Site C Clean Energy Project

Peace River and Site C Reservoir Water and Sediment Quality Monitoring Programs (Mon-8 and Mon-9)

Task 2b – Water Temperature

Construction Year 6 (2020)

Josh Sutherby, BSc
Golder Associates Ltd.

Dustin Ford, RPBio
Golder Associates Ltd.

17 May 2021

GOLDER
MEMBER OF WSP

REPORT

2020 Annual Report

Peace River and Site C Reservoir Water and Sediment Quality Monitoring Program (Mon-8/9) - Water Temperature Monitoring (Task 2b) - 2020

Submitted to:

BC Hydro
BC Hydro
1111 West Georgia Street, 9th Floor
Vancouver, British Columbia, V6E 4G2
Canada

Submitted by:

Golder Associates Ltd.
10803 91st Ave Unit A Fort St John, BC V1J 6L3 Canada

+1 250 785 9281

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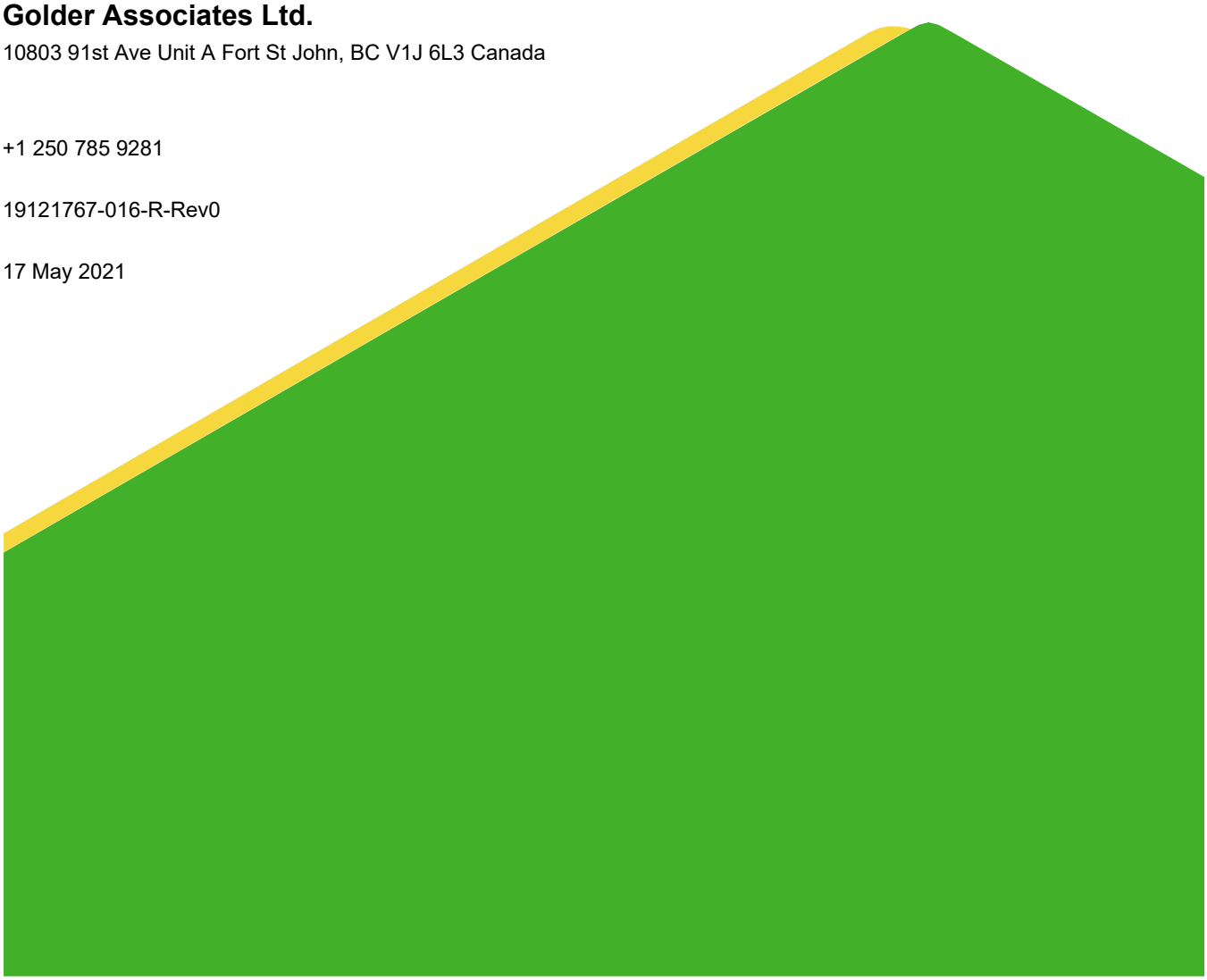
17 May 2021



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Executive Summary

In accordance with Provincial Environmental Assessment Certificate (EAC) Condition No. 7[1] and Federal Decision Statement (FDS) Condition Nos. 8.4.3[2] and 8.4.4[3] for BC Hydro's Site C Clean Energy Project (the Project), BC Hydro has developed the Site C Fisheries and Aquatic Habitat Monitoring and Follow-up Program (FAHMFP[4]). The Site C Reservoir Water and Sediment Quality Monitoring Program (Mon-8) and the Peace River Water and Sediment Quality Monitoring Program (Mon-9) represent two components of the FAHMFP and Site C Reservoir and Peace River Water Temperature Monitoring represents one task within Mon-8/9 (Task 2b). Task 2b is not intended to address specific management questions or hypotheses under the FAHMFP. Instead, temperature data collected under Task 2b provides information to diagnose causes of observed changes in other FAHMFP programs (i.e., Site C Reservoir Fish Community Monitoring Program [Mon-1a], Site C Reservoir Tributaries Fish Community and Spawning Monitoring Program [Mon-1b], and Peace River Fish Community Monitoring Program [Mon-2]) designed to monitor key indicator species of the Peace River.

The Peace River Water Temperature Database was developed in 2020. The database houses water temperature data collected between 2008 and 2014 by Diversified Environmental Services as part of BC Hydro's Water License Requirement (WLR) Peace River Baseline TDG and Temperature Program (GMSWORKS-2) and data collected during the first six years (2015 to 2020) of Mon-8/9.

In 2020, stations in the WAC Bennett and Peace Canyon Dam forebays and tailraces were downloaded on 19 February, 6 July, and 18 November 2020, as well as 23 February 2021. Stations in the Peace River mainstem and major tributaries (including the Pine and Beatton mainstem stations) were downloaded 26-28 February, 2-3 June, and 14-16 October 2020. Data from stations within the Project footprint were downloaded only during the February 2020 session and on 5 September 2020. Data from the Peace and Halfway tributaries were downloaded between 22 July and 14 August 2020. Seven stations with a single data logger at each could not be recovered in 2020 (BeatMS2, Moberly_2, Cypress_2, Farrell_2, Colt_2, Kobes_1, and Kobes_2). Four stations were moved. Data gaps exist in the data from 2020 for nearly all stations, with the exception of gmsUP1, gmsUP2, and pcnUP1. Gaps are typically present where recorded data was indicative of the logger being out of water, but also exist following the final download session of 2020 (July or August for tributary stations, mid-October for Peace mainstem stations).

Historical data collected between 2008 and 2014 under GMSWORKS-2, coupled with data collected under the FAHFMP between 2015 and 2020, provide a near continuous 13 year dataset of water temperature data at select locations.

[1] The EAC Holder must develop a Fisheries and Aquatic Habitat Monitoring and Follow-up Program to assess the effectiveness of measures to mitigate Project effects on healthy fish populations in the Peace River and tributaries, and, if recommended by a QEP or FLNR, to assess the need to adjust those measures to adequately mitigate the Project's effects.
[2] "The plan shall include: an approach to monitor changes to fish and fish habitat baseline conditions in the Local Assessment Area."
[3] "The plan shall include: an approach to monitor and evaluate the effectiveness of mitigation or offsetting measures and to verify the accuracy of the predictions made during the environmental assessment on fish and fish habitat."
[4] Site C Fisheries and Aquatic Habitat Monitoring and Follow-up Program available at https://www.sitecproject.com/document-library/environmental-management-plans-and-reports.

ACKNOWLEDGEMENTS

Site C Reservoir and Peace River Water Temperature Monitoring (Task 2b) is funded by BC Hydro's Site C Clean Energy Project. Golder Associates Ltd. would like to thank the following individuals for their contributions to the program:

BC Hydro

Nich Burnett	Vancouver, BC
Dave Hunter	Vancouver, BC
Michael McArthur	Vancouver, BC
Brent Mossop	Vancouver, BC

Blueberry River First Nations

Jane Calvert	Lands Manager
Geraldine Davis	Technician
Merli de Guzman	Director of Operations

The following employees of ***GOLDER ASSOCIATES LTD.*** contributed to the collection of data and preparation of this report:

Dustin Ford	Project Manager/Reviewer	Kevin Little	Biologist
Josh Sutherby	Junior Biologist/Coauthor	Bobby Bedingfield	Biologist
Gary Ash	Senior Advisor	Amy Cardinal	Biologist
Shawn Redden	Project Director	Corby Shurgot	Senior Environmental Technician
Beth Thompson	Indigenous Relations Lead	Natasha Audy	Biological Technician
Paul Grutter	Senior Biologist	Geoff Sawatzky	Biological Technician
Demitria Burgoon	Biologist	James Goodier	GIS Technician
David Roscoe	Biologist	Carrie McAllister	Project Coordinator
Sima Usvyatsov	Biological Scientist	Laurie Ell	Office Administration
Sean Hollis	Biologist	Devin Dickson	Warehouse Manager

LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Description
EAC	Environmental Assessment Certificate
Project	Site C Clean Energy Project
FAHMFP	Fisheries and Aquatic Habitat Monitoring and Follow-up Program
Mon-1b	Site C Reservoir Tributaries Fish Community and Spawning Monitoring Program
FDS	Federal Decision Statement
Mon-8	Site C Reservoir Water and Sediment Quality Monitoring Program
Mon-9	Peace River Water and Sediment Quality Monitoring Program
Task 2b	Site C Reservoir and Peace River Water Temperature Monitoring
GMSWORKS-2	Peace River Baseline TDG and Temperature Program
GMS	WAC Bennett Dam
PCN	Peace Canyon Dam
Mon-2	Peace River Fish Community Monitoring Program
WLR	Water License Requirements
WUP	Peace Project Water Use Plan

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FIGURES

APPENDICES

1.0 INTRODUCTION

In accordance with Provincial Environmental Assessment Certificate (EAC) Condition No. 7[5] and Federal Decision Statement Condition (FDS) Nos. 8.4.3[6] and 8.4.4[7] for BC Hydro's Site C Clean Energy Project (the Project), BC Hydro has developed the Site C Fisheries and Aquatic Habitat Monitoring and Follow-up Program (FAHMFP[8]; BC Hydro 2015). The FAHMFP is a suite of seventeen programs, each designed to monitor different aspects of Peace River fish habitat or the response of the Peace River fish community to the construction and operation of the Project. The Site C Reservoir Water and Sediment Quality Monitoring Program (Mon-8) and the Peace River Water and Sediment Quality Monitoring Program (Mon-9) represents two components of the FAHMFP and Site C Reservoir and Peace River Water Temperature Monitoring represents one task within Mon-8/9 (Task 2b). Task 2b is not intended to address specific management questions or hypotheses under the FAHMFP. Task 2b is not intended to address specific management questions or hypotheses under the FAHMFP. Instead, temperature data collected under Task 2b provides information to diagnose causes of observed changes in other FAHMFP programs (i.e., Site C Reservoir Fish Community Monitoring Program [Mon-1a], Site C Reservoir Tributaries Fish Community and Spawning Monitoring Program [Mon-1b], and Peace River Fish Community Monitoring Program [Mon-2]) designed to monitor key indicator species of the Peace River.

In 2008, as part of the BC Hydro Peace Project Water Use Plan (WUP; BC Hydro 2007), Diversified Environmental Services (DES) began maintaining an array of water temperature loggers in the Peace River between the WAC Bennett Dam (GMS) forebay and 6.5 km downstream of the Pine River's confluence with the Peace River (GMSWORKS-2; e.g., DES 2010). Areas monitored under the array included upstream and downstream of GMS and Peace Canyon Dam (PCN) and upstream and downstream of the confluences of the following Peace River tributaries: the Halfway River, the Moberly River, and the Pine River. In 2016, management of the array was transitioned from the WUP to the FAHMFP (DES 2017, 2018, 2019, 2020). Data from GMSWORKS-2 and the FAHFMP combined provide a continuous dataset of water temperature values at the above locations from 2008 to 2020. Data collection under Task 2b is currently scheduled through the remainder of Project construction and the first 30 years of Project operation.

With the transition from the WUP to the FAHMFP in 2016, three new monitoring stations were added to the array (i.e., the Peace River upstream of the Pouce Coupe River confluence and the mainstems of the Beatton and Pine rivers). These stations were added to Task 2b to collect the temperature data needed to help interpret results of the Peace River Fish Community Monitoring Program (Mon-2). In 2019, the array was expanded further to included Site C reservoir tributaries sampled as part of the Site C Reservoir Tributaries Fish Community and Spawning Monitoring Program (Mon-1b): the mainstems of the Chowade and Moberly rivers, and Colt, Cypress, Farrell, Kobes, and Fiddes creeks. Maurice Creek was added to the array in 2020.

This report summarizes the status of water temperature monitoring under Task 2b to the end of 2020.

[5] The EAC Holder must develop a Fisheries and Aquatic Habitat Monitoring and Follow-up Program to assess the effectiveness of measures to mitigate Project effects on healthy fish populations in the Peace River and tributaries, and, if recommended by a QEP or FLNR, to assess the need to adjust those measures to adequately mitigate the Project's effects.
[6] "The plan shall include: an approach to monitor changes to fish and fish habitat baseline conditions in the Local Assessment Area."
[7] "The plan shall include: an approach to monitor and evaluate the effectiveness of mitigation or offsetting measures and to verify the accuracy of the predictions made during the environmental assessment on fish and fish habitat."
[8] Site C Fisheries and Aquatic Habitat Monitoring and Follow-up Program available at https://www.sitecproject.com/document-library/environmental-management-plans-and-reports.

2.0 METHODS

Five years of water temperature data were collected under Task 2b between 2016 and 2020; however, when coupled with water temperature data collected under GMSWORKS-2 between 2008 and 2016, 13 years of continuous water temperature data are available at select locations. An additional three years of data (2021 to 2023) are scheduled to be collected during river diversion and prior to reservoir filling and operation of the Project. Task 2b is also scheduled for the first 30 years of Project operations.

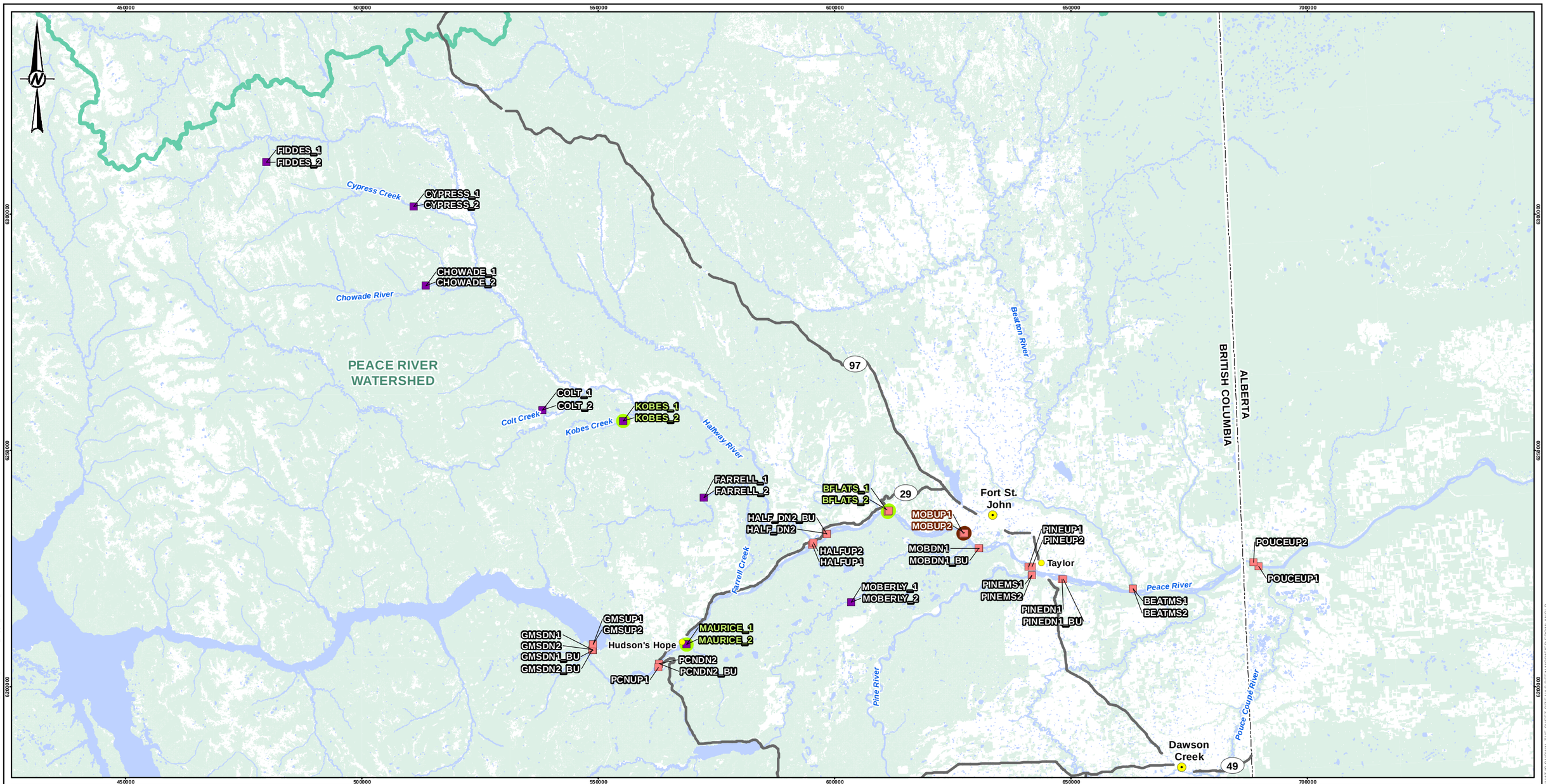
2.1 Study Area

A station is defined as a single location where water temperature is monitored as part of the array. A single station can have a single temperature logger or multiple temperature loggers (e.g., to record temperatures at different depths or to collect backup data).

Station locations assessed as part of the 2020 study are summarized in Appendix A, Table A1 and Figure 1. Stations were located in the Peace River mainstem from the forebay of GMS downstream to near the Pouce Coupe River confluence and in the following tributaries: the Beatton, Chowade, Moberly and Pine rivers, and Colt, Cypress, Farrell, Fiddes, Kobes, and Maurice creeks. At some of the above locations, loggers were initially deployed in 2020, but have not yet been retrieved and downloaded.

On 5 September 2020, two stations (mobUP1 and mobUP2) located approximately 2.5 km upstream of the Moberly River's confluence with the Peace River were downloaded and removed due to their location within the footprint of the diversions headpond. These stations were expected to be inaccessible after river diversion commenced in early October 2020. On 15 September 2020, two new stations (BFlats_1 and BFlats_2) were established near Bear Flats to provide alternate temperature monitoring locations for the Peace River between the Halfway and Moberly river confluences. These stations are scheduled to be downloaded for the first time in the spring of 2021.

In 2020, temperature loggers in the Peace River situated upstream of the Highway #29 bridge were maintained under BC Hydro's WUP. These loggers were downloaded and serviced by DES and provided to Golder for analysis and inclusion in the Peace River Water Temperature Database.



LEGEND

PROJECT DATA

TEMPERATURE LOGGER LOCATION

- PEACE RIVER MAINSTEM SITE
- TRIBUTARY SITE
- DECOMMISSIONED IN 2020
- INSTALLED IN 2020

BASE DATA

- CITY
- DISTRICT MUNICIPALITY
- HIGHWAY
- WATERBODY
- PROVINCIAL BOUNDARY
- PEACE RIVER WATERSHED

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BC HYDRO

CONSULTANT
GOLDER
MEMBER OF WSP

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DESIGNED	JS
PREPARED	LH
REVIEWED	DF
APPROVED	JS

PROJECT
SITE C RESERVOIR AND PEACE RIVER WATER AND SEDIMENT QUALITY MONITORING PROGRAMS (MON-8/9)

TITLE
OVERVIEW OF PEACE RIVER WATER TEMPERATURE MONITORING (TASK 2B) STATION LOCATIONS, 2020

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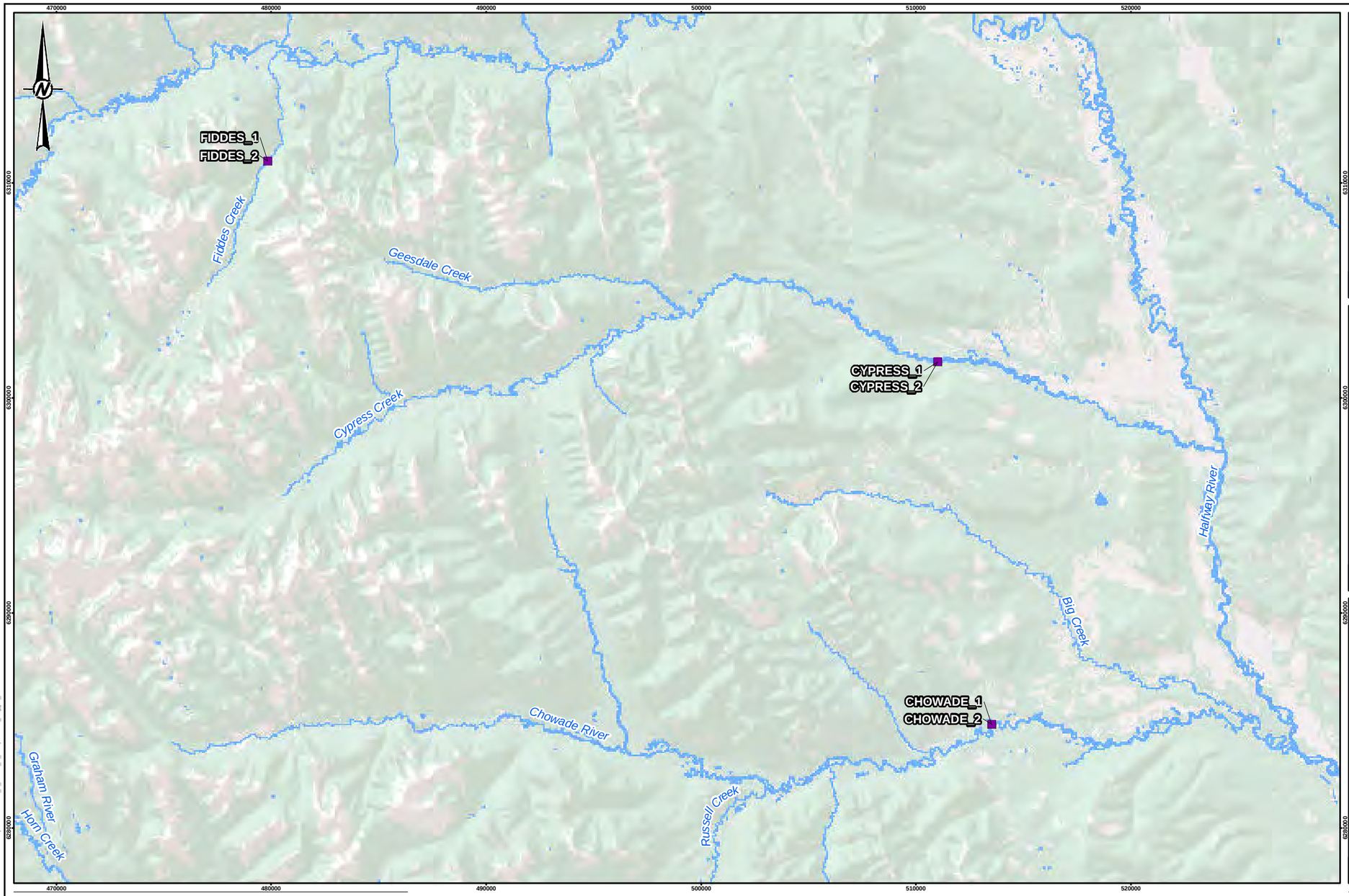

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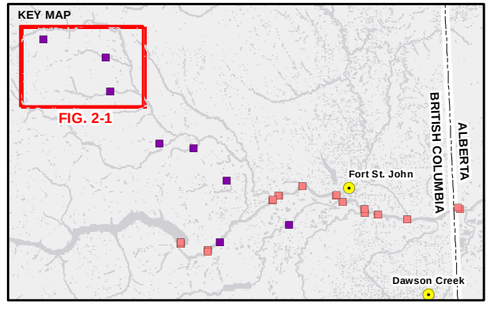
PROJECT DATA

TEMPERATURE LOGGER LOCATION

TRIBUTARY SITE

BASE DATA

WATERBODY



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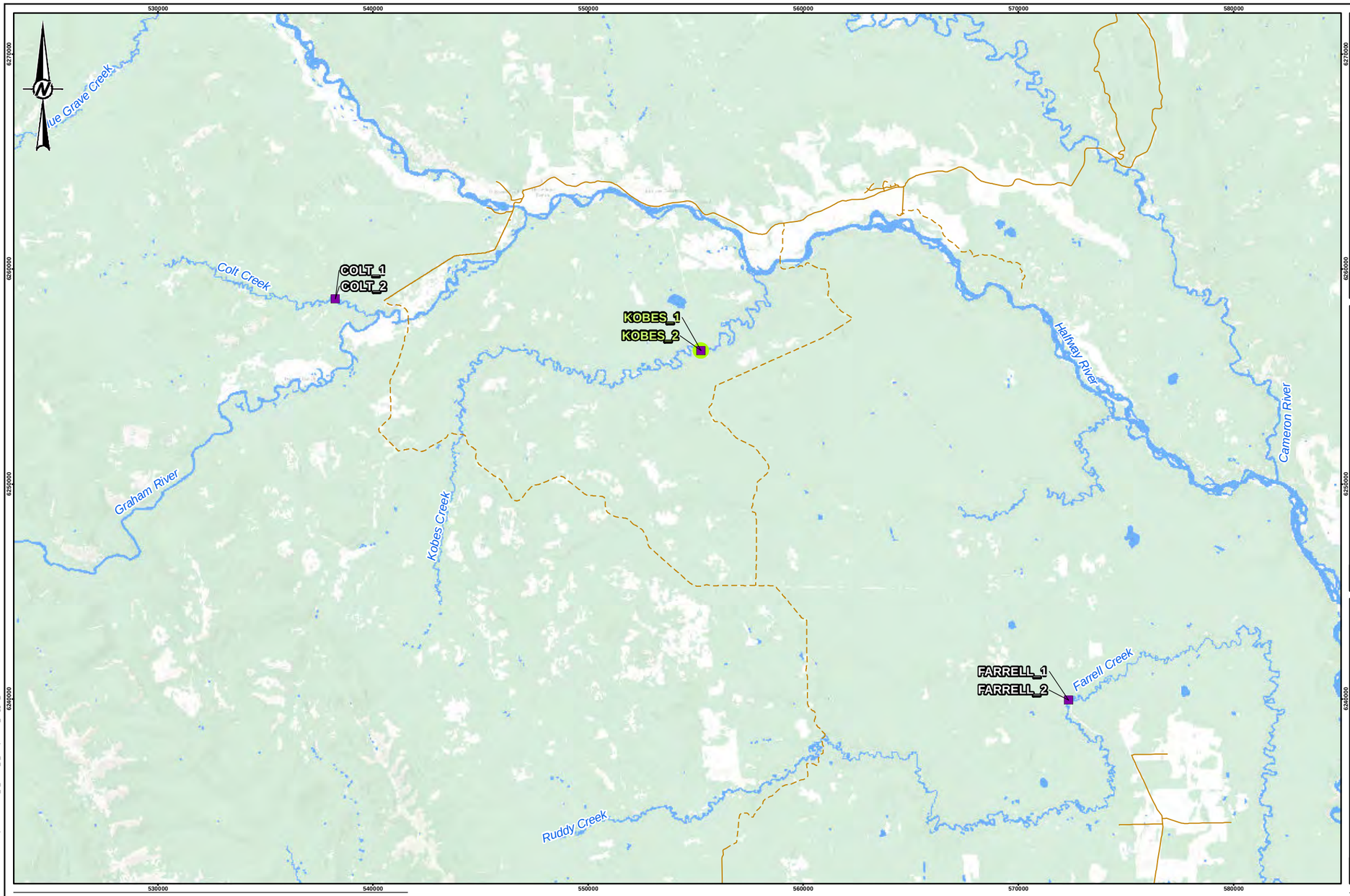

