

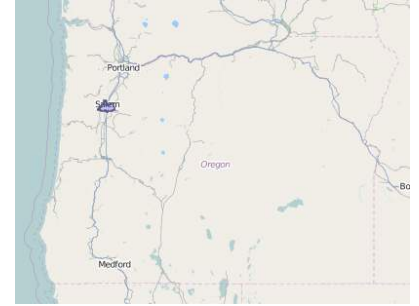
Southern Oregon Climate Action Now

**SOCAN**

Confronting Climate Change

## Climate Change in the Oregon 10th Senate District

May 2023



### History, Projections, and Consequences

1. The temperature has risen some 1°F during the last half of the 20th Century and may rise 8°F by the end of the 21<sup>st</sup> Century.
2. While precipitation has been steady and is likely to remain so annually, wetter winters and drier summers are likely.
3. The trend of declining snowfall will continue through the century, possibly dropping to 10% of historic levels by 2100.
4. These precipitation projections, combined with the trend towards increasing heavy rainfall and reducing light rainfall will likely increase flooding and compromise irrigation availability in those months when it is most needed.
5. Several important forest species both commercially and in terms of forest composition will likely be compromised as climate change overtakes the district.
6. The western wildfire season is already 105 days longer than in the 1970s, while reduced snowpack, warmer summers and earlier snowmelt will increase wildfire risk, with 200 – 300% of the area burned by mid-century.
7. Agricultural activities such as wine growing that depend on temperature and water are likely to be threatened through the century.
8. As sea levels rise, increased urban storm damage and destruction will be probable in addition to the loss of beaches and coastal wetlands.
9. Those engaged in agriculture, forestry or fisheries will be most affected by the forthcoming climate trends, will need most to adapt, and probably should be most supportive of mitigation efforts.
10. The main climate impacts are likely to be: storms, floods, and sea level rise. The main health concerns will be: disruption in core services, injuries, displacement, landslides, income loss, economic instability, and mental health impacts. Vulnerable communities will be: low-income households, older adults, people living on steep slopes, farmers of fish and shellfish, first responders, and children and pregnant women.
11. To achieve required emissions reduction goals, we need to reduce emissions 45% below 2010 levels by 2030; this requires immediate action!

Compiled by Brianne Foster & Alan Journet ([fosterb2@sou.edu](mailto:fosterb2@sou.edu), 971-404-6181) ([alanjournet@gmail.com](mailto:alanjournet@gmail.com), 541-301-4107)  
November, 2014

Updated by Hogan Sherrow ([hogan@you-evolving.com](mailto:hogan@you-evolving.com), 541-415-1013)

For more information on these points, see the full summary at: <http://socan.eco/oregon-legislative-districts/>

We invite copying of these materials, but request that authorship together with the SOCAN logo and attribution be retained.

## **Oregon Senate District 10 Climate Summary**

If you have any queries regarding this summary, please contact Alan Journet [alan@socan.eco](mailto:alan@socan.eco) (541-301-4107 or 541-500-2331).

**We invite copying of these materials, but request that authorship together with the SOCAN logo and attribution be retained.**



## Climate Change in the Oregon 10<sup>th</sup> Senate District

Compiled by Brianne Foster & Alan Journet

([fosterb2@sou.edu](mailto:fosterb2@sou.edu), 971-404-6181)

([alanjournet@gmail.com](mailto:alanjournet@gmail.com), 541-301-4107)

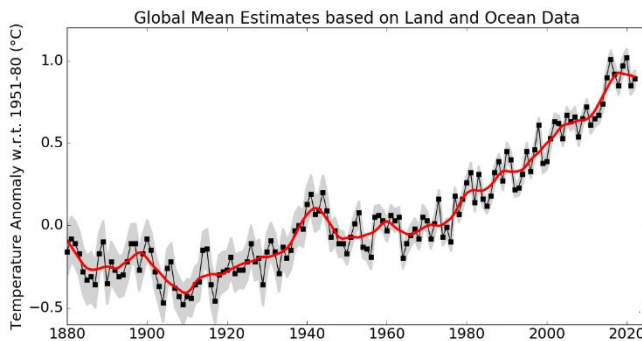
July, 2017

Updated by Hogan M. Sherrow

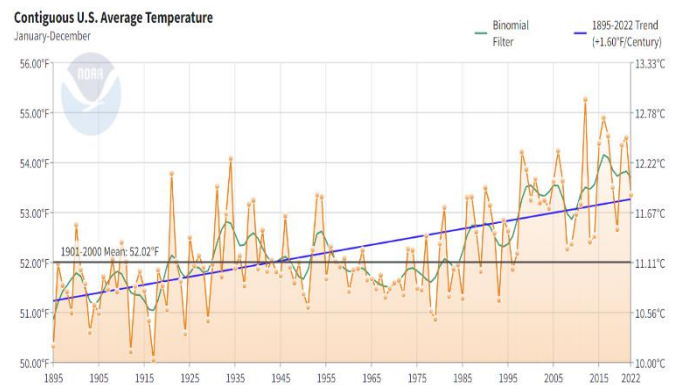
([hogan@you-evolving.com](mailto:hogan@you-evolving.com), 541-415-1013)

May, 2023

### ***Global and Regional Temperature:***



**Figure 1.** Historic global temperature trend (NASA 2023).

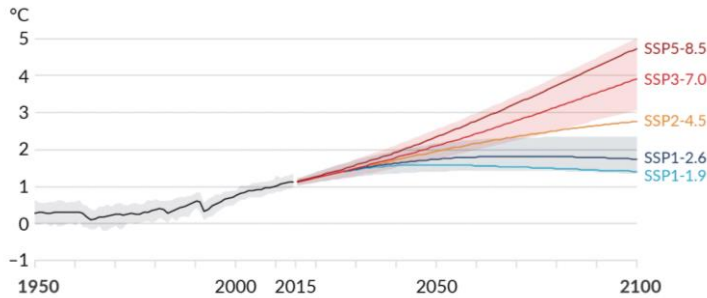


**Figure 2.** Historic U.S temperature trend. (NOAA 2023).

Data from NASA and NOAA reveal that the Global and U.S. atmospheric temperatures have increased substantially since 1880 (Figures 1 and 2) with the greatest effect occurring in the last five decades.

Global temperature projections to 2100 provided by the Intergovernmental Panel on Climate Change (IPCC 2021) Assessment Report 6 (Figure 3) were based on Shared Socioeconomic Pathways (SSPs). Discussed by Hausfather (2018), these pathways represent an advance over the Representative Concentration Pathways (RCPs) previously employed by the IPCC in that

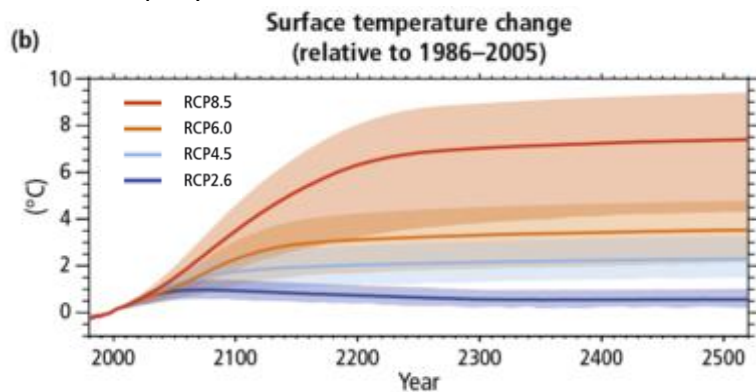
## Oregon Senate District 10 Climate Summary



**Figure 3.** Global temperature projections to 2100 relative to the 1850-1900 average. (IPCC 2021).

they include characterization of the human behavior that leads to specific projected atmospheric greenhouse gas concentrations. The SSP5-8.5 pathway incorporates a: “push for economic and social development ... coupled with the exploitation of abundant fossil fuel resources and the adoption of resource and energy intensive lifestyles around the world.” Effectively this seems to echo the RCP8.5 projections employed in the previous IPCC report and is the trajectory we are currently following globally. This scenario would likely result in global temperatures in the range of 3 to 5.1°C (5.4 to 9.18°F) above pre-industrial revolution temperatures by 2100 (Figure 3).

Meanwhile, projections further into the future have been provided by the Intergovernmental Panel on Climate Change (IPCC) in terms of RCP scenarios (Figure 4) The RCP 2.6 scenario assumes we rapidly eliminate emissions, whereas RCP 8.5 assumes we follow the current



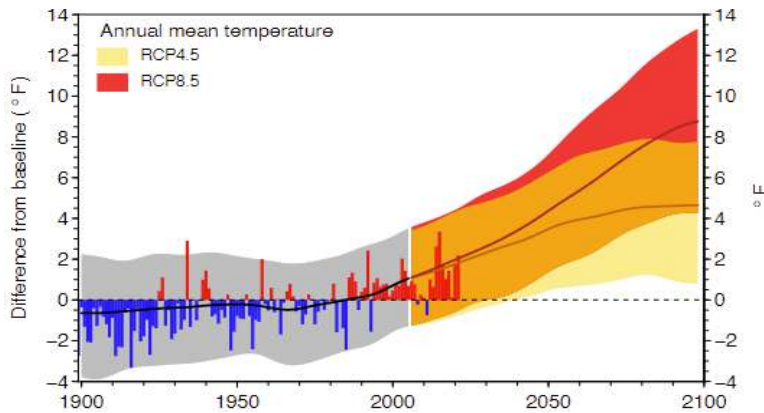
**Figure 4.** Long term global temperature trends according to RCP values. (Jones 2017).

trajectory of accelerating emissions. RCP 6.0 and 4.5 assume intermediate trajectories of emissions between the extremes. Note that only the RCP2.6 scenario results in a long-term global temperature increase below 2°C above pre-industrial conditions - the upper target for the 2015 Paris Agreement. Because the actual temperature trajectory we have experienced follows the RCP 8.5 scenario this has been dubbed the Business-As-Usual (BAU) scenario; we have yet to undertake sufficient actions globally to slow this trend.

Meanwhile, temperature projections for this century in Oregon (Fleishman 2023, Figure 5) suggest a similar range of temperature increases possibly reaching over 13°F above the 1970-1999 average by the end of the century under the BAU scenario (RCP 8.5).

