EXECUTIVE SUMMARY
TO THE SPOKANE CLIMATE VULNERABILITY AND RESILIENCE ASSESSMENT

Climate Impacts Research Consortium
A NOAA RISA TEAM

RISA
Regional Integrated Sciences and Assessments

About this Report

This executive summary is the first released document of a larger climate and weather vulnerability and resilience assessment for Spokane, Washington and its surrounding working lands and ecosystems. The full assessment is scheduled for completion in the spring of 2020. This document and the assessment to follow compiles the key research findings of the Spokane Community Adaptation Project (SCAP). Under the guidance of the NOAA-funded Climate Impacts Research Consortium (CIRC), SCAP participants from Spokane used CIRC's suite of online climate science tools, the Northwest Climate Toolbox, to investigate how climate and weather-related impacts, including rising temperatures, wildfire, and the loss of snowpack, are expected to affect Spokane in the decades ahead. SCAP participants wrote up their findings and presented them at the recent Spokane River Forum. These findings are presented here in brief. To determine the local impact of the Toolbox's climate data, section authors went the extra mile, interviewing local business owners and their fellow Spokane residents.

Climate Impact Categories

SCAP participants chose to explore climate and weather impacts related to the following:

- Temperature
- Precipitation
- Snow
- Fire
- Streamflow

About The Spokane Community Adaptation Project (SCAP)

The Spokane Community Adaptation Project (SCAP) is a collaborative effort between the Climate Impacts Research Consortium (CIRC) and the community of Spokane, Washington. SCAP's goals are to identify climate and weather impacts faced by the Spokane community as well as resiliency actions designed to keep the community, its economy, and natural systems healthy and prosperous.

SCAP participants include representatives from city and county entities, local universities, local nonprofits, and local businesses.

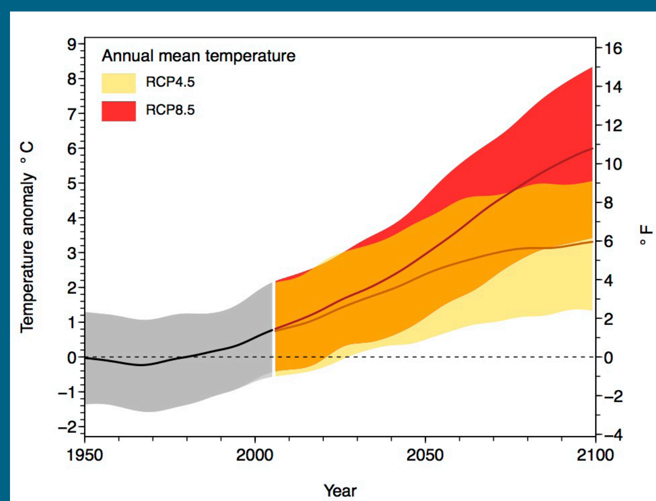
About CIRC

The Climate Impacts Research Consortium (CIRC) is a team of climate and social science researchers based in the Northwest United States. CIRC helps Northwest communities become more resilient to extreme climate and weather impacts. CIRC is publicly funded through the National Oceanic and Atmospheric Administration's Regional Integrated Sciences and Assessments (RISA) program. Part of NOAA's Climate Program Office, the RISA program supports research teams that help expand and build our nation's capacity to prepare for and adapt to climate variability and change. CIRC members can be found at Oregon State University, the University of Idaho, the University of Washington, and the University of Oregon.

Key Term: *Emissions Scenario*

The writers of this report primarily used the greenhouse gas emissions scenario (RCP 8.5) when examining future climate impacts. This scenario simulates in a computer what is likely to happen if greenhouse gases continue to be released into the atmosphere at their current rate.

RCP 4.5, a lower emissions scenario that assumes dramatic reductions in greenhouse gas emissions, was used by many groups as a useful comparison to RCP 8.5, offering a glimpse into a future in which emissions and climate impacts are reduced.