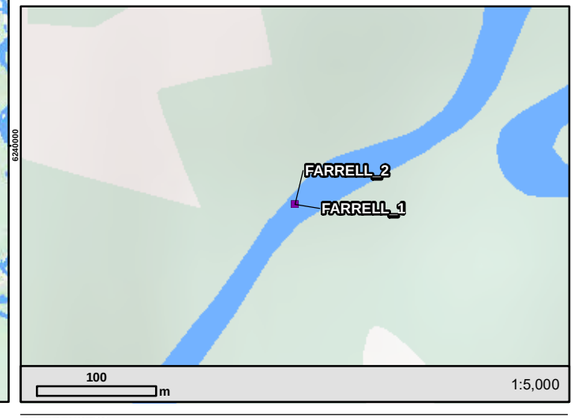

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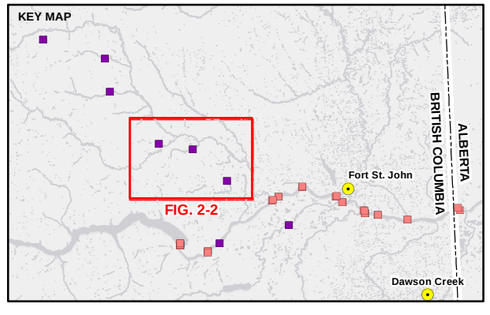
- LOCAL ROAD
- RESOURCE / RECREATION ROAD
- WATERBODY



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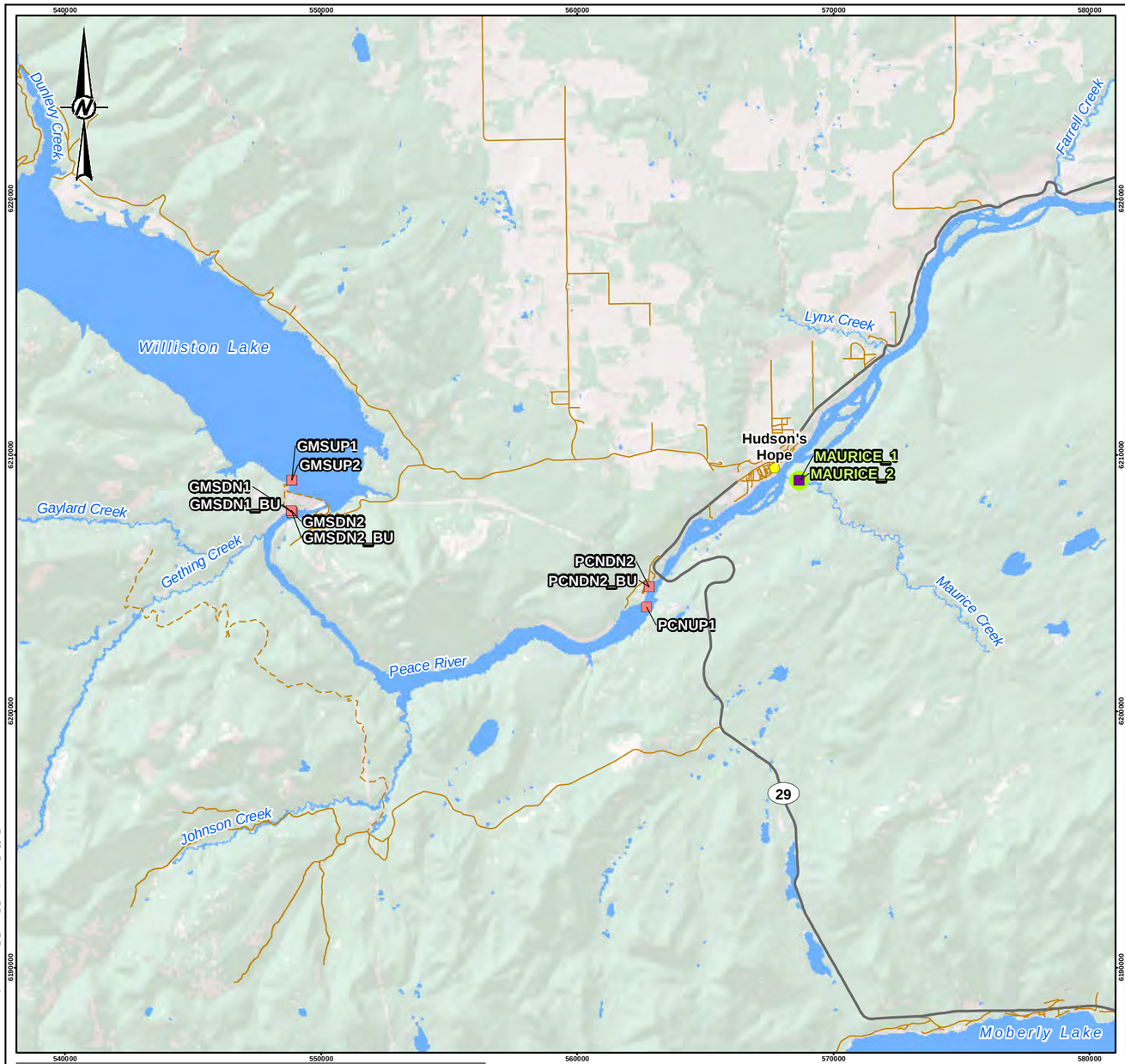

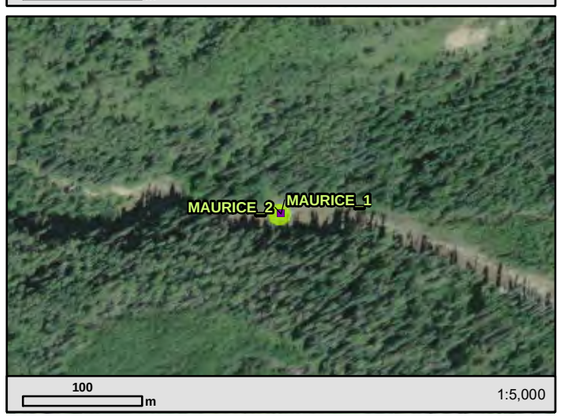

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TEMPERATURE LOGGER LOCATION

- PEACE RIVER MAINSTEM SITE
- TRIBUTARY SITE
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BASE DATA

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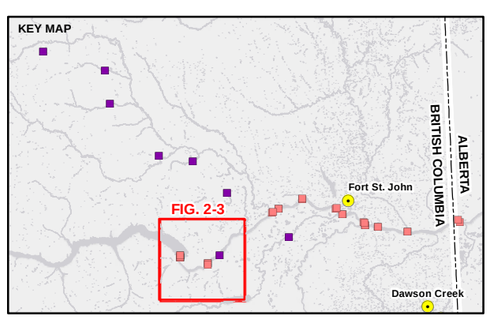

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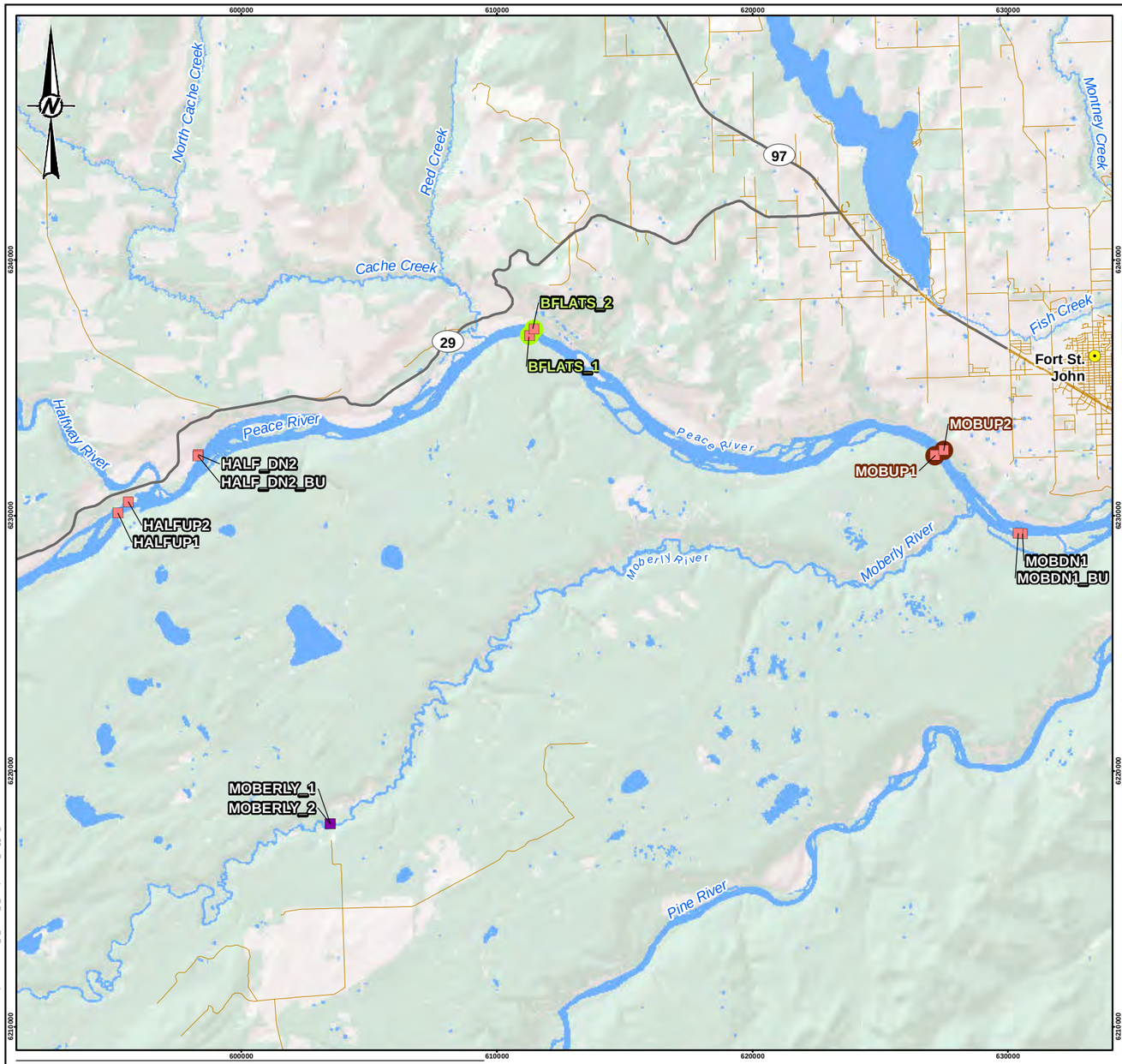

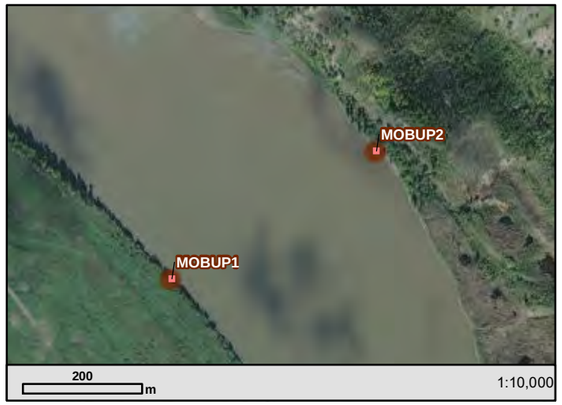

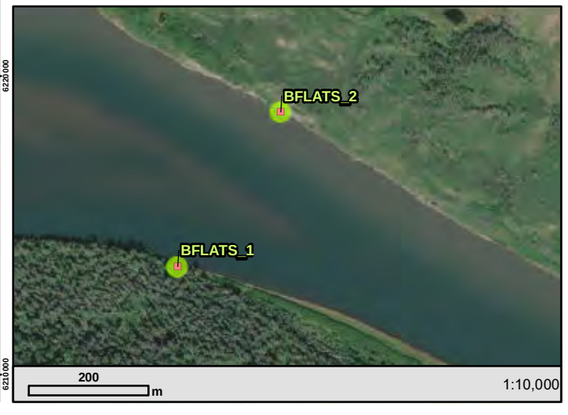

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PROJECT DATA

TEMPERATURE LOGGER LOCATION

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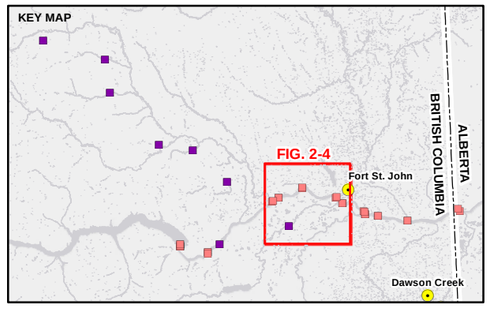
- TRIBUTARY SITE
- DECOMMISSIONED IN 2020
- INSTALLED IN 2020

BASE DATA

- CITY
- HIGHWAY
- LOCAL ROAD
- RESOURCE / RECREATION ROAD
- WATERBODY



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TITLE
OVERVIEW OF PEACE RIVER WATER TEMPERATURE MONITORING (TASK 2B) STATION LOCATIONS, 2020

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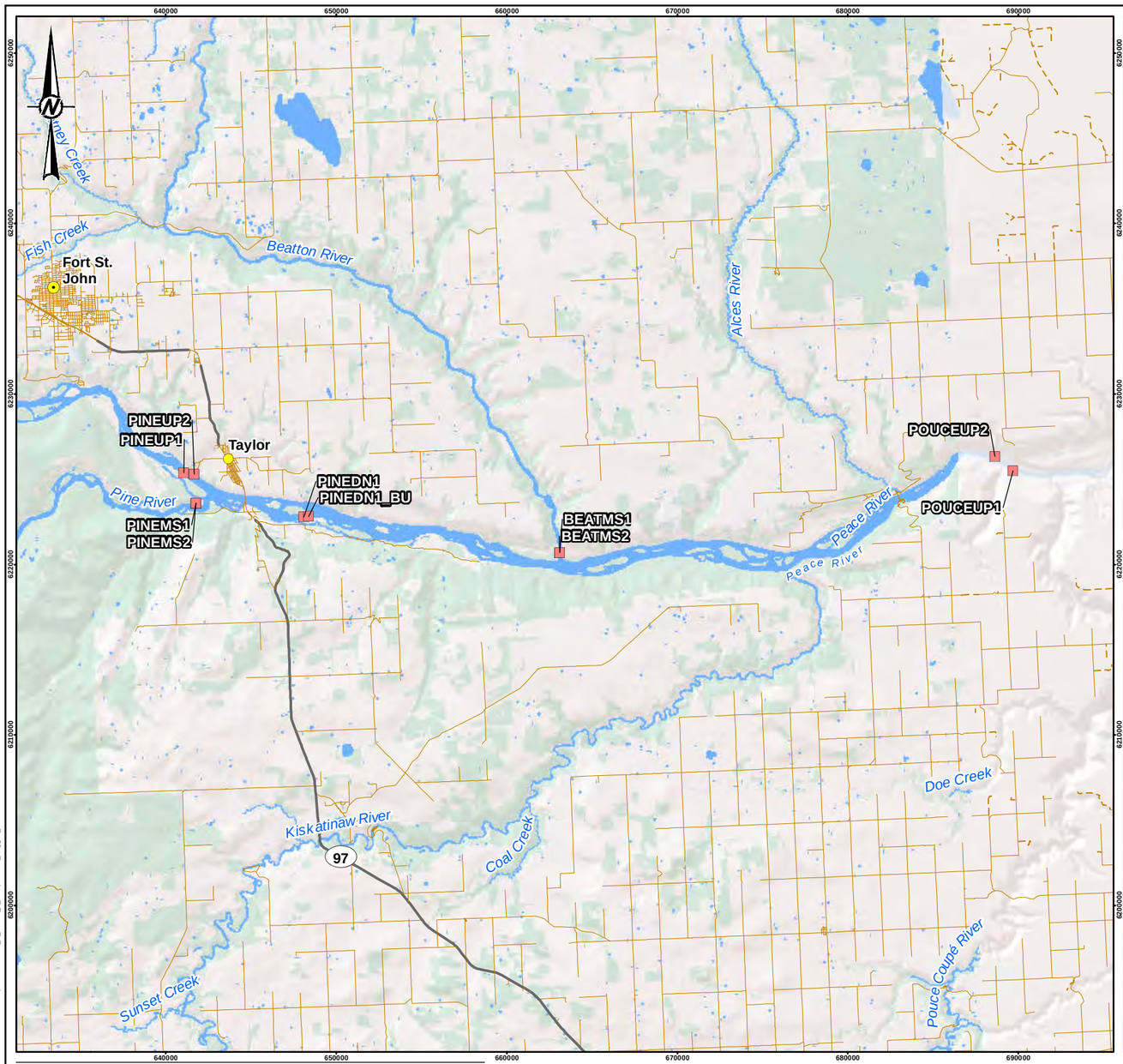

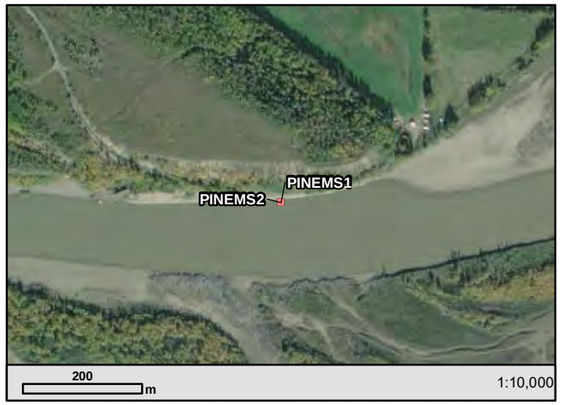

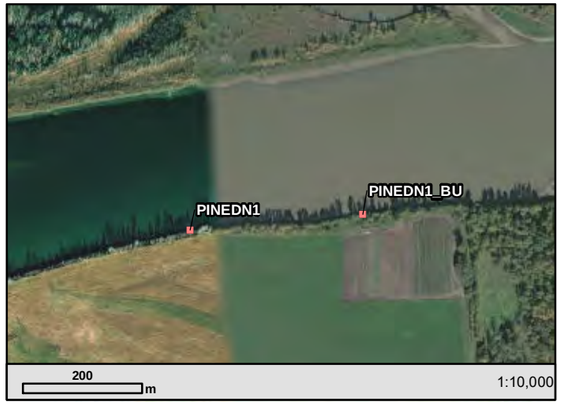

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PROJECT DATA

TEMPERATURE LOGGER LOCATION

PEACE RIVER MAINSTEM SITE

BASE DATA

CITY

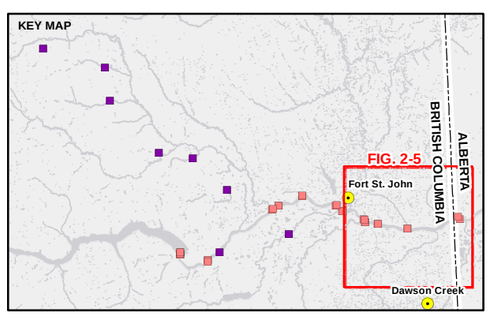
DISTRICT MUNICIPALITY

HIGHWAY

LOCAL ROAD

RESOURCE / RECREATION ROAD

WATERBODY



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CLIENT
BC HYDRO

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-09-27
DESIGNED	JS
PREPARED	LH
REVIEWED	DF
APPROVED	JS

PROJECT
SITE C RESERVOIR AND PEACE RIVER WATER AND SEDIMENT QUALITY MONITORING PROGRAMS (MON-8/9)

TITLE
OVERVIEW OF PEACE RIVER WATER TEMPERATURE MONITORING (TASK 2B) STATION LOCATIONS, 2020

PROJECT NO.	CONTROL	REV.	FIGURE
19121767	2 / 2.1	0	2-5

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2.2 Station Setup

At each station, paired HOBO TidbiT v2 temperature loggers (Model #UTBI-001; Onset Computer Corporation, Bourne, MA, USA) or HOBO 8K Pendant temperature loggers (Model #UA-001-08; Onset Computer Corporation, Bourne, MA, USA) were deployed. The v2 temperature loggers have an accuracy of ±0.2°C and the Pendant 8K temperature loggers have an accuracy of ±0.5°C. Both temperature logger models are initiated and downloaded using a HOBO waterproof optical shuttle (Model #U-DTW-1; Onset Computer Corporation, Bourne, MA). Generally, pendant temperature loggers are located at the more recently established stations and v2 temperature loggers are located at stations historically monitored under GMSWORKS-2. As the batteries in existing v2 temperature loggers expire, they are replaced with the pendant-style temperature loggers. All temperature loggers were programmed to record water temperature in one-hour intervals, except for those installed in the Chowade, Colt, Cypress, Farrell, Fiddes, Kobes, and the Moberly, which were set to record at 15-minute intervals.

Temperature loggers were contained in steel 38 mm wide x 100 mm long perforated cylinders with threaded steel end caps (initially deployed during GMSWORKS-2) or in 102 mm diameter ABS container with a single threaded end cap (initially deployed during Task 2b; Figure 2). Holes were drilled through the housing body and end caps to allow water to flow through them. The housings were ballasted with either 5 kg steel or concrete anchors and secured to shore with a steel cable or chain.

Figure 2: Examples of temperature logger housings deployed during the Site C Reservoir and Peace River Water Temperature Monitoring Program (Task 2b). The photo on the left denotes housings initially deployed during GMSWORKS-2. The photo on the right denotes housings initially deployed during Task 2b.

In 2020, all Peace River mainstem water temperature loggers were downloaded by DES in the early spring. Over the summer, temperature loggers were opportunistically downloaded by Golder staff when crews were participating in other field programs in the vicinity of stations. All remaining temperature loggers were downloaded and serviced in mid-October during dedicated station visits. During future study years, water temperature loggers will be downloaded and serviced approximately every four months.

2.3 Data Compilation and Analysis

All raw data collected from 2008 to 2020 were compiled and imported into the Peace River Water Temperature Database (Attachment A). Subsequent data manipulation and figure production were completed in R v4.0.3 (R Core Team 2021).

Prior to generating figures, erroneous data were identified and removed from the dataset. In general, high daily variability in water temperatures were considered indicative of the logger being out of water (i.e., station mobUP1 hourly temperature range = 0.8 to 24.2°C from 8 to 31 May 2020; Figure 12), low daily variability in water temperatures, especially when temperatures were close to 0°C, were interpreted as periods when a logger was frozen in ice, low daily variability in water temperature when temperatures were above 0°C, when loggers were found buried in sediment, were interpreted as the period during which they were buried, and temperatures less than 0°C were considered indicative of the logger being out of water. Data that fell under any of these four scenarios were removed from the final dataset. Rarely, single observations were flagged and removed for being suspiciously deviant from local trends.

For stations gmsDN1, gmsDN2, pcnDN2, HalfDN2, MobDN1, and PineDN1 (i.e., stations with backup data loggers), the R procedure queried the backup data loggers to fill gaps in the main dataset when possible.

Daily average temperature values were calculated from the cleaned dataset and plotted. To facilitate annual comparisons, mean, minimum, and maximum daily average temperatures were calculated for each day of the year for all other years with available data for each station.

3.0 RESULTS

In 2020, seven temperature loggers were not recovered due to their cables breaking, presumably from ice or debris: BeatMS2, Colt_2, Cypress_2, Farrell_2, Kobes_1 and Kobes_2, and Moberly_2; results are not presented for these stations. These temperature loggers were replaced and will be downloaded in 2021.

Three temperature loggers were buried in sand or out of the water when crews arrived on site to download them: BeatMS1, Farrell_1, and Colt_1. Data from these stations are presented, but their condition at the time of download should be considered when interpreting results.

3.1 Upstream of Peace Canyon Dam

3.1.1 WAC Bennett Dam Forebay

Water temperatures in the GMS forebay were measured at two different water depths. Both temperature loggers were suspended from the northernmost steel buoy along the GMS spillway log boom. Station gmsUP1 was a logger suspended 1 m below the water surface (Figure 3) and Station gmsUP2 was a logger suspended 10 m below the water surface (Figure 4). Data were available for the entire 2020 study period for both gmsUP1 and gmsUP2. Interannual comparisons of water temperature data for gmsUP1 are presented in Appendix B, Figure B1. Interannual comparisons of water temperature data for gmsUP2 are presented in Appendix B, Figure B2.

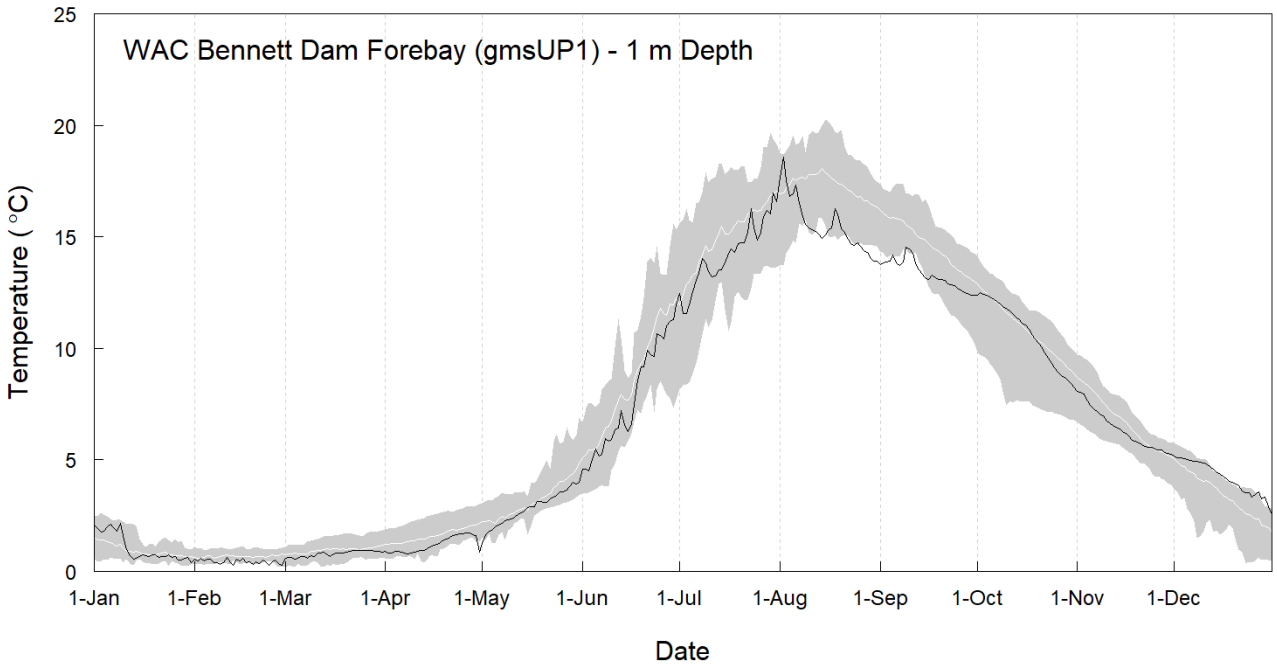

Figure 3: Mean daily water temperature (°C) for the WAC Bennett Dam (GMS) forebay 1 m below the water surface (gmsUP1; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at the station between 2008 and 2019. The white line represents average mean daily water temperatures over the same period.

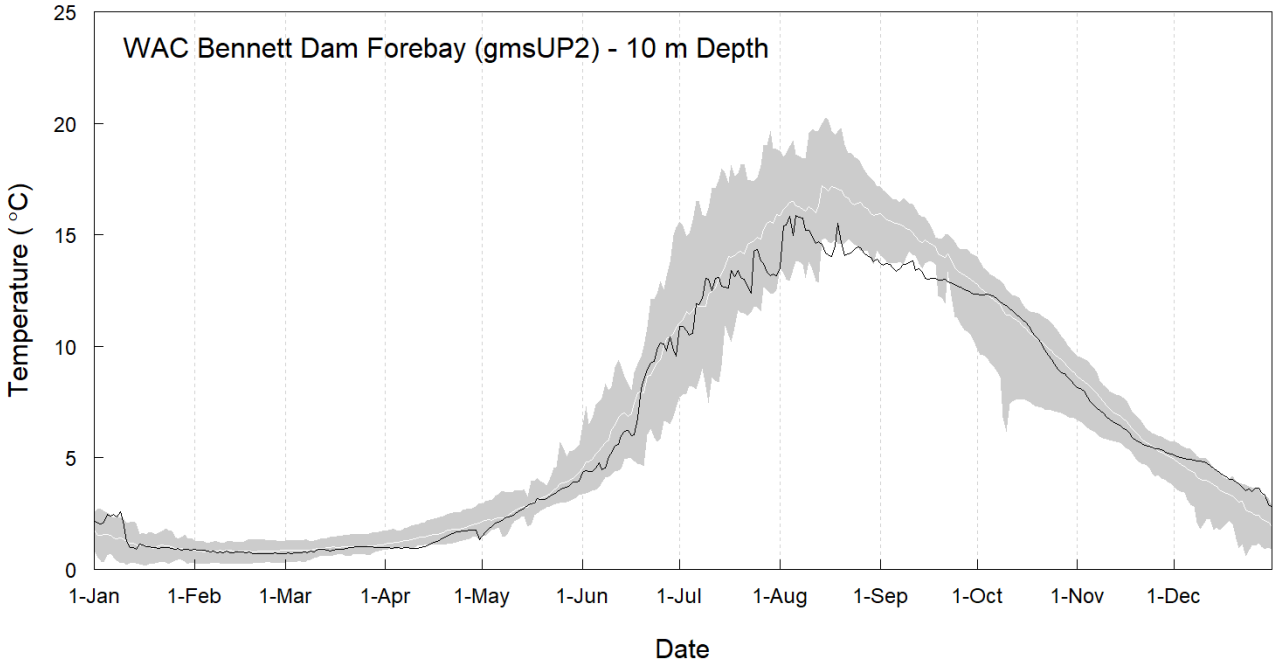

Figure 4: Mean daily water temperature (°C) for the WAC Bennett Dam (GMS) forebay 10 m below the water surface (gmsUP2; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at the station between 2008 and 2019. The white line represents average mean daily water temperatures over the same period.

