Nechako IRC NEWSLETTER

September 2024 | Volume 6 | Issue 3

NSERC/Rio Tinto Industrial Research Chair

“To better understand and quantify the roles of climate variability, climate change, and water management on the long-term water security of the Nechako Watershed."

Rio Tinto BC Works 70 years

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Territorial Acknowledgement

Working on traditional First Nations territories in a scientific context is a humbling and deeply appreciated privilege. The opportunity to work hand-in-hand with Indigenous communities is a gift for which we are sincerely grateful. This collaboration not only enriches scientific understanding but also fosters mutual respect and cultural exchange. We are grateful for the trust and partnership extended to us, and we strive to approach this work with the utmost gratitude and responsibility. We acknowledge that our work takes place within the unceded traditional lands of 15 First Nations:

- Binche Whut’en
- Cheslatta Carrier Nation
- Lake Babine Nation
- Lheildli T’enneh
- Nadleh-Whut’en
- Nak’azdli Whut’en
- Nee-Tahi-Buhn Indian Band
- Saik’uz
- Skin Tyee Band
- Stellat’en
- Takla Lake
- Tl’azt’en
- Ts’il Kaz Koh (Burns Lake) Band
- Wet’suwet’en First Nation
- Yekooche First Nation

Netʃa koh (Nechako River) at Cottonwood Island Nature Park in Prince George

The Nechako River is referred to as Netʃa koh, meaning **‘Big River’** in the traditional language of the Dakelh Nations

CONTENT

In this issue of the Nechako IRC newsletter you will find updates from the current team of researchers, including updates on another busy summer season!

September 30 is the National Day for Truth and Reconciliation. We wear orange to honour the thousands of survivors of residential schools. #EveryChildMatters

Happy Fall Equinox!

An introduction from the project leader

The summer of 2024 is already coming to an end, a season that brought a decent amount of rainfall in parts of the Nechako Watershed but also plenty of hot, dry weather interspersed by the occasional, and sometimes severe, thunderstorm. Lightning in the Nechako Watershed and across the rest of BC and in Alberta sparked hundreds of wildfires that consumed vast tracks of forests. Quite unfortunately, many communities were directly impacted by the wildfires including Jasper, Alberta. Despite the summer rains, drought conditions persisted across the Nechako Watershed. There is hope, however, that the emergence of La Niña by this fall will bring cooler than average air temperatures and more abundant precipitation (both rain and snow) across British Columbia. Perhaps several atmospheric rivers may also affect the Nechako Watershed this autumn and in combination with La Niña may alleviate this extended drought.

This issue of the Nechako IRC Newsletter discusses ongoing research by the IRC team spanning the atmospheric river phenomenon, extreme weather events and changing water temperatures in the Nechako Watershed. PhD student Bruno Sobral provides an update on his research as he nears the completion of his doctoral dissertation this autumn. MSc student and co-research manager Justin Kokoszka discusses ongoing efforts to explore indicators of hydrological alteration for the Nechako River. Post-doctoral fellow Mostafa Khorsandi presents recent findings on a frequency analysis for water temperature in the Nechako Watershed using both observational data and computer model simulations. As well, post-doctoral fellow Tamar Richards-Thomas highlights conditions during the hot, dry spells that affected Prince George during the summer of 2024. Finally, this summer's field crew of Kainen Parmar, Lynn Poeppelmann and Maria Tavares under the guidance of field crew leader Dylan Broeke, summarizes key outcomes of the team's field activities in summer 2024.

Indeed, this issue highlights some of the recent field activities that the team conducted over the (exceptionally busy!) 2024 field season. First, our most sincere thanks to the Nulki Tachick Lakes Stewardship Society and the Nechako Environment and Water Stewardship Society for its support of the deployment of a research-grade weather station in late May at Nulki Lake. We also thank local residents at Nulki Lake for offering their assistance in deploying this weather station on their property. Second, we express gratitude to the Department of Fisheries and Oceans Canada (DFO) for also allowing our team to set up a weather station at the Nadina River Spawning Channel in June. The area forms an important spawning ground for sockeye salmon with climate change impacting water temperatures among other aspects of the environment. We also take this opportunity to thank the many individuals, First Nations, small businesses, and other stakeholders across the Nechako Watershed that continue to support our research. Without their support, our efforts to better monitor and understand climate change impacts on water security in the Nechako Watershed would simply not be possible.

This month, my research update highlights a recent paper that was published in the open-access journal PLOS Water. This was an effort with my colleagues in UNBC's Integrated Watershed Research Group (IWRG) that have, over the past decade, undertaken an extensive effort at better understanding the complex Nechako Watershed. Among the wide range of issues affecting the Nechako Watershed are climate change, natural resources extraction and exploitation (e.g. mining, forest harvesting), land use changes (e.g. agricultural land development), land cover disturbances (e.g. mountain pine beetle outbreaks and wildfires). These stressors on watershed health often interact in multiple, complex ways leading to cumulative impacts on water and watershed security. Since the IWRG's inception in 2013, it was clear that we needed an integrative and interdisciplinary approach to address the complex interactions among climate change, land use, watershed dynamics and ecological processes, all of which have far-reaching implications for the communities living within the Nechako Watershed. Thus, our paper synthesizes a decade's worth of integrated research including key findings, outcomes and lessons learned.

You will also find in this issue of the Nechako IRC Newsletter an update on the NSERC Alliance project that explores, among various topics, thermal refuges in the Nechako River. Here, you will find a research update by Dr. Eduardo Martins of UNBC and Dr. Scott Hinch of UBC along with their teams on efforts to use thermal infrared imagery to identify thermal refuges in the Nechako River. Areas of cooler water temperature, which can be associated with groundwater inflows or cool water tributaries, are often exploited by thermally-sensitive fishes such as rainbow trout and sockeye salmon.

The outreach section of this newsletter provides information on a presentation I delivered to the President and CEO of BC Hydro, Chris O'Riley, during his visit to the UNBC campus in early August. This presentation allowed us to share our findings on the impacts of climate change on water security in the Nechako Watershed with implications to hydropower production. I continue attending meetings of various stakeholder groups including the Core Committee of the Nechako Watershed Roundtable.

Finally, we sincerely thank co-research manager Lisa Rickard for her exceptional dedication and hard work in supporting the IRC team since the start of this year. Sadly, Lisa's position at UNBC ended in mid-August as she accepted a new and exciting opportunity in her hometown of Fredericton, New Brunswick. As well, we express much gratitude to the tireless members of the field crew, Kainen Parmar, Lynn Poeppelmann and Maria Tavares, as their positions concluded in late August. Nonetheless, we hope to engage with all three of them in one capacity or another this fall in anticipation of their possible return to the team in summer of 2025. Otherwise, there has been no other changes to the composition of the team this summer but we are actively recruiting for additional highly-qualified personnel as new positions are now opening up in the team.

Stephen Déry

Wishing everyone across the Nechako Watershed and beyond a very pleasant and productive fall of 2024!

The Team

Industrial Research Chair members from the NHG

Stephen Déry
Project Leader

Justin Kokoszka
Research Manager
M.Sc. Candidate

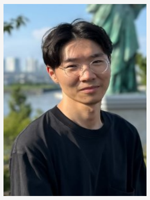
Bruno Sobral
Ph.D. Candidate

Maria Tavares
Database Administrator

Tamar Richards-Thomas
Post-Doctoral Fellow

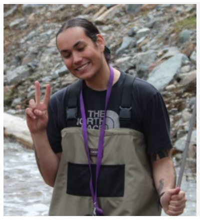
Dylan Broeke
Field Crew Team Leader

Mostafa Khorsandi
Post-Doctoral Fellow



Meng Wang
M.Sc. Candidate

Lucas Moura
Research Assistant/Newsletter Editor



Kainen Parmar
Undergraduate student

New Team Member

We welcome Lucas as newsletter editor in the team

Hello everyone. My name is Lucas. I am biologist and a PhD Candidate in Natural Resources and Environmental Studies program here in UNBC. Since the beginning of this year, I've been working as Research Manager to the Integrated Watershed Research Group—IWRG at UNBC and I am glad to be joining this team as well. I'll be in charge of editing the IRC Newsletter so I'd like to say hello and thank you for this opportunity to also contribute with this work.

