



How are rapid environmental changes influencing Canadian-origin Yukon River Chinook declines?

**Yukon Fish and Wildlife Enhancement Trust
Final Report**

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PROJECT ACTIVITIES

What activities did you complete during your project?

From February 2022 to October 2022, we advanced the first study from this project which looks at the drivers of Canadian-origin Yukon River Chinook salmon productivity. This part of our project is being finalized and we will be sharing our results via plain-language reports and a publication in a scientific journal. Our results suggest that Canadian Chinook are being impacted by numerous environmental changes occurring in their habitats that span a vast geographical area from local Yukon watersheds to conditions in the Bering Sea. Collectively, these environmental changes may be substantially altering the number of recruits produced by each spawning cohort, with implications for salmon run forecast accuracy and sustainable harvest goals.

As an example of our results, Figure 1 (below) indicates how much salmon recruitment may change due to different environmental conditions that were commonly observed over the 28-years of data. This Figure shows how median recruitment decreased by approximately 8,000 – 13,000 salmon in association with individual environmental changes including rising migration temperatures, wetter local conditions, and more marine competition. In contrast, median recruitment increased by approximately 9,000 – 19,000 salmon in years with warmer and snowier winters or an earlier spring onset.

The key conservation and management implications from our findings are that (1) Canadian Chinook salmon may greatly benefit from coordinated, largescale salmon conservation plans that encompass the entire Canadian-origin Chinook habitat range in order to effectively address the wide variety of potential productivity drivers revealed here, and (2) it may no longer be sufficient to sustainably manage Canadian-origin Chinook without considering a potential buffer for environmental change (Murdoch et al. *in review*).

How did your activities contribute to your goals and objectives?

Our main goals and tasks for the past eight months of the project were to (1) finalize the first part of our project to test different hypotheses of Yukon River Chinook salmon declines, and (2) begin developing a watershed-based conservation framework.

We submitted our research findings to a scientific journal in October 2022 (Murdoch et al. *in review*) and will be creating plain-language reports following the peer review process. We are still in the early stages of developing a watershed-based conservation framework (Objective 1), and this task will be revisited along with Objective 2 (harvest-climate scenarios) once Alyssa Murdoch returns from parental leave (Nov 2022 – Nov 2023).

We also attended the first Annual Salmon Gathering at Tatchun Creek hosted by the Council of Yukon First Nations and Little Salmon Carmacks First Nation through the Canadian Mountain Network Salmon Knowledge Hub (Photo 1). The gathering was a great opportunity to listen and share knowledge with a diverse group of salmon knowledge holders in an on-the-land setting by the Yukon River. In addition, the gathering provided an opportunity to learn about different conservation and stewardship initiatives led by Yukon First Nations which will inform the conservation framework (Objective 1).

Note any variances to your goals, objectives or work plan and explain why they occurred

Our original goals relating to the Yukon River Chinook project remain unchanged, although we note that progress has been slightly delayed due to COVID-19 challenges related to illness. We have also initiated a collaboration with Brendan Connors from Fisheries and Oceans Canada as an additional project member. Dr. Connors is a population ecologist studying Pacific salmon fishery complexes including Yukon River Chinook. His involvement in our project has been extremely beneficial given his expertise with quantitative population dynamics, northern salmon systems, and fisheries risk assessment and management. In addition, we are using the dataset that he developed for Canadian-origin Yukon River Chinook into our modelling.

Explain how the results of your work contributed to the protection, enhancement or restoration of fish, wildlife or their habitat

Our results will be used to (1) develop a conservation framework for Canadian-origin Yukon River Chinook that identifies 'climate risk level' and potential local conservation actions tailored to each major Canadian watershed, and (2) provide information to Yukon First Nations on how different climate-harvest management scenarios will influence salmon population sustainability, including more specific advice if the current harvest levels should be reduced given an increasingly warmer and more variable climate. The conservation framework will be co-produced with interested Yukon First Nations to achieve plans with meaningful conservation outcomes.

If you were to do the project again what would you do differently?

The main consideration for this project is the need for more time and resources to complete it effectively. To this end, we are considering expanding the project beyond the initially proposed two-year timeline in order to increase its conservation impact and relevance to Yukon First Nations.

COMMUNICATIONS

What did you do to ensure your results were shared with the appropriate groups, people or governments?

