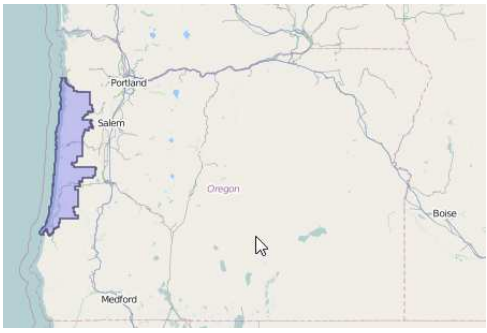
Southern Oregon Climate Action Now

SOCAN

Confronting Climate Change

Climate Change in the Oregon 5th Senate District



July 2017

History, Projections, and Consequences

1 The warming trend during the last half of the 20th century was about 1°F and may be a further 8°F greater by the end of the 21st century.
2 Precipitation has been flat through the last century and is expected to continue thus annually though winters will likely be wetter and summers drier.
3 Snowfall, already dwindling, will continue to fall through the century possibly dropping to 10% of historic levels.
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 tree species of commercial and natural importance will likely be compromised by late century.
6 Climate dependent agricultural activities, such as wine-grape growing, will likely become threatened as warming and water shortages develop.
7 Reduced snowpack, warmer summers and earlier snowmelt will increase wildfire risk, with a 200 – 300% increase in area burned by mid-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 At the current emissions trajectory, we will exhaust our allowance in 17 years if we wish to maintain the global temperature increase below 2°C (3.6°F) as international agreements dictate.
10 Main climate impacts to health 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.

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For a more complete summary, including sources, from which these points are taken, visit: http://socan.eco/oregon-legislative-districts/

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Global and Regional Temperature:

Data from NASA reveal that the Global and U.S. atmospheric temperatures have increased substantially since 1880 (Figures 1 and 2).

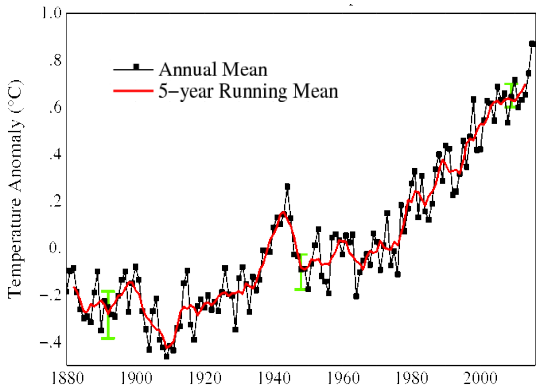


Figure 1. Historic global temperature trend NASA Goddard Institute for Space Studies 2017.

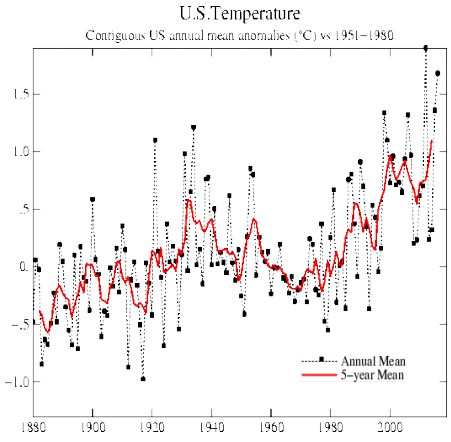


Figure 2. Historic U.S temperature trend. NASA Goddard Institute for Space Studies 2017.

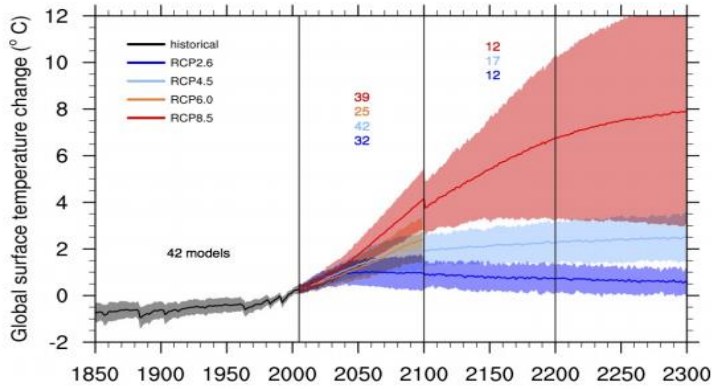


Figure 3. Intergovernmental Panel on Climate Change 2013 global projections.
http://www.climatechange2013.org/images/uploads/WGIAR5_WGI-12Doc2b_FinalDraft_Chapter12.pdf

Depending on the RCP (Representative [Carbon] Concentration Pathway) we follow globally (Fig. 3), this century may result in from a 2^0F increase, assuming immediate action, to a high of over a 9^0F increase. The trajectory beyond the century offers an even more challenging high extreme with an extreme 20^0F hotter. Meanwhile, temperature projections for the Pacific Northwest (Figure 4) suggest a similar range of temperature increases are possible, reaching – as an average – nearly a 12^0F increase by the end of the century

under the Business as Usual scenario (RCP 8.5) in which we continue the current trajectory of accelerating emissions.

