CLIMATE & ENVIRONMENT

PREPARED BY :

SIERRA BUSINESS COUNCIL

ACKNOWLEDGEMENTS

PREPARED BY:

Sierra Business Council:

- Kaeleigh Reynolds
- Sam Ruderman
- Lauren Kayari, intern
- Zachary Meyer, intern

Conversations, research, and feedback from the following groups contributed to the findings in this chapter:

Desert Research Institute

- Dr. Daniel McEvoy

OEHHA - CalEnviroScreen

- Laura August
- Andrew Slocombe

GIS Mapping and Analysis

- Hayley Pippin

Climate and Environmental Analysis - Redwood Coast

Introduction

Climate change and environmental impacts have far-reaching consequences on ecosystems, natural resources, and local economies, disproportionately affecting disinvested communities. Underserved and vulnerable populations are more likely to experience harm to their health, economic, and social well-being due to their race, gender, age, disability, poverty status, and limited access to resources. Many adverse effects on disinvested communities are systemically reinforced, and the CERF process identifies and mitigates these climate and environmental hazards.

The Redwood Coast CERF region is an ecologically and geographically diverse region with physical, emotional, and spiritual importance for many people. Most jurisdictions in the region are dependent on one or more of four main industries: (1) tourism, (2) maritime activities, (3) natural resources, or (4) agriculture. The region contains old-growth redwood forests, an active coastline, and expansive agricultural land. Communities within the region require both fiscal and physical infrastructure to provide adequate services amidst wildfires, rising temperatures, and changing precipitation patterns. These services will become even more important for the economic resilience of the Redwood Coast as the region is forced to face the climate emergency.

Climate Projections

Climate resilience is a region's ability to anticipate climate hazards, where and how those hazards will appear, and how they will impact a region. In the Redwood Coast, it is well-documented that climate change hazards can greatly impact the economic prosperity of a community. The effects of climate change hazards can be reduced in two ways:(1) climate change mitigation through actions that reduce greenhouse gas emissions or remove greenhouse gases from the atmosphere, and (2) climate change adaptation by adjusting to actual or expected future climate conditions. Climate resilience requires both mitigation and adaptation–the Redwood Coast can limit exposure to climate hazards through climate change mitigation efforts but must understand that climate hazards are caused by global emissions, therefore, climate adaptation is necessary to anticipate the hazards and adjust landscapes and communities to better handle them.

Therefore, understanding regional and local climate change projection data and implementing climate change mitigation and adaptation measures are key to developing economic resilience in this region.

Climate change projections can be used to understand the likely future climate and environmental scenarios that will exist in a region. An extensive list of indicators can be used to predict future climate trends, examples include metrics like the “number of extreme precipitation events” or “number of extreme heat days.” By looking at indicators that are relevant to a region’s geography, economic drivers, and demographic trends, planning efforts can be established to adapt to future climate scenarios.

Climate projections are important when developing mid to long-term economic forecasts and planning efforts. For example, increasing temperatures and changing precipitation patterns will likely lead to extensive drought which can lead to surface water shortages used to irrigate vineyards in Lake and Mendocino counties. The wine industry is a major economic contributor to these counties, and losses for grape production due to drought-induced pest infestation and water shortages could cause economic losses on larger scales than seen in recent years.

Climate Indicators

These indicators were chosen due to their specificity to the Redwood Coast region. Due to the varying ecosystems and climate zones within the Redwood Coast CERF region, there will be various impacts felt among the region. For example, Humboldt and Del Norte counties have a relatively safe extreme heat threshold–but the increase in the number of days may have extensive impacts on local economies and ecosystems.

Sea level rise maps are used for the coastal region since there is no readily available data at the county scale. While Lake County will not be directly impacted by sea level rise due to its inland location, there will be indirect impacts from its neighboring jurisdictions.

In this report, the following climate indicators were evaluated for future projections:

1. Annual Cooling Degree Days: measured in days per year, this indicator measures how many days in the 15 years will require indoor cooling because outdoor air temperatures are above a threshold temperature of 65 degrees Fahrenheit. While most households do not need cooling at this temperature, it is a common baseline temperature used by energy providers to indicate how many days will require high energy use for indoor space cooling.

2. Extreme Heat Days: measured in days per year above a threshold temperature (i.e., the daily high temperature representing the 98th percentile for the county) This indicator measures how many days will be hotter than the historical baseline and can be used to see how increases in extreme heat will impact a region.

3. Warm Nights: measured in nights per year above a threshold temperature (i.e., the nightly high temperature representing the 98th percentile for the county). While the regions tend to see

cooler nights even in the Summer months, understanding how nighttime temperatures are changing in the future may impact economic and public health planning.

4. Annual Average Precipitation: measured in inches, this indicator measures the average precipitation per year at the county level, precipitation is measured as liquid or solid water and is averaged over the county's area.

5. Area Burned: measured in hectares, this indicator measures how many acres will burn due to wildfire. This indicator can not predict where a fire will likely occur but can give an idea of how the local economy, public health, and health of local ecosystems may be impacted by wildfire overall.

Data Source and Methodology

Cal-Adapt Data
Future climate projects and historical baseline data were acquired through Cal-Adapt. Most indicators use downscaled LOCA CMIP5 modeled data provided by Scripps Institute of Oceanography.

Historical data used observed historical data for the 15 years from 1990 to 2004 where available (e.g., Area Burned does not have observed historical data available).

Indicator projections were analyzed under the emission scenario RCP8.5. RCP8.5 is a representative concentration pathway (RCP) that represents a no-mitigation scenario where global GHG emissions continue to rise throughout the 21st century. In California, annual average temperatures under this scenario are projected to increase by 4°C - 7°C by the end of this century[1]. While it may be likely that governments, corporations, and the global population will dramatically reduce the use of fossil fuel and engage in extensive greenhouse gas emission reductions, it may be beneficial to use a conservative approach and view climate projections under a "worst-case" or "business-as-usual" scenario.

Climate projections for the near future (2025–2039) and mid-future (2040–2054) are shown in this report. These 15-year timespans were chosen to show climate change impacts during the initiation and lifespan of CERF-funded projects.

Climate Engine
Additionally, observed climate change indicators of maximum monthly temperatures and average monthly precipitation from January 1969–May 2023 were collected from Climate Engine. This observed data is intended to show longer-term trends in temperature and precipitation patterns. The observed data uses the PRISM model with a 4000m scale and is aggregated by month.

[1] Cal-Adapt Glossary, Emission Scenario

EDDI Fire Projections

These datasets were provided by Dr. Daniel McEvoy of the Desert Research Institute and show wildfire risk projections[2]. These projections are under a 7-model ensemble for the historical time series from 1966–2005, and projections for the near future (2025–2039) and mid-century (2040–2054) during the summer (June, July, August) and autumn (September, October, and November). All data files used RCP 8.5 LOCA runs.

State of California Sea-Level Rise Guidance, 2018 Update

This report was published in partnership with the California Natural Resources Agency and California Ocean Protection Council. Sea-level rise projections for Cresent City, North Spit, and Arena Cove are presented in this chapter under RCP 8.5 for 2030, 2040, 2050, and 2060.

Interagency Sea Level Rise Scenario Tool – NASA Sea Level Change Portal

This tool uses sea level rise scenarios, also called Global Mean Sea Level (GMSL) scenarios, which represent possible future sea level changes in response to increasing greenhouse gas emissions and ocean and atmospheric warming. These scenarios are different than the RCP projections. As opposed to constructing a projection around a particular emissions pathway, the scenarios specify a targeted amount of sea level rise at a time in the future. The trajectory for getting to that target value relies on the same science and projection framework from the IPCC 6th Assessment Report[3].

Six GMSL scenarios together show a plausible range of sea level rise by 2100 being bound by the range 0.3-2.5m. This 0.3-2.5 m range was divided and aligned with emissions-based, conditional probabilistic storylines and global model projections into six GMSL rise scenarios: Low, Intermediate-Low, Intermediate, Intermediate-High, High, and Extreme, corresponding to GMSL rise by 2100 of 0.3 m, 0.5 m, 1.0 m, 1.5 m, 2.0 m and 2.5 m, respectively[4].

This chapter will present graphs with the six GMSL ranges showing sea level change in feet between the years 2020 and 2060.

Projections

Tables 1-4 provide an overview of the indicators' recent historical baseline and near and mid-future projections under RCP8.5[5] for each county from Cal-Adapt. The percent change from 1990–2004 to 2040–2054 is shown in the final column. Figures 1-4 are the historical maximum monthly temperature

[2] Due to various schools of thought on wildfire projections, the EDDI projections are included in addition to the Cal-Adapt Area Burned projections.

[3] What are the scenarios from the Sea Level Rise Interagency Task Force and how do they compare to the projections from the IPCC AR6?, September 2023

[4] Interagency Sea level Rise Scenario Tool, About the data

[5] Intergovernmental Panel on climate Change definition of RCP8.5

and average monthly precipitation trends. These historical trends can give context to future projections, and how the recent past may have already been impacted by climate change. Additionally, there is a second wildfire projection dataset from EDDI in Figures 5-6. Wildfire risk and secondary impacts, like wildfire smoke, loss of habitat, and the burning of hazardous materials, are likely the largest direct threats to the Redwood Coast's disinvested communities and economic resilience.

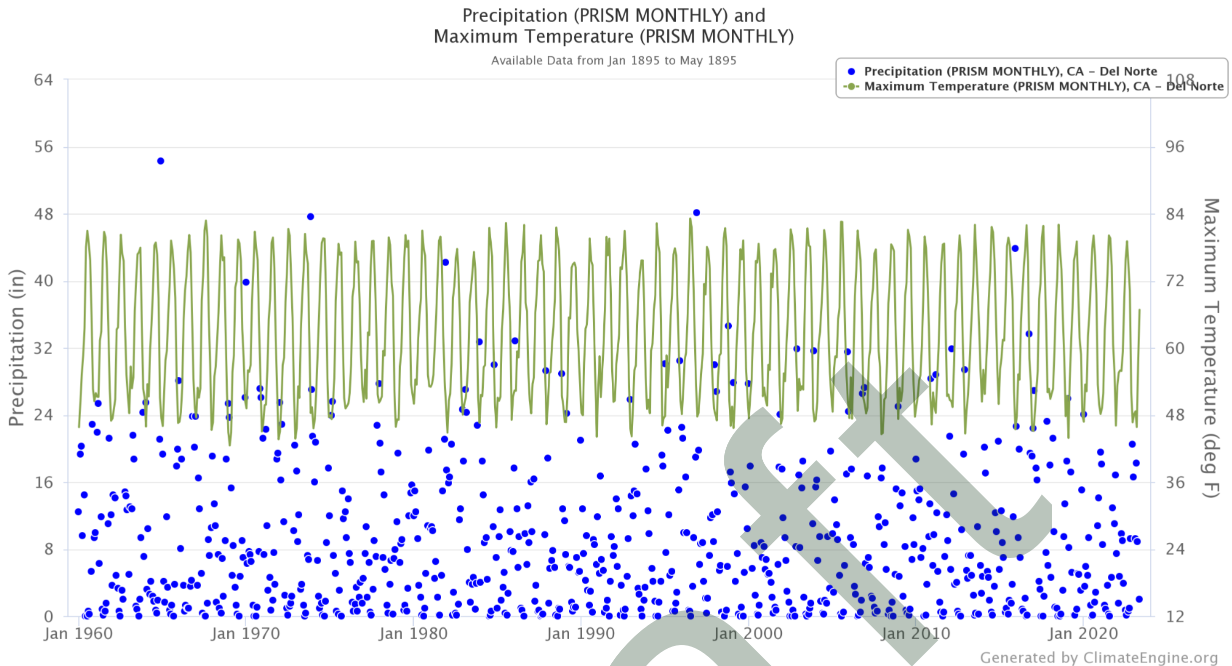
Table 1 Climate Projections for Del Norte County

Climate Indicators for Del Norte County	1990-2004 Observed Historical	2025-2039 RCP 8.5	2040-2054 RCP 8.5	Percent Change
Annual Cooling Degree Days Base 65F	0	4	10	-
Extreme Heat Days (days/yr) above 76.8F	2	10	15	650%
Warm Nights (nights/yr) above 49.2F	6	19	35	483%
Annual Average Precipitation (inches)	96	107	102	7%
Area Burned (hectares)	1,430	4,096	4,477	213%

Area Burned indicator does not have observed historical data and is modeled historical data under RCP 8.5.

Table: Sierra Business Council • Source: Cal-Adapt Tools • Created with Datawrapper

Figure 1 Historical Trends in Temperature and Precipitation for Del Norte County



Recorded rainfall has been consistently dropping since 1960. The monthly temperature high has been consistent.

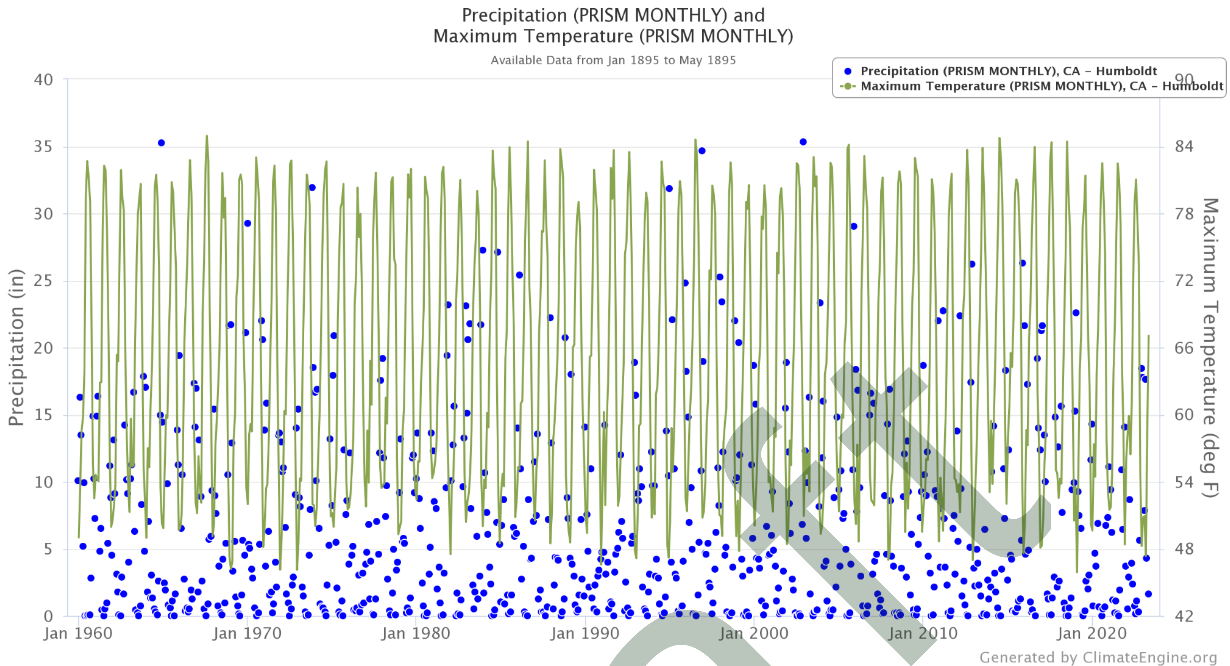
Table 2 Climate Projections for Humboldt County

Climate Indicators for Humboldt County	1990-2004 Observed Historical	2025-2039 RCP 8.5	2040-2054 RCP 8.5	Percent Change
Annual Cooling Degree Days Base 65F	3	84	129	4200%
Extreme Heat Days (days/yr) above 83.2F	1	12	18	1700%
Warm Nights (nights/yr) above 51.3F	6	33	49	717%
Annual Average Precipitation (inches)	70	80	75	6%
Area Burned (hectares)	4,787	7,543	8,156	70%

Area Burned indicator does not have observed historical data and is modeled historical data under RCP 8.5.