Lucas Moura

Farewell to Lynn, Kirsten, and Lisa

We express much gratitude to the tireless members of the field crew, Kainen Parmar, Lynn Poeppelmann and Maria Tavares, as their positions concluded in late August. Maria and Kainen are staying with us assuming new responsibilities on the team. Kirsten are stepping out from the position of data assistant and we also would like to express our gratitude for their work.

We also bid farewell to Co-Research Manager, Lisa Rickard, as she accepted a new and exciting opportunity in her hometown of Fredericton, New Brunswick.

Lynn Poeppelmann

Kirsten Calder-Sutt

Lisa Rickard

Research Chair Update

Synthesizing a decade's worth of integrated research on the Nechako Watershed including key findings, outcomes and lessons learned

Aside from leading the Northern Hydrometeorology Group (NHG) at UNBC, I have been a dedicated member of the Integrated Watershed Research Group (IWRG) that came together in 2013. At its inception, the IWRG comprised four researchers with different academic backgrounds: Dr. Stephen Déry (NSERC/Rio Tinto Senior Industrial Research Chair in climate change and water security), Dr. Philip Owens (Forest Renewal BC Research Chair in Landscape Ecology), Dr. Margot Parkes (Professor, School of Health Sciences), and Dr. Ellen Petticrew (Forest Renewal BC Research Chair in Landscape Ecology) with Barry Booth as the IWRG Research Manager. The IWRG has worked collaboratively for over a decade on integrated watershed-based research with an emphasis on the Nechako Watershed. In an effort to synthesize their efforts spanning the past decade and two phases of research, the IWRG recently published a paper outlining the main findings, outcomes and lessons learned of their work thus far.

Our study was published on 10 July 2024 in the open-access journal PLOS Water and is titled "Towards an integrative understanding of British Columbia's Nechako Watershed: Connecting knowledge systems to strengthen understanding of climate change, watershed security, health and well-being." The paper provides some background information on the rich history and complex geography of the Nechako Watershed including the presence of Indigenous peoples for thousands of years and their vast traditional territories. It also outlines some of the main issues affecting water and watershed security, including climate change, natural resources extraction and exploitation, land use changes and land cover disturbances. A summary of key findings is provided for each of the three research themes covering: 1) climate change and water security (led by Dr. Déry), 2) sediment sources and dynamics (led by Drs. Owens and Petticrew), and 3) tools for integration in watershed management and governance (led by Dr. Parkes).

Under Theme 1 that I led, it was established that the Nechako Watershed experienced an average warming of 2.3°C between 1950 and 2010. In response to this, precipitation type shifted considerably towards more rainfall with less snowfall, although overall annual total precipitation remained relatively stable over those seven decades. Rising air temperatures have accelerated spring snowmelt and advanced the timing of the spring freshet in unregulated watersheds. Conversely, the regulated Nechako River observed a substantial decline in overall flows throughout the water year with exception of the period from mid-July to mid-August. This is when the Summer Temperature Management Program (STMP) takes effect with the release of ecological flows from the Skins Lake Spillway to maintain mean daily water temperatures at no more than 20°C as measured on the Nechako River at Finmoore. Despite regulation on the main stem Nechako River to cool summer water temperatures, summer water temperatures have warmed on average by 0.9°C between 1950 and 2015.

Changes in the Nechako Watershed's hydroclimate has substantial implications to sediment transport, water quality and the health and well-being of the Nechako Watershed. Figure 1 illustrates time series of mean annual air temperature for Vanderhoof and daily streamflow for the Nechako River in Vanderhoof spanning 1950-2023. The rising trend in air temperature for Vanderhoof is quite apparent and warming reached a record value in 2023. The streamflow time series shows the abrupt decline in flows in the 1950s when the Nechako Reservoir was filled. The relatively dry decade of the 1980s was followed by wetter periods that included floods in 2007 and 2015. The contribution of channel banks to sediment transport increased in the 1970s and remained fairly stable thereafter. Chinook salmon escapements from the Nechako River dropped precipitously with the onset of regulation on the Nechako River but have recovered markedly since the 2000s. The bottom panel of Figure 1 summarizes the results of a "saturation literature search" that reveals recent increases in the number of publications focusing on the Nechako Watershed, particularly since the mid-1990s. This type of composite time series analysis facilitates bridging the gap between various academic fields of research to develop an integrative understanding of the Nechako Watershed.

Stephen Déry

For more information on our study, please consult the announcement on the IWRG's website. The IWRG thanks the many stakeholders in the Nechako Watershed that assisted with, and continue to support, our research and field activities, as our efforts would not have been possible without all of your support. The IWRG also expresses much gratitude to the primary funder of this research, namely the Nechako Environmental Enhancement Fund (NEEF). With the recent addition to the IWRG of Dr. Eduardo Martins, a freshwater fish ecologist at UNBC, the IWRG has entered its third phase of integrated watershed research focused on the Nechako Watershed. We therefore anticipate continued collaboration and future publications as our effort to better understand the Nechako Watershed continues in the coming years.

