# Potential Wet-Cool Refugia in Southeastern BC

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## Introduction

As part of ongoing conservation planning for southeastern BC, Wildsight and Y2Y have convened a series of meetings to assess the need and potential for additional protected areas in the Purcell Mountains of BC. An informal review of threats to biodiversity in the Purcell region identified climate change as a significant medium- and long-term threat, as well many historical ongoing threats such as pervasive forest harvesting, expanding property development, motorized recreation and the lack of effective access management. This report is the result of a **very prelimnary qualitative assessment** of projected climate and bioclimate data to identify potential cool and wet refugia in southeastern BC.

## Climate Change Impacts

Due to past, present and future greenhouse gas emissions, climate change in the Purcells, and the upper Columbia basin in general,is projected to cause a significant increase in temperatures in all seasons over the coming decades. During this period winter precipitation is projected to remain similar to today or possibly increase, however summer precipitation is likely to decrease (see Figure 1). Snowpack, and glacial landscapes will also change (see Figures 2, 3 and 4). The interaction of these various changes will also result in changes to streamflow and aquatic ecosystems (see Figure 5). Although there is some uncertainty in the magnitude and timing of these changes, it is clear that the future climate of the upper Columbia basin, including the Purcells, will be very different from the recent past. Given that the biodiversity present in the Purcells today is adapted to climatic conditions that presently occur, these changes in climate also mean that the present assemblages and distribution of biodiversity will also change.

## Bioclimate Shifts

Bioclimate envelopes are multi-dimensional ñenvelopesòof climate variables that are associated with the occurrence of specific ecosystems ï or in this case broad vegetation zones. Most projections of changes in bioclimatic envelopes for southeastern BC demonstrate a general trend to climates associated with hotter and drier conditions at lower elevations, including potential shifts from moist forests to open grasslands. Projections for the upper elevations are less certain, ranging from hotter and drier to warmer and wetter. The degree of change also varies across the landscape, with changes in the southern Purcells more extreme than in the north. In the south there are potential changes from bioclimates typical of moist cool subalpine forests at upper elevations to bioclimates associated with open savannah forests with frequent low intensity fire regimes, drier interior cedar-hemlock or coastal transitional cedar-hemlock forests in the coming 6 to 8 decades. All of the projections suggest that climates associated with the Engelmann spruce-subalpine fir forests that dominate the upper elevations today will likely be substantially reduced, or even disappear altogether by the end of this century. Figure 5 presents results from 3 bioclimate projections that generally span the range of all of the recent projections[1].

## Wet-Cool Refugia

Climate modeling has projected that areas in the northern upper Columbia basin are likely to undergo slightly less dramatic increases in winter and summer temperature, less reduction in summer

[1] For further information on the three projections, see Utzig 2012; for more information on changes to the northern Selkirks see Utzig 2016.

precipitation, and greater increases in non-summer precipitation than areas further south (see Figure 1). Projections of changes in snow storage and streamflow also indicate less dramatic decreases in the northern portion of the upper Columbia basin (see Figures 2-5), or even potential increases. Bioclimate projections also tend to indicate slightly cooler and wetter environments in similar areas, although the outcomes are somewhat variable.

Bioclimate modeling indicates that localized areas in the extreme northern end of the Purcell Mountains, through the northern Selkirk Mountains into the Cariboo Mountains, and some adjacent areas of the Rocky Mountains are likely to maintain cooler wetter environments, at least at higher elevations (see Figure 6).

Depending on the degree and rate of climatic change and the ability of species to shift their ranges, some of these areas may provide regional refugia for much of the biodiversity presently occupying the mid and upper elevations of the Purcell, Selkirk and Rocky Mountains of the upper Columbia basin today.

Based on very preliminary qualitative analysis of the three bioclimate projections shown in Figure 6, a series of potential cool-wet refugia have been designated. The range in classes vary depending on the general likelihood of them maintaining environments somewhat similar to the bioclimates currently present in mid and upper elevations of the southern upper Columbia basin (see Figure 7).