3.1.2 WAC Bennett Dam Tailrace

GMS tailrace water temperatures were monitored by two different stations. Both stations were situated approximately 700 m downstream of the dam. Station gmsDN1 was located on the left bank (as viewed facing downstream) and was positioned to monitor water flowing out of the south tailrace manifold (Figure 5). Station gmsDN2 was located on the right bank and was positioned to monitor water flowing out of the north tailrace manifold (Figure 6). Each of these stations had backup temperature loggers (gmsDN1BU and gmsDN2BU).

Data from station gmsDN2 are missing from early January to mid-February 2020, and both the primary and backup loggers appeared to dewater intermittently from mid-April through late June 2020, and from late September to early October. Station gmsDN1 dewatered briefly between 22 and 23 February and between 25 and 27 March 2020.

Interannual comparisons of water temperature data for gmsDN1 and gmsDN2 are presented in Appendix B, Figures B3 and B4, respectively.

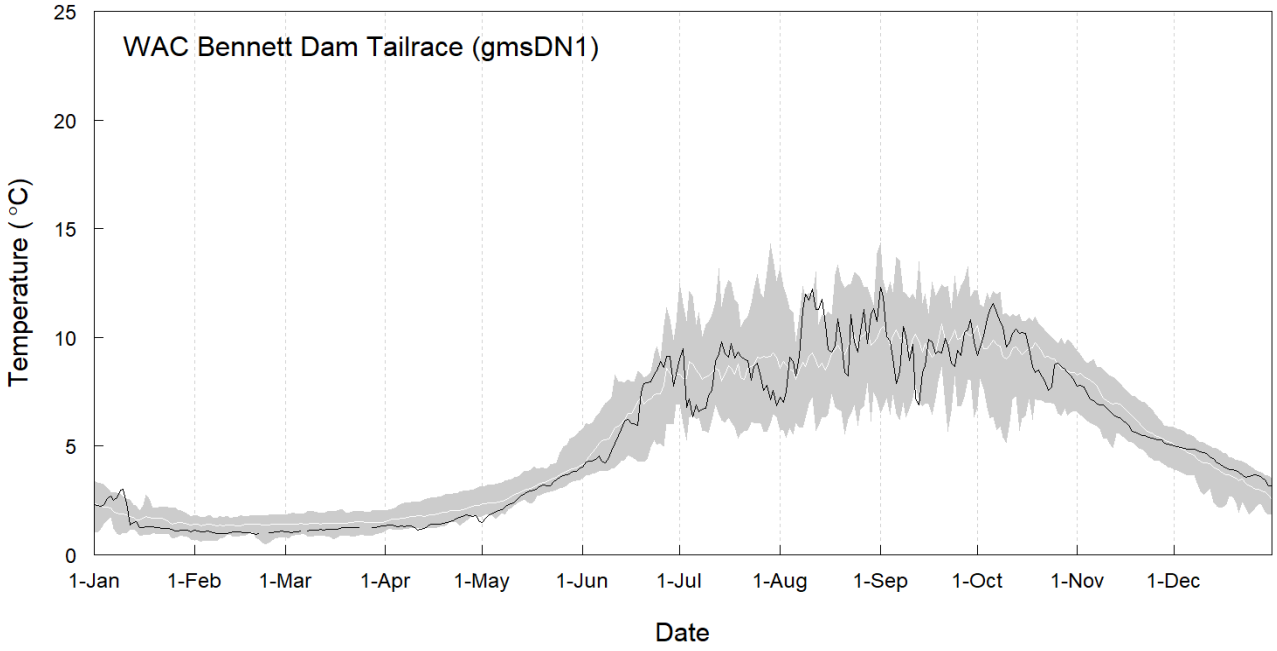

Figure 5: **Mean daily water temperature (°C) for the left bank (as viewed facing downstream) of the WAC Bennett Dam (GMS) tailrace (gmsDN1; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at the station between 2008 and 2019. The white line represents average mean daily water temperatures over the same period.**

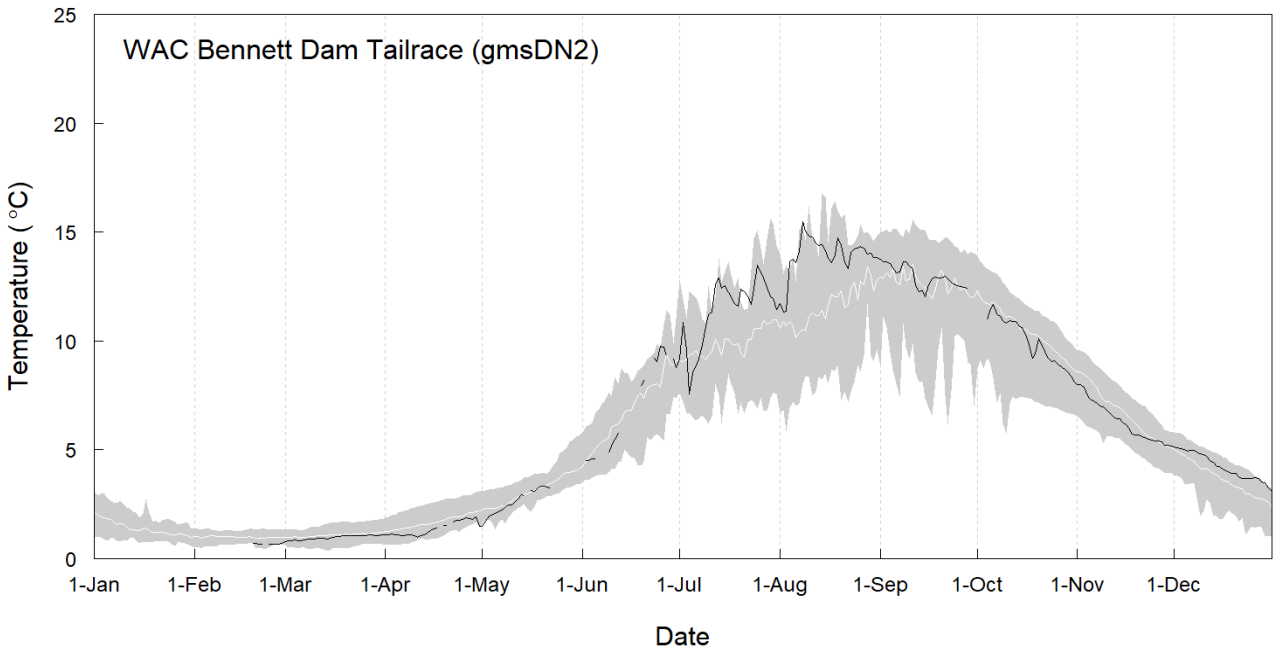

Figure 6: **Mean daily water temperature (°C) for the right bank (as viewed facing downstream) of the WAC Bennett Dam (GMS) tailrace (gmsDN2; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at the station between 2008 and 2019. The white line represents average mean daily water temperatures over the same period.**

3.1.3 Peace Canyon Dam Forebay

Water temperatures in the PCN forebay (pcnUP1) were measured 1 m below the water surface at the anti-vortex log boom, which is located approximately 450 m upstream of the dam (Figure 7). Data were available for the entire 2020 study period for pcnUP1. Interannual comparisons of water temperature data for pcnUP1 are presented in Appendix B, Figure B5.

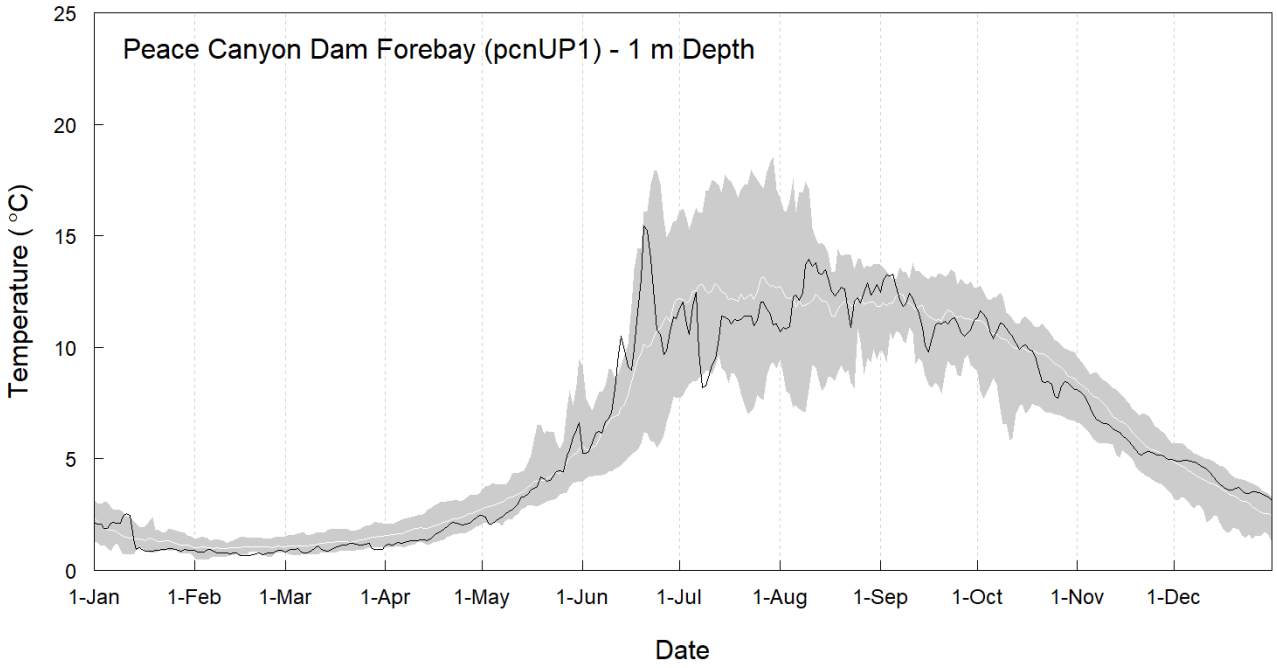

Figure 7: Mean daily water temperature (°C) for the Peace Canyon Dam (PCN) forebay 1 m below the water surface (pcnUP1; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at the station between 2008 and 2019. The white line represents average mean daily water temperatures over the same period.

3.2 Downstream of Peace Canyon Dam

3.2.1 Peace Canyon Dam Tailrace

PCN tailrace water temperatures were monitored by a single station (pcnDN2). The station was situated on the left bank approximately 200 m downstream of the dam (Figure 8). This station had a backup temperature logger (pcnDN2BU).

Data from station pcnDN2 are missing from early January to mid-February 2020; however, the dataset is complete from mid-February to the end of 2020.

Interannual comparisons of water temperature data for pcnDN2 are presented in Appendix B, Figure B6.

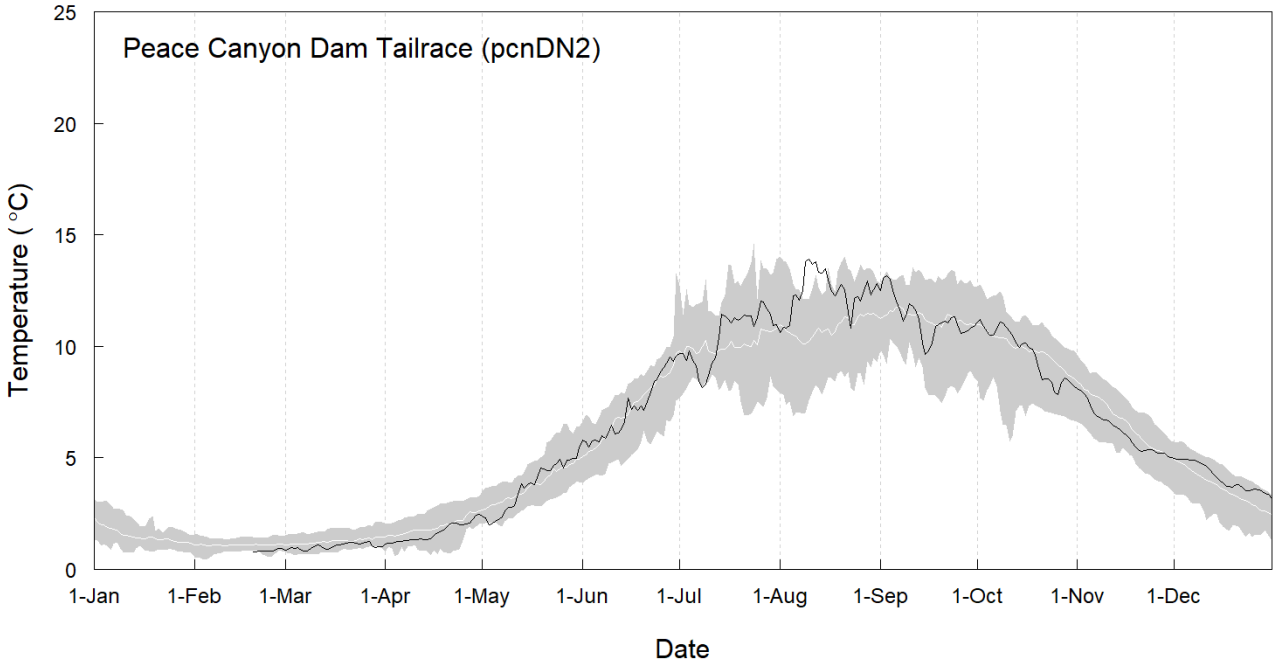

Figure 8: Mean daily water temperature (°C) for the left bank (as viewed facing downstream) of the Peace Canyon Dam (PCN) tailrace (pcnDN2; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at the station between 2008 and 2019. The white line represents average mean daily water temperatures over the same period.

3.2.2 Halfway River Confluence Area

In 2020, water temperatures in the Peace River were monitored at two different locations situated approximately 1 km upstream of the Halfway River's confluence with the Peace River. Station halfUP1 was located on the right bank and Station halfUP2 was located on the left bank. For Station halfUP1 (Figure 9), data were available from early January to mid-October 2020 (i.e., up to its most recent download). Station halfUP2 (Figure 10) was out of water when it was retrieved on 14 October 2020. A review of the temperature data indicated that it likely became dewatered on approximately 24 September. Interannual comparisons of water temperature data for halfUP1 and halfUP2 are presented in Appendix B, Figures B7 and B8, respectively.

Water temperatures in the Peace River were also monitored at a single station on the left bank approximately 2.5 km downstream of the Halfway River's confluence with the Peace River (halfDN2; Figure 11). For this station, data were available from early January to mid-October 2020 (i.e., up to its most recent download); however, both the station's main and backup temperature loggers dewatered or otherwise malfunctioned from mid to late January. During the 14 October 2020 station visit, the battery of the halfDN2BU temperature logger (serial #10156314) was at 30%; it was replaced with a new temperature logger (serial #20182030).

Data from mid-October 2020 to 31 December 2020 for halfUP1, halfUP2, and halfDN2 will be downloaded in 2021 and presented in the 2021 annual report.

Interannual comparisons of water temperature data for halfDN2 are presented in Appendix B, Figure B9.

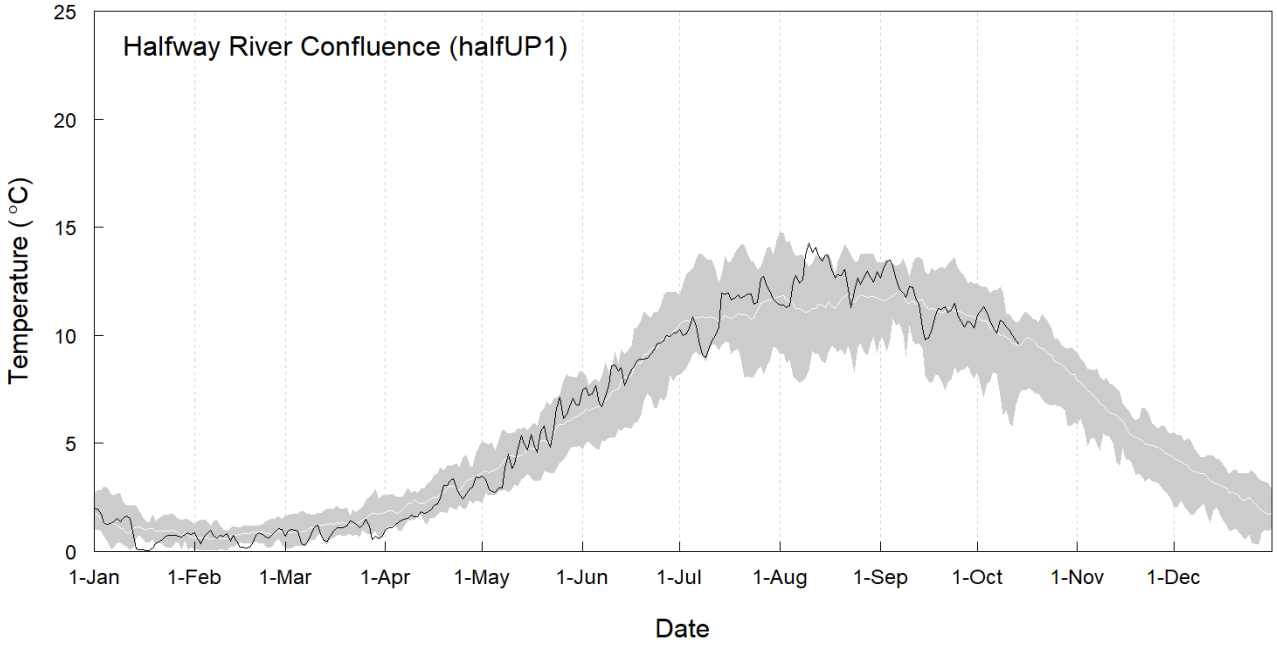

Figure 9: **Mean daily water temperature (°C) for the right bank (as viewed facing downstream) of the Peace River upstream of the Halfway River's confluence with the Peace River (halfUP1; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at the station between 2008 and 2019. The white line represents average mean daily water temperatures over the same period.**

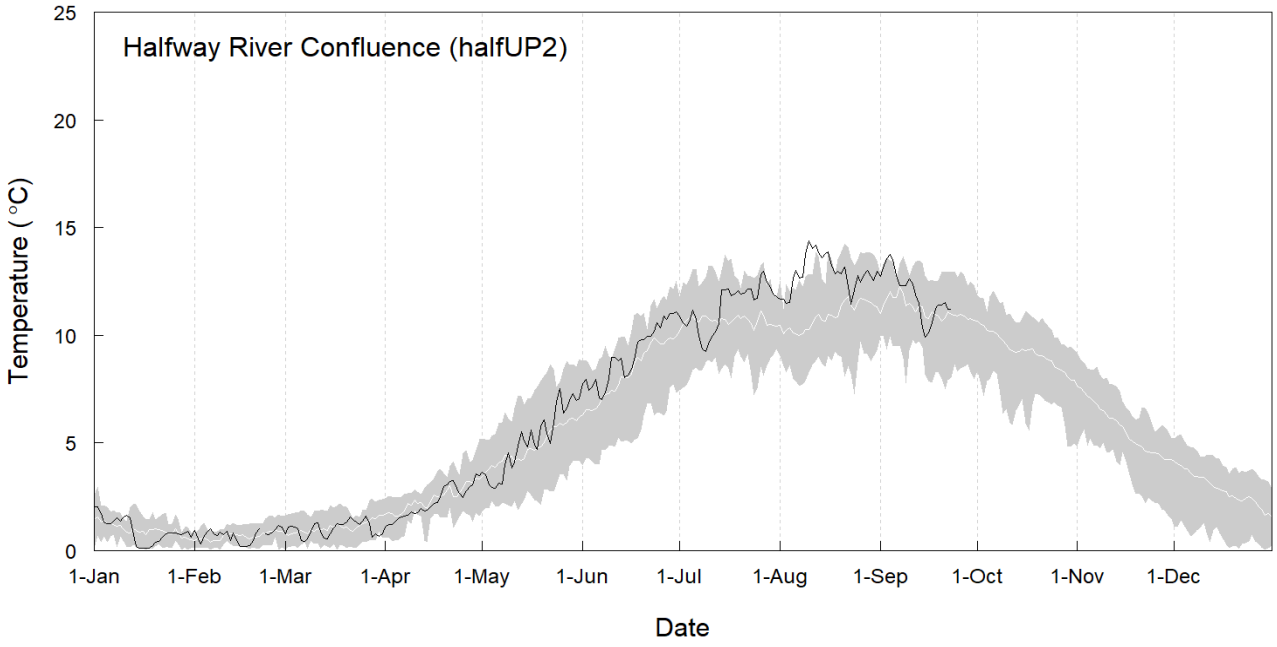

Figure 10: **Mean daily water temperature (°C) for the left bank (as viewed facing downstream) of the Peace River upstream of the Halfway River's confluence with the Peace River (halfUP2; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at the station between 2008 and 2019. The white line represents average mean daily water temperatures over the same period.**

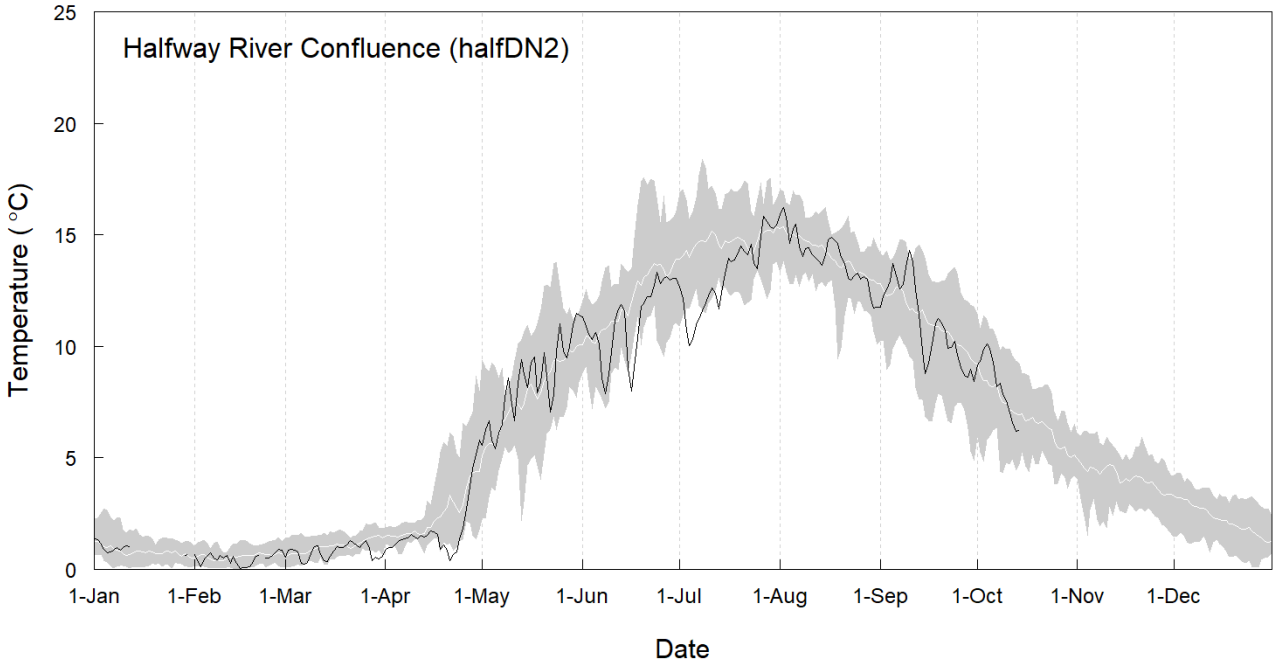

Figure 11: Mean daily water temperature (°C) for the left bank (as viewed facing downstream) of the Peace River downstream of the Halfway River's confluence with the Peace River (halfDN2; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at the station between 2008 and 2019. The white line represents average mean daily water temperatures over the same period.

3.2.3 Moberly River Confluence Area

In 2020, water temperatures in the Peace River were monitored at two different locations situated approximately 2.5 km upstream of the Moberly River's confluence with the Peace River. Station mobUP1 was located on the right bank and Station mobUP2 was located on the left bank.

Data from Station mobUP1 were highly variable over the winter and spring of 2020 and, at times, were lower than 0°C, which is indicative of the logger being out of the water. As such, only intermittent data are available for mobUP1 between mid-January and early June in 2020 (Figure 12). Near continuous data were available for this station from early June to 5 September, at which time, the station was removed. Data were not available for mobUP2 from early January to late February 2020 (Figure 13). Continuous data were available for this station from late February to 5 September, at which time, the station was removed.

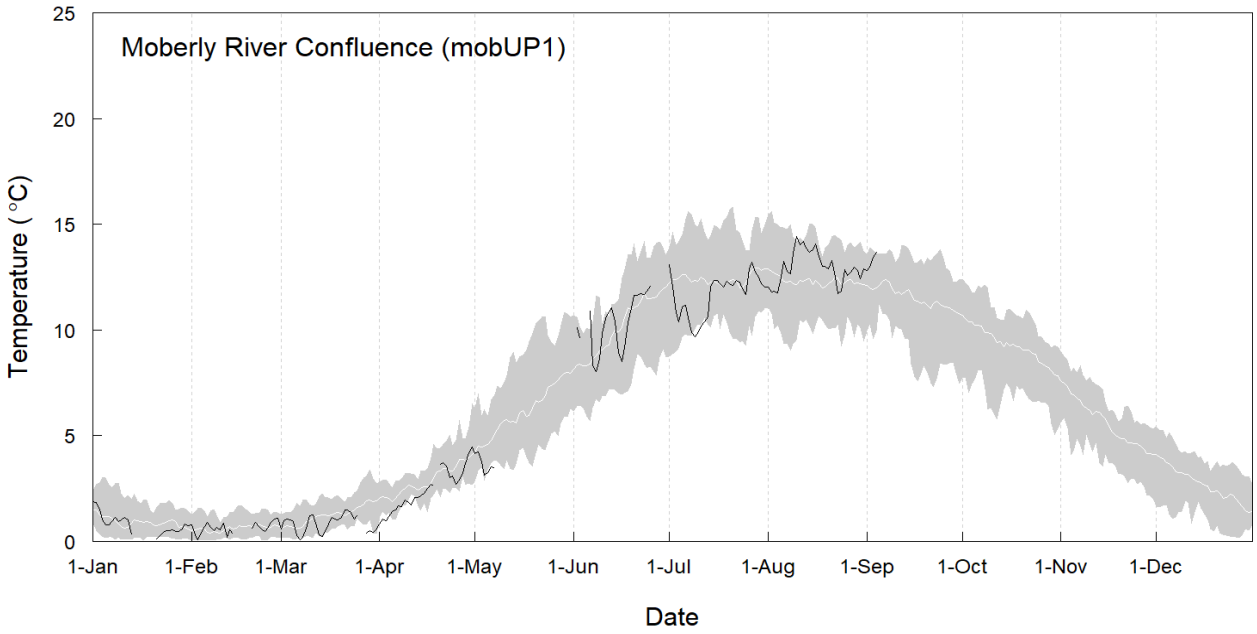

Figure 12: Mean daily water temperature (°C) for the right bank (as viewed facing downstream) of the Peace River upstream of the Moberly River's confluence with the Peace River (mobUP1; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at the station between 2008 and 2019. The white line represents average mean daily water temperatures over the same period. This station was decommissioned on 5 September 2020.

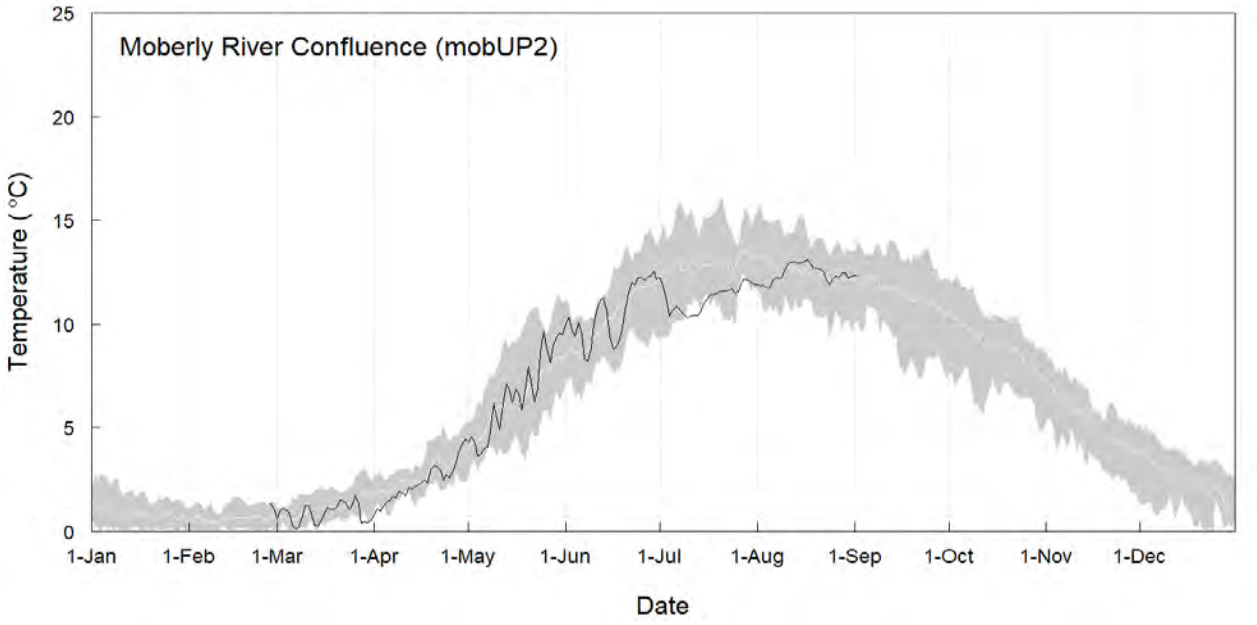

Figure 13: Mean daily water temperature (°C) for the left bank (as viewed facing downstream) of the Peace River upstream of the Moberly River's confluence with the Peace River (mobUP2; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at the station between 2008 and 2019. The white line represents average mean daily water temperatures over the same period. This station was decommissioned on 5 September 2020.