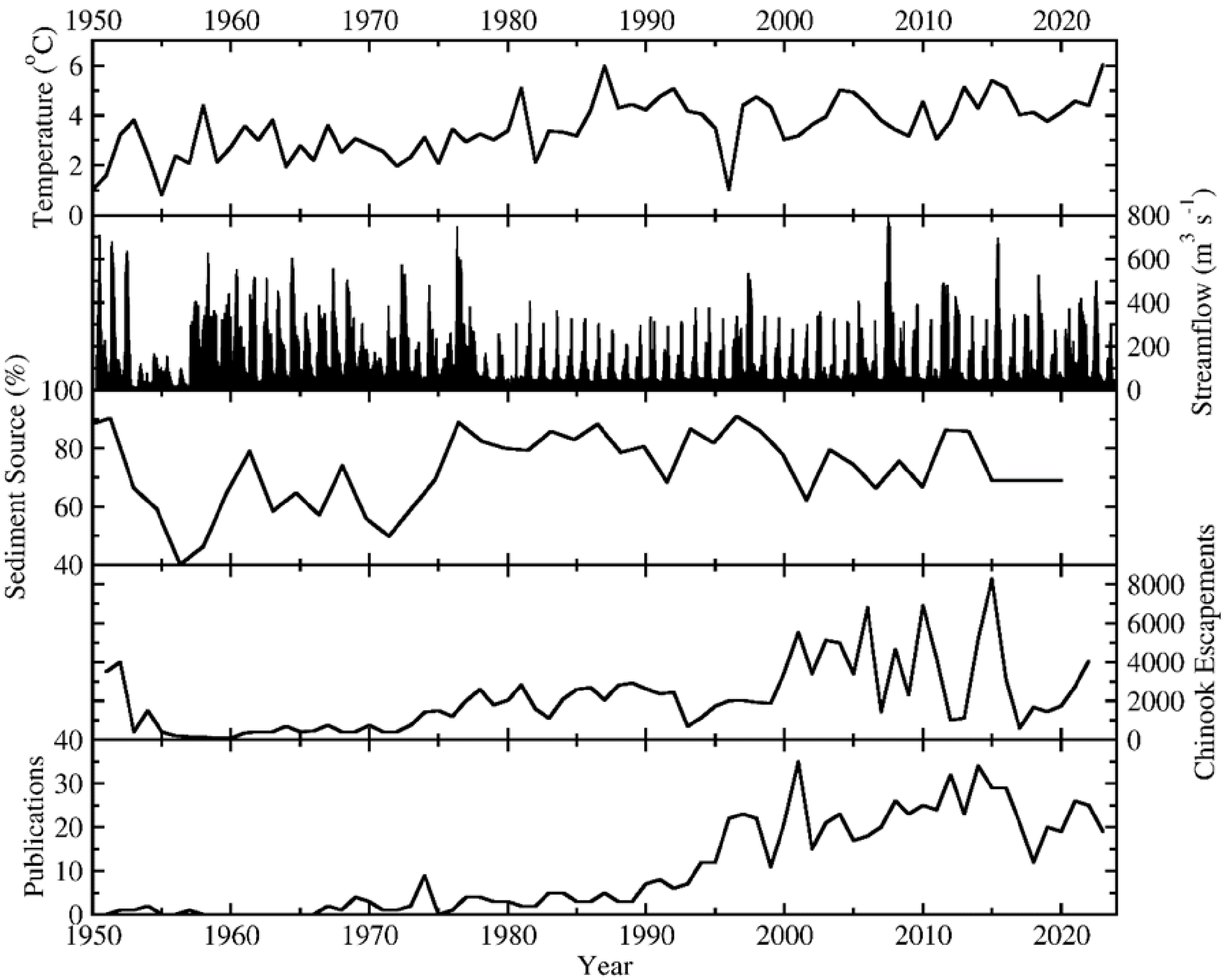


Figure 1: Time series of mean annual air temperature (for Vanderhoof), daily streamflow for the Nechako River at Vanderhoof, proportion of fine sediment derived from eroding channel banks for the Nechako River at Vanderhoof, Nechako River Chinook salmon escapements and annual number of publications focused on the Nechako Watershed, 1950–2023 (Parkes et al. 2024).

Field Work

Key outcomes of the team's field activities in summer 2024

The NHG field crew is celebrating a highly successful summer! Over the past three months, we've been extremely busy, completing three weeks of intensive onboarding and training, constructing two new weather stations, and visiting over 50 existing sites for data collection and maintenance. With only a few site visits remaining, we expect to wrap up our work before the end of August.

Our first weather station was set up at Nulki Lake. This station features several sensors, including a new addition to our equipment lineup: the frost probe. This device is a rod buried vertically in the ground, measuring soil temperature at 5 cm intervals from 0 cm to 20 cm. These data will help us understand how frost penetrates the soil. The station also includes a ClimaVue50, SnowVue10, Apogee Net Radiometer, and two T107 temperature probes with one measuring lake temperature.

The second weather station was installed at the Nadina River Spawning Channel, adjacent to an existing Tipping Bucket Rain Gauge (TBRG). This setup mirrors that of the Nulki Lake station, but it lacks the Frost Probe sensor and features an SR50AT instead of a SnowVue10. Thanks to the extensive training and expertise of this year's crew, this station was completed in record time!

Aside from the new weather stations in the Nechako Watershed, the other sites we visited were generally in good condition, allowing us to collect weather and stream temperature data across the watershed, from the Ancient Forest to Cheslatta Lake and Huckleberry Mine.

It's been a fantastic season, with minimal delays from fires and smoke and successful data downloads at most sites. With just three trips left this summer, it's remarkable how quickly the time has flown. After a busy season, we look forward to applying the knowledge and experience we've gained to next year's work.

Dylan Broeke

Nadina River above Nadina Lake, Stream Temperature Logger Redeployment.

Thoughts and reflections from our field team

This summer was filled with many new experiences for me! As a city girl from Toronto, venturing into the "bush" initially caused me some trepidation, however, the comprehensive training provided by the NHG helped me ease into what turned out to be a rewarding summer full of adventure. As the season draws to a close, I am grateful for the opportunity to have explored some of the most beautiful places in the country. I am inspired by the crucial research being conducted on the Nechako watershed, and I'm honoured to have supported these efforts. I also appreciated the chance to collaborate with nearby Indigenous territories, fostering stronger partnerships between local Nations and the NHG. Thanks to my amazing teammates—Dylan, Kainen, and Lynn—I made wonderful memories this summer. I can't wait for the next season!

Maria Tavares

Kainen Parmar

Working with the NHG across the Nechako Watershed this summer has been a fantastic experience. I've greatly enjoyed travelling to the many remote sites across the basin which consistently provided beautiful scenery, opportunities to observe wildlife, and the chance to meet many highly knowledgeable members of the community. I have learned about the deployment and upkeep of hydrometeorological sensors across diverse environments and tons about fieldwork techniques and best practices. I have had a wonderful time working with everyone this summer and would like to sincerely thank all the fantastic members of the NHG for creating a wonderful work environment and for the many great memories this summer!

One aspect of our time this summer that stood out to me was the fact that spending a lot of time together in the field and work trucks will easily create a bond with your coworkers if they are as easy-going as Maria, Dylan and Kainen: The team was incredibly supportive of each other whenever it came to troubleshooting situations, combating external field-related "discomfort" together or simply celebrating successful moments in the most beautiful places we called our "office". The places we got to see during the season were breathtaking and can humble you, considering we were working on First Nations Territories or shared the landscape with an abundancy of wildlife. Learning how to react in potential wildlife encounter situations before heading out into the field, made me feel more prepared. Luckily, we only saw grizzlies from the truck!

Lynn Poeppelmann

Some favorite pictures from the summer field season


Nadina Spawning Channel Weather Station


Our first field trip – Skins Lake Spillway


Grizzly near Huckleberry Mine


Moose swimming in the Nechako Reservoir


Our boat day on Nechako reservoir visiting Laventie, Kasalka, and Whitesail Creeks

Nechako Research

Explore some of our research!

Nearing the end of my journey as a PhD student at UNBC

As the end of 2024 approaches, I am nearing the end of my journey as a PhD student at UNBC. The past three months have been exceptionally busy as I have been carefully addressing the outstanding components of my study. A significant milestone was achieved by submitting the first draft of the dissertation to the PhD committee by mid-August 2024.

In addition to completing my dissertation, I've been incorporating feedback from reviewers on the manuscript that forms Chapter 3 of the dissertation. It has been renamed to "Water Budget Variability and Trends Linked to Atmospheric Rivers in British Columbia's Nechako River Basin," and significantly benefited from their suggestions. The past few months felt like a final sprint, with much of my time dedicated to writing and refining my work on atmospheric rivers to ensure it's in its best shape for a formal defence later this year.

I've also conducted a thorough review of recent papers to update the study's bibliography with the latest research on atmospheric rivers. Updating the coding scripts for Chapters 3 and 4 (Figures 2 and 3) has required considerable effort as well. Chapter 4, "Climate Dynamics of Exceptional Atmospheric Rivers and the Hydrological Response in British Columbia's Nechako River Basin," needed particular attention to ensure all graphical and spatial analyses were accurate and clear.

Looking ahead, my next steps involve completing Chapter 4 and preparing it for submission to a peer-reviewed journal. Simultaneously, I'll be working on creating a clear and engaging presentation for my defence in December 2024. This presentation will summarize my research and highlight the significant findings about atmospheric rivers and their impact on the Nechako River Basin.

Bruno Sobral

"The end of this meaningful academic journey is in sight, and I'm excited to share my work on ARs affecting the Nechako with the broader community."

