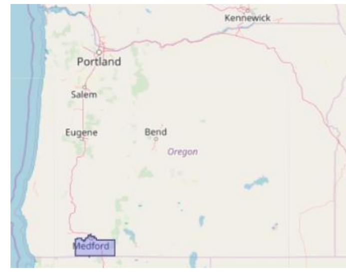
# Climate Change in the Oregon 3rd Senate District

**August 2019**




## History, Projections, and Consequences.

**1.** The last half century witnessed an average annual temperature increase of over 1°F. Meanwhile, projections suggest, compared to the average of the last half century, the temperature may rise about 9°F by late this century, with summers potentially rising 12°F and July reaching an average high of nearly 95°F.

**2.** Although annual average precipitation is expected to remain steady, seasonally winters are expected to be a little wetter and summers dryer, with more heavy downpours promoting floods and soil erosion.

**3.** Snowfall and snowpack accumulation, already dwindling, are projected to reduce further, possibly to 10% or less of historic levels threatening agriculture as snowmelt arrives earlier and summer and fall water availability dwindles.

**4.** Wildfires, already exhibiting a 105 day longer season than in the 1970s, are expected to become more serious, with some 200 to 300 percent greater area being consumed by mid-century posing a substantially greater problem for forests and tourism but also for human health through lower air quality and greater water and vector-borne disease risk.

6 Climatic shifts themselves will likely compromise the viability of important forest and timber species, such as Douglas fir and Ponderosa pine, in the district at the current emissions trajectory, we need to reduce emissions 45% below 2010 levels by 2030, requiring immediate action.

7 Important wine varietals may be compromised as the growing season warms.

8 The main health threats from drought, wildfire, heat, and infectious disease are: poor air quality, poor water quality, respiratory illness, occupational and recreational hazards, heat-related illness, residential displacement, contaminated and uncertain sources, food insecurity, vector-borne disease, income loss, economic instability, and mental health impacts. Communities that will be especially vulnerable will be: low-income households, Native Americans, private well users, people working in agriculture and outdoor recreation, firefighters and first responders, and children and pregnant women.

9 To achieve required emissions reduction goals, we need to reduce emissions 45% below 2010 levels by 2030; this requires immediate action!

Compiled by Meghan Fagundes & Alan Journet (Thompsom5@sou.edu , 541-973-5144) (alanjournet@gmail.com, 541-301-4107) June, 2014

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

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

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

Please contact Alan Journet (alan@socan.eco; 541-301-4107 / 541-5002331) with any queries.

Southern Oregon Climate Action Now

SOCAN

Confronting Climate Change

# Climate Change in the Oregon 3rd Senate District

**Compiled by Meghan Fagundes & Alan Journet**

**(fagundes.meghan@deq.state.or.us, 541-973-5144)**

**(alanjournet@gmail.com, 541-301-4107)**

**August, 2019**

**Updated by Hogan Sherrow**

**(hogan@you-evolving.com, 541-415-1013)**

**May, 2023**

## *Global and Regional Temperature:*

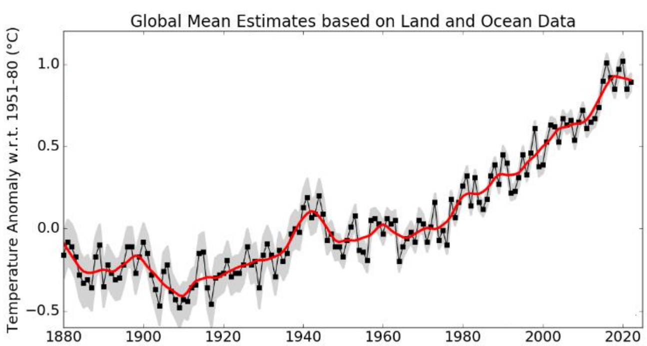



*Figure 1. Historic global temperature trend (NASA 2023).*

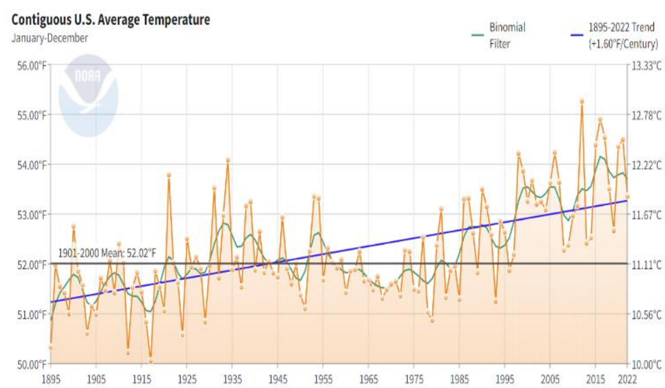



*Figure 2. Historic U.S temperature trend. (NOAA 2023).*

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.

