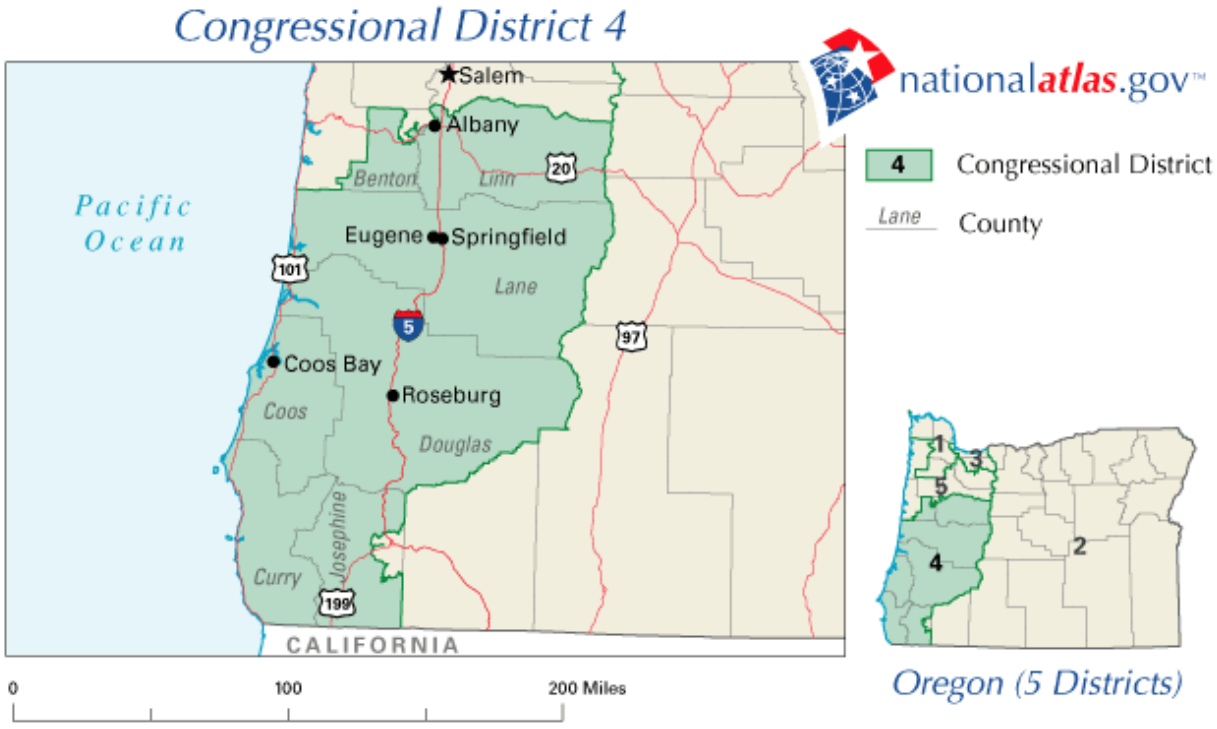
Southern Oregon Climate Action Now

SOCAN

Confronting Climate Change

Climate Change in the Oregon

4th Congressional District



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Global and Regional Temperature

Data from NASA plainly show that the Global and U.S. atmospheric temperatures have increased substantially since 1880 (Figure 1 and Figure 2). The future trajectory of climate change is dependent upon the greenhouse gas concentration in the atmosphere. Possible future scenarios are graphed in terms of scenarios defined by their "Representative Concentration Pathway", or RCP (Van Vuuren *et al.* 2011). Four potential pathways are described: RCP2.6, RCP4.5, RCP6, and RCP8.5 respectively identified by higher emissions trends. The RCP number correlates with greenhouse gas emission amounts – RCP 2.6 describes a scenario in which emissions peak between 2010 and 2020, and then decline substantially. RCP8.5 projects outcomes for a scenario in which human emissions continue along their current trajectory – this is also referred to as the "business as usual" scenario. In RCP4.5, emissions peak around 2040 and then decline. By the end of the century, temperatures will have risen in accordance with the RCP followed globally (Figure 3). If immediate action is taken (RCP2.6), the rise in temperature may only be 2°F. However, if no action is taken, and emissions rates continue to accelerate (RCP8.5), temperatures will soar by 9°F or more. Temperature projections for Oregon (Figure 4) suggest a similar range of temperature increases are possible, possibly reaching over a 13°F increase by the end of the century under the business-as-usual scenario.

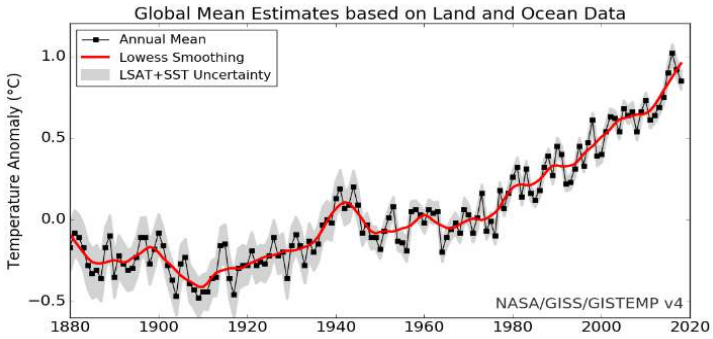

Figure 1. Historic global temperature trend NASA Goddard Institute for Space Studies 2019. https://data.giss.nasa.gov/gistemp/graphs/graph_data/Global_Mean_Estimates_based_on_Land_and_Ocean_Data/graph.png

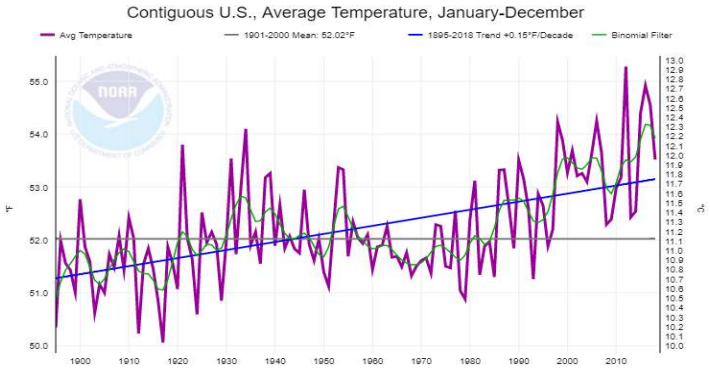

Figure 2. Historic U.S temperature trend. NOAA 2019. https://www.ncdc.noaa.gov/cag/national/time-series/110/tavg/12/12/1895-2018?base_prd=true&firstbaseyear=1901&lastbaseyear=2000&trend=true&trend_base=10&firsttrendyear=1895&lasttrendyear=2019&filter=true&filterType=binomial