Table: Sierra Business Council • Source: Cal-Adapt Tools • Created with Datawrapper

Figure 2 Historical Trends in Temperature and Precipitation for Humboldt County



Temperature high is higher in the last decade than in the 60s. December 2002, the highest rainfall at 35.36 inches

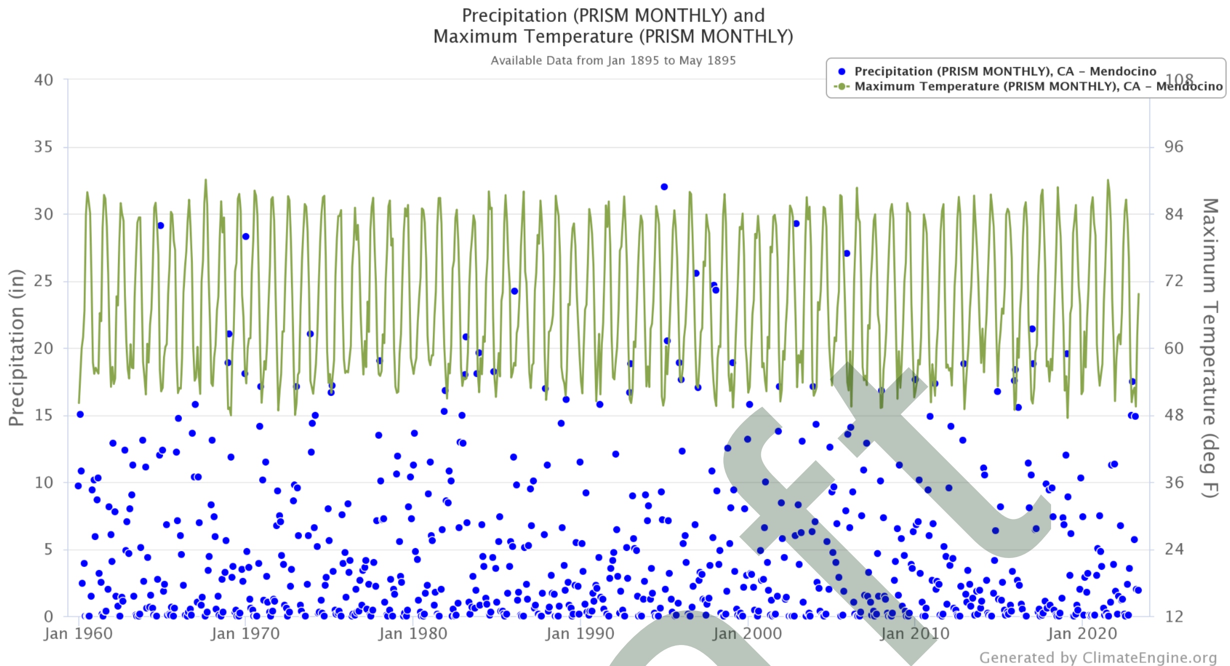
Table 3 Climate Projections for Mendocino County

Climate Indicators for Mendocino County	1990-2004 Observed Historical	2025-2039 RCP 8.5	2040-2054 RCP 8.5	Percent Change
Annual Cooling Degree Days Base 65F	135	305	366	171%
Extreme Heat Days (days/yr) above 90F	6	15	18	200%
Warm Nights (nights/yr) above 52.7F	7	27	35	400%
Annual Average Precipitation (inches)	56	62	57	2%
Area Burned (hectares)	4,586	6,159	6,962	52%

Area Burned indicator does not have observed historical data and is modeled historical data under RCP 8.5.

Table: Sierra Business Council • Source: Cal-Adapt Tools • Created with Datawrapper

Figure 3 Historical Trends in Temperature and Precipitation for Mendocino County



Precipitation has been lower in recent years. Max temperature has been rising since 2000.

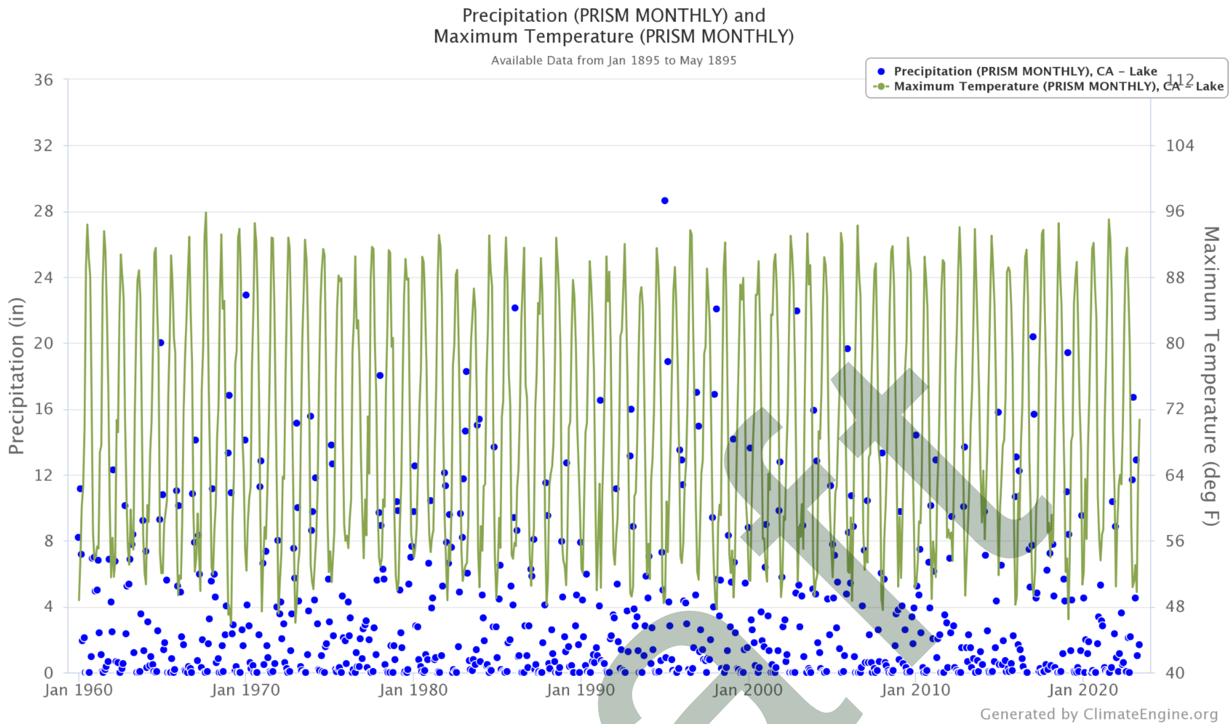
Table 4 Climate Projections for Lake County

Climate Indicators for Lake County	1990-2004 Observed Historical	2025-2039 RCP 8.5	2040-2054 RCP 8.5	Percent Change
Annual Cooling Degree Days Base 65F	319	686	805	152%
Extreme Heat Days (days/yr) above 97.1F	2	14	18	800%
Warm Nights (nights/yr) above 55.6F	5	20	27	440%
Annual Average Precipitation (inches)	44	47	44	0%
Area Burned (hectares)	3,207	3,923	4,129	29%

Area Burned indicator does not have observed historical data and is modeled historical data under RCP 8.5.

Table: Sierra Business Council • Source: Cal-Adapt Tools • Created with Datawrapper

Figure 4 Historical Trends in Temperature and Precipitation for Lake County



Since Aug 1993, the monthly max temperature has slowly risen. In the last decade, rainfall spiked in Jan 2017 and Feb 2019 but has remained low.

EDDI Projections

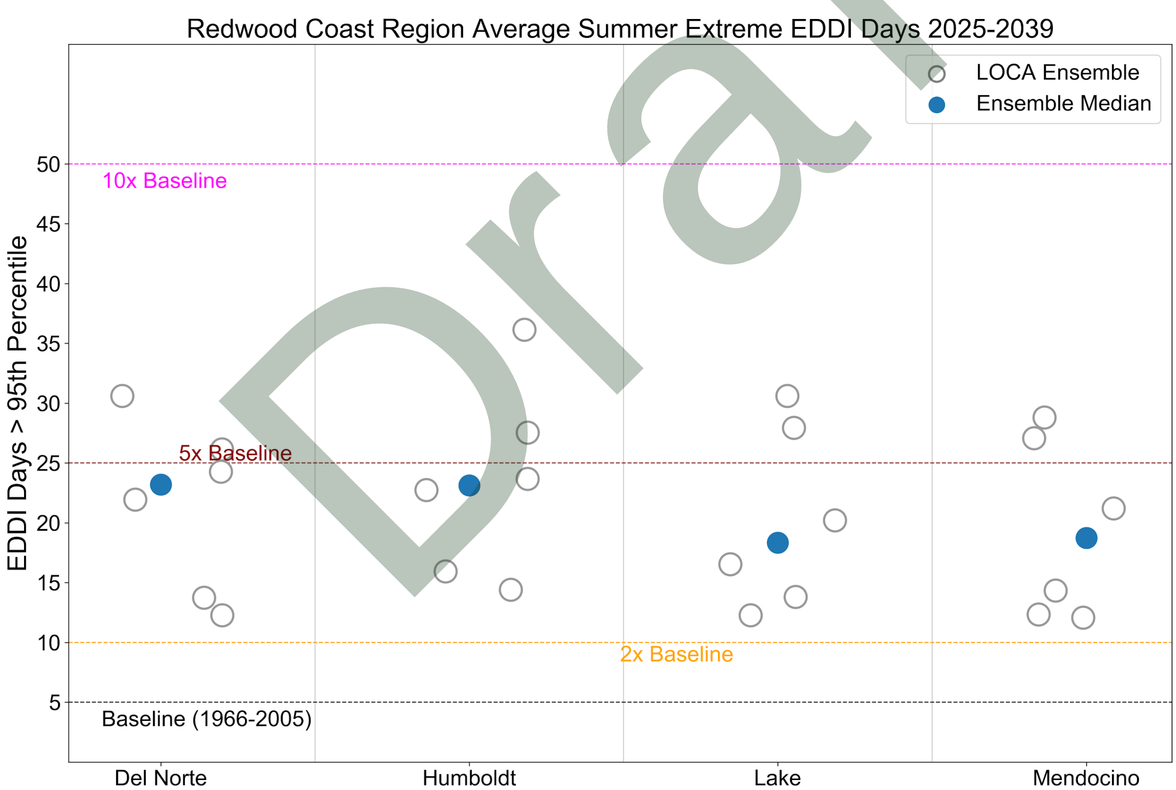
With increasing temperatures and changing precipitation patterns in the Redwood Coast region, one of the greatest climate threats to the region is wildfire. Changing climate conditions have led to greater wildfire severity with lasting economic and public health impacts in the region. As the region and state have struggled with ongoing droughts, measuring the evaporative demand can be used as a proxy for high fire danger days. As landscapes become drier, the risk of severe wildfires increases.

Recent high-impact wildfires and droughts have been linked to extremes in the Evaporation Demand Drought Index (EDDI). Evaporative demand can be thought of as how “thirsty” the atmosphere is, and how much moisture evaporates over a period of time. Increasing air temperature is the leading cause of increased evaporative demand for inland regions, and humidity has more of an overall influence on coastal regions. The likelihood of extreme wildfire potential is based on 2-week periods of elevated evaporative demand during the summer and autumn. When the 2-week EDDI is above the 95th percentile, the indicator can be used as a proxy for high fire danger days.

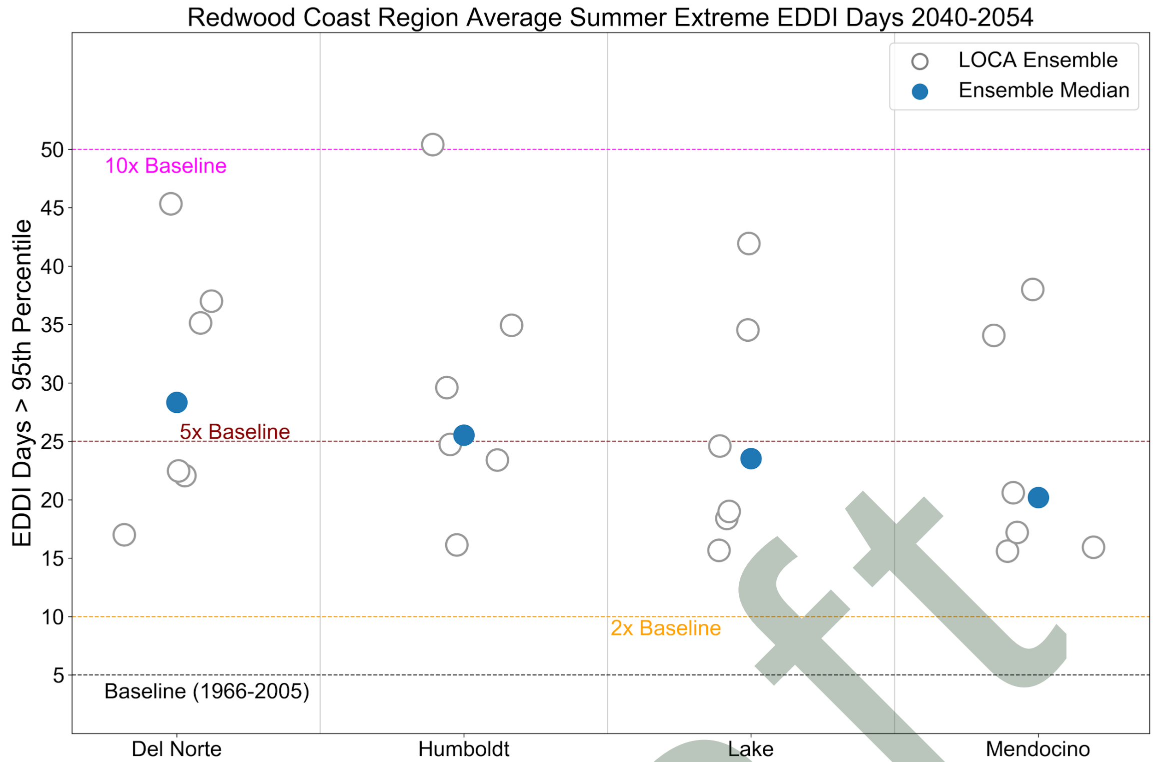
In the figures presented below, each dot is a modeled projection showing the number of days where the 2-week EDDI is above the 95th percentile, indicating a high fire danger day. The blue dot shows the ensemble median (i.e., the median of all the measured models). In the summer (June, July, and August), the total number of days possible is 92, and in the autumn (September, October, and November) 91 days are possible. If a dot has a value of 30, that indicates a third of all summer days are high fire danger days. The county data can be found in the column above the county name. The historical baseline is approximately 5 days per season have a 2-week EDDI above the 95th percentile.