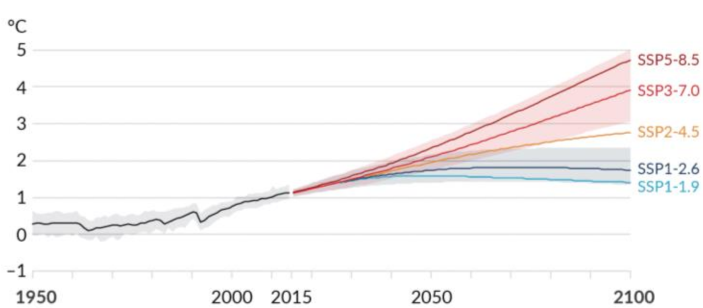



*Figure 3. Global temperature projections to 2100 relative to the 1850-1900 average. (IPCC 2021).*

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

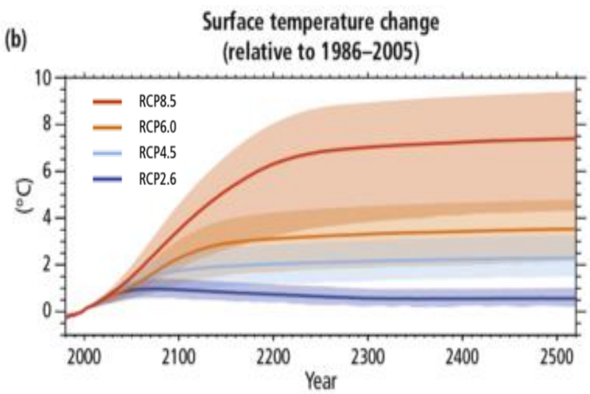



*Figure 4. Long term global temperature trends according to RCP values. (Jones 2017).*

Concentration Pathways (RCPs) previously employed by the IPCC (2013) in that they include characterization of the human behavior that leads to specific projected atmospheric greenhouse gas concentrations. The SSP5-8.5 pathway incorporates (SOS 2022) 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 (2013) 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$^{o}$C (5.4 to 9.18$^{o}$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 2013) 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 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.

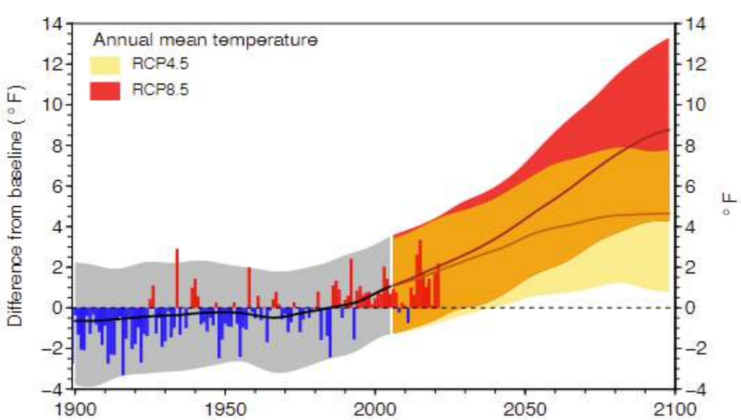



***Figure 5.*** *Oregon temperature history and projections through the century; baseline: 1970 – 1999 (Fleishman 2023).*

Meanwhile, temperature projections for this century in Oregon (Fleishman 2023, Figure 5) suggest a similar range of temperature increases possibly reaching over 13$^{0}$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 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:***

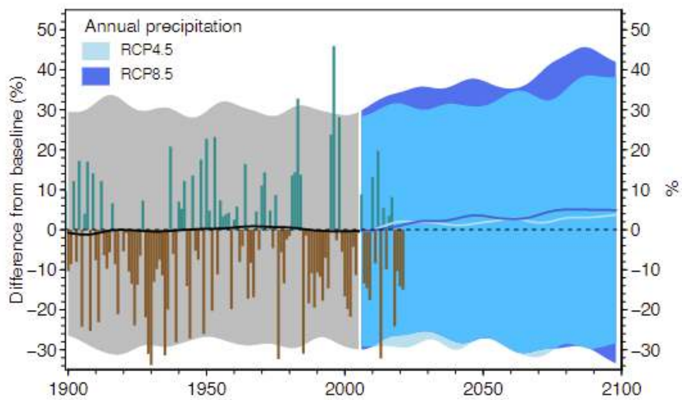



*Figure 6. History and projections for precipitation statewide. (Fleishman 2023).*

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.

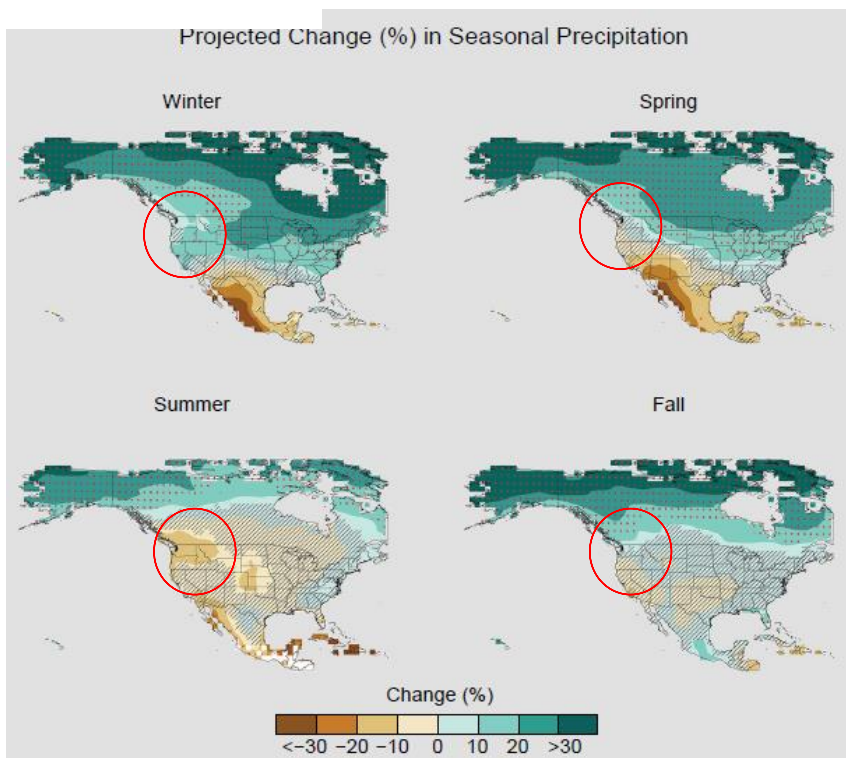



*Figure 7. Projected change in precipitation to 2077-2090 compared to 1960-2005 average; stippled areas indicate large change compared to natural variation; hatched areas small change. (Easterling et al. 2017).*

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.