Water temperatures in the Peace River were also monitored at a single station on the right bank approximately 2.5 km downstream of the Moberly River's confluence with the Peace River (mobDN1; Figure 14). For this station, intermittent data were available from early January to late February only. This station is situated within the in-river works area for the Project and was lost in the spring of 2020. This station was not replaced.

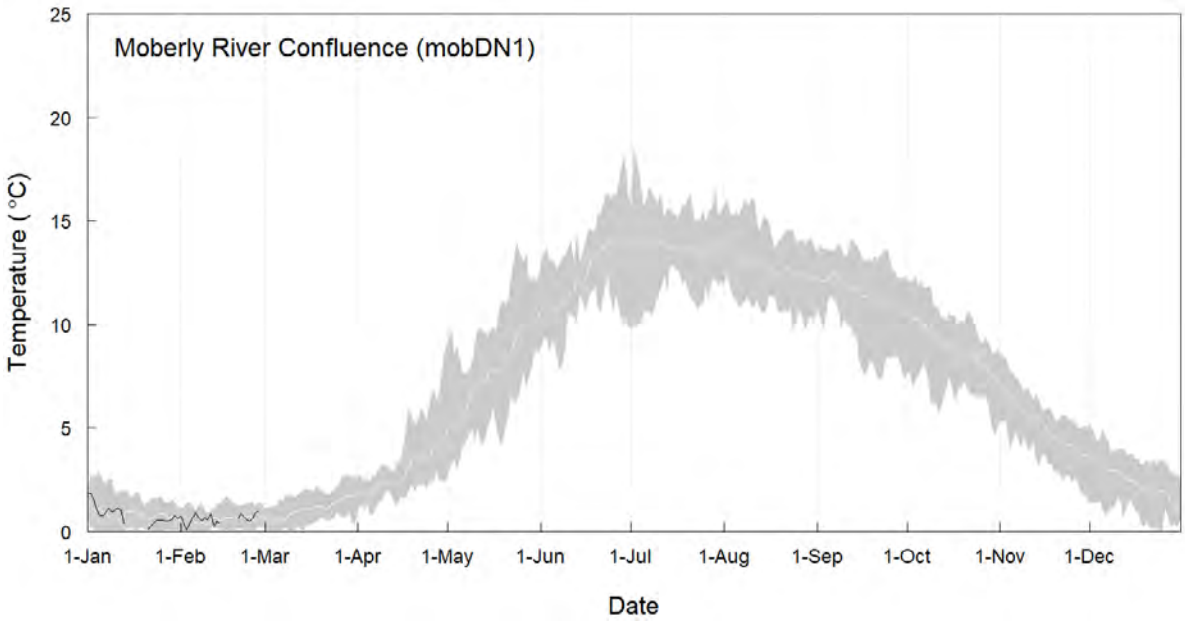

Figure 14: Mean daily water temperature (°C) for the right bank (as viewed facing downstream) of the Peace River downstream of the Moberly River's confluence with the Peace River (mobDN1; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at the station between 2008 and 2019. The white line represents average mean daily water temperatures over the same period.

Interannual comparisons of water temperature data for mobUP1, mobUP2, and mobDN1 are presented in Appendix B, Figure B10 to B12, respectively.

3.2.4 Pine River Confluence Area

In 2020, water temperatures in the Peace River were monitored at two different locations situated approximately 2.0 km upstream of the Pine River's confluence with the Peace River. Station pineUP1 was located on the right bank and Station pineUP2 was located on the left bank.

Data from Station pineUP1 were highly variable over the winter and spring of 2020 and, at times, were lower than 0°C, which is indicative of the logger being out of the water. As such, only intermittent data are available for pineUP1 in mid-January and mid-February of 2020 (Figure 15). Continuous data were available for this station from mid-February until its most recent download in mid-October.

Similar to pineUP1, data from Station pineUP2 suggested this logger was also out of the water in mid-January and mid-February of 2020 (Figure 16). Continuous data were available for this station from mid-February until its most recent download in mid-October.

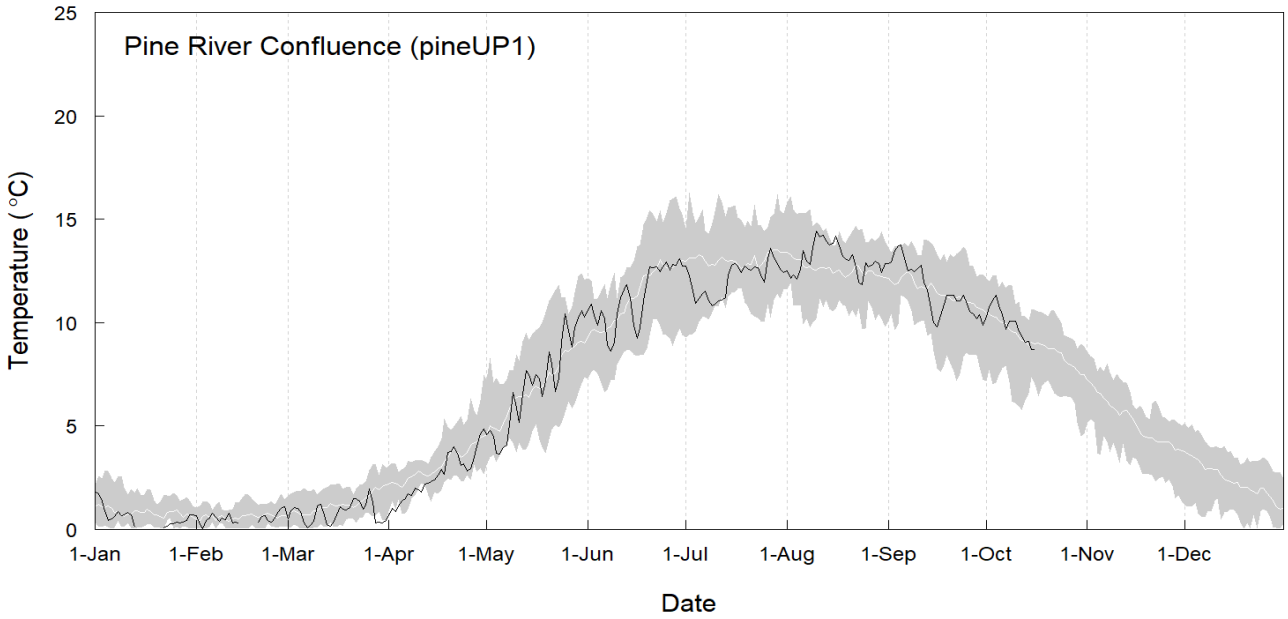

Figure 15: Mean daily water temperature (°C) for the right bank (as viewed facing downstream) of the Peace River upstream of the Pine River's confluence with the Peace River (pineUP1; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at the station between 2008 and 2019. The white line represents average mean daily water temperatures over the same period.

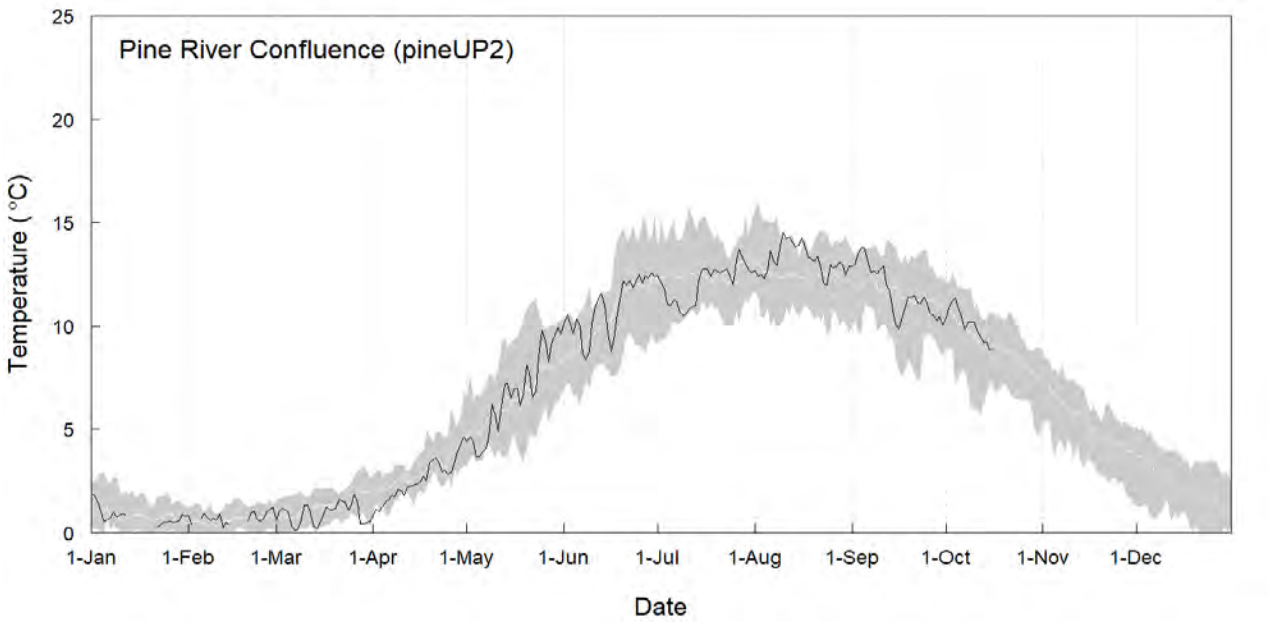

Figure 16: Mean daily water temperature (°C) for the left bank (as viewed facing downstream) of the Peace River upstream of the Pine River's confluence with the Peace River (pineUP2; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at the station between 2008 and 2019. The white line represents average mean daily water temperatures over the same period.

Water temperatures in the Peace River were also monitored at a single station on the right bank approximately 6.5 km downstream of the Pine River's confluence with the Peace River (pineDN1; Figure 17). In 2020, data between January and June were not available for pineDN1; therefore, data from the pineDN1 backup logger (i.e., pineDN1BU) were used for this time period. Similar to the pineUP1 and pineUP2 stations, data from the pineDN1 station were variable and below 0°C for some periods between January and March, suggesting that the logger emerged from water.

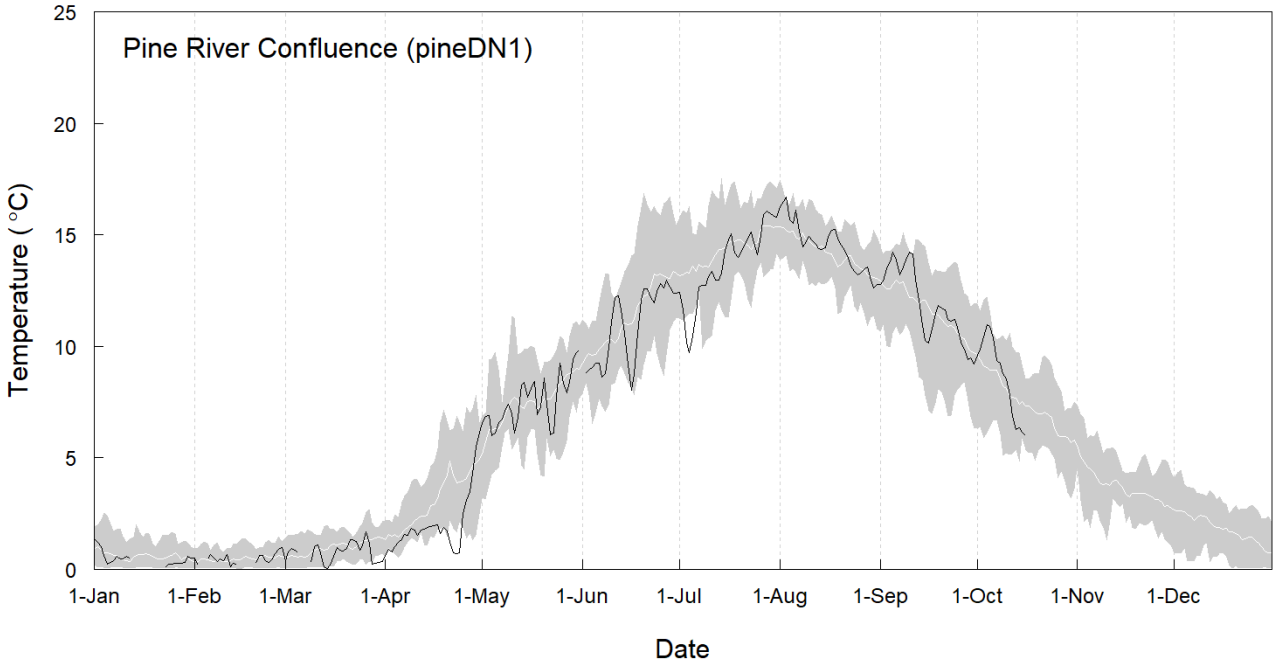

Figure 17: Mean daily water temperature (°C) for the right bank (as viewed facing downstream) of the Peace River downstream of the Pine River's confluence with the Peace River (pineDN1; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at the station between 2008 and 2019. The white line represents average mean daily water temperatures over the same period.

Data from mid-October 2020 to 31 December 2020 for pineUP1, pineUP2, and pineDN1 will be downloaded in 2021 and presented in the 2021 annual report.

Interannual comparisons of water temperature data for pineUP1, pineUP2, and pineDN1 are presented in Appendix B, Figure B13 to B15, respectively.

3.2.5 Pouce Coupe River Confluence Area

In 2020, water temperatures in the Peace River were monitored at two different locations upstream of the Pouce Coupe River's confluence with the Peace River. Station pouceUP1 was located approximately 2.4 km upstream of the confluence on the right bank and Station pouceUP2 was located approximately 3.3 km upstream of the confluence on the left bank.

Data from Station pouceUP1 were highly variable from early January to late March and, at times, were lower than 0°C, which are indicative of the logger being out of the water. As such, data are not available for this station for January or February and data are intermittent for this station in March (Figure 18). Continuous data were available for this station from late March until its most recent download in mid-October 2020.

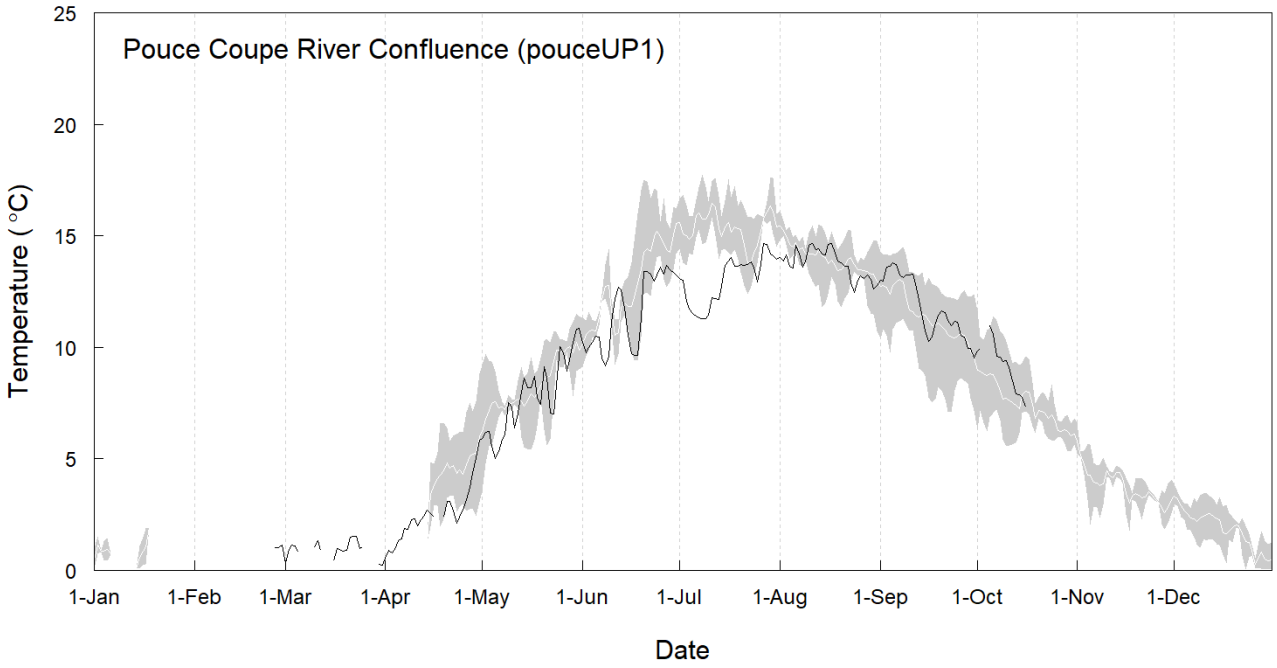

Figure 18: Mean daily water temperature (°C) for the right bank (as viewed facing downstream) of the Peace River upstream of the Pouce Coupe River's confluence with the Peace River (pouceUP1; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at the station between 2008 and 2019. The white line represents average mean daily water temperatures over the same period.

Similar to Station pouceUP1, data from Station pouceUP2 suggested this logger was also out of the water for most of January and intermittently out of the water in February and March 2020 (Figure 19). Continuous data were available for this station from early April until its most recent download in mid-October 2020. When field crews arrived on site to service this station on 16 October 2020, the logger was buried under approximately 0.5 m of sand, which should be considered when interpreting the results presented in Figure 19. During the 16 October download and service, the data logger (serial #10893068) was replaced with a new data logger (serial #20182032).

Data from mid-October 2020 to 31 December 2020 for pouceUP1 and pouceUP2 will be downloaded in 2021 and presented in the 2021 annual report.

Interannual comparisons of water temperature data for pouceUP1 and pouceUP2 are presented in Appendix B, Figures B16 and B17, respectively.

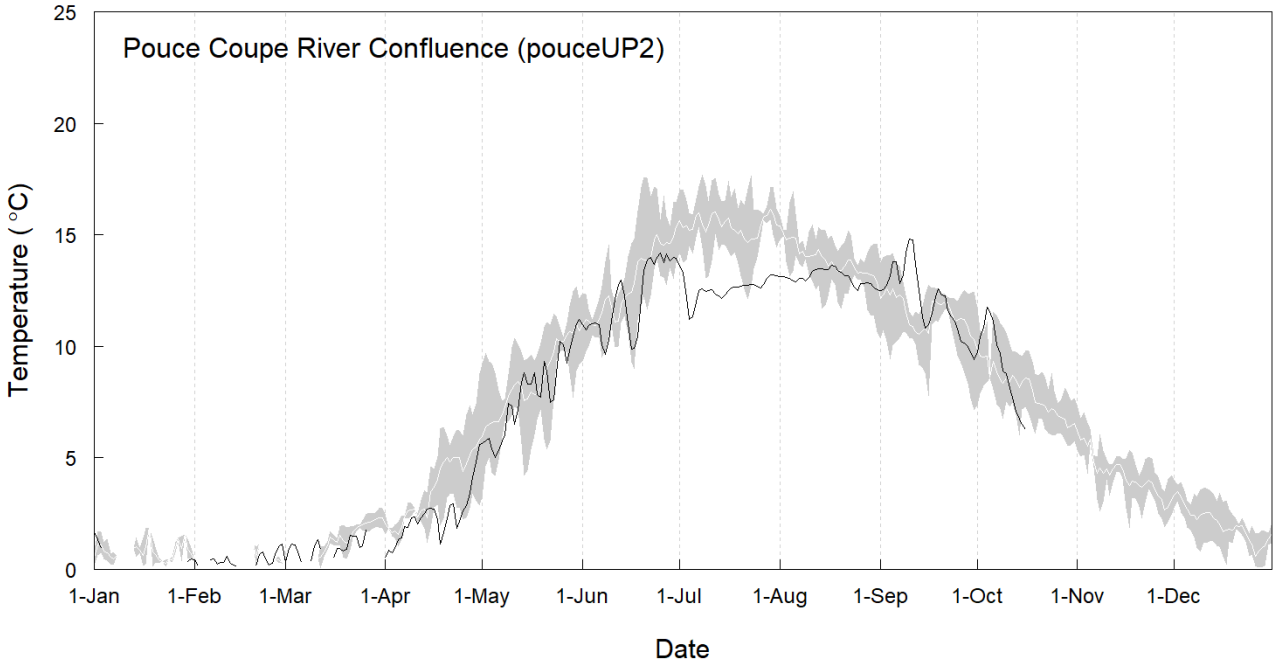

Figure 19: Mean daily water temperature (°C) for the left bank (as viewed facing downstream) of the Peace River upstream of the Pouce Coupe River's confluence with the Peace River (pouceUP2; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at the station between 2008 and 2019. The white line represents average mean daily water temperatures over the same period.

3.3 Peace River Tributaries

In the spring of 2016, temperature loggers were installed in the mainstems of the Pine and Beatton rivers. In the summer of 2019, temperature loggers were installed in the mainstems of the Moberly River and Farrell Creek and in the mainstems of the following Halfway River tributaries: the Chowade River and Colt (a tributary to the Graham River), Cypress, Kobes, and Fiddes creeks. Due to the remote location of most of these tributaries, some temperature loggers were only downloaded once in 2020 and data collected in 2020 after these downloads are not available. Data from each of these tributaries are presented below.

Two temperature loggers were installed in Kobes Creek in 2019 (Kobes_1 and Kobes_2); however, these loggers could not be found when the crew returned to the location in 2020. Both stations were replaced and are scheduled to be downloaded for the first time in July 2021. Location information for these stations is provided in Appendix A, Table A1. Water temperature data for Kobes Creek are not available for 2020.

In 2020, temperature loggers were installed for the first time in Maurice Creek (Maurice_1 and Maurice_2). These temperature loggers are scheduled to be downloaded for the first time in early 2021. Location information for these stations is provided in Appendix A, Table A1.

3.3.1 Peace River Mainstem Tributaries

3.3.1.1 Farrell Creek

Two stations were established for the Farrell Creek mainstem on 2 August 2019 approximately 62.5 km upstream of the Peace River. When crews returned to the station on 26 July 2020 to download the temperature loggers, one of the stations (Farrell_2) could not be located. A new temperature logger (serial # 20655128) was installed at Farrell_2 station on 2 August 2020 and is scheduled to be downloaded for the first time in early 2021. Farrell_1 station was located on 26 July 2020 but could not be retrieved because it was buried in sediment. It was retrieved on 2 August, when the crew returned with tools capable of excavating the logger housing. Based on the downloaded data, the temperature logger was likely buried in sediment in mid-June as daily temperature variations decreased substantially at that time; data collected after this time were considered spurious and excluded from the analysis (Figure 20). Further, data from Farrell_1 collected between early January and late April were also considered spurious and removed from the analysis due to substantial daily temperature variations.

Interannual comparisons of water temperature data for Farrell Creek are presented in Appendix B, Figure B18.

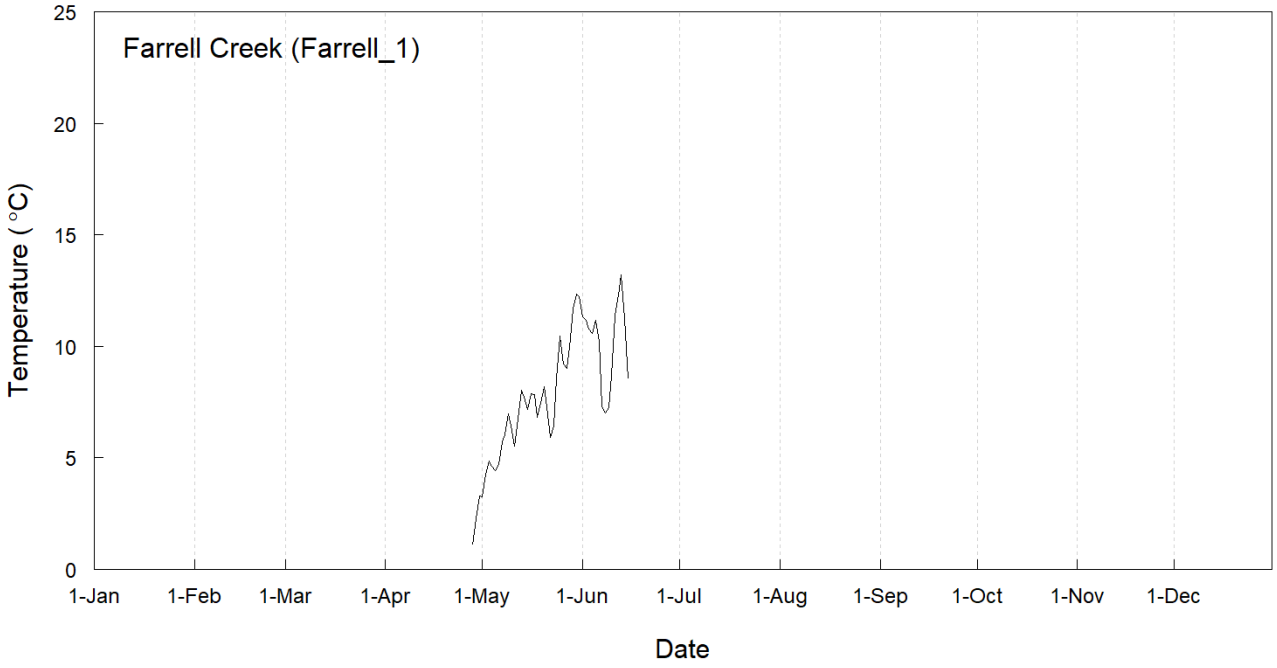

Figure 20: Mean daily water temperature (°C) for Farrell Creek (Farrell_1; black line), 2020.

3.3.1.2 Moberly River

Moberly_1 and Moberly_2 were established in the Moberly River on 21 July 2019 near the North Monias Road Bridge, approximately 42.6 km upstream of the river's confluence with the Peace River. Moberly_2 was not recovered in 2020; the tree that the station was attached to was not present when crews arrived on site in mid-July. Moberly_1 was recovered, downloaded, and replaced with a pendant-style logger. Based on the available data, Moberly_1 came out of water in early November 2019 and remained out of the water until late April 2020 (Figure 21).

Interannual comparisons of water temperature data for the Moberly River are presented in Appendix B, Figure B19.

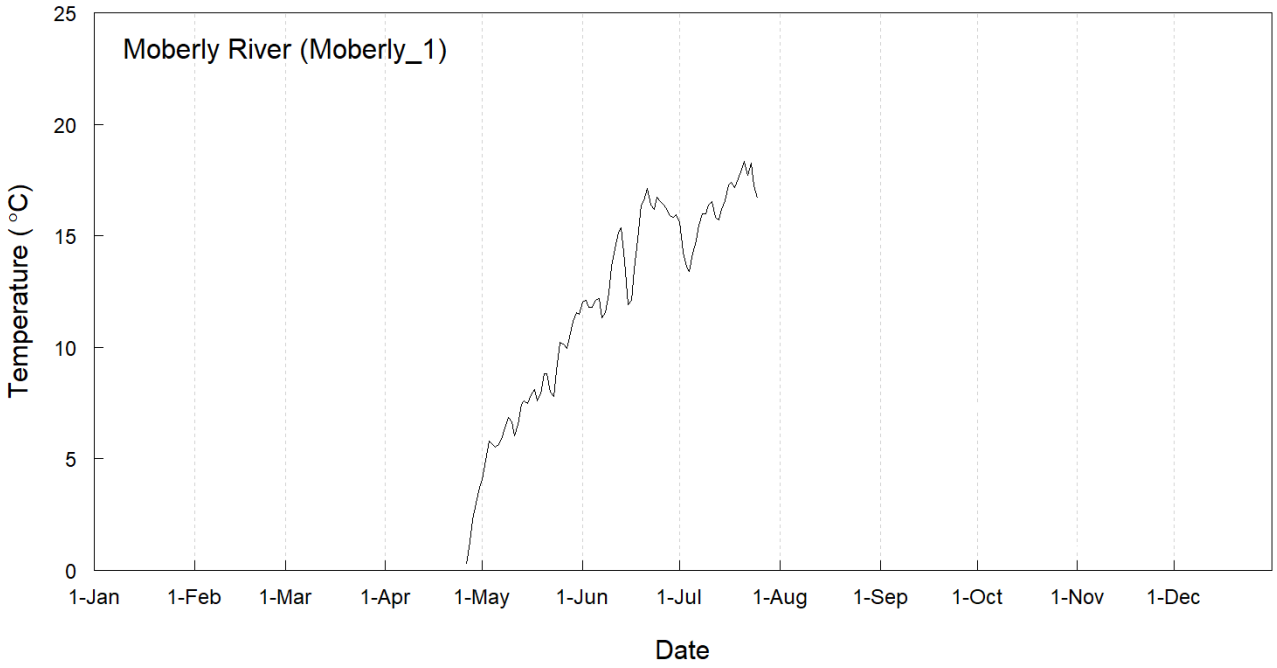

Figure 21: Mean daily water temperature (°C) for the Moberly River (Moberly_1; black line), 2020.