Class 1 areas are projected to generally maintain bioclimates that were typical of interior or coastal wet belt vegetation zones under all three climate scenarios. Class 2 areas are similar, but with slightly drier and/or warmer types in one scenario, or a shift to other climatic regimes in one scenario (boreal or alpine tundra). Areas in the Rocky Mountains have a tendency to shift to more boreal bioclimates under the Warm/Moist scenario, while those in the Cariboo Mountains tend to shift to alpine tundra bioclimates under the Hot/Wet scenario. Class 3 areas are projected to shift to much warmer/drier bioclimates in at least one scenario, and Class 4 to less suitable bioclimates in two of the three scenarios.

Further investigation of projected climate data for the potential refugia should be further investigated to better define the characteristics of the areas, and refine this preliminary mapping. The climate data could be used to evaluate the potential elevational sequences of bioclimates and the presence of winter snow.

## References


Schnorbus, M.A., K.E. Bennett, A.T. Werner and A.J. Berland, 2011: *Hydrologic Impacts of Climate Change in the Peace, Campbell and Columbia Watersheds, British Columbia, Canada*. Pacific Climate Impacts Consortium, University of Victoria, Victoria, BC, 157 pp. Available at: https://www.pacificclimate.org/sites/default/files/publications/Schnorbus.HydroModelling.FinalReport2.Apr2011.pdf

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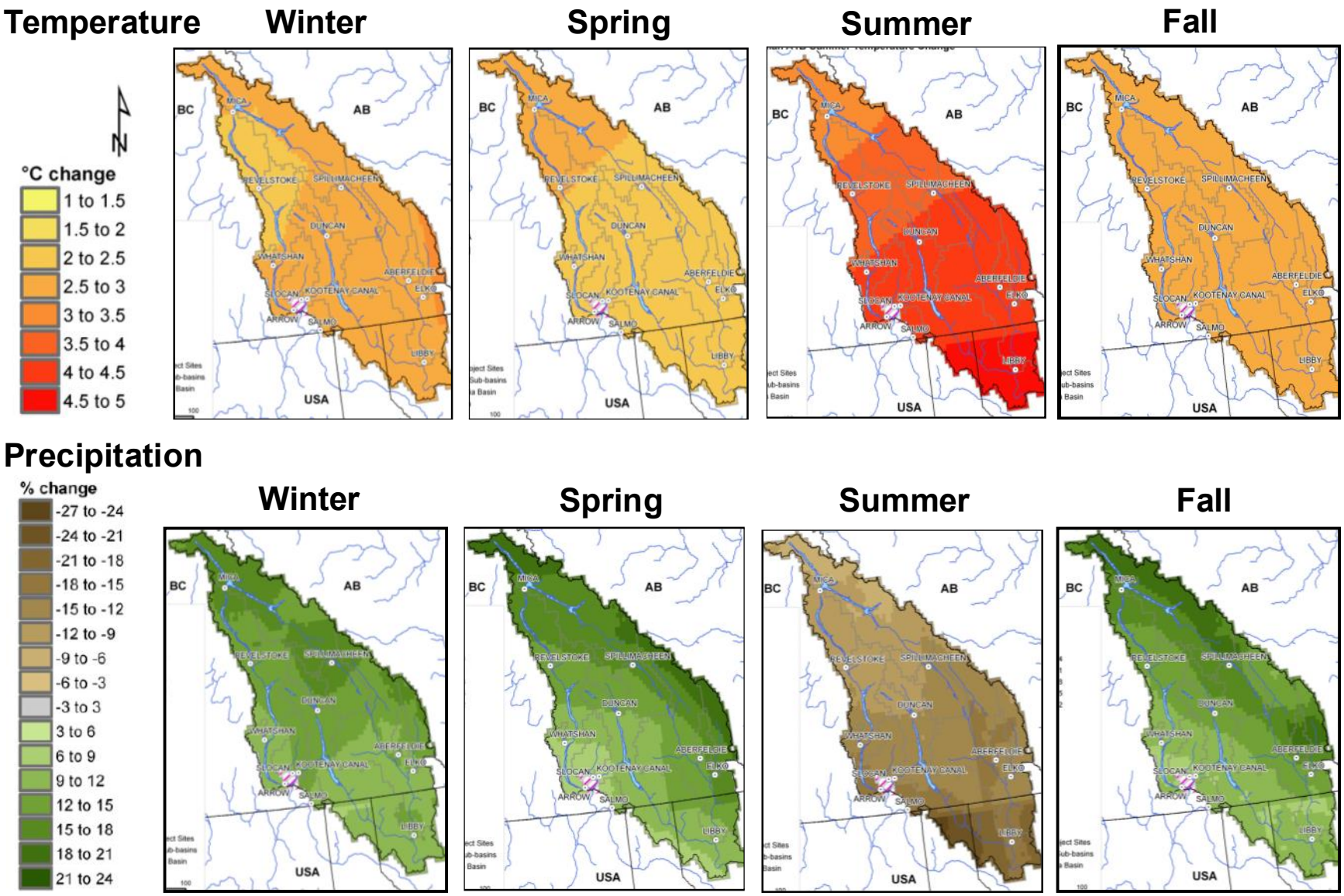



