outside Lakeport City limits), Hinman Park (Nice), John T. Klaus Park (Clearlake Oaks), Keeling Park (Nice), Kelseyville Community Park (Kelseyville), Lakeside Park (Kelseyville), Lucerne Creek Park (Lucerne), Lucerne Harbor Park & Artist Village (Lucerne), Middletown Park & Pool (Middletown), Middletown Square Park (Middletown), Middletown Trailside Park (Middletown), Mount Konocti Park (Kelseyville), Nice Community Beach (Nice), Nylander Park (Clearlake Oaks), Pioneer Park (Kelseyville), Rodman Slough Park (outside Lakeport City limits), Russell Rustici Park (Lower Lake), Upper Lake Park (Upper Lake).
        - Clearlake: Austin Park, Highlands Park, Redbud Park.
        - Lakeport:, Xabaten Community Park, Library Park, Westside Community Park.
    - State Parks: Clear Lake State Park, Anderson Marsh State Historic Park.
    - Federal lands:[143, 144]
        - Mendocino National Forest managed by the US Forest Service.
        - Cache Creek Wilderness Area, Indian Valley Recreation Area, Indian Valley Management Area, Berryessa Snow Mountain National Monument, North Cow Mountain Recreation Area managed by the Bureau of Land Management.
    - Trail Areas

10. Solid waste facilities (as mapped by CalRecycle).[145]
    - Clearlake: South Lake Resource Recovery and Compost, Eastlake Sanitary Landfill.
    - Lakeport: Lake County Waste Solutions, Inc.

11. Water and wastewater infrastructure:
    - County:
        - Finley/Lands End Water System – Domestic Water System (Finley), this system is part of and intertied with the Kelseyville water system.
        - Kelseyville Water System – Domestic Water System (Kelseyville)
        - Kono Tayee Water System – Domestic Water System (Kono Tayee subdivision)
        - North Lakeport Water Treatment Facility and Distribution System – Clearlake Water Source (North Lakeport)
        - Soda Bay Water Treatment Facility and Distribution System (Soda Bay, Lakewood Park, and Riviera Heights).
        - Spring Valley Water Treatment Facility and Distribution System (Spring Valley Lakes subdivision).
        - Kelseyville Wastewater System – Kelseyville Wastewater Collection and Treatment Facility (Kelseyville, Clear Lake State Park, Corinthian Bay).
        - Middletown Wastewater System – Middletown Wastewater Collection and Treatment Facility (Middletown).
        - Northwest Regional Wastewater Collection System – Northwest Regional Treatment Plant (North Lakeport, Upper Lake, Nice, Lucerne, Kono Tayee, and Paradise Valley).
        - Southeast Regional Wastewater Collection System (Clearlake and Lower Lake) – Southeast Regional Wastewater Treatment Plant.
        - South Lakeport Wastewater Collection System – Wastewater is conveyed to and treated at the City of Lakeport Wastewater Treatment Plant.
        - Anderson Springs system – Community of Anderson Springs low pressure wastewater collection system. Wastewater is conveyed to and treated at the Middletown Treatment Plant.
    - Clearlake:
        - Clearlake Water System – Konocti Water District, Highlands Water District, Golden State Water, Lake County Special District, Golden State Water's Sonoma Water Treatment Plant.
    - Lakeport:
        - Lakeport Water System – City of Lakeport Water Treatment Plant.

Buildings

Buildings data was collected from Google Maps, the California School Database, and local agency websites and GIS records. These eight assets are:

1. Community centers and libraries:
    - County: Middletown Library, Upper Lake Library, Lower Lake Community Center, Clearlake Oaks Community Center.

- Lakeport: Lakeport Public Library, the Harbor on Main Youth Center Lakeport Senior Center, Circle of Native Minds Cultural Center.
- Clearlake: Redbud Public Library, Clearlake Youth Center, Clearlake Community Senior Center Burns Valley Sports Complex (future build).