3.3.1.3 Pine River

PineMS1 and PineMS2 were established in the Pine River on 15 April 2016. Both stations were located on the left bank of the river tied to a steel piling approximately 1.5 km upstream of the river's confluence with the Peace River. On 16 October, both stations were found approximately 1.5 m from the waters edge. Based on a review of the data, these stations likely became exposed on 2 September 2020. Over the winter and early spring of 2020, both stations were exposed until late April. Data from PineMS1 and PineMS2 are combined and presented together in Figure 22.

Interannual comparisons of water temperature data for the Pine River are presented in Appendix B, Figure B20.

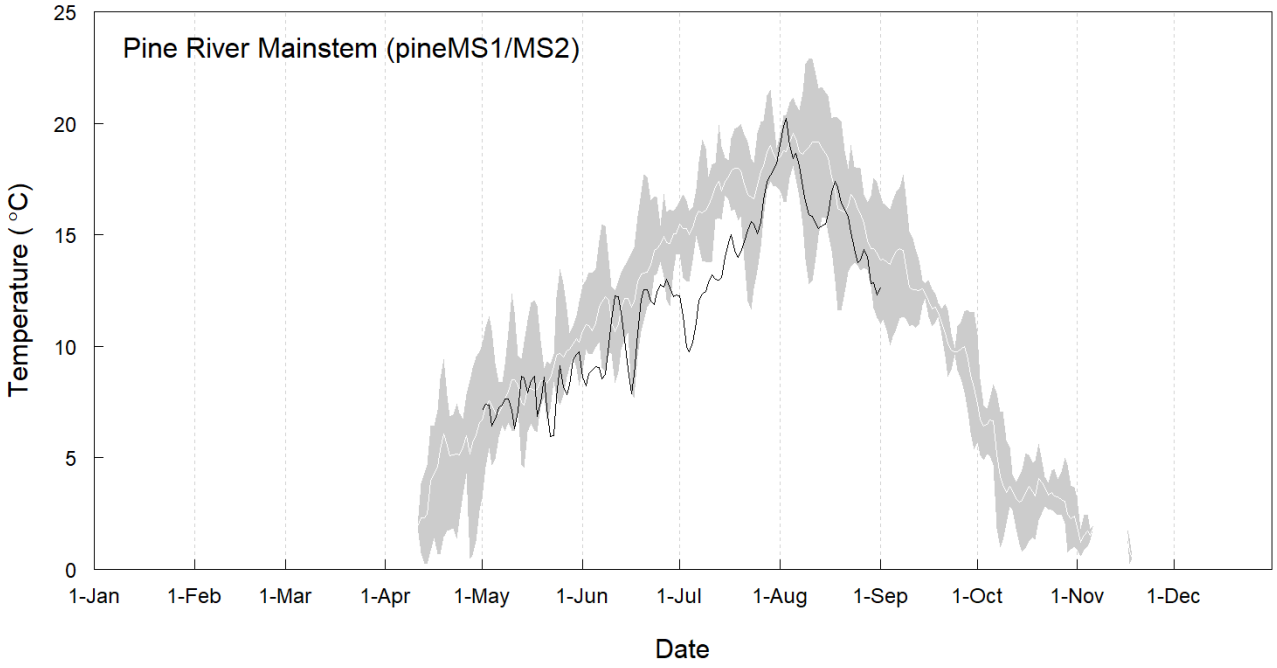

Figure 22: Mean daily water temperature (°C) for the Pine River (PineMS1 and PineMS2 combined; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at these stations between 2016 and 2019. The white line represents average mean daily water temperatures over the same period.

3.3.1.4 Beatton River

BeatMS1 and BeatMS2 were established in the Beatton River on 15 April 2016 approximately 0.9 km upstream of the river's confluence with the Peace River. On 16 October, BeatMS2 could not be located; it was replaced with a new station (serial # 20182027). BeatMS1 was located out of the water but could not be downloaded in the field. It was replaced with a pendant-style temperature logger (serial # 20182029). Due to the difficulties experienced in 2020 and historical difficulties noted by DES (2019), on 16 October, both stations were relocated approximately 50 m downstream from their initial location.

High daily variability in water temperature values from early January to mid-April, 2-7 June, 24 June to 1 July, and 3 September to 16 October 2020 suggest BeatMS1 was out of the water during these periods. These data were considered spurious and removed from the analysis.

Interannual comparisons of water temperature data for the Beatton River are presented in Appendix B, Figure B21.

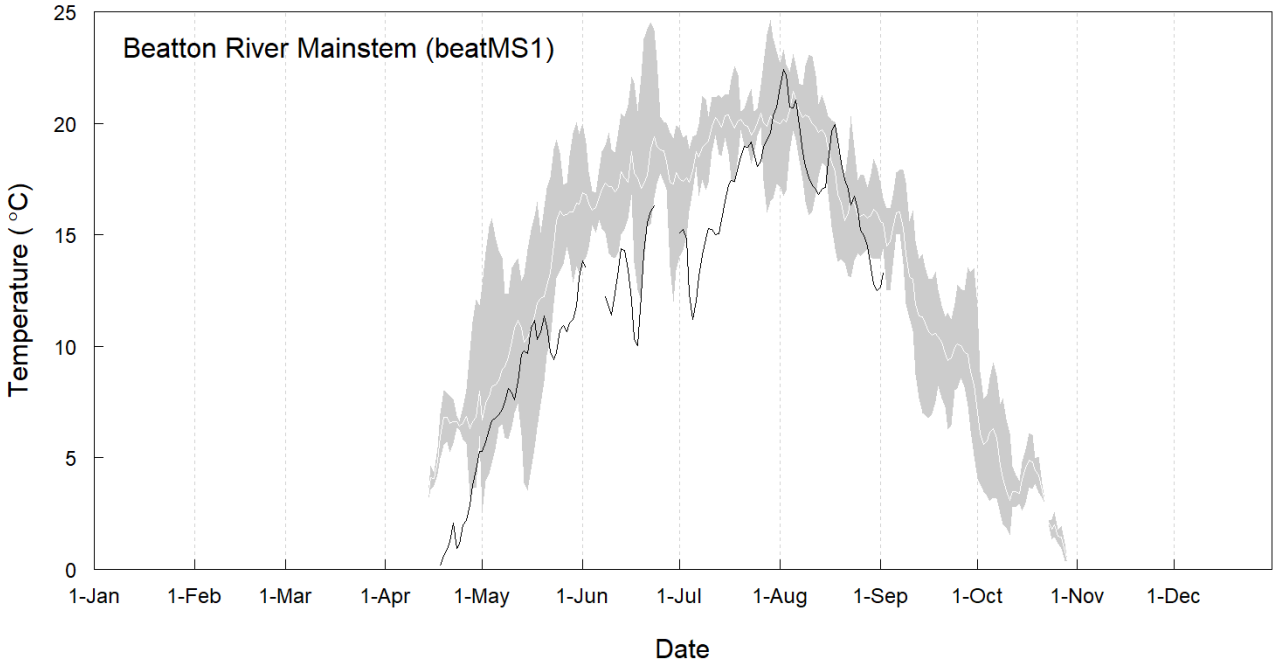

Figure 23: Mean daily water temperature (°C) for the Beatton River (BeatMS1; black line), 2020. The shaded area represents minimum and maximum water temperatures recorded at this station between 2016 and 2019. The white line represents average mean daily water temperatures over the same period.

3.3.2 Halfway River Tributaries

3.3.2.1 Fiddes Creek

Two stations (Fiddes_1 and Fiddes_2) were established in Fiddes Creek on 31 July 2019 approximately 7.2 km upstream of the stream's confluence with the Halfway River. Both stations were downloaded on 27 July 2020. A review of the data suggests that both logger became frozen in ice or came out of water in late October 2019 and remained out of flowing water until early May 2020. Data from Fiddes_1 and Fiddes_2 are combined and presented in Figure 24.

Interannual comparisons of water temperature data for Fiddes Creek are presented in Appendix B, Figure B22.

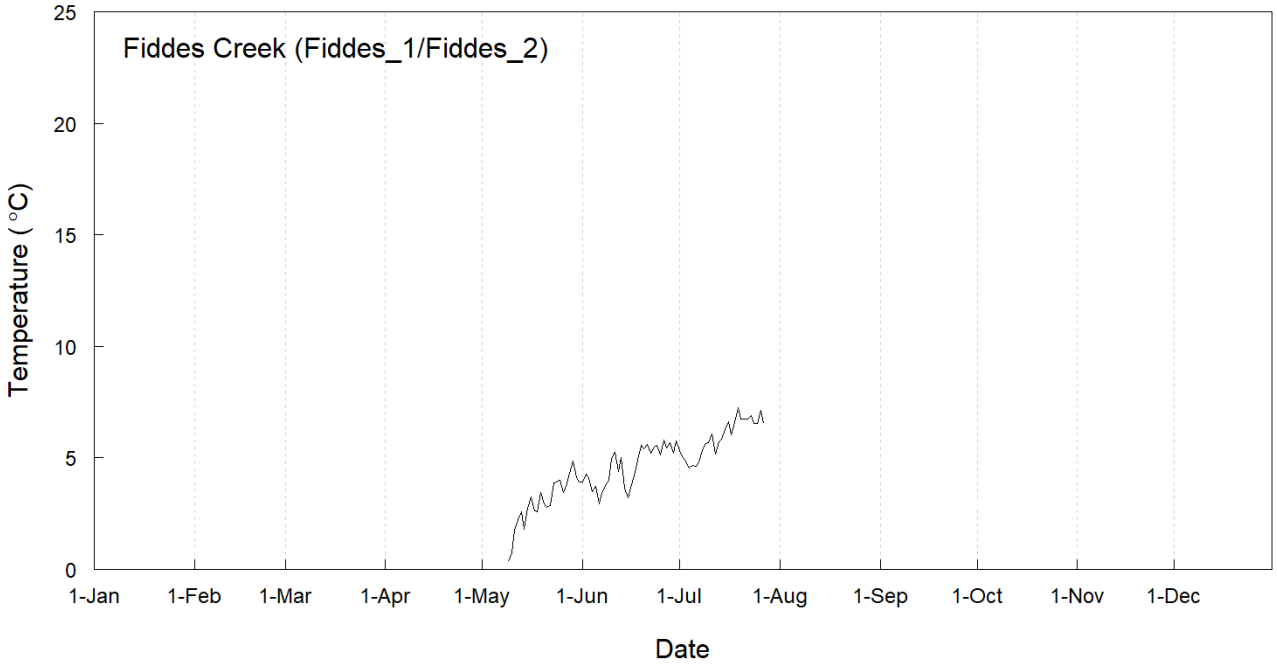

Figure 24: Mean daily water temperature (°C) for Fiddes Creek (Fiddes_1 and Fiddes_2 combined; black line), 2020.

3.3.2.2 Cypress Creek

Two stations (Cypress_1 and Cypress_2) were established in Cypress Creek on 27 July 2019 approximately 17.6 km upstream of the stream's confluence with the Halfway River. The Cypress_2 station could not be located and 2020 and was replaced (serial # 20655127) on 28 July 2020. Cypress_1 was located and downloaded on 28 July 2020. A review of the data suggests that the Cypress_1 station became frozen in ice or came out of water in early November 2019 and remained out of flowing water until late April 2020 (Figure 25).

Interannual comparisons of water temperature data for Cypress Creek are presented in Appendix B, Figure B23.

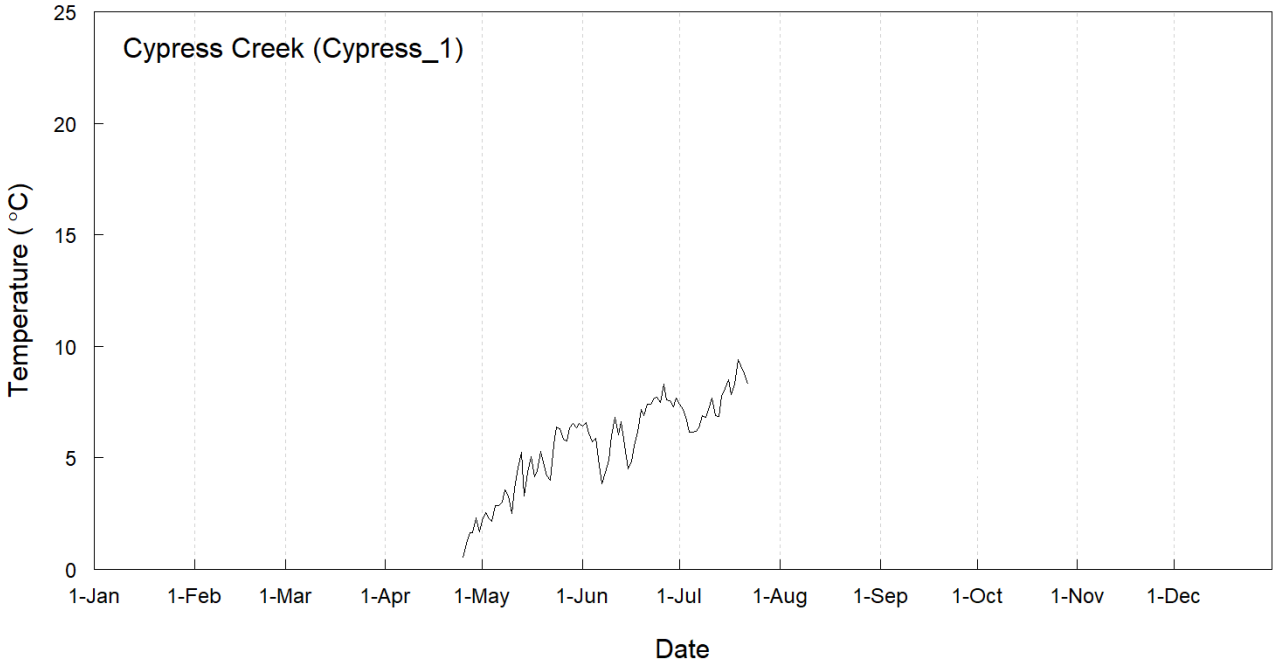

Figure 25: Mean daily water temperature (°C) for Cypress Creek (Cypress_1; black line), 2020.

3.3.2.3 Chowade River

Two stations (Chowade_1 and Chowade_2) were established in the Chowade River on 25 July 2019 approximately 20.9 km upstream of the river's confluence with the Halfway River. Both stations were located and downloaded on 23 July 2020. A review of the data suggests that both stations became frozen in ice or came out of water in late November 2019 and remained out of flowing water until late April 2020. Data from Chowade_1 and Chowade_2 are combined and presented in Figure 26.

Interannual comparisons of water temperature data for the Chowade River are presented in Appendix B, Figure B24.

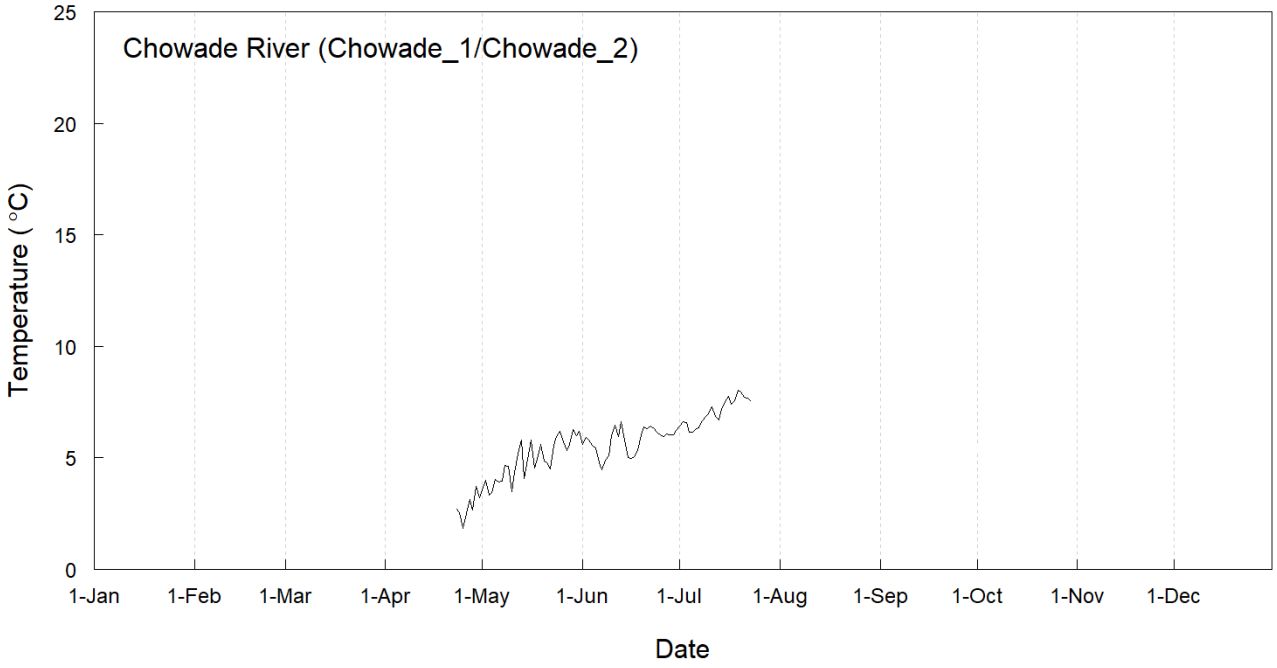

Figure 26: Mean daily water temperature (°C) for the Chowade River (Chowade_1 and Chowade_2 combined; black line), 2020.

3.3.2.4 Colt Creek

Two stations (Colt_1 and Colt_2) were established in Colt Creek on 1 August 2019 approximately 3.1 km upstream of the stream's confluence with the Graham River. In early August 2020, only one station was located and downloaded; however, the channel they were initially deployed in was dry. At some point between August 2019 and August 2020, the course of the stream shifted to a different channel. Based on daily temperature variations in the data, this shift likely occurred in mid-June of 2020. As such, data recorded after mid-June were excluded from analyses. The Colt_2 station could not be located and was replaced (serial #20615749) on 5 August 2020. Both stations were relocated to the wetted channel. Data from Colt_1 are presented in Figure 27.

Interannual comparisons of water temperature data for Colt Creek are presented in Appendix B, Figure B25.

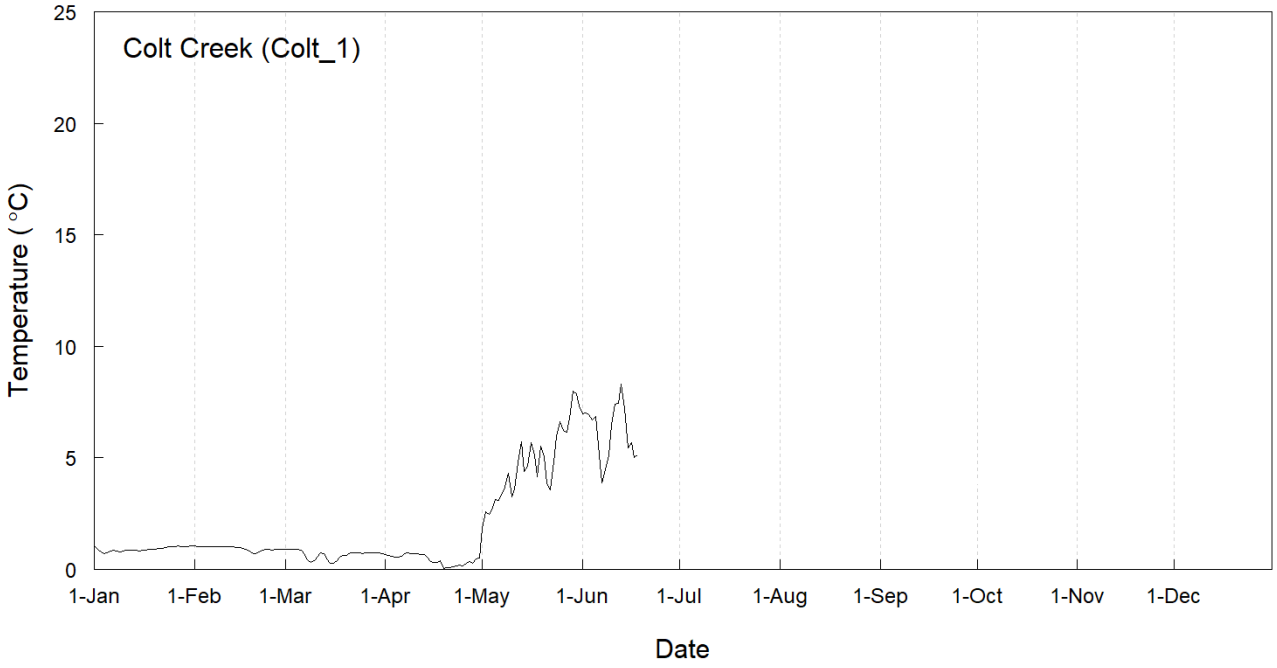

Figure 27: Mean daily water temperature (°C) for Colt Creek (Colt_1; black line), 2020.

4.0 DISCUSSION

The 2020 study was the fifth year of the Site C Reservoir and Peace River Water Temperature Monitoring Program (Task 2b), a multi-year water temperature monitoring program at select Peace River mainstem and Peace River tributary locations. When coupled with water temperature data collected under BC Hydro's WLR Peace River Baseline TDG and Temperature Monitoring Program (GMSWORK-2), a near continuous water temperature dataset exists for select locations from 2008 through to 2020.

Task 2b is not intended to address specific management questions or hypotheses under the FAHMFP. Instead, temperature data collected under Task 2b provides information to diagnose causes of observed changes in other FAHMFP programs (i.e., Site C Reservoir Fish Community Monitoring Program [Mon-1a], Site C Reservoir Tributaries Fish Community and Spawning Monitoring Program [Mon-1b], and Peace River Fish Community Monitoring Program [Mon-2]) designed to monitor key indicator species of the Peace River.

5.0 CLOSURE

We trust that this report provides the information required. If there are any questions or require further detail, please contact the undersigned.

Golder Associates Ltd.

Josh Sutherby, BSc
Fisheries Biologist

Dustin Ford, RPBio
Senior Fisheries Biologist, Associate

JS/DF/cmc

https://golderassociates.sharepoint.com/sites/107993/project files/6 deliverables/issued to the client_for wp/19121767-016-r-rev0/19121776-016-r-rev0-2020 peace river water temp monitoring program 17may_21.docx

6.0 LITERATURE CITED

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DES (Diversified Environmental Services). 2019. Peace River and Site C Reservoir Water and Sediment Quality monitoring Programs (Mon-8 and Mon-9) – Task 2b - Temperature Monitoring – Construction Year 4 (2018). Prepare for BC Hydro, Vancouver, BC. 11 pages + 2 appendices.

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APPENDIX A

Water Temperature Monitoring Station Location Data

Table A1 Summary of Peace River Water Temperature Monitoring station locations, 2020. Loggers are presented in upstream to downstream order.

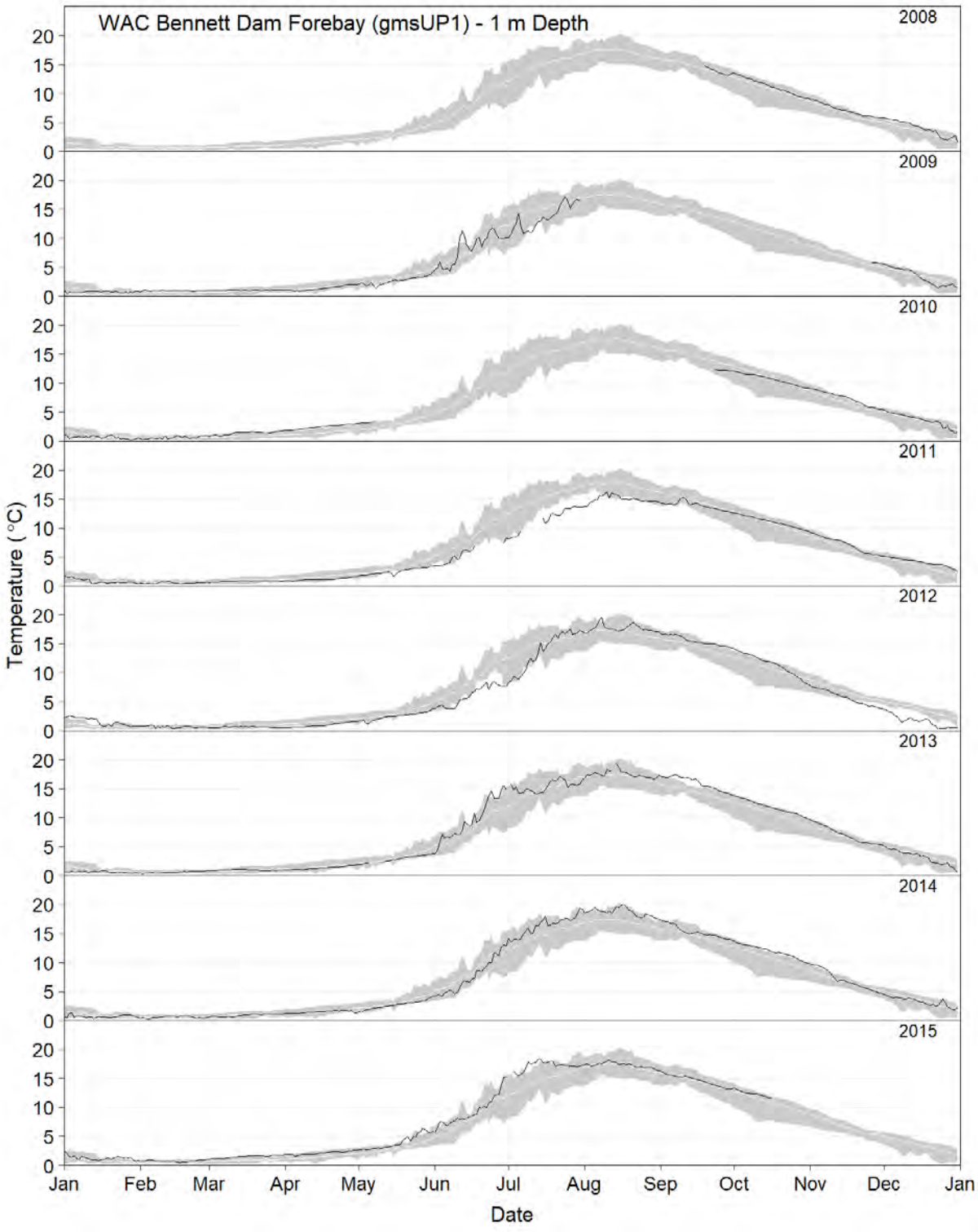
Station Name	River Km[a]	Stream Name	Location Description	First Year of Monitoring	Current Serial Number	UTM Coordinates			Comment
						Zone	Easting	Northing	
gmsUP1	-1.0	Peace River	WAC Bennett Forebay - Shallow	2008	10676155	10V	548841	6209022	
gmsUP2	-1.0	Peace River	WAC Bennett Forebay - Deep	2008	10676160	10V	548841	6209022	
gmsDN1	0.7	Peace River	GMS Tailrace - LDB	2008	10635063	10V	548881	6207761	
gmsDN1BU	0.7	Peace River	GMS Tailrace - LDB	2008	20332152	10V	548881	6207761	
gmsDN2	0.7	Peace River	GMS Tailrace - RDB	2008	10669739	10V	548828	6207836	
gmsDN2BU	0.7	Peace River	GMS Tailrace - RDB	2008	20332121	10V	548828	6207836	
pcnUP1	19.9	Peace River	Peace Canyon Forebay - Shallow	2008	10635067	10U	562710	6204068	
pcnDN2	20.8	Peace River	Peace Canyon Tailrace - LDB	2008	10156317	10U	562803	6204854	
pcnDN2BU	20.8	Peace River	Peace Canyon Tailrace - LDB	2008	10635061	10U	562803	6204854	
HalfUP1	64.0	Peace River	Halfway Confluence – RDB upstream	2008	20332123	10V	595165	6230094	
HalfUP2	64.3	Peace River	Halfway Confluence – LDB upstream	2008	20030829	10V	595569	6230541	
HalfDN2	68.3	Peace River	Halfway Confluence – LDB downstream	2008	10669748	10V	598313	6232378	
HalfDN2BU	68.3	Peace River	Halfway Confluence – LDB downstream	2008	20182030	10V	598286	6232332	TidbiT #10156314 was replaced with TidbiT #20182030 on 16 October 2020.
BFlats_1	83.5	Peace River	Peace River – Bear Flats RDB	2020	10887852	10V	611280	6237044	New station installed on 15 September 2020 using TidbiT recovered from Station mobUP1.
BFlats_2	83.5	Peace River	Peace River – Bear Flats LDB	2020	20655180	10V	611453	6237303	New station installed on 15 September 2020 using TidbiT recovered from Station mobUP2.
MobUP1	102.6	Peace River	Moberly Confluence - RDB upstream	2008	10887852	10V	627158	6232349	Station decommissioned on 5 September 2020.
MobUP2	102.6	Peace River	Moberly Confluence - LDB upstream	2008	20655180	10V	627501	6232563	Station decommissioned on 5 September 2020.
MobDN1	108.9	Peace River	Moberly Confluence - RDB downstream	2008	10676146	10V	630583	6229281	
MobDN1BU	108.9	Peace River	Moberly Confluence - RDB downstream	2008	10676147	10V	630402	6229303	
PineUP1	119.5	Peace River	Pine Confluence - RDB upstream	2008	10669747	10V	641034	6225375	
PineUP2	120.0	Peace River	Pine Confluence - LDB upstream	2008	20655135	10V	641653	6225304	
PineDN1	126.8	Peace River	Pine Confluence - RDB downstream	2008	20655185	10V	648073	6222796	
PineDN1BU	126.9	Peace River	Pine Confluence - RDB downstream	2008	10893055	10V	648362	6222823	
PouceUP1	171.4	Peace River	Pouce Coupe confluence - RDB upstream	2016	20655184	11V	316873	6225211	
PouceUP2	170.5	Peace River	Pouce Coupe confluence - LDB upstream	2016	10893068	11V	315887	6226158	
Maurice_1	0.8	Maurice Creek	Approximately 1.0 km upstream from confluence	2020	201823_1	10V	568663	6209018	
Maurice_2	0.8	Maurice Creek	Approximately 1.0 km upstream from confluence	2020	20823375	10V	568663	6209018	
Farrell_1	62.5	Farrell Creek	Downstream of Kobes Creek Road bridge	2019	20615716	10V	572332	6239949	TidbiT was found buried in sediment on 26 July 2020; some data lost.
Farrell_2	62.5	Farrell Creek	Downstream of Kobes Creek Road bridge	2019	20655128	10V	572332	6239949	Original TidbiT could not be located in 2020; replaced with TidbiT #20655128 on 2 August 2020.
Fiddes_1	7.2	Fiddes Creek	Approximately 7.2 km upstream from confluence	2019	20615751	10V	479836	6311013	
Fiddes_2	7.2	Fiddes Creek	Approximately 7.2 km upstream from confluence	2019	20562511	10V	479836	6311013	
Cypress_1[b]	17.6	Cypress Creek	Upstream of Cypress Creek bridge	2019	20562503	10V	511008	6301673	
Cypress_2[b]	17.6	Cypress Creek	Upstream of Cypress Creek bridge	2019	20655127	10V	511008	6301673	Original TidbiT could not be located in 2020; replaced with TidbiT #20655127 on 28 July 2020
Chowade_1[b]	20.9	Chowade River	Downstream of Chowade River bridge	2019	20615714	10V	513503	6284788	
Chowade_2[b]	20.9	Chowade River	Downstream of Chowade River bridge	2019	20615748	10V	513507	6284799	
Colt_1	3.1	Colt Creek	Upstream of Mile 95 Road bridge	2019	20823376	10V	538236	6258610	TidbiT #20562512 was found in dry channel, buried in sediment in 2020; replaced with TidbiT #20823376 on 5 August 2020.
Colt_2	3.1	Colt Creek	Upstream of Mile 95 Road bridge	2019	20615749	10V	538236	6258610	Original TidbiT could not be located in 2020; replaced with TidbiT #20615749 on 5 August 2020.
Kobes_1[b]	11.5	Kobes Creek	Bridge near RiverKm 11.0	2020	20562512	10V	555239	6256203	Original TidbiT could not be located in 2020; replaced with TidbiT #2056512 on 14 August 2020
Kobes_2[b]	11.5	Kobes Creek	Bridge near RiverKm 11.0	2020	20182165	10V	555239	6256203	Original TidbiT could not be located in 2020; replaced with Pendant #20182165 on 14 August 2020.
Moberly_1	42.6	Moberly River	Downstream of North Monias Road bridge	2019	20182166	10V	603472	6217933	TidbiT #20615749 was replaced with TidbiT #20182166 on 31 July 2020
Moberly_2	42.6	Moberly River	Downstream of North Monias Road bridge	2019	n/a	10V	603472	6217933	TidbiT could not be recovered in 2020 and was not replaced.
PineMS1	2.2	Pine River	LDB upstream of confluence	2016	10893069	10V	641762	6223599	
PineMS2	2.2	Pine River	LDB upstream of confluence	2016	10635067	10V	641762	6223599	
BeatMS1	0.9	Beatton River	LDB upstream of confluence	2016	20182029	10V	663101	6220759	TidbiT #10930722 was replaced with TidbiT #20182029 on 16 October 2020.
BeatMS2	0.9	Beatton River	LDB upstream of confluence	2016	20182027	10V	663101	6220759	TidbiT #20030828 could not be located in 2020; replaced with TidbiT #20182027 on 16 October 2020.