Whether we consider the global or Oregon future, the higher range of temperature increase would be unmanageable. It would devastate natural systems (see below:) and simultaneously

## Oregon Senate District 10 Climate Summary

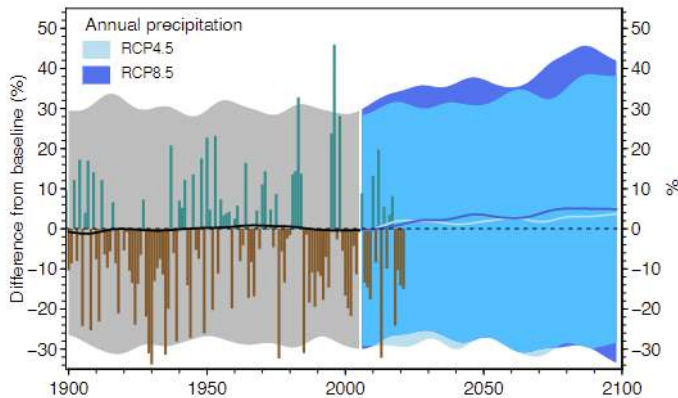


**Figure 5.** Oregon temperature history and projections through the century; baseline: 1970 – 1999 (Fleishman 2023).

threaten our climate dependent agricultural, ranching, and forestry activities. Bark beetle and other pest destruction of forests would likely increase as warmer temperatures enhance insect growth and development rates and enable larger overwintering populations. Similarly, invasion of natural and

agricultural systems by drought tolerant invasive species and pests will likely be enhanced.

### **Regional Precipitation:**



**Figure 6.** History and projections for precipitation statewide. (Fleishman 2023).

Annual precipitation is expected to increase very slightly (if at all) in Oregon through the balance of this century (Figure 6). However, the 2018 US Climate Change Assessment Report (Easterling *et al.* 2017) provides projections for seasonal late century precipitation patterns (Figure 7) according to the ‘business as usual’ RCP 8.5 scenario.

The region generally is expected to exhibit fall and spring seasons that are

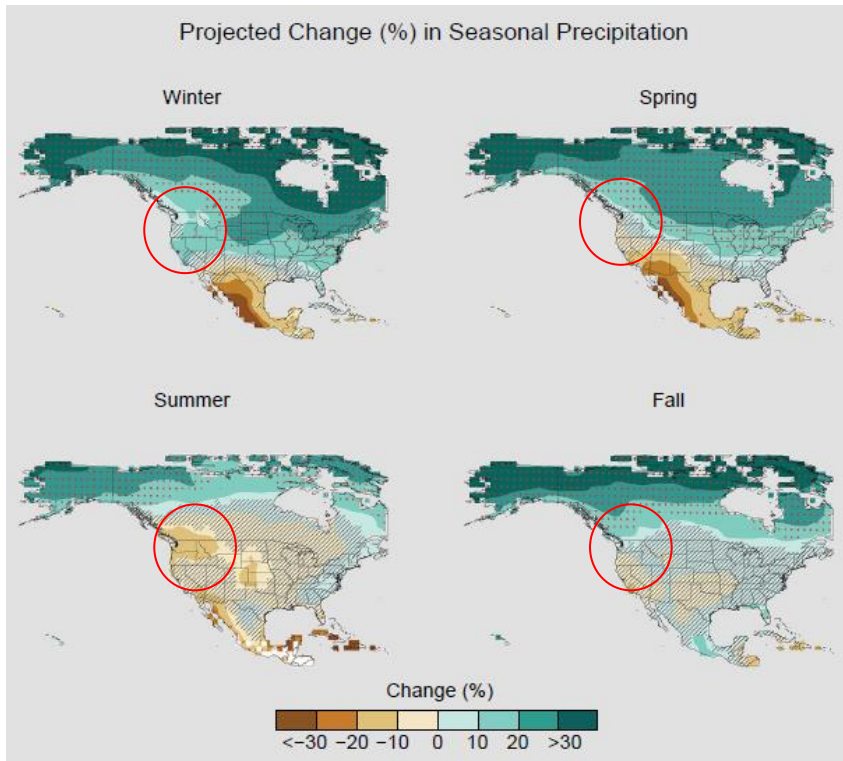
little different from historical patterns, with winters possibly a little wetter. Notably, however, accentuating the Mediterranean ‘winter wet - summer dry’ climate, winters will be wetter, and summers will likely be drier.

This Mediterranean climate exists in just 6 locations across the globe (IUCN undated) and leads to soils and vegetation drying out during summers such that vegetation tends to be fire prone, fire adapted and fire dependent (Safford et al. 2021).

Evaporation caused by increasing temperature will likely counter any increase in precipitation such that drought conditions continue. Water resources, already severely compromised in many locations, will become more threatened as snowpack continues to decline. Meanwhile, the current trend of precipitation occurring more frequently as severe storms rather than the light drizzle that replenishes soil moisture will continue. This will likely increase the risk of floods, soil erosion and landslides.



## Oregon Senate District 10 Climate Summary



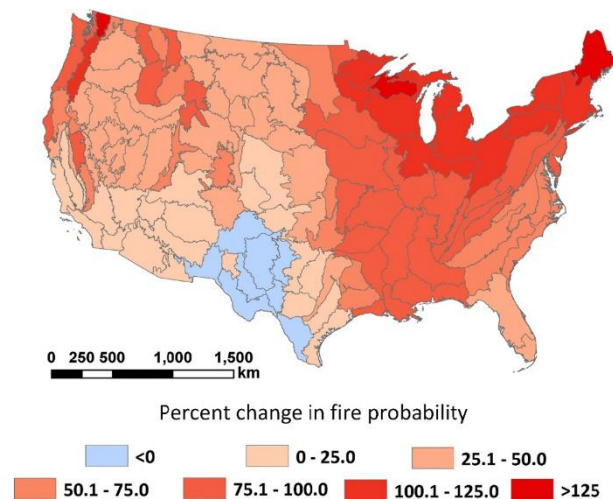
**Figure 7.** Projected change in precipitation to 2077-2090 compared to 1960-2005 average; stippled areas indicate large change compared to natural variation; hatched areas small change. (Easterling *et al.* 2017).

Stream and river flow occurring during summer/fall will decline and become warmer compromising many iconic Pacific Northwest cold-water aquatic species. Meanwhile, peak river flow will continue to advance earlier in the year, even reaching late fall of the previous year.

Gao *et al.* (2021) depicted the increasing risk of fire across the nation (Figure 8) under the RCP 8.5 scenario indicating that this would likely lead to increased fire

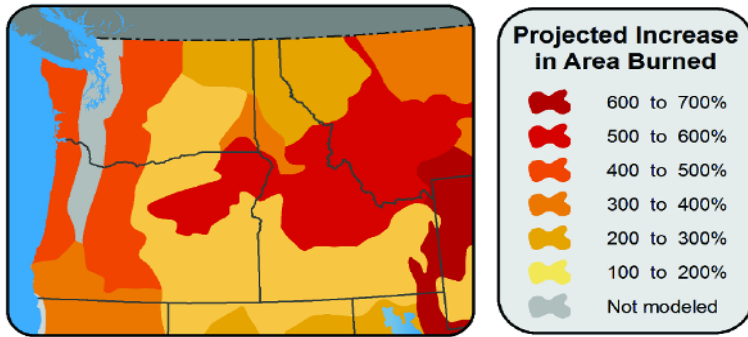
probability throughout most of Oregon of at least 50%.

Several years ago, the national climate assessment, (Melillo *et al.* 2014) reported the impact of increasing temperature of just 2.2°F on area burned from wildfire, a condition potentially arriving by mid-century (Figure 9). The range in increase is from 100% meaning a doubling of the area burned to 700% meaning 8-times the current area.



**Figure 8.** Potential increase in fire risk from the 1971-2000 baseline across the U.S. assuming the RCP 8.5 scenario. (Gao *et al.* 2021).

## Oregon Senate District 10 Climate Summary



**Figure 9.** Anticipated wildfire consequences of a 2.2°F warming in area burned (Mellilo et al. 2014).

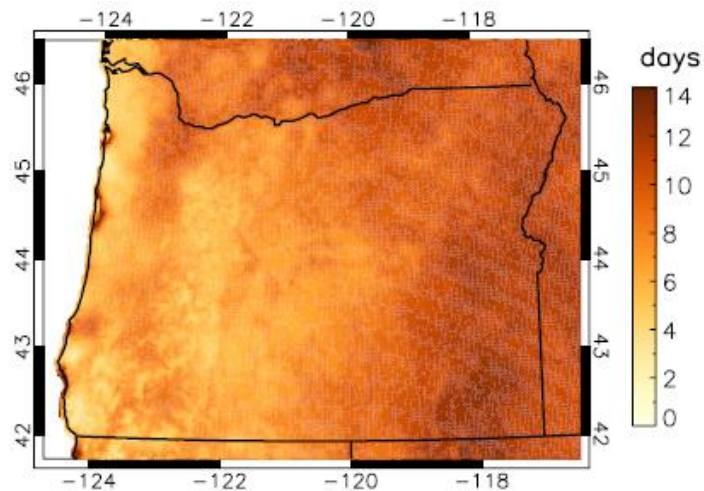
extended by 105 days since 1970s (Kenward et al. 2016), will likely become longer and more severe in Oregon. Even though our natural ecosystems have evolved with fire and are thus fire prone, fire adapted, and fire dependent, future trends may pose a serious threat to ecosystem ongoing health. In addition, of course, both human safety and human health will likely be threatened. . It was recognized long ago (Westerling et al. 2006) that warming and early spring snowmelt correlate with increasing fire risk.