All models for both the near future and the mid-century show an increase in extreme EDDI days, indicating more high fire danger days. The mid-century shows a consistent increase of over 400% from historical across the entire region, with Del Norte and Humboldt having more extreme EDDI days than the more southern counties in the region. As seen in the Autumn projections below in Fig 5 and 6, the summer months will see bigger increases in extreme EDDI days.

Figure 5 Extreme EDDI Days in Summer for Near Future and Mid-Century



Source: Dr. Daniel McEvoy, Desert Research Institute



Source: Dr. Daniel McEvoy, Desert Research Institute

As seen in the two timescales in Fig 5, high fire risk days will increase for all four counties between the near future (top graph) and the mid-century (bottom graph). By the mid-century, the northern counties will see an five fold increase in the number of days with high fire risk, with Del Norte County predicted to have nearly a third of summer days be high risk.

The number of days with extreme fire risk in the fall months are shown in Fig 6. Through the mid-century, the number of days with high fire risk will be lower than in the summer months, but still have a roughly three fold increase in high risk days compared to the historical average. This may be due to cooler temperatures in the fall, an increase in humidity, or other seasonal fluctuations.

Figure 6 Extreme EDDI Days in Autumn for Near Future and Mid-Century

Source: Dr. Daniel McEvoy, Desert Research Institute

Sea Level Rise

Sea level rise is a critical threat to the region due to the region's reliance on coastline tourism, maritime activities, and the critical infrastructure and communities within the threatened zones within feet of the high-tide line. Sea level rise projections should be used for planning decisions and to develop pathways for economic development that increase the adaptative capacity of the region.

The three tide ranges within the Redwood Coast region are Crescent City in Del Norte County, North Spit in Humboldt County, and Arena Cove in Mendocino County. Data for sea level rise is developed for tide ranges and shared below.

Table 5 Cresent City Sea Level Rise Projections under RCP 8.5

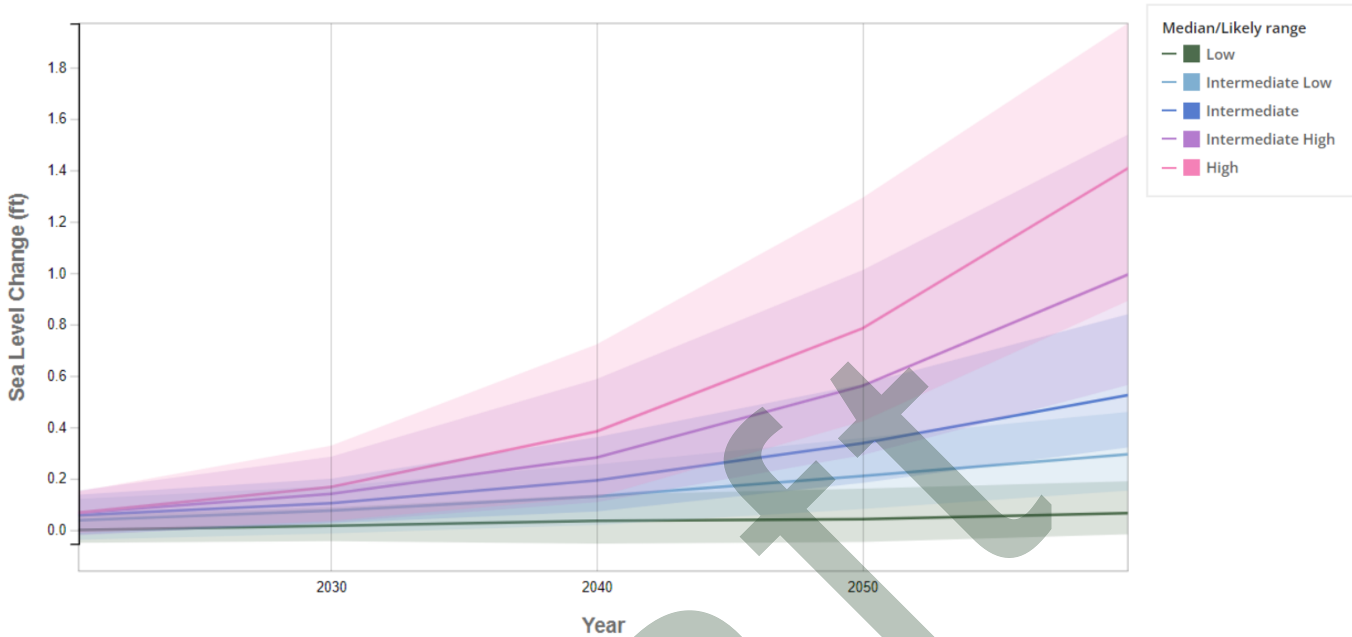
Probabilistic projections for the height of sea level rise with respect to a baseline of the average relative sea level over 1991 - 2009.

Time Period	Likely Range (ft)	1-in-200 Chance (ft)
2030	0.0 - 0.3	0.5
2040	0.1 - 0.4	0.9
2050	0.2 - 0.7	1.5
2060	0.2 - 0.9	2.1

The likely range shows a 66% probability of sea level rising between the shown range. The 1-in-200 chance shows a 0.5% probability of sea level rise reaching or exceeding the shown value.

Table: Sierra Business Council • Source: CA Ocean Protection Council • Created with Datawrapper

Figure 7 Cresent City Sea Level Rise Projections under GMSL Scenarios



Source: NASA Sea Level Change

Key Takeaways:

- Within the likely range in both datasets, Crescent City will likely see sea level rise within six inches by 2050. Even with extensive global greenhouse gas emissions reductions, most projections through 2050 are inevitable due to past emissions.
- Beaches with low gradients, like Crescent Beach could see nearly 100 feet of shoreline lost to sea level rise by 1960. It is typically assumed that beaches with slopes around 1% can expect 100 feet of shoreline lost for every foot of sea level rise.

Table 6 North Spit Sea Level Rise Projections under RCP 8.5

Probabilistic projections for the height of sea level rise with respect to a baseline of the average relative sea level over 1991 - 2009.

Time Period	Likely Range (ft)	1-in-200 Chance (ft)
2030	0.5 - 0.7	1.0
2040	0.7 - 1.1	1.6
2050	0.9 - 1.5	2.3
2060	1.2 - 1.9	3.1

The likely range shows a 66% probability of sea level rising between the shown range. The 1-in-200 chance shows a 0.5% probability of sea level rise reaching or exceeding the shown value.

Table: Sierra Business Council • Source: CA Ocean Protection Council • Created with Datawrapper

Figure 8 North Spit Sea Level Rise Projections under GMSL Scenarios

Source: NASA Sea Level Change

Key Takeaways:

- Subsidence, or the sinking of land, near Humboldt Bay could increase the rate of sea level rise.
- The North Spit will likely see the greatest rise in sea level in the Redwood Coast region and is one of the highest-risk tides ranges on the West Coast.

- The coastal dune habitat along the North Spit may increase coastal resilience in the region if it is restored and maintained.

Table 7 Arena Cove Sea Level Rise Projections under RCP 8.5

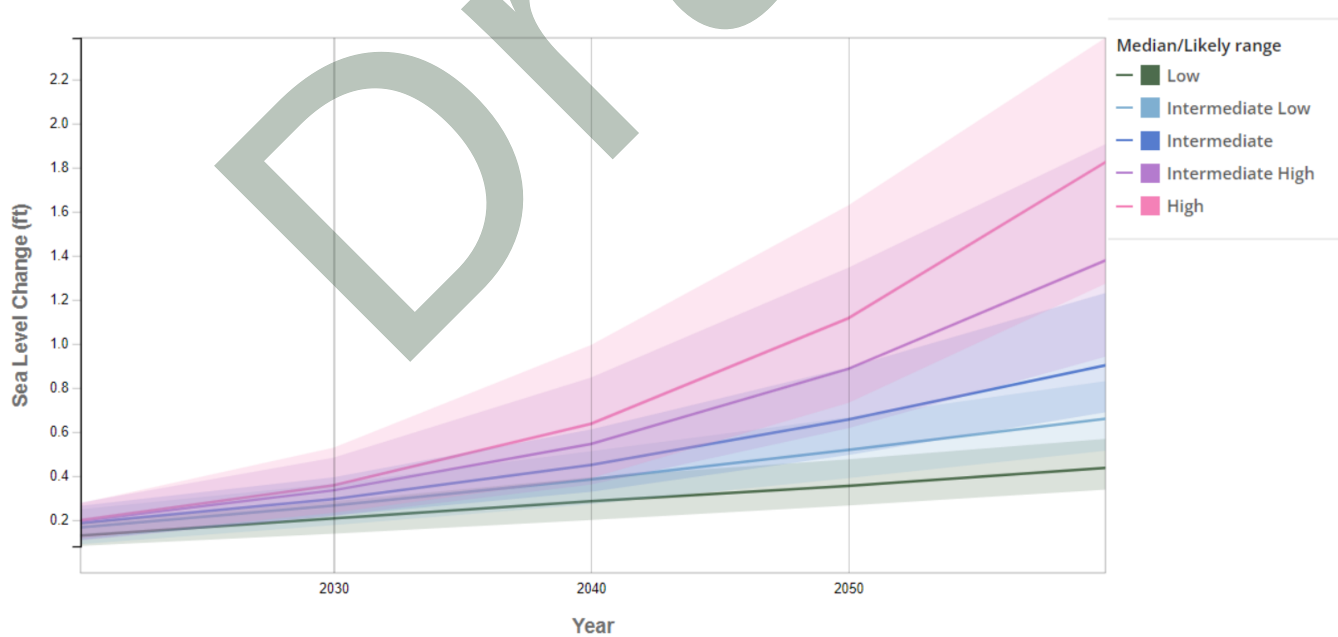
Probabilistic projections for the height of sea level rise with respect to a baseline of the average relative sea level over 1991 - 2009.

Time Period	Likely Range (ft)	1-in-200 Chance (ft)
2030	0.2 - 0.5	0.7
2040	0.3 - 0.7	1.2
2050	0.5 - 1.0	1.8
2060	0.6 - 1.3	2.5

The likely range shows a 66% probability of sea level rising between the shown range. The 1-in-200 chance shows a 0.5% probability of sea level rise reaching or exceeding the shown value.

Table: Sierra Business Council • Source: CA Ocean Protection Council • Created with Datawrapper

Figure 9 Arena Cove Sea Level Rise Projections under GMSL Scenarios



Source: NASA Sea Level Change

Key Takeaways:

- Within both datasets, Arena Cove can expect to see up to a foot in sea level rise by 2050. This may lead to a loss of shoreline near the Point Arena Pier, and cause erosion along the sea cliffs.
- Loss of shoreline in the Arena Cove area would lead to limited public and commercial access, and the Mendocino coastline with gentle slopes could see over 100 feet of shoreline lost by 2060.

Climate Change Impacts on Disinvested Communities

Disinvested populations are more likely to experience harm to their health, economic, and social well-being due to their race, gender, age, disability, poverty status, and limited access to resources. While many adverse effects are systemically reinforced, the region must identify, mitigate, and resolve these challenges to build resilience and prosperity.

Redwood Coast communities are vulnerable to climate change due to their geographical locations and environment, the lack of resources and essential services, and the reduced representation of at-risk populations. These communities tend to be defined by sparsely populated rural living, low-tech, outdoor and service-based jobs, outdoor adventure sports, and traditional values, where People of Color, people with disabilities, and families in poverty are present but silent and sometimes exist as hidden populations. Lack of diversity can lead to less state and federal funding being supplied to the region, and lead to greater disparities in climate change adaptation planning.

The populations in Table 8 may see the most impacts from climate change hazards. Young children, seniors, and people with disabilities are at higher risk of physical impacts from climate change due to reduced physical and mental capacities (due to age, illness, or isolation), and may be more reliant on caregivers and medical equipment. Power outages can cause immense physical stress on communities reliant on air conditioning, refrigeration of medicines, reliance on medical equipment, and other powered products. Additionally, these groups are less likely to be able to evacuate without assistance.

People experiencing poverty and those unable to work are more likely to face economic barriers to climate adaptation. This can present as insufficient shelter or mobility during extreme weather events. These groups are also more likely to leave the area in the aftermath of a natural disaster or extreme weather event; additionally, these groups can increase in population during and after a natural disaster. Growing populations of underresourced groups in the Redwood Coast can lead to lower community resilience, an increased need for climate planning, and more social services.