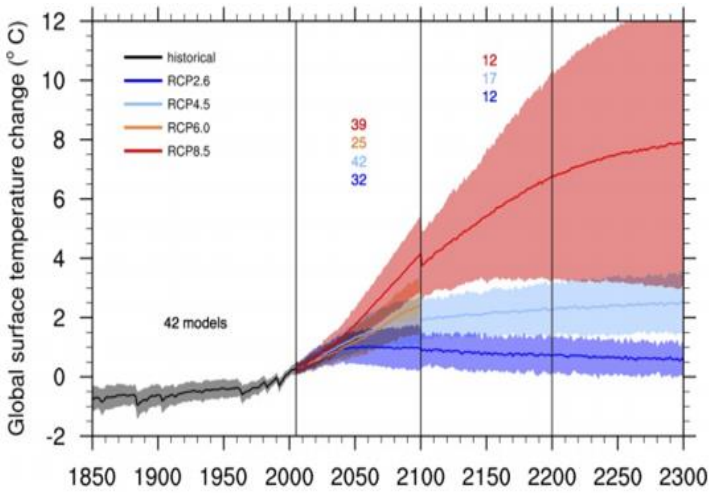

Figure 3. Intergovernmental Panel on Climate Change 2013 global projections. http://www.climatechange2013.org/images/uploads/WGIAR5_WGI-12Doc2b_FinalDraft_Chapter12.pdf

The predicted temperature increase described in RCP8.5 would cause rapid ecosystem changes that would challenge the survival of most species. Diversity of life in natural systems would be devastated. Climate dependent agricultural, ranching, and forestry activities would also be threatened. Forest pests, such as bark beetles, would likely increase as warmer temperatures enhance insect growth and development rates and enable greater overwintering populations. Similarly, invasion of natural and agricultural systems by drought tolerant invasive species and pests will likely become more dramatic.

The lower predicted temperature increases resulting from the greenhouse gases already released is inevitable; for this we will simply have to prepare and adapt.

Regional Precipitation

The 2013 US Climate Change Assessment (Melillo *et al.* 2014) provides projections for future precipitation (Figure 5) according to

Oregon is expected to see seasonal precipitation changes – winters may become slightly wetter, while summers will likely be considerably dryer. Spring and fall precipitation will not deviate greatly from normal trends.

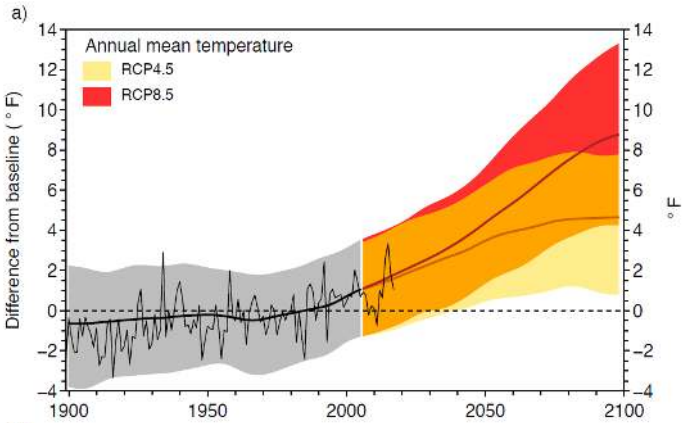

Figure 4. Oregon temperature history and projections through the century; baseline: 1970 - 1999 (Mote *et al.* 2019). http://www.occri.net/media/1095/ocar4full.pdf

Water resources, already severely compromised in many locations, will become more threatened as snowpack declines and precipitation occurs as severe storms rather than the typical light drizzle that rejuvenates soil moisture. This trend will likely enhance floods, soil erosion and potentially landslides.

The reduced stream and river flow occurring during summer/fall will be warmer compromising many iconic Pacific Northwest cold-water aquatic species.

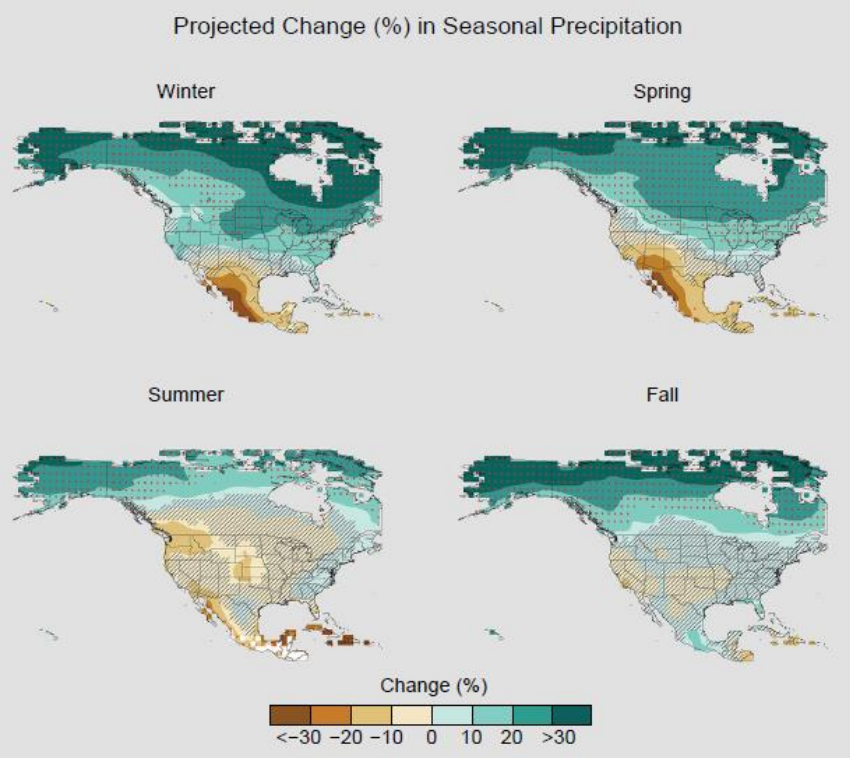

Figure 5. Projected change in precipitation compared to 2070 - 2099 average. Stippled areas large *cf* natural variation; hatched areas small *cf* natural variation. USGCRP 2017.