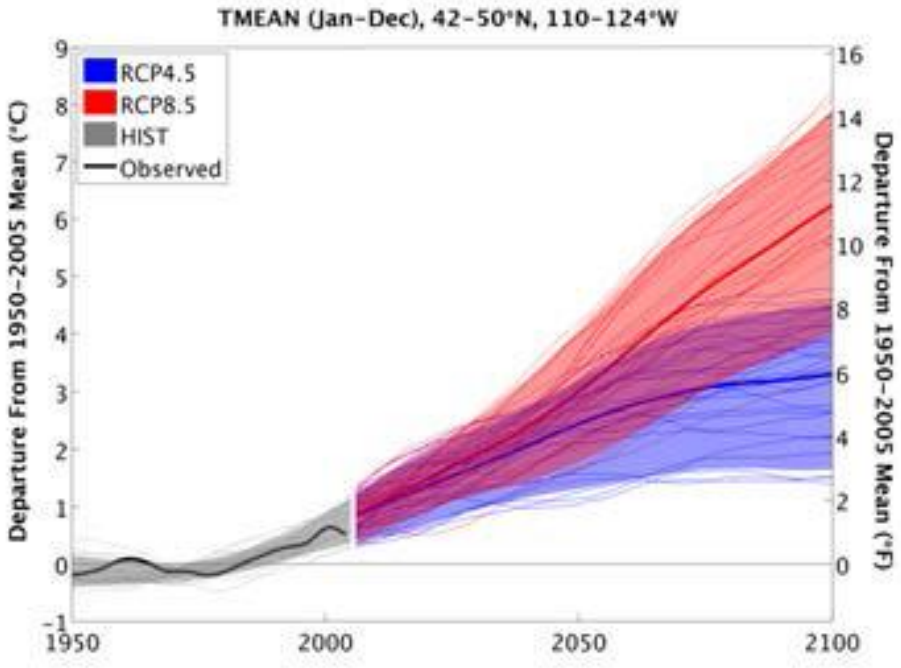


Figure 4. Oregon temperature history and projections through the century (Dalton *et al.* 2013).
http://library.state.or.us/repository/2010/201012011104133/summaries.pdf

The higher range of temperature increase would be unmanageable. It would devastate natural systems (forests, woodlands, shrub lands and the species they support) 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 greater overwintering populations. Similarly, invasion of natural and agricultural systems by drought tolerant invasive species and pests will likely be enhanced.

The lower range for continued temperature increase 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 the 'business as usual' 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, summers will likely be considerably drier.