Table 8 Populations with Critical Risk to Climate Hazards

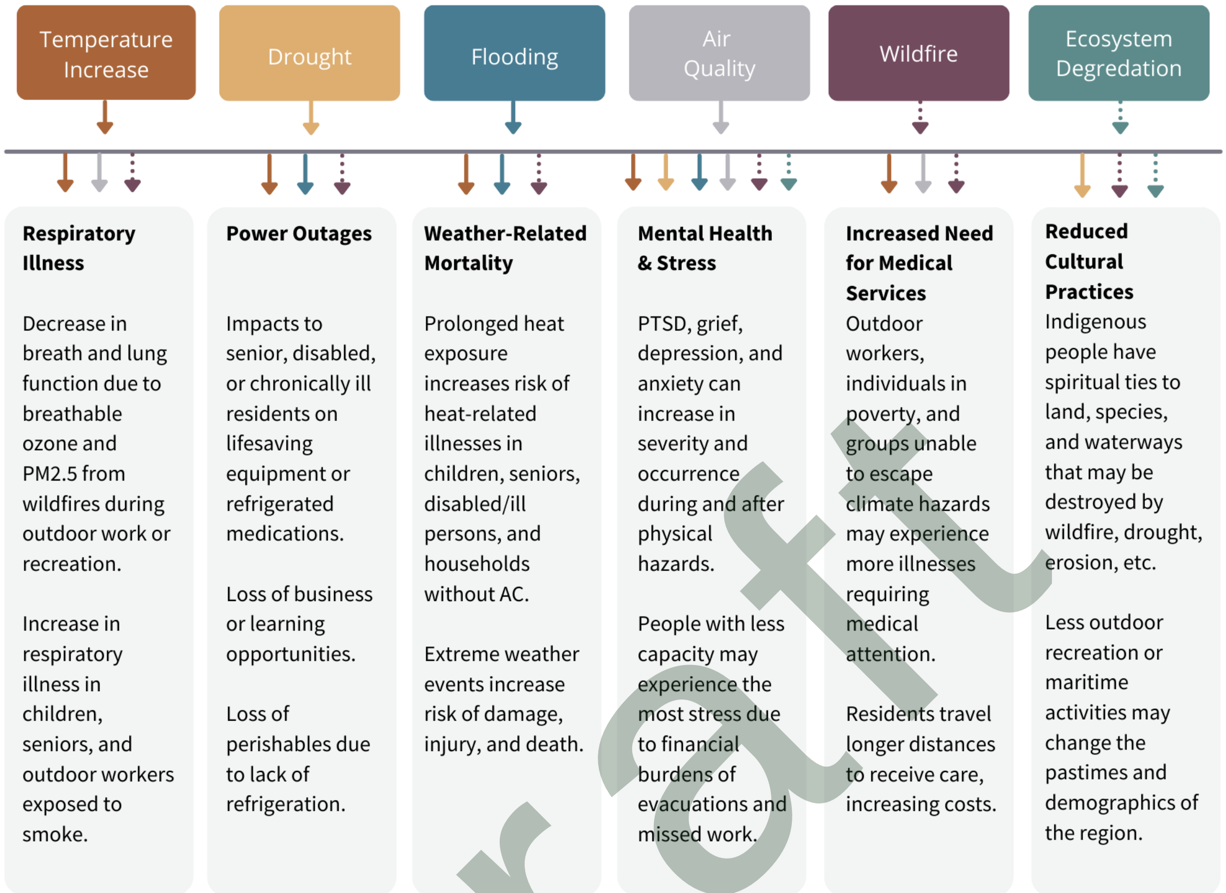
Population	Number of People	Percent of Total Population	Critical Risks
Under 5	17,421	5.4%	Extreme heat, air quality
Over 65	65,563	32.9%	Extreme heat, air quality, reduced evacuation ability
People of Color	79,956	64.6%	Extreme heat, air quality
People in poverty	56,819	17.8%	Extreme heat, air quality, reduced evacuation ability, water shortages (i.e., dry wells), extreme precipitation events
People that did not work (aged 16-64)	58,611	29.4%	Extreme heat, air quality, reduced evacuation ability, water shortages (i.e., dry wells)
Households with no car	8,104	6.6%	Extreme heat, air quality, reduced evacuation ability, water shortages (i.e., dry wells), extreme precipitation events
People with disabilities	58,697	18.4%	Extreme heat, air quality, reduced evacuation ability, power outages
People without health insurance	25,042	7.9%	Extreme heat, air quality

Various Total Population values were used based on population type. For example, the percent of households with no car is based on the total number of households in the Redwood Coast region, and not total population.

Table: Sierra Business Council • Source: U.S. Department of Commerce. 2022. Census Bureau, American Community Survey Office, Washington, D.C. • Created with Datawrapper

Most of the impacts felt by climate hazards will be similar across vulnerable populations and can be briefly summarized in the graphic below.

Figure 10 Climate Impacts on Vulnerable Populations



Greenhouse Gas Emissions

Greenhouse gas (GHG) emissions are air pollutants including carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), sulfur hexafluoride (SF6), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and nitrogen trifluoride (NF3). Each of these gases has a different potency or ability to contribute to global warming.

Common sources of GHG emissions include the generation of electricity for lighting, appliances, cooking, and heating in homes and businesses; the burning of fossil fuels to power passenger cars and road freight; and the burning of agricultural residues (i.e., crop burning) which all release CO2, N2O, and CH4.

While new technologies and renewable energy sources have contributed to lower energy-related GHG emissions, rising populations, and commercial growth result in increasing emissions. During the CERF process, it will be important to find a balance between increasing the number of high-quality jobs in the Redwood Coast region without compromising on GHG emissions reduction goals.

Some widely accepted methods for reducing emissions at the local level include energy efficiency retrofits (e.g., LED light bulbs, hot water heat pumps) in homes, commercial spaces, and public buildings, as well as increasing the adoption of fuel-efficient vehicles.

There are GHG emission data gaps in the Redwood Coast region, and it is recommended that all jurisdictions without a GHG emission inventory prepared within the last five years complete a comprehensive inventory to better understand existing emission sources and trends. This will allow local governments to develop reduction targets and strategies.

Data Source and Methodology

For the Redwood Coast CERF region, a community-level GHG emissions inventory was only available for Humboldt County but was more than five years old and the data was scaled using demographic changes and emission trends to estimate 2020 emissions. A detailed methodology for this normalization technique can be found in Appendix B. Due to the limitations of this methodology, only emissions from the Residential, Nonresidential, and Transportation sectors will be shown here. Local emissions from the Solid Waste and Water and Wastewater sectors can increase emission totals by varying proportions depending on the existence of treatment plants, landfills, and other sites that emit GHG within a jurisdiction's boundary. These sectors have been omitted from this analysis due to restraints on normalizing these values.

Del Norte, Lake, and Mendocino counties had greenhouse gas emission estimates available through Google Environmental Insights Explorer (Google EIE). The methodology used by Google EIE differs from the method used by Sierra Business Council and most consulting firms performing local and regional emissions inventories. Google EIE methodology can be found here. Due to the lack of available greenhouse gas inventories in the Redwood Coast CERF region, it was beneficial to utilize Google EIE to give a sense of regional emission totals and an estimated emission source breakdown by sector.

Due to the mixed methodologies used, the regional GHG emissions totals are inaccurate and should be used as a proxy.

DISCLAIMER: Due to the extensive reliance on estimated values, the county and regional totals shown below are not accurate. Further, the calculation methods and tools used do not align with GHG emission inventory best practices. Therefore, all GHG emissions shown should not be used for climate action planning purposes. They are provided for educational purposes only. It is highly recommended that jurisdictions complete comprehensive emissions inventories. comprehensive emissions inventories. For jurisdictions interested in having a GHG inventory developed, resources are available from CARB, ICLEI, and Redwood Coast Energy Authority.

Sources of Greenhouse Gas Emissions

County Emissions by Sector

Table 9 County and Regional Emissions by Sector

County	Year	Residential Emissions (MTCO2e)	Nonresidential Emissions (MTCO2e)	Transportation Emissions (MTCO2e)	Total Emissions (MTCO2e)
Del Norte	2022	1,196,000	140,500	181,300	1,317,800
Humboldt	2020	1,131,228	190,673	1,680,088	1,901,990
Lake	2022	1,521,000	158,000	1,173,000	1,752,000
Mendocino	2022	1,647,000	1,117,000	1,301,000	11,065,000
Regional	**-**	**11,495,228**	**1,306,173**	**11,235,388**	**13,036,790**

Table: Sierra Business Council • Source: Local Greenhouse Gas Inventories where available (scaled to 2020 when necessary), Google Environmental Insights • Created with Datawrapper

Figure 11 Regional GHG Emissions by Sector

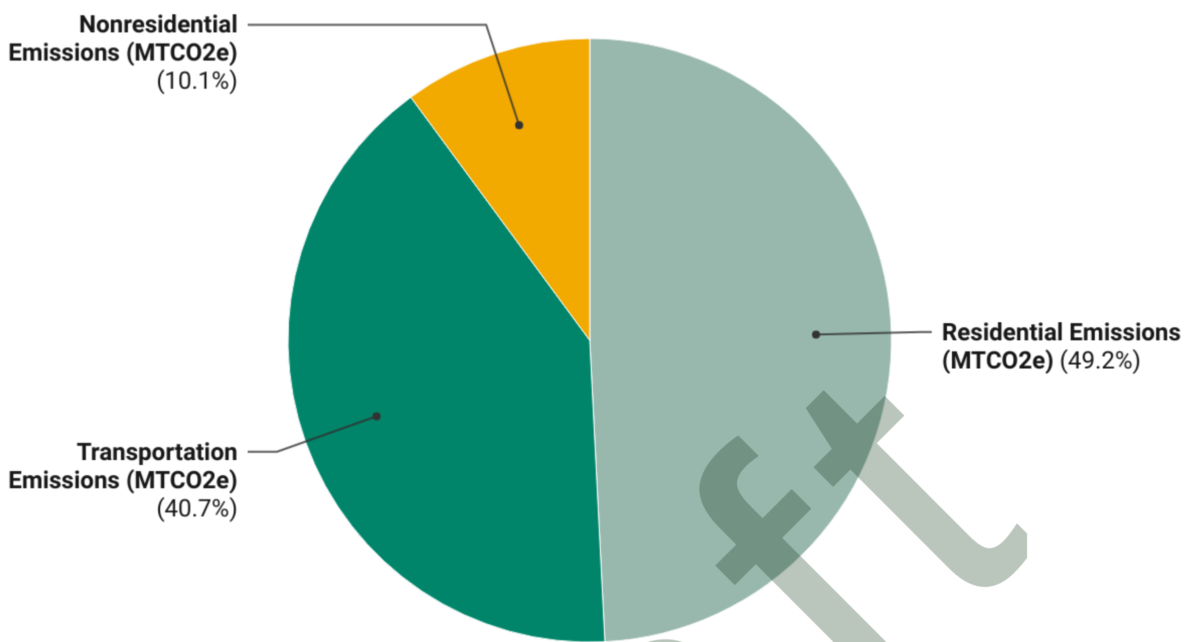


Chart: Sierra Business Council • Source: Local Greenhouse Gas Inventories where available (scaled to 2020 when necessary), Google Environmental Insights • Created with Datawrapper

In California, the Transportation sector is the largest contributor to GHG emissions, and many rural California regions see this trend. While the Redwood Coast region analysis shows the residential sector as the largest contributor to GHG emissions, it should be noted that emission data from Google EIE tends to show lower proportions of emissions from transportation than traditionally conducted GHG emission inventories.

Transportation is still heavily reliant on the burning of fossil fuels (e.g., gasoline and diesel), which contribute large amounts of greenhouse gases to the atmosphere. In rural areas, like the Redwood Coast region, it is unsurprising to see the transportation sector make up the vast majority of emissions due to residents needing to travel farther distances to town centers and typical services like schools, grocery stores, and health care. Rural areas with economies based on natural and working land industries may see even larger percentages of emissions associated with the Transportation sector due to the increased use of off-road vehicles and equipment.

Rural regions are also slower to adopt new technologies like electric vehicles (EVs); this may be due in part to local resistance, but largely in part to the lack of EV infrastructure and funding to support a transition, as well as the individual cost barriers to residents and cultural resistance to change.

Residential building energy use is typically rural regions' second largest GHG emitting sector. This is due to rural regions' reliance on natural gas and propane as primary fuel sources of home heating. As California begins to mandate cleaner energy sources and a transition to electrification, it will be important that the Redwood Coast region has access to energy efficiency resources, clean energy workforce development, and funding opportunities. Additionally, it will be important that large energy providers of the region can provide reliable transmission and distribution infrastructure to ensure power outages will not disproportionately affect rural communities where extreme weather conditions have led to a reliance on natural gas and propane.

Significant Stationary Sources of GHG Emissions

California Air Resources Board (CARB) requires facilities emitting 10,000 metric tons or more of carbon dioxide equivalent (MTCO2e) or more to report annually[6]. Only Lake and Humboldt County have facilities that meet or exceed the mandatory reporting thresholds for 2020. The following facilities were identified using CARB's Pollution Mapping Tool.

Table 10 Significant Stationary Sources of GHGs in 2020

County	City/Address	Source Name	Emissions (MTCO2e)	Year	NAICS	Sector
Lake	10350 Socrates Mine Rd, Middletown, CA 95461	Calpine - Geysers Power Company, LLC - Geothermal	210	2020	221116	Electricity Generation
Humboldt	97 Bay Street, Samoa, CA 95564	DG Fairhaven Power LLC	16	2020	221117	Electricity Generation
Humboldt	153 Main St, Scotia, CA 95565	Humboldt Sawmill Company	296	2020	221117	Cogeneration
Humboldt	1000 King Salmon Ave, Eureka, CA 95503	PG&E Humboldt Bay Generating Station	227	2020	221112	Electricity Generation
Humboldt	3160 Upper Bay Road, Arcata, CA 95521	The Sun Valley Group	12	2020	111422	Other Combustion Source

Table: Sierra Business Council • Source: CARB Pollution Mapping Tool, 2023 (Reporting Year 2020) • Created with Datawrapper

All of the facilities required to report annual GHG emissions to CARB are within the energy sector.

[6]Facilities report their emissions to CARB using CARB-designated quantification methods, and the data are stored in CARB's MRR database. GHG emissions data for facilities emitting over 25,000 metric tons of CO2 equivalents are subject to independent third-party verification by a CARB-accredited verifier.

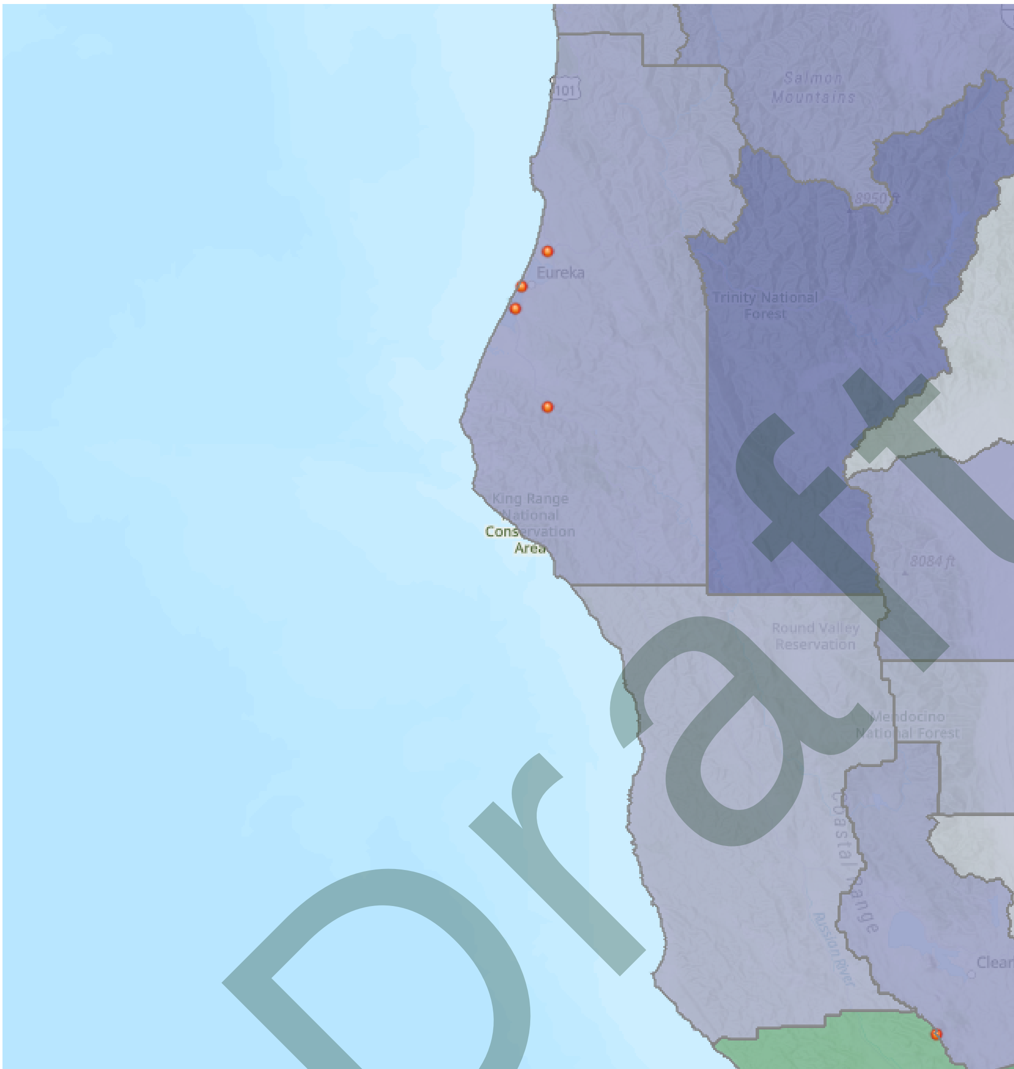
Greenhouse Gas Emissions Impacts on Disinvested Communications

Air pollutants from GHG emissions in the Redwood Coast CERF region have modest direct impacts on disinvested populations due to the low number of large stationary sources in the region and minimal multilane roadways with traffic congestion that leads to smog and air pollution. These GHG emissions impacts occur more frequently in areas with high volumes of manufacturing, mining, and extraction industries, or large roadways with heavy traffic near residential areas.