Wildfire

Melillo *et al.* (2013) also offered wildfire projections accompanying just a 2.2°F warming, a condition potentially evident by mid-century (Figure 6).

The fire season, already extended by 105 days since 1970s (Kenward *et al.* 2016), will likely become longer and more severe in Oregon. Both human safety and human health will likely be threatened.

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 7). 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 4) from which it is evident that most of our state's precious natural systems will be threatened if not 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, will likely compromise agriculture and forestry in the state. Indeed, Dalton et al. (2017) indicate not only that "suitable climates for many important tree species and vegetation types may

change considerably by the end of the 21st century…" but also that "different trees have varying degrees of sensitivity to climate change and adaptive capacity."

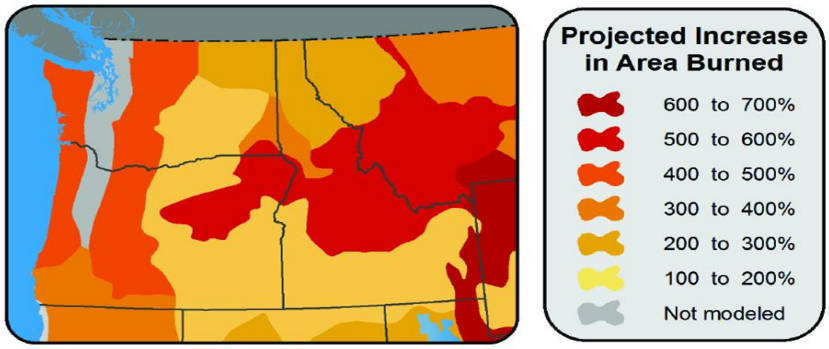

Figure 6. Anticipated wildfire consequences of a 2.2^{0}F warming in area burned (Melillo *et al.* 2014).
http://www.globalchange.gov/what-we-do/assessment

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 between 1900 and this century are already documented with further increases to 2.0 ^{o}F by mid-century expected [NEEDS A SOURCE]. 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^{o}C (approximately 37^{o}F). As the ocean warms, it inevitably expands and sea level 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 a subsiding coastal plate 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 sea level rise along the coast. As the In Oregon, the impact of the oceanic Juan de Fuca plate sliding under the continental North American plate is a rising continental plate (Lieberman 2012) countering the 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. 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 is 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 carbon-based shells since either, they are unable to form shells in acid conditions, or they lose shells already established. A recent study by Bednarsek, et al (2020) demonstrated that ocean acidification, that is a result of warming temperatures, off the coast of Oregon are 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. Additionally, acidosis, a build-up of acidic conditions in the tissues, threatens many marine life forms.

Warming oceans also 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:

Although climate change has a far greater direct effect on rural communities than urban areas, it must be remembered that urban areas rely on healthy rural regions for their water supply and their agricultural, and forestry products. 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 as reduced snowpack diminishes skiing, reduced river flow potentially diminishes fishing and water recreation, rising seas compromise our coastal communities, and increasing wildfire risk compromise our forests and air quality. 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 4th Oregon Congressional District Climate History and Projections

Climate models can specifically project future temperature and precipitation trends that Oregon's 4th Congressional District is likely to experience as greenhouse gas emissions continue to increase. Average annual temperature is expected to increase, along with a decrease in summer rainfall. The following figures (Figure 7 through Figure 10) provide graphs plotting historical data, and two projections through the century: blue is based on RCP4.5 and red on RCP8.5. In general, the higher emissions of RCP8.5 result in climate change of greater severity. Oregon's annual mean temperature trends (Figure 7) for the last half century show a slight rise from the 1970s. The low emissions scenario (blue) projection for the next century indicates a likely rise in average temperature of 5.4°F above the 1950-2005 average with average high temperatures reaching around 64°F by late century. The business as usual scenario (red) projects a rise in temperature of 10.1°F, with annual average highs of nearly 70°F at the end of the century. Congressional District 4, a coastal and inland region, will experience severe temperature increases in the eastern tier of counties (rising up to 11°F) with more moderate increases along the coast. Higher summer temperatures will create more potential for drought, particularly during the anticipated dryer summer growing season. The projected temperature increases may also bring about earlier breeding by animals and plants, a longer and more intense allergy season, and changes in vegetation zones. Higher temperatures and increased ocean acidification could result in fisheries that are no longer productive, and further economic hardships.

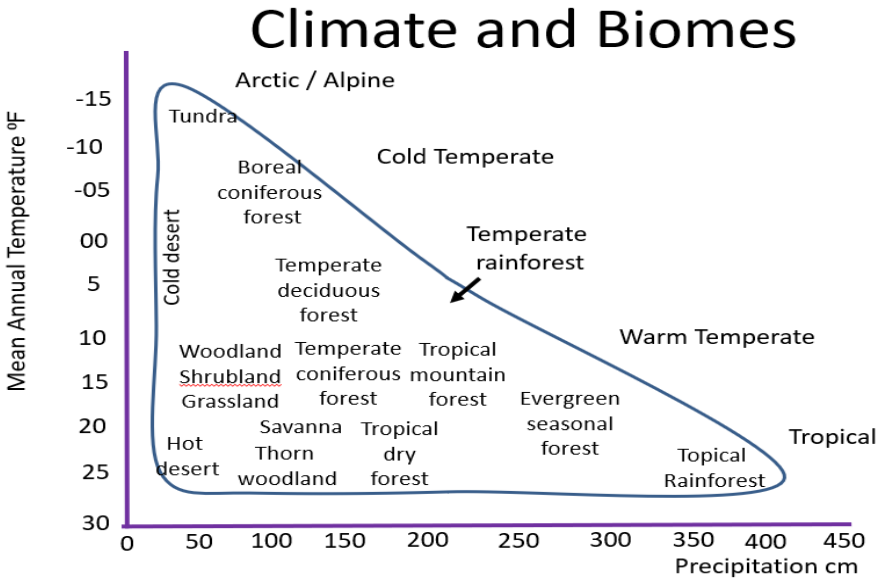

Figure 7. Global distribution of natural ecological systems in relation to mean annual temperature and precipitation patterns. Modified from Whittaker 1975.