Caption: Projected annual temperature simulations for both high emissions scenario (RCP 8.5) and lower emissions scenario (RCP 4.5) for the Northwest United States to the year 2100. (*Figure source: David E. Rupp; data source: Rupp et al. 2016, adapted.*)

Temperature

Lead Authors: Kara Odegard (Measure Meant), Rebecca MacMullan (350 Spokane), Jim Simon (Gonzaga University), and David Camp (Northwest Renewables)

Climate Data Story—Bloomsday

Held every year in May, Spokane's Lilac Bloomsday Run (Bloomsday) is a seven-and-a-half mile run that draws roughly 50,000 participants and raises money for charities. Bloomsday is already experiencing an increase in heat-related health issues. During the May 2018 Bloomsday race, warmer-than-normal temperatures likely led to an increase in heat-related illnesses and an increase in the dropout rate for the race. Heat-related illnesses will likely be a factor during future Bloomsdays. A comparison between recorded historical temperatures and projected future temperatures shows how. The first Bloomsday run was held in 1977. The mean maximum daily temperature for May for the race's early years (defined here as 1971–2000) was roughly 68 degrees Fahrenheit. By the end of this century (2081–2099), mean maximum daily temperature for May is projected to be 76°F under the high emissions scenario (RCP 8.5), an increase of over 8°F. The increase in temperature strongly suggests the likelihood of a corresponding increase in heat-related health issues during Bloomsday.

Key Findings:

1. Strong evidence suggests that human-caused climate change is leading to rising temperatures that will correspond to a rise in heat-related illness.
2. By the end of this century (2070–2099), mean annual temperature for the Spokane region is projected to be 9.5 degrees Fahrenheit warmer than it was from 1971 to 2000.
3. Temperatures in the Spokane region are projected to rise steadily across all months of the year.
4. By the 2070s, the hottest summer day is projected to be even hotter than the hottest summer day recorded for the historical period (1971–2000), increasing by 11°F.
5. Projected changes in Spokane's climate over the next 30–60 years include an increase in the number of peak summer temperatures throughout the year.
6. Rising temperatures create future challenges in the Spokane region that will require planning and preparation to protect the health and safety of outdoor workers and vulnerable populations. (Heat vulnerable populations include the young, the elderly, individuals with certain chronic diseases, the unsheltered, low-income households, and outdoor workers. Other groups affected by heat stress include infants, school-aged children during outdoor activities, outdoor athletes of any age, and first responders, including police, firefighters, and paramedics. Domestic animals and wildlife may also be vulnerable to heat stress.)

Resiliency Actions:

1. The negative outcomes of the high emissions scenario (RCP 8.5) can be mitigated by swift and significant reductions in greenhouse gas emissions. Many solutions to prevent dangerous climate conditions are currently available. These solutions require ongoing commitment, financial support, and political will at both the local and global level to ensure effective implementation.
2. Over the next 30–60 years, high heat dangers should be considered when scheduling outdoor public events.
3. Health and safety officials should create and promote safety protocols for extreme heat events with particular concern for outdoor workers, outdoor recreation/athletes, and vulnerable populations.
4. First responders should be trained and equipped to treat heat stress.

Precipitation

Lead Authors: Joel Breems (Avista) and Kevin Booth (Avista)

Climate Data Story—Dryland Wheat Farming

Dryland farming is dependent solely on precipitation for all of the moisture required for crop growth, maturation, and productivity. In the Inland Northwest, dryland farming dominates much of the landscape. In 2018 alone, Washington farmers produced 153 million bushels of wheat, according to the Washington Grain Commission. To get a sense of the potential climate impacts to dryland farming in the Spokane region, the authors of this section examined dryland wheat farming.

Dryland wheat production requires 8–25 inches of rain in the fall, winter, and spring, and benefits from relatively dry summer months. Additional research out of Washington State University has suggested that for dominant wheat varieties in our region 2.3 inches of soil moisture is required for vegetative growth. Each additional inch of soil moisture available to the plant for growth translates to an additional 5.6 bushels per acre yield. According to future climate projections tracked in the Northwest Climate Toolbox, the Spokane region will continue to meet the precipitation timing and volume requirements for dryland wheat production.

Key Findings:

1. The timing and volume of precipitation in the Spokane region is not expected to dramatically change over this century.
2. In recent decades, the Spokane region has experienced a trend of slightly increasing annual precipitation, slightly decreasing precipitation during the summer months, and slightly increasing precipitation during the fall, winter, and spring months.
3. In general the observed historical trend is expected to continue throughout this century.
4. Precipitation should not be considered alone. When precipitation is considered along with temperature increases, several climate impacts come to light, including decreased mountain snowpack (see *Snow* section of this report), changes in the timing and flows of local streams and rivers (see *Streamflow*), and increased likelihood of wildfires (see *Fire*).