2. Commercial centers:
   - Lakeport: Vista Point Shopping Center, Shoreline Shopping Center, 2019 S. Main Shopping Center, Willow Point Shopping Center.
   - Clearlake: Burns Valley Mall, Clear Lake Shopping Center, Highlands Center.
3. Facilities and structures on tribal lands: Big Valley Band of Pomo Indians, Elem Indian Colony, Habematolel Pomo of Upper Lake, Middletown Rancheria of Pomo Indians of California, Robinson Rancheria.
4. Government buildings:
   - County: Lake County Administrative Office, Lake County Superior Court, and Lake County Health Department, Lake County Corporation Yard, Public Services Building, Special Districts Administration Building.
   - Lakeport: Lakeport City Offices, Lakeport Corporation Yard.
   - Clearlake: Clearlake City Offices, Clearlake Corporation Yard, Burns Valley Sports Complex (future build).
5. Historic buildings and museums: [146, 147]
   - County: NO. 426 Site of Stone and Kelsey Home, No. 427 The Battle of Bloody Island, No. 428. Sulphur Bank Mine, No. 429 Lower Lake Stone Jail, No. 450 Stone House, No. 467. St. Helena Toll Road and Bull Trail, Gibson Museum & Cultural Center, Lower Lake Schoolhouse Museum.
   - Lakeport: No. 897 Old Lake County Courthouse, Courthouse Museum. Homes and residential structures.
6. Medical and care facilities:
   - County: Adventist Health Clear Lake Medical Office (Kelseyville), Kelsey Creek Medical Clinic (Kelseyville), Adventist Health Clear Lake (Kelseyville), Adventist Health Clear Lake (Hidden Valley Lake), Konocti Wellness Center: Adventist Health Clear Lake (Lower Lake).
   - Lakeport: Lake County Tribal Health, MCHC Health Centers-Lakeview, Sutter Lakeside Medical Practice.
   - Clearlake: Adventist Health Clear Lake, Highland Medical Center, Lake County Tribal Health South Shore.
7. Public safety buildings:
   - County: Lake County Sheriff's Department, Lake County Fire Protection District, Kelseyville Fire Protection District, Northshore Fire Department, South Lake County Fire Protection District.
   - Lakeport: Lakeport Police Department, Lakeport Fire District.
   - Clearlake: Clearlake Police Department, Lake County Fire Protection District.

8. Public Schools:
    - County:
        - Kelseyville Unified School District: Shade Canyon School (TK-3), Kelseyville Alternate Education, Kelseyville, Elementary School (K-5), Kelseyville High School (9-12), Kelseyville Learning Academy, Mt. Vista Middle School (6-8), Riviera Elementary School (K-5).
        - Konocti Unified School District: Blue Heron School (9-11), East Lake Elementary School (TK-4), Highlands Academy (3-8), Konocti Adult School (18+), Konocti Education Center, Lewis Center (Independent Study) (K-12), Lower Lake Elementary School (TK-7), Lower Lake High School (9-12), William C. Carle High School (Cont.) (10-12).
        - Lucerne Elementary School District: Lucerne Elementary School
        - Middletown Unified School District: Cobb Mountain Elementary School (K-6), Coyote Valley Elementary School (K-6), Lake County International Charter School, Loconoma Valley High School (Continuation School), Middletown Com. Day School, Middletown High School (9-12), Middletown Middle School (7-8), Minnie Cannon Elementary School (K-6).
        - Upper Lake Unified School District: Clover Valley High School (Continuation School), Upper Lake Elementary School (K-5), Upper Lake High School (9-12), Upper Lake Middle School (6-8).
    - Lakeport:
        - Lakeport Unified School District: Clear Lake High School (9-12), Lakeport Alternative School, Lakeport Community Day School, Lakeport Elementary School (K-3), Natural Continuation High School (9-12), Terrace Middle School (4-8).
        - Lake County Office of Education: Hance Community School.
        - Mendocino College Lake Center.
    - Clearlake:
        - Konocti Unified School District: Burns Valley Elementary School (K-7), Pomo Elementary School (TK-7).
        - Lake County Office of Education: Clearlake Creativity School.
        - Lake County Campus of Woodland Community College.