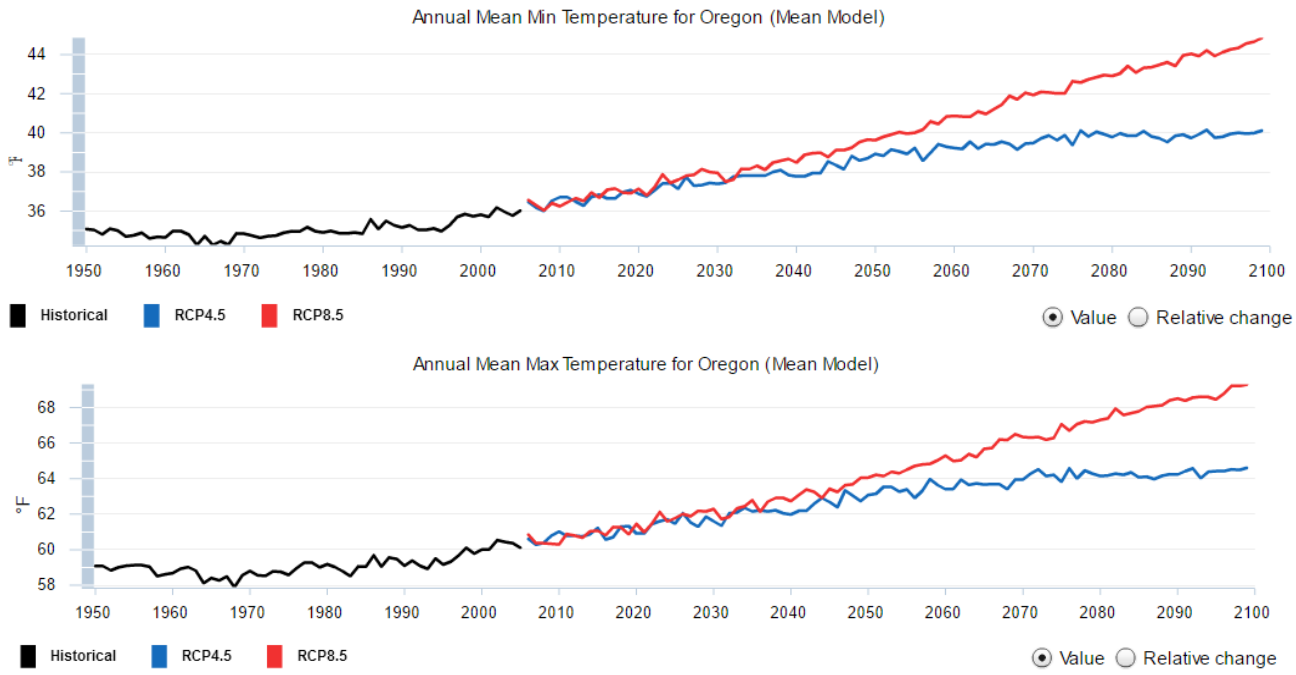

Figure 8. Annual Average Minimum & Maximum Temperature Trends and Projections for Oregon. http://www.usgs.gov/climate_landuse/clu_rd/nccv/viewer.asp

Climate change models project that the Pacific Northwest region will not experience much, if any change in total annual precipitation (Figure 8). However, important seasonal changes are expected. Summers are anticipated to become dryer, while winters become wetter (Figure 9).

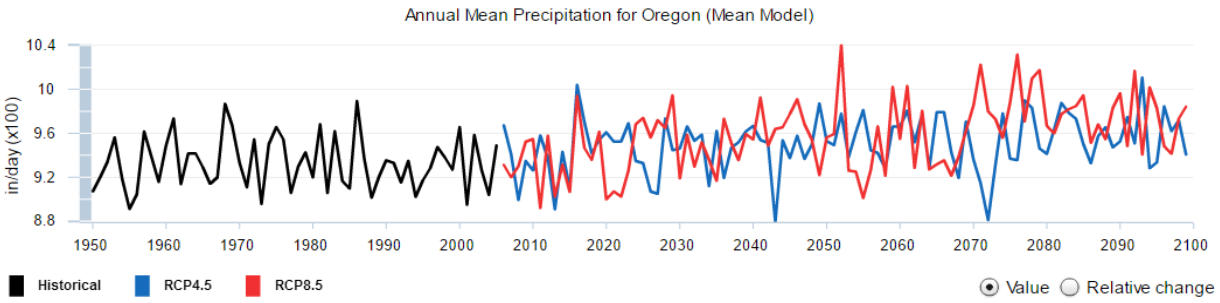

Figure 9. **A**nnual Trends and Projections for Oregon. http://www.usgs.gov/climate_landuse/clu_rd/nccv/viewer.asp

The inland areas of Congressional District 4 are accustomed to dry summers and wet winters, but, when coupled with higher temperatures, the region is likely to experience more drought and an increase in wildfire severity. The coastal regions of CD4 are likely to experience increased drought and wildfire severity as well, although the impact may be more moderate. Additionally, the effect on winter snowpack could potentially be devastating.

