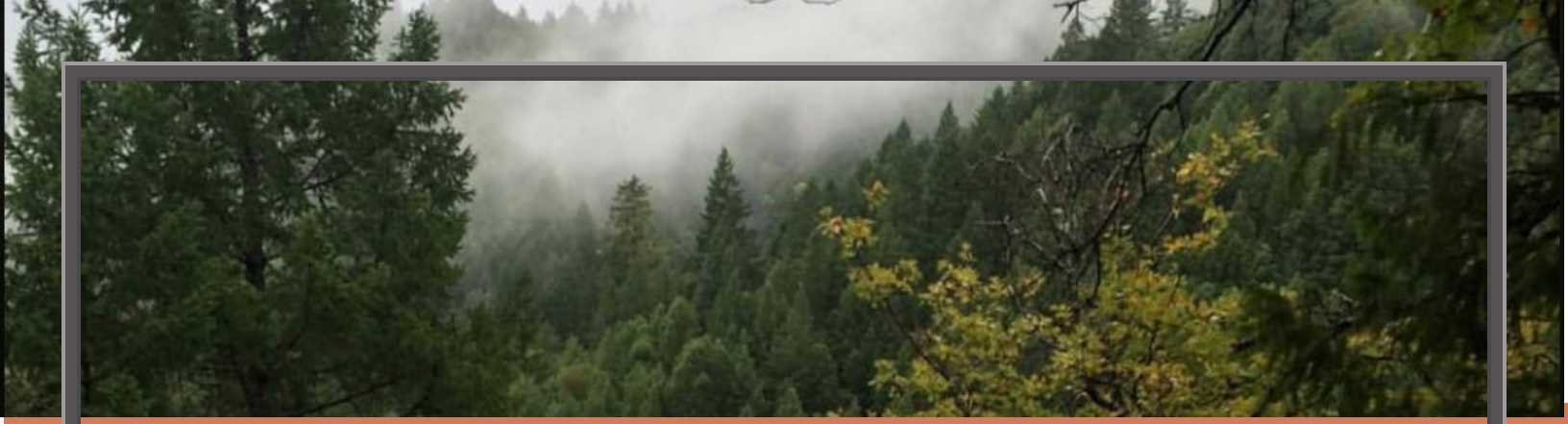

MENDOCINO COUNTY SAFETY ELEMENT UPDATE

CLIMATE VULNERABILITY ASSESSMENT REPORT

FINAL

MARCH 2021

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INTRODUCTION

Purpose of the Climate Vulnerability Assessment

Mendocino County is currently updating its Local Hazard Mitigation Plan (LHMP) and General Plan Safety Element to help the County and its residents adapt to potential harm caused by climate change hazards. A critical part of the safety element update is the climate vulnerability assessment, a detailed analysis of how a changing climate can harm people, physical structures, and other community assets throughout Mendocino County. The assessment looks at how severe climate change hazards are likely to be for the county's people and assets and identifies which groups of people and assets face the greatest threat. This report summarizes the method and results of the Climate Vulnerability Assessment, which the County will use to prepare goals, policies, and programs that will be integrated into the safety element to make Mendocino County more resilient.

The Climate Vulnerability Assessment covers all of Mendocino County, including the unincorporated areas and the cities of Fort Bragg, Point Arena, Ukiah, and Willits. It will enable these jurisdictions to identify and take action to address dangerous conditions from climate change hazards before they develop or become more intense and frequent. This will help protect the health and safety of residents and visitors, reduce damage and destruction of public and private property, minimize interruption to important services, protect local ecosystems, and keep Mendocino County's economy diverse and strong.

The Climate Vulnerability Assessment will also help Mendocino County follow state laws, including Senate Bill (SB) 379, SB 1035, SB 99, SB 244, and Assembly Bill (AB) 747. SB 379 is the foundation for adaptation and resiliency in general plan safety elements—it requires local governments to conduct vulnerability assessments as part of their long-range public safety planning efforts and to prepare policies that will protect against harm caused by climate change. SB 1035 builds on earlier legislation and requires local governments to review and update as needed their safety elements during an update to their housing element or LHMP (or no less than every 8 years). Any revisions should include updated information related to flood hazards, fire hazards, and climate adaptation and resilience. SB 99 requires jurisdictions to review and update the safety element to include information identifying residential developments in hazard areas that do not have at least two emergency evacuation routes. AB 747, which will go into effect at the beginning of 2022, focuses on evacuation

What is resiliency?

Resiliency is the ability of a community to withstand, recover, and learn from past disasters to strengthen future response and recovery efforts.

What is adaptation?

Adaptation is the process of making changes in response to current or future conditions, usually to reduce harm and take advantage of new opportunities.

What is vulnerability?

Vulnerability is 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.

Source: California Governor's Office of Emergency Services. 2020. California Adaptation Planning Guide. https://www.caloes.ca.gov/climate.

routes and will require local governments to identify the capacity, safety, and viability of evacuation routes in the safety element or LHMP. SB 244 requires cities and counties to address the infrastructure needs of disadvantaged unincorporated communities (DUCs) in city and county general plans, Local Agency Formation Commission Municipal Service Reviews, and annexation decisions. This Climate Vulnerability Assessment, along with the update to the safety element, will help Mendocino County meet the state's requirements.

COUNTY AND COMMUNITY PROFILES

Mendocino County is in northern California, north of the San Francisco Bay region. It is bordered by Humboldt and Trinity counties to the north; Sonoma County to the south; the Pacific Ocean to the west; and Tehama, Glenn, and Lake counties to the east. The coastal areas of Mendocino County consist of cliffs, dunes, and rivers bordered by redwood forests. Major river mouths that flow into the Pacific Ocean include the Gualala River North Fork, Garcia, Navarro, Albion, Big, Noyo, and Ten Mile Rivers. This western area of the county, which includes the cities of Fort Bragg and Point Arena, attracts tourists from across the region and supports an active timber industry. The redwood forests turn into conifer-dominated forests moving into the central part of the county, which has valleys bordered by mountains on either side. This area includes the cities of Ukiah and Willits and supports recreation and tourism activities in addition to a diverse agricultural economy, including wineries and vineyards, agritourism, livestock, and fruit and nut crops.[1] The eastern portion of the county contains more rural and isolated agricultural communities, such as Covelo and Potter Valley, which have major rivers such as the Russian River and Eel River flowing through them. Montane conifer forests and chaparral dominate the landscape of in this part of the county.

The following sections describe the balance of land uses and landowners, tribal communities and resources, and local demographics of the county and its four incorporated cities.

Mendocino County

Mendocino County covers approximately 3,878 square miles, and according to the California Department of Finance, the unincorporated areas of Mendocino County are home to approximately 59,330 people as of 2019.[2] The unincorporated areas include approximately 15 communities scattered throughout the coastal, mountain, and valley areas of the county. Major population centers in the unincorporated areas include Brooktrails, Redwood Valley, Covelo, Laytonville, Talmage, and Boonville. A large portion of the land uses in the unincorporated county are dedicated to forests, agriculture, and timber production. Residential uses are scattered throughout the county, with recreation- and tourism-related land uses primarily along the coastline, forests, and inland recreation areas.

Various federal, state, and tribal entities own and manage much of the unincorporated land. The U.S. Forest Service and National Park Service manage land in the Mendocino National Forest, located in the northeastern portion of the county, as well as smaller historically significant sites such as the Mendocino Coast Botanical Gardens and the Point Cabrillo Light Station. The U.S. Army Corps of Engineers and the Bureau of Land Management own and/or manager smaller areas of land, such as Lake Mendocino and Little Darby Natural Trail. California State Parks Department manages 17 state parks, reserves, recreation areas, and beaches in the county. Additionally, the California Department of Fish and Wildlife manages land within the Saunders Reef State Marine Conservation Area and Sea Lion Cove State Marine

Conservation Area. There are also 11 federally recognized tribal nations in the county, including the Cahto Tribe, Coyote Valley Band of Pomo Indians, Guidiville Indian Rancheria, Hopland Band of Pomo Indians, Manchester Band of Pomo Indians, Pinoleville Pomo Nation, Potter Valley Tribe, Redwood Valley Little River Band of Rancheria of Pomo Indians, Round Valley Reservation, and Sherwood Valley Rancheria.[3] These tribal governments provide varying levels of services to their local communities, including police, health, transportation, and education services.

Generally, annual temperatures extremes in Mendocino County range from lows of 5 degrees Fahrenheit (°F) to highs of 100°F in the inland areas, and coastal areas experience extremes ranging from lows of 20°F to highs of 80°F.[4] July and August are the warmest months (with average temperatures between 58°F and 74°F across the county), and December and January are the coldest (with average temperatures between 38°F and 46°F across the county). The county receives precipitation in the form of both rain and snow, with an average of approximately 41 inches in Redwood Valley and 80 inches near Branscomb annually, although this number varies significantly by location within the county. Most precipitation falls during winter, with snowfall constrained to higher elevations, and little rain falls during the summer months. Historically, the largest economic driver in Mendocino County has been timber harvesting in the forested areas, but recently agricultural production such as fruit and nuts, livestock, and field crops have surpassed timber harvesting. In 2018, agricultural production accounted for $188 million in revenue, and timber harvesting accounted for $133 million in revenue.[5] The natural setting, primarily undeveloped landscape, and plentiful parks and recreation areas of the Mendocino County also make it a prime place for outdoor recreation. Visitors spent approximately $482 million in the county in 2018, with most of the spending on hotels and lodging.[6] Though tourism has helped create a strong economy in Mendocino County, it has also led to challenges. The dependence on visitors makes Mendocino County vulnerable to disruptions in the tourism industry, which will be discussed further in other chapters of this report.

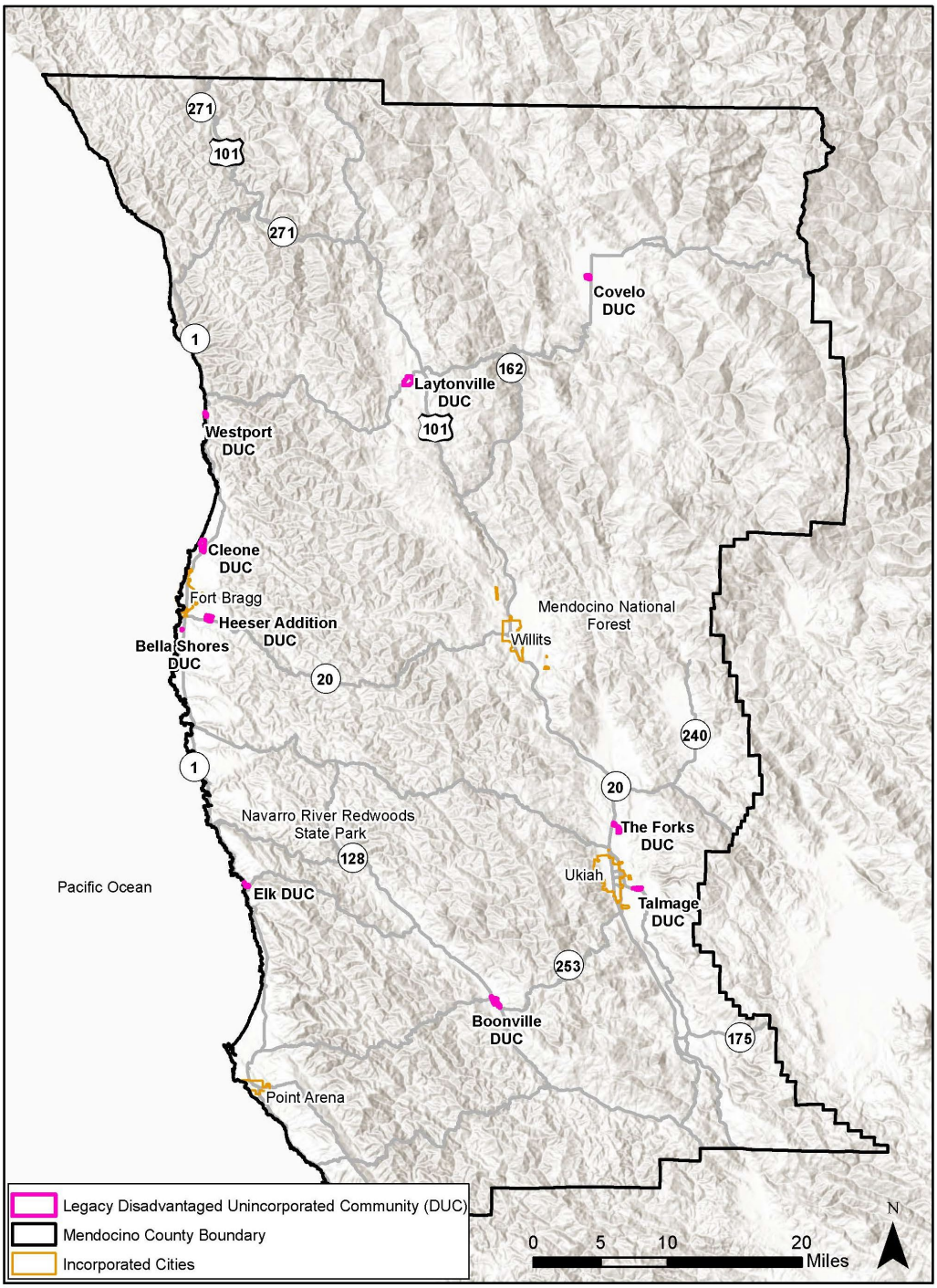
Mendocino County's primary transportation access is from US Highway 101 and State Route (SR) 1 (also known as Highway 1 or Hwy-1), which are the primary north-south roads in the region. Major east-west routes include SR-20, SR-218, SR-253, SR-175, and SR-162, which connect coastal areas to inland mountain and valley areas of the county. The county does not have an airport that provides commercial air service; however, Little River Airport, Round Valley Airport, Boonville Airport, and Ocean Ridge Airport provide municipal and private air services to the unincorporated areas of the county.

Disadvantaged unincorporated communities, or DUCs, are unincorporated communities that may be in isolated areas, have a lower medium income than other areas in the State, and be underserved by public services and utilities. The County has identified ten legacy communities that qualify as DUCs, none of which are in the coastal zone. These are communities that have 10 or more dwelling units in "close proximity" to one another where 12 or more registered voters reside; is within a city sphere of influence (SOI) (also known as a fringe community), is an island within a city boundary (also known as an island community), or is geographically isolated and has existed for at least 50 years (also known as a legacy community); and has a median household income that is 80 percent or less than the statewide median household income, which was $53,735 between 2013 to 2017. The ten neighborhoods of residential areas are shown on Figure 1[7].

- Bella Shores DUC is located south of Fort Bragg, near the central coast of the county, on Highway 1 and near Digger Creek.

- Boonville DUC is situated in the southern center portion of the county in Anderson Valley along Highway 128 and near Highway 253.
- Cleone DUC is located approximately three miles north of Fort Bragg, adjacent to the Pacific Ocean and transected by Highway 1.
- Covelo DUC is located in the northeast corner of the county about six miles west of the Mendocino National Forest along Highway 162.
- Elk DUC is located on the coast of Mendocino County approximately 15 miles north of Point Arena along Highway 1.
- Heeser Addition DUC is southwest of Fort Bragg by approximately two miles and sits along Highway 20.
- Laytonville DUC is located in the northern center of the county along Highway 101 and surrounds a small pond west of the community's commercial neighborhood.
- Talmage DUC is situated one mile southwest of Ukiah along Talmage Road and bounded by Mill Creek to the south.
- The Forks DUC is located due north of Ukiah and one mile west of Lake Mendocino adjacent to Highway 101.
- Westport DUC is situated on the northern coast of Mendocino County approximately 13 miles north of Fort Bragg.

Figure 1. Disadvantaged Unincorporated Communities within Mendocino County



Source: Mendocino County, 2019; ESRI, 2019; PlaceWorks, 2019

Legacy Disadvantaged Unincorporated Communities (DUC) within Mendocino County

City of Fort Bragg

The City of Fort Bragg covers approximately three-square miles along the coastline of Mendocino County between Virgin Creek to the north and Hare Creek to the south. The Noyo River and Pudding Creek also border the main part of the city, where the downtown and tourism hubs are located. The city is home to approximately 7,471 people as of 2019.[8] Historically, Fort Bragg was home to the Pomo Native American tribe, and a reservation was established along the Noyo River in 1856. In the summer of 1857, a military post was established, known as Fort Bragg, extending along the coastline on the western edge of the current city limits. By the late 1850s, the fort was abandoned, and the community switched gears to become a major logging and commercial fishing town. In 1889, Fort Bragg was incorporated as a city. Today, Fort Bragg's local economy relies on tourism, health care services, and retail trade.[9]

On average, annual high temperatures in Fort Bragg range from 52°F to 72°F, and annual low temperatures range from 42°F to 52°F.[10] August is the warmest month (with average temperature of 72°F), and December is the coldest (with average temperature of 42°F). Fort Bragg receives precipitation in the form of rain with an average of approximately 51 inches annually. Most precipitation falls during winter, and little rain falls during the summer months.

Fort Bragg's primary transportation access from the north and south is Hwy-1, and from the east and west is SR-20 and Sherwood Road. The city also has a tourism rail line, known as the Skunk Train, which provides visitors with a train ride through the redwood forests to Willits. Fort Bragg Airport just north of the city provides private aircraft with access to the city.

City of Point Arena

The City of Point Arena covers approximately 1.3 square miles along the coastline of Mendocino County at the mouth of the Point Arena Creek. The city is home to approximately 441 people as of 2019.[11] Historically, Point Arena produced 200,000 board feet of redwood lumber a day and was a major shipping port for Mendocino County.[12] The iconic lighthouse was first built in 1866 and rebuilt after the destructive 1906 earthquake. Soon after the City's incorporation in 1908, it experienced a devastating fire that burned down most of the city, prompting a change in the local economy from lumber to commercial and tourism-serving uses. Today, Point Arena's economy is based on recreation and tourism.[13]

On average, annual high temperatures in Point Arena range from 57°F to 68°F, and annual low temperatures range from 38°F to 50°F.[14] September is the warmest month (with average temperature of 68°F), and December is the coldest (with average temperature of 38°F). Point Arena receives precipitation in the form of rain, with an average of approximately 40 inches annually. Most precipitation falls during winter, and little rain falls during the summer months.

Point Arena's primary transportation access from the north and south is Hwy-1, and from the east and west is Riverside Drive. Although the city does not have a commercial airport, Ocean Ridge Airport is approximately 11 miles southeast of the city and provides private aircraft with access to the city.

City of Ukiah

Ukiah covers approximately 4.8 square miles and is in the central portion of Mendocino County, just west of the Russian River. It is the largest city in Mendocino County, home to approximately 16,028 people as of 2019.[15] Historically, Ukiah was part of the Yokayo Rancho, which was part of a Spanish land grant in

northern California.[16] The city was founded in 1856 as part of Sonoma County and was incorporated into Mendocino County as the county seat in 1859. Early population growth of Ukiah was largely due to the redwood lumber boom in the 1940s. Today, Ukiah's local economy relies on nearby agricultural and lumber operations, government operations, recreation, and tourism in the greater region. The city also contains the county fairgrounds and major commercial centers that provide services for residents in more rural areas of the county.