**Figure 1. Projected changes in seasonal temperatures and precipitation for the upper Columbia basin from the average of 1961-90 to the 2050s, based on the median of 8 global climate models (GCMs) driven by an intermediate (A1B) emission scenario. (from Schnorbus et al. 2011).**

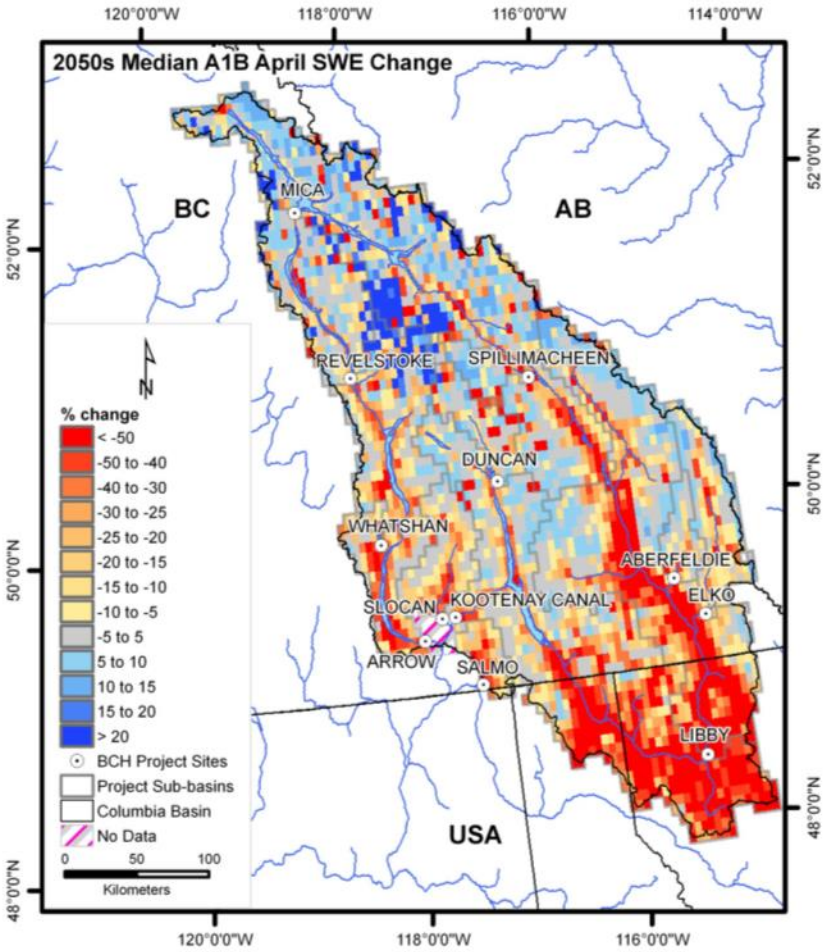



**Figure 2. Projected change from the average of 1961-90 to the 2050s in snow storage (snow water equivalent – SWE) in the upper Columbia basin, based on the median of 8 global climate models (GCMs) driven by an intermediate (A1B) emission scenario. (from Schnorbus et al. 2011).**