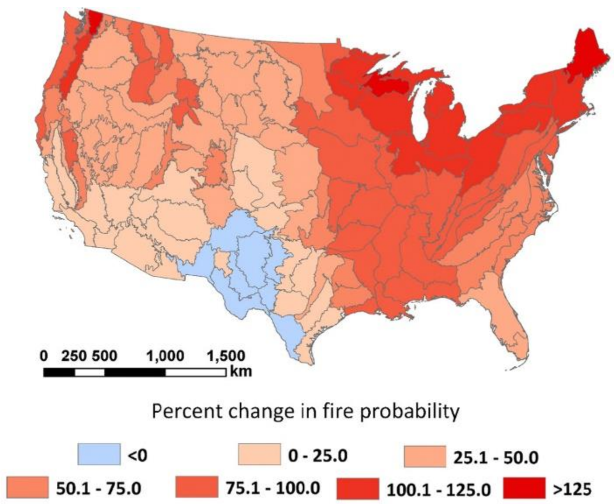



*Figure 8. Potential increase in fire risk from the 1971-2000 baseline across the U.S. assuming the RCP 8.5 scenario. (Gao et al. 2021).*

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 into 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$^{o}$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.

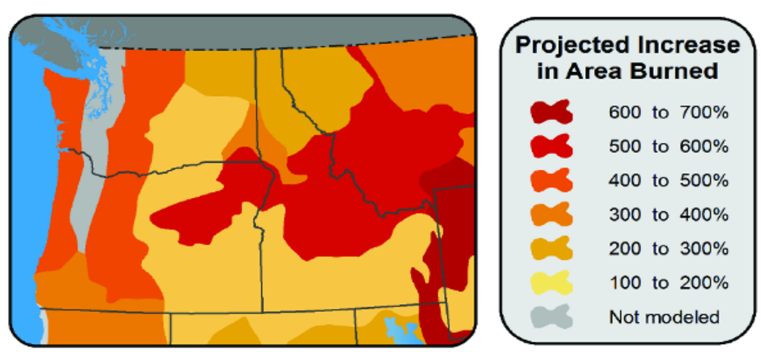



*Figure 9. Anticipated wildfire consequences of a 2.2$^{o}$F warming in area burned (Mellilo et al. 2014).*

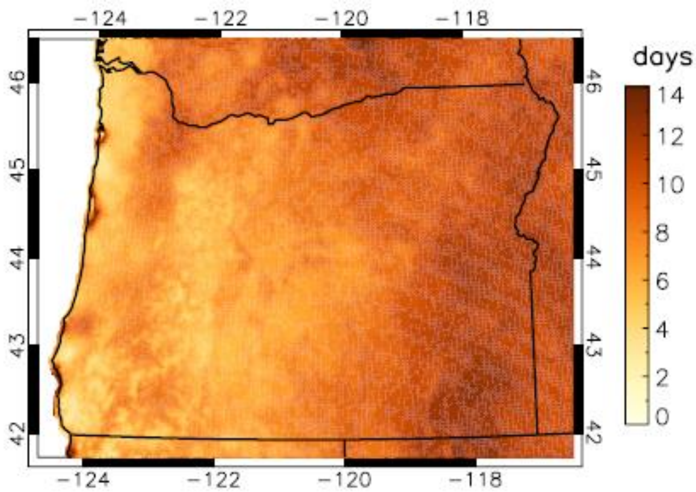



*Figure 10. Increase in number of days experiencing high fire risk by mid- century (2040 - 2069) compared to the end of the last century (1971-2000). (Mote et al. 2019).*

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 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*

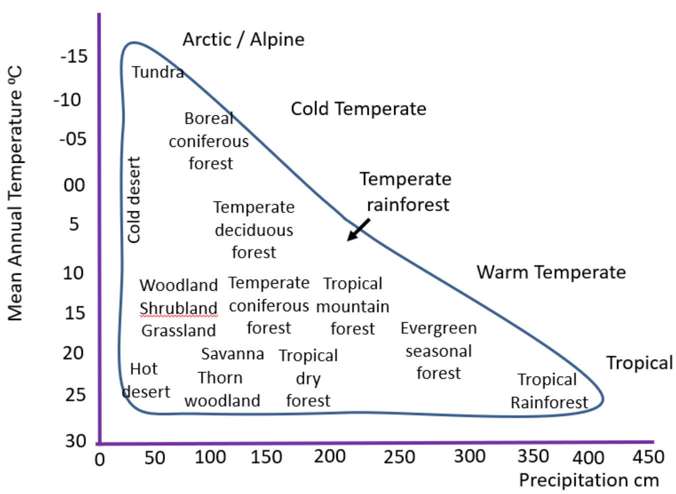



*Figure 11. Global distribution of natural ecological systems (biomes) in relation to mean annual temperature and precipitation patterns. (Modified from Whittaker 1975).*

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 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 21st century…." Climate envelope 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 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 consequence 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. Bednaršek *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 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. The 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 3rd Oregon Senate District Climate History and Projections:*

Temperature history and projections for Jackson County are presented in Figure 12 and demonstrate and increasing warming trend since 1950. Meanwhile, the county projections through the end of the century indicate a warming of over 9$^{o}$F by 2100 under the Business-as-Usual scenario compared to the 1980-2010 average with summers up to nearly 12$^{o}$F warmer and July exhibiting an average maximum of nearly 95$^{o}$F. However, warming reaches only about 5$^{o}$F if we adopt a less extreme RCP 4.5 trajectory.