### Natural System Consequences

That the geographic distribution of our natural ecological systems (biomes) is largely determined by the variables of temperature and precipitation (water availability) has been understood for decades. Community ecologist Robert Whittaker (1975) developed a classic chart indicating this relationship (modified in Figure 11). The chart depicts the climatic conditions that allow each of the designated biomes to exist. The critical message is that even a small shift in either of these variables from current conditions may threaten the viability of the biomes and the species of which they are comprised. This will be especially true for biomes currently existing at the edge of the climatic range that they require. It is especially worth comparing these temperature ranges to the potential shifts in Oregon's temperature through the century (Figure 5) from which it is evident that most of our state's precious natural systems will be threatened, and some (especially high-altitude cool climate systems) will likely be eliminated under future conditions. It is worth noting, also, that the same variables control our

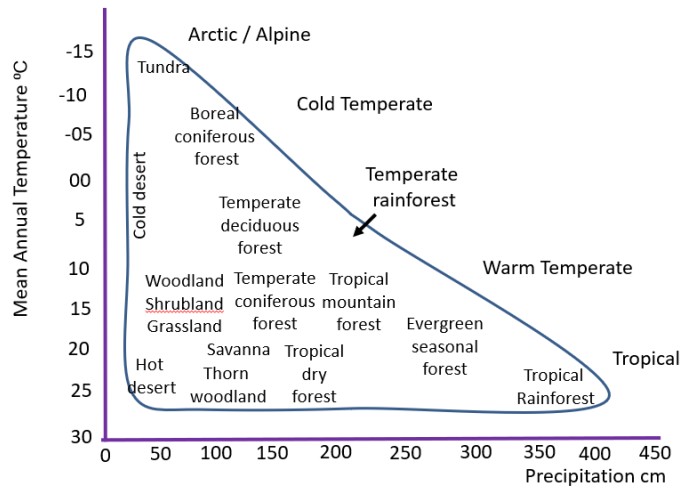
Mote et al. (2019) presented a summary of the potential increase in extreme fire risk days by mid-century (2040 - 2069) compared to historical conditions (1971 - 2000) where an increase of up to 14 days in the SE corner of the state is expected (Figure 10).

The fire season, already



**Figure 10.** Increase in number of days experiencing high fire risk by mid- century (2040 - 2069) compared to the end of the last century (1971-2000). (Mote et al. 2019).

## Oregon Senate District 10 Climate Summary



**Figure 11.** Global distribution of natural ecological systems (biomes) in relation to mean annual temperature and precipitation patterns. (Modified from Whittaker 1975).

projections (Rehfeldt and Crookston 2023), which assess the optimal conditions for tree species on the basis of their current and recent historic range and map these condition into the future, suggest that under the RCP 8.5 scenario, several species will likely suffer range reduction: Douglas fir, Western hemlock, Ponderosa pine, Grand fir, Western larch, Sugar pine, White fir, Pacific madrone, Western juniper, Western redcedar, Tanoak, and California laurel. Meanwhile, by the end of the century, the following species will likely find the Oregon climate completely outside their range (i.e., they will be extirpated from the state): Sitka spruce, Engelmann spruce, Lodgepole pine, Subalpine fir, and Jeffrey pine. Oregonians dependent on commercial timber harvest should be the first to demand climate action in the state.

### **Coastal Concerns:**

Though much of Oregon is land-locked, and will suffer little directly because of ocean consequences, coastal regions and economies will have to contend with warming oceans, sea level rise, and increasing ocean acidification.

**Warming Oceans.** Although there is considerable seasonal fluctuation in ocean temperature, warming of oceans in the Northwest are already documented with a reported and anticipated increase at the rate of 0.35°C per decade (Alexander *et al.* 2018) off the coast of Oregon over the period 1976 - 2099. Besides influencing species directly, temperature changes impact such events as algal blooms and shellfish poisoning.

**Sea Level Rise.** Sea levels are rising and will continue to rise for two reasons: First, water expands as it warms from 4°C (approximately 37°F). Thus, as the ocean warms, it inevitably expands, and sea level inevitably rises. Second, as land borne ice enters the ocean, whether as water or ice, it increases the volume of the ocean. Both these phenomena have already caused sea level to rise and are expected to continue this impact. The impact is influenced by the

agricultural productivity, and clearly, our forest viability. Thus, climatic shifts of the dimensions anticipated, absent any adjustment in our collective behavior that thwarts that trajectory, will likely compromise agriculture and forestry throughout the state. Indeed, Dalton *et al.* (2017) indicate not only that “different trees have varying degrees of sensitivity to climate change and adaptive capacity.” but also that “suitable climates for many important tree species and vegetation types may change considerably by the end of the 21<sup>st</sup> century....” Climate envelope



## Oregon Senate District 10 Climate Summary

pattern of land adjustment: if land is rising, the impact is reduced, whereas subsiding coastal land will exacerbate the impact. This complication is particularly relevant to the impact of the Cascadia Subduction Zone (CSZ) where a rising or falling land tectonic plate will influence apparent and locally detected sea level rise along the coast. The impact of the oceanic Juan de Fuca plate sliding under the continental North American plate is a rising continental plate (Lieberman 2012) apparently confounding the ability of a land-based gauge to detect sea level rise. However, should the earthquake occur, there will likely result a drop in the land level of a meter (3 feet) or so. Mote *et al* (2019), however, indicate that by century's end, the actual sea level rise off the coast of Oregon could plausibly reach 8 feet, a value reiterated in Fleishman (2023). During storm surges, a higher sea level will generate conditions that promote far greater storm damage and flooding than would otherwise have been the case. The impact of Hurricane Sandy in 2012 was a perfect illustration of this problem. Not long ago, the suggestion that New York subways could be flooded by a coastal storm would not have been taken seriously – yet it happened! Results of ocean rise, such as increased erosion and compromised coastal habitat integrity for tidal flat, estuary, and marsh natural communities, could become serious.

**Ocean Chemistry.** Serious as direct climatic consequences are, they do not constitute the sum total of the impacts of our emitting carbon dioxide into the atmosphere.

Because carbon dioxide is absorbed by our oceans, and is transformed into carbonic acid, oceans are becoming more acidic. This is detrimental for marine organisms with carbonate-based shells since either they are unable to form shells in acidic conditions, or they lose shells already established. Bednarsek, *et al.* (2020) demonstrated that ocean acidification off the coast of Oregon is already having a negative effect on Dungeness crab (*Metacarcinus magister*) shell formation and durability. Dungeness crab is one of the most valuable species on the Oregon coast, and the further acidification of our coastal waters could be catastrophic for this population. The losses to the Northwest coast oyster industry, where larvae lose their capacity to form shells, is costing hundreds of thousands of dollars (Ben Achur 2022). Additionally, acidosis, a build-up of acidic conditions in the tissues, threatens many marine life forms.

In addition, warming oceans exhibit reduced oxygen levels, potentially critical for marine animals since, like terrestrial animals, they rely on oxygen for basic metabolic respiration.

These consequences of increasing atmospheric greenhouse gases (notably carbon dioxide) pose threats to marine life, and thus to our fisheries, coastal economies, recreation, and tourism.

### ***Rural vs Urban Oregon:***

Rural communities are typically characterized by local economies and livelihoods that are reliant on direct interactions with the environment through agriculture, timber, fishing or outdoor based tourism activities. Urban communities, by contrast are typically characterized by local economies and livelihoods that are reliant on activities that do not include direct

## **Oregon Senate District 10 Climate Summary**

interactions with the environment. The result is that climate change has a far greater direct effect on rural communities than urban areas, including the direct effects of reduced snowpack, decreased river levels, rising seas, altered growing seasons, extended drought, increasingly hot summers, and increased wildfire risk. This has led to the misconception that urban communities are not vulnerable to the impacts of climate change.

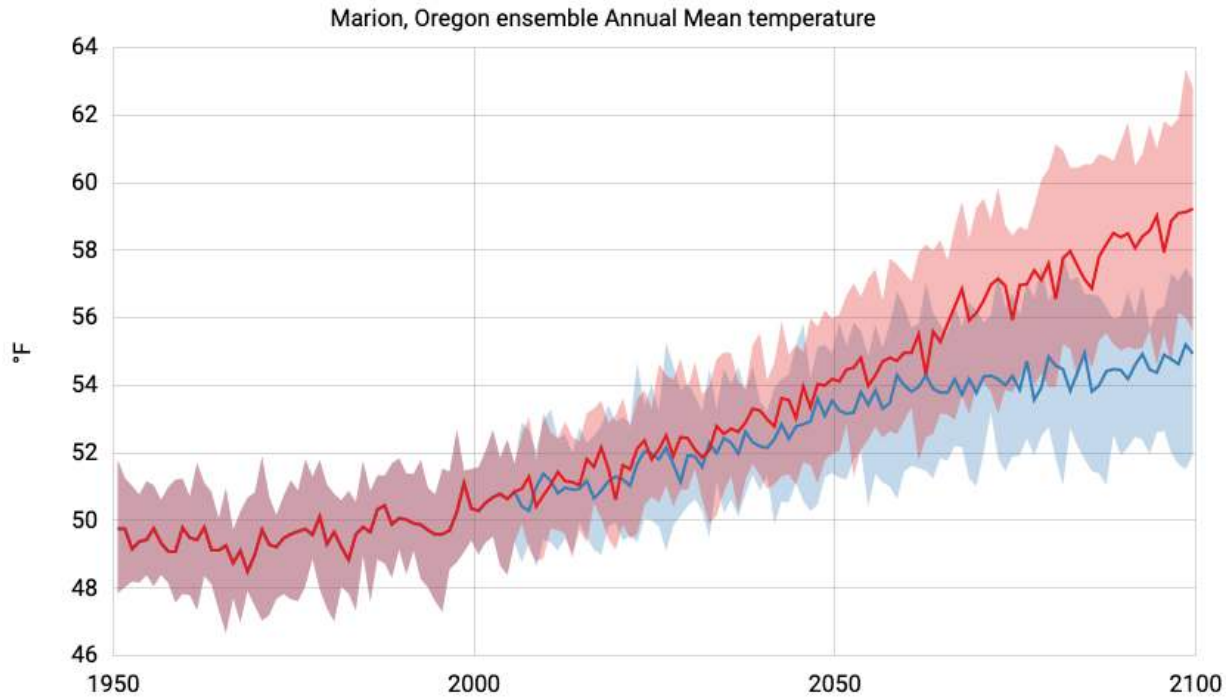
While rural communities are on the frontlines of the climate crisis and some of the most vulnerable communities across Oregon, urban areas are also vulnerable. The heat related deaths in the Portland-metro area in the summer of 2020 and the Labor Day fires later that year demonstrated that urban areas are under direct threat from the impacts of climate change. Beyond the direct impacts of climate change, urban areas rely on healthy rural regions for their water supply, their agricultural, and forestry products and recreational activities in wild and less developed areas. Indirect effects, therefore, can be substantial. Climatic events that compromise natural systems, and thus urban watersheds, and regional agriculture and forestry will also have a profound impact on life in the urban centers. This impact will not be limited to impacts on prices of food and wood products but will also compromise regional recreational opportunities. Additionally, because the Pacific Northwest is projected to suffer less than most of the country from the warming climate, the region will become the target for climate refugees from across the U.S. These migrants will increase our population and place a greater burden on our natural resources and dwindling water supplies.