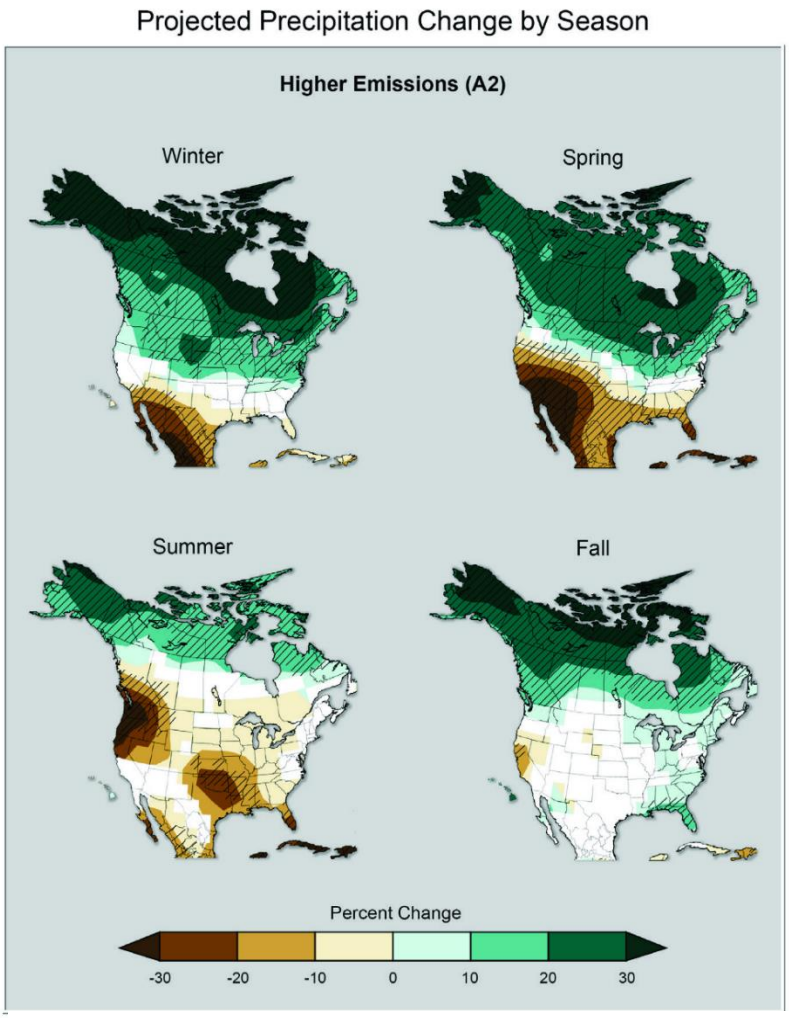


Figure 5. Projected precipitation patterns in the U.S. comparing 2071 – 2099 to the 1900 – 1960 average (Melillo *et al.* 2014). http://www.globalchange.gov/what-we-do/assessment

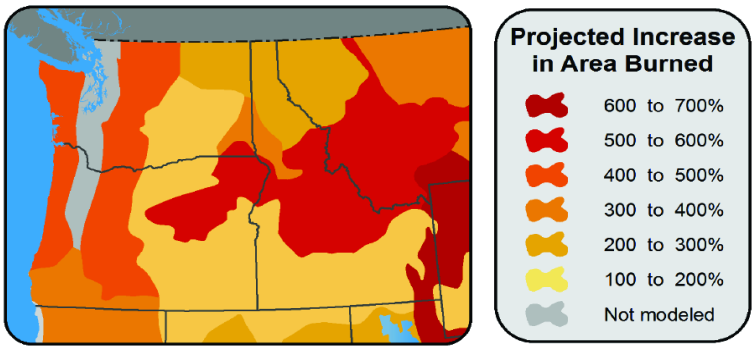


Figure 6. Anticipated wildfire consequences of a 2.2^{0}F warming in area burned (Melillo *et al.* 2014). http://www.globalchange.gov/what-we-do/assessment

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.

Melillo *et al.* (2013) also offered wildfire projections accompanying just a 2.2^{0}F warming, a condition potentially evident by mid-century (Figure 6).

The fire season, already extended by 2.5 months since 1970 (Westerling *et al.* 2006), will likely become longer and more severe in Oregon, with two to six times as many acres burned. Both human safety and human health will likely be threatened.

Coastal Concerns:

Though much of Oregon is land-locked, and will suffer little directly as a result 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. 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 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. Projections for Newport suggest a potential century rise of between 6" and nearly five feet. Higher sea level poses a greater threat than merely its impact on tidal level. 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 have not received any serious consideration – yet it happened! Consequences of ocean rise such as increased erosion and compromised coastal habitat integrity for tidal flat, estuary, and marsh natural communities could become serious.

Ocean Acidification. Serious as 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, our oceans are increasing in acidity. This is detrimental for marine organisms with carbon-based shells since they are unable to form shells in acid conditions, or they lose shells already established. Oysters suffering directly, and salmon indirectly, have been noted as particularly threatened by acidification. Acidosis, a build-up of acidic conditions in the tissues, threatens many marine life forms.

The 5th Oregon Senate District Climate History and Projections:

Although climate change is a complex issue, current models indicate several important trends in weather and climate that Oregon's 5th senate district is likely to experience if carbon emissions continue to increase. These trends include an increase in mean annual temperature (Figure 7). Red represents the business as usual scenario of accelerating fossil fuel use and greenhouse gas emissions while blue represents a lowered emissions trajectory

