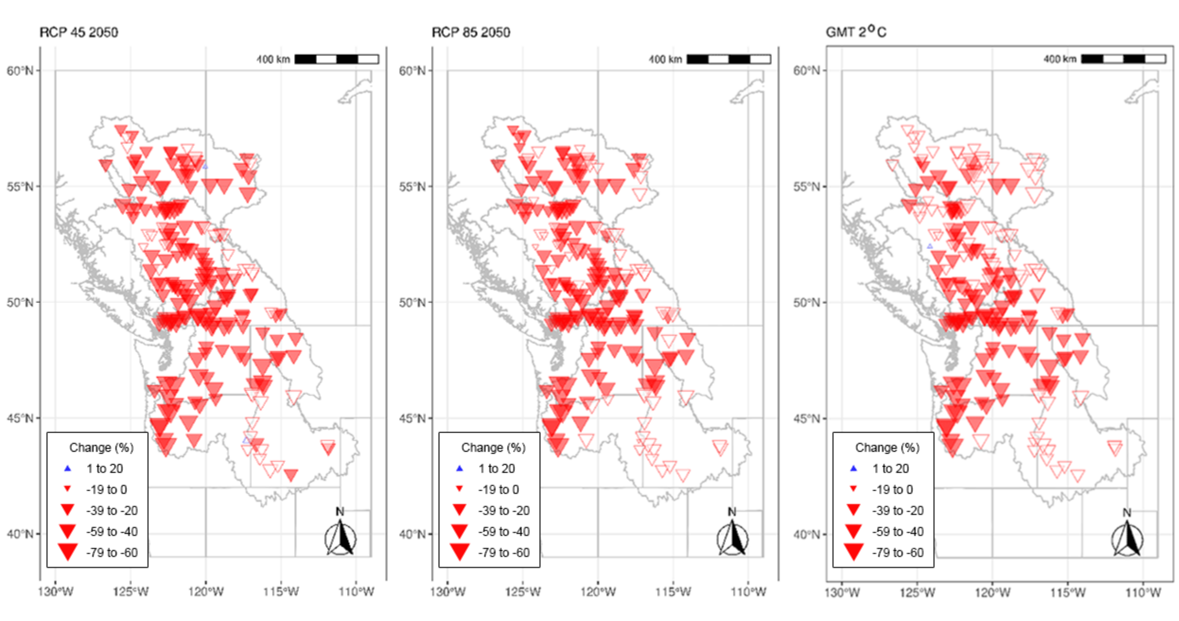
PACIFIC CLIMATE IMPACTS CONSORTIUM

PCIC UPDATE January 2021

PROJECT AND RESEARCH UPDATES

Supporting Water Planning in BC

Water licences are assigned by the provincial government for things such as agriculture, aquaculture and mining, to regulate the diversion, storage and use of the province's natural water resources. The changing climate presents increased challenges to water resource planning. In order to support decision-making in the water planning community, PCIC has partnered with the BC Ministry of Environment and Climate Change Strategy (ENV) and the Ministry of Forestry, Lands, Natural Resource Operations and Rural Development (FLNRORD).



This figure shows the change in summer (June, July and August) streamflow in the 2050s (2041-2070) versus a historical baseline period (1971-2000) for six global climate models (GCMs) run under the Representative Concentration Pathway (RCP) 4.5 (a) and RCP 8.5 (b) emissions scenarios, and for the same six GCMs run under two RCPs (making 12 ensemble members) at 2°C global mean temperature above the pre-industrial (1861-1880) period (c) for 187 hydrometric sites that were used to calibrate (158 sites) and evaluate (29 sites) the VIC-GL model in the Peace, Fraser and Columbia River basins. The direction of change of the ensemble median is denoted with red, downward-pointing arrows indicating decreases and blue, upward-pointing arrows indicating increases. Solid arrows are those where all ensemble members agree in the direction of change. The size of the arrows corresponds to the magnitude of the change.