Because GHG emissions lead to climate change by trapping heat, the greatest impact disinvested populations in the region will face is the various climate change impacts discussed in the previous section titled 'Climate Change Impacts on Disinvested Communities.' Most threatening will be the increase in extreme weather events like heavy winter storms, wildfires, and rising temperatures. It should be noted that wildfires are likely the leading source of GHG emissions in the region. There is currently no agreed-upon emissions accounting methodology across the state, and wildfire-induced GHG emissions are not included in this report.

The Redwood Coast region has five mandatory reporting facilities as mentioned in Table 10. As can be seen in Figure 12, these facilities are all located in census tracts with a median household income (MHI) far below the state's median household income of $84,097 and the national MHI of $69,000. Two of these facilities are within the Humboldt Bay region and may be at risk of sea level rise or flooding events. This could lead to pollution in the Bay and ocean waters that could pose a risk to ecosystems and public health. Two of these facilities are located in tracts with MHI's below $40,000.

Figure 12 Median Household Income and Large Emission Point Source Facilities



A zoomable version of this map is available here.

Air Pollution

In the Redwood Coast region, the scent and sensation of the coastal breeze and misty redwood forests are a crucial part of the desire to live and work in the area. “Pure air” is a mixture of gases containing about 78% nitrogen, 21% oxygen, less than 1% carbon dioxide, argon, and other gases, and varying amounts of water vapor. Air pollution is the degradation of air quality from unwanted chemicals or materials in the air. Any amount of foreign or natural substances in the air that may have negative impacts on humans, animals, and ecosystems are known as air pollutants or criteria.

Criteria air pollutants are pollutants where acceptable levels of exposure can be determined and a standard level for ambient air quality has been established. The following criteria pollutants will be discussed in this report (all definitions are from the California Air Resources Board [CARB]):

- **Ozone:** A strong-smelling, pale blue, reactive toxic chemical gas consisting of three oxygen atoms. It is a product of the photochemical process involving the sun's energy and ozone precursors, such as hydrocarbons and oxides of nitrogen. Ozone exists in the upper atmosphere ozone layer (stratospheric ozone) as well as at the Earth's surface in the troposphere (ozone). Ozone in the troposphere causes numerous adverse health effects and is a criteria air pollutant. It is a major component of smog.
- **Carbon monoxide:** A colorless, odorless gas resulting from the incomplete combustion of hydrocarbon fuels. CO interferes with the blood's ability to carry oxygen to the body's tissues and results in numerous adverse health effects. Over 80 percent of the CO emitted in urban areas is contributed by motor vehicles. CO is a criteria air pollutant.
- **Nitrogen oxides:** A general term pertaining to compounds of nitric oxide (NO), nitrogen dioxide (NO2), and other oxides of nitrogen. Nitrogen oxides are typically created during combustion processes and are major contributors to smog formation and acid deposition. NO2 is a criteria air pollutant and may result in numerous adverse health effects.
- **Sulfur dioxide:** A strong-smelling, colorless gas that is formed by the combustion of fossil fuels. Power plants, which may use coal or oil high in sulfur content, can be major sources of SO2 and other sulfur oxides contributing to the problem of acid deposition. SO2 is a criteria air pollutant.
- **PM10:** A criteria air pollutant consisting of small particles with an aerodynamic diameter less than or equal to a nominal 10 microns (about 1/7 the diameter of a single human hair). Their small size allows them to make their way to the air sacs deep within the lungs where they may be deposited and result in adverse health effects. PM10 also causes visibility reduction.
- **PM2.5:** Includes tiny particles with an aerodynamic diameter less than or equal to a nominal 2.5 microns. This fraction of particulate matter penetrates most deeply into the lungs.

This report will also look at the emissions of non-criteria pollutants. The most common non-criteria pollutants are Total Organic Gases (TOG), which include gases at atmospheric pressure and ambient temperatures, and Reactive Organic Gases (ROG), also known as Volatile Organic Compounds (VOC).

Data Source and Methodology

CARB Emission Tool, 2017 baseline year

Sources of Air Pollution

Stationary sources or point sources are sources that can be identified by locations and are often permitted by local Air Districts. Stationary sources may be power plants, landfills, or industrial processes.

Table 11 Stationary Sources of Air Pollution, 2017. All data is in tons per day.

STATIONARY SOURCES	TOG	ROG	CO	NOX	SOX	PM	PM10	PM2.5	NH3
FUEL COMBUSTION									
ELECTRIC UTILITIES	5.82	0.31	0.11	0.11	0	0.22	0.21	0.13	1.72
MANUFACTURING AND INDUSTRIAL	0.16	0.09	2.54	2	0.47	0.35	0.34	0.33	0
FOOD AND AGRICULTURAL PROCESSING	0.24	0.22	6.04	0.08	0.07	0.08	0.07	0.07	0
SERVICE AND COMMERCIAL	0.03	0.01	0.1	0.4	0.01	0.02	0.02	0.02	0
OTHER (FUEL COMBUSTION)	0	0	0.01	0.05	0	0	0	0	0
*** TOTAL FUEL COMBUSTION**	**6.25**	**0.63**	**8.8**	**2.64**	**0.56**	**0.67**	**0.64**	**0.55**	1.72
WASTE DISPOSAL									
LANDFILLS	39.75	0.26	0	0	0	0	0	0	0.08
OTHER (WASTE DISPOSAL)	0	0	0	0	0	0	0	0	0.13
*** TOTAL WASTE DISPOSAL**	**39.75**	**0.26**	**0**	**0**	**0**	**0**	**0**	**0**	**0.22**
CLEANING AND SURFACE COATINGS									
LAUNDERING	0.08	0.01	0	0	0	0	0	0	0
DEGREASING	1.09	0.93	0	0	0	0	0	0	0
COATINGS AND RELATED PROCESS SOLVENTS	0.49	0.48	0	0	0	0	0	0	0

ADHESIVES AND SEALANTS	0.21	0.19	0	0	0	0	0	0	0
*** TOTAL CLEANING AND SURFACE COATINGS**	**1.86**	**1.62**	0	0	0	0	0	0	0
PETROLEUM PRODUCTION AND MARKETING									
OIL AND GAS PRODUCTION	1.23	0.33	0	0	0	0	0	0	0
PETROLEUM MARKETING	2.39	2.39	0	0	0	0	0	0	0
*** TOTAL PETROLEUM PRODUCTION AND MARKETING**	**3.62**	**2.72**	0	0	0	0	0	0	0
INDUSTRIAL PROCESSES									
FOOD AND AGRICULTURE	0.36	0.36	0	0	0.12	0.01	0	0	0
WOOD AND PAPER	0.1	0.1	0	0.73	0	1.13	0.79	0.47	0
OTHER (INDUSTRIAL PROCESSES)	0	0	0	0	0	0.08	0.08	0.06	0
MINERAL PROCESSES	0.02	0.01	0.14	0.18	0.05	2.03	1.02	0.26	0
*** TOTAL INDUSTRIAL PROCESSES**	**0.47**	**0.47**	**0.14**	**0.91**	**0.17**	**3.25**	**1.9**	**0.79**	0
**** TOTAL STATIONARY SOURCES**	**51.96**	**5.7**	**8.93**	**3.56**	**0.73**	**3.92**	**2.54**	**1.34**	**1.94**

Key takeaways from the stationary sources include:

- Waste disposal is the largest emitter of total organic gases.
- Industry, namely mineral processes, is the largest stationary source of particulate matter.

Areawide sources do not have specific locations and are spread over large areas, such as paved road dust, use of fertilizers, and controlled burning (agricultural or forestry-related).

Table 12 Areawide Sources of Air Pollution

AREAWIDE SOURCES	TOG	ROG	CO	NOX	SOX	PM	PM10	PM2.5	NH3
SOLVENT EVAPORATION									

CONSUMER PRODUCTS	2.54	2	0	0	0	0	0	0	0
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	1.1	1.03	0	0	0	0	0	0	0
PESTICIDES/FERTILIZERS	0.32	0.32	0	0	0	0	0	0	4.75
ASPHALT PAVING / ROOFING	3.48	3.48	0	0	0	0	0	0	0
*** TOTAL SOLVENT EVAPORATION**	**7.46**	**6.83**	0	0	0	0	0	0	**4.75**
MISCELLANEOUS PROCESSES									
RESIDENTIAL FUEL COMBUSTION	7.31	3.33	18.61	0.83	0.23	2.76	2.57	2.48	0.15
FARMING OPERATIONS	21.63	1.74	0	0	0	0.87	0.4	0.07	4.26
CONSTRUCTION AND DEMOLITION	0	0	0	0	0	5.08	2.49	0.24	0
PAVED ROAD DUST	0	0	0	0	0	6.51	2.98	0.45	0
UNPAVED ROAD DUST	0	0	0	0	0	24.51	14.57	1.46	0
FUGITIVE WINDBLOWN DUST	0	0	0	0	0	0.98	0.58	0.08	0
FIRES	0	0	0.07	0	0	0	0	0	0
MANAGED BURNING AND DISPOSAL	6.8	4.8	61.05	0.82	0.36	6.53	6.32	5.46	0.54
COOKING	0.08	0.02	0	0	0	0.18	0.18	0.18	0
OTHER (MISCELLANEOUS PROCESSES)	0	0	0	0	0	0	0	0	0.52
*** TOTAL MISCELLANEOUS PROCESSES**	**35.81**	**9.89**	**79.7**	**1.65**	**0.6**	**47.43**	**30.08**	**10.42**	**5.47**
**** TOTAL AREAWIDE SOURCES**	**43.28**	**16.72**	**79.7**	**1.65**	**0.6**	**47.43**	**30.08**	**10.42**	**10.21**

Key takeaways from the area sources include:

- The bulk of the areawide sources come from dust being blown across unpaved roads and contributing to particulate matter. This is to be expected in rural areas.

- Residential fuel combustion is made up of wood burning and the use of natural gas for heating and cooking and is one of the largest areawide pollution sources in the region.
- Farming operations emit the most total organic sources.

Mobile sources of air pollution come from on-road vehicles, including personal and commercial travel, and off-road sources such as recreational boats and aircraft.

Table 13 Mobile Sources of Air Pollution

MOBILE SOURCES	TOG	ROG	CO	NOX	SOX	PM	PM10	PM2.5	NH3
ON-ROAD MOTOR VEHICLES									
LIGHT DUTY PASSENGER (LDA)	1.42	1.27	11.65	1.17	0.02	0.28	0.27	0.11	0.17
LIGHT DUTY TRUCKS - 1 (LDT1)	0.78	0.72	4.39	0.52	0	0.05	0.05	0.02	0.03
LIGHT DUTY TRUCKS - 2 (LDT2)	1.12	1.03	7.5	1.07	0	0.13	0.13	0.05	0.09
MEDIUM DUTY TRUCKS (MDV)	0.97	0.9	6.55	0.89	0	0.11	0.11	0.05	0.07
LIGHT HEAVY DUTY GAS TRUCKS - 1 (LHDGT1)	0.58	0.55	1.92	0.32	0	0.03	0.03	0	0
LIGHT HEAVY DUTY GAS TRUCKS - 2 (LHDGT2)	0.03	0.03	0.12	0.03	0	0	0	0	0
MEDIUM HEAVY DUTY GAS TRUCKS (MHDGT)	0.05	0.04	0.33	0.05	0	0	0	0	0
HEAVY HEAVY DUTY GAS TRUCKS (HHDGT)	0	0	0.02	0	0	0	0	0	0
LIGHT HEAVY DUTY DIESEL TRUCKS - 1 (LHDDT1)	0.16	0.14	0.66	2.87	0	0.09	0.09	0.05	0.05
LIGHT HEAVY DUTY DIESEL TRUCKS - 2 (LHDDT2)	0.03	0.03	0.13	0.46	0	0.02	0.02	0	0.01
MEDIUM HEAVY DUTY DIESEL TRUCKS (MHDDT)	0.1	0.08	0.22	1.01	0	0.05	0.05	0.05	0.02

HEAVY HEAVY DUTY DIESEL TRUCKS (HHDDT)	0.17	0.15	0.66	2.85	0	0.1	0.1	0.08	0.05
MOTORCYCLES (MCY)	0.51	0.45	2.58	0.12	0	0	0	0	0
HEAVY DUTY DIESEL URBAN BUSES (UBD)	0.01	0	0.09	0.01	0	0	0	0	0
HEAVY DUTY GAS URBAN BUSES (UBG)	0	0	0	0	0	0	0	0	0
SCHOOL BUSES - GAS (SBG)	0	0	0.02	0	0	0	0	0	0
SCHOOL BUSES - DIESEL (SBD)	0	0	0	0.16	0	0.01	0.01	0	0
OTHER BUSES - GAS (OBG)	0	0	0.07	0.01	0	0	0	0	0
OTHER BUSES - MOTOR COACH - DIESEL (OBC)	0	0	0	0.01	0	0	0	0	0
ALL OTHER BUSES - DIESEL (OBD)	0	0	0	0.01	0	0	0	0	0
MOTOR HOMES (MH)	0	0	0.17	0.07	0	0	0	0	0
*** TOTAL ON-ROAD MOTOR VEHICLES**	**6**	**5.45**	**37.11**	**11.67**	**0.05**	**0.91**	**0.89**	**0.45**	**0.55**
OTHER MOBILE SOURCES									
TRAINS	0	0	0	0.02	0	0	0	0	0
AIRCRAFT	0.05	0.05	1.26	0.04	0	0	0	0	0
OCEAN-GOING VESSELS	0.89	0.75	0.94	13.6	0.3	0.12	0.12	0.12	0.02
COMMERCIAL HARBOR CRAFT	0.08	0.07	0.22	0.62	0	0.03	0.03	0.03	0
RECREATIONAL BOATS	4.1	3.8	12.54	0.74	0	0.24	0.23	0.17	0
OFF-ROAD RECREATIONAL VEHICLES	0.3	0.28	1.24	0.02	0	0	0	0	0
OFF-ROAD EQUIPMENT	2.67	2.44	24.91	2.08	0	0.16	0.16	0.13	0
OFF-ROAD EQUIPMENT (PERP)	0.01	0.01	0.1	0.22	0	0.01	0.01	0.01	0

FARM EQUIPMENT	0.31	0.28	2.34	1.28	0	0.08	0.08	0.08	0
FUEL STORAGE AND HANDLING	0.11	0.11	0	0	0	0	0	0	0
*** TOTAL OTHER MOBILE SOURCES**	**8.55**	**7.8**	**43.56**	**18.61**	**0.31**	**0.66**	**0.63**	**0.53**	**0.02**
**** TOTAL MOBILE SOURCES**	**14.56**	**13.25**	**80.68**	**30.28**	**0.37**	**1.57**	**1.51**	**0.98**	**0.56**

Key takeaways from mobile sources of air pollution:

- On-road motor vehicles produce less air pollution than other mobile sources.
- Light-duty passenger cars, meaning typical vehicles driven by residents and visitors are responsible for more air pollutants than any other on-road motor vehicle.
- Off-road equipment produces the most air pollutants of any individual mobile source.