### ***The 10<sup>th</sup> Oregon Senate District Climate History and Projections:***

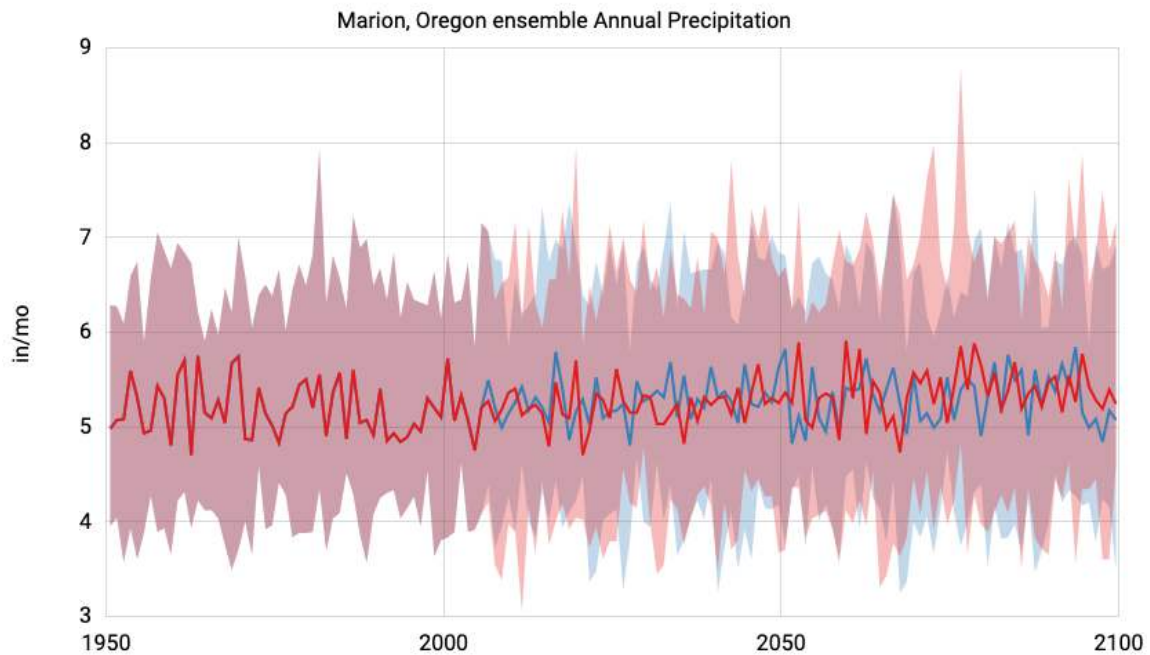
The 10<sup>th</sup> Senate District includes portions of Marion and Polk Counties.

Temperature history and projections for Marion County are presented in Figure 12 as an exemplar which shows historic and projected annual mean temperature (USGS 2021). The red lines represent the 'Business as Usual' scenario of increasing fossil fuel use and consequent emissions, while the blue lines assume that considerable emissions reductions are undertaken. Both maximum and minimum temperatures will likely rise from 4 to 8°F above the 1981-2010 average during the century. The analysis of precipitation in Marion County (Figure 13) indicates a historical flat pattern in that is likely to continue into the future, a pattern reflected in neighboring counties.

## Oregon Senate District 10 Climate Summary

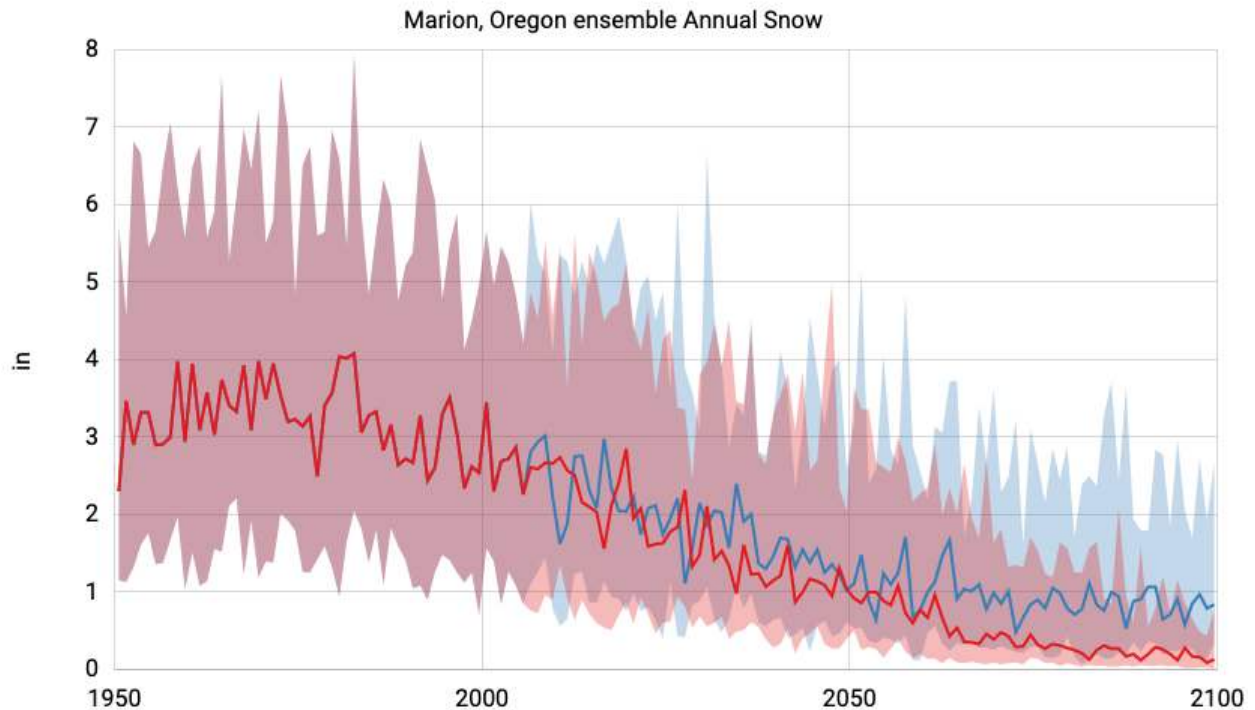


**Figure 12.** Historic and projected mean annual temperature for Marion County, Oregon (USGS, 2021).



**Figure 13.** History and projections for precipitation for Marion County, Oregon (USGS, 2021).

## Oregon Senate District 10 Climate Summary



**Figure 14.** Historic and projected snowfall for Marion County, Oregon (USGS, 2021).

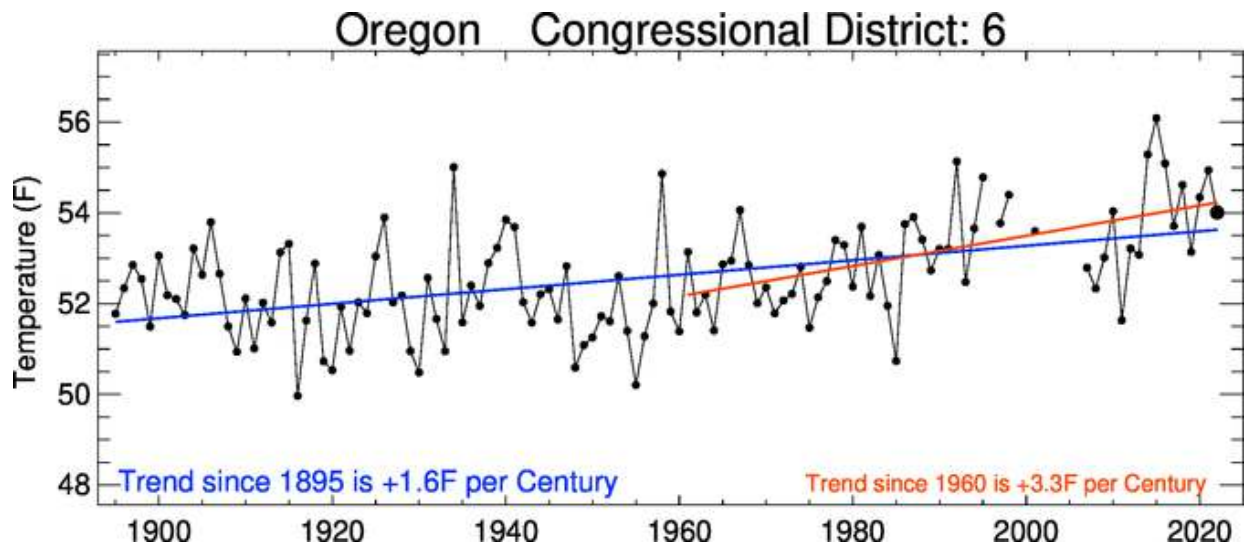
The trend for declining snowfall indicated throughout the state (Dello and Mote 2010, Dalton *et al.* 2013) is also evident in this District (Figure 14) where declining snowfall has been seen since the 1970s, and projections suggest will result in snowfall at some 10% of historical averages by the end of the century if we follow the business as usual scenario, but with a slightly less dramatic drop if we reduce our emissions. The current trend towards precipitation falling in more frequent downpours as opposed to the light rainfalls that rejuvenate soil moisture is also expected to continue meaning the rain that falls will more likely induce floods and soil erosion rather than replenish dry soils.

Unsurprisingly, the climate trends for neighboring Polk county are very similar.

### ***Federal 6<sup>th</sup> Congressional District Historic Temperature Trends***

Oregon's 10th Senate District falls within Oregon's newest Congressional District, CD6. Figure 16 indicates that the 6<sup>th</sup> Congressional District has been warming at a rate of 3.3<sup>0</sup>F per century since 1960. Clearly, this district is not immune from the consequences of climate change.

## Oregon Senate District 10 Climate Summary



*Figure 15. Temperature trend for Federal Congressional District 6 (CCT 2021).*

### ***Oregon's 10th Senate District Economy:***

The local economy of Senate District 10 is made up of agriculture, healthcare, manufacturing and forestry. Agriculture will likely suffer considerably due to climate change. Decreasing supplies of water for irrigation, increasing incidence of pests and disease attacks, and growing competition from weeds threaten local agriculture.