[a] Peace River River Km values are measured downstream from the base of WAC Bennett Dam. Tributary River km values are measured upstream from the stream's confluence with the Peace River.

[b] Tributary River km values are measured upstream from the stream's or river's confluence with the Halfway River.

APPENDIX B

Water Temperature Summary Data - Inter-Annual Comparison


WAC Bennett Dam Forebay (gmsUP1) - 1 m Depth
2008
2009
2010
2011
2012
2013
2014
2015
Temperature (°C)
0
5
10
15
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Date

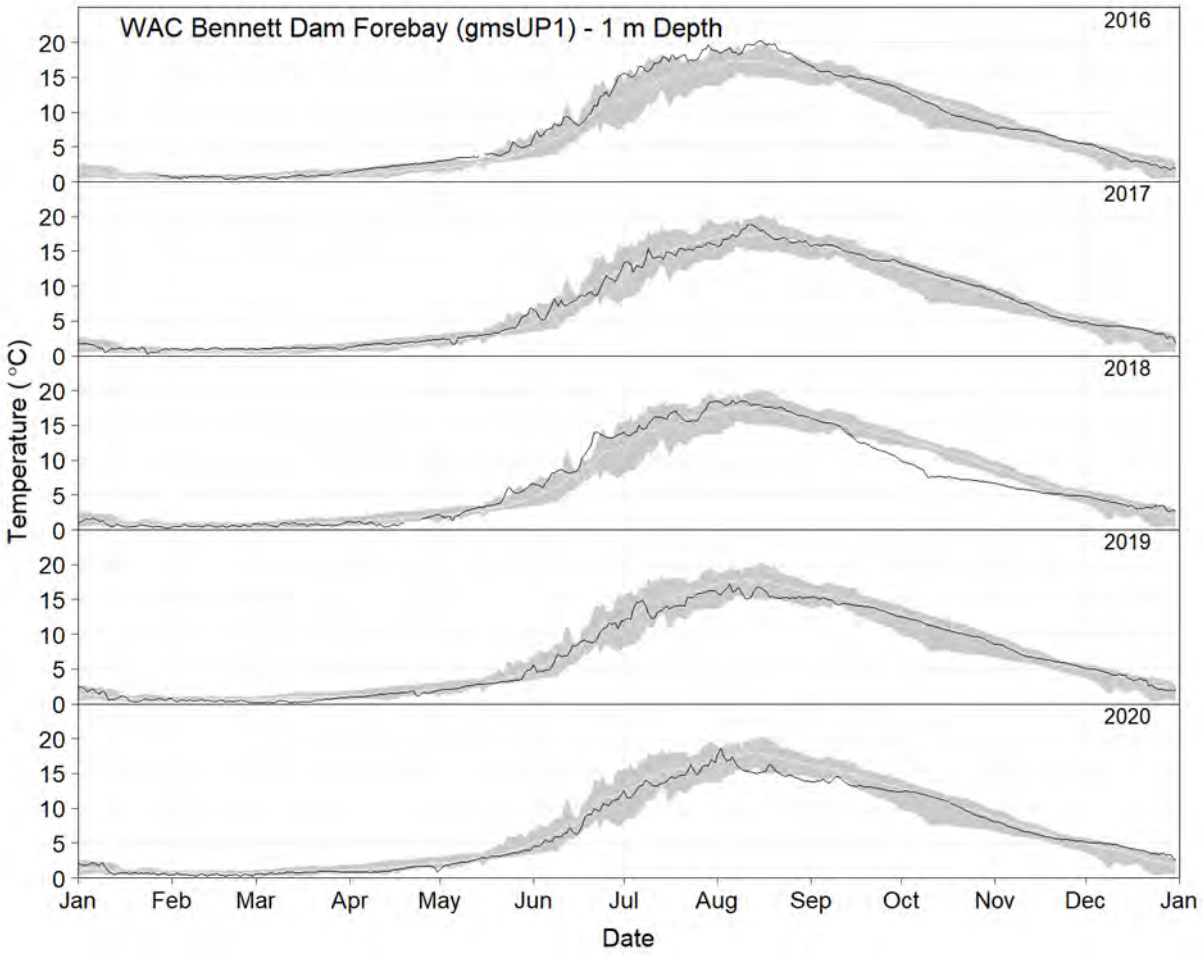
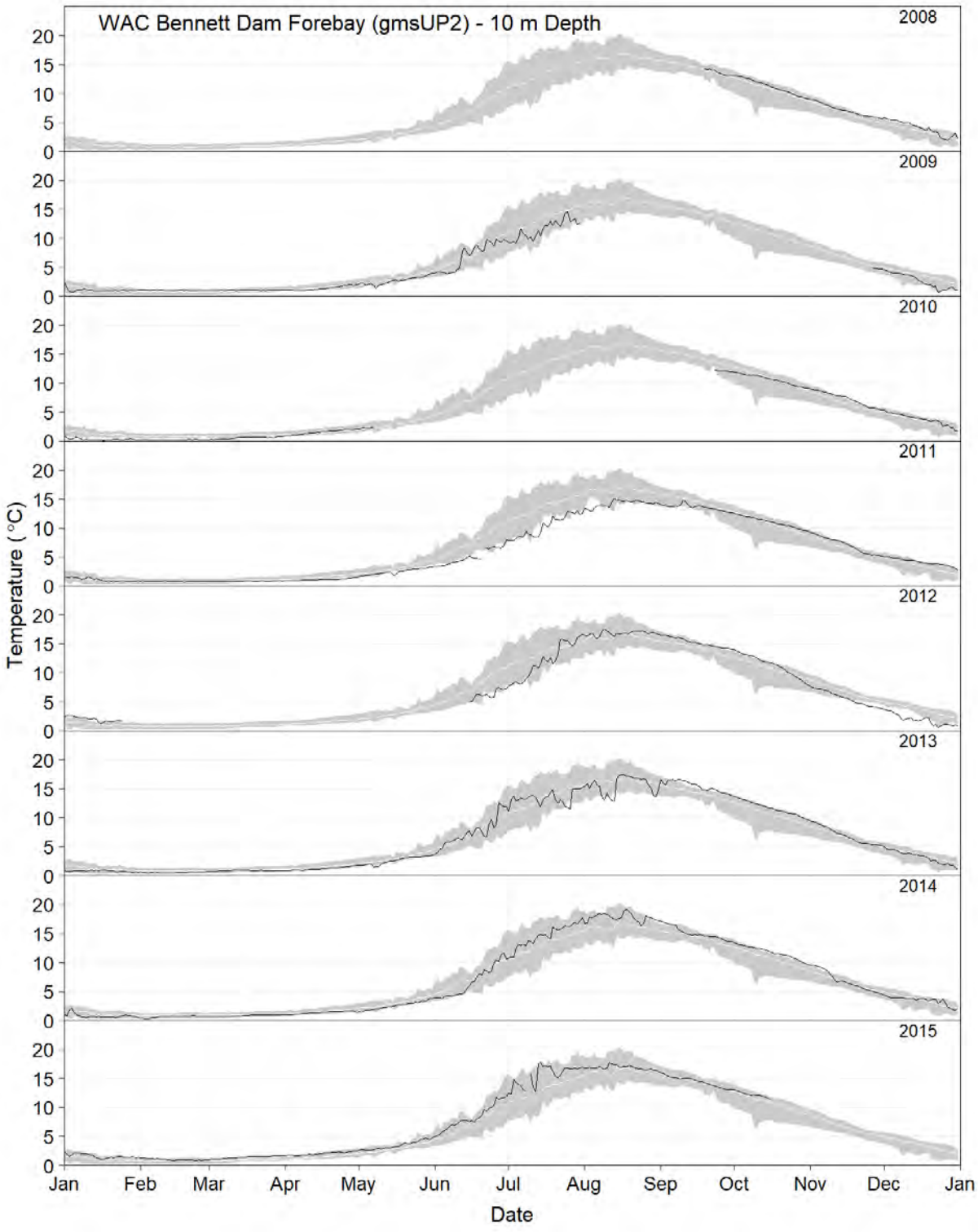


Figure B1 Mean daily water temperature (°C) for the WAC Bennett Dam (GMS) forebay 1 m below the water surface (gmsUP1; black line), 2008 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2008 and 2020. The white line represents average mean daily water temperatures over the same period.


WAC Bennett Dam Forebay (gmsUP2) - 10 m Depth
2008
2009
2010
2011
2012
2013
2014
2015
Temperature (°C)
0
5
10
15
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Date

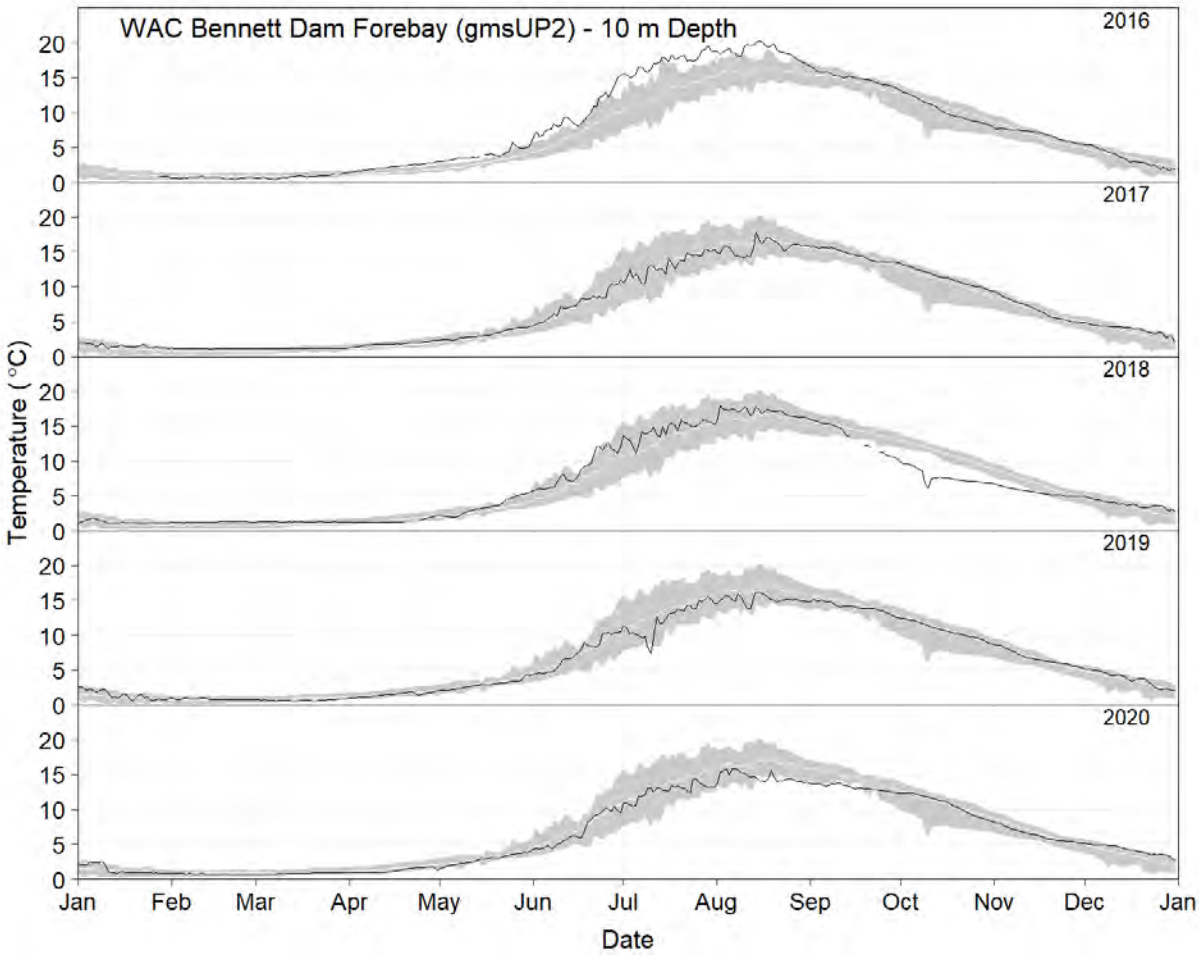
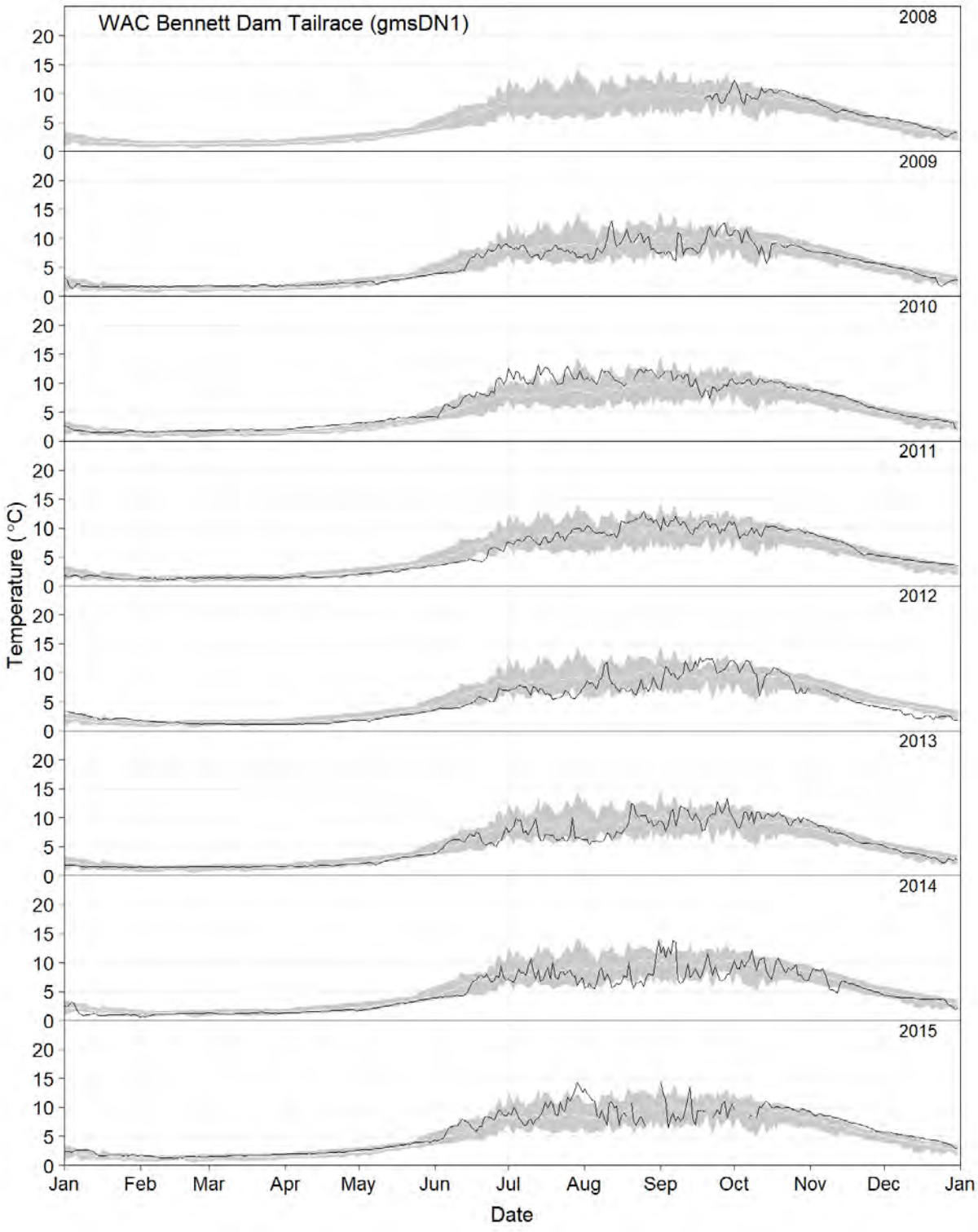


Figure B2 Mean daily water temperature (°C) for the WAC Bennett Dam (GMS) forebay 10 m below the water surface (gmsUP2; black line), 2008 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2008 and 2020. The white line represents average mean daily water temperatures over the same period.


WAC Bennett Dam Tailrace (gmsDN1)
2008
2009
2010
2011
2012
2013
2014
2015
Temperature (°C)
0
5
10
15
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Date

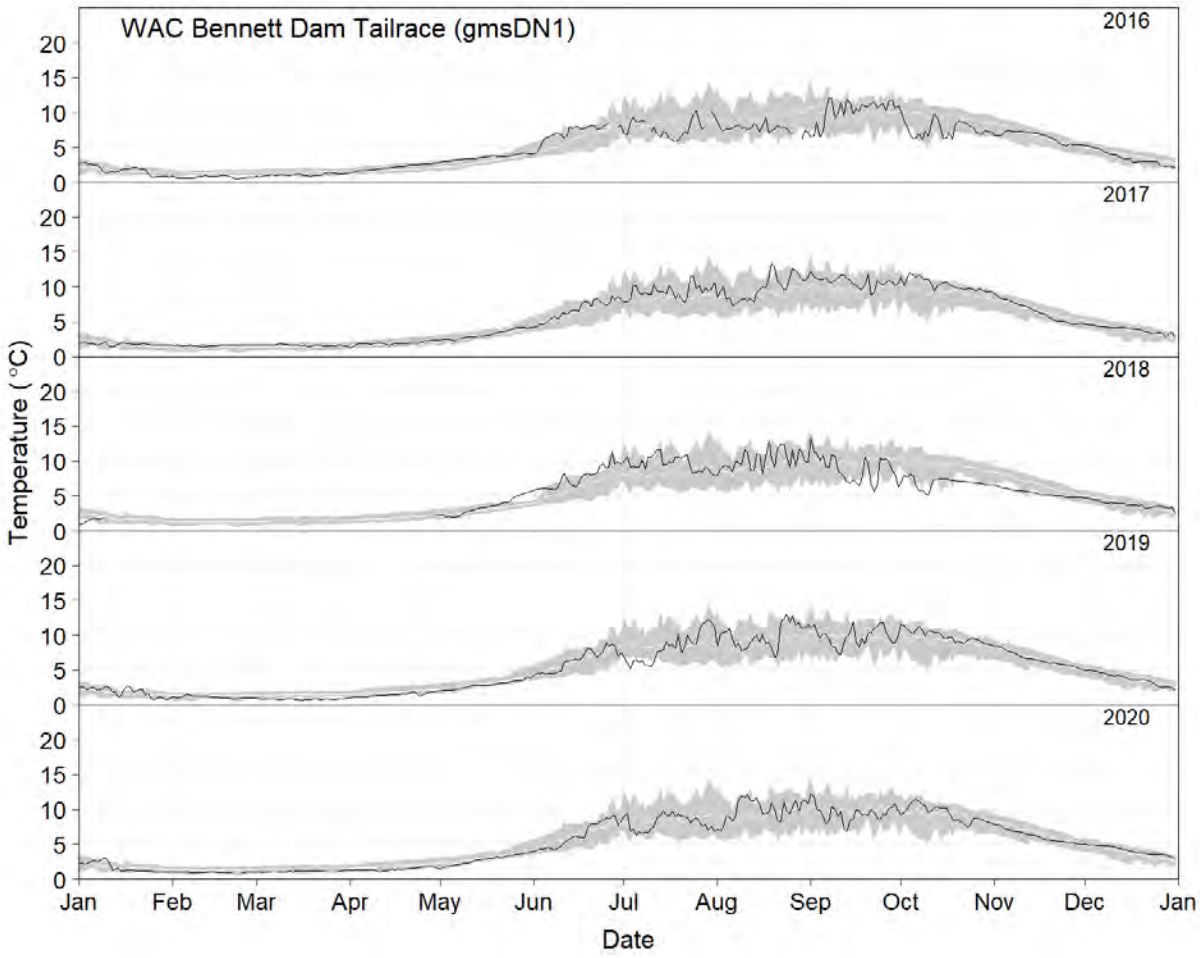
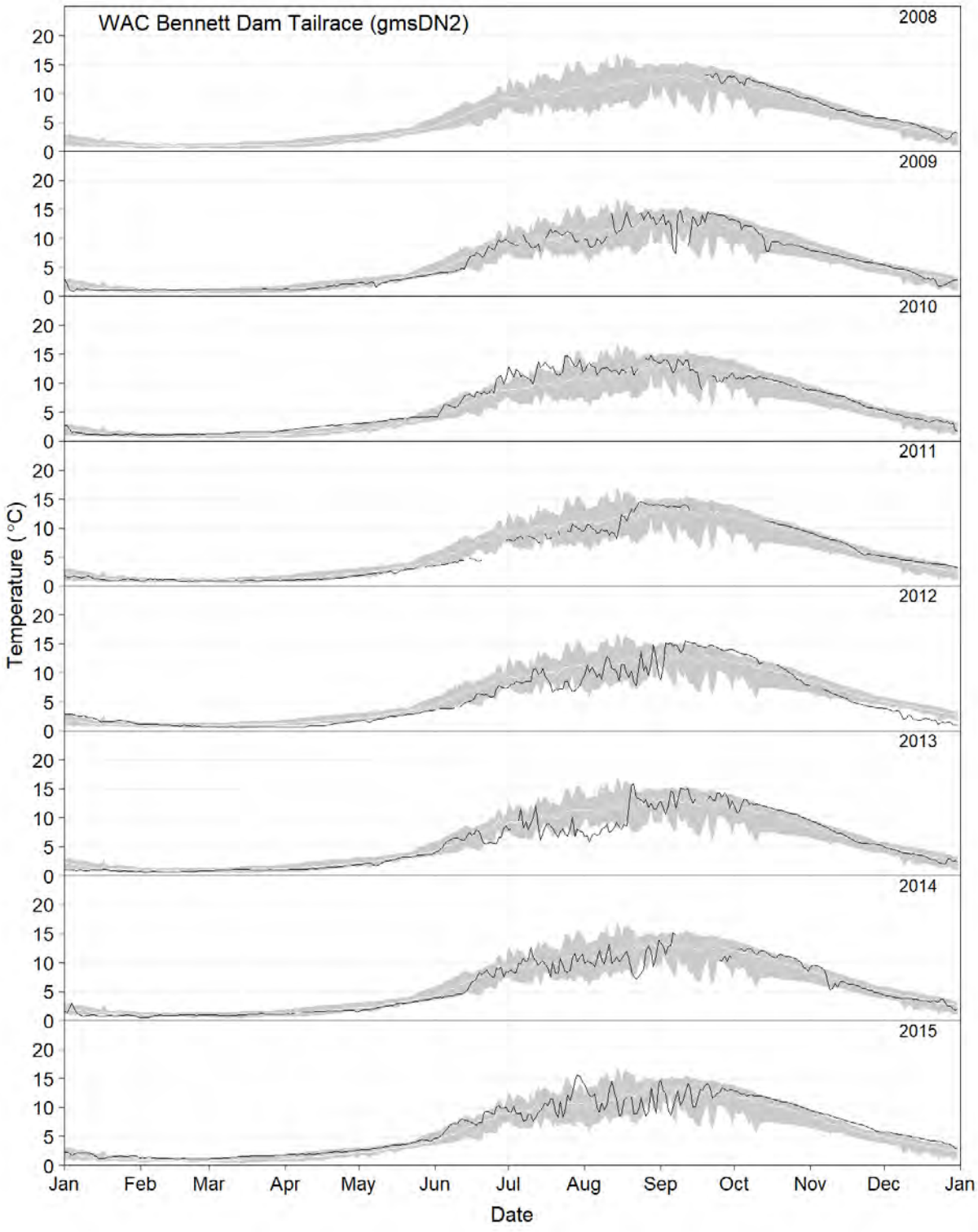


Figure B3 Mean daily water temperature (°C) for the left bank (as viewed facing downstream) of the WAC Bennett Dam (GMS) tailrace (gmsDN1; black line), 2008 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2008 and 2020. The white line represents average mean daily water temperatures over the same period.