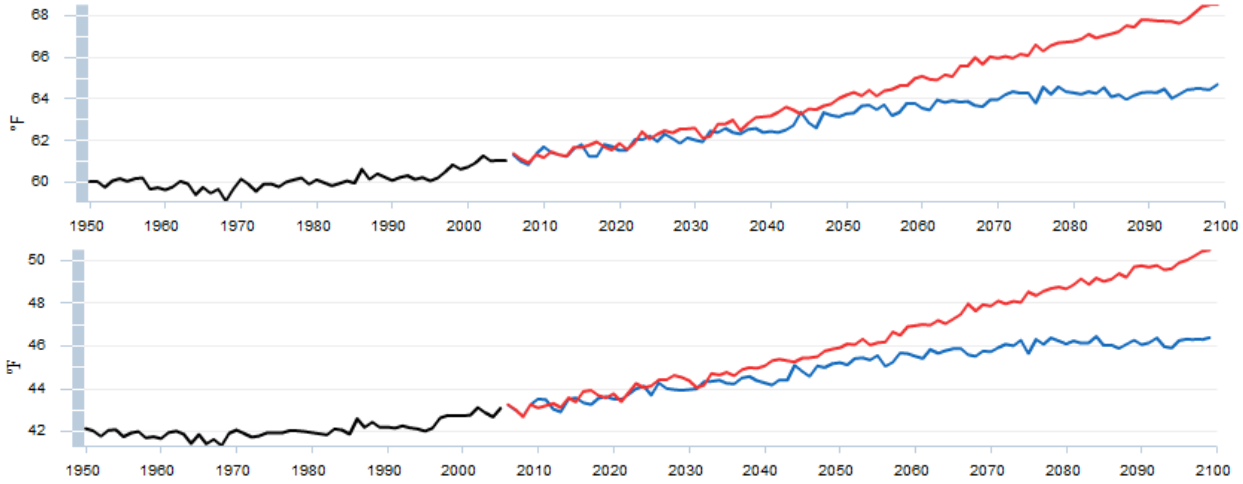


Figure 7. The historical and projected annual temperatures for Lincoln County, upper is mean maximum, lower is mean minimum. Red is business as usual, blue reduced emissions trajectory. USGS 2017

The temperature rose about 1^{o}F during the latter half of the 20th century with a projected rise of up to a further 8^{o}F above the mean for that period by the end of the century.

Precipitation history and projections from Lincoln County, presented in Figure 8, show essentially a constant history and future but with greater variability, meaning wetter and drier years. Should temperatures follow the path suggested above, however, this will likely lead to increased drought.

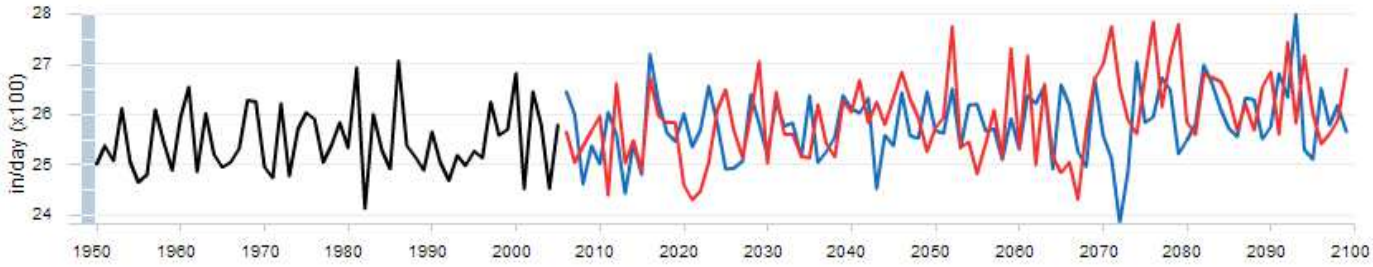


Figure 8. Precipitation history and projections for Lincoln County, Oregon. USGS 2017

Meanwhile, snowfall data for the same county (Figure 9) reveal a recent history of decline and a projected future of continuing reduction. Since accumulated snowfall serves as a source for summer irrigation, the reduced snowfall will likely compromise agriculture in the coming century.

The reduced snowpack also suggests more severe wildfire seasons are likely. The projected

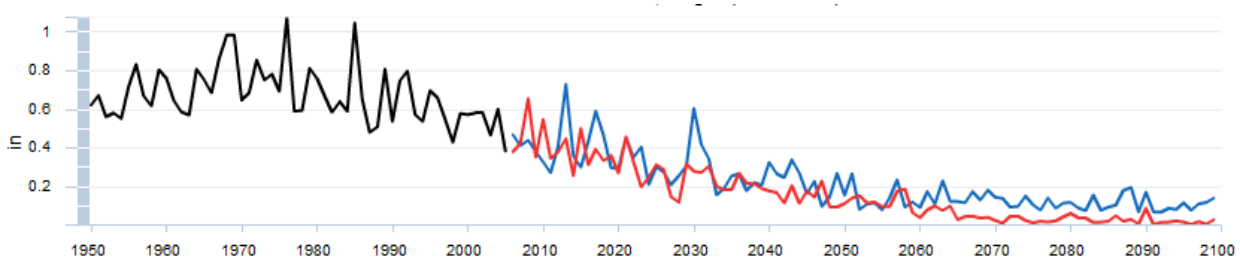


Figure 9. Snowfall history and projections for Lincoln County, Oregon
USGS 2017

trend in snowpack is for a continued decline, possibly to only 10% of historical levels by late century. Combined with the trend towards precipitation falling in heavy downpours on more days rather than light rain on many days as seen historically, this will likely result in earlier and decreased stream flow, a consequence that poses a serious threat to those agricultural activities dependent on late summer and early fall snowmelt as an irrigation source.