Resiliency Actions:

1. Farmers could select more frost-resistant crops to plant.
2. Farmers could change the timing of spring planting if increased frost mortality is observed.

However, when considered with other climate variables, such as temperature, several other potential impacts to agriculture become apparent.

The temperature projections for the Spokane region show a strong trend of increasing average annual temperatures. This warming is projected to occur during all four seasons, including the winter months. Warmer winter temperatures could result in more precipitation falling as rain and less as snow, particularly at lower elevations. This is important for agriculture because winter snowpack provides an insulating effect, protecting dormant crops from freezing temperatures. A reduced or absent snowpack could increase the susceptibility of some crops to frost damage.

Snow

Lead Authors: Brian Henning (Gonzaga University), David Camp (Northwest Renewables), and Erik Budsberg (Eastern Washington University)

Climate Data Story— Mt. Spokane Ski & Snowboard Park

Over the course of this century, projected temperature increases and the increasing likelihood that precipitation will fall as rain rather than snow during the cold months of the year is likely to shrink the length of the ski season and lead to economic impacts to the region's five ski resorts (Mt. Spokane, 49 Degrees North, Silver Mountain, Schweitzer Mountain, and Lookout Pass). For the purposes of this summary, the authors focused on future climate impacts at one of these five resorts: Mt. Spokane Ski & Snowboard Park. By the middle of this century (2040–2069) during the prime ski season (December–February), average mean temperature at Mt. Spokane is expected to rise from a historical mean of 25.9 degrees Fahrenheit to a best case scenario of 30.6°F (under RCP 4.5) and a worst case of 31.8°F (under RCP 8.5). During this same mid- century period, the annual number of days below freezing (32°F) is expected to drop from a historical average of 170 days to 128 days under the lower emissions scenario (RCP 4.5) and to 112 days under the high emissions scenario (RCP 8.5). In other words, there is expected to be 42–58 fewer freezing days per year by mid-century compared to what was observed during the last three decades of the 20th century. The decrease in the number of days below freezing means that winter precipitation at Mt. Spokane is 25–34% more likely to fall as rain instead of snow.

Fewer days below freezing also means fewer days cold enough to make snow with equipment and more days when snow is melting. Another way examine the impact to Mt. Spokane is to consider the length of the ski season by examining the first fall freeze day and the last spring freeze. During the last three decades of the 20th century, the first fall freeze day was around October 1st, while the last spring freeze was around May 15th–16th. By the middle of this century, the first freeze is projected to be 11–14 days later in the fall, while the last freeze of the season is expected to be 18–25 days earlier in the spring. Though an indirect indication, it is reasonable to infer that the dates of first and last freeze establish the broadest possible length of the ski season, meaning by mid-century, the local ski season could shrink by 29–39 days.

Key Findings:

1. Projected changes in the Spokane-area's climate over the next 30–60 years include: an increasing shift of precipitation from snow to rain during the fall, winter, and spring months, leading to a reduction in snowfall; a decrease in the total number of days below 32 degrees Fahrenheit; a later start of winter and an earlier start of spring.
2. There is strong evidence to suggest that human-caused climate change poses a continuing threat to the vitality of winter sport recreation in the Spokane region and that these impacts will worsen throughout the 21st century.
3. All five Spokane-area ski resorts will likely be impacted by rising temperatures.
4. Reducing greenhouse gas emissions—moving from the high emissions scenario (RCP 8.5) to the lower emissions scenario (RCP 4.5)—could mean the difference between a degraded but viable ski season and a nonviable ski industry for all five resorts.

Resiliency Actions:

1. The primary action for mitigating the risk of increased temperatures in the Spokane region is to reduce greenhouse gas emissions in order to avoid the high emissions scenario (RCP 8.5).
2. Snow-dependent recreation industries in the Spokane area, such as skiing, snowboarding, snowshoeing, and snowmobiling, need to prepare for seasons that start later, are shorter, and have less snow.
3. Winter recreation industries in the Spokane region should consider diversifying their business model. This should include emphasizing warmer weather recreation activities.