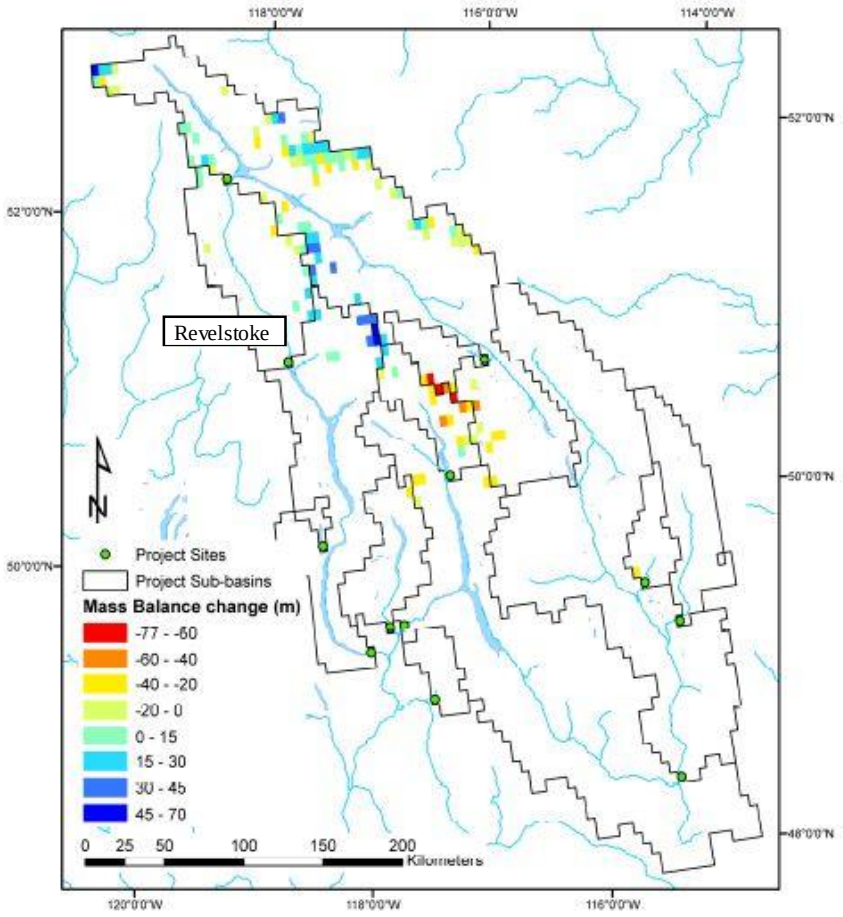
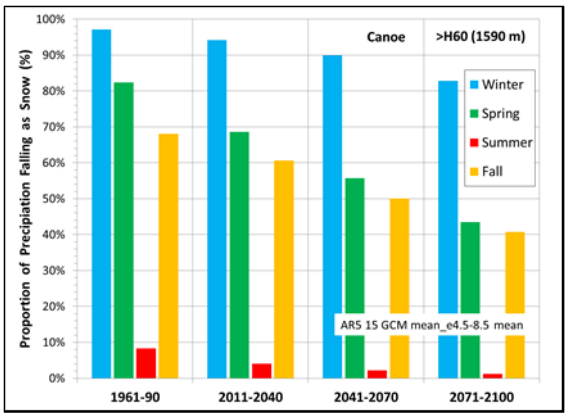
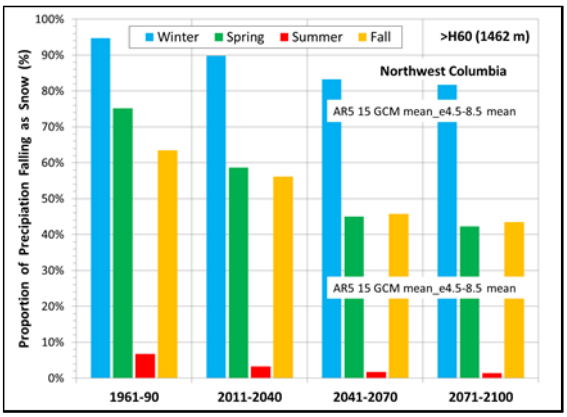
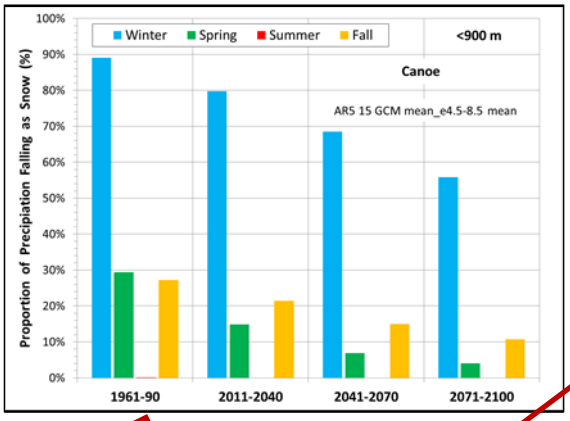
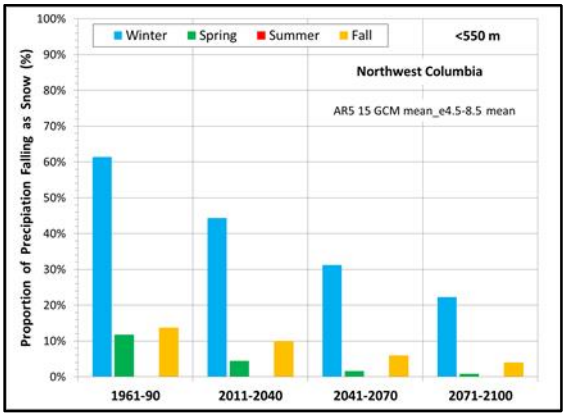