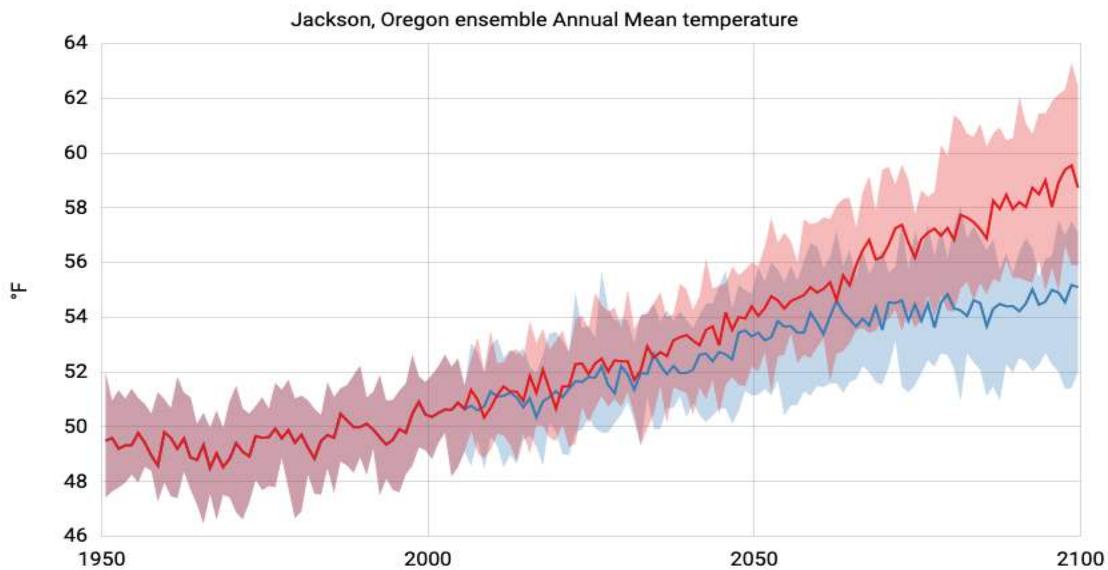



***Figure 12.*** *Jackson County temperature history and projections (USGS 2021).*

The trends and projections for precipitation in Jackson County (Figure 13), indicate a historical pattern that is variable but, on average, level, and a future on average about the same but with greater variability: namely, more frequent and severe wet and dry years.

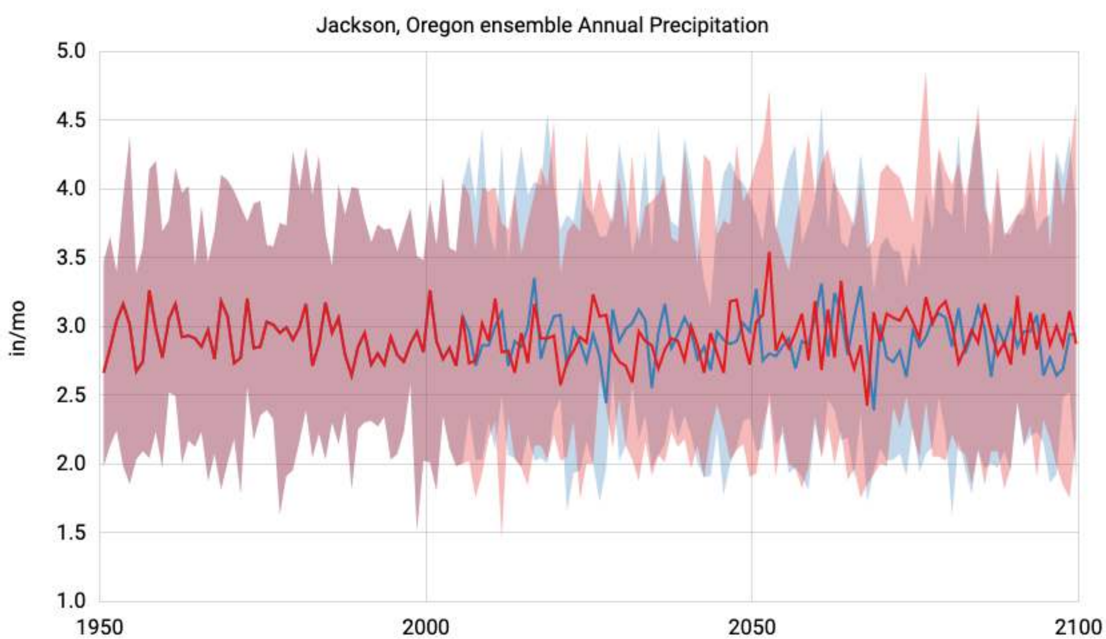



***Figure 13.*** *History and projections for precipitation in Jackson County (USGS 2021).*

Snowpack, measured as Snow Water Equivalent, has been declining since the 1970s. During this Century, it may drop to less than 10% of historical records (Figure 14). Lack of snow pack has negative effects on the valley since snowpack has been the historical reservoir for summer and fall water supplies. Reduced snowpack, accompanied by earlier snowmelt will likely increase the threat of drought and wildfire in summer and fall. Snow pack also affects winter recreational activities in the area; with reduced snowfall, the valley loses the potential revenue brought in by Mt. Ashland and its patrons.