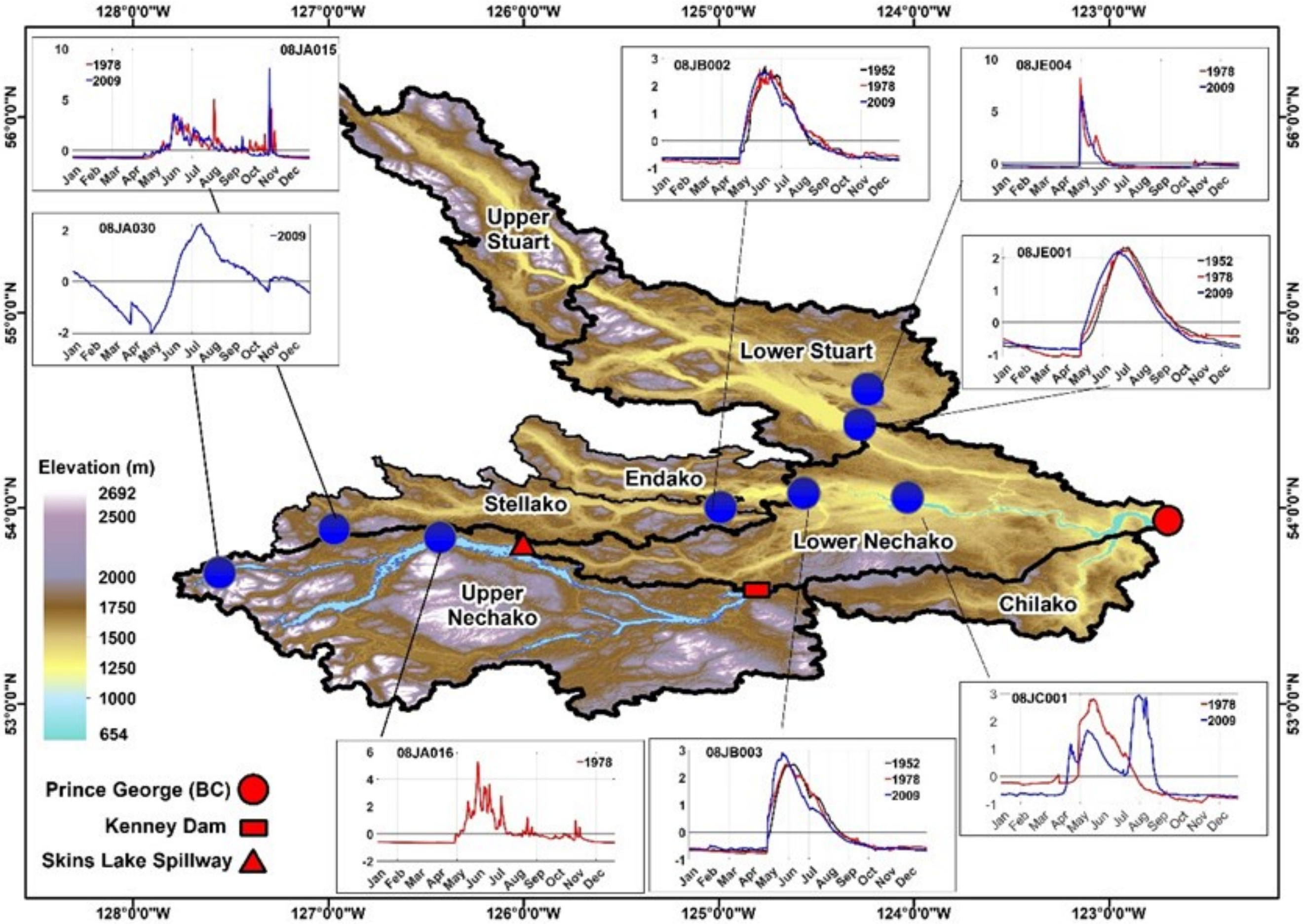


Figure 2: Standardized discharge data across the NRB for the exceptional atmospheric river events of 1952 (black line), 1978 (red line) and 2009 (blue line).

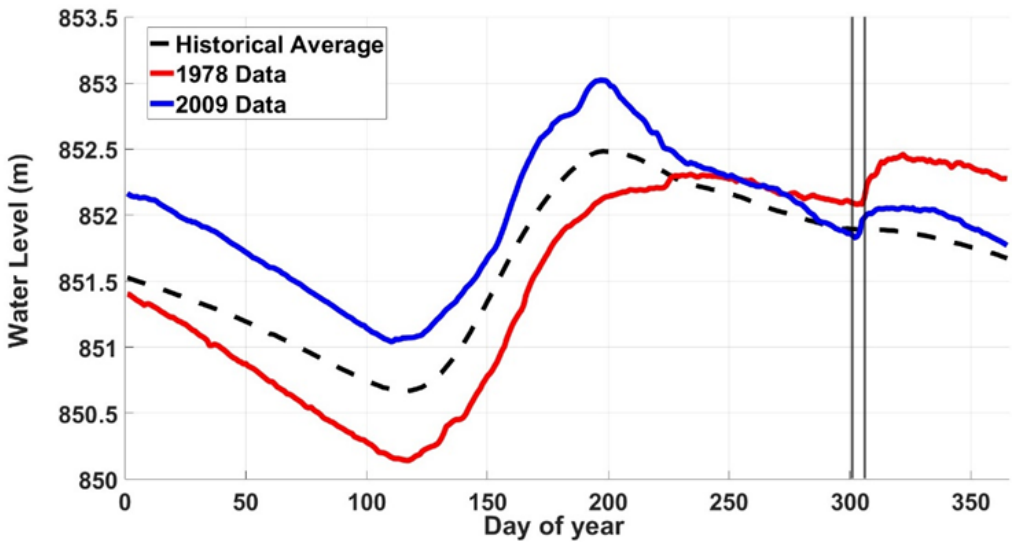
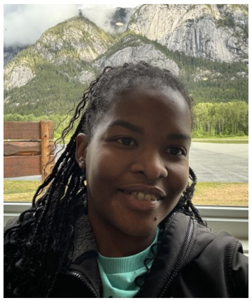


Figure 3: Water level (m) data in the Nechako Reservoir for the historical period (1955-2021) (black dashed line) in days of the calendar year (1-365), for the 1978 Atmospheric River (AR) event (red line) and the 2009 AR event (magenta line). The gray vertical lines represent the occurrence period of the exceptional AR events in 1978 and 2009. No data are available for the Nechako Reservoir during the exceptional AR event in 1952.

Hot Spell in Prince George, British Columbia

The rise in air temperature, caused by a strong ridge of high pressure over southwestern United States and ongoing fires in nearby areas, has resulted in a heatwave in Prince George and its surrounding regions in July 2024. The first heat wave of summer 2024 in Prince George occurred on the weekend of 7 July 2024 when air temperature rose to 31.2°C, decreased slightly to 30.9°C on the 8 July 2024, and then increased to 33.0°C on Tuesday, 9 July 2024 (red solid line; Fig. 4a), but did not break previous records at the Prince George Airport Auto (PGAA) station. There was no rainfall during this period (Fig. 4b). Air temperatures on days before the first weekend of July 2024 were well above 20 °C, setting the stage for increased temperatures as measured at the PGAA and Prince George A (PG) stations. In July, the air temperature rose above 30°C (purple horizontal dashed line; Fig. 4a) on the 17th, 18th, and peaked at 33.4°C on 21 July 2024 (Fig. 4a). The highest daily air temperatures, exceeding 30°C, were recorded on 17, 18, and 21 July 2024 at the PGAA station. These temperatures were the highest reported in the last 15 years, breaking previous records. Additionally, there was significant precipitation at the end of July 2024, with rainfall exceeding 20 mm per day on 25 July 2024.