On average, annual high temperatures in Ukiah range from 54°F to 93°F, and annual low temperatures range from 36°F to 56°F.[17] July is the warmest month (with average temperature of 93°F), and December is the coldest (with average temperature of 36°F). Ukiah receives precipitation in the form of rain, with an average of approximately 37 inches annually. Most precipitation falls during winter, and little rain falls during the summer months.

Ukiah's primary transportation access from the north and south is US 101 and State Street, and from the east and west is SR-222, SR-253, and Low Gap Road. The city also has a rail line running north and south through the city, providing both passenger and freight transit services to the region. Ukiah Municipal Airport provides emergency and private aircraft with access to the city.

City of Willits

The City of Willits covers approximately 2.8 square miles and is in the north-central part of Mendocino County, just west of Davis Creek and east of Willits Creek. Willits is known as the "Gateway to the Redwoods" and is home to approximately 5,117 people as of 2019.[18] Historically, the Pomo tribe of Native Americans inhabited Willits. In the 1850s ranchers arrived in the area, which expanded in 1888 as the tanbark industry grew. The railroad and timber industry brought prosperity to the city in the early 1900s, and by the late 20th century the railroad gave way to the highway, and Willits became home to more visitor-serving uses. Today, Willits still supports the lumber, tourism, and recreation industries, as well as a small artist and musician community.[19]

On average, annual high temperatures in Willits range from 51°F to 85°F and annual low temperatures range from 35°F to 53°F.[20] July is the warmest month (with average temperature of 85°F), and December is the coldest (with average temperature of 35°F). Willits receives an average of approximately 47 inches of precipitation annually. Most precipitation falls during winter as either rain or snow, and little rain falls during the summer months.

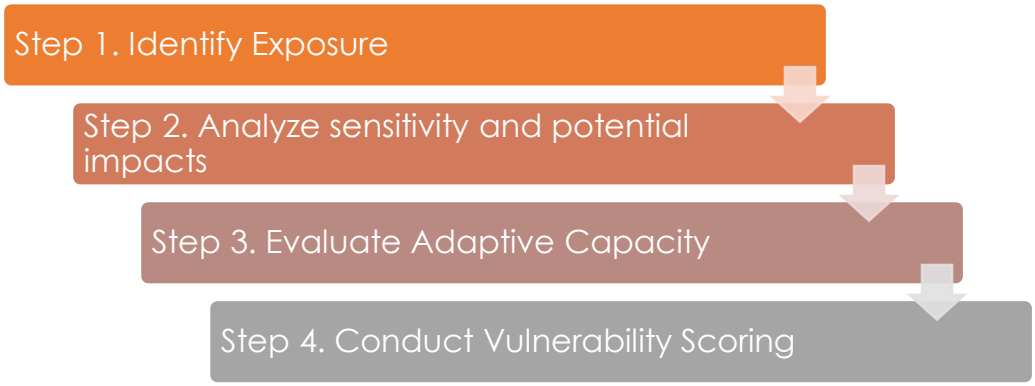
Willits' primary transportation access from the north and south is US 101 and Main Street, and from the east and west is SR-20, Sherwood Road, Hill Road, and Commercial Street. The city also has two rail lines (California Western Railroad and Northwest Pacific Railway) that provide both passenger and freight transit services to the region. Willits Municipal Airport provides emergency and private aircraft with access to the city.

METHOD

Adaptation Planning Guide Method

The Mendocino County Climate Vulnerability Assessment follows the recommended process in the California Adaptation Planning Guide (APG).[1] This document was recently updated by the California Governor's Office of Emergency Services (Cal OES) and provides the steps for local governments to identify and reduce climate change hazards. The APG suggests that vulnerability assessments follow a four-step process, which is shown in **Figure 2** and described below.

Figure 2. California Adaptation Guide Vulnerability Assessment Method



Identify Exposure: In a vulnerability assessment, *exposure* is the presence of people; infrastructure; natural systems; and economic, cultural, and social resources in areas that are subject to harm. A *hazard* is an event or physical condition that has the potential to cause types of harm or loss. To prepare the Climate Vulnerability Assessment, the County looked at which climate change hazards the different populations and assets in Mendocino County are exposed to. This step included confirming applicable hazards in the county, describing historical hazards, describing how hazards are expected to change, and mapping the hazard-prone areas.

Analyze sensitivity and potential impacts: *Sensitivity* is defined as the level to which a species, natural system, community, government, etc., would be affected by changing climate conditions. Potential *impacts* are the effects of a climate change hazard, or the combination of *exposure* and *sensitivity*. For example, if an increase in extreme heat events is the exposure, then the greater risk of heat-related illness on susceptible persons is the impact, and the degree to which they will be impacted is the sensitivity. Each population and asset in Mendocino County are likely to experience different impacts. The County assessed the sensitivities and potential impacts to each population or asset from each applicable climate change hazard.

Evaluate adaptive capacity: *Adaptive capacity* is the ability of people and assets to adjust to potential damage, to take advantage of opportunities, or to respond to the impacts of climate change, given

[1] California Governor's Office of Emergency Services. 2020. California Adaptation Planning Guide. https://www.caloes.ca.gov/HazardMitigationSite/Documents/CA-Adaptation-Planning-Guide-FINAL-June-2020-Accessible.pdf.

currently available or planned resources. The County looked at the adaptive capacity of each population and asset for each identified hazard as part of the vulnerability assessment.

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 APG, the County used the impact and adaptive capacity scoring to identify and prioritize the most vulnerable populations and assets in Mendocino County.

Assessment Process

After selecting the hazards, populations, and assets to include in the vulnerability assessment, the County conducted the Climate Vulnerability Assessment based on the APG's recommended process. Some of the assets were divided into the jurisdictions that own and manage them, such as privately owned airports or parks and open space in the city of Ukiah.

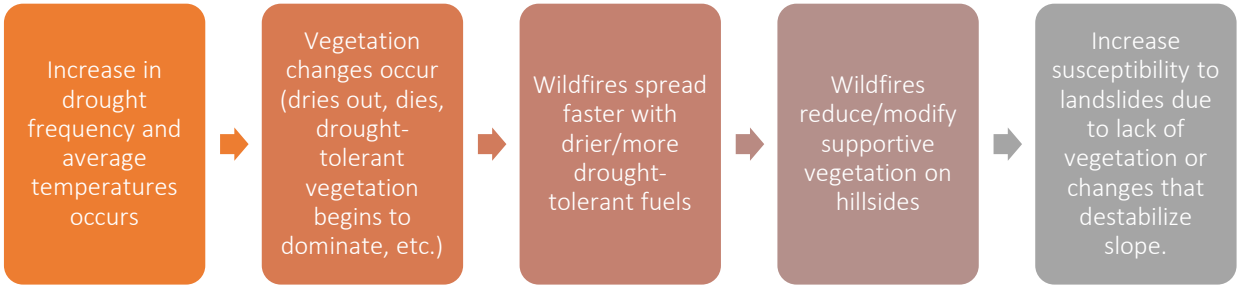
Applicability Review

The County looked at which hazards are likely to affect which populations and assets, because not all hazards would affect all populations or assets. For example, human health hazards are likely to impact most populations, but they would not affect the structural stability of a bridge or a dam. The outcome of this step was a matrix that identified if a population or asset is likely to be exposed to a hazard and was then used for the impact and adaptive capacity scoring.

If a population or asset has the potential to be affected directly or indirectly by a hazard, a "yes" was indicated. Direct impacts affect physical assets, health, or immediate operations, and they can lead to indirect impacts on the broader system or community, including asset types in a different category. For example, severe weather can *directly* damage electrical transmission lines, causing power outages, which can *indirectly* impact persons with chronic illnesses who depend on the electricity for life support systems. Therefore, both electrical transmission lines and persons with chronic illnesses were marked as "yes" for being affected by severe weather and would be evaluated in the assessment.

Additionally, this step was where cascading effects were first considered in the analysis. Cascading or compounding climate change effects are instances where one climate change hazard can lead to another, which can "cascade" into additional hazardous conditions. Figure 3 provides an example of these cascading effects. Human health hazards can also have cascading effects, such as workers being unable to work or visitors being unable to travel to an area, which can harm both economic drivers and key community services. These will be accounted for when developing the applicability matrix and later stages of the assessment.

Figure 3. Example of Cascading Effects



Assessing Impact

To assess the potential impacts that climate change hazards will have on populations and assets, the County considered various questions to ensure that the assessment broadly covered the range of potential harm. The questions below address physical or other impacts, the length of the impact, and how many people or assets could be directly or indirectly harmed. These questions allowed the County to account for both direct and indirect impacts:

- What type of potential impacts may occur?
- Could the potential impacts cause physical injury or damage? If not, is there a risk of behavioral or mental harm, loss of economic activity, or other nonphysical harm?
- How many people or assets could be affected by both direct and indirect harm?
- How long would the impacts persist after the exposure?
- Is there a substantial chance of death or widespread destruction?

Based on the results of the impact assessment, the County ranked each population and asset on a five-point scale (0 to 4) for each relevant hazard. IM0 is the lowest score (lowest impact), and IM4 is the high score (highest impact). An impact is considered a negative quality, and therefore a higher impact score means that there is a higher potential for harm to a population or asset. A lower impact score means that there is a lower potential for harm to a population or asset. **Table 1** provides more detail about what each score means.

Table 1. Impact Scoring Matrix

IMPACT SCORE	MEANING (POPULATIONS AND ECOSYSTEMS)	MEANING (BUILDINGS, INFRASTRUCTURE, SERVICES, AND ECONOMIC DRIVERS)
IM0. Minimal Impact	Community members may not notice any change.	Damage, interruption in service, or impacts on the local economy is small or intermittent enough to mostly go unnoticed.
IM1. Low Impact	Community members notice minor effects. Daily life may experience mild, occasional disruptions.	There are minor but noticeable interruptions in service, damage, or negative effects on the economy.

IMPACT SCORE	MEANING (POPULATIONS AND ECOSYSTEMS)	MEANING (BUILDINGS, INFRASTRUCTURE, SERVICES, AND ECONOMIC DRIVERS)
IM2. Moderate Impact	There is a marked impact to the community. Quality of life may decline. Impacts may be chronic, and at times substantial.	Damage, service interruptions, and other impacts are clearly evident. Impacts may be chronic and occasionally substantial.
IM3. Significant Impact	The well-being of the community declines significantly. The community's current lifestyle and behavior may no longer be possible.	Impacts are chronic. Buildings, infrastructure, and services may be often or always unable to meet community demand. Large sections of the economy experience major hardships.
IM4. Severe Impact	There is a severe risk of widespread injury or death to people, or of significant or total ecosystem loss.	Buildings, infrastructure, and services cannot function as intended or needed. Economic activities are not viable.

Assessing Adaptive Capacity

The County next evaluated the adaptive capacity of the individual populations and assets for each relevant hazard. Following a similar process used to analyze impacts, the County considered various questions to help ensure that the adaptive capacity assessment covered the full ability of a population or asset to resist and recover from harm, given current programs and resources. Examples of these questions include:

- Are there existing programs, policies, or funding to provide assistance?
- Are there barriers that limit response of recovery? Are these barriers, financial limitations, political challenges, lack of access to technology or other resources, or others?
- Do alternatives exist in or near Mendocino County that community members can use?

Based on the results of the adaptive capacity assessment, the County ranked each population or asset on a five-point scale (0 to 4) ranging from AC0 (the lowest adaptive capacity) to AC4 (the highest adaptive capacity). Adaptive capacity is considered a positive attribute, so a higher adaptive capacity score means that a population or asset may be more adaptable to the hazard. A lower adaptive capacity score means that a population or asset may have a harder time adjusting to the changing conditions. **Table 2** provides more detail about what each score means.

Table 2. Adaptive Capacity Scoring Matrix

ADAPTIVE CAPACITY SCORE	MEANING (ALL POPULATIONS AND ASSETS)
AC0. No Adaptive Capacity	Currently, there are no feasible means of adapting.
AC1. Low Adaptive Capacity	Adaptive solutions are available, but they are expensive, technologically difficult, and/or politically unpopular. Alternatives may not exist that can provide similar services.

ADAPTIVE CAPACITY SCORE	MEANING (ALL POPULATIONS AND ASSETS)
AC2. Some Adaptive Capacity	Some adaptation methods are available, but not always feasible. Adapting may create significant challenges for some sensitivities. Some alternatives exist within the jurisdiction area that can provide similar services.
AC3. High Adaptive Capacity	Adaptation solutions are feasible for most or all sensitivities. There may be occasional or small-scale challenges to implementing adaptation methods. Many alternatives exist in the area that can provide similar services.
AC4. Outstanding Adaptive Capacity	Sensitivities can adapt with little or no effort. Quality of life is unchanged or may improve.

Vulnerability Scoring

Mendocino County used the impact and adaptive capacity scores for each population and asset for each relevant hazard to determine the vulnerability score. The vulnerability (V) score reflects how susceptible a population or asset is to harm from a particular hazard. Vulnerability is assessed on a scale of 1 to 5, as shown in **Figure 4**. The matrix below (**Table 3**) shows how impact and adaptive capacity scores combine and translate into a vulnerability score.

Figure 4. Vulnerability Scale

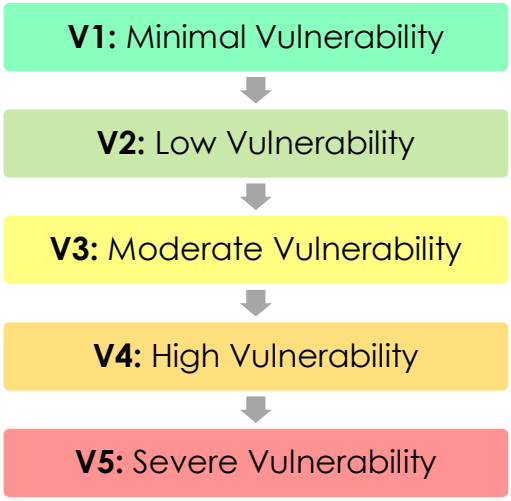


Table 3. Vulnerability Scoring Matrix

		IMPACT SCORE				
		IM0	IM1	IM2	IM3	IM4
ADAPTIVE CAPACITY SCORE	AC0	V3	V4	V5	V5	V5
	AC1	V2	V3	V4	V5	V5
	AC2	V1	V2	V3	V4	V5
	AC3	V1	V1	V2	V3	V4
	AC4	V1	V1	V1	V2	V3

Data Sources

The Climate Vulnerability Assessment must be based on the best available science and information. Mendocino County used data from a variety of credible sources to prepare the vulnerability assessment, determine the impact and adaptive capacity scores, and support the vulnerability scoring conclusions. These sources include scholarly research, locally provided data, and state and federal data.

Scholarly Research

Mendocino County relied on an extensive body of scientific research that analyzes and summarizes how climate change may affect people and community assets. In most cases, this research was not conducted in Mendocino County, but the results are applicable and relevant. Much of this research is peer reviewed to ensure greater accuracy, and it includes studies published in academic journals such as the *Proceedings of the National Academy of Science, Geophysical Research Letters,* and *Climate Change*. Mendocino County backed the information in these studies and reports with websites and publications from scientific and academic institutions, government organizations, and credible local and national sources.

Local and Regional Data

Local and regional government agencies have already prepared several plans and reports that support the Climate Vulnerability Assessment or contain information relevant to the analysis. Mendocino County relied on several local and regional plans to prepare the vulnerability assessment, including:

- City of Willits General Plan (1992)
- City of Point Arena General Plan (1995)
- City of Ukiah General Plan (1995)
- Mendocino County General Plan (2009)
- City of Fort Bragg General Plan (2012)
- Mendocino County Multi-Hazard Mitigation Plan (2014)
- North Coast Integrated Regional Water Management Plan (2014)
- Mendocino County Operational Area Emergency Operations Plan (2016)
- Mendocino County Community Health Improvement Plan (2018)
- Mendocino County Crop Report (2018)
- County of Mendocino Fiscal Year 2019-2020 Adopted Budget (2019)
- Mendocino County Digital Infrastructure Plan: 2019-2025 (2019)
- Point-in-Time County Mendocino County (2019)
- Mendocino County Evacuation Plan (2020)
- North Coast Resources Partnership Plan Healthy Communities, Functional Ecosystems, and Vibrant Economies (2020)
- Strategic Plan to Address Homelessness in Mendocino County (2020)

The County also relied on spatial datasets it maintains. These data show the locations of various buildings and infrastructure, different land uses, boundaries, critical facilities, and other items of importance to the vulnerability assessment.

State and Federal Data

Mendocino County supplemented the scholarly research and local or regional data with data from State and federal agencies, including published reports and datasets. The County relied on information from

several agencies, including Centers for Disease Control and Prevention, Federal Emergency Management Agency, the United States Geologic Survey (USGS), the National Oceanic and Atmospheric Administration, Caltrans, the California Energy Commission (CEC), the California Geologic Survey, Cal OES, the California Governor's Office of Planning Resources (OPR), and the California Department of Forestry and Fire Protection (CAL FIRE). The County also rely on the U.S. Census Bureau for demographic data, including information about disadvantaged persons in the community. Key state resources include the following guidance documents, reports, and tools:

- The state's APG and the Fourth Climate Change Assessment—including the North Coast Regional Report, California's Ocean and Coast Summary Report, the Summary Report from Tribal and Indigenous Communities within California, and the Climate Justice Summary Report—provided extensive information about climate-related exposures and vulnerabilities in addition to federal reports such as the National Climate Assessment.
- Cal-Adapt, a web-based tool developed by the CEC, provided highly specific information about historical climate conditions and future climate projections for extreme heat, drought, severe weather, and wildfire.
- The National Ocean and Atmospheric Administration's Sea Level Rise Viewer, a web-based geographic information system tool, provided county-specific spatial data on current and projected sea level rise.

CLIMATE CHANGE HAZARDS OF CONCERN

As described in the *California Adaptation Planning Guide*, hazards are events or physical conditions that have the potential to cause fatalities, injuries, property and infrastructure damage, interruption of business, and other types of harm or loss.

Selected Exposures

The County reviewed extensive scientific reports and datasets to assess which exposures apply to Mendocino County. Included were a number of state and federal reports as well as local planning documents, such as the 2014 Mendocino County Local Hazard Mitigation Plan and the Mendocino County Evacuation Plan. Staff from key county agencies, such as the Office of Emergency Services, recommended appropriate issues to discuss in this vulnerability assessment.

During the selection process, Mendocino County only considered climate change–related hazards for inclusion in the vulnerability assessment. For example, seismic hazards such as earthquakes may be harmful to areas in Mendocino County, but they do not have a known substantive connection with climate change that would affect the region. Climate change–related hazards focus on natural hazards that can change in frequency and intensity due to climate change. In some cases, an exposure can be an entirely new hazard, such as a new pest insect that did not live in the area before.