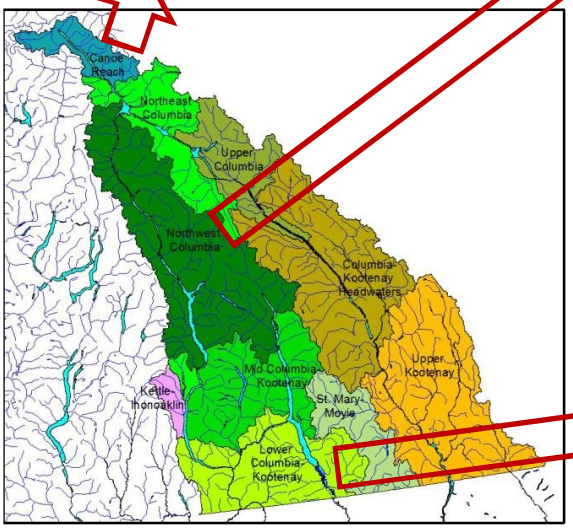

**Figure 3. Projected change from 1990 to 2070 in glacier Mass Balance by grid cell for the upper Columbia basin, based on the median of 8 global climate models (GCMs) driven by an intermediate (A1B) emission scenario. (from Schnorbus et al. 2011).**

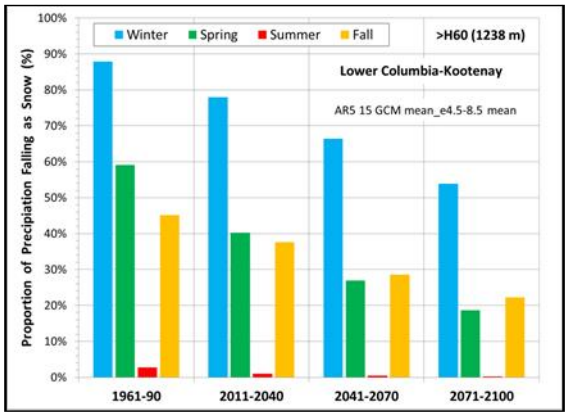


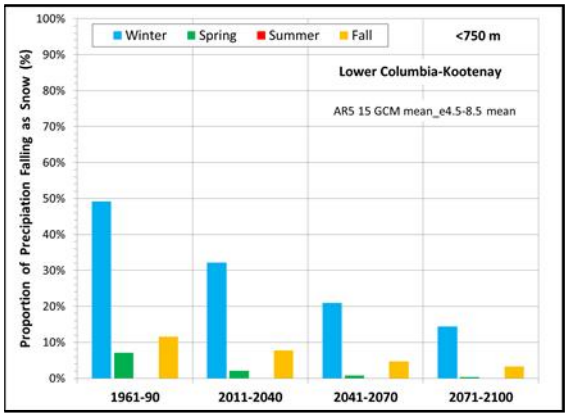




**Figure 4. The graphs portray the projected seasonal shifts in precipitation from snow to rain for upper and lower elevations for three selected Hydrologic Regions within southeastern BC. The Canoe and NW Columbia Regions are projected to maintain significantly more snow than the more southerly areas, especially at the upper elevations (see CBT 2017 for more details).**