WAC Bennett Dam Tailrace (gmsDN2)
2008
2009
2010
2011
2012
2013
2014
2015
Temperature (°C)
0
5
10
15
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Date

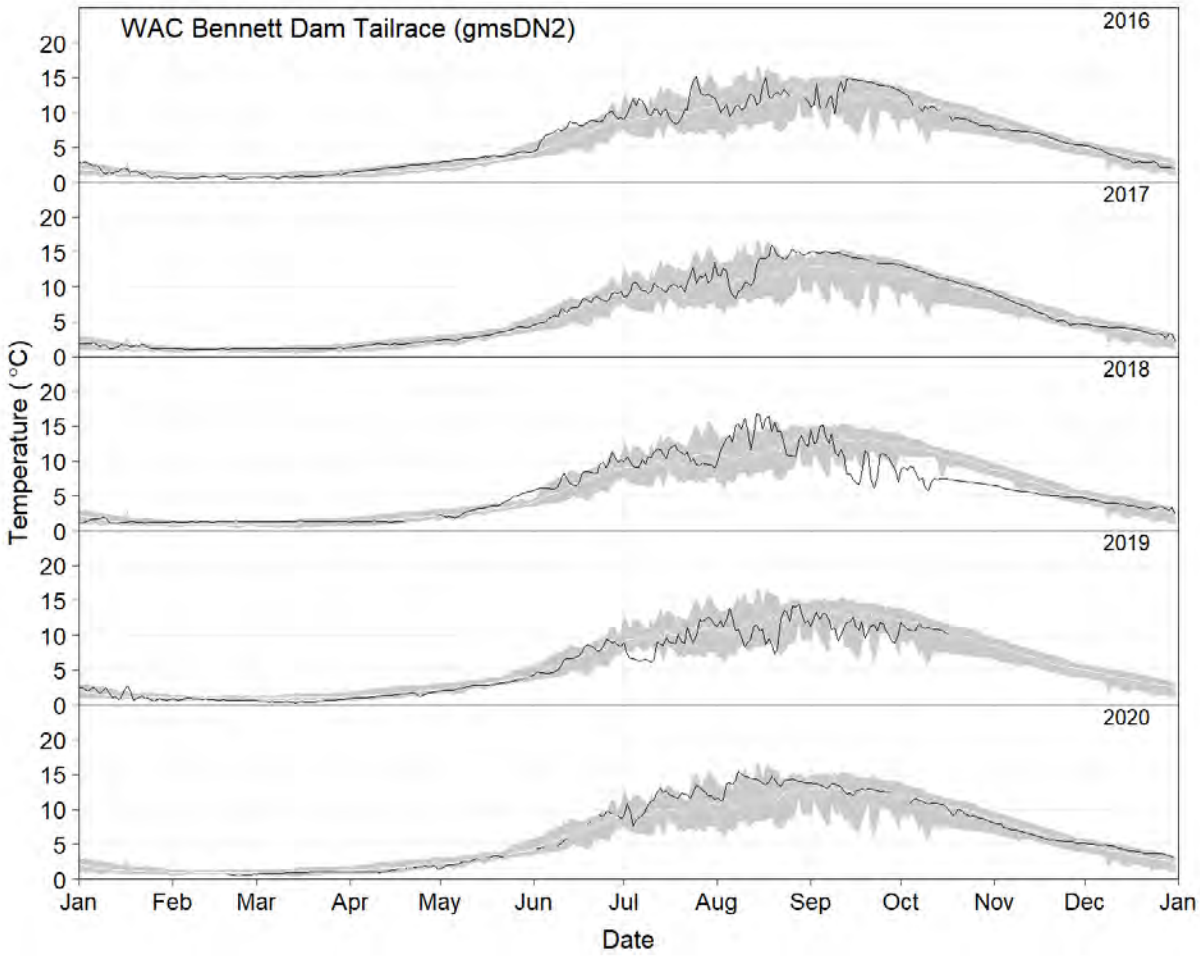
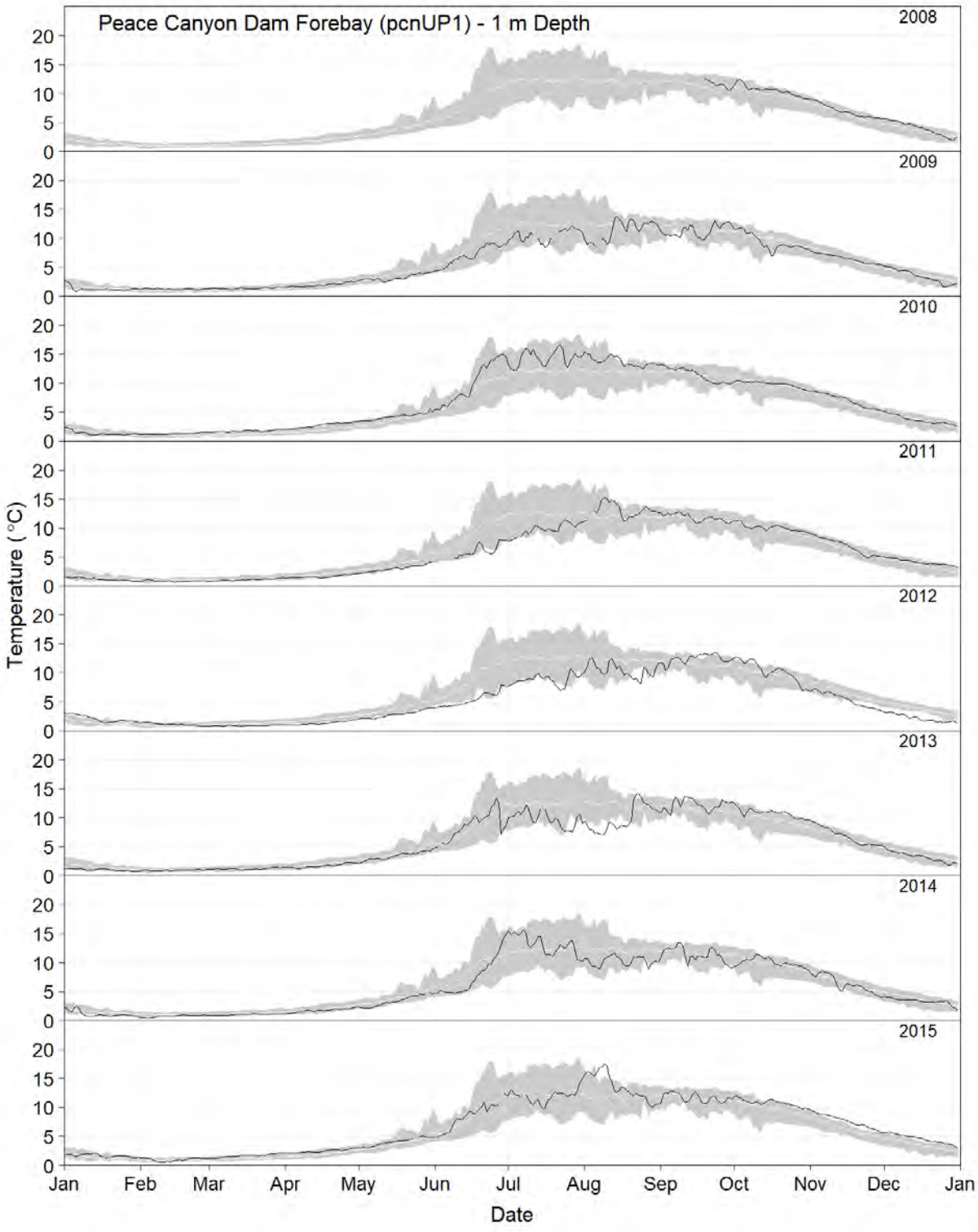


Figure B4 Mean daily water temperature (°C) for the right bank (as viewed facing downstream) of the WAC Bennett Dam (GMS) tailrace (gmsDN2; black line), 2008 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2008 and 2020. The white line represents average mean daily water temperatures over the same period.


Peace Canyon Dam Forebay (pcnUP1) - 1 m Depth
2008
2009
2010
2011
2012
2013
2014
2015
Temperature (°C)
0
5
10
15
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Date

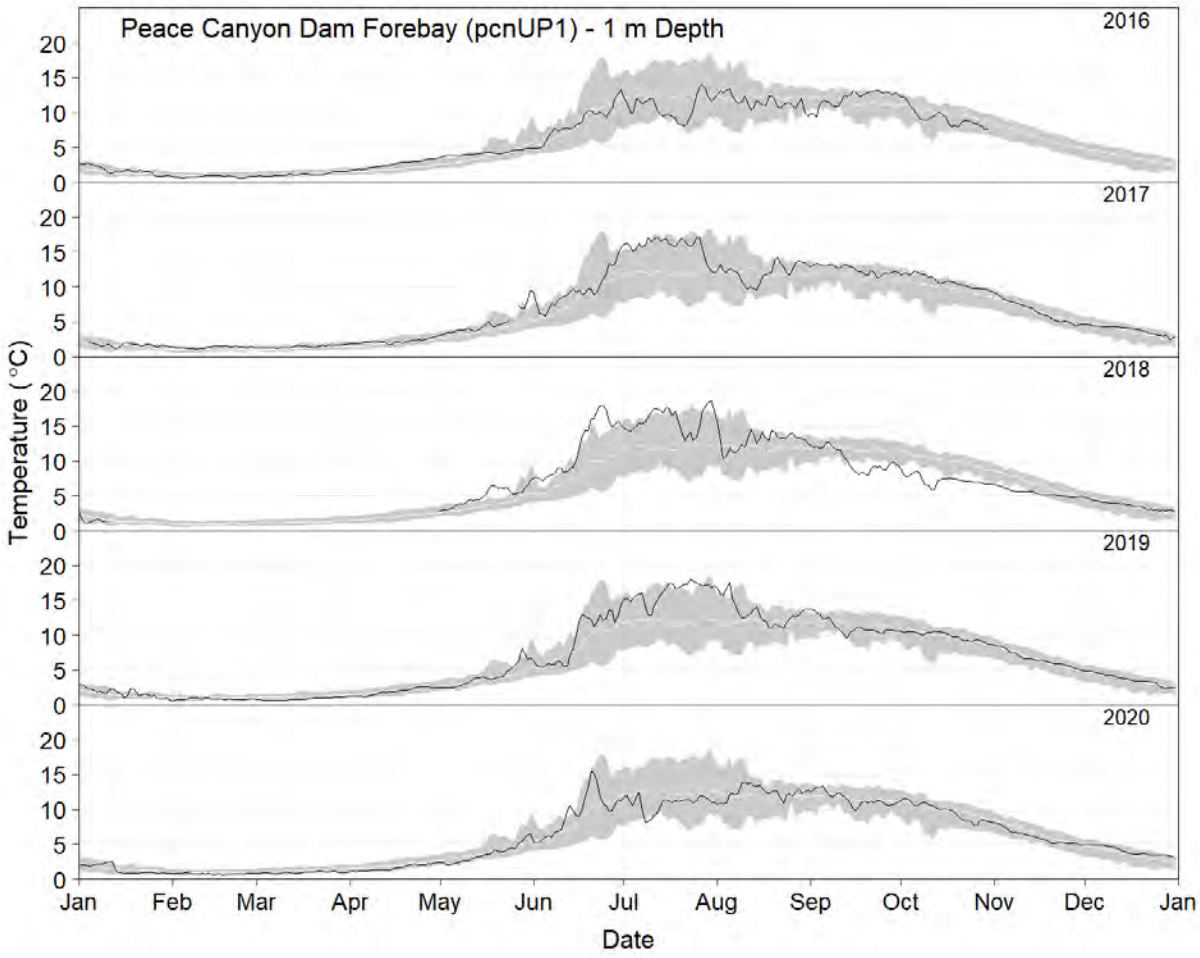
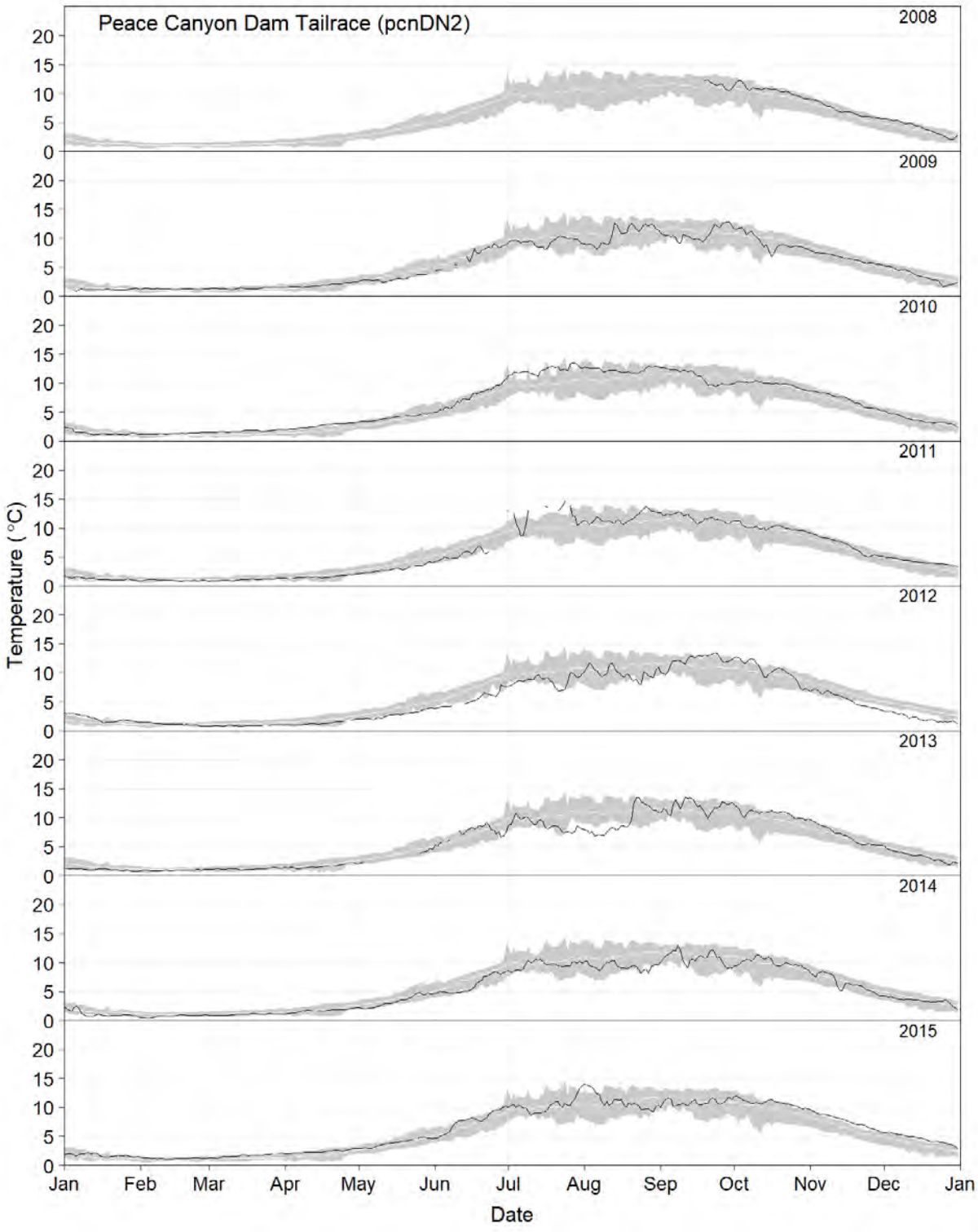


Figure B5 Mean daily water temperature (°C) for the Peace Canyon Dam (PCN) forebay 1 m below the water surface (pcnUP1; black line), 2008 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2008 and 2020. The white line represents average mean daily water temperatures over the same period.


Peace Canyon Dam Tailrace (pcnDN2)
2008
2009
2010
2011
2012
2013
2014
2015
Temperature (°C)
0
5
10
15
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Date

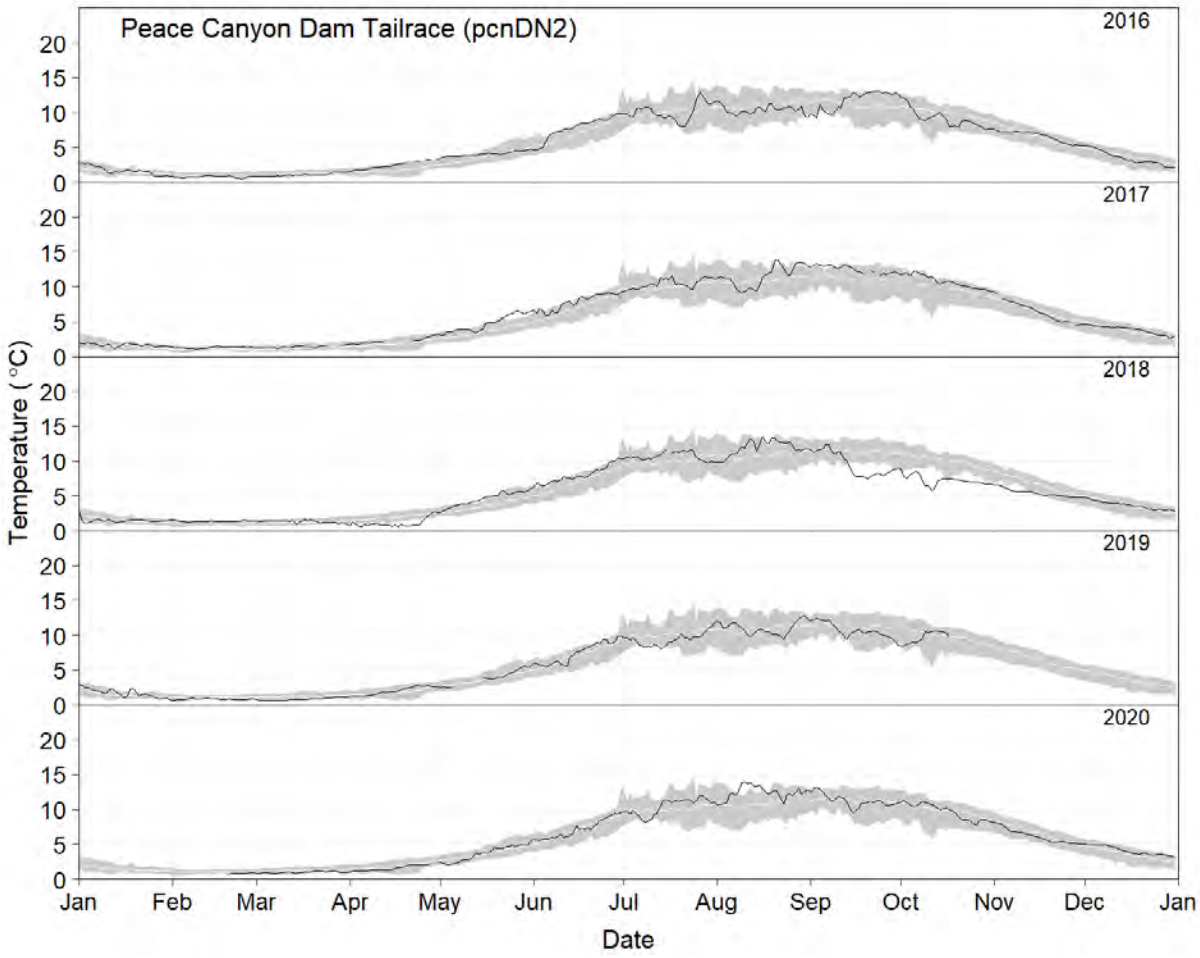
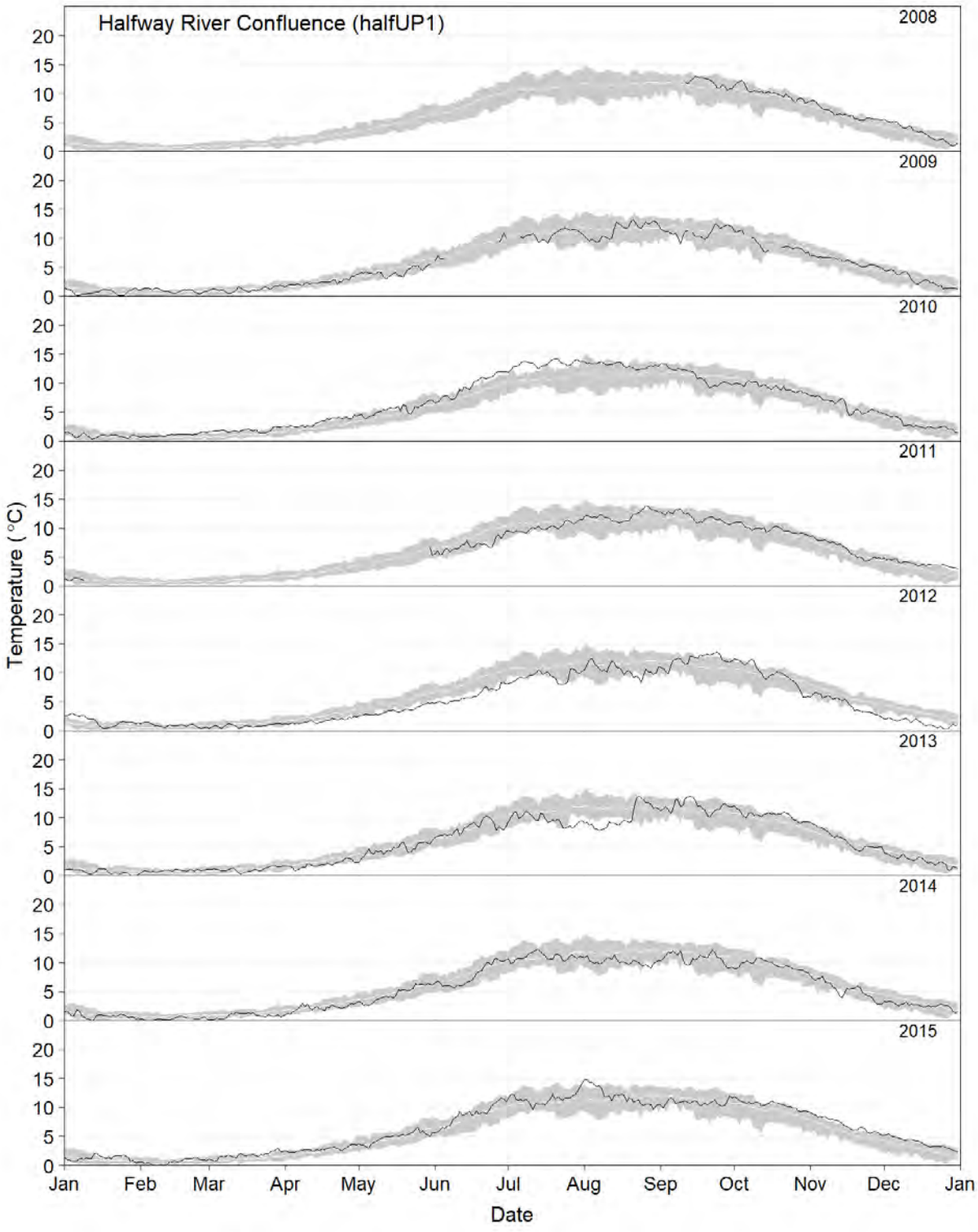


Figure B6 Mean daily water temperature (°C) for the left bank (as viewed facing downstream) of the Peace Canyon Dam (PCN) tailrace (pcnDN2; black line), 2008 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2008 and 2020. The white line represents average mean daily water temperatures over the same period.


Halfway River Confluence (halfUP1)
2008
2009
2010
2011
2012
2013
2014
2015
Temperature (°C)
0
5
10
15
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Date

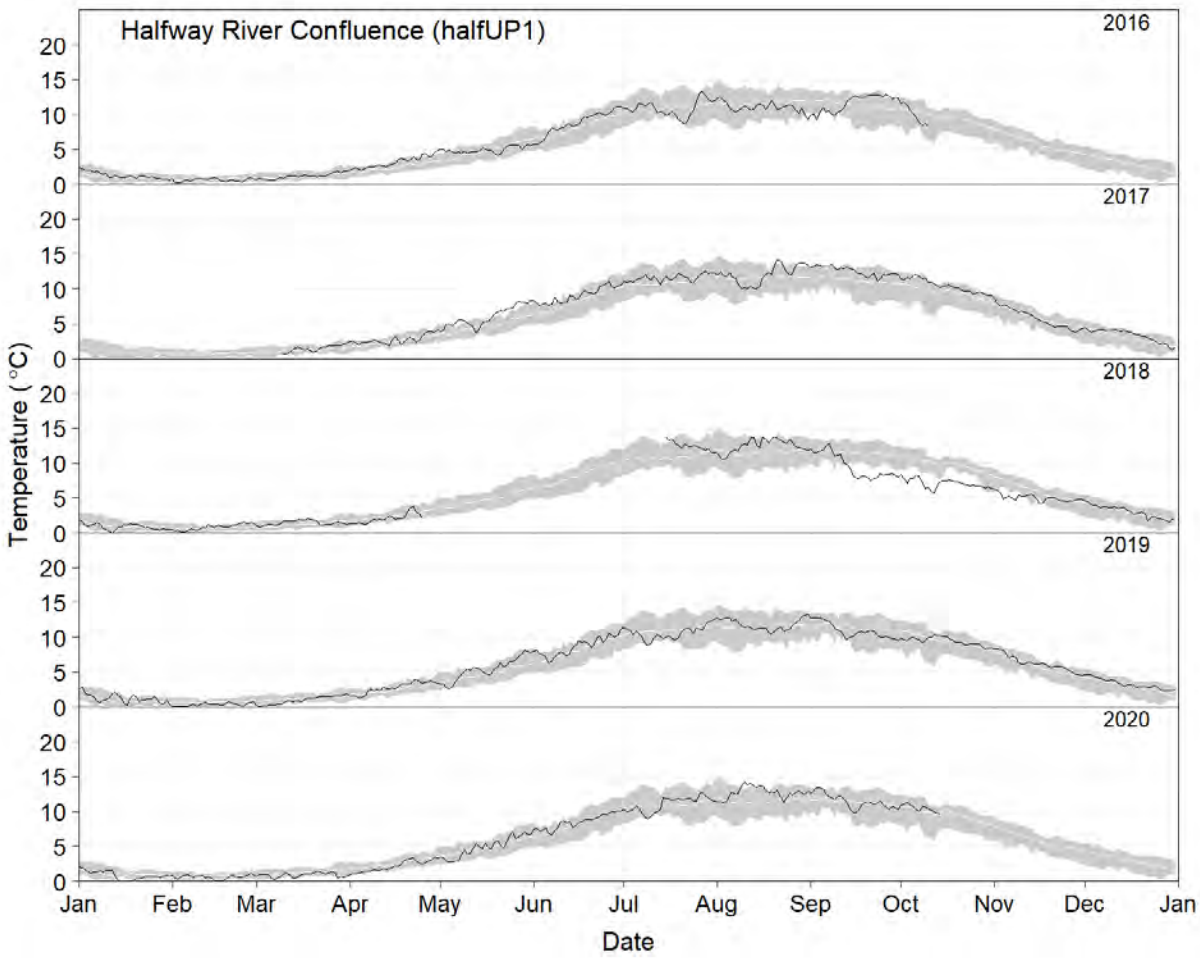
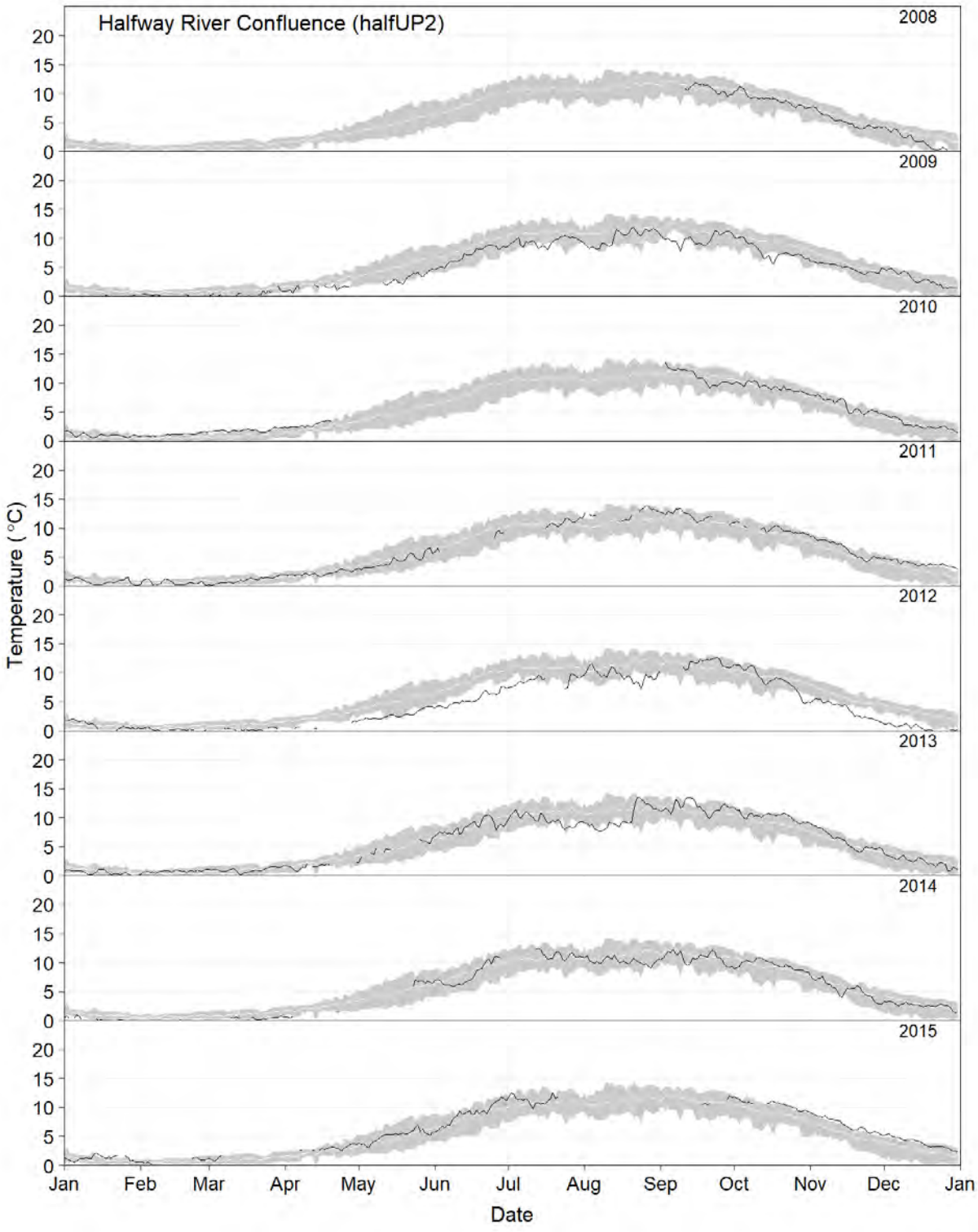


Figure B7 Mean daily water temperature (°C) for the right bank (as viewed facing downstream) of the Peace River upstream of the Halfway River's confluence with the Peace River (halfUP1; black line), 2008 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2008 and 2020. The white line represents average mean daily water temperatures over the same period.