After reviewing the reports and data, the County selected 12 hazards to consider in the vulnerability assessment.

1. Agricultural and Ecosystem Pests and Diseases
2. Drought
3. Dune and Bluff Erosion
4. Extreme Heat
5. Fog
6. Human Health Hazards
7. Inland Flooding

8. Landslides and Debris Flows
9. Sea Level Rise
10. Shoreline Flooding
11. Severe Weather
12. Wildfire

Exposure Considerations

When selecting these hazards and applying them to Mendocino County, County staff acknowledged the following considerations.

Climate Scenarios

Like any forecast, there is some uncertainty in the projections of climate change hazards. Climate change is caused by greenhouse gas (GHG) emissions, and therefore changes in the amount of emissions emitted in the near term compared to the distant future will all have an effect on the severity of potential climate change effects. These uncertainties depend in part on factors such as population levels, economic activities, government policies, and personal behavior.

This Climate Vulnerability Assessment uses data and reports that look at multiple scenarios of future GHG emissions and severity of climate change. The global scientific community most commonly uses four different scenarios, known as Representative Concentration Pathways (RCPs):

- RCP 2.6: This scenario assumes that global GHG emissions peak around 2020, then decline quickly. Under this scenario, emissions of carbon dioxide (CO_2) from human activities zero around 2075.
- RCP 4.5: This scenario assumes that global GHG emissions peak around 2040, then decline. Carbon dioxide emissions decline to less than half of current levels by 2080.
- RCP 6: This scenario assumes that global GHG emissions peak around 2060. Human-caused carbon dioxide emissions decline after 2060, although they remain above current levels at the end of the century.
- RCP 8.5: This scenario assumes that global emissions continue to climb until at least the end of the century.[21]

In California, the most accurate and detailed data is available for the RCP 4.5 and RCP 8.5 scenarios, and Mendocino County used these two scenarios to prepare this vulnerability assessment. The data under the RCP 2.6 and RCP 6 scenarios is only available at a large scale and would not provide enough detail to accurately identify changes to climate conditions in and around Mendocino County.

Weather and Climate

This Climate Vulnerability Assessment recognizes the importance of considering weather and climate as two different things. “Weather” is the set of conditions at a particular time and place, and “climate” is the long-term average of conditions. For example, depending on the specific day and time, the temperature in Mendocino may be 100°F or 5°F. These daily conditions are the weather. However, the average temperature in Mendocino County is generally between 38°F and 91°F (averaged throughout the county).[22] This description of the usual conditions is the climate.

It is difficult to accurately forecast the weather more than a few days in advance because there can be so much variation in the day-to-day conditions. However, because climate is a long-term average, it can be forecast for years or decades with a higher degree of accuracy. This allows climate scientists to make reasonable forecasts of what climate conditions will be like decades into the future. Because climate is an

average, climate projections do not say whether a condition will or will not occur, only how likely the condition is. For example, if climate projections say that the average temperature is likely to increase, a day with very cold temperatures does not mean these projections are wrong, only that very cold days still occur, though they are likely to become less common.

Downscaling

Projections of climate exposures rely on climate models, which are computer simulations that forecast future climate conditions. No model can project future conditions perfectly, but current models are heavily reviewed by climate scientists and can accurately reproduce observed climate conditions and project future conditions. Most climate models are meant to simulate conditions across the globe. The model divides Earth's surface into cells using a grid, then forecasts the conditions in each square of the grid. The size of these squares makes them suitable for projecting global conditions, but they are too big to accurately model the difference in climate across smaller areas to information local-level climate adaptation planning.[23,24]

Scientists in California and elsewhere have created much finer grids using a process called "downscaling." This process uses various mathematical techniques to calculate more detailed climate projections using the original model as a starting point. State guidance documents identify four priority models that have been downscaled and are most suitable for projections in California, plus six other downscaled models and a downscaled average of 32 global models. Current best practice and State guidance is to create an average of multiple models and use this average to generate projections of future conditions. This Climate Vulnerability Assessment uses an average of California's four "priority" climate models when possible, and an average of other vetted models if the priority ones are not available.

Exposure Profiles

Agricultural and Ecosystem Pests and Disease

The forests and farms of Mendocino County face risk from various pests and diseases that may affect crop plants, trees, and vineyards. These pests and diseases can cause plants and animals to grow more slowly, damage them so that their products are less appealing and harder to sell, or even kill them. Though there are treatment options for several agriculture and forestry diseases, some have no cure. The forests face particular harm from insects and other pests, diseases caused by bacterial or viruses, fungal infections, and other conditions that can affect the health of forest trees and plants. Specific pests and diseases include sudden oak death, red turpentine beetle, western pine beetle, balsam woolly adelgid, root-feeding bark beetle, pitch canker, and Diplodia diseases.[25] Pest or disease infections can cause trees and other plants to grow more slowly, damage them so they are less able to function in an ecosystem, or kill them outright. Forest and wilderness managers can cure or treat some pests or diseases or control their spread. However, in some cases, there is nothing that can be done.

One of the most direct effects of climate change is that average temperatures will increase, and this has a bearing on many pests and diseases. Many pests and organisms that carry diseases are most active during warmer months, so the threat of infection or infestation can be higher during this time of year. Temperatures are expected to get warmer earlier in the year and remain warmer until later in the year due to climate change, creating a wider activity window for pests and diseases. Climate change can also indirectly create a greater risk of agriculture and ecosystem pests and diseases. Agriculture, forests, and livestock may be harmed and weakened by warmer temperatures and changes in precipitation, which can leave them more susceptible to pests and diseases or inhibit their ability to fight infestations or infections.

In places where forests are a scenic and recreation attraction—and an important contributor to local quality of life—such as the coastal redwood or conifer forests, ecosystem pests and diseases can cause significant economic harm. Dead trees or tree limbs may fall, especially during high winds, and can damage or destroy buildings and structures, cars, and other property. Falling trees or tree limbs may block roadways and cause injuries or even fatalities to community members and visitors. Dead trees and other plants can also create more fuel for wildfires.

Drought

A drought occurs when conditions are drier than normal for a long period of time, making less water available for people (especially if local water supply depends on surface water), agricultural uses, and ecosystems. Communities in Mendocino County may experience water shortages during drought conditions, which could lead to mandatory water restrictions for both domestic and agricultural purposes. Farmers may need to cut back on irrigation activities and homeowners may need to change water use behavior. Less precipitation could lower water levels or decrease water quality in streams and lakes, which can affect both natural habitats and recreation activities. Where rivers and creeks meet the ocean along the coastline, water can become more saline and brackish as freshwater levels decline and high tides push further upstream.

Droughts are a regular occurrence in California; however, in the past 50 years, there have been four major statewide droughts, plus smaller regional droughts.[26] Scientists expect that climate change will lead to more frequent and more intense droughts statewide. In Mendocino County, overall precipitation levels are expected to increase slightly, with more frequent years of extreme levels of precipitation, both high and low, as a result of climate change, as shown in **Figure 5**.[27] This is expected to cause more droughts that are more intense and last longer compared to historical norms.[28] As shown in **Figure 6**[29] and **Figure 7**,[30] baseflow in rivers and creeks in both coastal and inland areas of Mendocino County are projected to decline significantly in early century extended-drought scenarios.

Figure 5. Average Annual Projected Precipitation in Mendocino County, RCP 8.5

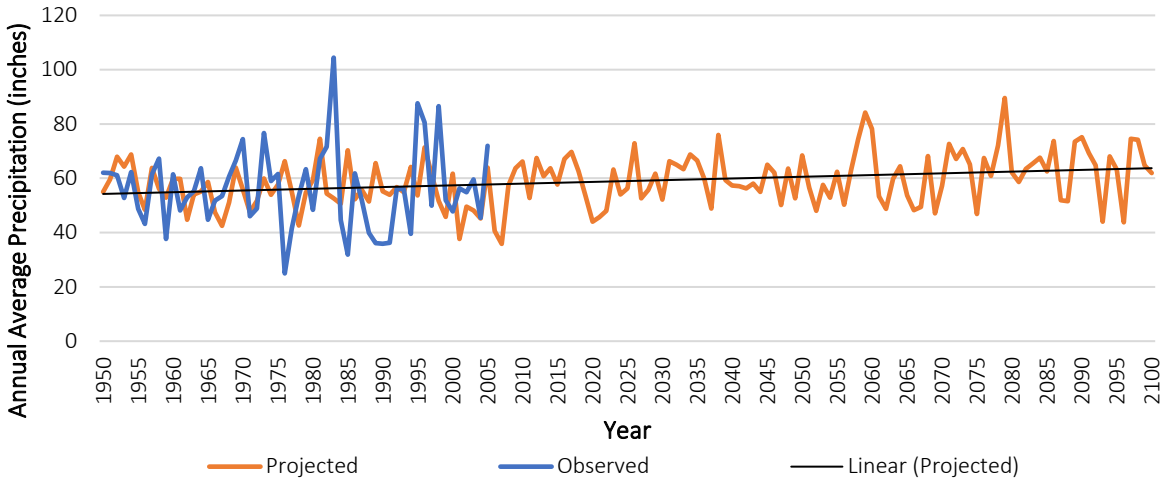


Figure 6. Baseflow of Creeks in the Community of Mendocino with a Midcentury Drought (2019–2046)

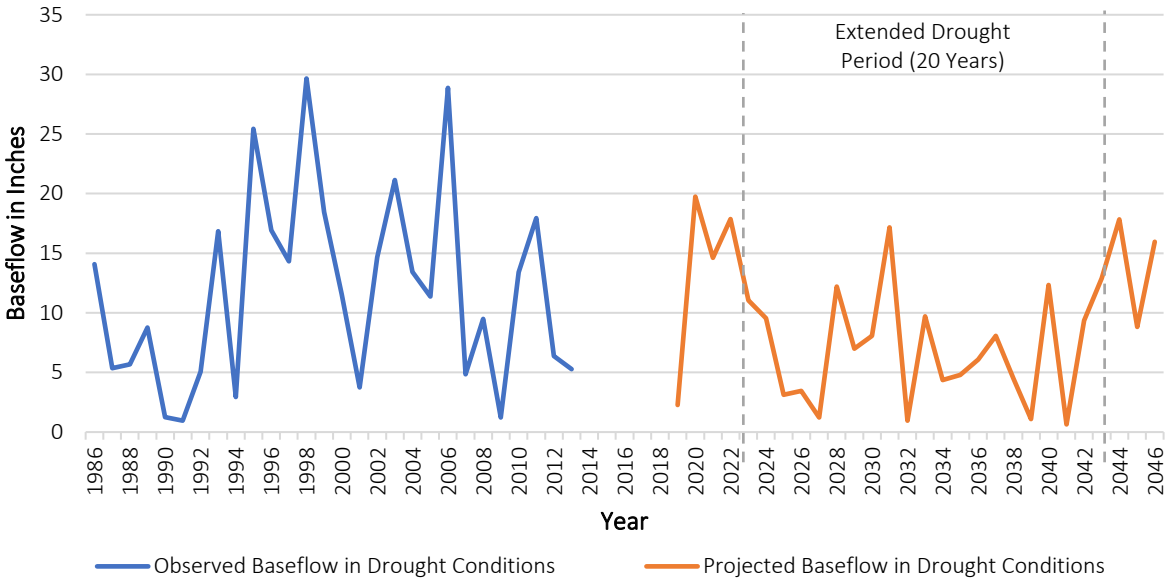
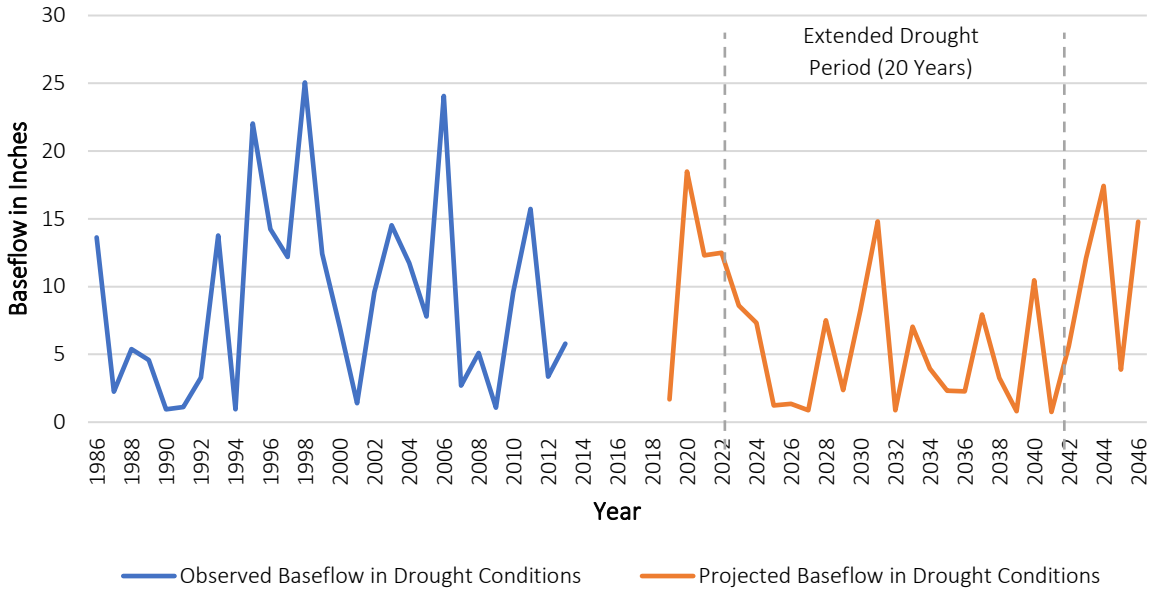


Figure 7. Baseflow of Creeks in the Community of Redwood Valley with a Midcentury Drought (2019–2046)



Dune and Bluff Erosion

Erosion along the coastline is the process by which local sea level rise, high tides, and wave action wear down and carry away rocks and sand or soil.[31] Dune and beach areas of the county, such as Ten Mile Beach, are also directly linked with accretion, which is the process of sediment accumulating on the beach from a river or other systems. Dunes have natural erosion and accretion processes that can change the extent and shape of the sandy areas. In bluff areas of the county, such as Gualala and Westport, accretion typically does not occur, and erosive processes slowly eat away at the foundations of the bluffs. Dune and bluff erosion can not only disrupt key ecosystems and recreation areas, but also undermines the foundation of Hwy-1 and buildings along the coastline. Services that rely on Hwy-1 and other major roadways, such as public transit, vital goods delivery, and emergency services, could be impeded if erosion damaged or destroys roadways.

Eroded bluffs along the Mendocino County coastline.

Natural erosion processes that have historically occurred along the coastline are projected to continue or worsen as climate change continues. Historically, dune erosion and accretion rates have been fairly balanced, resulting in stable beach and dune habitats.[32] Bluff erosion, on the other hand, has been high in Mendocino County, with a regional average cliff erosion rate of -1.3 feet per year, and the highest rate recorded at -10.2 feet per year in Rockport Bay.[33] According to *The Impacts of Sea-Level Rise on the California Coast* report from the California Climate Change Center, sea level rise is projected to increase dune and bluff erosion in the county. By 2100, dunes are projected to erode an average of 623 feet and cliffs are projected to erode an average of 108 feet.[34] Roadways, buildings, and recreation areas lie within these erosion areas. There are adaptive measures, such as shoreline armoring and breakwaters, which slow down dune and bluff erosion. However, these can negatively impact ecosystems and recreational use of the land; they are also politically unpopular.

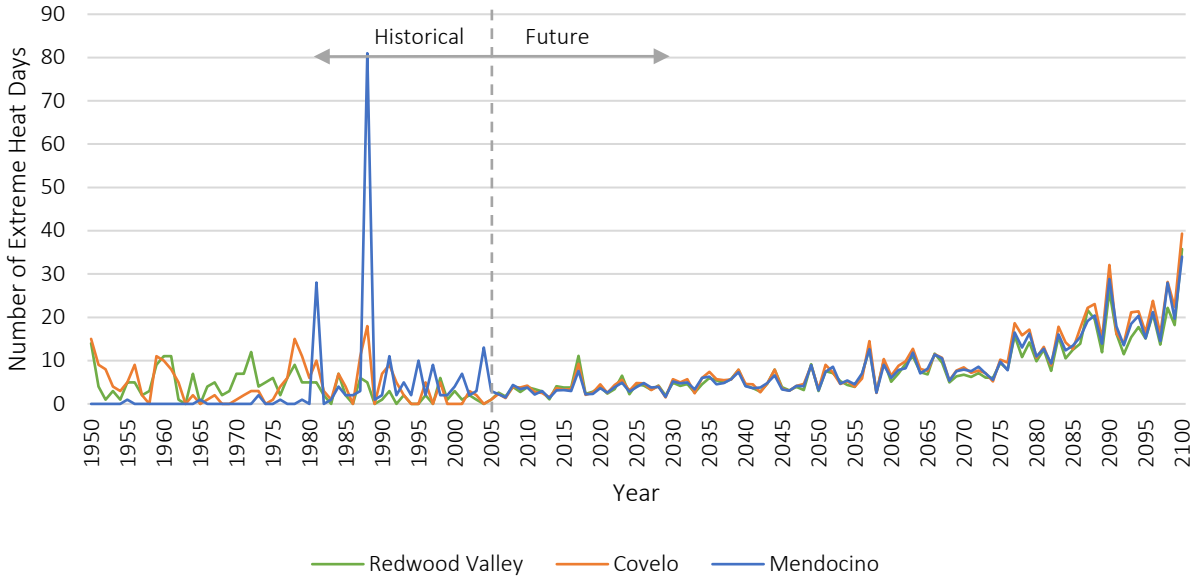
Extreme Heat

Extreme heat occurs when temperatures rise significantly above normal levels. “Extreme heat” is a relative term—temperatures of 100 degrees are normal in locations like Palm Springs, but almost unprecedented in coastal areas of Mendocino County. Mendocino County has different extreme heat temperatures in different regions of the county. An extreme heat day is where temperatures reach 86 degrees in Mendocino, 101.5 degrees in Covelo, and 102.3 degrees in Redwood Valley.[35] Although temperatures are lower in the coastal areas of the county, it is still dangerous when temperatures are higher than usual for people and assets that are not accustomed to them. Warm nights, when the daily minimum temperatures remain significantly above normal levels, can worsen an extreme heat day, because people and assets may not get relief from the high temperatures. A warm night is where

temperatures remain above 55.6 degrees in Mendocino, 56.6 degrees in Covelo, and 58.8 degrees in Redwood Valley.[36]

Historically, Mendocino County has experienced an average of four extreme heat days a year. This is expected to increase dramatically because of climate change. By the middle of the 21st century (2040–2070), Mendocino County is likely to see an average of 7 to 19 extreme heat days per year. By the end of the century, the county is projected to experience an average of 15 to 35 extreme heat days per year. **Figure 8** shows the projected increase in extreme heat days in three different communities in the county.

Figure 8. Frequency of Extreme Heat Days in the Communities of Mendocino, Covelo, and Redwood Valley.