Natural sources of air pollution are non-anthropogenic sources and include emissions from vegetation, petroleum seeps, and wildfires.

Table 14 Natural Sources of Air Pollution

NATURAL SOURCES	TOG	ROG	CO	NOX	SOX	PM	PM10	PM2.5	NH3
NATURAL SOURCES									
BIOGENIC SOURCES	382.67	338.87	0	1.7	0	0	0	0	1.09
GEOGENIC SOURCES	0.38	0.07	0	0	0	0	0	0	6.51
WILDFIRES	81.88	67.62	966	4.67	4.64	92.81	89.2	75.56	9.66
*** TOTAL NATURAL SOURCES**	**464.91**	**406.57**	**966**	**6.37**	**4.64**	**92.81**	**89.2**	**75.56**	**17.26**

Key takeaways from natural sources of air pollution:

- Wildfire is the largest contributor to air pollution from natural sources.
- Biogenic sources like the breakdown of plants contribute the most total organic and reactive organic gases.

Across all sources of air pollution in the Redwood Coast region, natural sources contribute the most, followed by areawide sources.

Figure 13 Summary of Regional Sources of Air Pollution

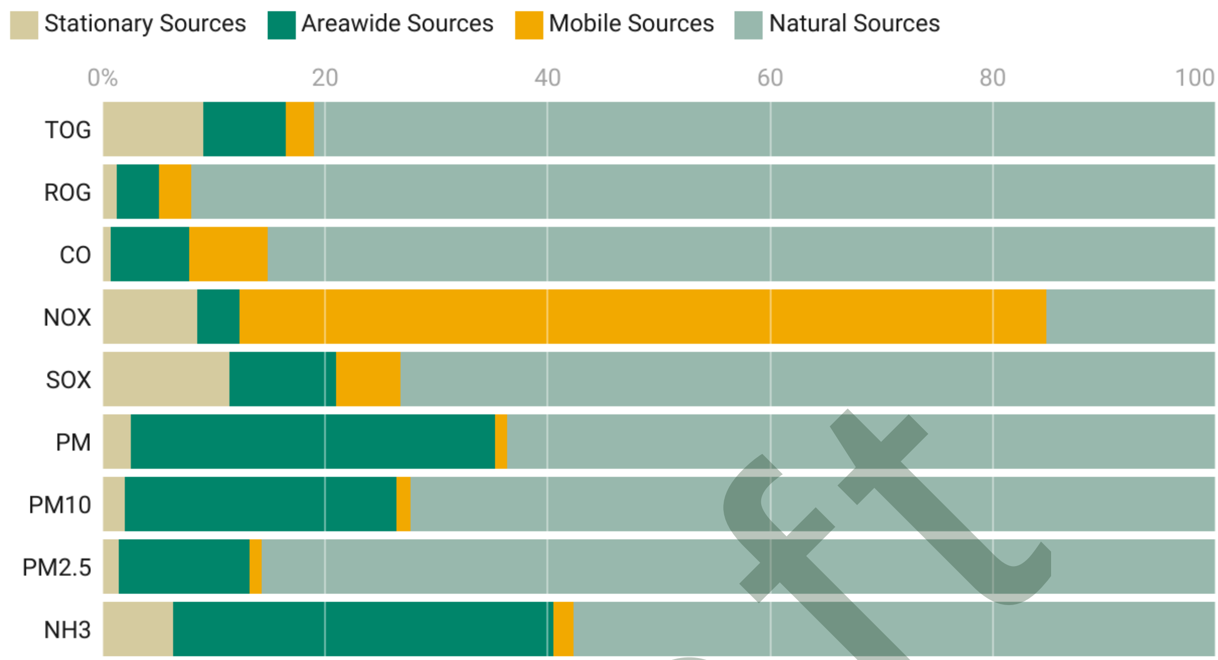


Chart: Sierra Business Council • Source: CARB Emission Tool, 2017 Baseline Year • Created with Datawrapper

Air Pollution Impacts on Disinvested Populations

In the Redwood Coast region, many residents and visitors are most affected by air pollution from wildfires, where smoke contributes heavily to local levels of carbon monoxide, and particulate matter (PM10 and PM2.5). Wildfire smoke in the North State region leads to public health and economic impacts. Wildfire smoke has been shown to cause respiratory illnesses in sensitive populations and outdoor workers. It limits the tourism and recreation industry which fuels many local economies in the summer months. As shown in the data above, wildfire is the leading cause of air pollution in the region.

The other leading air pollution causes like dust from unpaved roads and wood burning for residential heating can be mitigated through paving and residential energy retrofits. In many local circumstances, financial barriers impact disinvested communities more and may not be viable solutions.

Water Pollution & Quality

The rivers and streams of the North Coast region flow west to the Pacific Ocean and account for nearly 40% of the state's total runoff[7]. These rivers not only supply local water, but they are also used for sportfishing, white-water rafting, and river recreation, and are important spawning habitats for local wildlife. Drinking water in the region primarily comes from surface water sources, but groundwater aquifers are also tapped, namely in Humboldt County.

Maintaining these water sources and water infrastructure is critical for the well-being of residents and for the economic growth of the region. The North Coast Regional Water Quality Control Board has several programs to address and regulate polluted runoff that can be viewed on the California Water Boards' website.

Data Source and Methodology

Data is from the CalEnviroScreen Indicator Maps and was requested by Sierra Business Council in July 2023. Individual Indicator Maps are not available to the public as of the writing of this report.

CalEnviroScreen 4.0 Indicator Map for Impaired Water Bodies is from the 2018 303(d) List of Impaired Water Bodies developed by the State Water Resources Control Board (SWRCB). The data from this source provided by CalEnviroScreen is from water quality data collected before May 3, 2017.

CalEnviroScreen 4.0 Indicator Map for Groundwater Threats is from two sources from the SWRCB, the GeoTracker Database and the California Integrated Water Quality System Project. These datasets were downloaded and analyzed by CalEnviroScreen in 2021.

Sources of Water Pollution

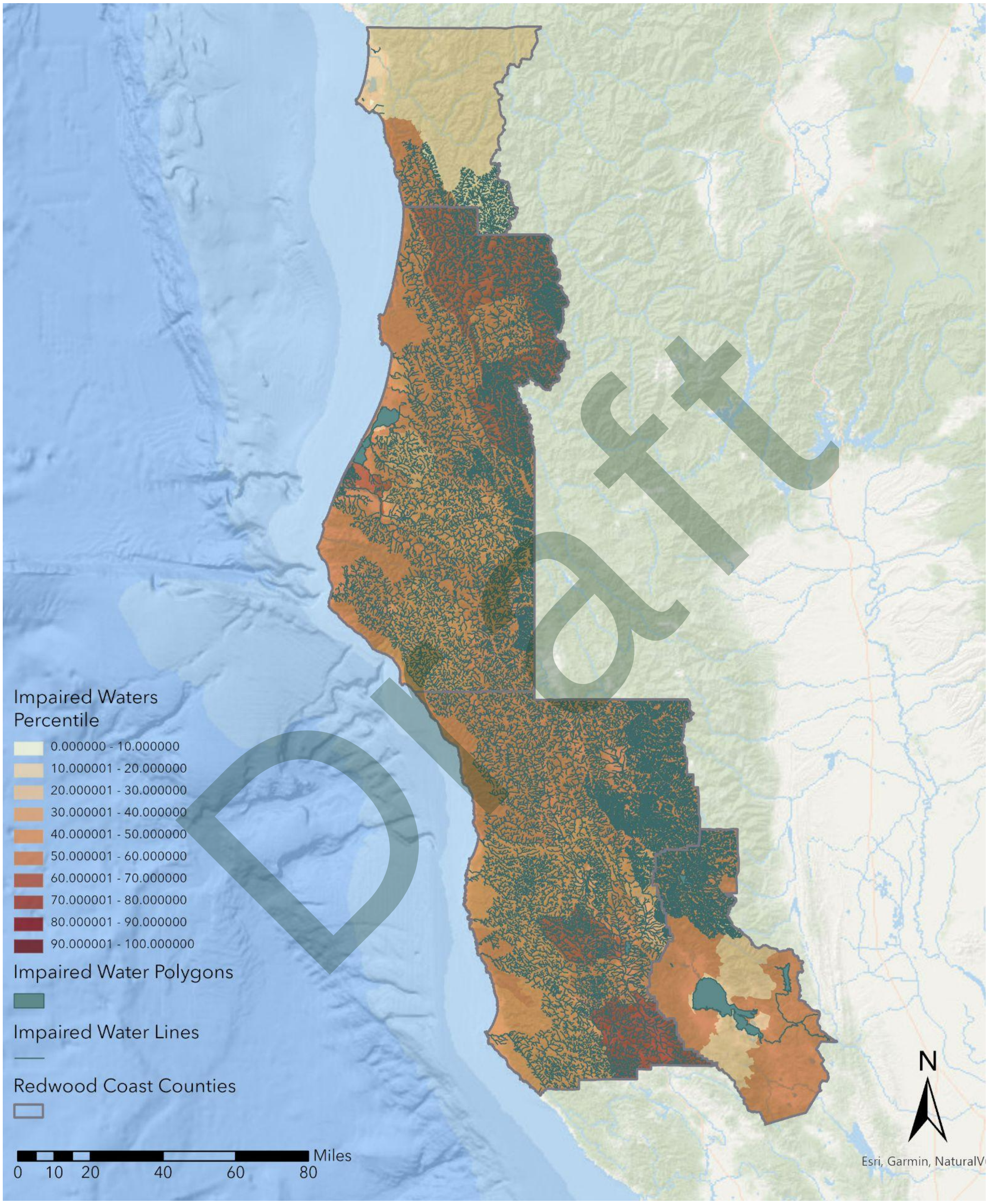
The greatest source of water quality impairment is from nonpoint sources (NPS), or polluted runoff. NPS is caused by water runoff moving across the ground picking up various natural and man-made pollutants and depositing them into lakes, rivers, wetlands, groundwater, and coastal waters. Common sources of NPS pollution include agricultural activities like feedlots and dairies, erosion from timber harvesting, construction, and roads. These sources are not easily cataloged and this section will primarily review point sources of water pollution.

Impaired waters are defined by the Office of Environmental Health Hazard Assessment as bodies of water like streams, rivers, lakes, and shorelines that have been contaminated by pollutants. These

[7] Water Education Foundation, North Coast Rivers, web access in November 2023.

impairments can harm ecosystems, and wildlife habitats, and prevent recreational or sustenance-based uses of the water body.

Figure 14 Impaired Water Bodies



Source: CalEnviroScreen Indicator Maps: Impaired Water Bodies, requested July 2023. For an interactive version of this map, visit this link.

Across the region, there are over 36,000 miles of rivers and streams that are considered impaired due to pollutants. Fifty-eight river and stream locations have tested for at least one pollutant that is over the safe threshold as deemed by the California Water Boards. Of the recorded locations, 67% have Sedimentation listed as a pollutant, 66% have heightened water temperature, and 45% have Aluminum. Other listed pollutants include indicator bacteria, mercury, copper, and dissolved oxygen. Sediment can create shallower waterways increasing the risk of flooding, harming ecosystems and habitats, reducing water clarity, and increasing the cost of drinking water processing, among other impacts. Increasing water temperatures in streams and rivers impact wildlife and can lead to reduced biodiversity. Aluminum is a naturally occurring element in nature, but large amounts of it can lead to health effects in high doses.