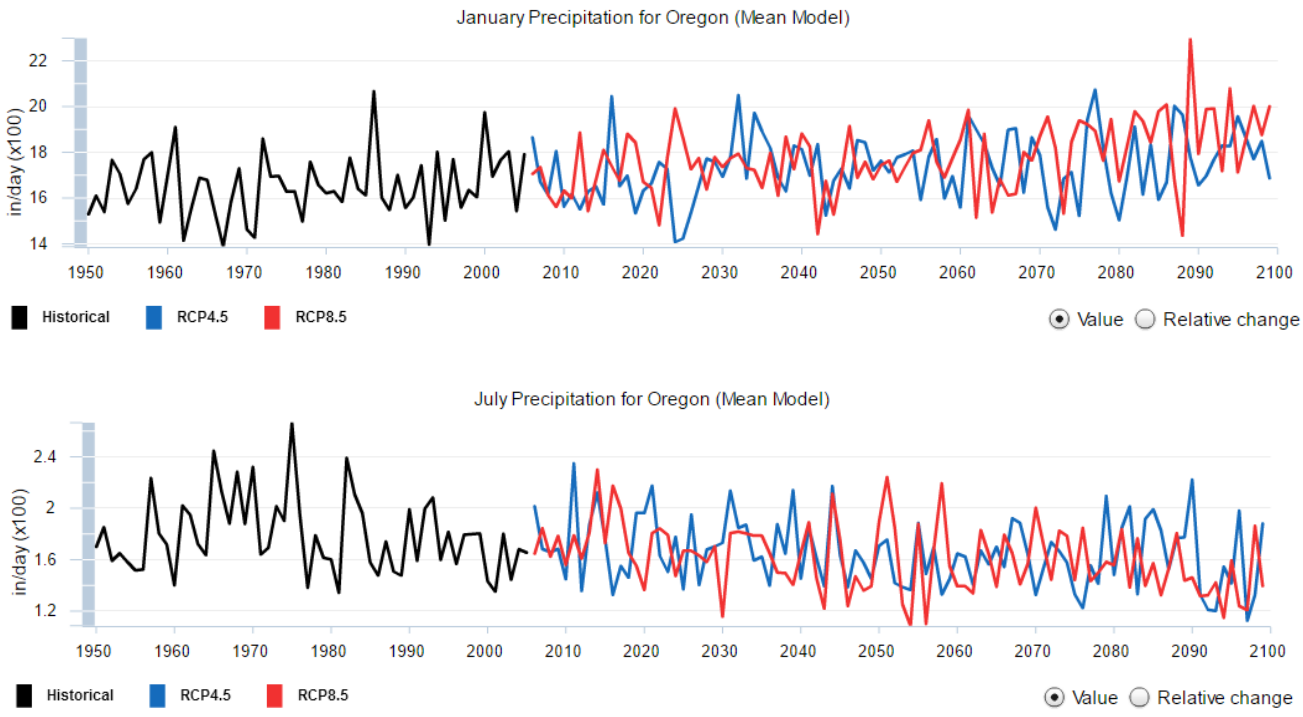

Figure 10. January & July Precipitation Trends and Projections for Oregon.
http://www.usgs.gov/climate_landuse/clu_rd/nccv/viewer.asp

Figure 10, depicting the predicted change in annual snowfall (using the RCP8.5 model), shows that mountainous regions will see considerably less snowfall and resulting snowpack. The cumulative annual drop in snowpack, averaged across all of Oregon, is expected to be by 80 – 90%. Natural ecosystems and Oregon residents will have to adjust to the coming temperature and precipitation trends. Wetlands and lower order streams are vulnerable to drying up; groundwater will decline; and aquatic species, such as native fish, will have to contend with lower stream flow and potentially a lethal increase in water temperatures. Agriculture is taking a hit from the reduced snowpack in the form of less available irrigation water when it is most needed. Cities that have historically relied on snow melt to fill reservoirs throughout the summer are seeking new water sources to meet human consumption needs. Recreational water activities are hampered by falling reservoir

and stream levels, and the winter recreation season is shortening. By choosing to change our carbon emissions habits, we can make the coming changes less drastic.

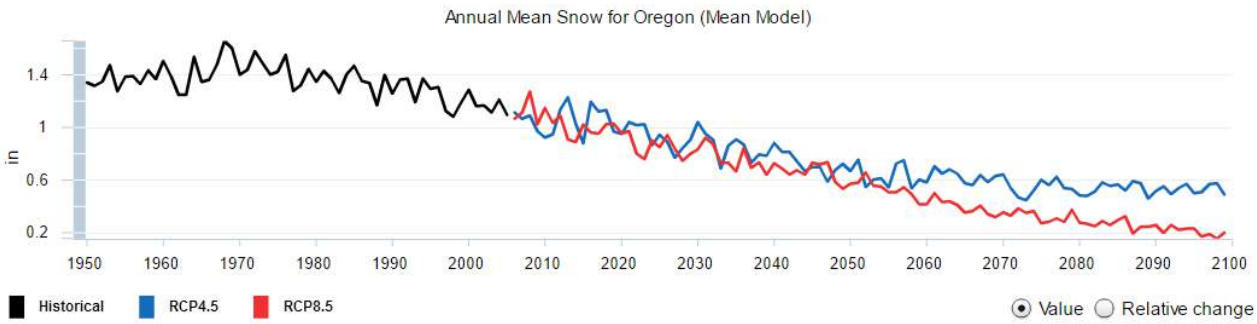

Figure 11. Annual Snowfall Trends and Projections for Oregon.
http://www.usgs.gov/climate_landuse/clu_rd/nccv/viewer.asp