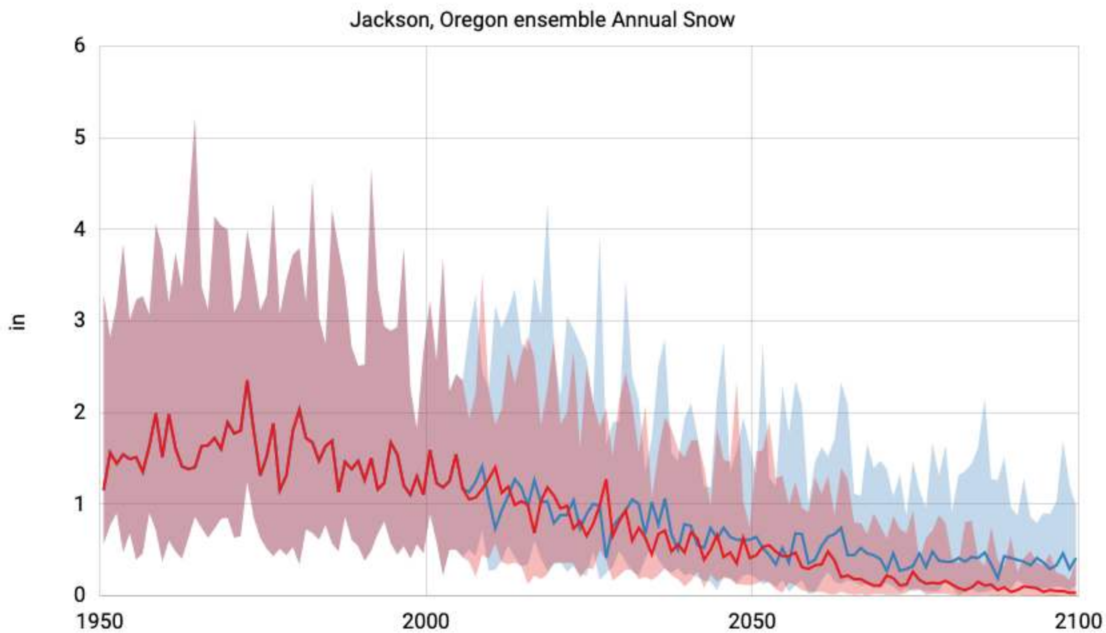



***Figure 14.*** *Trend and projections of snowpack as snow water equivalent in Jackson County (USGS 2021).*

## ***Federal Congressional District 2:***

Senate District 3 is located within Congressional District 2. Figure 15 demonstrates that the historical temperature trend within the 2nd Congressional District is similar to that reported locally with an increase of over 2$^{o}$F per century since 1895 and a more recent increase at 3.9$^{o}$F per century.

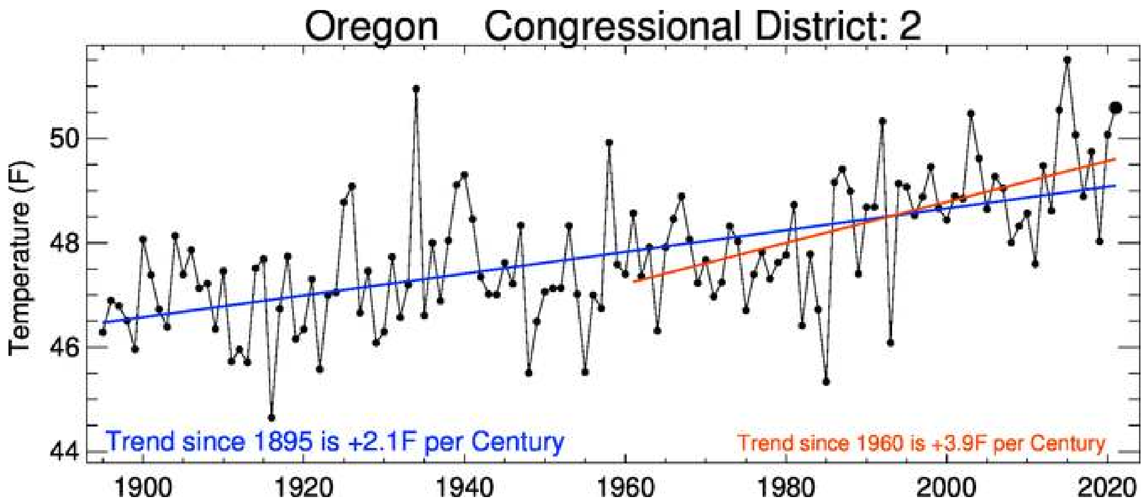



***Figure 15.*** *Temperature trend for Federal Congressional District 2 (CCT 2021).*

### *Oregon 3rd Senate District Economy:*

The economy of Oregon's 3rd Senate district involves healthcare, agriculture, forestry, manufacturing, and tourism. Even though timber/lumber production has declined it is still a significant component of this district's economy.