Over the past eight months, we have continued our project engagement through various outlets. Alyssa Murdoch presented our ongoing findings at the Yukon Fish Community of Practice Speaker Series in April 2022 (Murdoch et al. 2022a) as well as attended an International workshop (Schoen et al. 2022) where a group of scientists, Indigenous and non-Indigenous government employees, and community members shared perspectives on climate change impacts on Chinook salmon in the Arctic-Yukon-Kuskokwim region. As noted above, we also attended the first Annual Salmon Gathering at Tatchun Creek hosted by the Council of Yukon First Nations and Little Salmon Carmacks First Nation through the Canadian Mountain Network Salmon Knowledge Hub this past August. As our project develops, we will be sharing our results via scientific publications, plain-language reports, presentations, and meetings for further input on project direction including the co-development of the conservation framework with Yukon First Nations.

Describe how you recognized the Enhancement Trust and/or its mandate

We have acknowledged funding from the Yukon Fish and Wildlife Enhancement Trust (YFWET) in WCS Canada's Annual Reports. In addition, YFWET was included as a funder in the acknowledgements of all past presented materials. For example, we published a global review examining how climate and

landscape change are influencing freshwater biodiversity, including a focus on how these effects may vary in northern landscapes such as the Yukon River drainage (Figure 2; Murdoch et al. 2022b). We will continue to recognize YFWETs contribution to supporting our work in all reports, presentations, and communications that emerge from this project.

Identify any communication materials, strategies or techniques that you used to promote your project and its objectives

We circulated our initial project plan to various Yukon First Nations and fisheries experts as a platform to engage and learn from these parties during project development. We presented our preliminary results at the Yukon Fish Community of Practice Speaker Series in April 2022 and our presentation was well attended (>35 attendees) and garnered some useful discussion with audience members. Attending the International Arctic-Yukon-Kuskokwim Chinook workshop and the Annual Salmon Gathering at Tatchun Creek were beneficial gatherings for sharing our project goals with people working on complementary salmon stewardship, management, and research activities in Canada and Alaska. After the project lead returns back from maternity leave, we plan to continue our project engagement by providing plain language report summaries and offering community presentations, as well as holding workshops with interested groups to facilitate knowledge sharing and support the co-production of our conservation framework.

Supporting photos and figures:

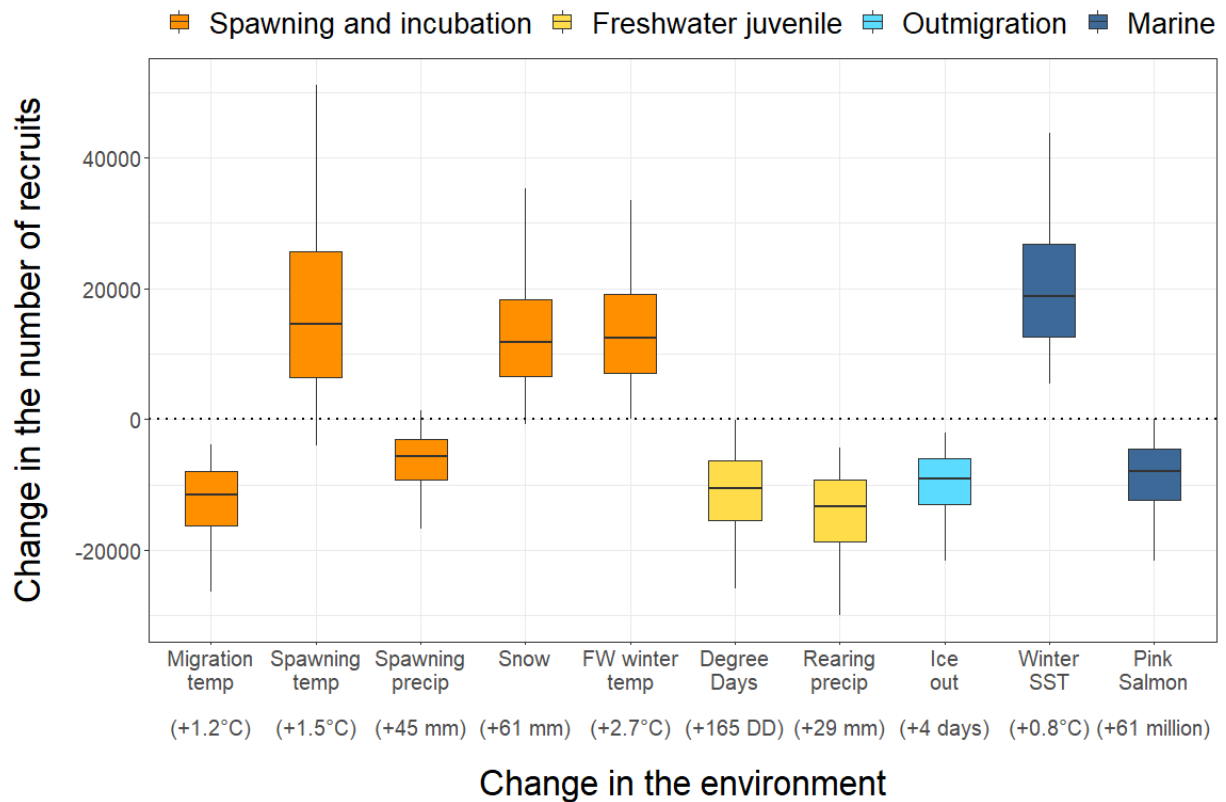


Figure 1. Estimated change in total Canadian-origin Yukon River Chinook salmon recruitment for each one standard deviation increase of an environmental covariate value (indicated in brackets), while holding all the other covariates at their long-term mean. Predictions are based on a median aggregate spawner abundance of 47,000 salmon. Only variables that had relationships with productivity are displayed. SST = Sea surface temperature, FW = freshwater.

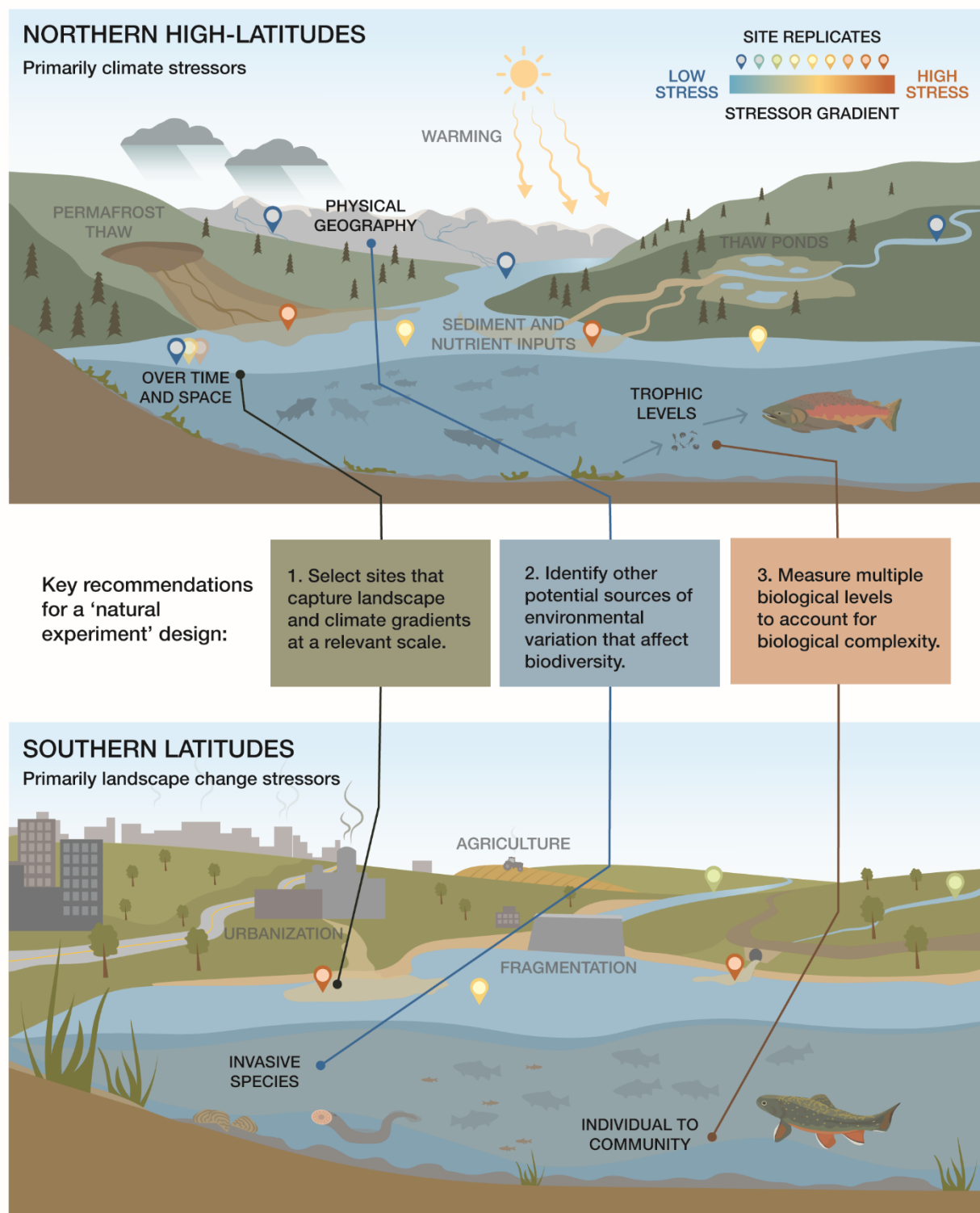


Figure 2. Infographic submitted in our global review examining the cumulative effects of climate change and landscape change on freshwater biodiversity. Here, we identify three key recommendations for conducting 'natural experiments' and illustrate how study design may differ depending on the primary stressor types and the complexity of ecological systems. Created by Fuse Consulting.