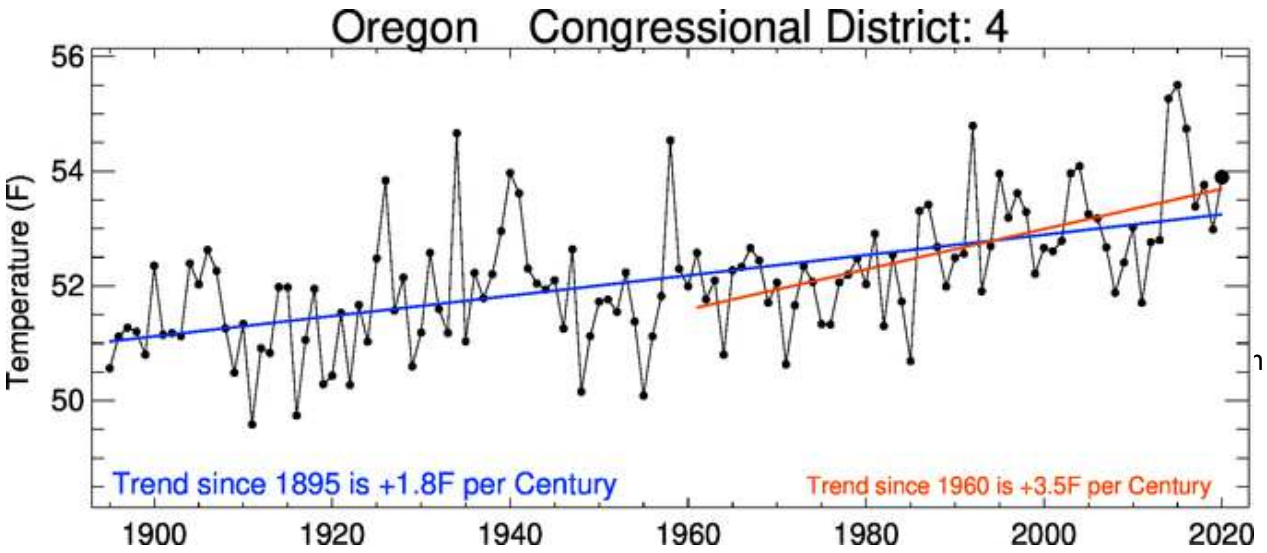

Figure 12 Temperature trends for Congressional District 4 CCT 2018
http://temperaturetrends.org/district.php?district=4&state=OR

Oregon 4th Congressional District Economy

Because of its size and the ecoregions within it, CD4 is one of the most diverse districts in Oregon. The largest employer in the region is health care (https://www.census.gov/mycd/?st=41&cd=04) followed by retail and manufacturing. Oregon's 4th Congressional District is home to the University of Oregon, the largest university in the state and one of the largest employers in the region. Within the last fifteen years breweries and wineries have continued to occupy a larger share of the overall economy. Outside the urban areas in the northern part of the district, CD4's economy is based in large part around forestry,

agriculture, livestock, and tourism and recreation. Each of those sectors is particularly vulnerable to changes in climate.

Forestry

Like all natural systems, our forests are influenced by the key variables of temperature and precipitation, the two factors most influenced by climate change. At the same time, because forests store carbon in their biomass, they can also have a profound direct impact on climate change, as they either store this carbon or release it through fire and logging operations. An important forest - climate interaction exists where each influences the other.

The most important commercial tree species in the 4th Congressional District are Douglas fir and Ponderosa pine (in the southwest region of the district). Their current distributions, and the location of appropriate climate conditions through the century have been analyzed at the USDA Forest Service Labs in Moscow Idaho (Rehfeldt et al. 2006). Their projections, based on

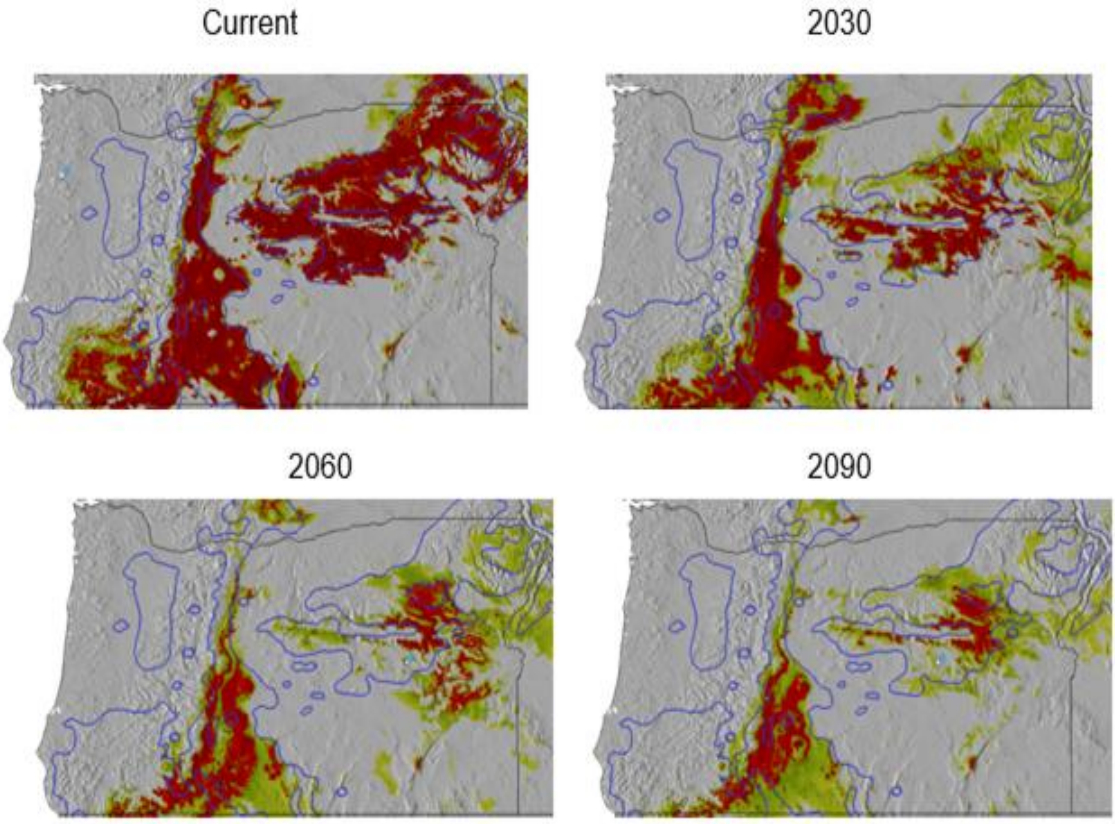

Figure 13. Ponderosa pine (*Pinus ponderosa*) current and projected distribution. http://charcoal.cnre.vt.edu/climate/species/

models that assume a continuation of the current trend of increasing atmospheric carbon dioxide emissions, suggest the geographic range of conditions favorable for these species will be reduced in the future (Figures 13 & 14). This means that the forests and the timber industry of the district will likely be severely challenged as the century unfolds, especially if we do