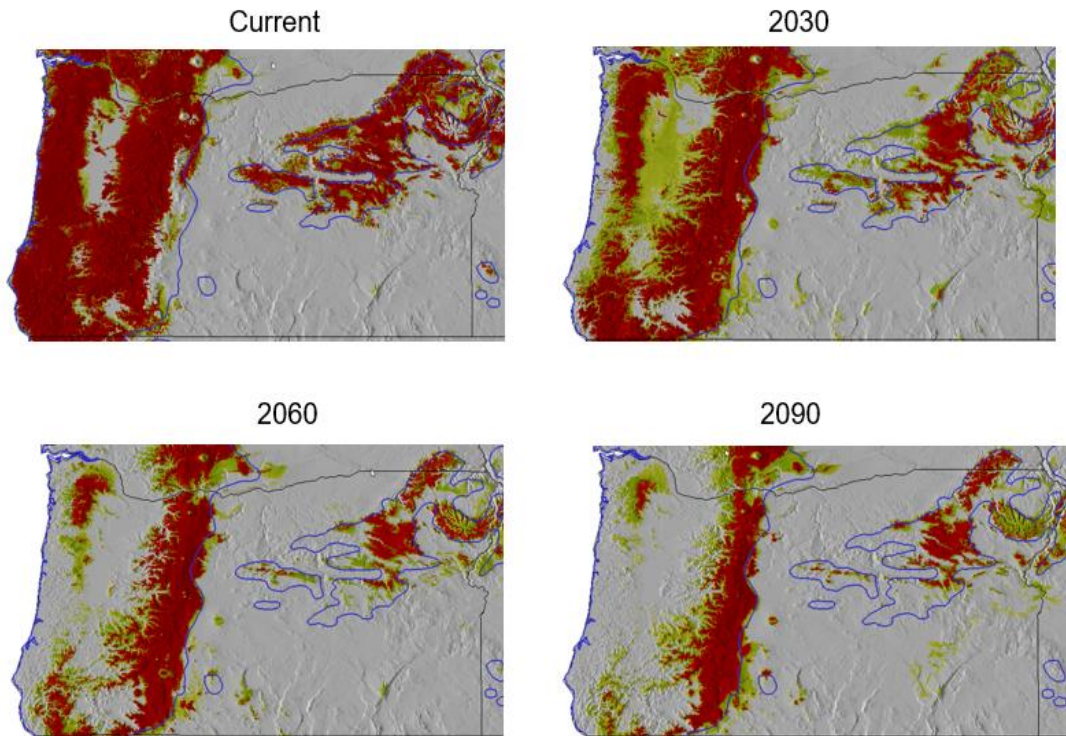
The forest cover consists predominantly of the coniferous species of Douglas Fir, Western and Mountain Hemlock, Western Red Cedar and True Firs (Marion undated). Deciduous species occur to a lesser extent at lower elevations and have only limited commercial value.

Although timber/lumber production has declined it is still a significant component of this district's economy. The current and future climatic range for Douglas fir, Western redcedar and Western hemlock are depicted in Figure 16 – 18. These projections suggest reduced viability in the district through this century for all species (high tree viability is indicated in red, low viability in green and absence in areas without color).

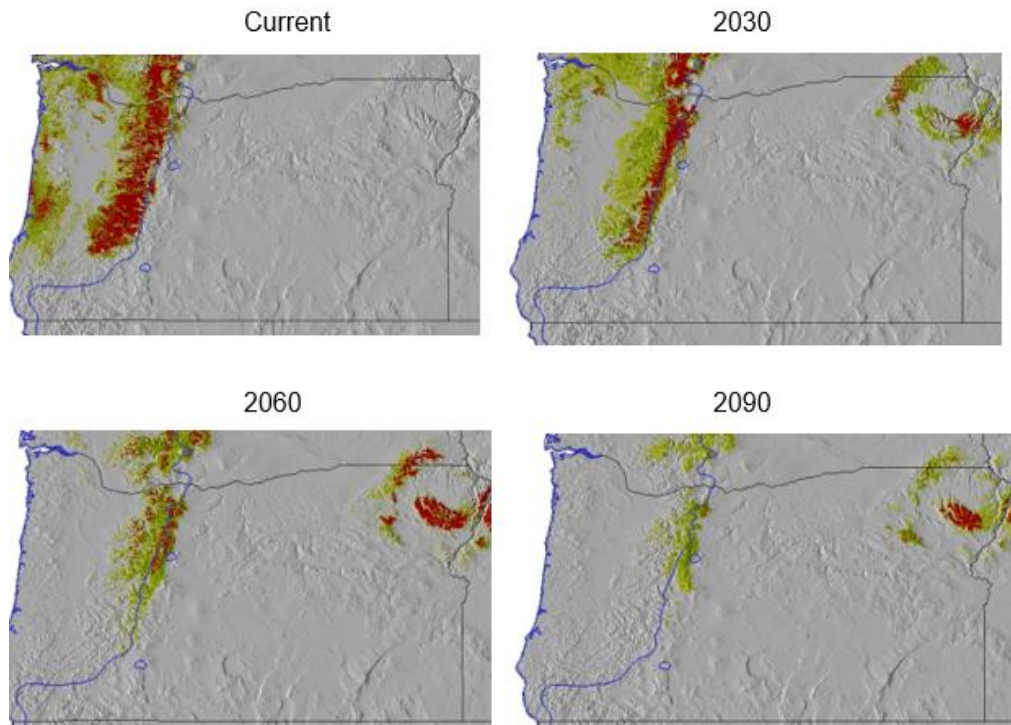
According to Marion County (2015) lumber is one of the principal industries in that county. The following projections for the future viability of commercial tree species should represent a warning to this industry.



## Oregon Senate District 10 Climate Summary

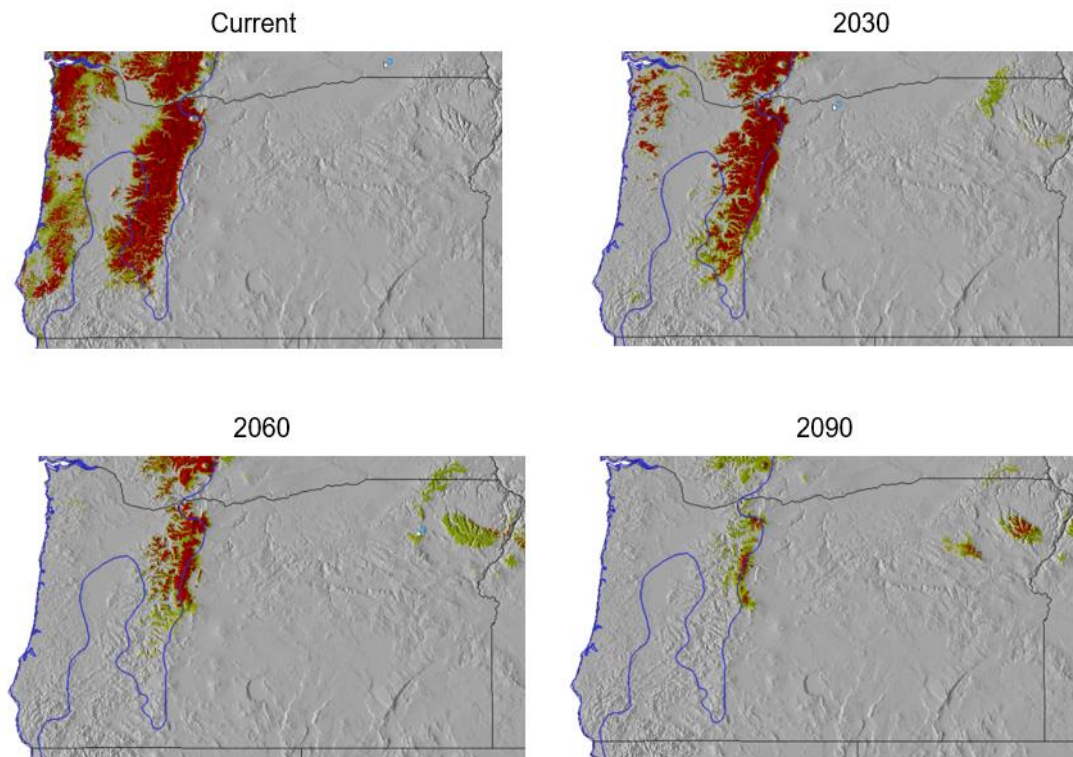


**Figure 16.** Douglas fir (*Psuedotsuga menzeisii*) current and projected distribution through the 21<sup>st</sup> Century (Crookston and Radtke 2023).



**Figure 17.** Western redcedar (*Thuja plicata*) Current and Projected Distribution (Crookston and Radtke 2023).

## Oregon Senate District 10 Climate Summary



**Figure 18.** Western hemlock (*Tsuga heterophylla*) current and projected distribution through the 21<sup>st</sup> Century (Crookston N, Radtke P. 2023).

Given the ability of many Oregon forests to store carbon (Hudiburg *et al.* 2009; Law *et al.* 2018), it is critical that climatic conditions not diverge such that these important species are compromised. Halofsky *et al.* (2016) discuss the potential and disturbing impacts of climate change of SW Oregon's forests.

### **Potential Agricultural Impacts:**

According to Census (2017) Marion County was ranked first in the state in terms of the dollar value of its agricultural products, with nursery, greenhouse, floriculture, and sod the most valuable category. Climate change will affect each of these sectors differently. Orchard-based crops will mature more rapidly in higher temperatures which will affect crop quality and timing to markets, potentially creating a conflict with historic market need. Further shifts to earlier and earlier harvests during warmer summers could both lower the quality of the fruit and shift the competitive environment in which Oregon producers must sell their crop. In addition, unlike parts of California, winter chilling requirements for orchard crops in Oregon appear still to be sufficient. In California, chilling hours during winter have declined by as much as 30% since 1950 in areas of the Central Valley to the point of making some orchard crops non-viable. However, as climates continue to change, similar winter dormancy issues could mean trouble

## Oregon Senate District 10 Climate Summary

for Oregon's perennial crops (Dello and Mote 2010). Additionally, as snowpack decreases in the Cascades, availability of irrigation water could become more restricted as summer heat waves and droughts become more commonplace. The most consistent changes in global climate models show regional warming and drying in the summer. The multi-model average decrease for summer precipitation is 14% by the 2080s. As a result of water use "an estimated 130 kilometers [80 miles] of 2nd to 4th order streams go dry in a moderately dry summer (EPA 2002). For a 1.8°F rise in temperature, irrigation demands are projected to increase by 10% (Dello and Mote, 2010).