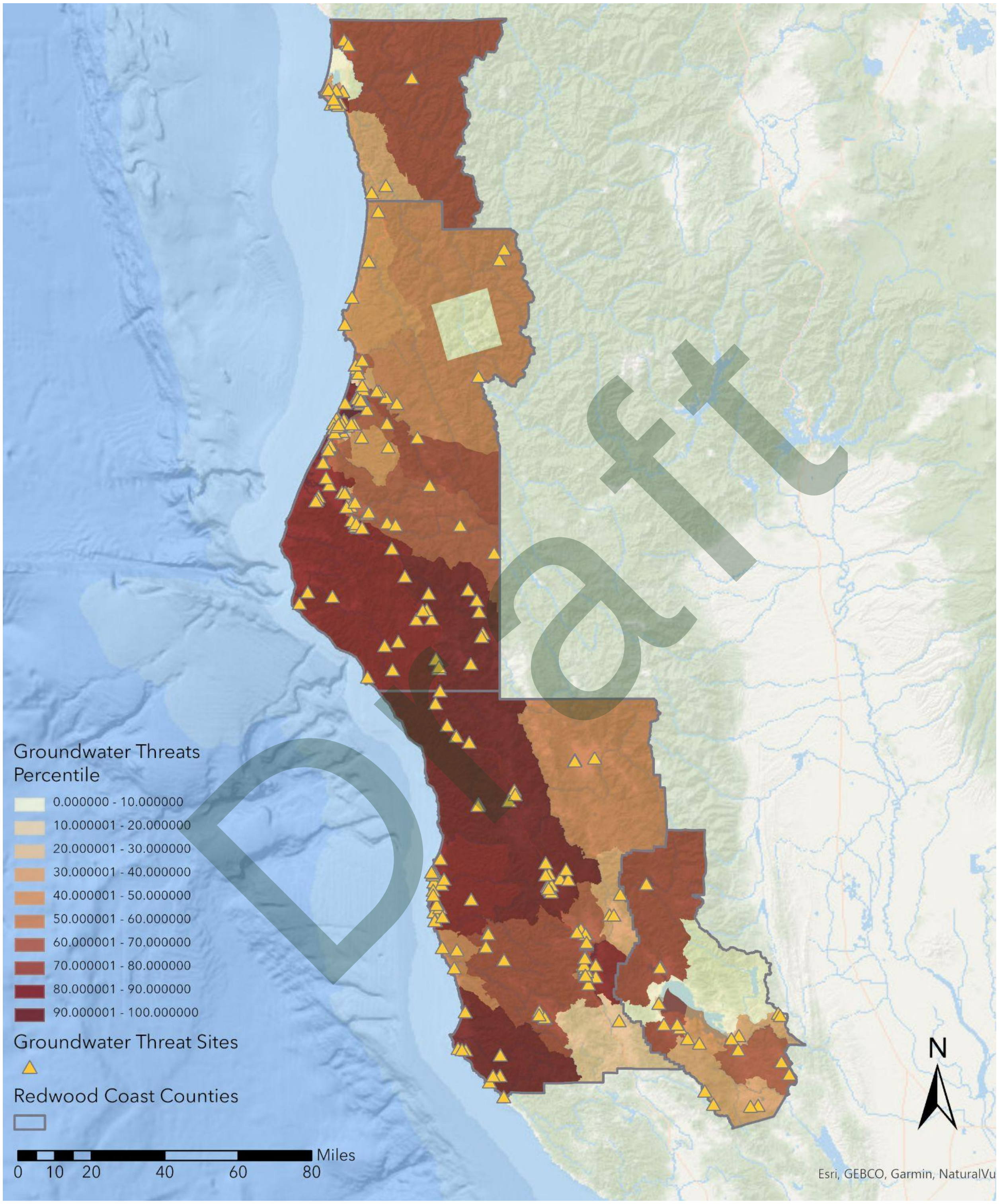
There are just over 11 miles of impaired coastal and bay shoreline, across 16 beaches in Humboldt and Mendocino counties (there is no listed impaired coastline in Del Norte County as of this report). Each of these locations is polluted by indicator bacteria, surrogates used to measure the potential presence of fecal material and pathogens. The source of most indicator bacteria is the feces or other waste of humans and various warm-blooded animals (e.g., birds and mammals). The presence of indicator bacteria in water sources can lead to illness in humans and pets, and contaminate food sources caught or collected from contaminated waters.

Among the many lakes, reservoirs, harbors, and estuaries in the region, eight bodies of water comprising over 63,000 acres are listed as polluted. Three-quarters of them are contaminated by mercury, which increases levels of mercury found in fish species in the region. This can lead to advisories for eating fish caught locally, and interrupt recreation or economic activities related to fishing.

A more in-depth review of the pollution sources and levels can be viewed on the map. Impaired water bodies can disproportionately impact tribal or low-income communities who may depend on the fish and wildlife in local water bodies and may become ill from the catching, processing, or consuming of foods from these locations; additionally, culturally important locations may be impacted by pollutants and mitigate the visitation or cultural practices that happen near water bodies. Other impacts may result from reduced economic value due to less visitation, mandated restrictions, or advisories due to public health concerns.

Impaired groundwater can also affect drinking water and soil and lead to adverse health impacts. The State Water Resources Control Board (SWRCB) hosts a GeoTracker Database that oversees and tracks projects at cleanup sites that can impact groundwater, and hosts the California Integrated Water Quality System Project which tracks information about environmental impacts, manages permits, tracks inspections, and manages enforcement activities. Fig. 15 and the associated interactive map link in the caption can provide more detailed information on each site.

Figure 15 Groundwater Threats



Source: CalEnviroScreen Indicator Maps: Groundwater Threats, requested July 2023. For an interactive version of this map, visit this link.

There are approximately 270 locations across the region that have led to common soil and groundwater pollutants being leaked and threatening the safety of drinking water or exposing people to contaminated soil and air. Of these sites, 30% are land disposal sites, 40% are Cleanup Program sites, and the remaining sites are Leaking Underground Storage Tanks (LUSTs) and military cleanup sites. Common groundwater pollutants are gasoline and diesel fuels at gas stations, as well as substances like pesticides or heavy metals that are leaked from landfills or burn sites. Land and groundwater that has been contaminated can take years or decades to clean up. This can lead to water shut-offs, mandatory bottled water deliveries to impacted communities, and public health concerns if exposure goes undetected.

Hazardous and Toxic Waste

Rural regions tend to have fewer hazardous waste storage facilities and generators than more urban regions where material produced by factories and businesses is more commonplace. Still, 120 locations produce hazardous waste and one permitted storage facility in the Redwood Coast region.

Data Source and Methodology

Data is from the CalEnviroScreen Indicator Maps and was requested by Sierra Business Council in July 2023. Individual Indicator Maps are not available to the public as of the writing of this report.

CalEnviroScreen 4.0 Indicator Map for Hazardous Waste Generators and Facilities is from the EnviroStar Hazardous Waste Facilities Database and Hazardous Waste Tracking System maintained by the Department of Toxic Substances Control (DTSC).

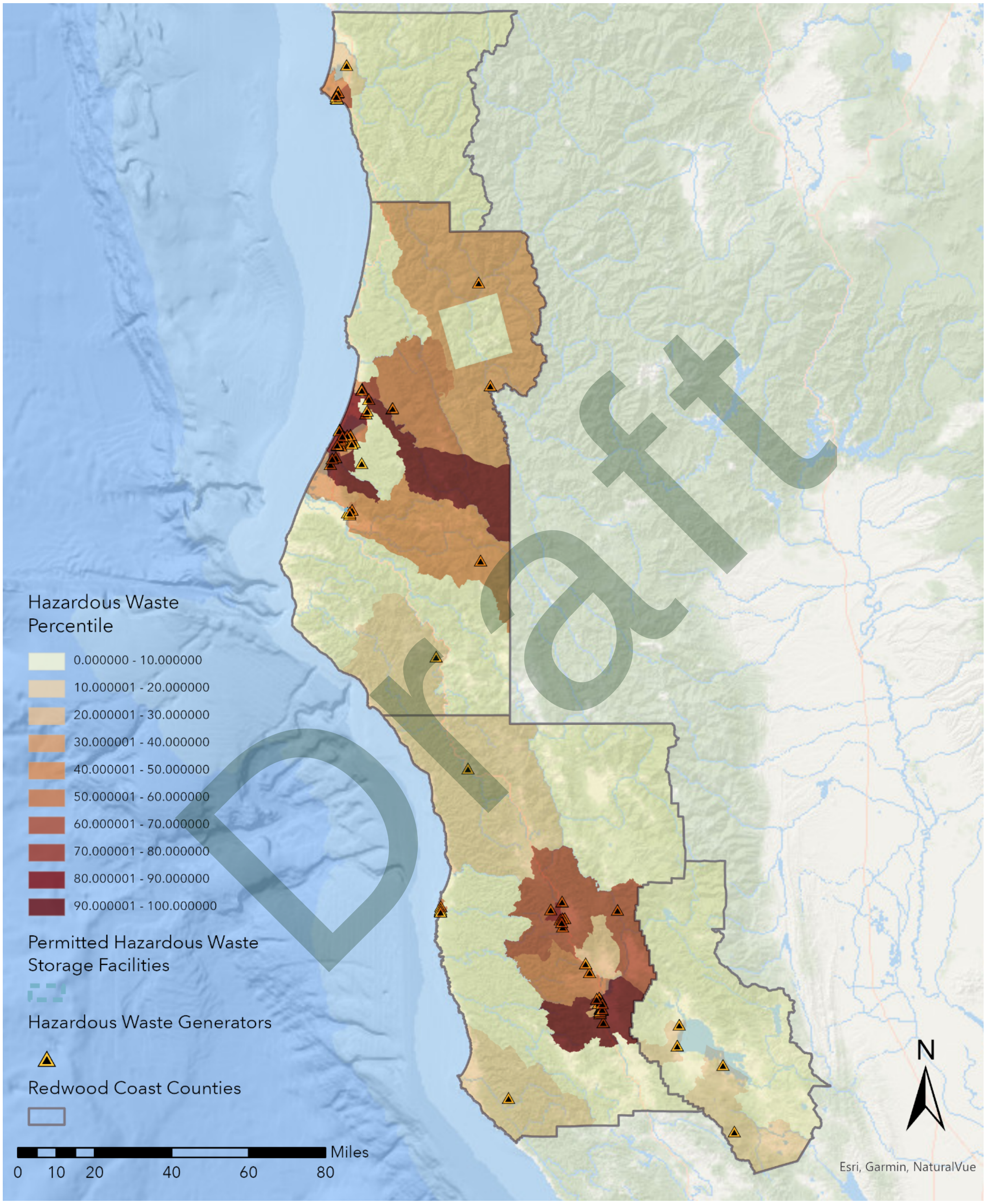
CalEnviroScreen 4.0 Indicator Map for Cleanup Sites is from the EnviroStar Cleanup Sites Database maintained by the Department of Toxic Substances Control (DTSC). Data on the Superfund Sites comes from the Region 9 NPL Sites (Superfund Sites) Polygons (2021 Draft Data), managed by the US Environmental Protection Agency, Region 9.

The data provided to Sierra Business Council is from 2018–2020 and was downloaded by CalEnviroScreen in 2021 for inclusion in the CalEnviroScreen 4.0 Indicator Maps.

Sources of Hazardous and Toxic Waste

Across the region, there are 120 hazardous waste generators. Just over 15% of these generators are drug stores and supermarkets like Rite Aid, Safeway, and Walmart. These locations are considered hazardous waste generators due to the pharmaceutical waste they produce, as well as the products they sell like pesticides, bleach, paint, and aerosols; these products must be delivered to a person or facility authorized to manage hazardous waste. Other hazardous waste generators in the region are Pacific Gas and Electric, forest products companies, and health care facilities.

Figure 16 Hazardous Waste Generators and Storage Facilities



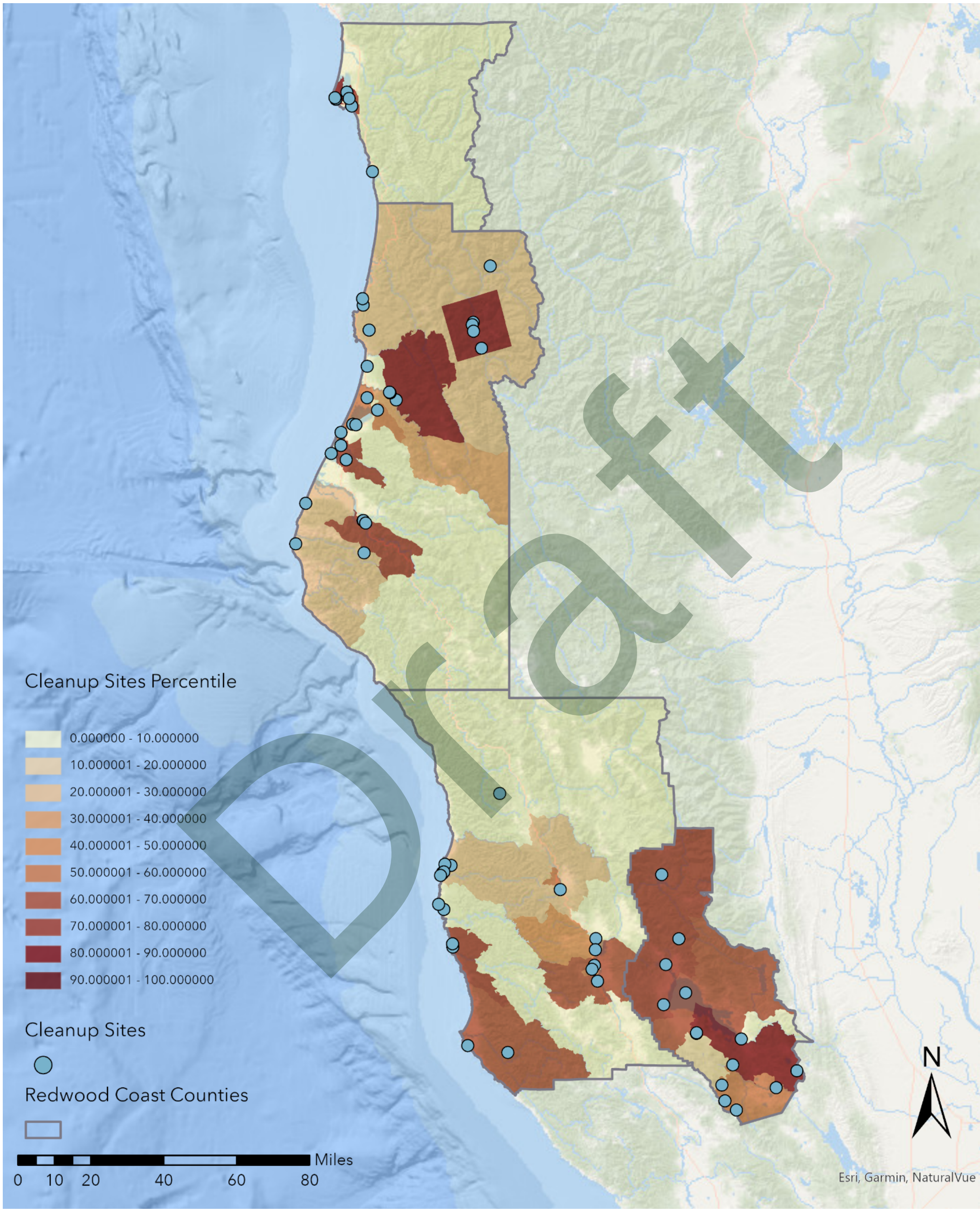
Source: CalEnviroScreen Indicator Maps: Hazardous Waste, requested July 2023. For an interactive version of this map, visit this link.

Notably, hazardous and toxic waste related to disasters like wildfires can lead to exposure to emergency personnel, the public, the environment, and restoration workers. Mendocino and Lake counties have hazardous waste generator locations affiliated with the 2020 August Complex Fire (2020), the Redwood Valley Fire (2017), and the Mendocino Complex Fire (2018).

Within the region, there is only one permitted hazardous waste storage facility, located in the City of Fortuna in Humboldt County. It is located in a census tract with 4,606 people.

When a site has had mismanagement of hazardous materials or accidental spills or leaks of dangerous chemicals, a site is deemed a Cleanup Site by the Department of Toxic Substances Control and requires cleanup by property owners or government agencies. Within the region, there are 74 listed Cleanup Sites, with seven qualifying as Federal Superfund Sites. 21 sites are under Military evaluation, 12 that require state response, and 15 that are voluntary cleanup sites. As of the writing of this report, 13 sites are listed as inactive, and 24 require no further action. When no further action is required, the site has been deemed safe with no more potential hazards related to the hazardous chemicals.