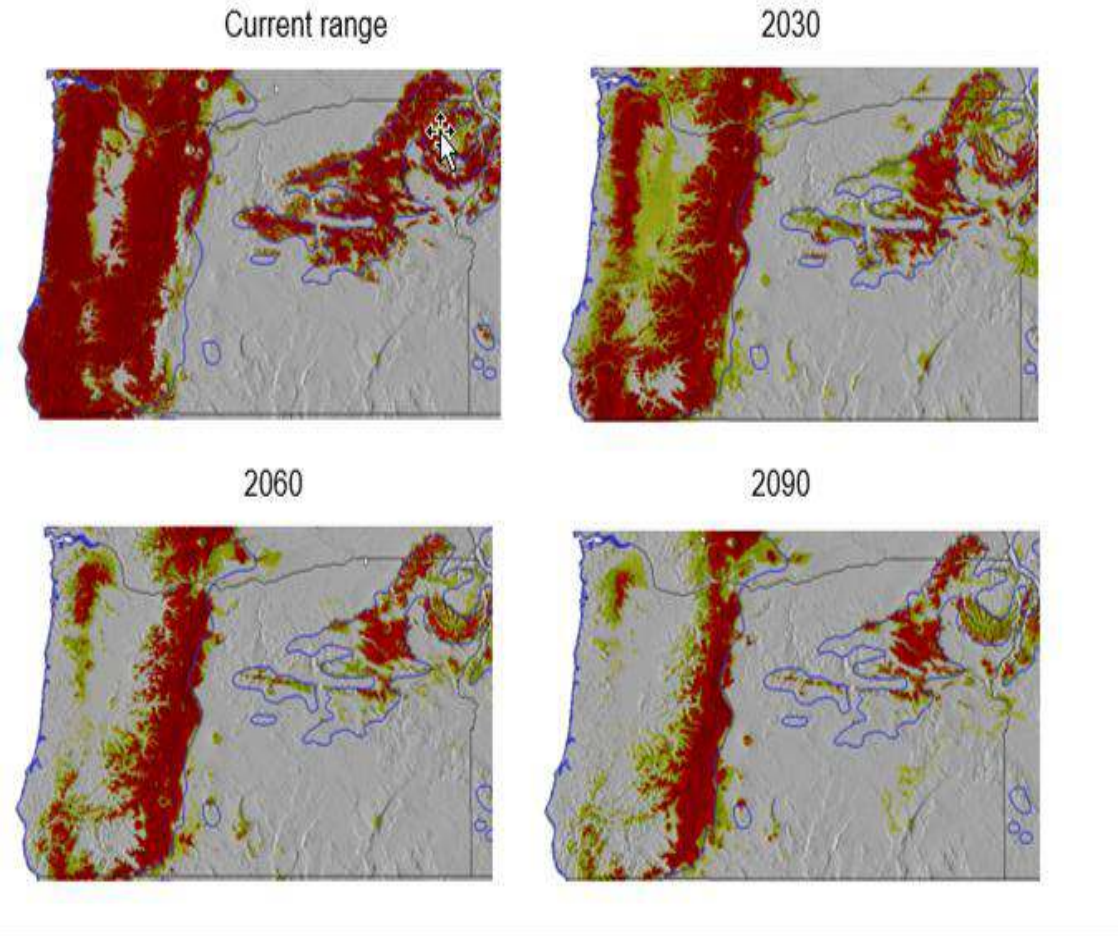

Figure 14. Douglas fir (*Psuedotsuga menzeisii*) current and projected distribution. http://charcoal.cnre.vt.edu/climate/species/

nothing to mitigate the climate trends already evident.

Agriculture and Livestock

Agriculture and livestock production are likely to be negatively affected by climate change. Because climate change, as discussed earlier, is expected to increase temperatures in the region over the next century, lengthen the summer drought period, and reduce winter snowpack and the winter chill period, it will likely become increasingly difficult for farmers

to grow certain crops, while yields will inevitably decrease. Some orchard crops, such as pears, require a lengthy winter chill period in order for them to thrive. Furthermore, many crops grow in a restricted temperature range, and increasing temperatures may make Oregon's 4th Congressional District a less favorable place for these crops over the century.

Wine

The predominant wine varietals in this area are Pinot Noir, Pinot Gris, Chardonnay, and Pinot blanc. Figure 17 depicts the growing season optimal temperatures for varietals grown in the region. Color overlays, inserted by Alan Journet, indicate specific temperature ranges predicted with RCP8.5 for the Willamette Valley, a popular area for wineries within Congressional District 4. Historic temperatures are indicated in blue, while red highlights projected temperatures from 2035-2045, and purple highlights temperatures projected for 2075-2085. While many of the grape varietals grown in this area seem reasonably well-adapted to current growing season temperatures, they all could be severely compromised by mid-century.