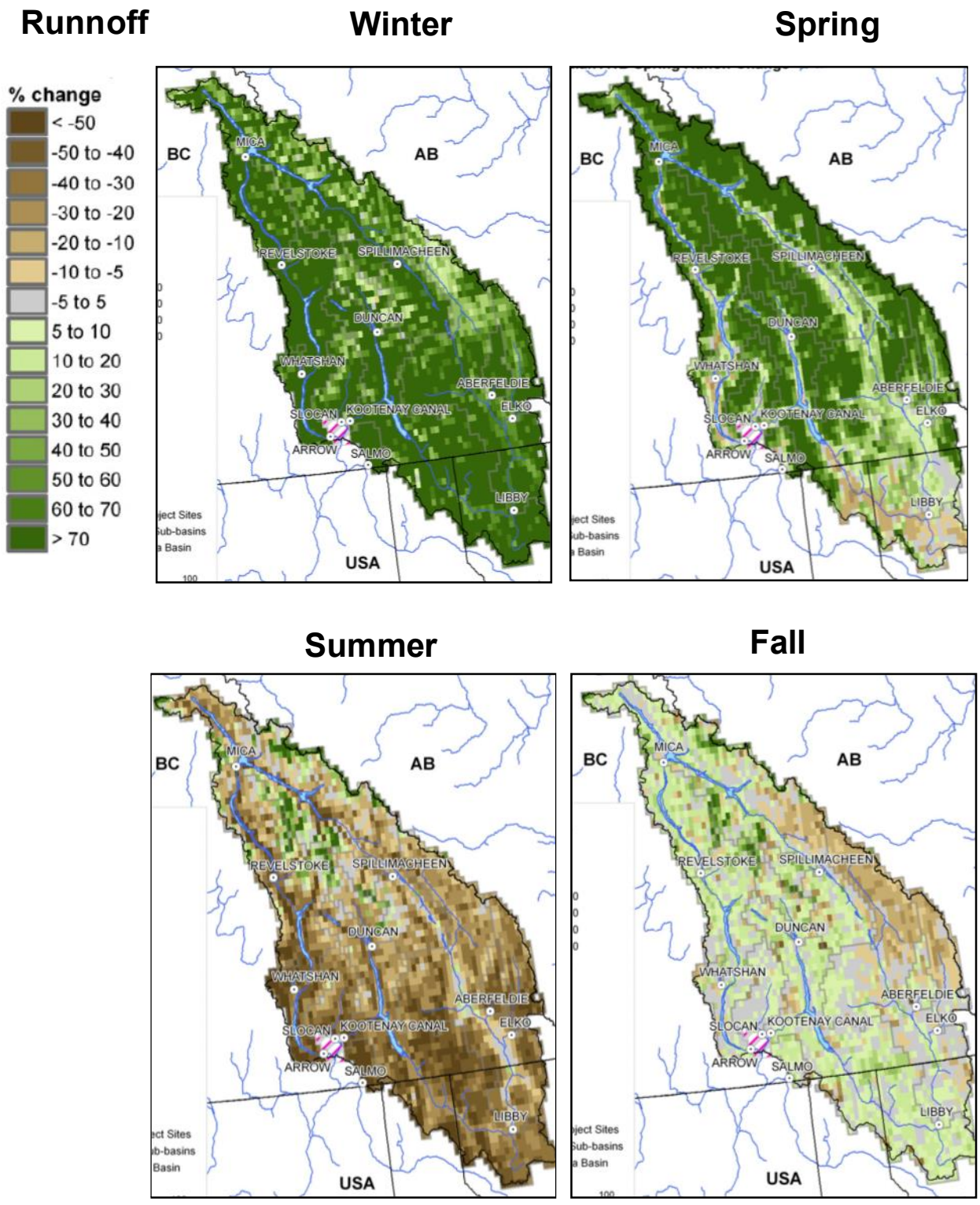



**Figure 4. Projected change in runoff for the upper Columbia basin from the average of 1961-90 to the 2050s, based on the median of 8 global climate models (GCMs) driven by an intermediate (A1B) emission scenario. (from Schnorbus et al. 2011**