Furthermore, snowfall and consequent snowpack accumulation have been declining for decades both at Crater Lake and in the northern Siskiyous, compromising water supplies through the summer.

Federal Congressional District

Oregon State Senate District 5 falls within Federal Congressional Districts 4 and 5. The historic temperature trend for Congressional District 5 (Figure 10) shows an increase of app 2.0^{o}F during the last century a value comparable with Federal Congressional District 4 and the 5th State Senate District.

Oregon 5th Senate District Economy:

Oregon's 5th senate district has a vibrant, viable and diverse economy that is based around agriculture, forestry, fishing, tourism, shipping, and wine growing. Unfortunately, all these

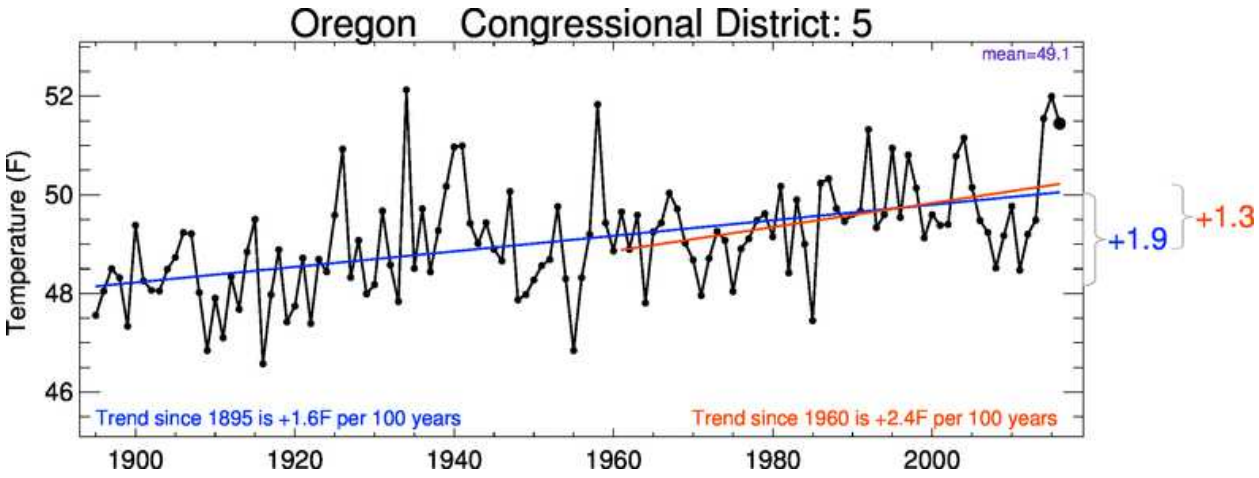


Figure 10. Temperature trend for Federal Congressional District 5.
http://temperaturetrends.org/district.php?district=5&state=OR

industries will undoubtedly be negatively impacted by climate change in the next century if nothing is done now to mitigate potential problems before they arise.

Parts of Oregon's 5th senate district enjoy some of the region's best commercial timber, and logging and timber production are important parts of the district's economy. However, predictions for the future of this industry under climate change scenarios are grim. As temperatures continue to increase over the next century, the range of many of Oregon's commercially important tree species is likely to shift. Projections for the future success of Douglas fir, Western hemlock and Sitka spruce, the most important local species, are presented in Figures 10 – 12. If we follow a 'business as usual' pathway in terms of emissions, where nothing is done to reduce carbon emissions and climate change continues on its projected path, then these tree species could be severely compromised causing problems for the local timber industry. This would mean not only a loss of jobs for the region, but a loss of an important part of Oregon's timber producing heritage.

In addition, given the ability of many Oregon forests to store carbon (Hudiburg *et al.* 2009), it is critical that climatic conditions not diverge such that these important species are compromised.

Figure 10 Douglas fir (*Psuedotsuga menzeisii*) current and projected distribution through the 21st Century
http://charcoal.cnre.vt.edu/climate/species/