Fire

Lead Authors: Mike Petersen (Lands Council), Jerusha Hampson (Lands Council), Levi Keesecker (E2 Environmental), Wei Li (E2 Environmental), Terry Lawhead (ret.), Katherine Rowden (NOAA), and Joel Breems (Avista)

Climate Data Story—Local Forest Fires

Spokane is surrounded by forests. While wildfires have long been a natural feature of this landscape—for instance, playing a role in forest succession—wildfires can be incredibly destructive to human life and property as well as wildlife and ecosystem services.

The primarily means through which climate change is expected to impact wildfire potential in the Spokane region is through fuel dryness. The National Fire Danger Rating System employs several fire indices to determine fire danger according to how dry local vegetation is. This analysis employs the *100-hour fuel moisture index*, the standard metric used to by foresters and wildland firefighters to determine the risk of fire ignition and how fast a fire could spread. (Readers may already be familiar with this metric. The 100-hour fuel moisture index is used to create the color-coded fire danger scale that Smokey Bear stands next to at the entrance to our nation's national forests.) For this analysis, the authors of this section look at *Extreme Fire Danger Days*, which is defined in the Northwest Climate Toolbox as calendar days that fall into the lowest 3rd percentile of fuel dryness as defined by the 100-hr fuel moisture index. Future projections indicate that over the entire Spokane region (defined as the HUC10 Spokane watershed), the number of Extreme Fire Danger Days will increase throughout this century. The number of Extreme Fire Danger Days are projected to number 13.9 days through the early decades of this century (2010-2039), and 20.4 days for the middle decades (2040-2069). While the 100-hour fuel moisture index does not predict that fires *will* occur only that they are *likely* to occur given the right ignition source (be it human or natural), the rise in the number of days with extremely dry fuels is very likely to produce more days of wildfire each year.

Key Findings:

1. Rising temperatures are expected to make conditions ideal for larger, more destructive wildfires in the Spokane area.
2. Spokane has been experiencing wetter springs, followed by drier, hotter summers. This setup—spring moisture aiding plant growth that dries out in summer, becoming fuel—puts the Spokane area at high risk of wildfire.
3. Under the high emissions scenario (RCP 8.5), climate projections indicate a continuation of this trend over the entire Spokane region.
4. The number of Extreme Fire Danger Days will increase throughout this century.

Resiliency Actions:

1. Prepare for increased fire and smoke/ash danger through policies and adaptation strategies. This could include strategies for monitoring air quality related to outdoor activities (such as school recess) and, when necessary, issuing particulate masks at large outdoor events.
2. Create "air quality shelters" for vulnerable populations by providing large public spaces—school gyms, community centers, etc.—with high quality air filtration systems.
3. Manage forests to reduce the amount of fuel available through, for instance, prescribed burns.
4. Create education outreach campaigns that:
   a. Ensures the public understands why fire management strategies, such as prescribed burns are being used;
   b. Encourages voluntary compliance with fire safe housing recommendations (clear space around homes and structures);
   c. And communicates health risks associated with smoke and ash.
5. Create new regulations designed to increase defensible areas around structures for business and homeowners in the wildland/urban interface.

Streamflow

Lead Authors: Karl Rains (WA Department of Ecology), John Porcello (GSI Water Solutions, Inc.), Kara Odegard (Measure Meant), Jule Schultz (Spokane Riverkeeper), and Brad Morin (Spokane Riverkeeper)

Climate Data Story—Recreation on the Spokane River

The Spokane River is arguably the region's top natural attraction, especially during the spring and summer months. Summertime recreation associated with the river have a significant economic impact for our region, amounting to nearly $1.2 billion and 12,500 jobs annually, according to the Washington State Recreation & Conservation Office 2015. To determine the impact of projected low flows during the summer and earlier high flows during the spring, several individuals representing local paddling organizations and commercial rafting enterprises were interviewed by the authors of this section. Although qualitative information from the individuals was mixed, a few common themes came out of the discussions. The first is that the lower portion of the river—which includes the Spokane River Gorge, the Bowl & Pitcher rock formation, and the Devil's Toenail whitewater rapids—relies on a minimum flow of approximately 2,500 cubic feet per second (cfs) for the commercial rafting companies and most kayakers to safely navigate. Once flow drops below 2,000 cfs, all but the most extreme kayakers are limited to milder "float" trips, which include longer sections of calmer water. Historical stream flows typically allowed rafting companies to market whitewater trips through this section during the month of June when school is out and many Americans begin their summer vacations. By the end of the century, flows conducive to "whitewater" rafting and kayaking could cease earlier in the year, limiting local rafting companies from capitalizing on the combination of warmer temperatures and summer vacation plans.