The most important commercial tree species in the 3rd Senate District are Douglas fir and Ponderosa pine. Their current distributions, and the location of the climate conditions supporting them through the century have been analyzed at the USDA Forest Service Labs in Moscow, Idaho. Projections for these tree species are presented in Figures 16 and 17 for models that assume the Business as Usual trend of increasing atmospheric carbon dioxide emissions. High tree viability is indicated in red, low viability in green and absence in areas without color.

These projections suggest conditions for these species may be less favorable than currently-meaning the forests and timber industry of the district could be severely challenged as the century unfolds, especially if we do nothing to mitigate the climate trends already evident.

Furthermore, 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.

***Figure 16.*** *Douglas fir, Psuedotsuga menzeisii appropriate climate now and in the future (Crookston and Radtke 2023).*

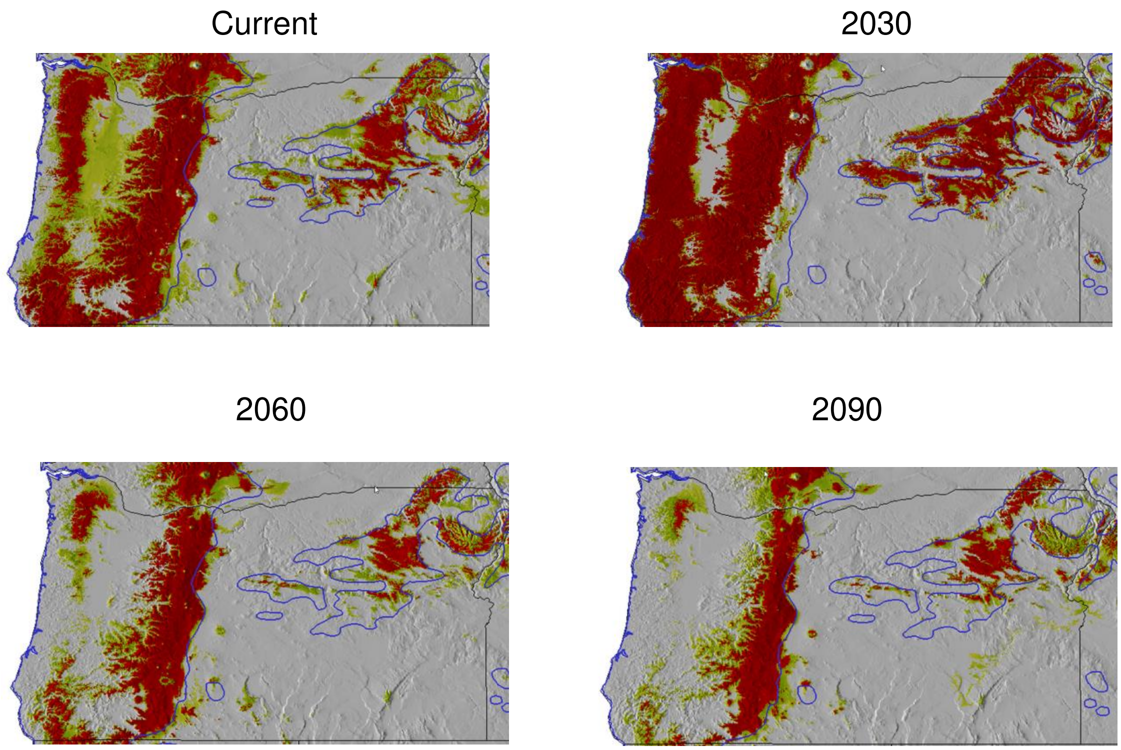
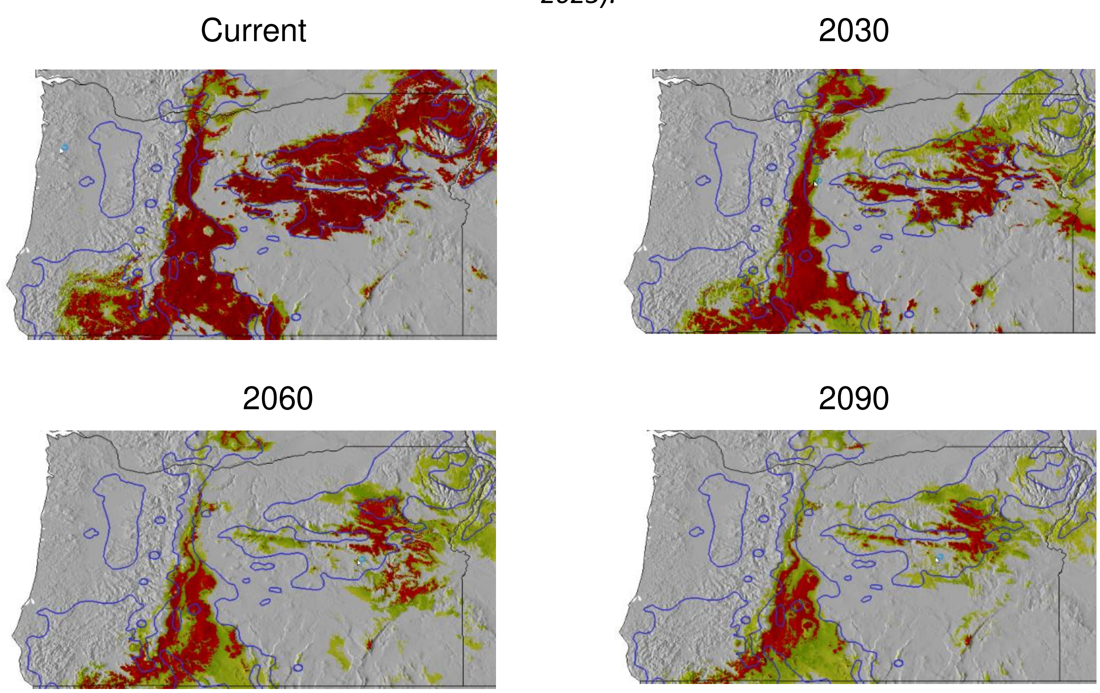



***Figure 17.*** *Ponderosa pine, Pinus ponderosa appropriate climate now and in the future (Crookston and Radtke 2023).*



## *Potential Agricultural Impacts:*

Our field 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. 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 2014) posing a great risk of extended drought. Farmers and home gardeners in Oregon should be concerned about a compromised future.