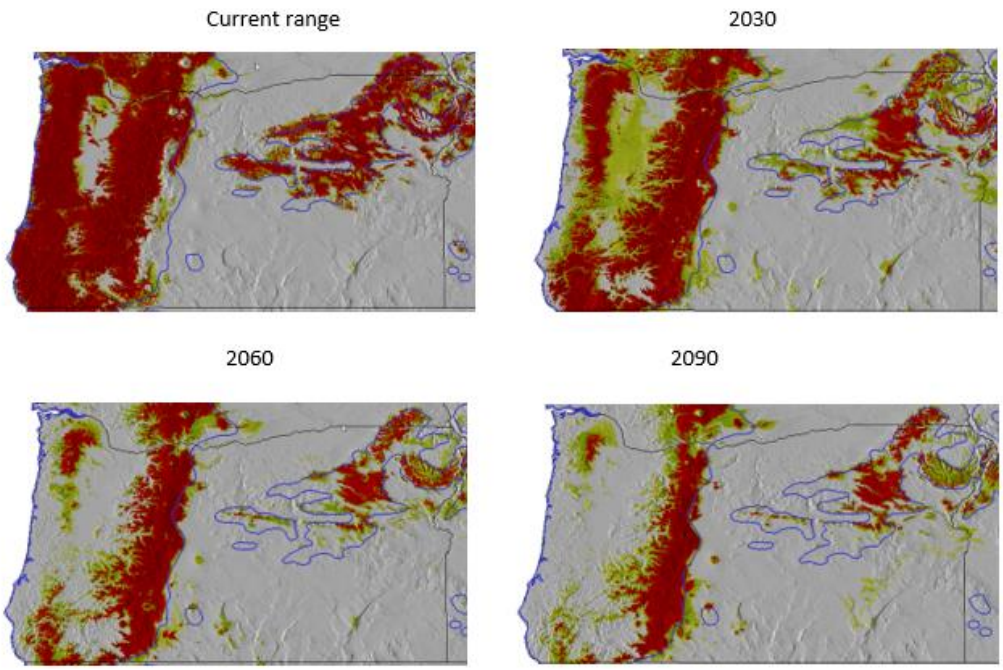


Figure 11 Western hemlock (*Tsuga heterophylla*) current and projected distribution through the 21st Century