Economic Drivers

Important economic assets were determined based on the 2023 Comprehensive Annual Financial Report and land uses in the county. These seven assets are:

1. Agriculture
2. Education services
3. Government administration
4. Healthcare
5. Major employers: County of Lake, Adventist Health St. Helena, Konocti Unified School District, Sutter Lakeside Hospital, Calpine Corp., Lake County Tribal Health, Kelseyville Unified School District, Robinson Rancheria Resort & Casino, Middletown Unified School District, Safeway.
6. Local outdoor recreation and tourism.

7. State and federal land outdoor recreation: Clear Lake State Park, Anderson Marsh State Historic Park, Mendocino National Forest, Cache Creek Wilderness Area, Indian Valley Recreation Area, Indian Valley Management Area, Berryessa Snow Mountain National Monument, North Cow Mountain Recreation Area.

Ecosystems and Natural Resources

Ecosystems and natural resources were determined based on information from the Lake County Area Plans. These six resources are:

1. Chaparral
2. Conifer and deciduous forests
3. Grasslands
4. Oak woodland
5. Riparian
6. Wetlands

Key Services

These assets are based on typical services provided in cities throughout California, which are supported by the infrastructure and buildings listed previously. Key community services include the operation and functions needed to provide and maintain services. The Climate Vulnerability Analysis assesses the infrastructure and people needed to support them separately. These eight services are:

1. Education services
2. Emergency services:
    - County: Emergency Operations Center, Lake County Sheriff's Department, Lake County Fire Protection District, Kelseyville Fire Protection District, Northshore Fire Department, South Lake County Fire Protection District
    - Lakeport: Lakeport Police Department, Lakeport Fire District
    - Clearlake: Clearlake Police Department, Lake County Fire Protection District and Administrative Offices
3. Energy delivery and communication services: PG&E, radio, television, cellular and landline phone, and internet
4. Government administration and community services
5. Propane and natural gas services
6. Public transit access: Lake Transit Authority
7. Solid waste removal:
    - County: Lake County Waste Solutions, South Lake Refuse and Recycling
    - Lakeport: Lakeport Disposal Company
    - Clearlake: Clearlake Waste Solutions

8. Water and wastewater treatment, delivery, and collection:
    - County:
        - Cal Water – Redwood Valley District (Lucerne)
        - Callayomi County Water District (Middletown)
        - Clearlake Oaks County Water and Sanitation District (Clearlake Oaks)
        - Clearwater Mutual Water Company (Kelseyville)
        - Cobb Mountain Water Company (Cobb)
        - Konocti County Water District (Kelseyville and Finley)
        - Lake County Environmental Health – oversees wells and onsite waste management systems (septic)
        - Lower Lake County Water Works (Lower Lake)
        - Upper Lake County Water District (Upper Lake, Nice, Lucerne, Kono Tayee, and Paradise Valley)
        - Special Districts Administration is the water and wastewater agency of Lake County, which oversees:
            - Finley/Lands End Water System – Domestic Water System (Finley)
            - Kelseyville Water System – Domestic Water System (Kelseyville)
            - Kono Tayee Water System – Domestic Water System (Kono Tayee subdivision)
            - North Lakeport Water Treatment Facility and Distribution System – Clearlake Water Source (North Lakeport)
            - Soda Bay Water Treatment Facility and Distribution System (Soda Bay, Lakewood Park, and Riviera Heights)
            - Spring Valley Water Treatment Facility and Distribution System (Spring Valley Lakes subdivision)
            - Kelseyville Wastewater Collection and Treatment System (Kelseyville, Clear Lake State Park)
            - Northwest Regional Wastewater System (North Lakeport, Upper Lake, Nice, Lucerne, Kono Tayee, and Paradise Valley)
            - Southeast Regional Wastewater system (Clearlake, Lower Lake)
            - Middletown Wastewater collection and treatment (Middletown)
            - Anderson Springs collection (treated at Middletown plant)
            - South Lakeport/Lands End wastewater collection (treated by City of Lakeport treatment plant)
    - Lakeport:
        - City of Lakeport Public Works Department – water services
    - Clearlake:
        - Golden State Water Company – Clearlake System
        - Highlands Mutual Water Company
        - Konocti County Water District

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