This work draws on the extensive hydrologic modelling of PCIC's Hydrologic Impacts theme, who have recently completed hydrologic projections for the Peace, Fraser and Columbia River basins—a region that encompasses roughly two-thirds of the province—using global climate model (GCM) output from the fifth phase of the Coupled Model Intercomparison Project (CMIP5). In the first phase of this work, PCIC developed a report on future changes in low, median and high flows for three sub-basins of the Fraser, Chilliwack and Seymour Rivers, and Cayoosh Creek, selected to represent different regions and streamflow regimes of the province. This was an opportunity for PCIC researchers to dig deeper into their latest modelling results, discuss inherent limitations and uncertainties, and to articulate their understanding of upcoming changes to streamflow.

Lessons learned in the first phase of the project included: (1) watersheds 500 km^2 or smaller are of interest to water-use planners and hence, methods to validate PCIC's modelling results on watersheds of that scale are needed to build confidence in results; (2) understanding the general pattern of change projected across the province, especially in late-summer (July, August and September) streamflow, regardless of watershed size or hydrometric regimes, would be of value and (3) agreement between GCMs in the direction of change, an indicator of the confidence in the result, did not increase over time by Representative Concentration Pathways (RCPs), which made for large ranges in uncertainty and difficulty in choosing planning pathways.

Table 1 – The number of hydrometric stations (out of 187) in the Peace, Fraser and Columbia basins where all members in the ensemble agree in the sign of change in summer (June, July and August) streamflow as grouped by time (2020s, 2050s and 2080s) and Representative Concentration Pathway (RCP). Note there are six members per ensemble.

Epoch	2020s	2050s	2080s
RCP 4.5	96	151	148
RCP 8.5	141	136	173

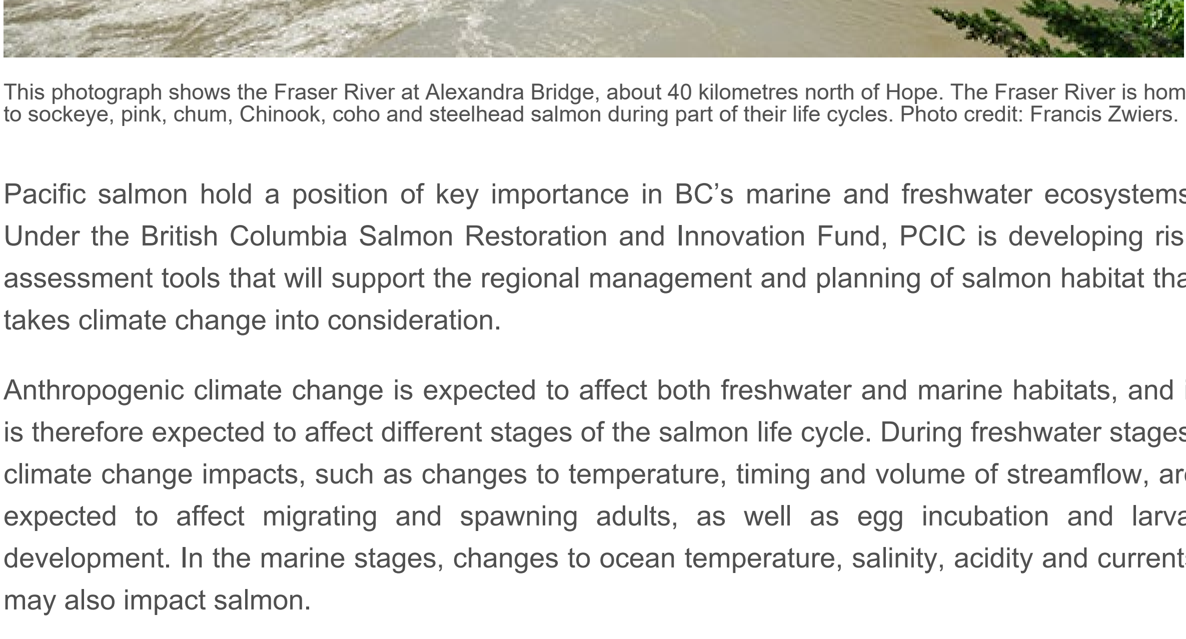
PCIC researchers continue their work to turn raw projections into actionable information to assist decision making. This includes further model validation and evaluating changes to summer (June, July and August) streamflow conditions across the modelling region, to look for patterns of change and agreement between climate models (see figure). Results presented by RCPs and time periods, such RCP 4.5 and 8.5 in the 2050s (see figure, Table 1), are contrasted with those organized by global mean temperature (GMT) change, such as a level that is 2°C above preindustrial (1861-1880) levels (see figure, Table 2; here). The number of models in the ensembles that agree in the direction of change increases with GMT, so as the temperature increases, the ensemble members tend to collectively show decreases in streamflow (Table 2). This may not be true for time and RCPs, for which the pattern is unclear. Because of this, using GMT may offer some benefits for planning.

