Summary of climate-related changes in the Nez Perce-Clearwater National Forest				
Climate variable	**Changes experienced historically**	**Direction and range of change expected in the future**	**Seasonal patterns of change**	**Confidence**
Air Temperature	Over the past 30 years, air temperature has been increasing an average of 0.13°C per decade.[1] In the PNW region and Columbia Basin, 84% of monitored sites display an increase of 0.5°C or more over the period 1950-2006.[2] From 1915-2003, average winter temperatures in the Nez Perce region ranged from -10°C to 0°C.[3] From 1900-2003, mean temperature in January ranged from -3 to -8°C and from 18 to 19°C in July across Idaho and western Montana.[4]	Across the greater PNW and Columbia Basin, an ensemble forecast from ten of the best performing GCMs project that under the IPCC A1B CO_2 emissions scenario regional climate will warm by an estimated 2.1°C by 2040 and 3.8°C by 2080.[2]	Air temperature change has been most pronounced during summer months (0.36°C per decade) relative to spring months which have witnessed a general cooling (-0.13°C per decade).[1]	Temperature is projected to increase according to all of the GCMs under multiple IPCC emissions scenarios. Thus regional warming is almost certain in the future.[2]
Precipitation	Across Idaho, precipitation estimates range from an annual mean of 60.9-182.9 cm (1900-2003)[4] or an average of 69.94 cm from Oct.-March (1963-1996).[5] From 1950-2006, there has been a slight increase in precipitation around the Nez-Perce.[2]	Precipitation trends are more correlated with decadal sources of variability than long-term climate trends making it difficult to detect any trends associated with climate change. It is therefore difficult to project how precipitation may change in the future.[3] However, an ensemble forecast from ten of the best performing GCMs project that under the IPCC A1B emissions scenario, the PNW and Columbia Basin region on average will see no precipitation changes by 2040 and be 2% wetter by 2080.[2]	Models project that JJA will experience a decrease in precipitation while all other months experience a slight increase.[2] Note also that the Pacific Decadal Oscillation (PDO) may best explain the decadal variability seen in precipitation patterns; cool PDO equates with wetter conditions, warm PDO equates with drier conditions.[3]	We have low skill in predicting precipitation trends in the PNW. A longer-term and larger-scale response to climate warming cannot be ruled out but currently the PDO signal overwhelms any other potential signal.[3]

Summary of climate-related changes in the Nez Perce-Clearwater National Forest				
Climate variable	**Changes experienced historically**	**Direction and range of change expected in the future**	**Seasonal patterns of change**	**Confidence**
Wildfire	The most intense fire seasons have occurred in the early and late 20th century: 6 from 1900-1934 and 5 from 1988-2003. Fires are becoming more extensive in cold and dry forests.[4] Since the 1980s, increased wildfire frequency has been concentrated at elevations centered around 2130 m and the greatest absolute increase in large wildfires has occurred in forests of the Northern Rockies. While fire suppression policies have impacted fire regimes in some areas across the western U.S., it has had little impact on the natural fire regime in the Northern Rockies.[6]	In Idaho forests, fire years are most common and intense in years when warm springs with low snowpack are followed by warm, dry summers and when the PDO is positive (which influences spring temperatures in the northern Rockies).[4] Given that the climate models predict that the future will have warmer springs, less snowpack and earlier melt, and drier summers, large fires are expected to become more common.[4,6]	Year to year variability caused by ENSO does not appear to dramatically influence the fire season in the PNW. Rather, long term change induced by shifts in the PDO appears to be correlated with the intensity of the fire season.[4]	We have relatively high confidence that as air temperatures rise, the frequency and intensity of wildfires will also increase. Temperature alone explains roughly 66% of the variance in the annual incidence of fires in western forests.[6]
Snowpack	From 1916-2003, models suggest that snow water equivalent (SWE, amount of water contained in snowpack) in the Nez Perce region has increased by 0-0.5% per year.[3] From 1963-1996, roughly 62% of annual precipitation fell as snow (equivalent to 47.32 cm April 1 SWE) at an average elevation of 1905m across Idaho and in western Montana.[5]	Precipitation patterns in the future are difficult for climate models to predict. However, for elevations with marginal snow coverage, as air temperature warms, these areas will see greater amounts of rain and lesser amounts of snow. For areas and elevations where wintertime temperatures remain below -5^{o}C, precipitation patterns will explain SWE more than temperature patterns. [3,7]	The Pacific Decadal Oscillation (PDO) may best explain the decadal variability seen in precipitation patterns, which, in combination with temperature, controls the SWE in the Nez Perce region.	Currently, there is relatively low skill in predicting annual snowpack because the snowpack depends upon precipitation patterns (poorly predicted) and temperature patterns (relatively well predicted).