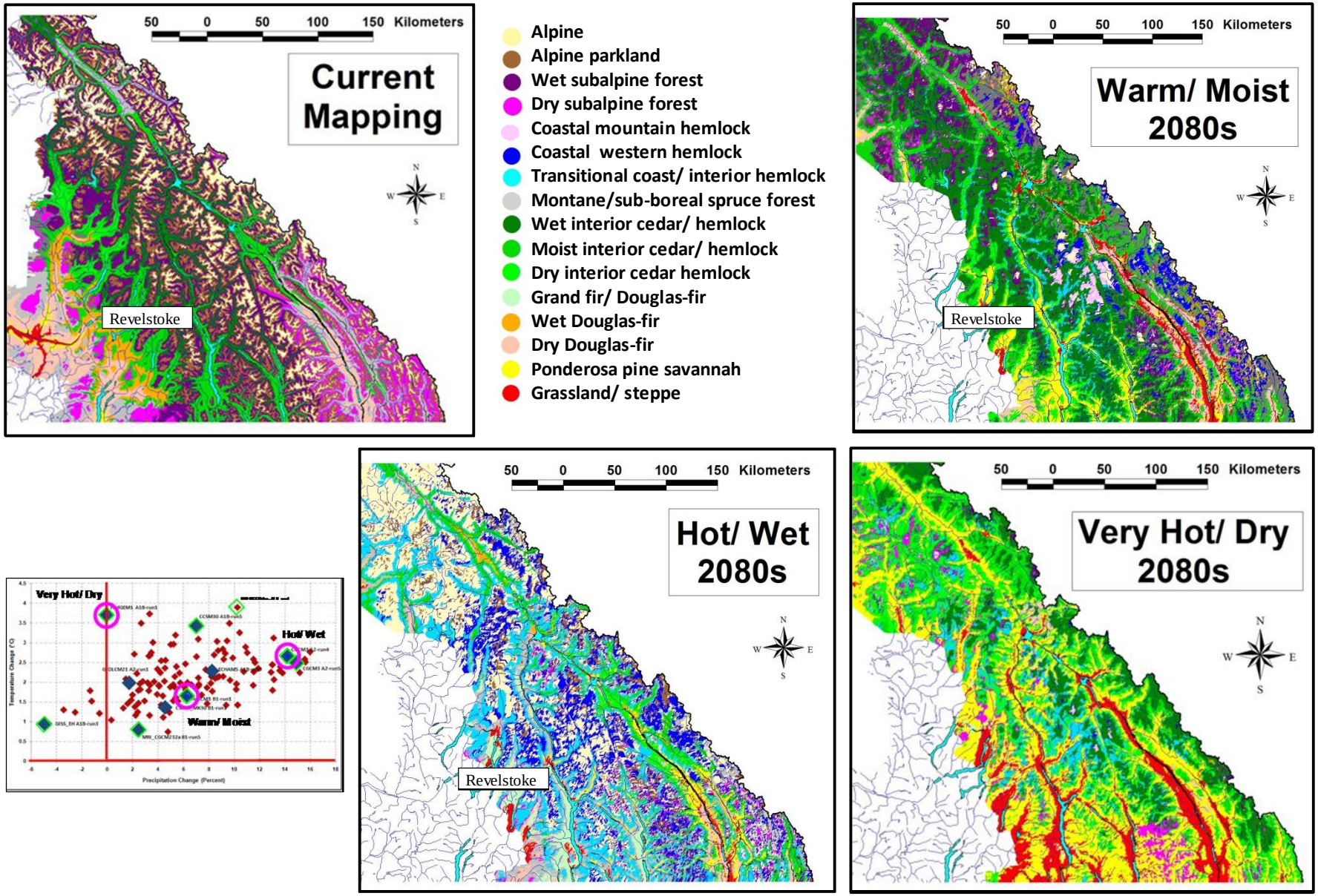



**Figure 5. Current mapping of bioclimates and projected bioclimate envelope shifts for the northern upper Columbia River basin and the upper Fraser River basin based on three GCM scenarios. Graph shows where the three scenarios compare with approximately 40 other scenarios for BC for changes in annual temperature and precipitation (for more information on the projections see Utzig 2012).**