Table 2 - The number of hydrometric stations (out of 187) in the Peace, Fraser and Columbia basins where all members in the ensemble agree in the sign of change in summer (June, July and August) streamflow as grouped by Global Mean Temperature change (GMT) for traditional summer (June, July and August) and late summer (July, August and September). Note the number of members in the ensemble changes with GMT because four of the GCMs run under RCP 4.5 do not reach 3°C, and six do not reach 4°C, before 2100.

GMT (ensemble members)	1.5°C (12)	2°C (12)	3°C (8)	4°C (6)
JJA summer	88	110	155	168
JAS summer	119	152	170	172

The dialogue between PCIC, ENV and FLNRORD during the writing of the report was instrumental in gaining mutual understanding and in drafting a document that is useful for a wider audience. Follow-on work continues to improve the utility of the hydrologic modelling results. In the second phase, project advisors from both ministries will provide informal feedback on how this information could be applied. These advisors may also participate in structured planning exercises, comparing decisions made with and without PCIC's information, depending on priorities set by the new provincial government.

Developing Risk Assessment Tools for Salmon Habitat Management



This photograph shows the Fraser River at Alexandra Bridge, about 40 kilometres north of Hope. The Fraser River is home to sockeye, pink, chum, Chinook, coho and steelhead salmon during part of their life cycles. Photo credit: Francis Zwiers.

Pacific salmon hold a position of key importance in BC's marine and freshwater ecosystems. Under the British Columbia Salmon Restoration and Innovation Fund, PCIC is developing risk assessment tools that will support the regional management and planning of salmon habitat that takes climate change into consideration.