Figure 17 Cleanup Sites



Source: CalEnviroScreen Indicator Maps: CleanupSites, requested July 2023. For an interactive version of this map, visit this link.

Hazardous Waste Impacts on Disinvested Communities

These sites are potentially dangerous for humans and wildlife to be exposed to. As with other hazardous waste sites, the waste at cleanup sites can move through air or groundwater, potentially exposing more people to harm. People living near these sites are at higher risk of exposure.

In general, Cleanup Sites are typically located near poorer neighborhoods. Within the region, there are only eight sites that are located in a census tract with a median household income above the national median of $69,000.

Climate Impacts on Regional Economies

The abundance of natural resources in the region was the foundation of economic growth for the Redwood Coast. Extensive logging in the region depleted much of the forested regions, but the ecosystems have proved resilient and are still home to some of the highest-quality habitats for wildlife in California. The extraction industries have declined, and today government and social services employ the majority of workers in the region. Visitation to the region has increased, and the service industry has grown. Despite the abundance of natural resources and natural beauty of the region, the Redwood Coast is weaker than most coastal regions in California.

Across the region, the economic drivers will be impacted by varying climate hazards. Rising temperatures will impact agriculture productivity and rising surface water temperatures will lead to tourism impacts due to harmful algae blooms, and endangered fish populations will reduce fishing opportunities. Changing precipitation patterns will likely result in longer dry spells and extreme precipitation events which will lead to water shortages for crops and pasture land, and severe storms lead to flooding, infrastructure damage, and ruined agricultural lands.

Increasing wildfire risk and recent wildfire activity in the region have caused economic losses in the agriculture industry and can threaten the historic Redwood forests along the inland boundary of the region.

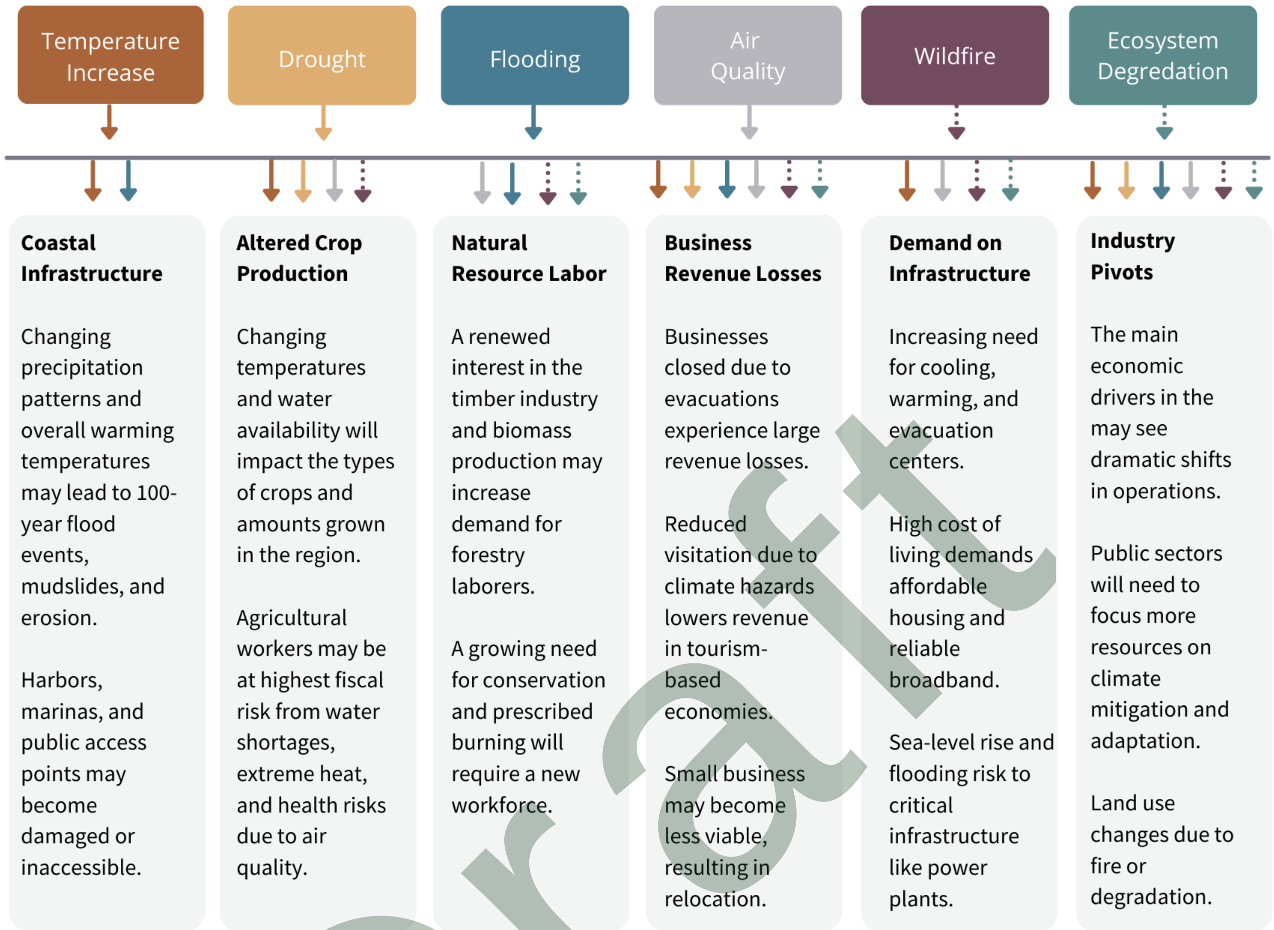
Sea-level rise in Humboldt Bay could lead to flooding and erosion which would lead to severe infrastructure damage and could cause public health concerns. Sea-level rise projections indicate that communities around Humboldt Bay could become inundated, not only displacing residents and causing personal financial injury, but may also lead to lowered home values, a reduced tax base, and more poverty in the region. Public infrastructure like roads, water pipes, electricity towers, and wastewater treatment plants are within the inundation zone.

Examples of how climate change can impact the targeted industries in the region include:

1. Allied Health and Caregiving: an increased need to accessible healthcare during extreme events like wildfire and flooding that can have disproportionate impacts on aging populations and outdoor workers.
2. Working Lands and Blue Economy: the output of natural resources, crops, and ranching may be impacted by changing temperature and precipitation patterns and at risk from wildfire or heavy precipitation events. As sea level rise increases, maritime activities, fishing and harvesting, and ocean transportation may be impacted and need to pivot based on emerging needs and outcomes.
3. Arts, Culture, and Tourism: extreme climate patterns can lead to ecosystem degradation and negatively impact culturally important landmarks, sites, and infrastructure leading to spiritual, cultural, and economic losses. Extreme weather events like flooding, impacted air quality from wildfire, and wildfire can decrease visitation numbers and lead to economic losses.
4. Renewable and Resilient Energy: increased need for building cooling, and reliable energy sources during heat waves, wildfires, and storms will increase with climate change impacts. Mitigating greenhouse gas emissions due to building energy will be a key strategy in decreasing the state's emissions. This sector could prove to have high demand as climate change impacts accelerate in the future.

Some ways the current economic drivers in the region may be impacted by climate change are shown in Figure 18.

Figure 18 Climate Impacts on Regional Economies



Appendices

Appendix A: Climate Projections

Cal Adapt Data Methods

All Cal-Adapt climate indicators will be analyzed for three different time periods

1. Observed Historical (1990–2004)
2. Near Future (2025–2039) under RCP 8.5
3. Mid Future (2040–2054) under RCP 8.5

Steps:

1. Go to the Cal-Adapt Tools webpage
2. Instructions by Climate Indicators:
   a. Extreme Heat Days
      i. Change Location to the correct County
      ii. Select Climate Variable: Extreme Heat Days
      iii. Select Indicator: Frequency
      iv. Select Scenario: High (RCP 8.5)
      v. Set Threshold: 98th Percentile
      vi. Select Models: 4 auto-selected models
      vii. Record the threshold temperature
      viii. Baseline Box -> Change Period
         1. Click Observed Historical (not MODELED DATA)
         2. Custom year range 1990 – 2004
         3. Record 15 year average
      ix. Mid-Century Box -> Change Period
         1. Custom year range: 2025 – 2039
         2. Record 15 year average
      x. End-Century Box -> Change Period
         1. Custom year range: 2040 – 2054
         2. Record 15 year average
   b. Warm Nights
      i. Change Location to the correct County
      ii. Select Climate Variable: Warm Nights
      iii. Select Indicator: Frequency
      iv. Select Scenario: High (RCP 8.5)
      v. Set Threshold: 98th Percentile
      vi. Select Models: 4 auto-selected models
      vii. Record the threshold temperature in the Warm Night row in spreadsheet
      viii. Baseline Box -> Change Period
         1. Click Observed Historical (not MODELED DATA)
         2. Custom year range 1990 – 2004
         3. Record 15 year average
      ix. Mid-Century Box -> Change Period
         1. Custom year range: 2025 – 2039
         2. Record 15 year average
      x. End-Century Box -> Change Period
         1. Custom year range: 2040 – 2054
         2. Record 15 year average
   c. SWE/Snowpack
      i. Click the Chart Tab at the top (the Map is cool, but not helpful for us)

    ii. Change Location to the correct County
    iii. Select Scenario: High (RCP 8.5)
    iv. Select Month: April (this tells us how much water we will get from spring snow melt)
    v. Select Models: 4 auto-selected models
    vi. Baseline Box -> Change Period
        1. Click Observed Historical (not MODELED DATA)
        2. Custom year range 1990 – 2004
        3. Record 15 year average
    vii. Mid-Century Box -> Change Period
        1. Custom year range: 2025 – 2039
        2. Record 15 year average
    viii. End-Century Box -> Change Period

d. [Wildfire]
    i. Click the Chart Tab at the top (the Map is cool, but not helpful for us)
    ii. Change Location to the correct County
    iii. Select indicator: Area Burned
    iv. Select Scenario: High (RCP 8.5)
    v. Select Simulation: Annually
    vi. Select Models: 4 auto-selected models
    vii. Baseline Box -> Change Period
        1. THIS INDICATOR DOES NOT HAVE HISTORICAL RECORD, used modeled historical
        2. Custom year range 1990 – 2004
        3. Record 15 year average
    viii. Mid-Century Box -> Change Period
        1. Custom year range: 2025 – 2039
        2. Record 15 year average
    ix. End-Century Box -> Change Period

e. [Average Precipitation]
    i. Change Location to the correct County
    ii. Select Climate Variable: Precipitation
    iii. Select Scenario: High (RCP 8.5)
    iv. Select Models: 4 auto-selected models
    v. Baseline Box -> Change Period
        1. Click Observed Historical (not MODELED DATA)
        2. Custom year range 1990 – 2004
        3. Record 15 year average
    vi. Mid-Century Box -> Change Period
        1. Custom year range: 2025 – 2039

            2. Record 15 year average
      vii. End-Century Box -> Change Period
            1. Custom year range: 2040 – 2054
            2. Record 15 year average

Climate Engine Data Methods

Steps:

1. Go to the Climate Engine app
    a. Make Graph tab
2. Time Series Calculation:
    a. Native Time Series
    b. Two variable
3. Region:
    a. Custom Polygon from Table -> click Show US counties example
    b. Pick a county! Drop-down menu appears
4. Variable 1
    a. Type: Climate & Hydrology
    b. Dataset: PRISM - 4km - Monthly
    c. Variable: Precipitation (PPT)
        i. Units: Inches
    d. Scale: 4000m
    e. Statistic: Mean
5. Time Period: Custom
    a. Jan 1960
    b. May 2023
6. Variable 2
    a. Type: Climate & Hydrology
    b. Dataset: PRISM - 4km - Monthly
    c. Variable: Maximum temperature
        i. Units: deg F
    d. Scale: 4000m
    e. Statistic: Maximum
7. Time Period: Custom
    a. Jan 1960
    b. May 2023

Appendix B: Greenhouse Gas Emissions

Redwood Coast Greenhouse Gas Inventories

The following inventory was available for one county. Inventories that were greater than five years old were normalized to reflect 2020 emissions estimates.

Humboldt County, 2015

Scaling GHG Emissions Methodology

For emissions data from GHGi from 5+ years ago, the data was scaled to 2020 using demographic and emissions trends. Note that this process was used as a means of estimation and has a high margin of error.

For emissions trends, percent change [(final value - initial value) / initial value] in California statewide emissions between the GHGi year and 2020 was calculated. Emissions trends data was acquired from the California Air Resources Board (CARB), linked here. For transportation emissions, CARB's transportation parameter was used. For residential and non-residential emissions, CARB's electric power generation parameter was used.

For demographic trends, the percent change in employment and population data between the GHGi year and 2020 was calculated. Residential energy was normalized using population by county, based on Census data. Non-residential energy was normalized using the number employed by the county, based on labor market information from the California Employment Development Department. Transportation emissions were normalized using service population, the sum of each county's population, and the number employed.

To scale the GHGi data to 2020, the following formula was used for each of the three sectors (residential energy, non-residential energy, and transportation): unscaled emissions * (1 + % change in emissions) * (1 + % change in demographics). Estimated total emissions were calculated by finding the sum of the three sectors.

Below is a walkthrough of the calculations for Alpine County, starting with the initial emissions data from their 2014 GHGi.

Data Year	Residential Energy	Non-Res Energy	Transportation	Solid Waste	Potable/Wastewater	Total Emissions
2014	4972	4156	31442	357	285	41212

First, find the percent change in emissions between 2014 and 2020 using CARB Emission Trends.

Sector	2014	2020	% change ('14-'20)
Transportation	157.7	135.8	(135.8-157.7) / 157.7 = -13.89%
Electric Power Generation (Res & Non-res)	89.8	59.5	-33.74%

Then, find the percent change in county-specific demographics – population, employment, and service population – between 2014 and 2020.

Demographic	2014	2020	% change ('14-'20)
Population (Res)	1083	1119	3.32%
Employment (Non-res)	470	460	-2.13%
Service Population (Transportation)	1553	1579	1.67%

Lastly, scale the GHGi data to 2020 using both emission trends and demographic changes:

Estimated Year	Residential Energy	Non-Res Energy	Transportation	Solid Waste	Potable/ Wastewater	Total Emissions
2020	(4972 * (1 + [-33.74%]) * (1 + 3.32%) = 3404	2695	27529	x	x	33628

Appendix C: Air Pollution

1. Go to CARB Emission by County Tool
2. Click on County Name
3. Copy and Paste the table into the spreadsheet tab for each county
4. For each air pollutant source, sum across all county tabs to get a regional total
    a. For example, all counties have air pollution under Mobile Sources from Light Duty Passenger vehicles. The tons per day for each ccriterionair pollutant is summed so the ROG presented in the final table is the total amount emitted by Light Duty Passenger vehicles for the region.