http://charcoal.cnre.vt.edu/climate/species/

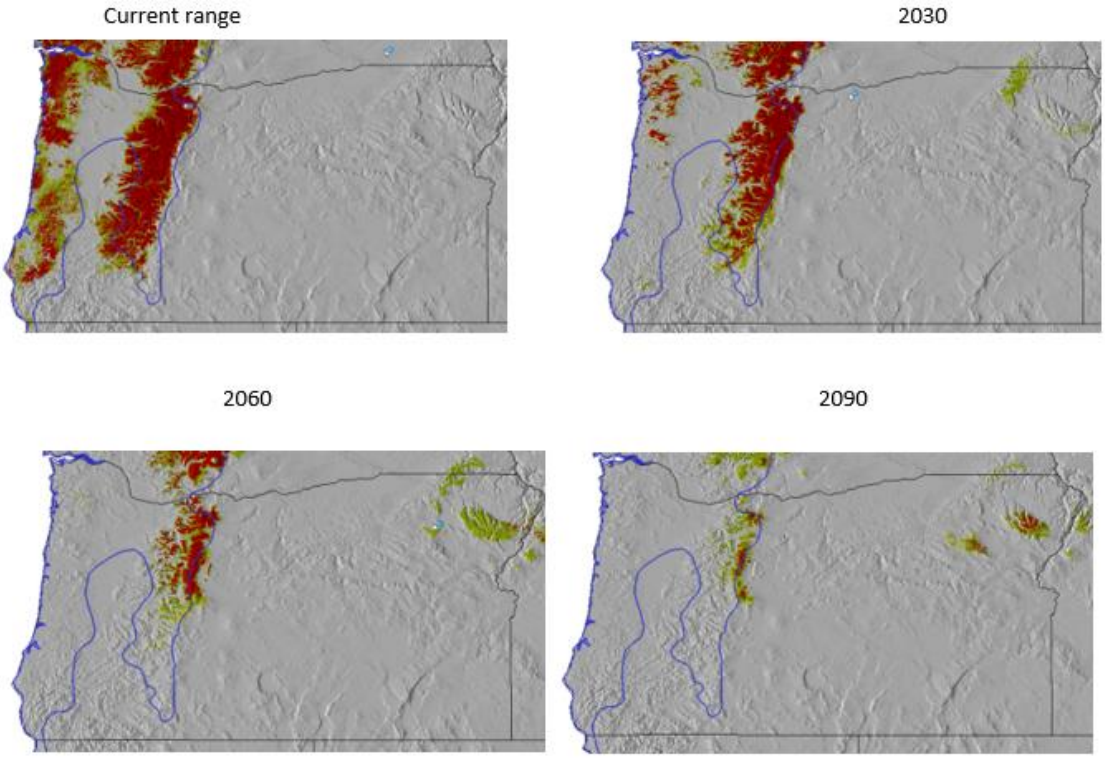
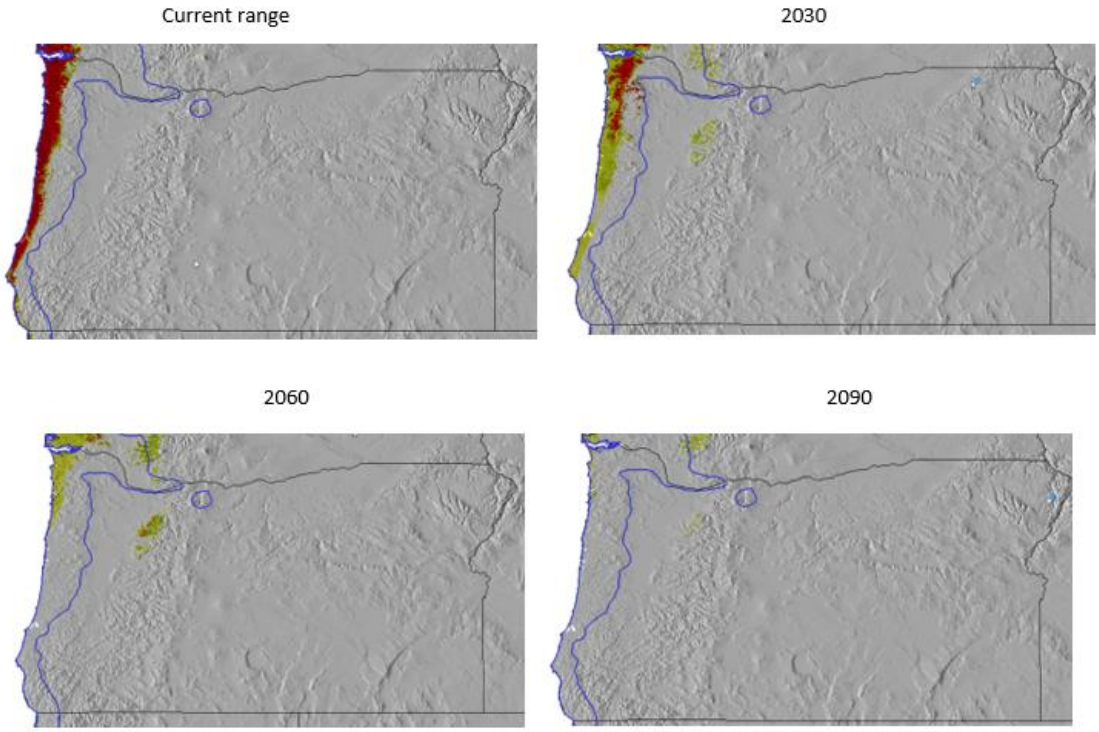