Tamar Richards-Thomas

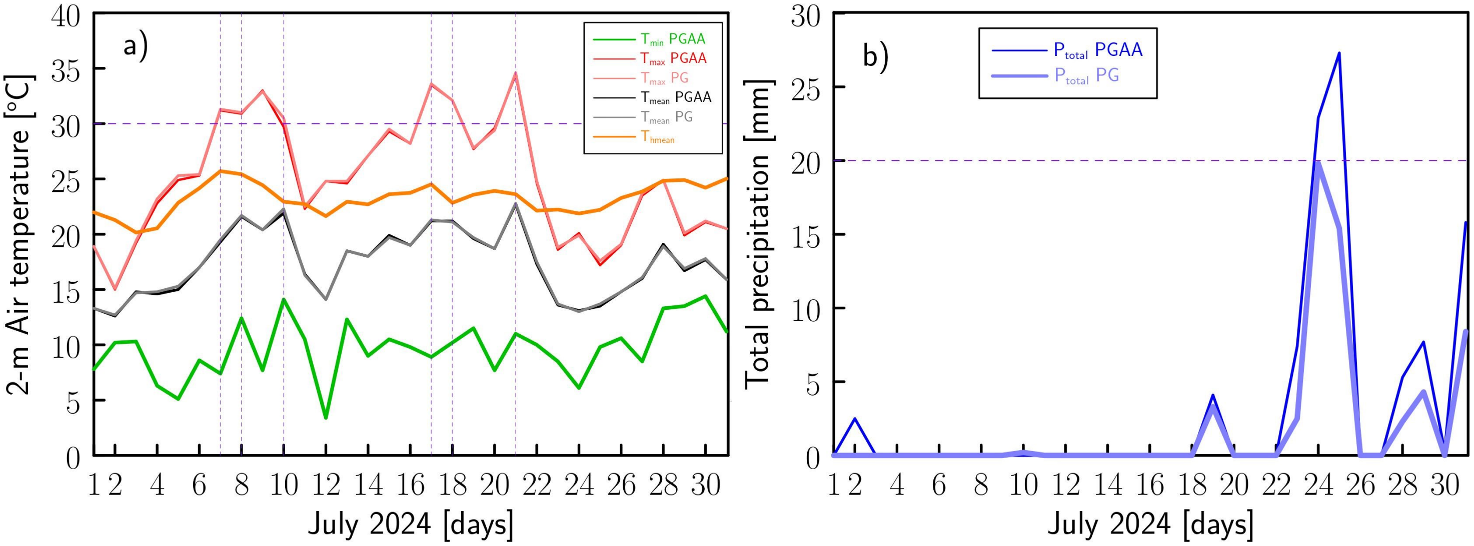


Figure 4: Heat waves in Prince George—BC. 4a:graphic showing air temperature estimates for region of Prince George. 4b:Estimative of precipitation for July 2024.

Pinpointing Key Water Flow Metrics at Vanderhoof

Rivers are dynamic systems, their flow patterns in a constant state of flux due to the interplay of both natural and human factors. Precipitation, snowmelt, evapotranspiration, and even human activities such as dam construction and land-use change all influence streamflow patterns. Additionally, these factors can be amplified or attenuated due to climate change and long-term climate patterns. The Nechako River Basin exhibits all these factors which have led to significant flow variability over time. In addition to having significant implications for both water resources and aquatic ecosystems in the region, this inherent variability makes understanding hydrological patterns a significant challenge, yet one that is essential for water resource management and preservation of aquatic ecosystems.

Quantifying the role of human-induced hydrological alteration amidst natural variability remains a particularly challenging task, especially when considering the numerous metrics that can be used to evaluate alteration of flow. In terms of ecological significance, the 32 Indicators of Hydrological Alteration (IHA) provide a robust picture of altered flow regimes in terms of magnitude, frequency, duration, timing, and rates of change of flow events. These metrics have been widely used in ecological studies to assess the impacts of human activities on riverine ecosystems[1]. However, arbitrarily relying on numerous metrics of variability can lead to information overload and obscure key changes.

We aimed to investigate flow patterns along the Nechako River at Vanderhoof. We used Principal Component Analysis (PCA), a robust statistical technique, to distill the complex relationships among the 32 IHA metrics into a few key factors, or principal components that contribute the most to hydrological alteration (~80% of overall variability). By focusing on these principal components, we gain a clearer understanding of the dominant patterns in hydrological changes making it easier to detect trends, assess impacts, and provide a more targeted assessment of human influenced hydrological alteration and implications for aquatic ecosystems[2].

Justin Kokoszka

Our analysis included both regulated and naturalized flow data at Vanderhoof between water years (Oct – Sep) 1952 to 2021. All 32 IHA metrics were calculated for the observed and naturalized flows followed by PCA to identify the principal components of each flow type, their relative contributions to overall flow variability, and the most significantly associated IHA metric (Figure 5). For the observed data, reflecting both natural and human-induced influences, the PCA identified five key IHA metrics, describing 83% of the observed flows overall variability: May median flow (PC1/42%), base-flow (PC2/24%), date of maximum flow (PC3/8%), high-pulse count (PC4/5%), and reversals (PC5/4%). The high-pulse count and reversals reflect the impact of human interventions like spillway operations on flow patterns. In contrast, the naturalized data, representing the natural flow regime, resulted in only four key metrics, describing 81% of the naturalized flows overall variability: 1-day minimum flow (PC1/44%), base-flow (PC2/23%), date of maximum flow (PC3/9%), and low-pulse length (PC4/5%). The high-pulse count and reversals reflect the impact of human interventions like spillway operations on flow patterns. This suggests that the natural regime is particularly sensitive to periods of low flow, highlighting the importance of maintaining adequate base-flow conditions for ecological health. Both regimes identify base-flow and timing of maximum flow as significant contributors to overall flow variability, suggesting the fundamental role of groundwater contributions and seasonal flow patterns.

This analysis highlights the key components of flow variability, in terms of ecologically significant metrics, between the natural and regulated flow regimes at Vanderhoof. Understanding these key metrics is critical for effective water management strategies and conservation efforts. Identifying the key components of variability enables us to investigate these key components in terms of significant trends and interannual variability. These further investigations will enhance our understanding of streamflow variability in the Nechako River Basin, bridging the gap between natural and human-induced hydrological alteration and potential ecological implications.

“The high-pulse count and reversals reflect the impact of human interventions like spillway operations on flow patterns. This suggests that the natural regime is particularly sensitive to periods of low flow, highlighting the importance of maintaining adequate base-flow conditions for ecological health.”