Extreme heat can cause heat-related illnesses, such as heat cramps, heat exhaustion, and heat stroke. These temperatures can harm animals and plants that are not adapted to these conditions. Some types of infrastructure, including power lines and roadways, face greater stresses during high temperatures, which make materials unstable and failure more likely. Very high temperatures make people less likely to venture outside, hurting recreation and tourism economic sectors that depend on outdoor activities. Extreme heat can also increase wildfire conditions by drying out plant material, and prolonged high temperatures can contribute to drought conditions.

Fog

Fog is a very low cloud that usually is low enough to touch the ground and that forms when the air near the Earth's surface reaches the right temperature for water in the air to condense into a cloud. In Mendocino County, fog forms along the coast as it flows in from the Pacific Ocean toward warmer temperatures on land. The cool air brought in by fog is necessary for cooling off the coastal communities and providing a key water source for the coastal redwood forests. However, fog can also be dangerous because it decreases visibility for vehicles. This can lead to traffic accidents and cause significant injury or death. The impacts of climate change on fog are less clear than other hazards. Coastal fog shows a long-

term decline of 12 to 20 percent in California over the 1900 to 2070 period.[37] Climate scientists believe that the warmer temperatures created by climate change make it harder for the air to become cool enough to create fog, and warmer temperatures are more likely to evaporate any fog that does form.

Human Health Hazards

Human health hazards are bacteria, viruses, parasites, and other organisms that can cause diseases and illness in people. Some of these diseases may only cause mild inconvenience, but others are potentially life threatening. Examples include hantavirus pulmonary syndrome, Lyme disease, West Nile virus, and influenza, which can be debilitating or fatal for some of the population. These diseases are carried by animals such as mice and rats, ticks, and mosquitos, which are usually seen as pests even if they do not cause infections.

Similar to agriculture and ecosystem pests and diseases, changes in temperature and precipitation can increase the rates of infections because many of the animals that carry diseases are more active during warmer weather. Warmer temperatures earlier in the spring and later in the winter can cause these animals to be active for longer periods, increasing the time for the disease to be transmitted. Warmer temperatures and higher levels of rainfall lead to increased populations of animals such as mosquitos, rodents, and ticks, creating a greater risk of diseases carried by these animals.

Inland Flooding

A flood occurs when there is too much water to be held in local water bodies, carried away by creeks and rivers, or to soak into the soil. The water can build up and wash into normally dry areas and cause significant harm to buildings, people, and ecosystems. Floodwaters can be deep enough to drown people and may move fast enough to carry away people or heavy objects (such as cars). In some cases, floods can be strong enough to lift buildings off their foundations. Floods can be caused by heavy rainfall or long periods of moderate rainfall, or block drainage areas during periods of rainfall. In rare instances, a break in a dam, water pipe, or water tank can also cause flooding. Floods that develop very quickly are called flash floods and can be especially dangerous because there may be little or no warning. Approximately 6,846 people, or 12 percent of the population in Mendocino County (both unincorporated and incorporated areas) live in a flood hazard area.[38]

Although climate change is expected to increase the frequency and intensity of droughts, scientists also project that it will increase the frequency and intensity of floods in Mendocino County, although precipitation levels are expected to increase only slightly. Up to half of California's precipitation comes from a relatively small number of intense winter storms, which are expected to become more intense

Drought, Flood, Precipitation

Scientists expect overall precipitation levels in Mendocino County to increase only slightly, but both droughts and floods are likely to happen more often. How is this possible?

Climate change is likely to shift precipitation patterns in California toward the extremes. Storms are expected to become stronger, dropping more precipitation statewide. At the same time, dry periods are likely to become drier, and occur more often.

The "normal" conditions in California are likely to become more extreme during both wet and dry periods. However, the more intense and frequent very wet and very dry periods are expected to average out, so overall precipitation levels are not expected to change much.

with climate change. For example, what is currently a 20-year storm, or one that could occur once in 20 years, would increase in frequency by a factor of more than three by the end of the century.[39] Figure 9 shows the current 100-year and 500-year flood hazard areas as well as coastal and floodway areas that may face flood risks.

Landslides and Debris Flows

Landslides occur when a hillside becomes unstable, causing soil and rocks to slide downslope. Landslides are most common on steep slopes made up of loose soil and other material, but they can also occur on shallower slopes. Types of landslides include slow-moving earth flows, mudflows, debris flows, rock falls, and alluvial fans.[40] This Climate Vulnerability Assessment looks at landslides that are caused by precipitation, although the shaking of an earthquake can also trigger landslides. Hillsides commonly absorb water, which increases instability of the slope, leading to increased slope failure. Steep slopes made up of loose or fractured material are more likely to slide. In some cases, the hillsides can become so saturated that slope failures can result in a mudslide (a mixture of soil and water moving downslope). Landslides and mudslides can move fast enough to damage or destroy buildings or other structures in their path, block roads or railways, and injure or kill people caught in them. As shown in Figure 10, much of the land in the county is in areas of moderate or high landslide risk.

Sea Level Rise and Shoreline Flooding

Sea level rise is one of the direct impacts of climate change. As global temperatures rise, glaciers and other land ice near the north and south poles melt. As this water flows into the ocean, sea levels increase across the globe. High average temperatures can also cause ocean water to expand, causing additional rise in sea levels. Sea level rise is a gradual process, taking place over years or decades. In California, guidance suggests that sea levels will increase in most places by 6 to 10 inches by 2030, 13 to 23 inches by 2050, and 41 to 83 inches by 2100.[41] However, it is possible that sea levels could rise faster than these projections. Along the Mendocino County coastline, sea levels are projected to rise approximately 22 inches by 2050 and 80 inches by 2100.[42]

Ultimately, sea levels may rise enough to permanently inundate low-lying areas along the coastline of Mendocino County. Sea level rise threatens buildings and infrastructure that may be temporarily or permanently flooded by water along the coastline, such as Highway 1 or buildings at the Point Arena port. Structures built above the increased sea level can still be harmed if the higher levels of the water erode the rock or soil supporting the structures, potentially making them unsafe and at risk of collapse. This can cause bridges and roadways to become impassable, isolating communities and preventing access for emergency services. Natural systems, such as marshland and aquatic habitats, will be disrupted by higher tide levels and intrusion of saltwater into freshwater systems. Many of the tidal marsh lands in Mendocino County are expected to migrate inland where possible or convert to another habitat type.

Rising sea levels can also cause the shoreline to flood more frequently and severely. Because ocean levels are higher during normal conditions due to sea level rise, shoreline floods such as king tides can reach further onto land. For example, a storm that has a one in ten chance of occurring in a given year (known as a ten-year storm) can create a temporary increase in sea levels of approximately 28 to 30 inches. This means that if sea levels rise by 24 inches during normal conditions, a ten-year storm event would create a temporary sea level rise of around 52 inches.[43] Higher sea levels can also give a “boost” to smaller floods that would not have been large enough to flood dry land during normal conditions, making shoreline

flooding more frequent. During strong storms and king tides, bay shoreline flooding can damage or destroy buildings in low-lying areas, disrupt transportation routes, and harm important economic assets such as coastal recreation and tourism sites.

Severe Weather

Severe storms include strong winds, hail, lightning, and heavy rainfall. Severe weather is usually caused by intense storm systems, although types of strong winds can occur without a storm. Severe winds, which can reach speeds up to 100 miles per hour in some areas, can damage or destroy buildings, knock over trees, and damage power lines and electrical equipment (potentially causing wildfires).[44] Hail can damage buildings and plants (and in extreme cases injure people), and lightening can spark fires, injure people, or cause fatalities. Heavy rainfall, which is characterized by rainfall greater than four millimeters per hour, can lead to flooding in both rural and urban areas of the county.[45] Strong winds and heavy rainfall are the most common types of severe weather in the county.

Wildfire

Wildfires are a regular feature of the landscape in much of California. The Mediterranean-type climate found throughout most of the state, including Mendocino County, is especially fire prone. Winter rains support plant growth and the summer dry season dries out vegetation, increasing the potential for ignition during the late summer and autumn when temperatures are high for several months without precipitation. They can be sparked by lightning, malfunctioning equipment, vehicle crashes, or many other causes. Wildfires are fires burning in natural areas, although they can easily spread into the developed areas between urban and wildland zones, known as the wildland-urban interface. Figure 11 shows wildfire risk exposure areas in Mendocino County. The wildland-urban interface can expose people and property to the flames, increasing the risk of injury, death, and property damage or destruction. The smoke from wildfires increases air pollution levels and create a significant health risk in the region, particularly under weather conditions that prevent smoke from clearing, such as those during the Camp Fire in 2018.

Climate change is expected to lead to an increase in wildfires throughout California. Warmer temperatures, an increase in drought conditions, and forestry pests and diseases are likely to create more fuel for fires throughout the county, leading to a greater chance that a spark will grow into a potentially dangerous blaze. Climate change is also expected to extend the fire season throughout much (or even all) of the year. Fire activity is projected to increase from 11,735 annual acres burned historically in Mendocino County, to 17,885 annual acres burned by midcentury, and 25,360 annual acres burned by end of century. This is an annual average, and some years may see significantly larger fires.[46] Because wildfires burn the trees and other vegetation that help stabilize a hillside and absorb water, more areas burned by fire may also lead to an increase in landslides and floods.

Figure 9. Current 100-Year and 500-Year Flood Hazard Areas in Mendocino County

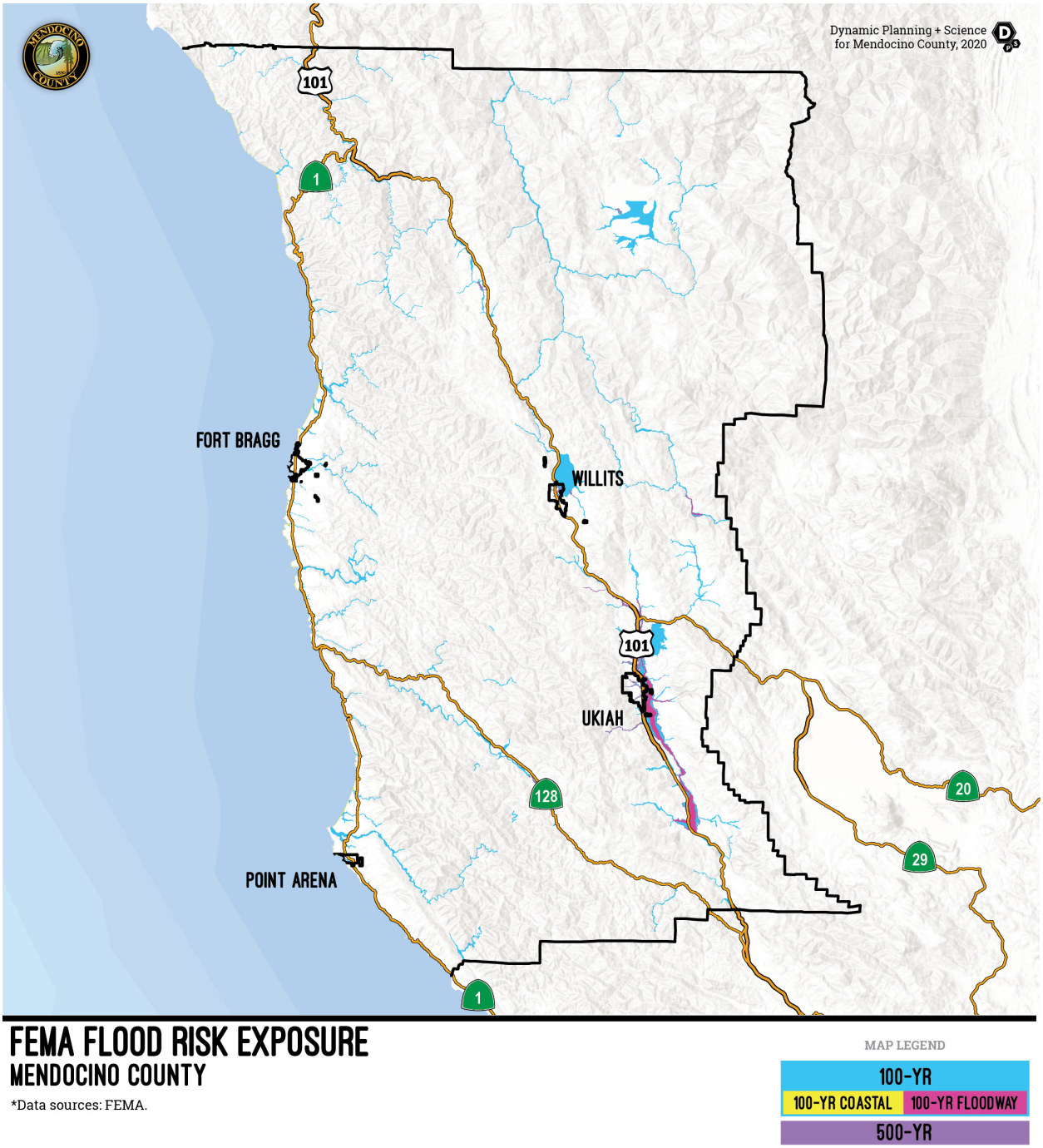


Figure 10. Landslide Hazards in Mendocino County

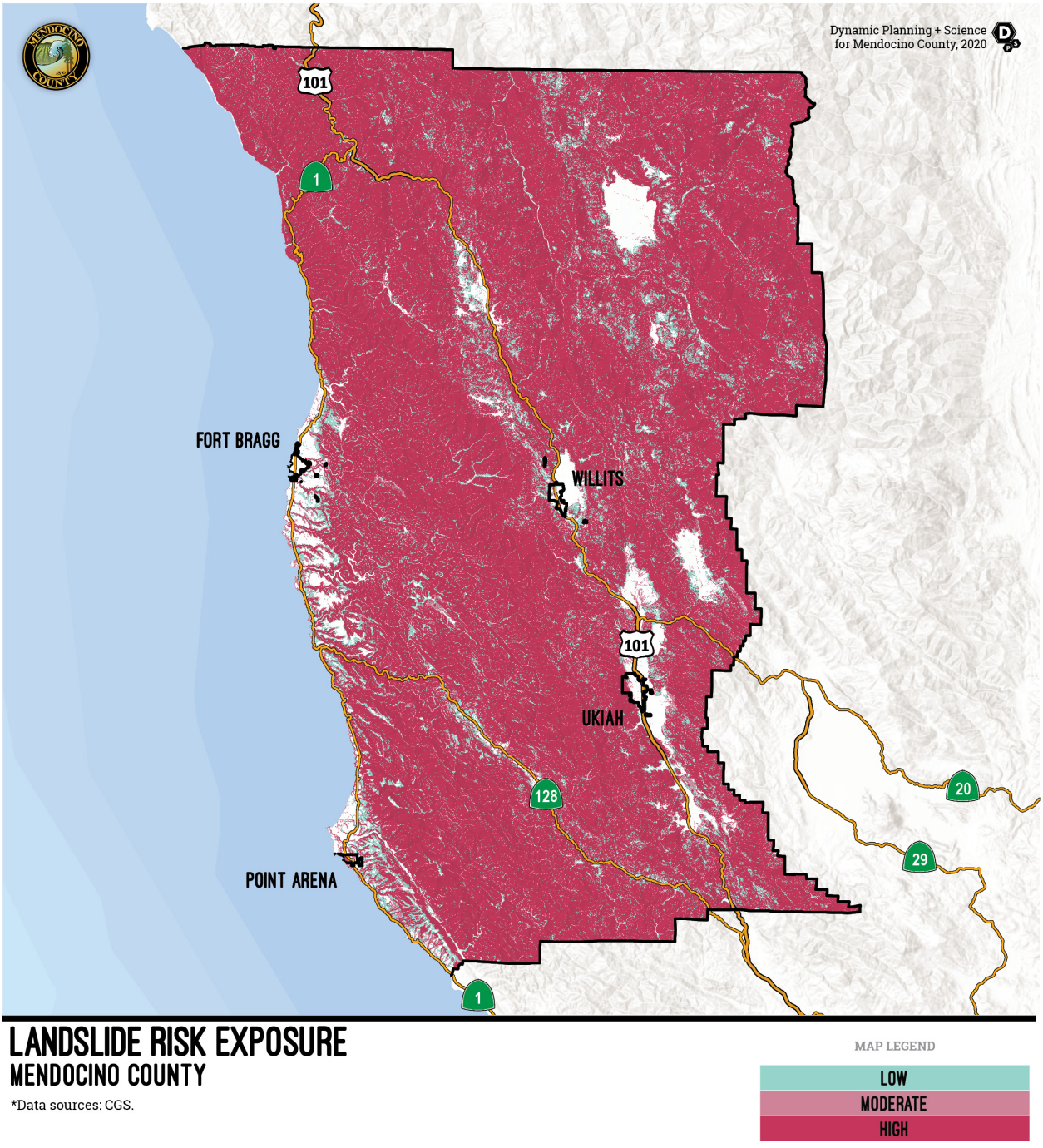
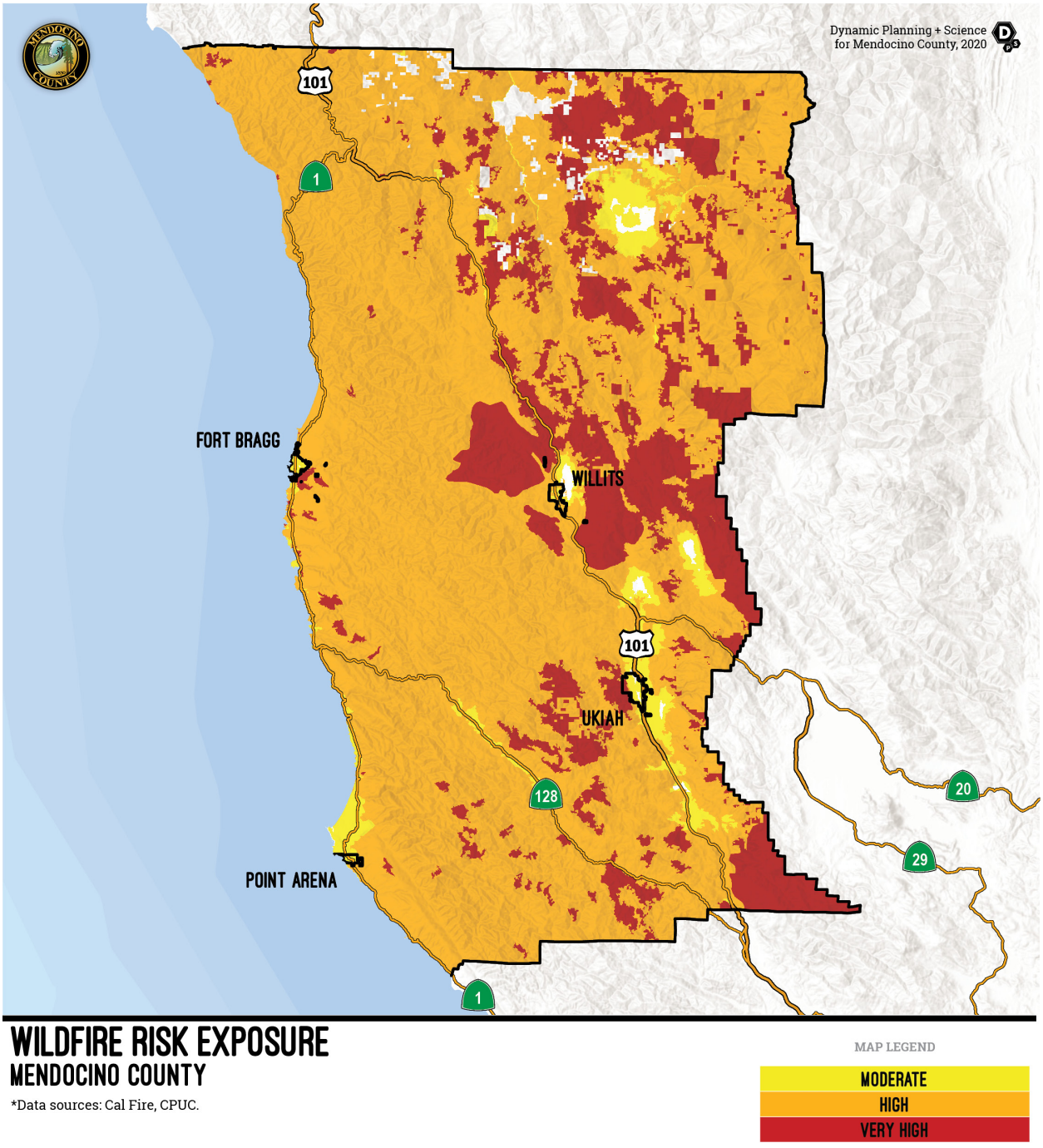


Figure 11. Wildfire Risk Exposure Areas in Mendocino County



CRITICAL VULNERABILITIES

Population and Asset Considerations

While selecting and assessing various populations and assets to include in the vulnerability assessment, Mendocino County kept a few consideration in mind, including 1) differences in the population sample pool between datasets, 2) the limitations of the data sources for Mendocino County that were used to prepare this assessment, and 3) how some population and asset categories may appear to refer to the same thing.