Tourism & Recreation

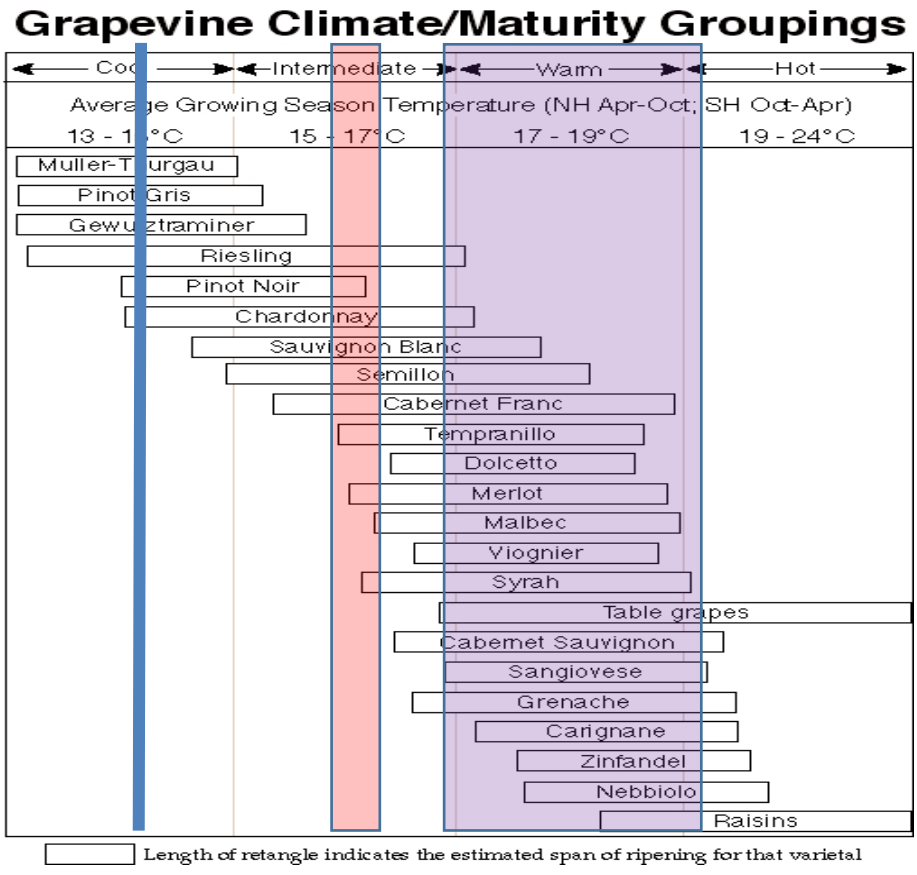

Figure 17. Grape varietal optimum growing season temperatures. Jones 2015

Tourism and recreation are also important parts of Oregon's Fourth Congressional District's economy. Much of the tourism in Oregon is focused on outdoor recreation, which is extremely dependent on the natural resource base and the weather. Impacts from climate change will vary among leisure activity. The region experiences around 150 total days with sun per year, and during

summer visitors enjoy activities such as hiking, birding, mountain biking, rock climbing, camping, golfing, boating, rafting, and whale-watching. In the winter months, whale-watching is still possible in some coastal areas, and cross-country skiing, snowshoeing, and snowmobiling are all popular activities. Both summer and winter recreation will be affected by climate change; the indirect effects of this include the loss of tourism revenues to local restaurants, hotels, and other forms of amusement, and job losses within the recreation and tourism sectors.

According to Travel Oregon tourism produced nearly $4 billion in revenue for Oregon's 4th Congressional District in 2018 (https://industry.traveloregon.com/wp-content/uploads/2020/01/45896-Oregon-Coast-Meaningful-Jobs.pdf, https://industry.traveloregon.com/wp-content/uploads/2020/01/45896-Willamette-Valley-Meaningful-Jobs.pdf). The ongoing health of our natural ecosystems is pertinent to retain that revenue stream. Many plant and animal species will likely be unable to quickly adapt to changing climates and may become extinct or extirpated. Hunters and wildlife enthusiasts may follow the wildlife north, adapt to the new wildlife that will be migrating from the south, or stop engaging in these activities altogether.

Potential Health Risks

As mentioned in the economic discussion above, Oregon's 4th Congressional District has become increasingly popular as a retirement location. Climate change can impact the health of the most vulnerable segments of the population. The Oregon Health Authority conducted a recent study to determine impacts of climate on health. Consequences depicted below in Table 2 could have a severe impact on the health of Oregonians and visitors. Many of the health consequences involve respiratory problems due to heat and particulates emitted by wildfires. Health costs in the area are likely to rise as a result, and the wave of retirees that have recently bolstered the economy may diminish. Not only will the projected climate change be negative for our economy, it will also change the lives of people in the 4th Congressional District.

It's not a question of if climate change will negatively affect the Fourth Congressional District's natural resources, its citizens and its economy, but a question of when and how. Scientists can help to answer some of these questions, but it's up to government officials at every level of government to act now in order to prevent problems before they arise.

Table 2. Climate Impacts to Health
Oregon Health Authority (2014)

Impacts to Health	Top Health Concerns	Vulnerable Communities
Drought	Poor Air Quality	Low-income Households
Wildfire	Poor Water Quality	Native Americans
Heat	Respiratory Illness	Private Well Users
Infectious Disease	Occupational Hazards	Agricultural Workers
	Recreational Hazards	Outdoor Recreation Workers
	Heat-Related Illness	Firefighters
	Displacement	First Responders
	Contaminated Drinking Water	Children
	Water Insecurity	Pregnant Women
	Food Insecurity	Elderly
	Vector-Borne Disease	
	Income Loss	
	Economic Instability	
	Mental Health Impacts	

Renewable resources

One of the most promising renewable energy resources in Oregon's 4th Congressional District is offshore wind capture and conversion into electricity. Oregon has one of the most idyllic locations to generate electricity from wind turbines on wind farms that can then be transported to interior locations for use. A coalition of industry, non-profits, and local government organizations OSWE (oswe.org) has formed in the Coos Bay area to explore and develop the idea. Within the interior of the 4th Congressional District, the potential of low impact hydroelectric dams and solar are yet to be fully explored.

A Timeline for Action:

The trends and consequences discussed here are based on readily available data. Based on the projected consequences of the warming global climate, international agreements (e.g. UNFCCC 2015) have 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 is echoed by the World Bank (2014). Meanwhile, in a startling report, the Intergovernmental Panel on Climate Change (IPCC 2018a) indicated that the 2°C limits pushes us too close to many global tipping points beyond which recovery is less possible, and that we absolutely should target 1.5°C is we wish a reasonable chance of retaining a livable planet. Emissions of greenhouse gases have already induced a temperature rise and inevitable continued rise totaling 1.5°C to 1.6°C (2.7 -

2.9°F) (Dixon 2001). 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. The math tells us that we can only allow another 825 gigatons (billions of tones) of carbon dioxide and equivalent emissions. Global emissions for 2017 totaled 53.7 gigatons of carbon dioxide equivalent (IPCC 2018b) which includes between 32.5 (IEA 2019) and 36.5 Gigatons (WRI 2018) gigatons of carbon dioxide, implying that between 30 and 40% of the global warming emissions are due to gases other than carbon dioxide. Considerable variability exists among estimates of the emissions budget remaining of we are to restrict warming to the 1.5°C or 2.0°C increase targets (Levin 2018, Carbon Brief 2018). Indeed, the latter report identifies a range in estimates for a 66% chance of keeping warming to below 1.5°C from 28 gigatonnes to 779 GT.

Considering the current accelerating rate of emissions, the IPCC (2018a) conclusion that by 2030 we must impose a substantial (45%) reduction in emissions, and we must reach net zero emissions by 2050 seems both conservative and reasonable. It is worth underlining that the World Bank (2012) long ago acknowledged there is: "no certainty that adaptation to a 4°C world is possible."

There can be little doubt that substantial urgency must be attached to addressing this issue.

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