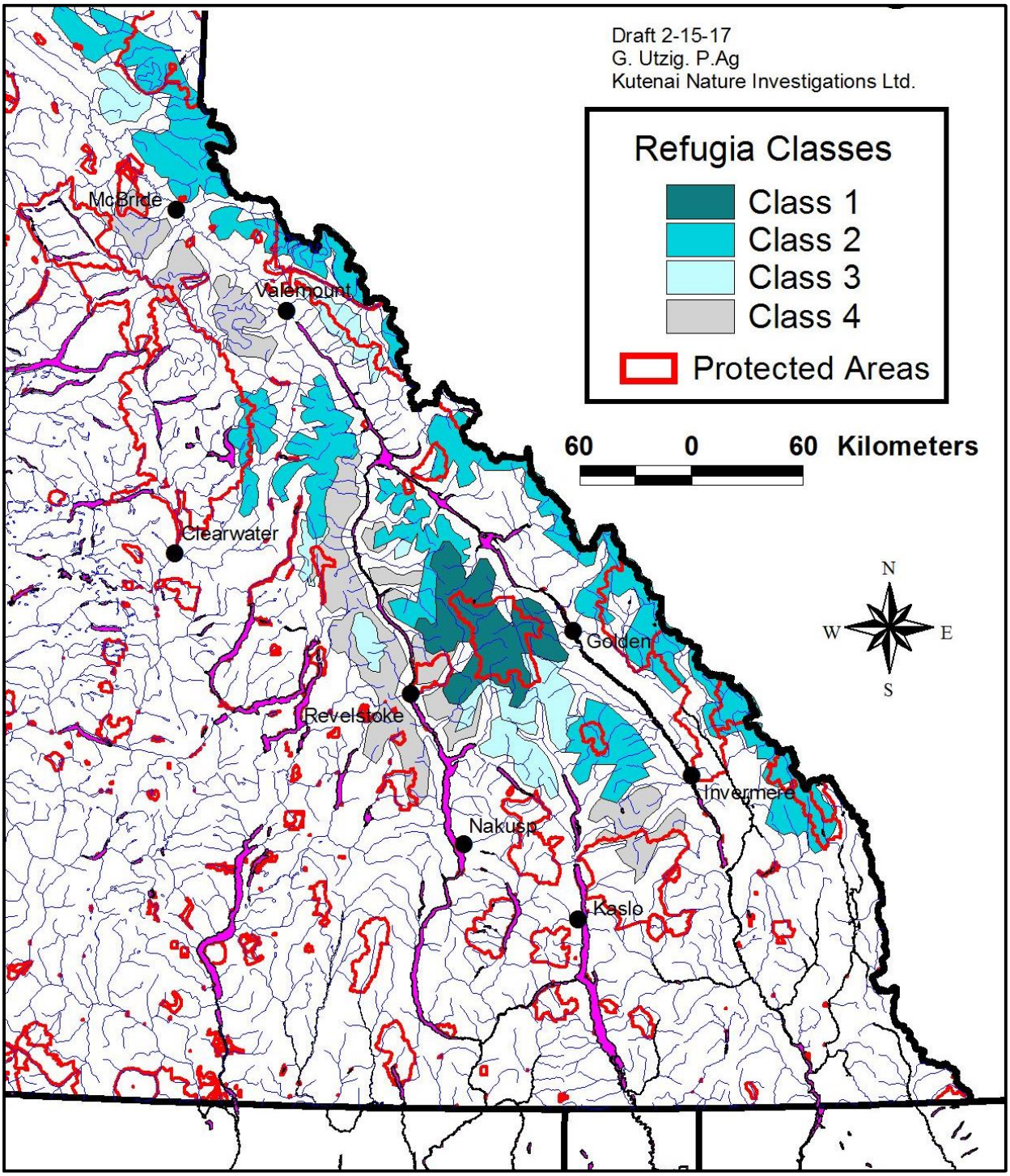



**Figure 6. Potential wet and cool regional refugia in the northern Purcell, northern Selkirk, Cariboo and adjacent Rocky Mountains. Class 1 is estimated have a high likelihood of maintaining wet and cool conditions, while class 4 has a distinctly lower likelihood, with Classes 2 and 3 intermediate likelihood.**