Population Sample Pool

Statistics, especially statistics related to population, use the concept of a sample pool. In this context, the sample pool is the overall group of people that the individuals being measured or studied are drawn from. For example, in a political poll that is conducted among registered voters, the sample pool is registered voters, since people who are not registered voters are not counted.

This concept was important for the Mendocino County Climate Vulnerability Assessment because some of the demographics used in the Climate Vulnerability Assessment have different sample pools. Most of the demographic data come from the US Census Bureau's American Community Survey (ACS), and most of this data have a sample pool of either all residents or all households in the county. However, a few that are different include:

- Data on persons with limited English proficiency only count people who are at least 14 years old, since young children generally are not proficient in any language.
- Statistics that only count the noninstitutionalized population (e.g., people not in prisons or long-term care homes).

This does not affect the outcome of the vulnerability assessment, but it can create slight differences in the number of people counted as part of each population.

Data Limitations

The Climate Vulnerability Assessment pulled in data from a wide array of sources. Mendocino County only used reliable, credible sources with the best available information. In some cases, the Climate Vulnerability Assessment was constrained by the lack of high-quality information or spatial information about the geographic distribution of particular populations or assets. For example, there is no accurate information about the distribution of undocumented persons in Mendocino County, and even information about the total number of undocumented persons countywide is an educated estimate. Because of this, the Climate Vulnerability Assessment considers undocumented persons but cannot identify specific areas where they may face elevated risk from certain hazards.

Related Assets

Throughout the 115 populations and assets in the vulnerability assessment, there are a few that may appear redundant. For example, the Climate Vulnerability Assessment looks at both public safety buildings (as a Building asset) and at public safety response (as a Community Service asset). To be as comprehensible as possible, the Climate Vulnerability Assessment looked at physical structures separately from the services or benefits they provide. In the same way, the Climate Vulnerability Assessment looked

at underserved populations separately from the homes they live in or the industries where they are employed.

This is because the effects of climate change on one type of population or asset can be different from the effects on related populations and assets. For example, if a landslide damaged or destroyed a single access road such as Highway 1, it would have a significant impact on public safety services in coastal communities, particularly if staff and resources were needed from elsewhere in Mendocino County. However, the disruption of the Highway 1 would do no physical damage to police or fire stations. Similarly, a drought can have a major effect on water and wastewater services by reducing the amount of water available in the county, but droughts have little or no physical effect on water and wastewater pipelines, pumps, or treatment facilities.

Populations

The Climate Vulnerability Assessment evaluated the following 15 populations that may be disproportionately harmed by climate change hazards. Some vulnerable populations may live in the DUCs identified above, which may have limited resources due to the isolated nature of the community or lack of capital improvement funding. DUCs are also more likely to be underserved by public facilities and services than other unincorporated areas of the county. For example, five out of the ten of the DUCs (Boonville, Covelo, Laytonville, Talmage, and The Forks) do not have sufficient water supplies, wastewater facilities, or stormwater infrastructure.[47] Some DUCs, such as Boonville and Talmage are underserved for multiple services.[48] This can heighten the vulnerability of populations living within these communities, as these deficiencies may worsen due to climate change hazards. Mendocino County gathered data for many populations listed from the American Community Survey, the 2020 Housing Element, the Healthy Places Index, and the 2019 Point-in-Time Count for Mendocino County.

Populations Evaluated

Children: Children ten years old or younger. There are approximately 6,951 children in the unincorporated areas of the county, 943 children in Fort Bragg, 24 children in Point Arena, 2,284 children in Ukiah, and 570 children in Willits. [49] Children comprise approximately 12 percent of the total population in the county.

Households in poverty: Households with an income below the 2020 poverty level, which is $26,200 for a household of four.[50] There are approximately 3,138 households in poverty in the unincorporated county, 875 household in poverty in Fort Bragg, 64 households in poverty in Point Arena, 1,762 households in poverty in Ukiah, and 912 households in poverty in Willits.[51] Households in poverty consist of about 28 percent of all households in the county.

Immigrants and refugees: Persons who were born outside of the United States that moved to the United States for employment or other purposes. There are approximately 7,088 foreign-born persons in the unincorporated county, 1,506 foreign-born persons in Fort Bragg, 109 foreign-born persons in Point Arena, 2,421 foreign-born persons in Ukiah, and 365 foreign-born persons in Willits.[52] Immigrants and refugees consist of about 13 percent of all people in the county.

Outdoor workers: Persons in industries that require them to be outdoors, such as agriculture, outdoor recreation, construction, and landscaping. Among people who are at least 16 years old and employed,

outdoor workers account for approximately 11 percent of people in the unincorporated area, 7 percent of people in Fort Bragg, 15 percent of people in Point Arena, 10 percent of people in Ukiah, and 6 percent of people in Willits.[53] These percentages include undocumented workers, but undocumented workers may be underrepresented in census data and other datasets.

Persons experiencing homelessness: Persons experiencing homelessness are individuals with a primary nighttime residence that is in a public or private space not designed for use as a regular sleeping accommodation for human beings. There are approximately 645 persons experiencing homelessness in the unincorporated county, or 0.73 percent of the population.[54]

Persons in overcrowded households: Persons living in households with more than 1.0 person per room (including all rooms except bathrooms) are considered overcrowded. Persons living in households with more than 1.5 persons per room are considered severely overcrowded. There are approximately 1,506 overcrowded households in the unincorporated county, 224 overcrowded households in Fort Bragg, 10 overcrowded households in Point Arena, 258 overcrowded households in Ukiah, and 44 overcrowded households in Willits.[55] Approximately 6 percent of all households in the county are overcrowded.

Persons in tribal communities: Members of tribal nations living on tribal lands within the county. Tribal nations in the county include the Cahto Tribe, Coyote Valley Band of Pomo Indians, Guidiville Indian Rancheria, Hopland Band of Pomo Indians, Manchester Band of Pomo Indians, Pinoleville Pomo Nation, Potter Valley Tribe, Redwood Valley Little River Band of Rancheria of Pomo Indians, Round Valley Reservation, and Sherwood Valley Rancheria.[56]

Persons living in isolated communities: Persons living in communities located in rural, low density areas away from large developed areas, often with limited access routes, such as Leggett, Covelo, and Potter Valley.

Persons with chronic health problems: Persons with a persistent or long-lasting illness or disease, including those with compromised immune systems.[57]

Persons with disabilities: Persons with a physical condition that limits their movements, senses, or activities, including those with access and functional needs, and persons with psychological conditions, including mental, behavioral, cognitive, and developmental disabilities. There are approximately 9,417 persons with disabilities in the unincorporated county, 1,547 in Fort Bragg, 58 in Point Arena, 2,249 in Ukiah, and 1,229 in Willits. [58] Approximately 16 percent of the population in the county has a disability.[59]

Persons with limited English proficiency: A person 5 years of age or older who speaks a language other than English at home and does not speak English very well. There are approximately 4,234 limited-English-speaking households in the unincorporated county, 1,024 limited-English-speaking households in Fort Bragg, 72 limited-English-speaking households in Point Arena, 1,968 limited-English-speaking households in Ukiah, and 249 limited-English-speaking households in Willits. There are approximately 9 percent of all households in the county that are limited English speaking.[60]

Persons without access to lifelines: Persons without access to a car, transit, or communication systems (internet and phone services). There are approximately 947 households without access to a vehicle in the unincorporated county, 326 households without access to a vehicle in Fort Bragg, 16 households without access to a vehicle in Point Arena, 650 households without access to a vehicle in Ukiah, and 399

households without access to a vehicle in Willits.[61] Approximately 7 percent of households in the county do not have access to lifelines.

Senior citizens: Individuals 65 or older. There are approximately 12,796 senior citizens in the unincorporated areas of the county, 1,247 senior citizens in Fort Bragg, 77 senior citizens in Point Arena, 2,229 senior citizens in Ukiah, and 872 senior citizens in Willits.[62] Senior citizens comprise approximately 20 percent of the total population in the county.

Senior citizens living alone: Individuals 65 or older living alone. There are approximately 3,025 seniors living alone in the unincorporated areas of the county, 386 seniors living alone in Fort Bragg, 35 seniors living alone in Point Arena, 956 seniors living alone in Ukiah, and 412 seniors living alone in Willits.[63] Approximately 14 percent of households are seniors living alone in the county.

Undocumented persons: Persons residing in the country and the county without legal documentation.

Critically Vulnerable Populations

Several groups are considered critically vulnerable, meaning that they face high or severe vulnerability (see Figure 4) because of one or more climate-related hazard.

Households in poverty: Households in poverty in Mendocino County and incorporated cities have substantial financial burdens that can increase the severity of impacts and lower their capacity to adapt to climate change hazards, making them more vulnerable. This population is severely vulnerable to inland flooding, severe weather, and extreme heat because they are more likely to live in structures that are less insulated or less structurally resilient. Flooding and severe weather can damage homes or cause mold to grow, which can make unhealthy living conditions. Extreme heat can cause indoor air temperatures to skyrocket, causing dehydration and other heat-related illnesses for those inhabiting the structures. Although homes can be retrofitted to be more insulated or protected from flooding and severe weather, this can be expensive and may not be financially feasible. The expense of retrofitting and repairing damaged buildings also makes households in poverty severely vulnerable to landslides. Financial assistance programs such as Property Assessed Clean Energy (PACE) are available to assist with upgrades to homes, but households may be unaware or unable to participate in these services. Households in poverty are severely vulnerable to wildfires due to financial limitations that make it difficult to maintain defensible space or fire insurance on homes to help rebuild after a fire. Smoke from wildfires and human health hazards create vulnerabilities for households in poverty because they may not be able to seek refuge from smoke conditions if they cannot afford air filtration devices, may live in overcrowded conditions that can spread human health hazards, and may not be able to seek medical attention due to a lack of medical insurance. Households in poverty are also highly vulnerable to drought and shoreline flooding due to extra costs associated with increased utility prices and property maintenance associated with adapting to these hazards.

Persons experiencing homelessness: Persons experiencing homelessness lack access to permanent, and often temporary shelter, which makes them severely vulnerable to extreme heat, human health hazards, severe weather, and wildfire. A lack of permanent shelter increases the potential of exposure to pathogens, smoke from wildfires, and extreme heat conditions that can cause cardiovascular and respiratory illnesses. Persons experiencing homelessness may not have access to medical care, which can make it harder for them to recover from illnesses. Mendocino County currently has a comprehensive

strategy to provide affordable housing and reduce homelessness in the county, and there are six shelters in Ukiah, Willits, and Fort Bragg.[64] However, persons experiencing homeless may be unaware or unable to travel to these services. Persons experiencing homelessness are also highly vulnerable to inland and shoreline flooding, as temporary shelters are more likely to be in flood-prone areas.

Immigrants, refugees, and undocumented persons: Immigrants, refugees, and especially undocumented persons may be afraid or unable to seek help before, during, or after a climate change hazard due to their citizenship status.[65] People with citizenship or immigration concerns, such as undocumented immigrants, are severely vulnerable to agriculture and forestry pests and diseases, human health hazards, and severe weather, because these may reduce the work available in the region or cause illness or injuries. Undocumented persons may have limited access to health care or other services that could help them recover from these hazards. Undocumented persons are also highly vulnerable to extreme heat, inland flooding, landslides, shoreline flooding, and wildfire, which can create unbearable heat waves and smoke conditions, wash out or damage roadways, and harm housing and other structures that these persons depend on. Similarly, immigrants and refugees are highly vulnerable to human health hazards, inland flooding, landslides, severe weather, and wildfire. These populations may face difficulties during emergencies that require evacuations, because potentially lower levels of social capital and language barriers may prevent adequate preparation and warnings for evacuations.

Persons living in isolated communities and persons living in tribal communities: Persons living in isolated communities and persons living in tribal communities are vulnerable to several climate change hazards because they are in areas that can be easily cut off from the rest of the region and from receiving vital goods and services. In coastal areas, isolated communities such as Gualala, Manchester, Casper, and Westport are highly vulnerable to becoming even more isolated if Highway 1 is damaged or destroyed by dune and bluff erosion, landslides, inland flooding, shoreline flooding, or sea level rise. This can affect the delivery of goods, availability of services, emergency medical response, and visitors traveling to the area to sustain the economy. Tribal communities in both coastal and inland areas can similarly be cut off from the rest of the region if roadways are blocked, damaged, or destroyed by landslides, inland flooding, or severe weather. Both persons living in isolated and in tribal communities are highly vulnerable to wildfire because they may not be able to effectively evacuate from a wildfire nearby. Traditionally, persons in tribal communities use prescribed burns and vegetation management techniques to reduce exposure from wildfire; however, they do not have much control over the nearby forested lands.[66] Isolated communities are also highly vulnerable to human health hazards and tribal communities are highly vulnerable to extreme heat due to the lack of access to medical care or communication of heat waves or human health hazards in the region.

Senior citizens and senior citizens living alone: Seniors citizens and senior citizens living alone are vulnerable to several different climate change hazards due to health and mobility factors. Seniors are usually more susceptible to heat-related illnesses, pathogens, and smoke conditions because they are more likely to have medical conditions that can worsen with extreme heat, and often take medicine that makes it harder for them to stay cool. Senior citizens are more susceptible to poor air quality associated with wildfires, and seniors may have a decreased awareness of impending fire events. Additionally, they may have reduced mobility that makes it difficult to quickly evacuate in hazardous conditions. Seniors living alone may face additional challenges, because they are more likely to not have the social

connections with the community or caretakers that can help with preparation, evacuation, or recovery during inland and shoreline flooding, landslides, severe weather, or wildfires. Mendocino County maintains an evacuation assistance list to locate vulnerable populations and help them evacuate safely.[67] However, seniors living alone may be unaware of this service due to an absence of social networks. Seniors living alone in coastal areas are also highly vulnerable to dune and bluff erosion and shoreline flooding, which can damage homes or infrastructure that they rely on.

Outdoor workers: Individuals working outdoors face greater exposure to climate change hazards because they do not work in sheltered locations and often have physically intensive work. Outdoor workers can easily face economic hardship if work is halted or delayed. Therefore, outdoor workers are severely vulnerable to smoke from wildfires, extreme heat, and human health hazards. Extreme heat can cause individuals to overheat and cause dehydration and heat stroke, and smoke and ash can irritate the respiratory system and create difficulty breathing with extended exposure. Outdoor work sites can make water, shelter, and protective gear available, although not all sites may do so even when required to. Persons working outdoors are often aware of the warning signs of heat-related illnesses, although access to medical care may be more limited in remote outdoor work sites. Drought and agricultural or forestry pests and diseases can harm crops, vineyards, and trees, which can reduce the amount of outdoor work available to this population and create economic hardships for outdoor workers. Some outdoor workers may be able to transfer industries through educational programs in the county, such as the Mendocino Lake Adult & Career Education program; however, this may not be feasible for all individuals.[68]

Persons with chronic health problems: Persons with chronic health problems have existing conditions that make it difficult to adapt to climate change hazards. These persons may find it difficult to adapt to increases in extreme heat and smoke from wildfires, or to effectively evacuate during shoreline flooding or wildfire events. Persons with chronic health problems typically have compromised immune systems that leave them more susceptible to human health hazards. These persons may also rely on life-supporting equipment or treatment machines, such as dialysis or breathing equipment, which requires electricity, which can be turned off or lost during severe weather conditions. Mendocino County maintains an evacuation assistance list to locate vulnerable populations and help them evacuate safely. This helps improve the adaptive capacity of participants, although not all vulnerable persons may be aware of this list.[69]

Infrastructure

There are 19 types of infrastructure in this vulnerability assessment. Some infrastructure is publicly owned by Mendocino County or the cities of Fort Bragg, Point Arena, Ukiah, and Willits, and some is privately owned and managed.

Infrastructure Evaluated

Airports (city managed, county managed, privately managed): There are six airports in the County of Mendocino. Two of these airports, Ukiah Municipal Airport and Willits Municipal Airport, are owned and operated by cities and primarily used for municipal and private aircraft. Mendocino County manages Little River Airport, Round Valley Airport, and Boonville Airport, which are primarily used for private and emergency aircraft. Emergency aircraft use includes response by CAL FIRE and search and rescue teams.

One airport, the Ocean Ridge Airport, is privately owned and primarily used by private aircraft in addition to publicly managed emergency medical and fire agency aircraft.

Hiking trails: These trails are mostly intended for hiking or walking, although some may be multiuse paths. These trails may be paved or unpaved, based on location and use type. Many of the trails are in state parks, beaches, or recreation areas, and some trails are part of a much larger network, such as the 1,200-mile-long California Coastal Trail.[70]

Biking Trails: These trails are mostly intended for either road biking or mountain biking, although some may be multiuse paths. Biking trails can be paved or unpaved, based on location and intended use. Many of the mountain biking trails are in the Jackson State Demonstration Forest, Mendocino Woodlands State Park, Big River Unit, Mendocino Headlands State Park, and Sinkyone Wilderness State Park.