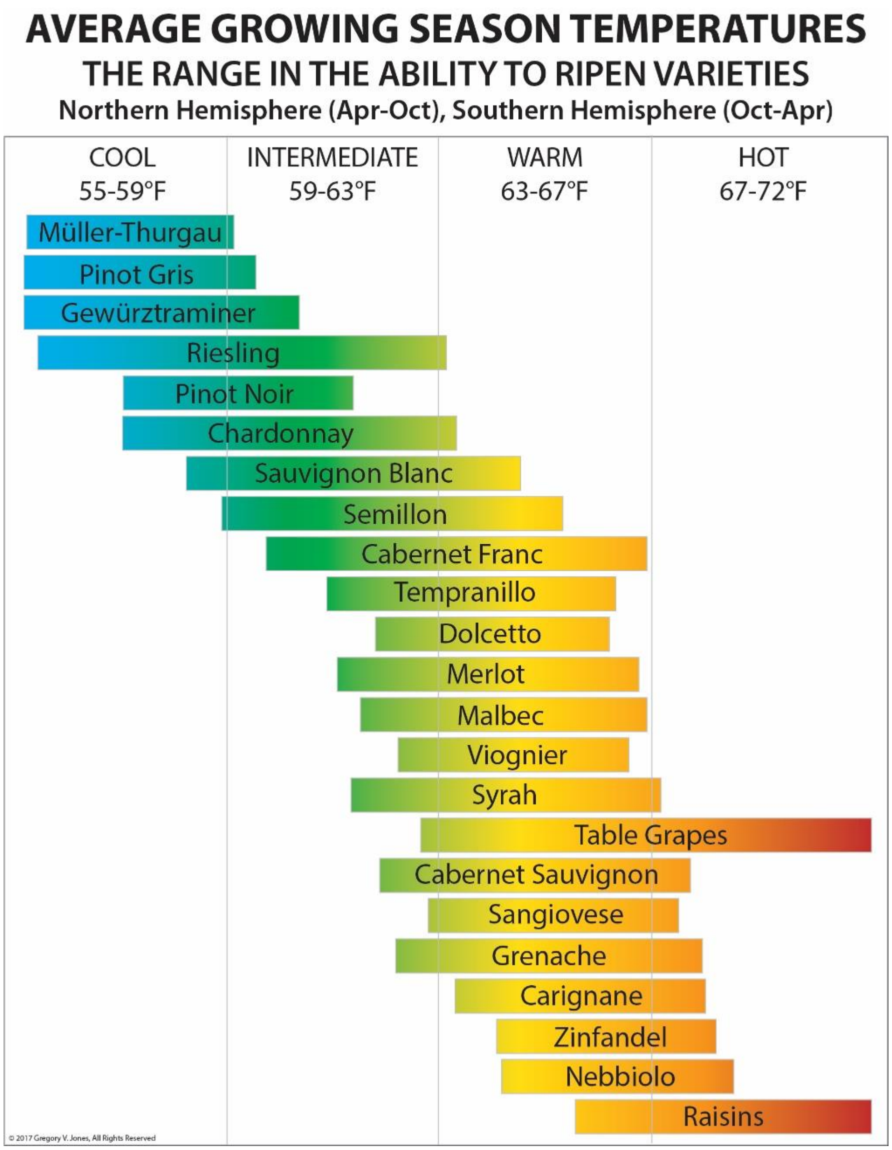



***Figure 18.*** *Grape varietal optimum growing season temperature (Jones 2015).*

Future climate patterns as projected would negatively impact the economy through a reduction in crop yields since increasing temperature consistently reduces crop productivity and a potential for lost tourism due to wildfire. The blossoming wine industry and the pears produced by and for Harry and David would also be affected by the altered growing season. A potential problem for pear growers is the need for a solid winter chill period. This is decreasing. While not immediately a problem, if the trend of decreasing chill hours continues the consequences for pear production could become relevant. Legally grown marijuana and hemp have also become important components of the economy in Senate District 2. Both are water intensive practices and will, therefore be severely impacted by reduced precipitation and stream flows.

The predominant wine varietals in this area are Pinot Gris, Syrah, Merlot, Cabernet Sauvignon, Pinot Noir, and Chardonnay. Figure 18 depicts the growing season optimal temperatures for varietals grown in the region including the impact climate change will likely have on wine growing.  While many of the grape varietals grown in this area seem reasonably well-adapted to mid-century growing season temperatures, even some of the warm climate varietals could be compromised by late century.  However, of particular note are the cooler growing season varietals of the region (especially Illinois Valley wines) such as Pinot gris, and Gewürtstraminer, which could be severely compromised even by mid-century.