Key Findings:

1. In the coming decades, the shift of precipitation from snow to rain during the fall, winter, and spring months is expected to alter the timing of streamflow.
2. Because annual future precipitation projections are expected to remain similar to historical observed conditions, the total annual volume of streamflow is also expected to remain similar to historical levels even while the timing of this flow changes.
3. Projections suggest that as temperatures rise in the Inland Northwest, snow from the mountains will thaw faster and earlier in the season, creating earlier seasonal high flows during the spring months and more noticeable low flow rates in the river during the summer months.
4. Summer flow rates in the river are projected to decrease throughout the 21st century.
5. Impacts from these low summer flows are likely to intensify over time, particularly if greenhouse gas emissions are allowed to continue increasing at their current rate.
6. By the end of the century, flows conducive to "whitewater" rafting and kayaking may cease earlier in the year.
7. The expected changes to the unregulated flow of the Spokane River would have several detrimental impacts, including for native Redband Trout, summer recreational opportunities, and the general aesthetic value that the Spokane River provides.

Resiliency Actions

1. Take all possible actions to reduce greenhouse gas emissions.
2. Reconsider regulations at Post Falls to help prioritize Redband Trout habitat.
3. Conduct more research to fully understand the longer-term impacts of climate change on the Spokane Valley-Rathdrum Prairie aquifer.
4. Investigate well-depth and pump technology.

Climate Data Story—Redband Trout

The Redband Trout is the primary native species of the Spokane River. The Washington Department of Fish and Wildlife considers Redband Trout a *sentinel species*, meaning the species' health and abundance are indicating factors of the overall health of the river ecosystem. Over the past century, many factors have contributed to a decline in the population of Redband Trout. Projected future changes in streamflow rates are likely to exacerbate this decline. The greatest impacts to the species will likely occur in the upper Spokane River, where populations are already depressed. Projected reduced flows below Post Falls Dam would result in warmer water temperatures that benefit smallmouth bass (a non-native species) and approach the upper lethal temperature range for Redband Trout. Earlier peak-flow and reduced summer flows will also decrease viable rearing habitat. Reduced flows in late May/early June are predicted to dewater and desiccate trout eggs, reducing trout populations.

Climate Data Story—Spokane Valley-Rathdrum Prairie Aquifer

The Spokane Valley-Rathdrum Prairie (SVRP) aquifer is the sole source of drinking water for over 500,000 people. According the analysis performed here, the SVRP appears to be less sensitive to climate change impacts than aquifers in other regions due to how the aquifer is recharged. Water levels in the SVRP are primarily recharged by the Spokane River as well as by regional lakes. While seasonal changes in streamflow under projected climate conditions are anticipated, because the timing and volume of annual precipitation in the Spokane region is not expected to dramatically change over this century, this could suggest that the annual volumes of aquifer recharge could remain stable. However, SVRP levels could drop below their observed historical levels should the region experience multi-year droughts. Due to the low water levels observed in the SVRP during the past few summers, the City of Spokane is now actively working to understand the resiliency of several of its water supply wells and to evaluate what types of modifications (if any) to certain wells and/or pumping systems might be warranted for future implementation. More research is needed before we can fully understand the longer-term impacts of climate change on the Spokane Valley-Rathdrum Prairie aquifer.

Resources:

- **Spokane Community Adaptation Project page:** https://pnwcirc.org/spokane-communityadaptation-project
- **CIRC website:** http://pnwcirc.org/circ
- **The Northwest Climate Toolbox:** https://climatetoolbox.org/
- **The Northwest Climate Toolbox Workbook:** https://pnwcirc.org/sites/pnwcirc.org/files/nwct.pdf
- **CIRC's newsletter, *The Climate CIRCulator*:** https://climatecirculatororg.wordpress.com