Bridges: Bridges may carry roads, railways, or trails. In Mendocino County, these range from the large, state-owned bridges that carry Highway 1 to locally owned bridges that carry hiking trails over small creeks. There are approximately 199 state bridges and 163 local bridges in the county.[71,72]

Communication facilities: These facilities include public radio and television transmitters, cell phone towers, emergency communication antennae, and a wide range of other public and private communication infrastructure systems. There are 102 known communication towers in the county (radio, TV, etc.).[73]

Dams: A barrier to hold back water and raise its level, resulting in a reservoir. There are approximately 31 public and private dams in Mendocino County.[74]

Electrical substations (incorporated and unincorporated): Electrical substations are facilities that convert electricity from one voltage to another, making it suitable for long-distance transmission or for use by homes, businesses, and other electrical customers. There are 12 substations in the unincorporated areas of the county, 1 substation in Fort Bragg, 1 substation in Point Arena, 3 substations in Ukiah, and 1 substation in Willits, owned and operated by PG&E and other owners.[75]

Electrical transmission lines: Electrical transmission lines are power lines that carry high-voltage electricity long distances between power plants and electricity customers. Transmission lines are owned and operated by PG&E and other owners in the county.[76]

Electric vehicle charging stations: Electric vehicle charging stations provide battery recharge locations for electric and hybrid electric vehicles. There are approximately 82 existing level 2 chargers (47 open access and 31 other or private access) and 9 DC fast chargers.[77]

Evacuation routes: Major roadways or access roads that function as emergency evacuation routes during disasters.

Flood control infrastructure: This infrastructure includes levees, dikes, drainage channels, and other infrastructure meant to help prevent the creeks and other water bodies in Mendocino County from overflowing their banks and causing floods. Some DUCs are underserved by flood control and storm water infrastructure, including Covelo, Talmage, and The Forks.[78] There are approximately 3.1 miles of levees in the county.[79]

Landfills and transfer stations (incorporated and unincorporated): Sites that are used for the disposal or transfer of waste materials. There are 16 transfer stations or composting or disposal facilities in the unincorporated county, 1 disposal site in Fort Bragg, 1 soil amendment site in Ukiah, and 1 transfer station in Willits.[80]

Major roads and highways (incorporated and unincorporated): Mendocino County's major roads and highways connect individual communities to others in the region and to points beyond. Major highways and roadways in the unincorporated county include US-101, Hwy-1, SR-162, SR-20, SR-128, SR-175, SR-253, Old River Road, North State Street, East and West Roads Redwood Valley, East-Side Road Potter Valley, Orr Springs/Comptche Ukiah Road, Fish Rock Road, Mt. View Road, Philo Greenwood Road, Flynn Creek Road, Brascomb Road, Laytonville Dos Rios Road, and Bell Springs Road. Major roadways in Fort Bragg and Point Arena include East Oak Street and Riverside Drive, respectively. Additional major roads in Ukiah consist of SR-222, State Street, Gobbi Street, Perkins Street, and Low Gap Road, and in Willits include Main Street, Sherwood Road, Valley Street, and Commercial Street.

Parks and Open Space (incorporated and unincorporated): Parks and open space includes parks, trails, and outdoor activity centers within the county. The unincorporated county has 8 parks and open spaces, Fort Bragg has 6 parks and open spaces, Point Arena has 2 parks, Ukiah has 17 parks and open spaces, and Willits has 6 parks and open spaces.

Power Plants (incorporated and unincorporated): Power plants generate large amounts of electricity that is distributed through the state and regional electrical grid. There are seven power plants, including hydroelectric, solar, and biomass facilities, in the unincorporated areas of the county. There are four solar power plants in the city of Ukiah.

Rail lines: Two railroads, California Western Railroad and Northwest Pacific Railroad Company, provide both freight and passenger service in Mendocino County.

Single access roads: Roadways that only have one access point in or out of a neighborhood or region. The single or limited number of entry and exit points does not make the road itself more vulnerable than other roads, but loss of these roadways can effectively cut off large numbers of people from the rest of Mendocino County.

Transit stops: Transit stops provide key connections for transit riders and those transferring between rail and bus routes in the county. Mendocino Transit Authority, Greyhound Bus, and Amtrak manage transit stops.

Water and wastewater infrastructure (incorporated and unincorporated): These facilities provide and/or treat water for public use and treat wastewater so it can be safely discharged into the environment. These facilities include surface storage reservoirs, distribution systems, water treatment facilities, and wastewater treatment facilities. Water and wastewater facilities serving unincorporated areas of the county include Aquatic Bioscience Water Treatment Plant and Mendocino Water Treatment Plant. The city of Fort Bragg has a water treatment plant, the city of Ukiah has two wastewater treatment plants, and the city of Willits has a sewage treatment plant. In rural areas of the county, septic tanks are the primary wastewater infrastructure. Some water and wastewater infrastructure in DUCs, such as Boonville, Laytonville, Talmage, and The Forks have existing deficiencies and underserve these communities.[81]

Critically Vulnerable Infrastructure

Major roads, highways, and evacuation routes: Major roads and highways are frequently used as evacuation routes throughout the county and its incorporated areas. In the coastal areas of the county, hazards such as dune and bluff erosion, shoreline flooding, and sea level rise can inundate, damage, or destroy roadways, leaving communities isolated from the inland areas of the county. The most vulnerable major roadway is Highway 1. Both inland and coastal roadways can be damaged by landslides in the form of rockslides or debris flows. Landslides can cover roadways and damage the foundations of the road, making them impassable. This is detrimental to communities that rely on these roadways for vital goods, evacuations, and emergency medical response. Landslides can block not only Highway 1 but also major routes that connect coastal or eastern areas of the county to Highway 101. Major roadways throughout the county are also vulnerable to wildfires and inland flooding, which can cause them to close or become impassable, isolating residents and business owners. Severe weather and forestry pests and diseases can cause trees to fall, damaging or blocking roadways. Major roads, highways, and evacuation routes can be cleared of vegetation and fuels, retrofitted to resist landslides and prevent flooding, and repaired when damaged. However, major roads and highways are the primary method of travel in the county for both residents and visitors, and therefore any disruptions could harm the economy and quality of life.

Single access roads: Single access roads are the second most vulnerable infrastructure assets in Mendocino County due to their remote nature and location in heavily forested or hazardous areas. Dozens of single access roadways are severely vulnerable to wildfire and flooding, which can block or inundate single access roads, making them impassable. In steep areas of the county, landslides can damage the foundations or completely cover single access roads. In coastal areas, single access roadways, including Highway 1, can be damaged or destroyed by dune and bluff erosion that completely undermine the foundation of the roadways. In inland areas, many of the single access roads are in highly forested areas, which increases the risk of a dead or diseased tree falling on the road and making it impassable. Any single access roadway that becomes blocked to vehicle traffic can prevent residents, visitors, and business owners from effectively evacuating during an emergency. Single access roads can be cleared and repaired following damage and alternative roads can be built to ensure access is kept open. However, due to the remote nature of Mendocino County and its communities, clearing and repairs could last over an extended period.

Bridges: Many bridges in the inland and coastal areas of the county are in hazard-prone areas that make them more susceptible to damage. In coastal areas, 15 bridges along Highway 1 are in the dune and bluff erosion area, and 5 bridges are in the sea level rise and shoreline flooding area.[82] Bluff erosion can undermine the foundations of bridges, causing damage or collapse. Repeated inundation from sea level rise or shoreline flooding can damage roadway materials, and frequent enough inundation can make the bridge impassable. In both inland and coastal areas, bridges are highly vulnerable to inland flooding, landslides, and severe weather. Inland flooding can completely wash out bridges, making them periodically impassable. This already happens along Highway 1 between Point Arena and Manchester, where the bridge is frequently washed out due to inland flooding. Landslides and severe weather that knock down trees can also block bridges.[83] Blocked and impassable bridges are especially harmful for isolated communities that rely on these bridges as key roadway connections to other areas of the county. If one bridge is down along Highway 1, residents and visitors may have to drive hours out of their way to travel inland or evacuate in an emergency.

Electrical transmission lines: Electrical transmission lines in Mendocino County run through wildfire- and landslide-prone areas and can be damaged or destroyed in these events. Extreme heat reduces efficiency in transmission lines because higher temperatures cause power loss in the lines. Increased electricity usage for air conditioning during heat waves can overtax electrical transmission lines and transformers, which may disfunction or fail, causing power outages. Severe weather can also have wind speeds that cause transmission lines to sway into close in proximity of each other, potentially leading to arcing. This can generate sparks, excessive heat, and damage the lines. In recent years, infrastructure owners have turned off the electrical transmission lines during high wind events to reduce the possibility of sparking. Those who manage the power lines can turn off power, retrofit older lines, and create defensible space around transmission lines to prevent extensive damage. However, when electrical transmission lines are damaged or turned off, residents and business owners experience power outages, which can cause economic and other hardships throughout the county.

Rail lines: Rail lines in the county run through wildfire, inland flooding, and landslide hazard areas. Approximately 45 miles of railroad are within 100-year flood hazard zones, 84 miles are within medium- to high-landslide areas, and 114 miles are within high or very high wildfire hazard areas.[84] Inland flooding can damage tracks and disrupt service if conditions are too dangerous for trains to travel on them. Landslides can cover tracks or destroy stations, which could prevent rail cars from passing through the station in either direction. Wildfires can damage tracks and cause debris to fall on the rail lines, making them impassable. Rail lines can be hardened and protected from these hazards; however, this can be expensive, repairs would need to be coordinated among multiple agencies, and specialized equipment and materials would be needed for the repairs.

Buildings

Buildings include different types of public and private structures. There are nine different types of building assets included in the vulnerability assessment.

Buildings Evaluated

Commercial buildings: Buildings that supports economic activities such as retail and tourism.

Community centers (Incorporated and unincorporated): Community centers are public properties that provide gathering and activities spaces, such as youth centers, senior centers, veterans' centers, and other community centers. Community centers in the unincorporated areas of the county include Casper Community Center, Community Center of Mendocino, Brooktrails Community Center, Potter Valley Youth and Community Center, and Manchester Community Center. Fort Bragg has the Fort Bragg Community Center, Fort Bragg Town Hall, and CV Star Community Center; Point Arena has the Coastal Seniors Center; Ukiah has the Bartlett Hall, Ukiah Valley Conference Center, and Alex Rorabaugh Center; and Willits has the Willits Community Center.

Government buildings: Buildings owned and/or operated by Mendocino County or incorporated cities that provide administrative and other services. These buildings include the Mendocino County Administration Center, Ukiah Civic Center, Willits City Hall, Fort Bragg City Hall, Point Arena City Hall, and other administrative buildings.

Homes and residential structures: Homes and residential structures in the county, including older buildings that may have greater heating/cooling needs or be more susceptible to damage.

Libraries: Facilities containing collections of books, periodicals, and other resources for public or institutional use. Libraries serving the unincorporated areas and cities include Mendocino County libraries, Willits Library, Coast Community Library, Round Valley Public Library, Native Media Resource Center, and Ukiah Library.

Medical care facilities: The primary medical facilities are Mendocino Coast District Hospital in Fort Bragg, Frank Howard Memorial Hospital in Willits, and Ukiah Valley Medical Center in Ukiah.

Public safety buildings: Public safety buildings include police and sheriff buildings, fire stations, California Highway Patrol facilities, and related structures such as dispatch centers, correctional facilities, animal shelters, and emergency operation centers. There are 60 fire stations and 12 police or sheriff stations in the unincorporated areas, and 9 fire stations and 9 police or sheriff stations in the incorporated cities.[85]

Schools (incorporated and unincorporated): Schools in Mendocino County include elementary schools, middle schools, high schools, continuing education, and special education facilities. The districts serving the unincorporated areas include Anderson Valley Unified, Laytonville Unified, Leggett Valley Unified, Manchester Union Elementary School District, Mendocino Unified, Potter Valley Community Unified, and Round Valley Unified. The school districts serving the incorporated cities include Fort Bragg Unified, Area Union Elementary School District, Point Area Joint Union High School, Ukiah Unified, and Willits Unified.

Tribal facilities: Tribal facilities are the buildings and cultural sites that support the government, services, and economic drivers of tribal nations within Mendocino County. Tribal nations with facilities in the county include Coyote Valley Band of Pomo Indians, Guidiville Rancheria, Hopland Band of Pomo Indians of the Hopland Rancheria, Cahto Indian Tribe of Laytonville Rancheria, Manchester Band of Pomo Indians of the Manchester-Point Arena Rancheria, Pinoleville Rancheria of Pomo Indians, Potter Valley Tribe, Redwood Valley Rancheria of Pomo Indians, Round Valley Indian Tribes of Round Valley Reservation, and Sherwood Valley Rancheria of Pomo Indians.

Critically Vulnerable Buildings

Homes: Homes are vulnerable to more hazards than any other building. Homes in the inland areas of the county are severely vulnerable to inland flooding and wildfires because they are in the 100-year floodplain and high or very high fire hazard severity zones. These hazards can damage or destroy homes. If flooding does not destroy a home, it can leave mold and mildew, making the structure uninhabitable. In coastal areas, homes along the bluffs are highly vulnerable to erosion, which can undermine the foundation of the home. Landslides can undermine the foundations of homes or cover homes in their path, damaging or destroying the structure. Homes, especially older homes, can also be damaged by high winds and hail. North Coast Energy Service offers a home weatherization program for low-income residents and homeowners to retrofit their homes. Homes can also be hardened against flooding and landslides, and defensible space can be created to prevent damage from wildfires. However, these adaptive options can be expensive and are not always feasible for residents.

Tribal facilities: Tribal facilities are highly vulnerable to severe weather and wildfire. Severe weather can cause trees and debris to damage facilities and tribal cultural sites, which can harm cultural practices and community activities. Wildfires can damage tribal government buildings, housing, and important cultural sites, causing harm to those living and working in these buildings. Tribal communities have abundant local knowledge of fire management practices that can help protect buildings and facilities. However, fire suppression efforts have historically prevented this from occurring.[86] Access to fewer financial resources can also make it harder for persons in tribal communities to recover or prepare for more frequent hazard events, and sufficient assistance may not always be available.[87]

Important Economic Assets

Economic drivers are the main contributors to an economy. This category of the Climate Vulnerability Assessment covers the 12 most important economic drivers for Mendocino County.

Economic Assets Evaluated

Agriculture: This category includes the production of fruit and nut crops (excluding wine grapes), livestock, nursery products, vegetable crops, and field crops. These agricultural products are scattered throughout Mendocino County, with the majority occurring in the central valley of the county. In 2018, agriculture produced $50.3 million in agricultural products, excluding wine grapes.[88]

Agritourism: The economic activities provided by festivals, U-pick operations, and other agriculture-based tourism activities. There are at least nine different agritourism sites in the unincorporated county.[89]

Casinos: Casinos support the economy of some of the tribal nations in Mendocino County. The county has five casinos—Garcia River Casino, Coyote Valley Casino, Sherwood Valley Casino, Red Fox Casino, and Hidden Oaks Casino.

Coastal recreation and tourism: This category includes economic activities provided by beaches, historic landmarks, parks and open space, hiking trails, bicycling routes, and shorelines. It also includes sailing, boating, whale-watching, and other ocean-oriented tourism.

Communication Utilities: The trans-Pacific fiber-optic cable runs along the floor of the Pacific Ocean between Asia and North America. The community of Manchester, just north of Point Arena, has connection points for the Hong Kong-Americas and Japan-U.S. fiber-optic cable networks.[90]

Cultural and historical sites: Mendocino County has over 40 cultural and historic sites in different subregions.[91] These sites include schoolhouses, cemeteries, cottages and homes, hotels, and train depots scattered throughout the county's landscape. There are also dozens of tribal cultural sites scattered throughout the county.

Fisheries and fishing grounds: This category includes catching fish and other seafood for commercial profit from wild or human-made fisheries. Fish and seafood include Dungeness crab, sablefish, chinook salmon, lingcod, hagfish, and rockfish. In 2018, approximately 4.7 million pounds of commercial fish were caught in the county, bring in approximately $9.3 million in revenue.[92]

State and federal land recreation and tourism: This category includes activities on State and federal land, including Jackson State Demonstration Forest, Mendocino Woodlands State Park, Big River State Park, Mendocino Headlands State Park, Sinkyone Wilderness State Park, and other state parks, beaches, and recreation areas.

Hunting grounds: This category includes areas of the county where game is hunted. Hunting grounds are primarily in the Mendocino National Forest. A number of hunting grounds are also associated with private ranches and operate in conjunction with the California Department of Fish & Wildlife.

Inland recreation and tourism: This category includes economic activities provided by lakes, rivers, historic landmarks, parks and open space, hiking trails, and bicycling routes in the inland areas of the county and not on state or federal lands.

Wineries and Vineyards: Wineries and vineyards include the production of both wine grapes and wine. In 2018, wineries and vineyards produced approximately $138 million in revenue.[93]

Timber production: Timber production includes the growing, harvesting, and processing of wood products. In 2018, timber production produced approximately $133 million in revenue.[94]

Critically Vulnerable Economic Assets

Agriculture, agritourism, and wineries: These operations are highly or severely vulnerable to several different hazards. Extreme heat is expected to have the most severe impact on agriculture and wineries, and wildfire is expected to have the most severe effect on agritourism. Agriculture and forestry pests and diseases, drought, human health hazards, inland flooding, and severe weather may also cause significant harm. Drought can reduce water supplies, making less water available for crop irrigation and reducing yields or forcing farmers to change crop patterns or even the crops themselves. Extreme heat can damage vineyards and fruit and nut crops; crops that depend on long, cold winters may become less common. For example, cold-hardy crops such as cabbage and peaches may become less suitable as temperatures increase, and melons and sweet potatoes may become more common because they can withstand high temperatures. Inland flooding and severe weather can harm or kill crops and agricultural infrastructure, reducing yields and causing costly repairs. Human health hazards and smoke from wildfires can also harm farmworkers, which can impact the ability to effectively manage and harvest the products. In some cases, farmers may be able to find crop varietals that are more resilient to these changes. Improved drainage and other infrastructure, changes to pest management activities, and increased personal protective equipment at farming operations may help reduce damage from hazards. However, many of these actions can be expensive and may not be appropriate for all types of farming operations.

Timber production: Timber production in Mendocino County is highly susceptible to forestry pests and diseases, drought, extreme heat, fog, and landslides. Forestry pests and diseases can have short-term benefits for timber harvesting, but bark beetles and other pests can do long-term damage to timber harvesting sites. This can be exacerbated by drought and extreme heat, which directly lead to tree mortality and wildfires that can devastate the timber industry. Redwood forests, a major part of the timber harvesting industry in Mendocino County, are highly dependent on coastal fog, which may disappear in the future. Timber harvesting is also in landslide-prone areas, which can prevent logging companies from transporting timber out of forests. Timber harvest plans are required for large-scale operations to account for the hazards that may affect timber production. However, extreme heat,

drought, and decreased coastal fog may change forest ecosystems so they do not function as needed for timber production.