Feld crops are planted in soil and climatic conditions to which they are well adapted. This means adjustments from current climate can be detrimental. The agricultural 'one-degree problem' occurs because increasing temperature generally reduces crop yield, in fact for each degree C temperature rise crop yield drops some 5 - 10% (Brown 2006). Meanwhile, the 'business as usual' scenario of increasing greenhouse gas emissions suggests that throughout Oregon the temperature will likely increase 5 or more degrees C with decreasing soil moisture (USGS 2021) posing a great risk of extended drought. Farmers and home gardeners in Oregon should be concerned about a compromised future.

As of 2008, greenhouses, nurseries, and tree farms made up nearly 20% of Oregon's total agricultural market and was valued at more than \$880 million (Dello and Mote 2010). Christmas tree farms constitute a significant commodity within the tree farm industry, being valued at more than \$122 million. Many of the Christmas trees in the region are Grand or Douglas fir which will likely be compromised (see above). Additionally, common varieties such as Noble fir, Fraser fir, Scotch pine, and Norddman fir could become less viable in the region or at least less able to grow in areas where they previously thrived. Other crops such as field (27.42%), seed (11.11%), and fruit and nut crops (9.74%) make up nearly 50% of Oregon's agricultural commodity sector. Common crops within these sectors include grass seed (\$510 million), wheat (\$340 million), pears (\$92 million), cherries (\$56 million), hazelnuts (\$52 million), corn (\$52 million), and blueberries (\$49 million). More locally, Marion county's nursery crop sales reached sales of \$134 million while nursery sales in Yamhill County were \$82 million in 2011 (O'Conner).

Climate change will affect each of these sectors differently. Orchard-based crops will mature more rapidly in higher temperatures affecting crop quality and affect timing to markets, potentially creating a conflict with historic market need. Further shifts to earlier and earlier harvests during warmer summers could both lower the quality of the fruit and shift the competitive environment in which Oregon producers must sell their crop. In addition, winter chilling requirements for orchard crops in Oregon appear to still be sufficient, unlike California. There, chilling hours during winter have declined by as much as 30% since 1950 in areas of the Central Valley to the point of not making some orchard crops viable. However, as climates continue to change, similar winter dormancy issues could mean trouble for Oregon's perennial crops (Dello and Mote, 2010). Additionally, as snowpack decreases in the Cascades, availability

## Oregon Senate District 10 Climate Summary

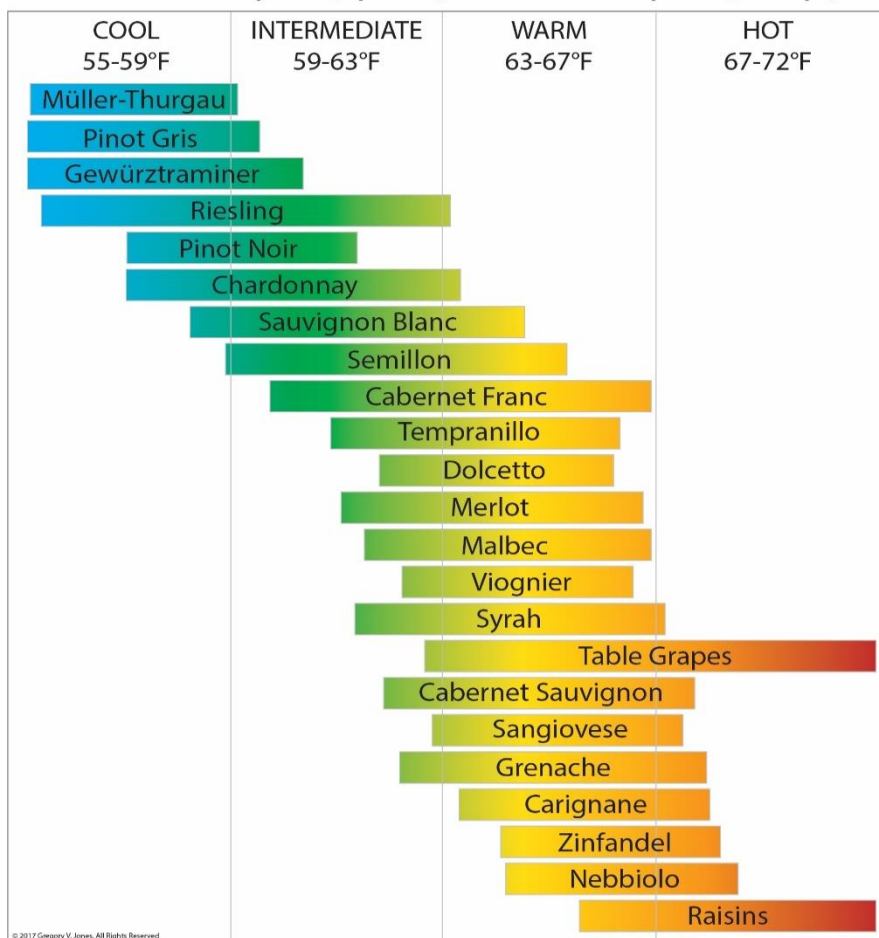
of irrigation water could become more restricted as summer heat waves and droughts become more commonplace. The most consistent changes in global climate models show a regional warming and drying in the summer. The multi-model average decrease for summer precipitation is 14% by the 2080s. For a 1.8°F rise in temperature, irrigation demands are projected to increase by 10% (Dello and Mote, 2010).

Rising temperatures allow both insects and pathogens to develop more rapidly and expand their ranges to regions where they were once not found (See Figure 11 above and discussion). Consequently, climate change is expected to enhance invasion risks from many crop diseases, pests, and weeds. In addition, warmer winter temperatures allow more insects to survive, whereas colder winters once controlled their populations. Changes in climate have the potential to disrupt the natural enemies of some crop pests (beneficial insects), ultimately producing greater overall crop vulnerability.

### AVERAGE GROWING SEASON TEMPERATURES

#### THE RANGE IN THE ABILITY TO RIPEN VARIETIES

Northern Hemisphere (Apr-Oct), Southern Hemisphere (Oct-Apr)



**Figure 19.** Grape varietal optimum growing season temperature (Jones 2015).

Warmer temperatures may also allow for additional generations of insect pests within a single growing season. Models of codling moth populations under baseline conditions and four Global Climate Model (GCM) projections indicate earlier emergence of adults in spring coupled with warmer temperatures in summer would result in most apple-growing locations in Washington State experiencing a complete third generation hatch. These results suggest additional costs to apple growers from additional pheromone and sprays per season (Dello and Mote, 2010).



## Oregon Senate District 10 Climate Summary

Much of the region's tourism is connected to the Mid and North Willamette Valley's thriving wine industry. The Willamette Valley is home to two thirds of the state's wineries and is notable for its Pinot Noir varietal (Willamette Valley Wine 2023). Statewide, the wine industry was the 11<sup>th</sup> largest agricultural sector, valued at more than \$71 million in 2008 (Dello and Mote 2010). Figure 19 indicates the optimum growing season temperature ranges for each major grape varietal. All the locally important varietals will be affected by projected temperature changes, but over the course of this century, they are likely to remain viable. However, of the listed varieties, Pinot Noir, due to its narrow temperature niche for optimum quality, is the most vulnerable. If there are further increases in temperature, vineyards will likely need to move much of current acreage planted in the Willamette Valley outside of what is currently considered suitable for Pinot Noir. This would necessitate costly adaptation processes of replanting to different, warmer climate grape varietals, or moving to higher elevations or further north in latitude. Additional risks come from the marketing side, where changes in varieties or wine styles would require a substantial effort to inform consumers and maintain market viability (Dello and Mote, 2010). Many vineyards in the area that contribute to drive our local economy will likely be directly affected.

As with the agricultural sector, water may become a constraining factor for local residences, industry, and business. Many Oregonians depend on water pumped from the ground to provide much of their water supply. Many municipalities rely on rivers driven by snow melt which will become more limited as snowpack decreases. At the same time, efficiency and reliability of power transmission and delivery is likely to decline as power lines are stressed by higher ambient temperatures and increased risk from wildfires. As a result, more brownouts and blackouts are possible. Expansion of biomass-based energy production may also be limited due to loss of supply from forests and agriculture from increased wildfire (Dello and Mote 2010).

Climate change is likely to have an impact on public health issues in Oregon including the spread of communicable diseases as well as an increase in water-borne, food-borne, and air-borne infections. Predicted average increases in summer temperatures will make heat waves a greater likelihood, causing heat-related morbidity and mortality, especially among vulnerable populations, such as the elderly, low income populations, pregnant women and those who work in outdoor occupations. Increasing temperatures in Oregon could raise the threat of vector-borne diseases and emerging infections. Respiratory conditions, especially among persons with pre-existing lung problems would be exacerbated by exposure to smoke from forest fires, as well as from the projected increase in air pollution levels in our region. Air pollution and increases in pollen counts (and a prolonged pollen producing season) may increase cases of allergies, asthma, and other respiratory conditions among susceptible populations (Dello and Mote, 2010). Climate change and its consequences target the most vulnerable - such as the very young and the very old. The consequences depicted here could have a severe impact on the health of the elderly. Many of the health consequences involve respiratory problems for this vulnerable segment of the population. Not only will the projected



## **Oregon Senate District 10 Climate Summary**

climate change be negative for our economy, it will also change the lives of people in the 10<sup>th</sup> District.

If climate trends continue as projected, Oregon's 10<sup>th</sup> Senate District will experience considerable natural and economic disruption. In order to sustain a vibrant economy, the region will find it necessary to adapt. Avoiding the worst-case scenario depicted in these projections will require the concerted effort of elected leaders at all levels of government: regional, national, and international.

### ***Potential Health Risk:***

According to the Oregon Health Authority (2014), the main climate impacts to health are likely to be: heat, allergens, storms, and floods. The top health concerns will be: poor air quality, respiratory illness, heat-related illness, harmful algal blooms, recreational hazards, increased allergens, displacement, landslides, economic instability, and mental health impacts. Communities that will be especially vulnerable will be: low-income households and neighborhoods, communities of color, older adults, people living on steep slopes, people working in agriculture, first responders, Native Americans, young children, and pregnant women.