If climate trends continue as projected, Oregon's 3rd 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 Risks:*

Not only will climate change be negative for our economy, it will also change the lives of people in the 3rd Senate district. Oregon Senate District 3 and surrounding areas have become increasingly popular as retirement locations; Climate change and its consequences target the most vulnerable - such as the young and the 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. Heat waves and particulates emitted by wildfires can be particularly hazardous to those with respiratory problems.

According to the Oregon Health Authority (2020), the impacts of climate change on health are likely to be numerous: poor air quality, poor water quality, respiratory illness, occupational and recreational hazards, heat-related illness, residential displacement, contaminated drinking water, water insecurity, food insecurity, vector-borne disease, income loss, economic instability, and mental health issues are all forecasted.  Communities that will be especially vulnerable are: rural and low-income communities, BIPOC communities, private well users, agricultural and outdoor recreation workers, firefighters and other first responders, and 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$^{o}$C (preferably 1.5$^{o}$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$^{o}$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$^{o}$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$^{o}$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$^{o}$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 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± 3 Gigatonnes annually suggesting that, for a 50% chance at a rise below 1.5°C, the remaining budget for emissions is 580 GT $CO_2$, while for a 66% chance, the remaining emissions budget is 420 GT $CO_2$. 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$^{o}$C world is possible."

Representing the People at the 24$^{th}$ 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.

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 assumes 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 allow 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 of 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 Legislators:

### Senator Jeff Golden

**Capitol Phone:** 503-986-1703
**Capitol Address:** 900 Court St NE, S-421, Salem, OR, 97301
**Email:** Sen.JeffGolden@oregonlegislature.gov
**Website:** http://www.oregonlegislature.gov/golden

### *House District 5: Representative Pam Marsh*

**Capitol Phone:** 503-986-1405
**Capitol Address:** 900 Court St NE, H-375, Salem, OR 97301
**Email:** Rep.PamMarsh@oregonlegislature.gov
**Website:** http://www.oregonlegislature.gov/marsh

### *House District 6: Representative Kim Wallan*

**Capitol Phone:** 503-986-1406
**Capitol Address:** 900 Court St NE, H-482, Salem, OR 97301
**Email:** Rep.KimWallan@oregonlegislature.gov **Website:** http://www.oregonlegislature.gov/wallan

## *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

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).

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 Sciences, Oregon State University, Corvallis, OR. http://www.occri.net/media/1055/ocar3_final_all_01-30-2017_compressed.pdf

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

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

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-snowpack-over-a-halfcentury-of-climate-warming-in-california-usa/E7153C040C54C29DFC9EDB92678C02FD

Hudiburg T, Law B, Turner D, Campbell J, Donata D, Duane M. 2009 Carbon dynamics of Oregon and Northern California forests and potential land-based carbon storage. Ecological Applications. **https://doi.org/10.1890/07-2006.1**

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.

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
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

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

Jones N 2017 How the World Passed a Carbon Threshold and Why It Matters. Yale Environment 350 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

Law B, Hudiburg T, Berner L, Harmon M 2018 Land use strategies to mitigate climate change in carbon dense temperate forests. Proceedings of the National Academy of Sciences. 115 (14) 3663-3668. https://www.pnas.org/doi/10.1073/pnas.1720064115

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/

Mauritsen T, Pincus, R. 2017, Committed warming inferred from observations, Nature Climate Change, 7: 652–655 https://www.nature.com/articles/nclimate3357

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

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 2019 Global mean [temperature] estimates based on land and ocean data. NASA Goddard Institute for Space Studies.
https://data.giss.nasa.gov/gistemp/graphs/graph_data/Global_Mean_Estimates_based_on_Land_and_Ocean_Data/graph.png

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/

NOAA 2019a Climate at a Glance. NOAA National Centers for Climate Information.
National Data: https://www.ncdc.noaa.gov/cag/national/time-series/110/tavg/12/12/1895-2018?base_prd=true&firstbaseyear=1901&lastbaseyear=2000&trend=true&trend_base=10&firsttrendyear=1895&lasttrendyear=2019&filter=true&filterType=binomial

NOAA 2019b Climate at a Glance. NOAA National Centers for Climate Information.
County Data: https://www.ncdc.noaa.gov/cag/county/time-series/OR-029/tavg/1/7/1895-2019?base_prd=true&firstbaseyear=1901&lastbaseyear=2000&trend=true&trend_base=10&firsttrendyear=1895&lasttrendyear=2019

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&begtrendyear=1895&endtrendyear=2023&filter=true&filterType=binomial

Oregon Health Authority 2020, Climate and Health in Oregon, Climate and Health Program, Public Health Division, Oregon Health Authority. https://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/CLIMATECHANGE/Documents/2020/Climate%20and%20Health%20in%20Oregon%202020%20-%20Full%20Report.pdf

Rundel P, Arroyo M, Cowling R, Keeley J, Lamont B, Pausas J, Vargas P 2018 Fire and Plant Diversification in Mediterranean-Climate Regions Frontiers in Plant Science 9: 1-13. https://www.frontiersin.org/articles/10.3389/fpls.2018.00851/full

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 [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.

SOS 2022 Climate Model - Surface Temperature Change: SSP1 (Sustainability) - 2015 – 2100. Science on a Sphere. National Oceanographic and Atmospheric Administration https://sos.noaa.gov/catalog/datasets/climate-model-surface-temperature-change-ssp1-sustainability-2015-2100/

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/

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

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

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. Word Resources Institute. https://www.wri.org/blog/2018/12/new-global-co2-emissions-numbers-are-they-re-not-good