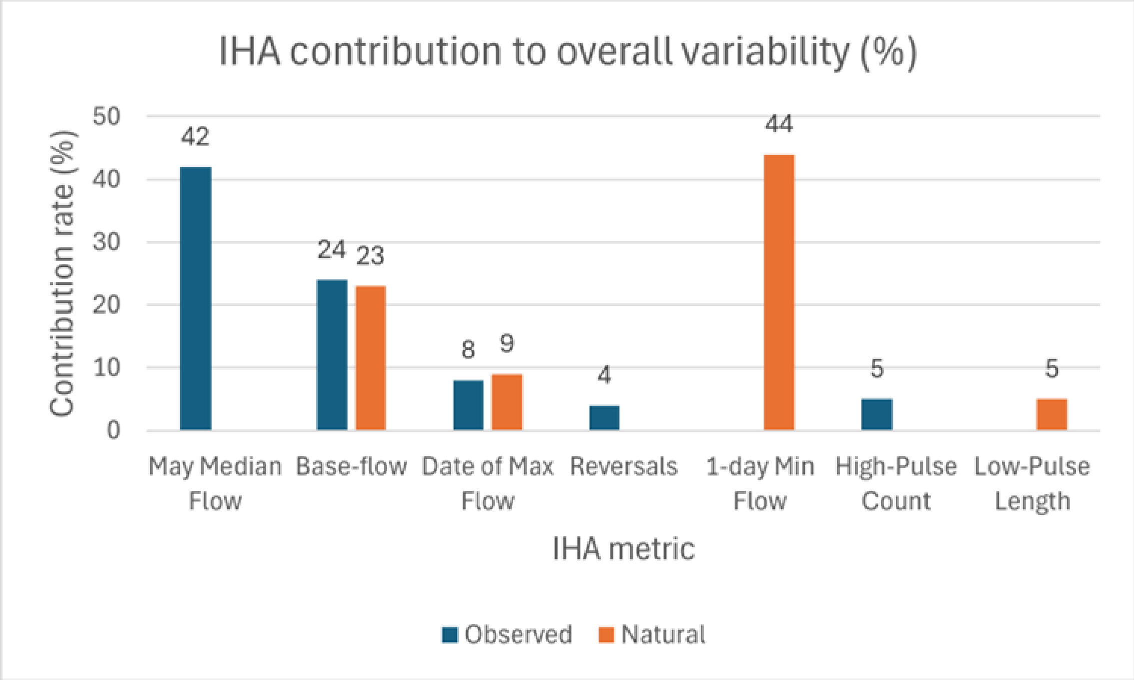


Figure 5: Contribution of Indicators of Hydrological Alteration (IHA) to overall flow variability in observed and naturalized flow regimes at Vanderhoof for water years (Oct - Sep) 1952 to 2021. See table 1 for IHA descriptions and ecological implications.

Table 1: Principal IHA metrics and their ecological implications for aquatic ecosystems.

Metric (IHA)	Description	Ecological Implication
May Median Flow	The median flow value for the month of May.	Associated with spring snowmelt and provides adequate flows for fish spawning and migration[3].
Base Flow	The portion of streamflow sustained by groundwater discharge.	Provides critical year-round habitat for aquatic life, particularly during low-flow summer and winter periods[4].
Date of Maximum Flow	The date on which the highest flow occurs in a year.	Provides critical flows that impacts the life cycles of aquatic organisms[5].
Reversals	The number of times flow direction changes within a year.	Influences backwater habitats including refuge for fish and other aquatic species during high flows[6].
1-day Minium Flow	The lowest flow value observed over a 24-hour period within a year.	Affects environmental stressors for fish and other aquatic species in terms of habitat loss, water temperature, resource competition, and predation during low flow periods[4].
High-Pulse Count	The number of times flow increases rapidly and then decreases within a short period, associated large scale magnitudes.	Influences habitat diversity by scouring streambeds and triggers key ecological processes, such as fish migration[5].
Low-Pulse Length	Median duration of streamflow below a specified threshold.	Influences habitat degradation in terms of water quality and temperature[8].

Frequency analysis of high water temperatures in the Nechako Watershed, British Columbia

After calibrating the Air2Stream model for eight stations across the Nechako watershed, we proceeded with the analysis. The first manuscript is nearly complete, based on these results.

In this manuscript, we conducted a frequency analysis of observed water temperatures, alongside a similar analysis using Air2Stream simulations. Additionally, we examined water temperature variations for the Nechako River at Vanderhoof and Isle Pierre stations using naturalized flows. Therefore, we have the simulated water temperatures at these two stations both with and without the presence of the Kenney Dam/Skins Lake Spillway.

Furthermore, the calibrated models for all eight stations enabled us to perform a hindcast of water temperatures, offering valuable data for further analysis in these data-scarce locations.

Next month, we will submit the findings of this research to a scientific journal focused on water temperature modeling. In summary, our results indicate that the Air2Stream outputs are highly accurate, with a root mean square error of less than 1.3°C. However, the frequency analysis of yearly percentiles does not align perfectly with observations. We found that the 5^{th} and 10^{th} percentiles provide the closest match between simulations and observations. Therefore, we recommend using these percentiles for future environmental modeling based on Air2Stream outputs.

Part of the results can be visualized as frequency curves which show the water temperature percentiles (0th, 1th, 5th, 10th, and 50th) versus their return period (Figure 1). Based on the agreement between simulations and observations for the 5th and 10th percentiles, these curves can be used for hydraulic design, or updating the STMP program in the future.

Currently, I am conducting site visits and fieldwork in the Nechako watershed (3-18 August 2024), which offers a better physical understanding of the watershed and improve my knowledge of the data collection process.

Mostafa Khorsandi

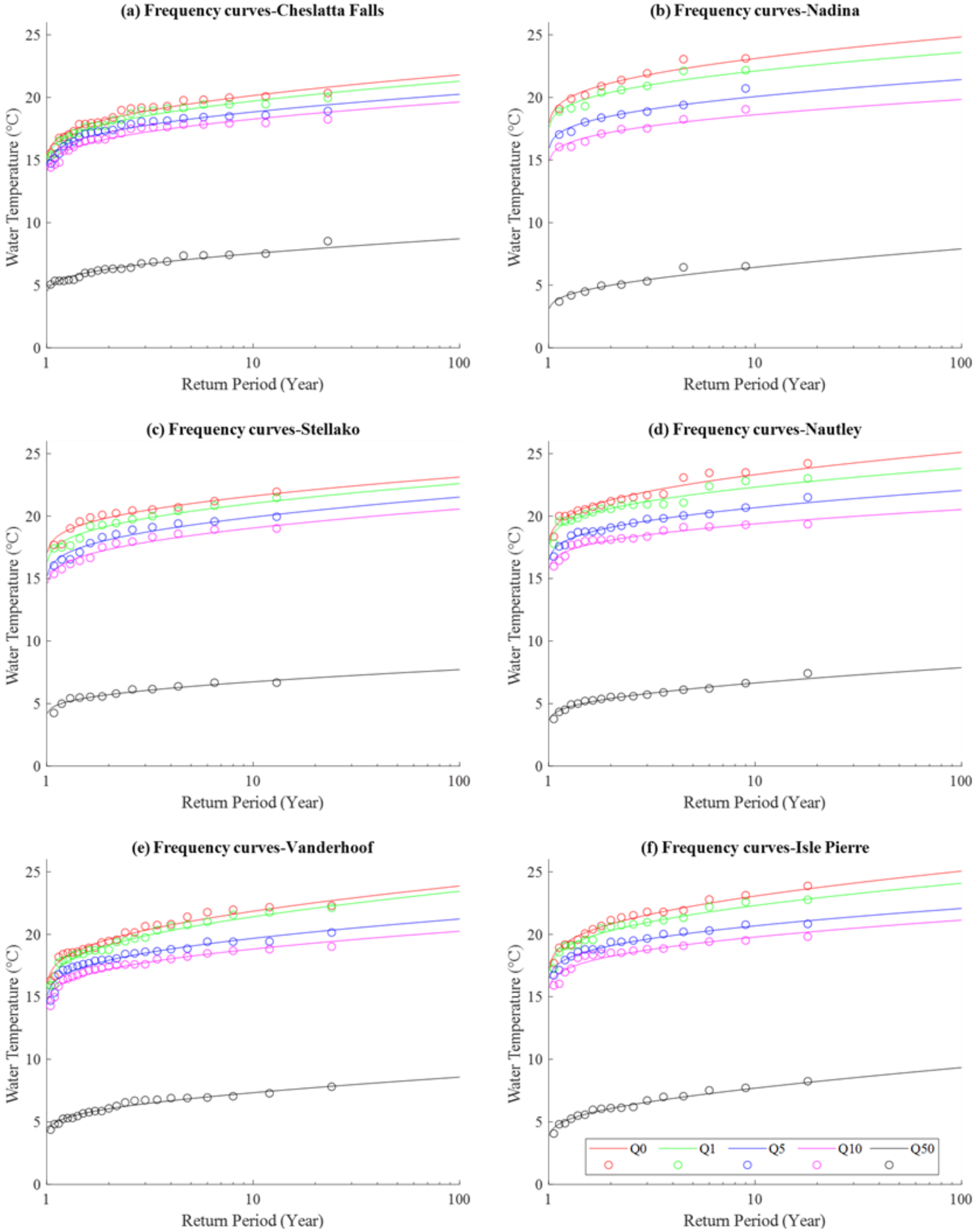


Figure 5: Frequency curves of water temperature percentiles using the lognormal distribution.