### ***A Timeline for Action:***

Based on the projected consequences of the warming global climate, international agreements (e.g. UNFCCC 2015) some years ago established 2°C (preferably 1.5°C) above pre-industrial conditions as the limit beyond which we should not allow the global temperature to climb. This limit was echoed by the World Bank (2014). Meanwhile, the Intergovernmental Panel on Climate Change (IPCC 2018a) indicated that the 2°C limit pushes us too close to many global tipping points beyond which recovery becomes a reducing possibility. Thus, they recommend that we absolutely should target 1.5°C if we wish a reasonable chance of retaining a livable planet. Unfortunately, underlining the urgency, emissions to date may have already committed us to the 1.5°C increase (Mauritsen and Pincus 2017).

Global greenhouse gas emissions during 2017 totaled 53.7 Gigatonnes (GT) of carbon dioxide equivalent (IPCC 2018b) which includes between 32.5 (IEA 2019) and 36.5 GT of carbon dioxide (WRI 2018). This implies that between 30% and 40% of the global warming emissions are due to gases other than carbon dioxide. The trends and consequences discussed here are based on readily available data. This underlines the urgency for immediate action across the globe to curtail greenhouse gas emissions if we wish to avoid an increase over 2°C. Considerable variability exists among estimates of the emissions budget remaining if we are to restrict warming to the 1.5°C increase targets (Levin 2018, Carbon Brief 2018). Indeed, the latter source identifies a large range in estimates for a 66% chance of keeping warming to below

## Oregon Senate District 10 Climate Summary

1.5°C of between 28 GT and 779 GT. Meanwhile, the IPCC (2018a) indicated that the rate of carbon dioxide emissions alone is currently  $42 \pm 3$  Gigatonnes annually suggesting that, for a 50% chance at a rise below 1.5°C, the remaining budget for emissions is 580 GT CO<sub>2</sub>, while for a 66% chance, the remaining emissions budget is 420 GT CO<sub>2</sub>. Considering the current accelerating rate of emissions, the IPCC (2018a) concluded that by 2030 we must impose a reduction in emissions of 45% below the 2010 level and by 2050 we must reach net zero emissions. Considering the increasing impact of greenhouse gases other than carbon dioxide, that seems both conservative and reasonable. Underlining the urgency and imperative of limiting warming to 1.5°C, long ago the World Bank (2014) acknowledged there is: “no certainty that adaptation to a 4°C world is possible.”

Representing the People at the 24<sup>th</sup> United Nations Framework Convention on Climate Change Conference of the Parties in Poland (COP24), British naturalist and broadcaster Sir David Attenborough argued that in climate change “we are facing a man-made disaster of global scale, our greatest threat in thousands of years...” and “If we don't take action, the collapse of our civilizations and the extinction of much of the natural world is on the horizon.” (Domonoske 2018). The choice is ours!

From the trends and consequences discussed here, all based on readily available data, there should be little doubt that substantial urgency must be attached to addressing this issue.

### **Solutions:**

In addition to individual action wherein we evaluate our actions and adjust our behavior to reduce activities that result in greenhouse gas emissions or increase those that result in atmospheric greenhouse gas sequestration (capture and storage), we can promote local, state and federal actions that do the same on a larger scale. Local communities can develop Climate Action Plans that promote emissions reductions and capture/sequestration activities. Meanwhile, at the state and federal level, similar such programs can be instituted. The predominant proposals to achieve this involve either:

- a) imposing a jurisdictional cap on emissions which declines over time to establish a trajectory of emissions reductions that meet long term reductions goals. This approach involves the issuance of allowances to emit that reduce over time. Allowances may be sold/auctioned, or allocated free, or involve some combination.
- b) imposing a fee or tax on emissions that rises over time to achieve reductions that are consistent with a desired trajectory and long-term goals.

## **Oregon Senate District 10 Climate Summary**

The cap approach is direct since it involves assessing emissions from target polluters and requiring that reductions occur while the tax/fee approach is indirect since it is assumed that a rising tax will result in reduced emissions.

Both approaches usually involve the generation of funds either via sold/auctioned allowance in the case of the cap, or a fee in the case of the tax/fee approach. The second question associated with either approach involves a decision as to what will be done with the funds raised. One approach is to return these to residents or taxpayers (the individuals who ultimately pay the cost of the pollution reduction); hence the concept of a Dividend. Alternatively, the funds raised can be used to offset other reductions in other taxes, whether individual or corporate. Finally, these funds may be used for investments that (a) promote activities that themselves lead to reductions in atmospheric greenhouse gas concentrations, either by reducing emissions or promoting sequestration and/or (b) serve the goals of promoting environmental / social justice by assisting communities historically disadvantaged by pollution or likely to suffer disproportionately from the transition to a clean energy economy.

Since the state legislature has declined to implement a comprehensive policy, if Oregon is to contribute its share to addressing the climate crisis and wishes to appear credible when seeking action elsewhere, it will be necessary to take smaller targeted steps that reduce emissions in designated sectors or activities and/or promote the sequestration of carbon from our atmosphere in our natural and working lands.

### **Contact Your Representatives:**

#### ***Senator Deb Patterson***

**Capitol Phone:** 503-986-1710

**Capitol Address:** 900 Court St NE, S-411, Salem, OR, 97301

**Email:** [Sen.DebPatterson@oregonlegislature.gov](mailto:Sen.DebPatterson@oregonlegislature.gov)

**Website:** <http://www.oregonlegislature.gov/patterson>

#### ***House District 19: Representative Tom Andersen***

**Capitol Phone:** 503-986-1419

**Capitol Address:** 900 Court St NE, H-479, Salem, OR 97301

**Email:** [Rep.TomAndersen@oregonlegislature.gov](mailto:Rep.TomAndersen@oregonlegislature.gov)

**Website:** <http://www.oregonlegislature.gov/andersen>

#### ***House District 20: Representative Paul Evans***

**Capitol Phone:** 503-986-1420

**Capitol Address:** 900 Court St NE, H-281, Salem, OR 97301

## Oregon Senate District 10 Climate Summary

Email: [Rep.PaulEvans@state.or.us](mailto:Rep.PaulEvans@state.or.us)

Website: <http://www.oregonlegislature.gov/evans>

### **Literature:**

Alexander M, Scott J, Friedland K, Mills K, Nye J, Pershing A, Thomas A, 2018. Projected sea surface temperatures over the 21st century: Changes in the mean, variability and extremes for large marine ecosystem regions of Northern Oceans. *Elem Sci Anth*, 6(1), p.9. DOI:

<http://doi.org/10.1525/elementa.191>

Bednaršek N, Feely R, Beck M, Alin S, Siedlecki S, Calosi P, Norton E, Caenger C, Strus J, Greeley D, Nezlin N, Roethler M, Spicer J. 2020 Exoskeleton dissolution with mechanoreceptor damage in larval Dungeness crab related to severity of present-day ocean acidification vertical gradients. *Science of the Total Environment*. 716, 10 136610

<https://doi.org/10.1016/j.scitotenv.2020.136610>

Ben Achur S. 2022 Ocean acidification raises economic concerns for shellfish hatcheries. Market Place Minnesota Public Radio July 5 2022. <https://www.marketplace.org/2022/07/05/ocean-acidification-raises-economic-concerns-shellfish-hatcheries/>

Brown L 2006 *Plan B 2.0: Rescuing a Planet Under Stress and a Civilization in Trouble*. W.W. Norton, & Co. N.Y. London 365 pp.

Carbon Brief 2018 Analysis: How much 'carbon budget' is left to limit global warming to 1.5°C?

<https://www.carbonbrief.org/analysis-how-much-carbon-budget-is-left-to-limit-global-warming-to-1-5c>

Census 2017. 2017 Census of Agriculture; County Profile Marion County

[https://www.nass.usda.gov/Publications/AgCensus/2017/Online\\_Resources/County\\_Profiles/Oregon/cp41047.pdf](https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/Oregon/cp41047.pdf)

Crookston N, Radtke P. 2023 Plant Species and Climate Profile Predictions, Climate Estimates, Climate Change and Plant Climate Relationships.

<https://charcoal2.cnre.vt.edu//climate/species/index.php> (A discussion of the site can be found at: <https://www.fs.usda.gov/ccrc/tool/plant-species-and-climate-profile-predictions> though the site has been relocated from the USDA so the links on that page are dead ends).

CTT 2021 Congressional Temperature Trends: Thermometer Records from Weather Stations

<http://temperaturetrends.org/district.php?district=4&state=OR>

Dalton M, Mote P, Snover A [Eds.]. 2013. *Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities*. Washington, DC: Island Press.

<http://cses.washington.edu/db/pdf/daltonetal678.pdf>

Dalton M, Dello K, Hawkins L, Mote P, and Rupp D (2017) *The Third Oregon Climate Assessment Report*, Oregon Climate Change Research Institute, College of Earth, Ocean and Atmospheric

## Oregon Senate District 10 Climate Summary

Sciences, Oregon State University, Corvallis, OR.

[http://www.occri.net/media/1055/ocar3\\_final\\_all\\_01-30-2017\\_compressed.pdf](http://www.occri.net/media/1055/ocar3_final_all_01-30-2017_compressed.pdf)

Dello K, Mote P. 2010. Oregon climate assessment report. Corvallis, OR: Oregon Climate Change Research Institute, College of Oceanic and Atmospheric Sciences, Oregon State University.

[https://ir.library.oregonstate.edu/concern/technical\\_reports/9c67ww200](https://ir.library.oregonstate.edu/concern/technical_reports/9c67ww200)

Domonoske C, 2018 David Attenborough Warns Of 'Collapse Of Civilizations' At U.N. Climate Meeting. npr news. <https://www.npr.org/2018/12/03/672893695/david-attenborough-warns-of-collapse-of-civilizations-at-u-n-climate-meeting>

Easterling, D, Kunkel K, Arnold J, Knutson T, LeGrande A, Leung L, Vose R, Waliser D, Wehner M, 2017: Precipitation change in the United States. In: Climate Science Special Report: Fourth National Climate Assessment, Volume I [Wuebbles, D, Fahey D, Hibbard K, Dokken D, Stewart B, Maycock T. (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 207-230, doi: 10.7930/J0H993CC.