Summary of climate-related changes in the Nez Perce-Clearwater National Forest				
Climate variable	**Changes experienced historically**	**Direction and range of change expected in the future**	**Seasonal patterns of change**	**Confidence**
Timing of snowmelt and amount	Dates of peak snow accumulation in the Nez Perce occurred 0-5 days later in the season from 1916-2003. 90% of snowmelt has been occurring 0-5 days later from 1916-2003.[3]	Across the western U.S., changes in the timing of peak snow accumulation and 90% melt are a complex function of precipitation and temperature, but the dominant effect is due to temperature trends.[3] Without the slight regional increase in precipitation patterns, the entire western U.S. would have experienced reduced April 1 snowpack due to warmer temperatures.[8] The Nez Perce experiences low enough wintertime temperatures that the warming signal has not been evidenced yet in regards to the timing of snowmelt. However, as air temperatures increase and persistently become warmer during winter, it is expected that snowmelt will begin to occur earlier in the season.	Peak snowpack and peak spring flow from snowmelt occur in the springtime in the western U.S. In Idaho and western Montana, max SWE generally peaks in mid-April and the snowpack has melted by early July.[5] Peak snow is typically observed about a month before peak streamflow.	Currently, there is relatively low skill in predicting annual snowpack because the snowpack depends upon complex relationships between precipitation (poorly predicted) and temperature (relatively well predicted).

Summary of climate-related changes in the Nez Perce-Clearwater National Forest				
Climate variable	**Changes experienced historically**	**Direction and range of change expected in the future**	**Seasonal patterns of change**	**Confidence**
Water temperature	Temperatures of free flowing, unregulated streams, are generally correlated (r=0.74) with each other and to air temperature across the western U.S (r^2=0.70). Over the past 30 years, streams have on average increased by .01°C per decade (n=9). Air temperature accounted for 82-94% of the warming signal in unregulated stream temperatures from 1980-2009.[1] In contrast, regulated streams, or streams with an upstream reservoir, are relatively poorly correlated with each other (r=0.41) and with air temperature (r^2=0.34). On these streams, the regulation activity has varying degrees of control over the water temperature. For example, the Clearwater River at Spaulding has cooled 0.71°C per decade for the past 30 years.[1] During the 20th century, it has been estimated that stream isotherms shifted 1.5-43 km as air temperatures increased by 0.6°C.[9]	As air temperatures increase, it is expected that stream temperature will respond similarly. In the summer, stream temperatures may warm at rates of 0.3°C per decade to 0.45°C per decade. This would cause a net increase of 1.2-1.8°C by midcentury.[1] Many fish species and other stream biota are vulnerable to stream temperature alterations; it can augment their ectothermic physiologies, growth, and survival. Stream isotherms are lines of constant or equal temperature used to track thermal properties of the stream. By the mid-21st century, stream isotherms are expected to shift 5-143 km upstream if air temperature rises by 2°C.[9]	Warming rates are highest during the summers (0.17°C per decade) while streams tend to cool during spring (-0.14°C per decade), partially due to snowmelt runoff.[1]	If low stream flow coincides with high air temperatures, then streams may heat up more quickly than projected.[1] The additive effect stream flow rate has to stream temperature is still not fully understood by the models and regression equations used to estimate stream temperatures.[1] Wildfire can also influence stream temperature by reducing the natural vegetation cover and shading over rivers.