NSERC Alliance

Habitat selection and thermoregulation by Nechako white sturgeon and Chinook salmon

In this project, we are investigating thermal habitat selection and thermoregulation (i.e., maintenance of body temperature within a preferred temperature range) by two economically, socially and ecologically important species in the Nechako River – white sturgeon and Chinook salmon. Given the increase in mean river temperatures and extreme thermal events due to ongoing climate change, this research will generate knowledge about the availability of thermal refuges (patches of colder water due to tributary or groundwater input) and their use (if available) by the study species to maintain body temperatures at preferred or non-stressful temperatures. The findings of this work will be critical to inform management practices and policies in the Nechako River towards improving thermal conditions for white sturgeon and Chinook salmon. The core members of the research team include the project leaders, Drs. Eduardo Martins and Scott Hinch; two PhD students, Avery Dextrase and John Gray, and one Research Assistant, Melody Mah.

In this first year of the project, our focus is initiating data collection from white sturgeon and in piloting and refining some of the data collection techniques that will be used in subsequent years (radio receiver and temperature logger deployments, drone-based thermal imagery of the river, and echosounder-based habitat mapping). In May and June 2024, a total of 20 hatchery-reared juvenile white sturgeon and six wild-caught adult sturgeon were tagged and released into the Nechako River in collaboration with team members from the Nechako White Sturgeon Conservation Centre (NWSCC) in Vanderhoof, BC (Figure 6). All fish were tagged with temperature, depth, and activity sensing radio transmitters. The hatchery-reared tagged fish were released in about equal numbers at three locations used by the NWSCC, distributed along the lower Nechako River. The tagged wild-caught fish were captured and released between river kilometers (rkm) 125 and 132. All tagged fish are being monitored by five radio receiver stations (rkm 21, 110, 117, 136, and 191) to continuously monitor the fish movements and log the transmitted sensor data (Figure 7). Fourteen temperature data loggers were deployed in the reaches monitored by radio receivers (data not downloaded yet).

Body temperature data transmitted by tagged white sturgeon to the receiver station (rkm 191) near the Nautley River confluence in June and July revealed that the fish experienced temperatures that closely tracked the Nechako River temperature measured in Vanderhoof (compare the mean river temperature trend to the pattern of body temperature exhibited by the fish represented by the pink and green lines/dots in Figure 8). Their body temperature exceeded 20°C for a period of about 10 days during the heat wave in mid-July and were as high as 24°C. These preliminary findings suggest the unavailability of thermal refuges or lack of their use (if present) near the Nautley River confluence, with the fish remaining in the area throughout the heatwave (Figure 8). In addition to transmitting the sensor data to radio receiver stations, the transmitter also logs the information internally on the tag, which will enable us to learn about the full thermal, depth, and activity experience of a fish if it is found dead in the river, onshore due to otter or eagle predation, or recaptured by other groups after the three-year lifespan of the transmitter.

The tagged fish are also being monitored at monthly flights conducted by biologists at the Ministry of Water, Land and Resource Stewardship (WLRS), who carry a radio receiver that can detect our transmitters. The June and July flights detected 25 of the 26 fish tagged in May. Between releases in May (adults) and June (juveniles) and tracking in mid-June and mid-July, tagged fish have exhibited a variety of movement behaviours in relation to their release site. They either 1) remained close to the release site; 2) moved downstream (up to > 100 rkm); or 3) moved upstream, then downstream (and vice versa). No fish were detected moving upstream of the Old Fort Fraser Bridge at rkm 197 (Figure 9).

For the remainder of the field season, we will continue to monitor the tagged fish and refine data collection designs/protocols for river temperature (using data loggers and drone-based thermal imaging) and physical habitat (using an echosounder), which will be fully implemented in 2025. We are also preparing to initiate work on juvenile and adult Chinook salmon in 2025, which will consist of lab-based thermal preference trials, tagging of adults with temperature, depth and activity sensing radio-transmitter and expansion of the radio receiver network, and capture-recapture of juveniles Chinook salmon.

Dr. Eduardo Martins

With contributions from Scott Hinch, Avery Dextrase, John Gray and Melody Mah.

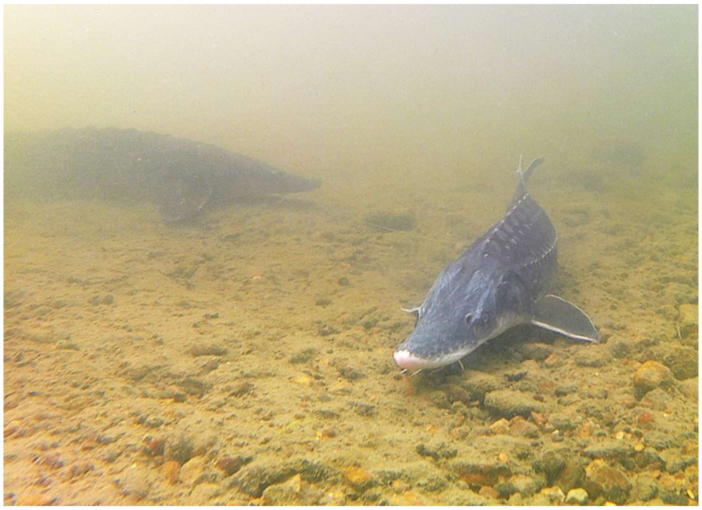


Figure 6: Two tagged juvenile white sturgeon in the Nechako River in June 2024.

Figure 7: Radio receiver station deployed at rkm 191.