[https://science2017.globalchange.gov/downloads/CSSR\\_Ch7\\_Precipitation.pdf](https://science2017.globalchange.gov/downloads/CSSR_Ch7_Precipitation.pdf)

EPA 2002 Willamette Basin Alternative Futures Analysis. Environmental Assessment Approach that Facilitates Consensus Building United States Environmental Protection Agency.

[https://www.fsl.orst.edu/pnwer/wrb/proj\\_summary.pdf](https://www.fsl.orst.edu/pnwer/wrb/proj_summary.pdf)

Fleishman, E., editor. 2023. Sixth Oregon Climate Assessment. Oregon Climate Change Research Institute, Oregon State University, Corvallis, Oregon.

<https://blogs.oregonstate.edu/occri/oregon-climate-assessments>

Gao P, Terando A, Kupfer J, Varner J, Stambaugh M, Lei T, Hiers J. 2021 Robust projections of future fire probability for the conterminous United States. *Science of the Total Environment* 789: 147872. <https://www.sciencedirect.com/science/article/pii/S0048969721029430>

Halofsky J, Peterson D, Metlen K, Myer G, Sample V. 2016 Developing and Implementing Climate Change Adaptation Options in Forest Ecosystems: A Case Study in Southwestern Oregon, USA forests 7: (268) 1 - 18.

<file:///F:/Alan/Documents/KACONJOUR/Climate%20%20Change%20Literature/Forests,%20Fire%20&%20BLM%20RMP/Halofsky,%20Peterson,%20%20Metlen,%20Myer,%20Sample%202016%20climate%20change%20and%20adaptation%20in%20the%20Rogue%20Basin%20Oregon.pdf>

Hausfather Z. 2018 Explainer: How 'Shared Socioeconomic Pathways' explore future climate change. Climate Modeling. Carbon Brief. <https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change/>

Howat I, Tulascyk S. 2005 Trends in spring snowpack over a half-century of climate warming in California, USA *Annals of Glaciology* 40: 151-156.

<https://www.cambridge.org/core/journals/annals-of-glaciology/article/trends-in-spring->



## Oregon Senate District 10 Climate Summary

[snowpack-over-a-half-century-of-climate-warming-in-california-usa/E7153C040C54C29DFC9EDB92678C02FD](https://www.senate.gov/committees/subcommittees/energy-environment-and-climate/snowpack-over-a-half-century-of-climate-warming-in-california-usa/E7153C040C54C29DFC9EDB92678C02FD)

IPCC 2013. Climate Change 2013: The Physical Science Basis; Summary for Policymakers WGI  
IPCC Switzerland. <https://www.ipcc.ch/report/ar5/wg1/>

IPCC 2018a. Global Warming of 1.5°C, (An IPCC Special Report) Intergovernmental Panel on  
Climate Change Summary for Policymakers -  
[https://report.ipcc.ch/sr15/pdf/sr15\\_spm\\_final.pdf](https://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf)  
Full Report - <https://www.ipcc.ch/sr15/>

IPCC 2018b. Emissions Gap Report United Nations Environment Programme  
<https://www.ipcc.ch/site/assets/uploads/2018/12/UNEP-1.pdf>

IUCN undated. Overview and description. IUCN CEM Mediterranean Type Ecosystems Specialist  
Group. International Union for the Conservation of Nature. [https://www.iucn.org/our-union/commissions/group/iucn-cem-mediterranean-type-ecosystems-specialist-group#:~:text=Mediterranean%2Dtype%20ecosystems%20\(MTEs\),and%20Southwestern%20and%20South%20Australia](https://www.iucn.org/our-union/commissions/group/iucn-cem-mediterranean-type-ecosystems-specialist-group#:~:text=Mediterranean%2Dtype%20ecosystems%20(MTEs),and%20Southwestern%20and%20South%20Australia).

Jones G 2015 Climate, Grapes and Wine: Terroir and the Importance of Climate to Winegrape  
Production. GuildSomm  
[https://www.guildsomm.com/public\\_content/features/articles/b/gregory\\_jones/posts/climate-grapes-and-wine](https://www.guildsomm.com/public_content/features/articles/b/gregory_jones/posts/climate-grapes-and-wine)

Jones N 2017 How the World Passed a Carbon Threshold and Why It Matters. Yale Environment  
360 <https://e360.yale.edu/features/how-the-world-passed-a-carbon-threshold-400ppm-and-why-it-matters>

Karl T, Melillo J, Peterson T 2009 Global Climate Change Impacts in the United States,  
Cambridge University Press <https://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf>

Kenward A, Sanford T, Bronzan J 2016 Western Wildfires: A Fiery Future. Climate Central:  
<file:///H:/Alan/Documents/KACONJOUR/Climate%20Change%20literature/Forests,%20Fire%20&%20BLM%20RMP/Kenward%20et%20al%20westernwildfires2016vfinal.pdf>

Levin K 2018 According to New IPCC Report, the World Is on Track to Exceed its “Carbon  
Budget” in 12 Years, World resources Institute. <https://www.wri.org/blog/2018/10/according-new-ipcc-report-world-track-exceed-its-carbon-budget-12-years>

Lieberman B 2012 ‘CSZ’ — A Key Factor for Pacific Northwest Sea-Level Rise. Yale Climate  
Connections. <https://www.yaleclimateconnections.org/2012/07/cascadia-subduction-zone-a-key-factor-for-pacific-nw-sea-level-rise/>

## Oregon Senate District 10 Climate Summary

Marion undated. Forestlands and farm timber lands.

<https://www.co.marion.or.us/PW/Planning/zoning/Documents/ComprehensivePlan/forestandfarm.pdf>

Marion County 2015 About the County. Marion County, Oregon.

<https://www.co.marion.or.us/Pages/about.aspx>

Maycock, and B.C. Stewart (eds.). U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018 <https://nca2018.globalchange.gov/>

Melillo, J, Richmond T, Yohe G, Eds., 2014: Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

[http://s3.amazonaws.com/nca2014/low/NCA3\\_Climate\\_Change\\_Impacts\\_in\\_the\\_United%20States\\_LowRes.pdf?download=1](http://s3.amazonaws.com/nca2014/low/NCA3_Climate_Change_Impacts_in_the_United%20States_LowRes.pdf?download=1)

Mote, P.W., J. Abatzoglou, K.D. Dello, K. Hegewisch, and D.E. Rupp, 2019: Fourth Oregon Climate Assessment Report. Oregon Climate Change Research Institute. occri.net/ocar4.

<http://www.occri.net/media/1095/ocar4full.pdf>

NASA GISS 2023 Annual Mean Temperature Change Over Land and Over Ocean. GISS Surface Temperature Analysis (v4). National Aeronautics and Space Administration Goddard Institute for Space Studies. [https://data.giss.nasa.gov/gistemp/graphs\\_v4/](https://data.giss.nasa.gov/gistemp/graphs_v4/)

NOAA 2023 Climate At A Glance National Time Series. National Oceanographic and Atmospheric Administration. [https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/national/time-series/110/tavg/12/12/1895-2022?base\\_prd=true&begbaseyear=1901&endbaseyear=2000&trend=true&trend\\_base=100&egtrendyear=1895&endtrendyear=2023&filter=true&filterType=binomial](https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/national/time-series/110/tavg/12/12/1895-2022?base_prd=true&begbaseyear=1901&endbaseyear=2000&trend=true&trend_base=100&egtrendyear=1895&endtrendyear=2023&filter=true&filterType=binomial)

Oregon Health Authority 2014, Oregon Climate and Health Profile Report, Climate and Health Program, Public Health Division, Oregon Health Authority: Summary provided by Emily York MPH, Climate & Health Program Coordinator, Oregon Public Health Division, Oregon Health Authority.

<http://public.health.oregon.gov/HealthyEnvironments/climatechange/Documents/oregon-climate-and-health-profile-report.pdf>

Parks B 2022. Oregon Public Broadcasting. <https://www.opb.org/article/2022/04/27/offshore-wind-oregon-coast-coos-bay-brookings/>

Poet 2023 Pacific Coast Advantage. Pacific Ocean Energy Trust: <https://pacificoceanenergy.org/information/pac-coast-advantage/>.

## Oregon Senate District 10 Climate Summary

Safford H, Butz R, Bohlman G, Coppoletta M, Estes B, Gross S, Merriam K, Meyer M, Molinari N, Wuenschel A. 2021 Fire Ecology of the North American Mediterranean-Climate Zone. Chapter 9 [https://www.fs.usda.gov/psw/publications/srs/srs\\_2021\\_safford001.pdf](https://www.fs.usda.gov/psw/publications/srs/srs_2021_safford001.pdf) [In] Greenberg C, Collins B (eds.), Fire Ecology and Management: Past, Present, and Future of US Forested Ecosystems, Managing Forest Ecosystems 39, [https://doi.org/10.1007/978-3-030-73267-7\\_9](https://doi.org/10.1007/978-3-030-73267-7_9).

UNFCCC 2015 The Paris Agreement Unites Nations Climate Change. <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>

USGCRP, 2017: Climate Science Special Report: Fourth National Climate Assessment, Volume I [Wuebbles D, Fahey D, Hibbard K, Dokken D, Stewart B, and Maycock T (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 470 pp  
<https://science2017.globalchange.gov/downloads/>

USGS 2021 National Climate Change Viewer, U.S. Geological Survey Land Change Science Program. <https://www.usgs.gov/tools/national-climate-change-viewer-nccv>

Westerling A, Hidalgo H, Cayan D, Swetnam D. 2006 Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity. *Science* 313 no. 5789 pp. 940-943.  
<https://www.science.org/doi/10.1126/science.1128834>

Whittaker RH 1975 Communities and Ecosystems Macmillan Publishing CO., New York

Willamette Valley Wine 2023 About the Valley: Autumn in Wine Country. Willamette Valley Wineries Association. <https://www.willamettewines.com/about-the-valley/>

World bank 2014, *Turn Down the Heat: Confronting the New Climate Normal*. The World Bank, Washington DC. 275pp <https://openknowledge.worldbank.org/entities/publication/98508814-21c5-53e6-b36c-912a4ecf9da7>

WRI 2018 New Global CO2 Emissions Numbers Are In. They're Not Good. World Resources Institute. <https://www.wri.org/blog/2018/12/new-global-co2-emissions-numbers-are-they-re-not-good>

**We invite copying of these materials, but request that authorship together with the SOCAN logo and attribution be retained. (<http://socan.eco/oregon-legislative-districts/>).**