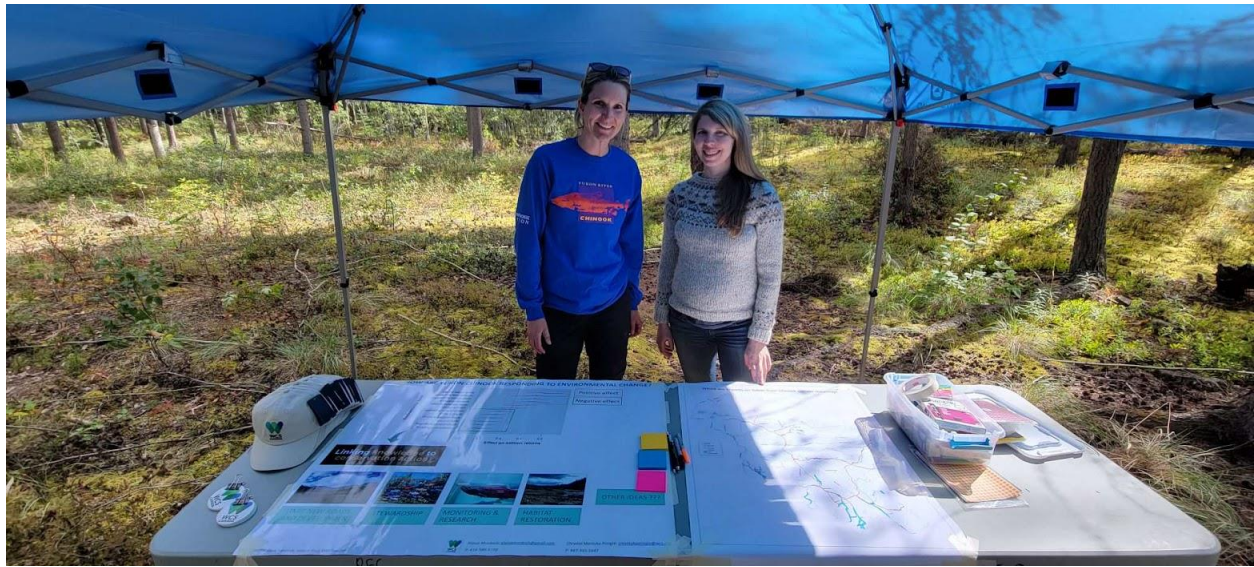


Photo 1: Chrystal Mantyka-Pringle (left) and Alyssa Murdoch (right) at the Annual Salmon Gathering held by Tatchun Creek, August 2022

References:

- Murdoch, A., Connors, B.M., Lapointe, N.W.R., Mills Flemming, J., Cooke, S.J., and Mantyka-Pringle, C. (*in review*). Multiple environmental drivers across life-stages influence Yukon River Chinook salmon productivity. *Canadian Journal of Fisheries and Aquatic Sciences*.
- Murdoch, A.M., S.J. Cooke, B. Connors, N. Lapointe, J. Mills-Flemming, and C. Mantyka-Pringle. 2022a. How is Canadian-origin Yukon River Chinook Salmon responding to environmental change? Virtual presentation at the Yukon Fish Community of Practice Speaker Series, May 2022.
- Murdoch, A., Yip, D.A., Cooke, S.J., and Mantyka-Pringle, C. 2022b. Evidence for the Combined Impacts of Climate and Landscape Change on Freshwater Biodiversity in Real-World Environments: State of Knowledge, Research Gaps and Field Study Design Recommendations. *Curr. Landsc. Ecol. Reports* 2022: 1–15. Springer. doi:10.1007/S40823-022-00074-7
- Schoen, E., M. Feddern, R. Shaftel, and C. Cunningham. 2022. Drivers and Diversity of Chinook Salmon: A workshop focused on the Arctic-Yukon-Kuskokwim region. International Arctic Research Center, Fairbanks, Alaska.