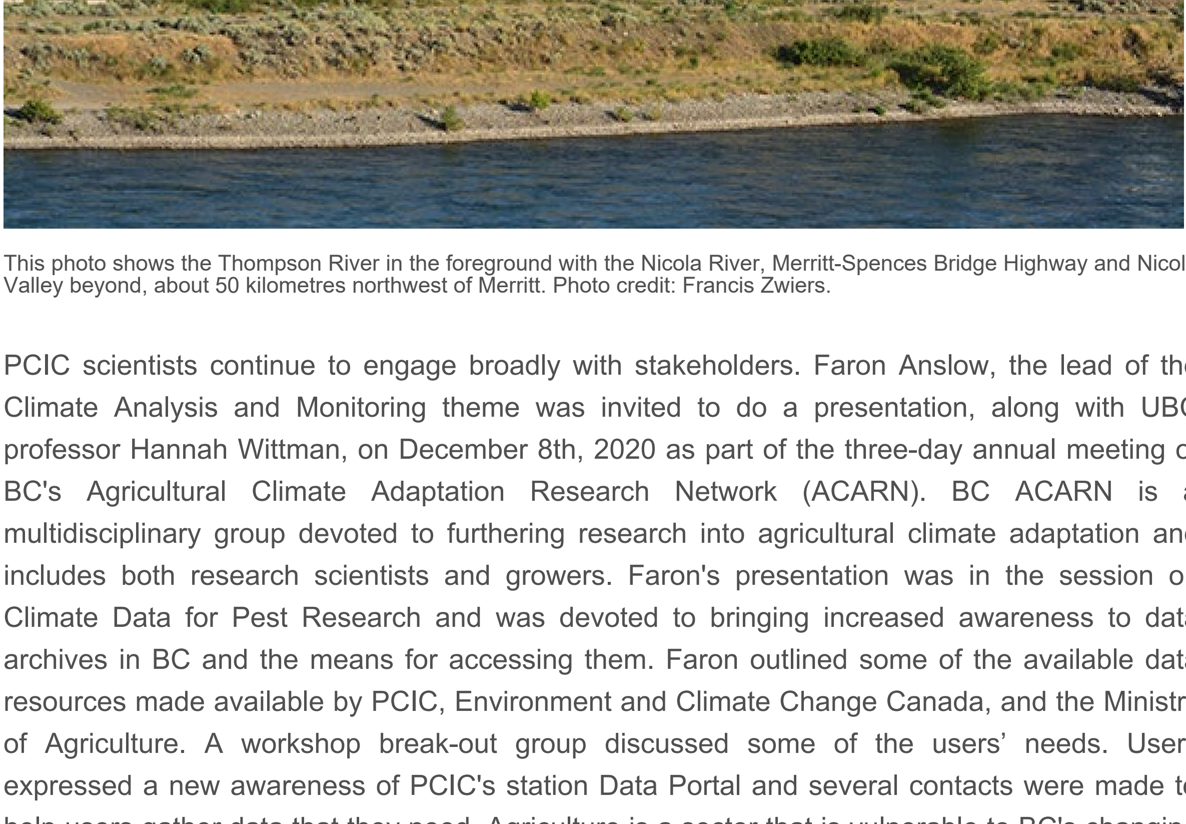
Anthropogenic climate change is expected to affect both freshwater and marine habitats, and it is therefore expected to affect different stages of the salmon life cycle. During freshwater stages, climate change impacts, such as changes to temperature, timing and volume of streamflow, are expected to affect migrating and spawning adults, as well as egg incubation and larval development. In the marine stages, changes to ocean temperature, salinity, acidity and currents may also impact salmon.

PCIC researchers are developing methods and indicators for a BC-wide risk assessment for all wild salmon species by conservation unit, as defined by the Department of Fisheries and Oceans's Wild Salmon Policy. Building on existing and ongoing modelling being conducted at PCIC, the risk assessment will estimate the exposure and sensitivity of salmon to climate change effects, as well as the adaptive capacity of salmon to climate change impacts.

The sensitivity analysis will look at factors including migration distance, migration season, freshwater duration, incubation season, and elevation of spawning grounds habitat, while the exposure analysis will include changes in temperature, flow, and hydrological regime using hydrologic model outputs. Adaptive capacity is a measure of the ability of salmon to respond to climate change and will also be assessed. This part of the analysis will focus on the current biological status (a measure of salmon population health), habitat diversity and area, and abundance data.

The risk assessment will be conducted for each major drainage in BC, then combined for a province-wide assessment. The results of the risk assessment will provide information to researchers, government and policymakers, and eventually end-users.

Engaging with the Agricultural Community



This photo shows the Thompson River in the foreground with the Nicola River, Merritt-Spences Bridge Highway and Nicola Valley beyond, about 50 kilometres northwest of Merritt. Photo credit: Francis Zwiers.

PCIC scientists continue to engage broadly with stakeholders. Faron Anslow, the lead of the Climate Analysis and Monitoring theme was invited to do a presentation, along with UBC professor Hannah Wittman, on December 8th, 2020 as part of the three-day annual meeting of BC's Agricultural Climate Adaptation Research Network (ACARN). BC ACARN is a multidisciplinary group devoted to furthering research into agricultural climate adaptation and includes both research scientists and growers. Faron's presentation was in the session on Climate Data for Pest Research and was devoted to bringing increased awareness to data archives in BC and the means for accessing them. Faron outlined some of the available data resources made available by PCIC, Environment and Climate Change Canada, and the Ministry of Agriculture. A workshop break-out group discussed some of the users' needs. Users expressed a new awareness of PCIC's station Data Portal and several contacts were made to help users gather data that they need. Agriculture is a sector that is vulnerable to BC's changing climate and PCIC aims to work closely with the sector to meet their needs for climate services and provide expertise as it is needed.