Summary of climate-related changes in the Nez Perce-Clearwater National Forest				
Climate variable	**Changes experienced historically**	**Direction and range of change expected in the future**	**Seasonal patterns of change**	**Confidence**
Instream flows (low and high flows)	Free flowing streams (unregulated) have seen an average decrease in flow of 2.1% per decade over the past 30 years. Regulated streams (have a reservoir) have seen a decrease in flow of 2.8% per decade over the past 30 years.[1] From 1967-2007, most of the unregulated streams in the Nez Perce have had significantly lower annual mean streamflow and earlier peak streamflow.[10]	Warmer wintertime temperatures may alter snowmelt-dominant watersheds resulting in reduced and earlier spring peak flows, reduced warm season water availability and late summer low flows.[11]	Unregulated streams have seen the largest drop in flow during summer and winter months (-3.5% per decade) while regulated streams have seen the largest drop in flow during spring and winter (-5.5% and 3.8% respectively).[1]	Regulated stream flow is predominately controlled by reservoirs and dams. Provided there is enough water in the reservoirs (a function of the reservoir size and associated snowpack in its watershed), instream flows will be controlled by management choices. Unregulated, snow-fed stream flow will be more difficult to predict because it is a function of timing of peak snowmelt (moderately understood) and snowpack accumulation (moderately understood).
Extreme events: Flooding	No specific info found for the region. For general trends and changes in the Northern U.S. Rockies see IPCC 2007 and PRISM historical climate data.	Earlier snowmelt coupled with late winter/early springtime precipitation might increase the risk of springtime flooding in low elevation stream basins.[10]	No specific info found for the region. For general trends and changes in the Northern U.S. Rockies see IPCC 2007 and PRISM historical climate data.	N/A
Extreme events: Temperature	No specific info found for the region. For general trends and changes in the Northern U.S. Rockies see IPCC 2007 and PRISM historical climate data.	Downscaled climate models suggest that extreme heat days near Nez Perce, T_{95} (= days where the heat maxima is in the 95^{th} percentile), will increase in frequency, up to 300% in central Idaho, and will last 3-6 days longer by the end of the 20^{th} century. Similarly, extreme cold days are expected to decrease in frequency.[12]	No specific info found for the region. For general trends and changes in the Northern U.S. Rockies see IPCC 2007 and PRISM historical climate data.	It is generally expected that the frequency of extreme hot/cold events will increase/decrease as mean air temperature rises and the loss of snow cover reduces regional ice albedo feedbacks.[12]

Summary of climate-related changes in the Nez Perce-Clearwater National Forest				
Climate variable	**Changes experienced historically**	**Direction and range of change expected in the future**	**Seasonal patterns of change**	**Confidence**
Extreme events: Precipitation	No specific info found for the region. For general trends and changes in the Northern U.S. Rockies see IPCC 2007 and PRISM historical climate data.	Downscaled climate models suggest that extreme precipitation events near Nez Perce, P_{95} (= days where precipitation maxima is in the 95^{th} percentile), may increase in frequency by 2-4 days per year by the end of the 20^{th} century.[12]	No specific info found for the region. For general trends and changes in the Northern U.S. Rockies see IPCC 2007 and PRISM historical climate data.	There is moderate to low confidence in this prediction. Extreme precipitation might be caused by altered atmospheric circulation patterns coupled with increased atmospheric moisture content.[12]
Evapotranspiration rates	Warm season evapotranspiration (ET) rates have followed trends in regional precipitation patterns. In early spring snowmelt increases ET, but by late summer, warmer temperatures overwhelm the system, reducing ET during July-September.[11]	Warmer temperatures are expected to increase evapotranspiration. During the spring and early summer, ET will be heavily correlated with snowmelt. During the late summer, ET will be more dependent upon precipitation and temperature.[11]	ET in spring and summer are primarily determined by precipitation and snowmelt. Snowmelt is the main contributor to the positive springtime ET. From Jul-Sep precipitation trends strongly influence ET.[11]	Currently there is relatively low skill in predicting changes in ET because they are caused by changes in cloud cover/radiation (poorly understood), air temperature/dewpoint (relatively well understood), and water availability (poorly understood). Because of the close seasonal coupling between ET and snowmelt, future projections of ET and runoff in the spring and early summer are likely more reliable than projections for the late summer.[11]
Other – Changes in forested vegetation	Ponderosa pine and western larch have low survival during drought.[13]	Changes is soil moisture may affect tree establishment, growth, cone and seed development, phenology, and disease and fire susceptibility.[13]	Tree growth is affected by water stress more than any other seasonal factor.[13]	

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