Recreation and tourism: Outdoor recreation and tourism is an essential component of the county's economy and can be directly affected by shoreline flooding, wildfire, severe weather, landslides, forestry pests and diseases, drought, dune and bluff erosion, and extreme heat. Inland water recreation can be directly impacted if there is not enough water to attract people to fishing, swimming, and boating activities. Outdoor recreation facilities may be shut down or reduce hours during extreme heat, severe weather, or wildfire conditions, and people may be less willing to travel to the county for hiking, bicycling, camping, and horseback riding. Smoke created by wildfires can also curtail outdoor recreation activities in inland, coastal, and state or federal land areas. Landslides and bluff erosion can cut off roadways in coastal or inland areas, preventing residents and visitors from traveling to some recreation and tourism sites. Defensible space can be created around some sites, and outdoor recreation activities can be relocated to areas with accessible roadways and away from poor air quality or high temperatures, but these areas may not be in the county or attract as much economic activity.

Ecosystems and Natural Resources

There are 11 primary ecosystem types in Mendocino County, although many of them can be subdivided into specific habitats. The Climate Vulnerability Assessment analyzes these 11 ecosystems as well as Marine Protected Areas. The 2008 General Plan Update Draft Environmental Impact Report provides a basis for the acreage and descriptions of each ecosystem. Table 4 lists these 11 wild vegetated areas as well as developed and wild unvegetated areas and their acreage in the county.

Table 4. Ecosystem Coverage in Mendocino County

ECOSYSTEM	ACRES	PERCENTAGE OF WILD VEGETATED AREA	PERCENTAGE OF COUNTY AREA
Wild Vegetated Areas			
Aquatic	5,230	0.3%	0.3%
Chaparral	108,613	6.1%	5.3%
Coastal scrub	9,848	0.6%	0.5%
Conifer forests	391,039	22.0%	19.1%
Grasslands	149,014	8.4%	7.3%
Mendocino cypress woodlands	21,268	1.2%	1.0%
Montane hardwood forests	565,484	31.8%	27.6%
Oak woodlands	19,293	1.1%	0.9%
Redwood forests	510,133	28.7%	24.9%
All wild vegetated areas	**1,779,923**	**100%**	**87%**

ECOSYSTEM	ACRES	PERCENTAGE OF WILD VEGETATED AREA	PERCENTAGE OF COUNTY AREA
Developed and Wild Unvegetated Areas			
Barren and open dune	9,461	-	0.5%
Open water	236,160	-	11.5%
Agricultural and range land	12,637	-	0.6%
Urban	1,544	-	0.1%
Cities (Fort Bragg, Point Arena, Ukiah, Willits)	7,644	-	0.4%
Not yet mapped	2,764	-	0.1%
Total developed and wild unvegetated areas	**270,210**	**-**	**13%**
Total County Area	**2,050,133**	**-**	**100%**

Source: Mendocino County General Plan, 2009; Mendocino County General Plan Draft EIR, Table 4.4-1, 2008.

Ecosystem Evaluated

Aquatic: Aquatic habitat includes plants and wildlife in the lacustrine, saline emergent wetland, and wet meadows habitats, which make up approximately 0.3 percent of the county. The largest lacustrine habitat in Mendocino County is Lake Mendocino. This ecosystem also includes estuarine habitat, which is a transitional zone between riverine and marine waters. Wildlife in this habitat includes various species such as the Pacific giant and California giant salamanders, western pond turtle, brown pelican, great blue heron, and northern river otter, among many others.

Chaparral: The chaparral ecosystem includes plants and animals living in the mixed chaparral, chamise-redshank chaparral, eucalyptus, and montane chaparral habitats, which encompass approximately 5.3 percent of the county. Mixed chaparral occurs in foothill and montane areas in the southern and eastern portions of the county; chamise-redshank chaparral occurs in the montane extreme eastern portions; eucalyptus occurs throughout the county; and montane chaparral occurs in higher montane habitats in the northeastern part of the county. Chaparral habitats in the county tend to be patchy and mixed with montane hardwood or conifer forests. Animal species in this ecosystem includes southern alligator lizards, western rattlesnake, turkey vulture, barn owl, Pacific kangaroo rat, and coyotes.

Coastal scrub: Coastal scrub occurs along the coastal bluffs and covers approximately 0.5 percent of the county. These habitats often occur in drier, hotter, or areas of other severe conditions that other ecosystems may not survive in. This ecosystem is dominated by coyote-brush, lupines, ceanothus, monkeyflower, and various grasses, with animals such as bullfrog, Western fence lizard, blue-gray gnatcatcher, western bluebird, great horned owl, California ground squirrel, and fray fox.

Conifer forests: Conifer forest ecosystems include plants and wildlife in the Douglas fir, white fir, red fir, Ponderosa pine, Klamath mixed conifer, and Jeffrey pine habitats, and cover approximately 19.1 percent of the county. Conifer occur in both western and eastern Mendocino county, where areas are too dry for redwood and hardwood trees. This ecosystem supports a variety of wildlife species, including several bird species, salamanders, frogs, and mammals such as the coyote, gray fox, tule elk, mule deer, deer mouse, and shrew-mole.

Grasslands: Grasslands occur throughout Mendocino County and primarily consist of annual grassland, perennial grassland, montane meadow, and coastal prairie, covering approximately 7.3 percent of the county. Wildlife species in grassland areas are foragers, including the Pacific chorus frog, common garter snake, western meadowlark, American kestrel, California ground squirrel, coyote, black bear, and fallow deer.

Marine Protected Areas: Marine protected areas are marine sanctuaries, estuarine research reserves, ocean parks, and marine wildlife refuges. There are 12 marine protected areas in Mendocino County, including Double Cone Rock State Marine Conservation Area (SMCA), Ten Mile State Marine Reserve (SMR), Ten Mile Estuary SMCA, MacKerricher SMCA, Point Cabrillo SMR, Russian Gulch SMCA, Big River Estuary SMCA, Van Damme SMCA, Navarro River Estuary SMCA, Point Arena SMCA and SMR, Sea Lion Cove SMCA, and Saunders Reef SMCA.[95]

Mendocino Cypress Woodlands: This ecosystem consists of the plants and wildlife in the closed-cone pine-cypress habitat, which covers approximately 1.0 percent of the county. This ecosystem includes the endemic Pygmy Forests located along the coast of Mendocino County. Mendocino cypress woodlands are typically associated with rocky and/or infertile soils and frequently found in mountainous regions along the southern and central coast of the county. Wildlife in this ecosystem include southern alligator lizard, dusky flycatcher, hermit thrush, red-tailed hawk, western scrub jay, and big brown bat.

Montane hardwood forests: Montane hardwood forests contain plants and wildlife with montane hardwood, montane hardwood-conifer, and montane riparian habitats, and cover approximately 27.6 percent of the county. This ecosystem is most common in the mountains in the central part of the county, dominated by oak species and California bay-laurel. Animals in Montane hardwood forests include relictual slender salamanders, western rattlesnake, northern flicker, ruby-crowned kinglet, wild turkey, dusky-footed woodrat, black bear, and western grey squirrel.

Rangeland: Rangeland commonly occurs in grassland areas in the county. Livestock, such as cows, sheep, and goats, typically graze in rangeland areas.

Oak woodlands: Oak woodlands consist of plants and wildlife in blue oak woodland, blue oak-foothill pine, coastal oak woodland, and valley oak woodland habitats, covering approximately 0.9 percent of the county. Oak woodlands are in the inland areas of the county, east of the coastal mountain range. Wildlife in these habitats includes various salamanders, frogs, snakes, and mammals such as ground squirrel, big brown bat, gray fox, raccoon, mule deer, and fallow deer.

Open dune: Open dune is on the beaches in the coastal areas of the county. This ecosystem has low habitat value for wildlife, but does support a variety of shorebirds, gulls, terns, and other bird species. Other wildlife species include western rattlesnake, red-tailed hawk, common raven, killdeer, and coyote.

Redwood forests: Redwood forests are in the coastal mountains of Mendocino County, covering approximately 24.9 percent of the county. Almost 200 wildlife species can be found in redwood forests, including salamanders, lizards, snakes, and bird species such as turkey vulture, great horned owl, gray jay, and pine siskin. Mammal species include coyote, gray fox, and mule deer.

Critically Vulnerable Ecosystems

Aquatic: Aquatic ecosystems are highly susceptible to damage from drought and extreme heat in the inland areas of the county and sea level rise in the coastal areas. Drought can lower water levels and water quality, which contribute to algal blooms that impact fish such as Coho salmon and steelhead.[96] Extreme heat can raise water temperatures in aquatic systems, increasing dissolved oxygen content and decreasing overall water quality. With rainfall and cooler temperatures, species and water quality may recover. But higher temperatures also contribute to algal blooms, which fish and plant populations may not be able to fully recover from. In coastal areas, sea level rise can cause salt water to infiltrate freshwater systems further inland. Freshwater ecosystems can migrate inland, but upstream hydrology may not be suitable for estuarine habitat.

Conifer forests: Conifer forests are severely vulnerable to forestry pests and diseases and wildfire, and are also highly vulnerable to drought, extreme heat, and fog. Higher temperatures and lack of water from drought or decreases in fog can stress conifer trees and make them more susceptible to damage from pests and infestation. Forestry pests such as bark beetles can decimate conifer forests when trees are weakened and unable to resist infestation. Diseased or dying forests are more susceptible to wildfire threats, which can decimate conifer forests, especially those that have been weakened by drought, extreme heat, and forestry pests and diseases. This threatens habitat for coyote, gray fox, tule elk, mule deer, deer mouse, and shrew-mole, among other reptiles, birds, and amphibians. Many conifers have reduced capacity to effectively recover from extreme heat events, prolonged drought, or pests and diseases. Seed longevity is projected to decrease, and fertility can decline slightly, making it harder for forests to reestablish themselves. This can create barriers to continuity (interconnected patches of a particular ecosystem) and dispersal (when seeds move from one site to a growing site) due to the rural and remote nature of the county.[97] These forests can also be managed to prevent or lessen the severity of wildfires; however, land management faces regulatory, financial, and personnel restrictions that limit the ability to effectively manage forests.[98]

Open dunes: Open dune ecosystems are severely vulnerable to dune erosion, severe weather, and shoreline flooding, and highly vulnerable to fog loss and pests and diseases. Dune erosion can cause inward migration of open dune ecosystems. Higher storm surges from shoreline flooding will likely accelerate this erosion and weaken dunes, leaving them open to other hazards.[99] Severe weather can also damage open dune habitat, because heavy rainfall, subsequent flooding, and salt spray can kill dune grass.[100] Several open dune plant species rely on coastal fog for a water source, and decreases in coastal fog can reduce water available and leave species more susceptible to ecosystem pests and diseases. Open dune ecosystems may be able to migrate inland and recover from disturbances. However, changes in sediment supply and development of roads and buildings make this difficult in some areas of the county.

Community Services and Utilities

There are nine community services analyzed as part of this vulnerability assessment.

Community Services Evaluated

Communication services: Communication services include radio, television, cellular and landline phone, and internet. These services can be delivered via wires or wirelessly, and most are delivered by private companies. Communication services are often used for entertainment, but are also vital for information sharing, social connections, accessing healthcare and educational services, and seeking jobs, among many other tasks.

Emergency medical response: Emergency medical response services are typically ambulances but may also be fire or police respondents if ambulances are not available. Ambulance services in the county include Coastal Valley EMS Agency and Medstar Ambulance of Mendocino County. In areas where the roads become impassable, emergency medical response may arrive by helicopter. These services are critical in providing rapid and urgent medical care.

Energy delivery (incorporated and unincorporated): Energy delivery in Mendocino County is delivered through high-capacity utility lines and pipelines connected to small local lines. Electricity and natural gas are needed for vital functions such as space heating and telecommunications as well as many other forms of entertainment and comfort. PG&E provides electricity infrastructure and natural gas services to county residents, and Sonoma Clean Power provides the electricity. In Ukiah, electricity is provided by the City of Ukiah Electric Utility Department.

Vital goods delivery: Vital goods are essential for residents and business owners. These include food, fuels such as gasoline and propane, medicine, basic hygienic supplies, and clothing, among others. Vital goods in the county are currently transported via truck freight on Highway 1 and Highway 101, or by railway. In remote locations and in emergencies, they can be delivered via airports.

Government administration: Government administration includes the programs, permitting centers, County assessor's office, and other services provided to the public by the County. These services could also include emergency services and emergency public works projects during disasters.

Public health (county and tribal): Public health services are programming provided by Mendocino County Human and Health Services Agency and other public and private health care providers, including mental and behavioral health care providers. Tribal nations also provide public health services through health and human service organizations, including Coyote Valley Band of Pomo Indians Health and Human Services, Hopland Band of Pomo Indians Health Department, Round Valley Indian Tribes Health Center, and Sherwood Valley Band of Pomo Indians Community Health. These services include health care and immunization clinics, women and children services, senior nutrition, and many others.

Public safety response (incorporated, unincorporated, and tribal): Public safety services are provided by law enforcement and fire agencies. In the unincorporated areas, these agencies include Mendocino County Sheriff's Office, CAL FIRE, Anderson Valley Fire Department, Covelo Fire Protection District, Hopland Fire Protection District, Leggett Valley Fire and Rescue, Piercy Fire Protection District, and Redwood Valley Calpella Fire District. In the incorporated cities, these agencies include Fort Bragg Police Department, CAL FIRE, Fort Bragg Fire Department, Ukiah Police Department, Ukiah Fire Department,

Ukiah Valley Fire District, Willits Police Department, Little Lake Fire Protection District, and Brooktrails Fire Department. Tribal nations also have public safety response personnel, including Hopland Band of Pomo Indians Police Department and Round Valley Indian Tribes Tribal Police.

Public transit access: Mendocino Transit Authority, Greyhound Bus, and Amtrak provide public transit in Mendocino County.

Water and wastewater (incorporated and unincorporated): These services involve treating and transporting water to be used by customers and transporting and treating wastewater so it can be safely released into the environment. Water and wastewater treatment plants in the county, including those in incorporated areas, include Aquatic Bioscience Water Treatment Plant, Mendocino Water Treatment Plant, Fort Bragg Water Treatment Plant, City of Ukiah Wastewater Treatment Plant, Ukiah Valley Sanitation District Water Treatment Plant, and City of Willits Sewage Treatment Plant. Water supply is obtained from a combination of reservoirs, rivers, groundwater, and recycled water, depending on the location in the county.

Critically Vulnerable Community Services

Communication services: Communication services are highly vulnerable to landslides, severe weather, and wildfires. These hazards can damage communication facilities or cut off the power to them, preventing communities from receiving or relaying emergency notifications and other essential communications. Wildfires can also cause more public safety personnel to travel to the County to help fight the fires. This can overwhelm the limited communication system in isolated or rural areas, causing degradation of service.

Vital goods: Vital goods delivery is the most vulnerable community service in both coastal and inland areas. In coastal areas, dune and bluff erosion, sea level rise, and shoreline flooding can inundate roadways or undermine their foundations, preventing freight trucks and other vehicles from delivering fuel, food, and other goods to remote areas along the coastline. In inland areas of the county, inland flooding can wash out roads and rail, landslides can damage or cover roads and highways, and severe weather can knock down trees, preventing freight trucks and trains from delivering vital goods to remote areas such as Covelo and Potter Valley. This could harm communities if stores do not have enough supplies such as food or medicine, or if residents using propane to heat homes do not have a sufficient supply of fuel. The impacts could persist for days or weeks depending on the severity of the winter storm. The airports throughout the county could be used to deliver vital goods to remote areas of the county. However, this is expensive and not always feasible, especially for remote coastal communities.

Energy delivery: Energy delivery services is dependent on overhead power lines and underground natural gas pipelines owned and operated by PG&E, which are susceptible to extreme heat, fallen trees from forestry pests and diseases and high winds, landslides, and wildfire. Extreme heat can cause power outages due to mechanical failure of electrical equipment, heat damage to the above-ground infrastructure, and a high demand for electricity due to air conditioning units. Solar and hydroelectric energy production could also decrease due to extreme heat. Solar photovoltaic panels experience a decrease in efficiency due to excessive heat of converting solar energy to electric energy by 10 percent to 25 percent as temperatures rise. The reservoirs that produce hydroelectric energy may experience higher rates of evaporation, which reduces the amount of water available to generate electricity. Electrical lines

that are close to forested areas could be damaged by falling trees that result from pests and diseases and severe weather. These impacts could become chronic as conifer forest ecosystems weaken. Landslides can damage both electrical transmission lines and natural gas pipelines if their foundations are undermined or fail. High winds from severe weather can also cause PG&E to turn off electricity to prevent sparks, as part of a Public Safety Power Shutoff, which disrupts energy delivery to nearly every area of the county. Wildfires can also damage power lines, natural gas lines, and substations. PG&E can retrofit power lines and other equipment to insulate them against extreme heat events and severe weather and remove diseased or dead trees surrounding the lines to protect them from falling trees and wildfires. However, these measures can both be expensive and require yearly or seasonal management activities.

Public transit access: Public transit is highly dependent on roadway infrastructure in the county, and therefore is severely vulnerable to landslides and sea level rise, and highly vulnerable to inland flooding, severe weather, and shoreline flooding. In coastal areas, coastal transit services, such as Mendocino Transit Authority bus routes 60, 75, and 95, may face delays or service disruptions due to sea level rise and shoreline flooding that can affect Highway 1 at several locations. If Highway 1 is closed, these routes cannot operate, and alternative routes may not support transit vehicles. Landslides and severe weather can make roadways or rail lines impassable, which could also disrupt public transit services, tourism, and recreation activities. If roadways completely fail, transit services could be suspended for days or weeks. Inland flooding in areas surrounding the Eel River or Russian River can cause service disruptions if roadways and rail lines become impassable. Some public transit routes in inland areas may have alternative routes available. Mendocino Transit Authority, Amtrak, and other transit agencies can also protect infrastructure from damage and prepare emergency routes to ensure continuity of services.

Water and wastewater: Water and wastewater services are severely vulnerable to drought in Fort Bragg and Willits, and highly vulnerable to drought in Ukiah. Extended droughts can cause significant reduction in water supplies for communities that rely primarily on surface waters. Ukiah relies on both surface and groundwater, and therefore is slightly less vulnerable. In Fort Bragg, bluff erosion could disrupt wastewater services since the wastewater treatment plant is within 100 feet of the bluff edge. In Ukiah and Willits, the wastewater treatment plants lie within the flood hazard zone, and therefore wastewater services would be disrupted during flooding events. In unincorporated areas of the county, Fort Bragg, and Willits, wildfires could affect river water sources by decreasing water quality due to ash and fire retardant. Reduced water supplies throughout the county could reduce the overall quantity of water available for agriculture, commercial, and residential demands. Water conservation measures, use of more recycled water, and more extensive filtering equipment can protect the water services throughout the county. Wastewater services may have a more difficult time adapting due to the expensive nature of moving wastewater infrastructure.