JOINT STAFF PROFILES: JESSIE BOOKER & CAIRO SANDERS

PCIC is committed to encouraging the growth of regional climate services and guiding the next generation of climate scientists, computer scientists, climate communicators and engagement specialists. One of the ways in which PCIC does this is through offering co-op programs to undergraduate and graduate students, so that they can bring new energy to PCIC's projects and learn from PCIC's research themes and computational support group. This staff profile focuses on two talented co-op students who have been working alongside PCIC's team for the past four months.

Jessie Booker is an undergraduate student in civil engineering and a Content Development and User Engagement Assistant with PCIC's Regional Climate Impacts theme. She is assisting with transportation case study development for a new transportation module that is being developed for Climatedata.ca. She has been testing the transportation module content. Recounting her choice to pursue engineering, she says, "I started at UVic planning to do an Environmental Studies and Geography double major, but realized the applied design and problem solving of engineering fit my abilities better. I chose civil engineering due to my interest in creating a more sustainable society." Expanding on this she says, "With civil [engineering], I can make a career out of my academic interests such as green buildings, transportation engineering, urban planning, and preparing infrastructure and its users for extreme weather events in a changing climate."

Her work is centered on developing surveys for users of the transportation module of Climatedata.ca. These surveys will help to make the module as useful as possible to a diverse group of users, including engineers, government officials, and urban planners who are looking for a starting point for incorporating future climate projections into their designs and plans.

Cairo Sanders is completing her combined undergraduate degree in psychology and computer science with a minor in statistics, and is an Assistant Programmer in PCIC's Computational Support Group. Her work is focused on the Data Analytics for Canadian Climate Services (DACCS) project, writing code that wraps existing PCIC software with an additional layer of code to create a simplified interface, and working on the software itself to improve its efficiency and accessibility. Though she began her undergraduate program studying psychology with the goal of becoming a therapist, she soon switched her focus: "I found the discipline frustratingly open ended and decided to pursue computer science and statistics along with psychology." These have allowed her to use her strengths in finding patterns and problem solving, while exploring multiple areas: "my favorite thing about these fields is how they overlap with other fields so much!" She continues, "like here at PCIC in the CSG group, I have the privilege of writing code, but also learning about climate impacts."

Cairo's current work in the CSG team is centered around the ClimDown software that provides statistical downscaling of coarse scale global climate model (GCM) output to a fine spatial resolution. She analyzes the time spent in each function within ClimDown, trying to identify where possible improvements can be made to the code so that the process runs faster. Following this, she will be adding ClimDown to the DACCS project.

PCIC STAFF NEWS

Trevor Murdock recently began an interchange with the Canadian Centre for Climate Services, where he is Manager of the Data and Products Office. PCIC is proud of Trevor and excited to see the projects that he will be working on as part of the Federal Public Service. This winter, Scientific Software Developer Nicolaas Annau has moved from PCIC to UVic in order to begin his master's of science program. In addition, co-op students Jessie Booker and Sangwon Lim are returning to their studies. PCIC is grateful for the work that Nicolaas, Jessie and Sangown have done while with us and wishes them all the best in their studies.

PEER-REVIEWED PUBLICATIONS

Kim, J., **S. Park**, J. Kwon, Y. Lim and H-S. Oh, 2021: Estimation of spatio-temporal extreme distribution using a quantile factor model. *Extremes*, accepted for publication.

Li, C., **F. Zwiers**, X. Zhang, G. Li, Y. Sun and M. Wehner, 2020: Changes in annual extremes of daily temperature and precipitation in CMIP6 models. *Journal of Climate*, early online view, doi:10.1175/JCLI-D-19-1013.1.

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