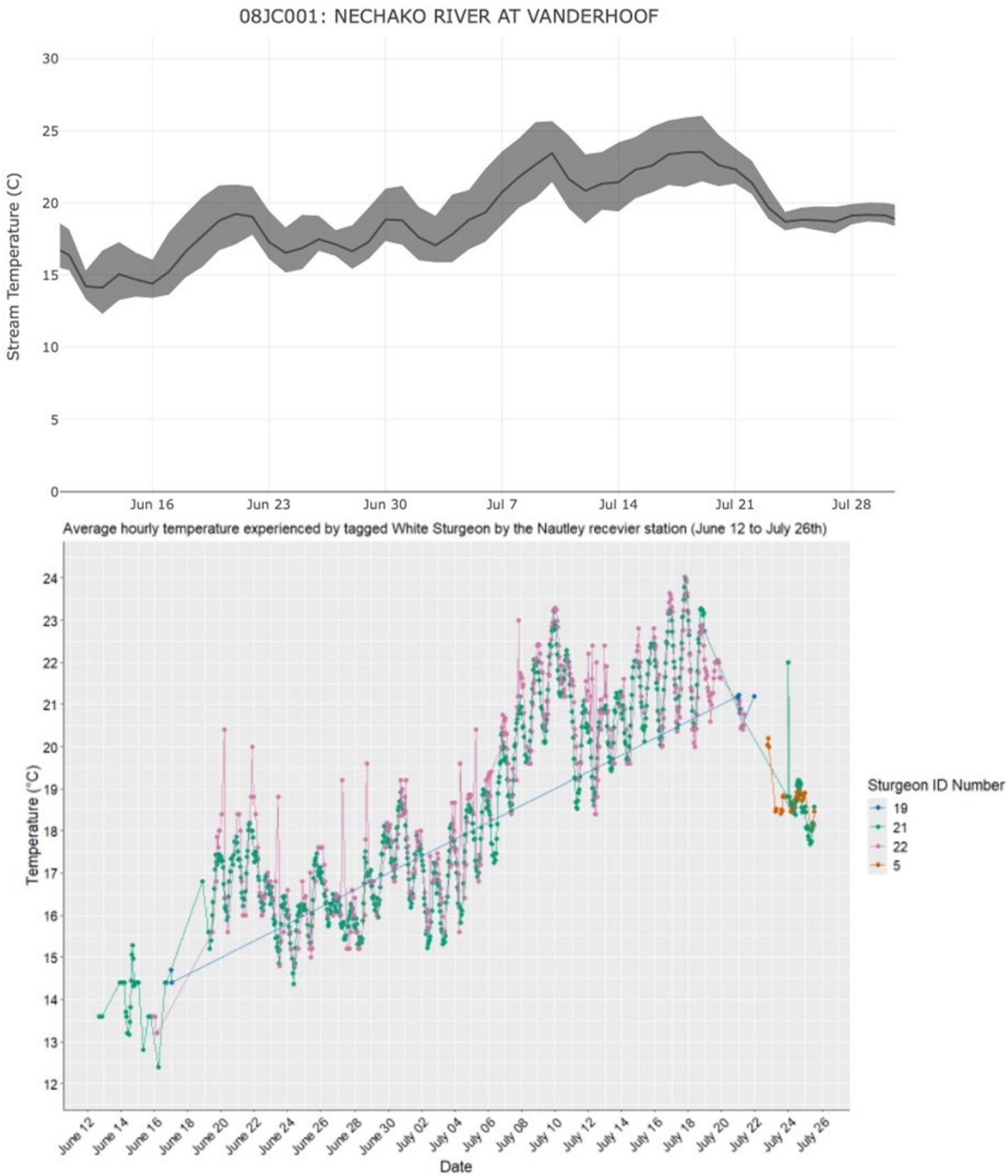


Figure 8: Nechako River temperature at the Water Survey of Canada station at Vanderhoof (top, plot generated at https://bcgov-env.shinyapps.io/nbchydro/) and body temperature transmitted by tagged white sturgeon to the receiver station near the confluence of the Nautley River.

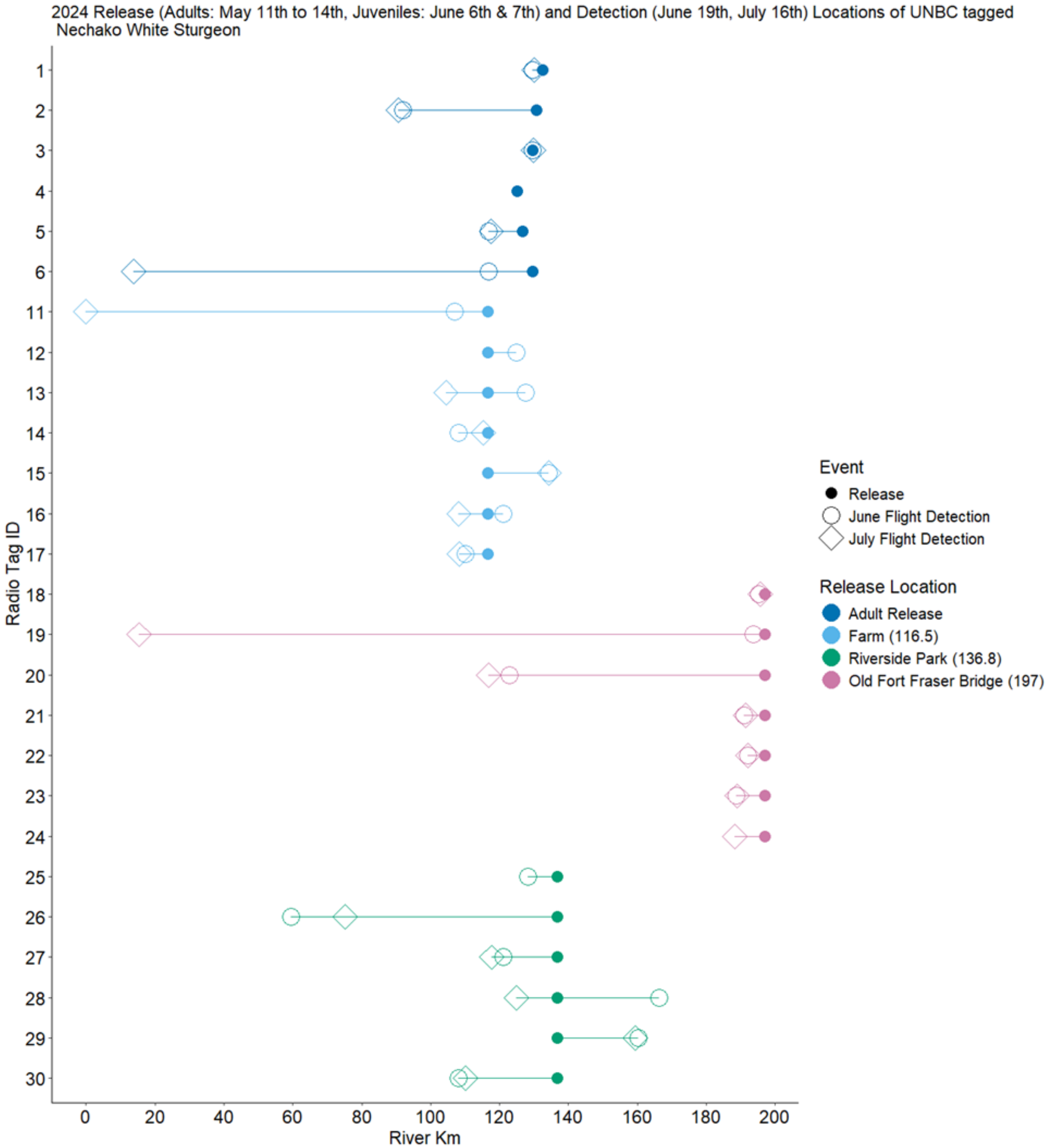


Figure 9: Detections of tagged juvenile and adult white sturgeon during flights conducted in June and July 2024.

Outreach

Communicating our findings through various means continues to be a top priority!

Presentations

- S. Déry. (2024). Climate change and water security research in the Nechako Watershed. Visit of the BC Hydro President and CEO, Chris O'Riley, to the UNBC campus, Prince George, Canada, 7 August 2024.
- T. Richards Thomas, S. Woyke and S. J. Déry (2024). Moisture Fluxes During Three Atmospheric Rivers in September and October 2021 in British Columbia's Upper Nechako Watershed, International Atmospheric Rivers Conference, La Jolla California, USA, 25 June 2024.
- T. Richards Thomas, S. Woyke and S. J. Déry (2024). Moisture Fluxes During Three Atmospheric Rivers in September and October 2021 in British Columbia's Upper Nechako Watershed, Canadian Meteorological and Oceanographic Society Annual Congress, Virtual, 4 June 2024.

Publications

- Parkes, M. W., Déry, S. J., Owens, P. N., Petticrew, E. L., and Booth, B., 2024: Towards an integrative understanding of British Columbia's Nechako Watershed: Connecting knowledge systems to strengthen understanding of climate change, watershed security, health and well-being, PLOS Water, 3(7), e0000263. https://journals.plos.org/water/article?id=10.1371/journal.pwat.0000263
- Richards-Thomas, T. S., Déry, S. J., Stewart, R. E., and Thériault, J. M., 2024: Climatological Context of the Mid-November 2021 Floods in the Province of British Columbia, Canada, Weather and Climate Extremes, 45, 100705, doi: 10.1016/j.wace.2024.100705. https://www.sciencedirect.com/science/article/pii/S2212094724000665

Meetings

- Nechako Watershed Roundtable core committee meeting (11 June, 9 July , and 13 August 2024).

Check out our website! https://web.unbc.ca/~sdery/irc

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