CONCLUSION

Out of the 115 populations and assets Mendocino County analyzed, 75 are highly or severely vulnerable to one or more hazard conditions. Wildfire and smoke are responsible for the most V4 and V5 vulnerability scores, followed by inland flooding and landslides. The resilience of these populations and assets can increase through the implementation of adaptation measures. Adaptation is the adjustment to natural and human systems in response to actual or expected changes in climate conditions to reduce the harmful effects of actual or expected changes.[101]

Potential adaptation measures that could reduce vulnerability in Mendocino County include:

- Promoting the creation of community support networks to check on persons without access to lifelines, seniors living alone, and persons with disabilities during dangerous conditions.
- Funding and implementing infrastructure improvements for underserved DUCs throughout the county.
- Increasing funding through grants or private organizations for fuel reduction and vegetation management projects for both neighborhoods and infrastructure.
- Conducting structural retrofits for at-risk bridges and ensuring that these retrofits include protections against flooding and landslides.
- Expanding the chipper program throughout the county to help private homeowners dispose of trees near structures, supplementing existing cost-sharing programs.
- Working with farming organizations and the University of California Cooperative Extension to promote the availability of crop varieties that are more resilient to climate change exposures while meeting market demand for yield and quality, as options become available.
- Continuing to work with state and federal land management agencies to support fuel and pest management activities.
- In coordination with local, state, and federal plant and wildlife management agencies and organizations, monitoring shifts in habitats, and preserving habitats where habitat migration may be needed.
- Working with local, state, and federal plant and wildlife management agencies and organizations to protect vulnerable habitat and improve ecosystem connectivity.
- Coordinating with utility providers to conduct regular evaluations and retrofits of energy transmission and delivery infrastructure.
- Incentivizing water conservation measures by establishing indoor plumbing retrofit and turf replacement programs.

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APPENDIX A

Abbreviations

AB: Assembly Bill

ACS: American Community Survey

APG: California Adaptation Planning Guide

CAL FIRE: California Department of Forestry and Fire Protection

Cal OES: California Governor's Office of Emergency Services

CEC: California Energy Commission

CO_2: carbon dioxide

CVA: Climate Vulnerability Assessment

GHG: greenhouse gas emissions

Hwy: highway, usually state highway

LHMP: Local Hazard Mitigation Plan

OPR: Governor's Office of Planning and Research

PACE: Property Assessed Clean Energy

RCPs: Representative Concentration Pathways

SB: Senate Bill

SMCA: State Marine Conservation Area

SMR: State Marine Reserve

SR: State Route

USGS: United States Geologic Survey

WUI: Wildland-Urban Interface

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.[1, 2]

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".[3]

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 (such as average rainfall or high temperatures), 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.[4]

Extreme Event: When a weather or climate variable exceeds the upper or lower thresholds of its observed range.[5, 6]

Hazard: An event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural losses, damage to the environment, interruption of business, or other types of harm or loss.[7]

Hazard Mitigation: Sustained action taken to reduce or eliminate the long-term risk to human life and property through actions that reduce hazard, exposure, and vulnerability.[8]

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

Probability: The likelihood of hazard events occurring. Probabilities have traditionally been determined from the historic frequency of events. With changing climate and the introduction of non-climate stressors, the probability of hazard events also changes.[9]

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 grow from a disruptive experience. Community resilience is the ability of communities to withstand, recover, and to 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.

Sensitivity: The level to which a species, natural system, or community, government, etc., would be affected by changing climate conditions.[10]

Social Vulnerability: Social vulnerability is "the susceptibility of a given population to harm from exposure to a hazard, directly affecting its ability to prepare for, respond to, and recover."[11, 12]

Susceptibility: A person or population's potential for vulnerability due to demographic, socioeconomic, and geolocation characteristics.

Vulnerability: Climate vulnerability describes 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."[13]

Vulnerability Assessment: An analysis 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, the potential impact(s), and the community's adaptive capacity.

Vulnerable Communities: Vulnerable communities experience heightened risk and increased sensitivity to climate change and have less capacity and fewer resources to cope with, adapt to, or recover from climate impacts. These disproportionate effects are caused by physical (built and environmental), social, political, and/or economic factor(s), which are exacerbated by climate impacts.[14]

Vulnerable Populations: Vulnerable populations include, but are not limited to women; racial or ethnic groups; low-income individuals and families; individuals who are incarcerated or have been incarcerated; individuals with disabilities; individuals with mental health conditions; children; youth and young adults; seniors; immigrants and refugees; individuals who are limited English proficient (LEP); and Lesbian, Gay, Bisexual, Transgender, Queer, and Questioning (LGBTQQ) communities, or combinations of these populations.[15, 16]

Endnotes

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APPENDIX B: VULNERABILITY ASSESSMENT RESULTS MATRIX

POPULATIONS AND ASSETS	AGRICULTURAL & ECOSYSTEM PESTS AND DISEASES	DROUGHT	DUNE & BLUFF EROSION	EXTREME HEAT	FOG	HUMAN HEALTH HAZARDS	INLAND FLOODING	LANDSLIDES	SEA LEVEL RISE	SEVERE WEATHER	SHORELINE FLOODING	WILDFIRE
Populations												
Children (Under 10)	-	-	-	V5	-	V3	V3	V4	-	V3	V2	V4
Households in poverty	-	V4	V3	V5	-	V5	V5	V5	V3	V5	V4	V5
Immigrants and refugees	-	-	V2	V3	-	V4	V4	V4	-	V4	V2	V4
Outdoor workers	V4	V5	V3	V4	V2	V4	V3	V3	V2	V3	V3	V5
Persons experiencing homelessness	-	-	-	V5	-	V5	V5	-	-	V5	V5	V5
Persons in overcrowded households	-	-	-	V3	-	V3	V3	V2	-	V2	V2	V3
Persons in tribal communities	V3	V3	-	V4	V3	V3	V4	V5	-	V4	-	V4
Persons living in isolated communities	V3	V3	V5	V3	V3	V4	V4	V5	V4	V4	V5	V4
Persons with chronic health problems	-	-	V3	V4	-	V4	V3	V2	-	V4	V4	V4
Persons with disabilities	-	-	V3	V3	-	V3	V3	V3	-	V3	V3	V4
Persons with limited English proficiency	-	-	-	V3	-	V3	V4	V3	-	V4	V2	V3
Persons without access to lifelines	-	-	V4	V3	-	V3	V5	V4	-	V3	V3	V4
Senior citizens	-	-	V3	V4	-	V4	V4	V4	-	V3	V3	V5
Senior citizens living alone	-	-	V4	V5	-	V5	V5	V5	-	V4	V4	V5
Undocumented persons	V5	-	-	V4	-	V5	V4	V4	-	V5	V4	V4
Infrastructure												
Airports (city managed)	-	-	-	V2	-	-	V3	-	-	V3	-	V3
Airports (county managed)	-	-	-	V2	-	-	V2	-	-	V3	-	V3

POPULATIONS AND ASSETS	AGRICULTURAL & ECOSYSTEM PESTS AND DISEASES	DROUGHT	DUNE & BLUFF EROSION	EXTREME HEAT	FOG	HUMAN HEALTH HAZARDS	INLAND FLOODING	LANDSLIDES	SEA LEVEL RISE	SEVERE WEATHER	SHORELINE FLOODING	WILDFIRE
Airports (privately managed)	-	-	-	V2	-	-	-	V4	-	V3	-	V4
Biking trails	V2	V1	V3	-	-	-	V3	V4	V2	V2	V2	V4
Bridges	-	-	V5	-	-	-	V5	V5	V4	V4	V4	V3
Communication facilities	-	-	V2	V2	-	-	V2	V3	-	V3	-	V3
Dams	-	-	V3	-	-	-	V2	V4	-	V4	-	V2
Electrical substations (County)	-	-	-	V2	-	-	-	V3	-	V3	-	V3
Electrical substations (Fort Bragg)	-	-	-	-	-	-	-	-	-	V3	-	-
Electrical substations (Point Arena)	-	-	-	-	-	-	-	-	-	V3	-	V4
Electrical substations (Ukiah)	-	-	-	V3	-	-	V3	-	-	V3	-	-
Electrical substations (Willits)	-	-	-	V3	-	-	-	-	-	V3	-	-
Electrical transmission lines	V3	-	V1	V4	-	-	V3	V4	V2	V4	V3	V5
Electric vehicle charging stations	-	-	V2	V3	-	-	V4	V3	V2	V4	V3	V3
Evacuation routes	V4	-	V4	-	-	-	V5	V5	V4	V4	V4	V5
Flood control infrastructure	-	-	-	-	-	-	V3	V1	-	V3	-	V2
Hiking trails	V2	V2	V2	-	-	-	V2	V4	V2	V2	V2	V4
Landfills and transfer stations (County)	-	-	-	-	-	-	V1	V3	-	V1	-	V4
Landfills and transfer stations (Fort Bragg)	-	-	-	-	-	-	-	-	-	V1	-	-
Landfills and transfer stations (Ukiah)	-	-	-	-	-	-	-	-	-	V1	-	-
Landfills and transfer stations (Willits)	-	-	-	-	-	-	-	-	-	V1	-	-
Major roads and highways (County)	V3	-	V5	-	-	-	V5	V4	V3	V4	V3	V5

POPULATIONS AND ASSETS	AGRICULTURAL & ECOSYSTEM PESTS AND DISEASES	DROUGHT	DUNE & BLUFF EROSION	EXTREME HEAT	FOG	HUMAN HEALTH HAZARDS	INLAND FLOODING	LANDSLIDES	SEA LEVEL RISE	SEVERE WEATHER	SHORELINE FLOODING	WILDFIRE
Major roads and highways (Fort Bragg)	V2	-	V4	-	-	-	V4	V3	V5	V3	V5	V4
Major roads and highways (Point Arena)	V3	-	V2	-	-	-	V4	V3	V1	V3	V3	V5
Major roads and highways (Ukiah)	V1	-	-	V3	-	-	V4	V2	-	V3	-	V3
Major roads and highways (Willits)	V1	-	-	V2	-	-	V4	V3	-	V3	-	V4
Parks and open space (County)	V3	V3	V2	V2	-	-	V2	V4	V3	V2	V3	V3
Parks and open space (Fort Bragg)	V2	V2	V4	V1	-	-	V1	V1	V3	V2	V3	V3
Parks and open space (Point Arena)	V3	V2	V3	V2	-	-	-	V3	V2	V2	V3	V3
Parks and open Space (Ukiah)	V2	V3	-	V2	-	-	V4	V2	-	V3	-	V2
Parks and open space (Willits)	V3	V3	-	V2	-	-	V4	V2	-	V2	-	V2
Power plants (County)	-	V1	-	V3	-	-	V1	V1	-	V2	-	V1
Power plants (Ukiah)	-	-	-	V3	-	-	V2	-	-	V2	-	-
Rail lines	V1	-	-	V2	-	-	V4	V4	V3	V3	V3	V5
Single access roads	V4	-	V4	V2	-	-	V5	V4	V3	V4	V3	V5
Transit stops	-	-	V1	-	-	-	-	V3	-	V2	-	V3
Water and wastewater infrastructure (County)	-	V2	V3	-	-	-	V2	V3	V2	V3	V2	V3
Water and wastewater infrastructure (Fort Bragg)	-	V2	V4	-	-	-	V3	V1	V3	V2	V3	V3
Water and wastewater infrastructure (Ukiah)	-	V2	-	-	-	-	V4	V3	-	V3	-	V3
Water and wastewater infrastructure (Willits)	-	V2	-	-	-	-	V4	V3	-	V2	-	V4

POPULATIONS AND ASSETS	AGRICULTURAL & ECOSYSTEM PESTS AND DISEASES	DROUGHT	DUNE & BLUFF EROSION	EXTREME HEAT	FOG	HUMAN HEALTH HAZARDS	INLAND FLOODING	LANDSLIDES	SEA LEVEL RISE	SEVERE WEATHER	SHORELINE FLOODING	WILDFIRE
Buildings and Facilities												
Commercial buildings	-	-	V2	V2	-	-	V3	V3	V2	V3	V3	V3
Community centers (County)	-	-	-	V2	-	-	V1	V1	-	V3	-	V3
Community centers (Fort Bragg)	-	-	-	V1	-	-	-	-	-	V2	-	-
Community centers (Point Arena)	-	-	-	V2	-	-	-	-	-	V2	-	-
Community centers (Ukiah)	-	-	-	V1	-	-	-	-	-	V2	-	-
Community centers (Willits)	-	-	-	V2	-	-	V2	-	-	V2	-	V2
Government buildings	-	-	-	V1	-	-	V1	-	-	V2	-	V2
Homes and residential structures	V3	-	V4	V3	-	-	V5	V4	V3	V4	V3	V5
Libraries	-	-	-	V2	-	-	V2	V2	-	V3	-	V2
Medical care facilities	-	-	-	V2	-	-	-	V3	-	V3	-	V4
Public safety buildings	-	-	V3	V1	-	-	V3	V2	-	V2	-	V4
Schools (County)	-	-	-	V3	-	-	V3	V3	-	V3	-	V3
Schools (Fort Bragg)	-	-	-	V2	-	-	-	-	-	V3	-	V2
Schools (Point Arena)	-	-	-	V2	-	-	-	-	-	V3	-	-
Schools (Ukiah)	-	-	-	V3	-	-	V3	V2	-	V3	-	V3
Schools (Willits)	-	-	-	V3	-	-	V4	V2	-	V3	-	V3
Tribal facilities	-	-	-	V3	-	-	V3	V3	-	V4	-	V4

POPULATIONS AND ASSETS	AGRICULTURAL & ECOSYSTEM PESTS AND DISEASES	DROUGHT	DUNE & BLUFF EROSION	EXTREME HEAT	FOG	HUMAN HEALTH HAZARDS	INLAND FLOODING	LANDSLIDES	SEA LEVEL RISE	SEVERE WEATHER	SHORELINE FLOODING	WILDFIRE
Economic and Cultural Assets												
Agriculture	V4	V4	V2	V5	V3	V4	V4	V3	V2	V4	V2	V4
Agritourism	V4	V4	V2	V4	-	V4	V4	V3	-	V4	-	V5
Casinos	-	-	-	-	-	V3	V1	V2	-	V2	-	V2
Coastal recreation and tourism	V2	V1	V2	V1	V2	V3	V3	V4	V3	V4	V5	V5
Communication Utilities	-	-	V1	-	-	-	V1	V3	V1	V3	V2	-
Cultural and historical sites	V3	-	V4	V3	V3	V3	V3	V4	V3	V2	V3	V2
Fisheries and fishing grounds	V1	V3	-	V4	-	V2	V2	V2	V2	V2	V3	V3
Hunting grounds	V3	V2	-	V1	V1	V2	V2	V3	-	V2	-	V3
Inland recreation and tourism	V3	V4	-	V4	V1	V3	V3	V4	-	V3	-	V4
State and federal land recreation and tourism	V4	V3	V4	V3	V3	V3	V3	V4	V3	V3	V4	V4
Timber production	V4	V4	-	V4	V4	V3	V2	V4	-	V2	-	V3
Wineries & vineyards	V4	V4	V2	V5	V3	V4	V4	V3	-	V4	V2	V5
Ecosystems												
Aquatic	V2	V5	V1	V5	V1	-	V1	V4	V5	V2	V4	-
Chaparral	V4	V3	-	V2	V2	-	V2	V3	-	V3	-	V4
Coastal scrub	V2	V2	V5	V3	V3	-	-	V1	V2	V1	V2	V3
Conifer forests	V5	V4	V2	V4	V4	-	V2	V2	V1	V3	V1	V5
Grasslands	V2	V3	V3	V2	V3	-	V3	V2	V2	V2	V2	V3
Marine protected areas	-	-	V2	V3	-	-	-	-	V1	V1	V1	-
Mendocino cypress woodlands	V3	V3	-	V3	V3	-	-	V3	V2	V3	V2	V4

POPULATIONS AND ASSETS	AGRICULTURAL & ECOSYSTEM PESTS AND DISEASES	DROUGHT	DUNE & BLUFF EROSION	EXTREME HEAT	FOG	HUMAN HEALTH HAZARDS	INLAND FLOODING	LANDSLIDES	SEA LEVEL RISE	SEVERE WEATHER	SHORELINE FLOODING	WILDFIRE
Montane hardwood forests	V3	V2	-	V2	V2	-	V2	V3	-	V3	-	V2
Oak woodlands	V4	V2	-	V2	V2	-	V2	V3	-	V4	-	V2
Open dune	V4	V1	V5	V2	V4	-	-	-	V3	V5	V5	-
Rangeland	V2	V3	-	V2	V3	-	V3	V2	V1	V2	V2	V3
Redwood forests	V3	V4	V2	V3	V5	-	V2	V3	V2	V3	V1	V4
Community Services and Utilities												
Communication services	-	-	V2	V2	-	-	V3	V4	-	V4	-	V3
Emergency medical response	V2	-	V3	V2	V2	V4	V2	V3	V3	V3	V3	V3
Energy delivery (County)	V5	V2	V1	V4	-	-	V2	V4	V1	V5	V2	V5
Energy delivery (Ukiah)	V4	V2	-	V3	-	-	V3	V3	-	V4	-	V3
Government administration	-	-	-	V1	-	V1	V1	V2	V1	V1	V1	V2
Public health (County)	-	-	V3	V3	-	V3	V2	V2	-	V2	-	V3
Public health (Tribal)	-	-	-	V3	-	V3	V2	V3	-	V2	-	V4
Public safety response (County)	V3	-	V4	V2	V2	V2	V3	V3	V3	V2	V3	V4
Public safety response (Fort Bragg)	V2	-	V2	V2	V2	V2	V2	V2	V4	V2	V4	V2
Public safety response (Point Arena)	V3	-	V3	V2	V2	V2	V4	V3	V3	V2	V4	V3
Public safety response (Ukiah)	V1	-	-	V2	V1	V2	V3	V1	-	V2	-	V2
Public safety response (Willits)	V2	-	-	V2	V1	V2	V3	V1	-	V2	-	V3
Public safety response (Tribal)	V3	-	-	V3	V2	V3	V4	V3	-	V3	-	V4
Public transit access	V3	-	V2	V3	V1	V2	V4	V5	V5	V4	V4	V3
Vital goods	V3	-	V4	V1	V1	V2	V4	V4	V4	V4	V5	V3

POPULATIONS AND ASSETS	AGRICULTURAL & ECOSYSTEM PESTS AND DISEASES	DROUGHT	DUNE & BLUFF EROSION	EXTREME HEAT	FOG	HUMAN HEALTH HAZARDS	INLAND FLOODING	LANDSLIDES	SEA LEVEL RISE	SEVERE WEATHER	SHORELINE FLOODING	WILDFIRE
Water and wastewater (County)	-	V3	V2	V2	-	-	V2	V3	V2	V1	V3	V4
Water and wastewater (Fort Bragg)	-	V5	V4	V1	-	-	V2	V2	V3	V1	V3	V4
Water and wastewater (Ukiah)	-	V4	-	V2	-	-	V4	V3	-	V3	-	V2
Water and wastewater (Willits)	-	V5	-	V2	-	-	V4	V3	-	V3	-	V4

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