Figure 11 Sitka spruce (*Picea sitchensis*) current and projected distribution through the 21st Century
http://charcoal.cnre.vt.edu/climate/species/



Agriculture is one of the areas that is likely to be hit the hardest by the consequences of climate change. Due to the predicted longer summer drought period, increasing temperatures and a decrease in winter snowpack and winter chill period, irrigating crops and producing high crop yields is going to become increasingly difficult. Parts of Oregon's 5th senate district are the focus of Oregon's vibrant wine economy. However, most varietals of wine tend to grow within a very specific temperature range. This range is likely to shift as temperatures increase throughout the century, making this region a less ideal place to grow some of its most popular varietals of wine, especially Pinot Gris and Pinot Noir. Temperatures may be too warm to effectively grow these popular varietals by the end of the century, which would be devastating not only to the region's wine economy, but to Oregon's wine industry as a whole (see Figure 13).

As previously mentioned, tourism, fishing and shipping are important parts of Oregon's 5th senate district as well. These industries in Oregon's 5th senate district are generally centered on the coast, Coos Bay in particular.

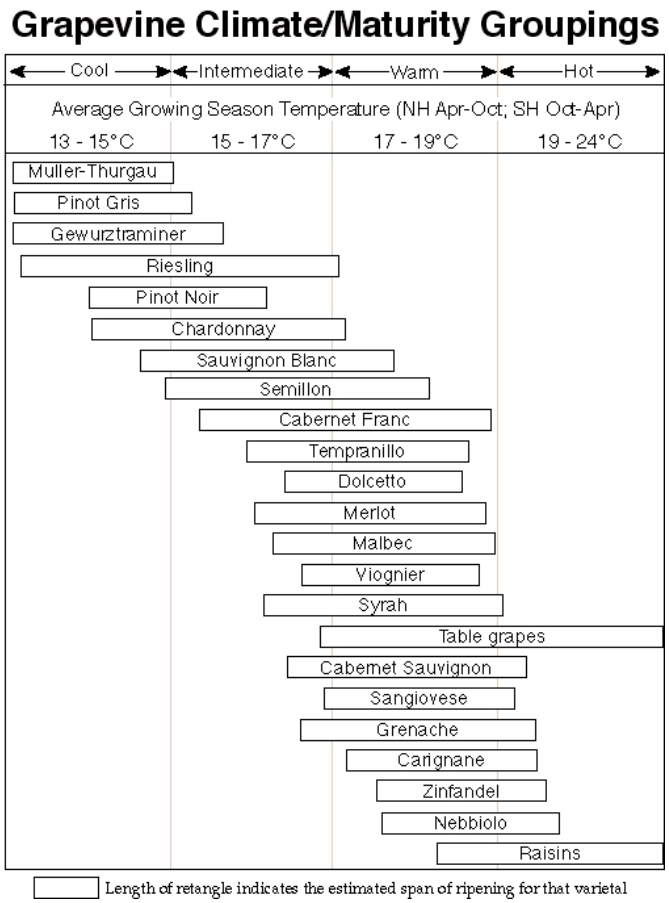


Figure 13. Grape varietal optimum growing season temperature. http://www.sou.edu/envirostudies/gjones_docs/GJones%20Climate%20Change%20Geoscience%20Canada.pdf

The port of Coos Bay, previously the largest shipper of timber in the world, still plays an important part in the region's economy. However, coastal regions are particularly threatened by climate change. Some sources predict that sea levels on the Oregon coast could rise anywhere from 5" to 6 feet. A rise of even 5" could be devastating to coastal infrastructure and development, especially coastal ports. Such damage would also undoubtedly affect the tourism industry along Oregon's coast.

Coastal regions face other challenges, as well, as climate change continues to progress. Studies have shown that ocean acidification, a direct consequence of rising carbon levels from carbon emissions, can have devastating consequences to the development of juvenile fish and the survival of adult fish. Ocean acidification is undoubtedly going to negatively impact coastal Oregon's fishing industry, as fish become more and more scarce.

Because of scientific models, we can predict when and how climate change is going to affect Oregon's 5th senate district. While we may not be able to reverse climate change, there are things that we can do to ensure that Oregon's 5th senate district's economy continues to thrive, even as the climate changes. It is vital, however, that we act now in order to mitigate problems before they arise.

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

Potential Health Risk:

According to the Oregon Health Authority (2014), the main climate impacts to health are likely to be: storms, floods, and sea level rise. The main health concerns resulting from these are: disruption in core services, injuries, displacement, landslides, income loss, economic instability, and mental health impacts. Communities that are especially vulnerable will be: low-income households, older adults, people living on steep slopes, farmers of fish and shellfish, first responders, and children and pregnant women.

Sea Level Rise

By 2100, sea level rise in the Pacific Northwest is anticipated to range from 1 to over 4 feet (Melillo *et al.* 2014, Dalton et al. 2013). This will likely inundate wetlands, and cause declines in quality of tidal flats and beaches. With higher ocean levels, the impact of storms will become more dramatic and destructive. Meanwhile, warming oceans will compromise marine migratory species such as salmon, while these species and others (such as oysters and crustaceans) will suffer more extensively as ocean acidification becomes more severe.

A Timeline For Action

Based on the projected consequences of a warming climate, international agreements (e.g. UN 2009) have established $2^{o}C$ as a limit beyond which we should not allow the global temperature to climb. This limit is echoed by the World Bank (2012, 2013, 2014) and the International Energy Agency (IEA 2009).

The trends and consequences discussed here are based on readily available data. An overall summary of our global temperature trajectory is depicted in Table 1 (from Quick M 2014) This shows that emissions of greenhouse gases to date have induced a temperature rise and inevitable continued rise totaling 1.5°C to 1.6°C (2.7 - 2.9°F) (Dixon 2001). If we wish to avoid an increase over 2°C, the math tells us that we can only allow another 825 gigatons (billions of tons) of carbon dioxide and equivalent emissions. Given that the current annual rate of global emissions is 37 gigatons (Le Quéré *et al.* 2014) and assuming the 'business as usual' scenario of accelerating emissions is followed into the future as it has been to date, we will exhaust this budget in about 17 years. Unfortunately, if known and suspected fossil fuel reserves were extracted and burned, the temperature impact would be far in excess of that agreed 2°C upper limit. In relation to shooting beyond 2°C, the World Bank (2012) acknowledged there is: "no certainty that adaptation to a 4°C world is possible."

Table 1 Carbon Dioxide Emissions and Temperature Consequences

Emissions	Gigatons CO_2 added to atmosphere	Temperature increase
1850 – 2000	**1035**	**0.8°C**
2000 – Now	**440**	**1.5°C**
Allowed	**825**	**2°C**
Fossil Fuel Reserves	**725**	**3 - 4°C**
Accessible Reserves	**780**	**5 - 6°C**
Additional Reserves	**1280**	**??**

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

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