Halfway River Confluence (halfUP2)
2008
2009
2010
2011
2012
2013
2014
2015
Temperature (°C)
0
5
10
15
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Date

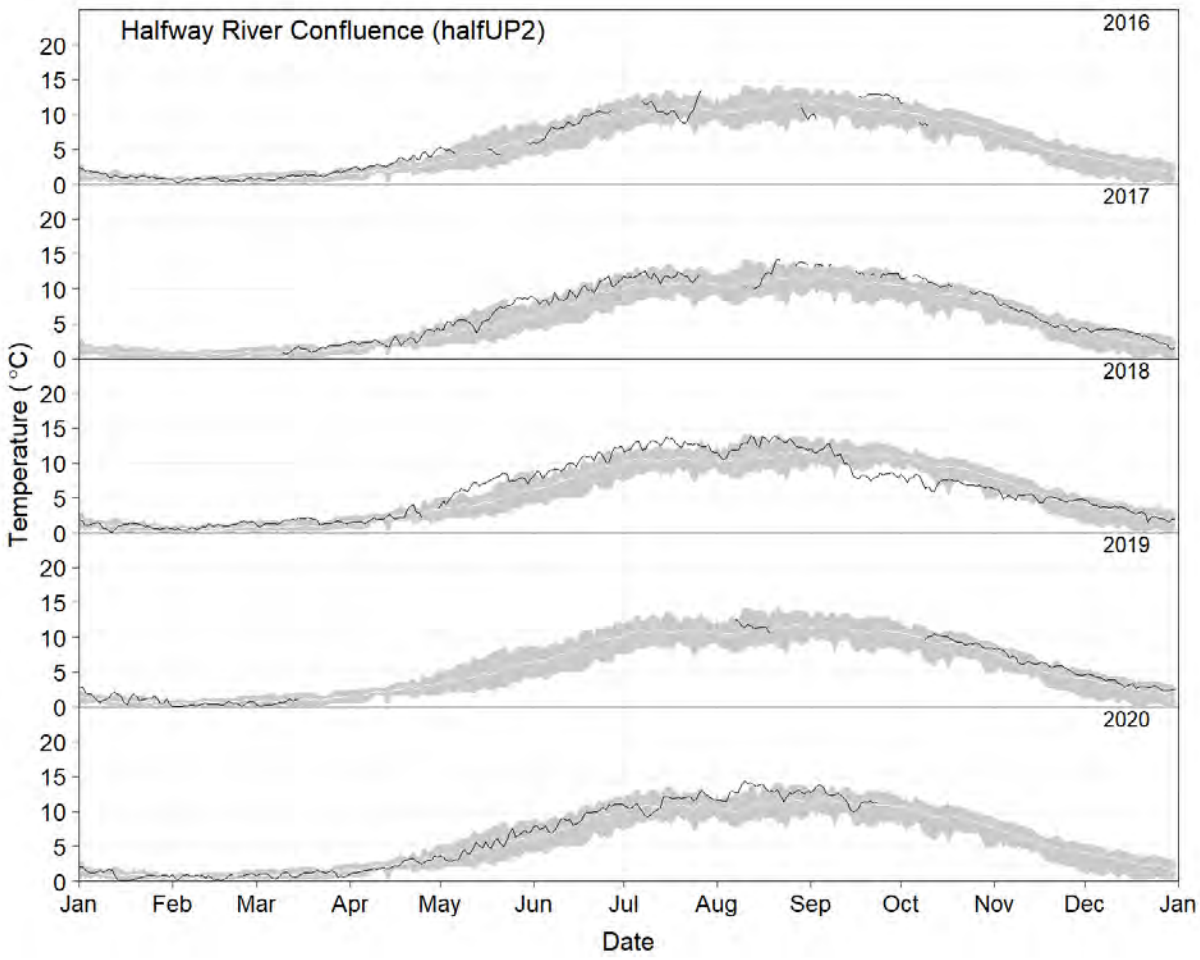
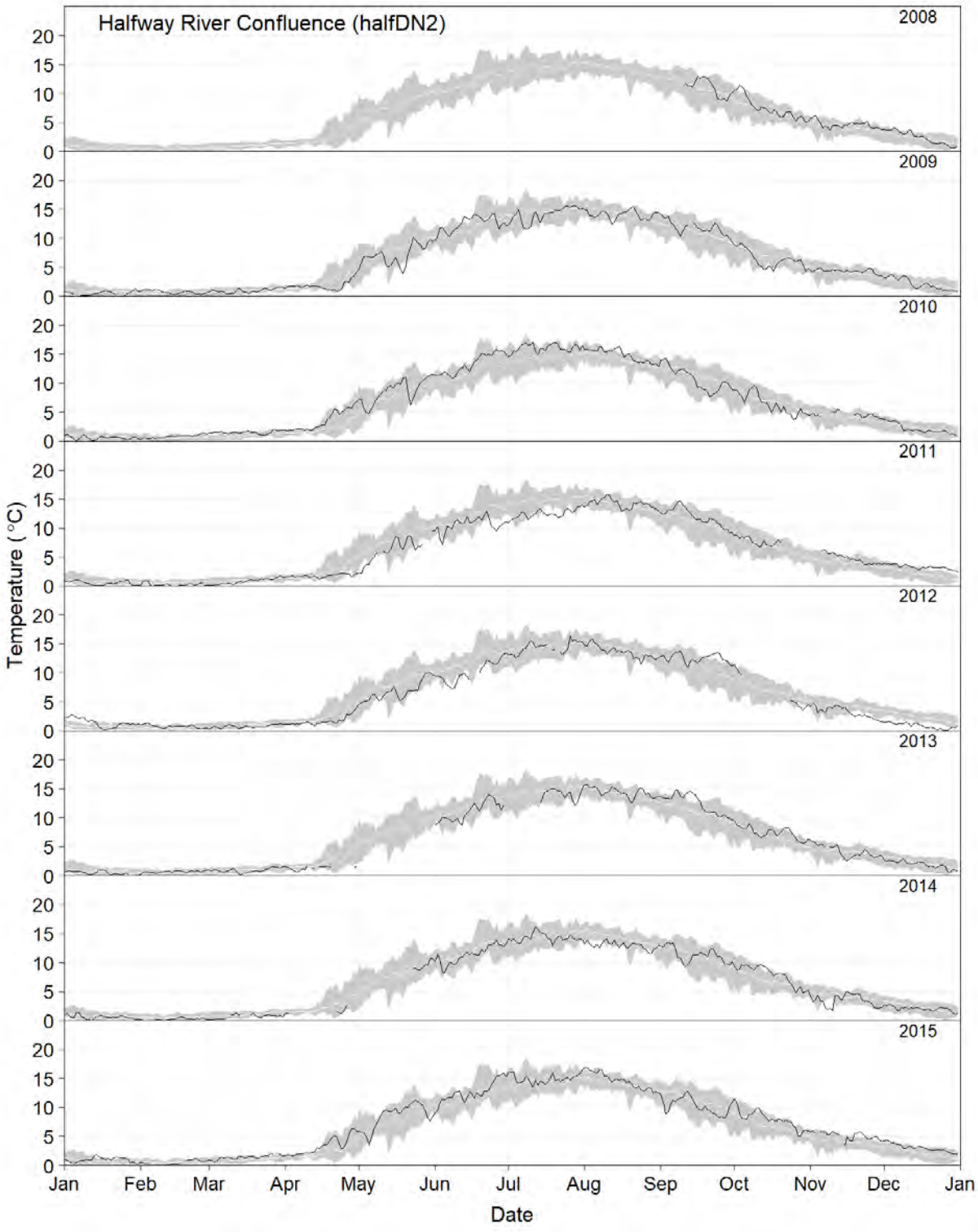


Figure B8 Mean daily water temperature (°C) for the left bank (as viewed facing downstream) of the Peace River upstream of the Halfway River's confluence with the Peace River (halfUP2; black line), 2008 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2008 and 2020. The white line represents average mean daily water temperatures over the same period.


Halfway River Confluence (halfDN2)
2008
2009
2010
2011
2012
2013
2014
2015
Temperature (°C)
0
5
10
15
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Date

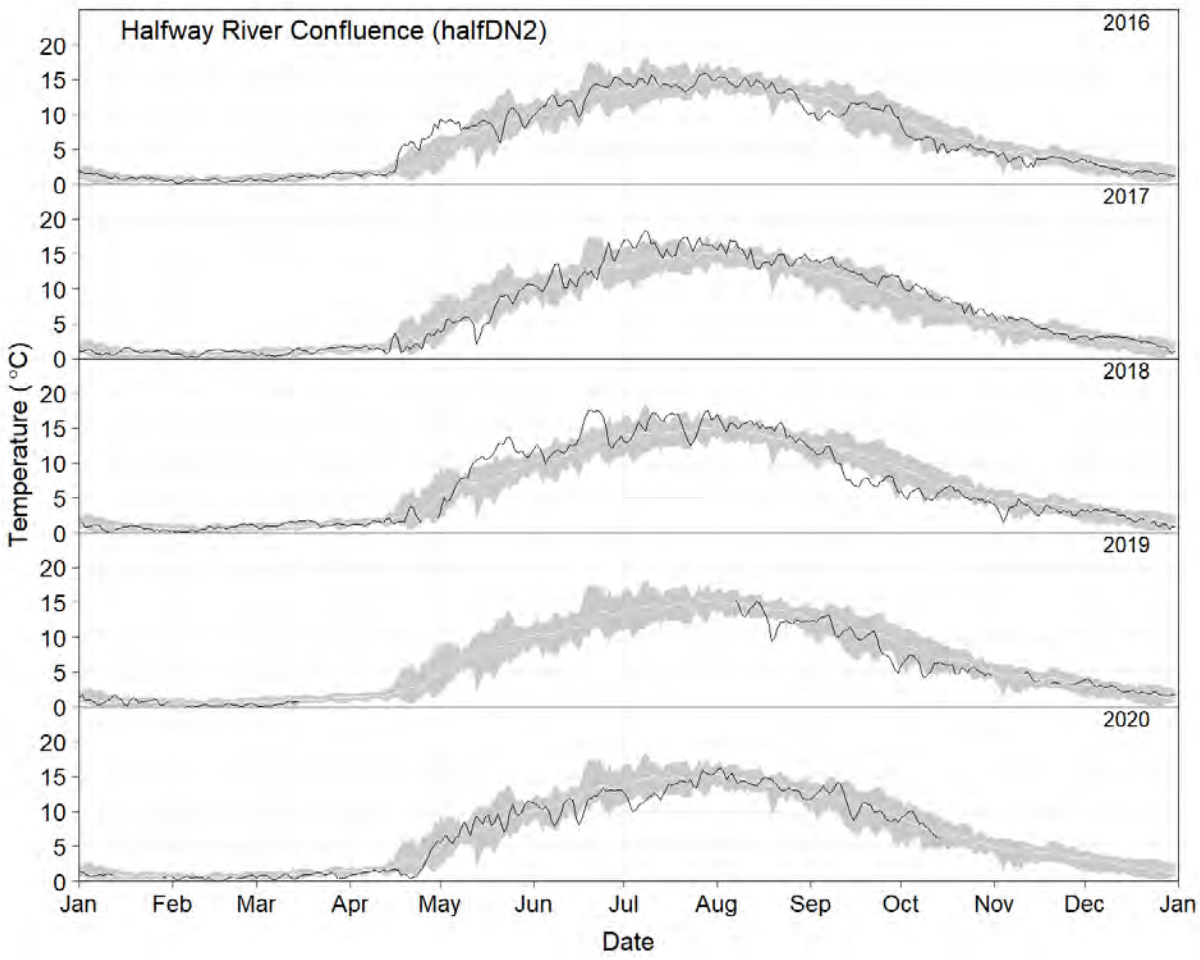
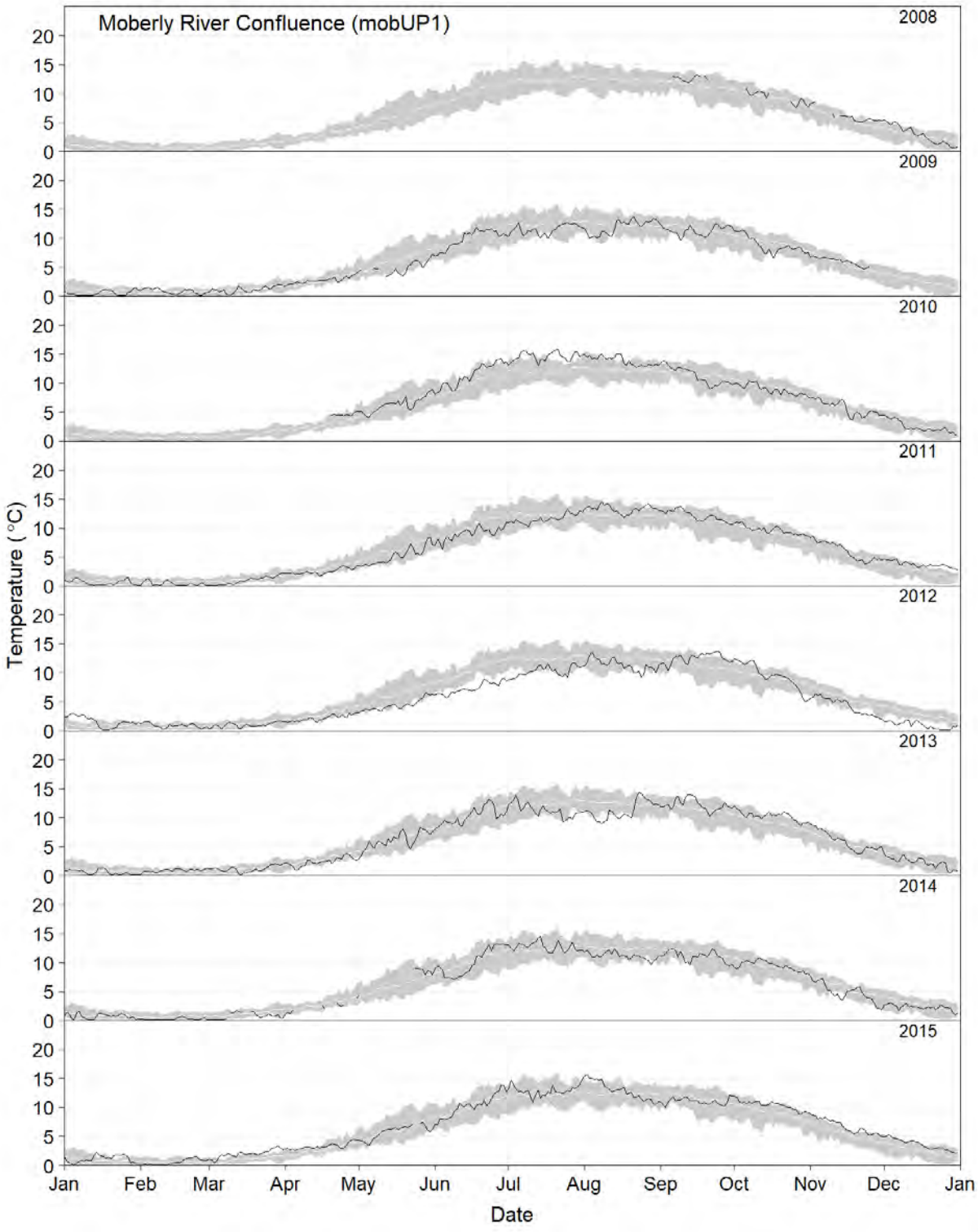


Figure B9 Mean daily water temperature (°C) for the left bank (as viewed facing downstream) of the Peace River downstream of the Halfway River's confluence with the Peace River (halfDN2; black line), 2008 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2008 and 2020. The white line represents average mean daily water temperatures over the same period.


Moberly River Confluence (mobUP1)
2008
2009
2010
2011
2012
2013
2014
2015
Temperature (°C)
0
5
10
15
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Date

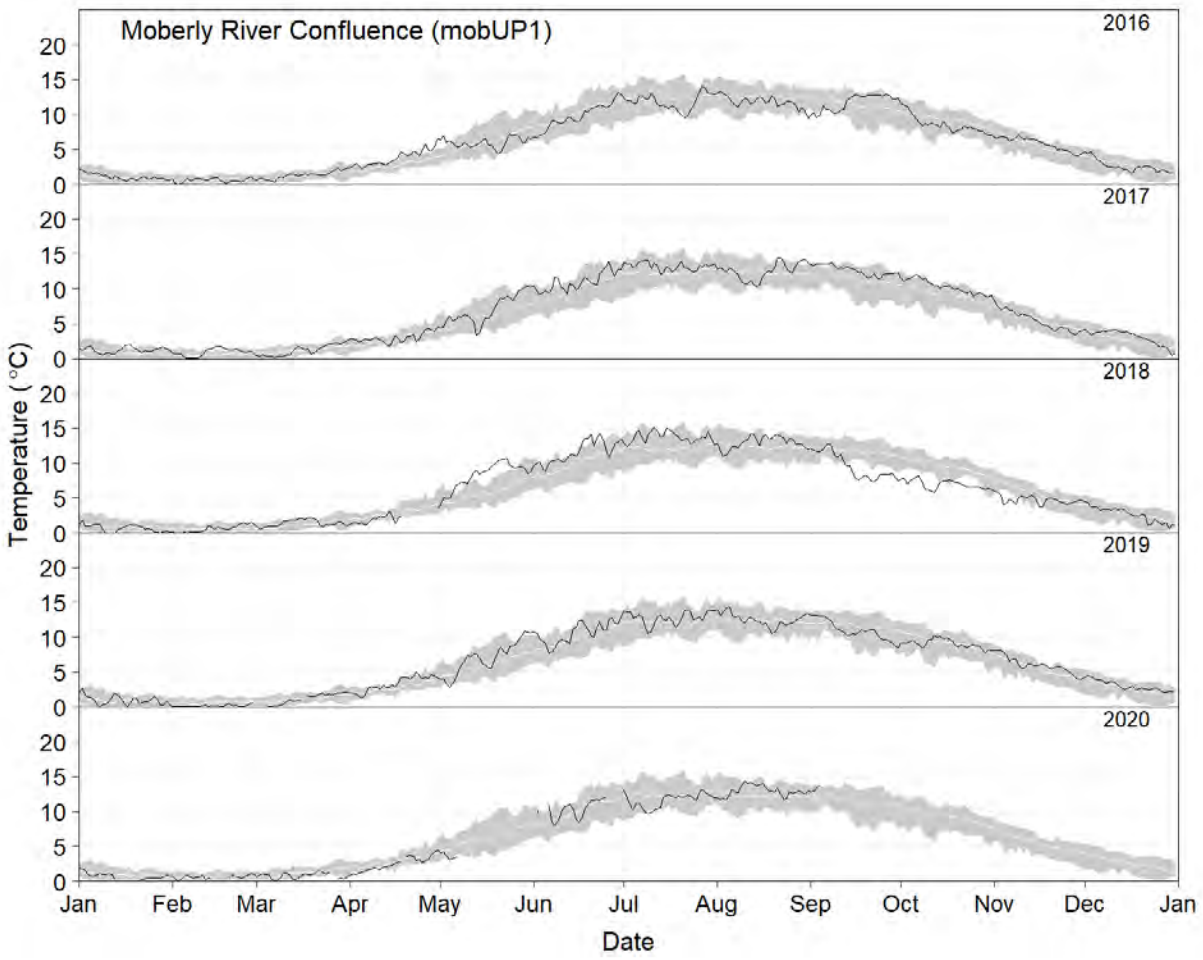
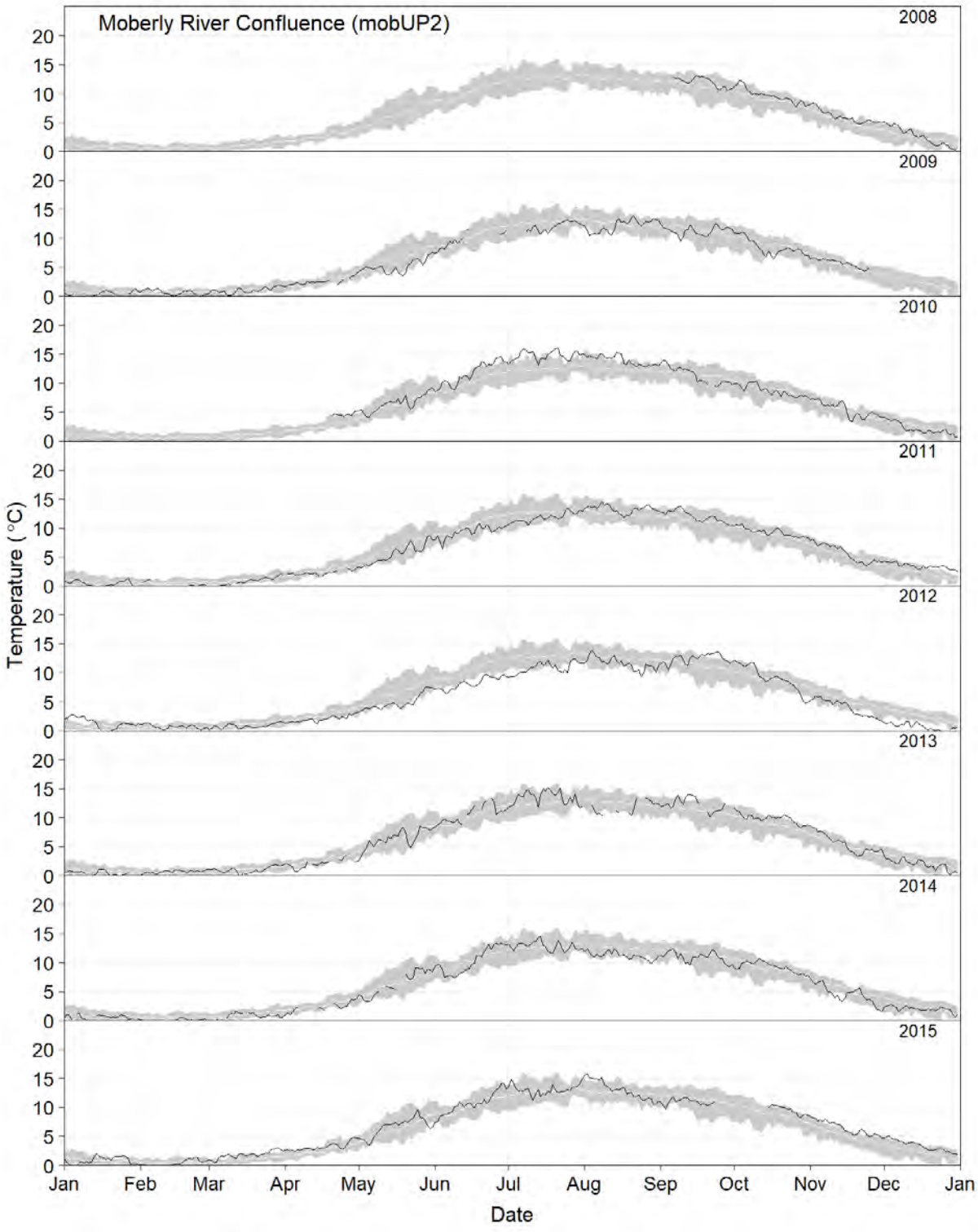


Figure B10 Mean daily water temperature (°C) for the right bank (as viewed facing downstream) of the Peace River upstream of the Moberly River's confluence with the Peace River (mobUP1; black line), 2008 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2008 and 2020. The white line represents average mean daily water temperatures over the same period.


Moberly River Confluence (mobUP2)
2008
2009
2010
2011
2012
2013
2014
2015
Temperature (°C)
0
5
10
15
20
Jan
Feb
Mar
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May
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Jul
Aug
Sep
Oct
Nov
Dec
Jan
Date

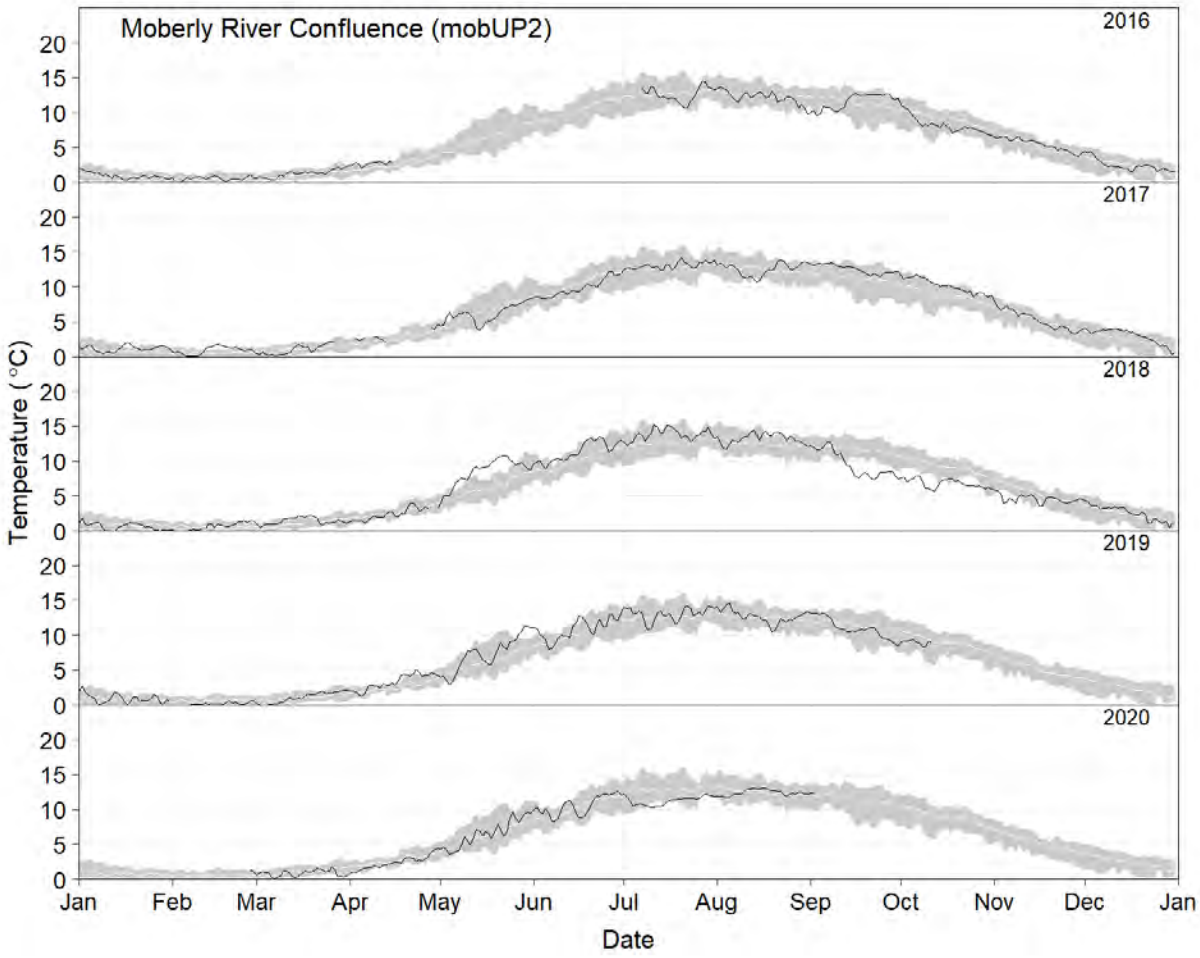
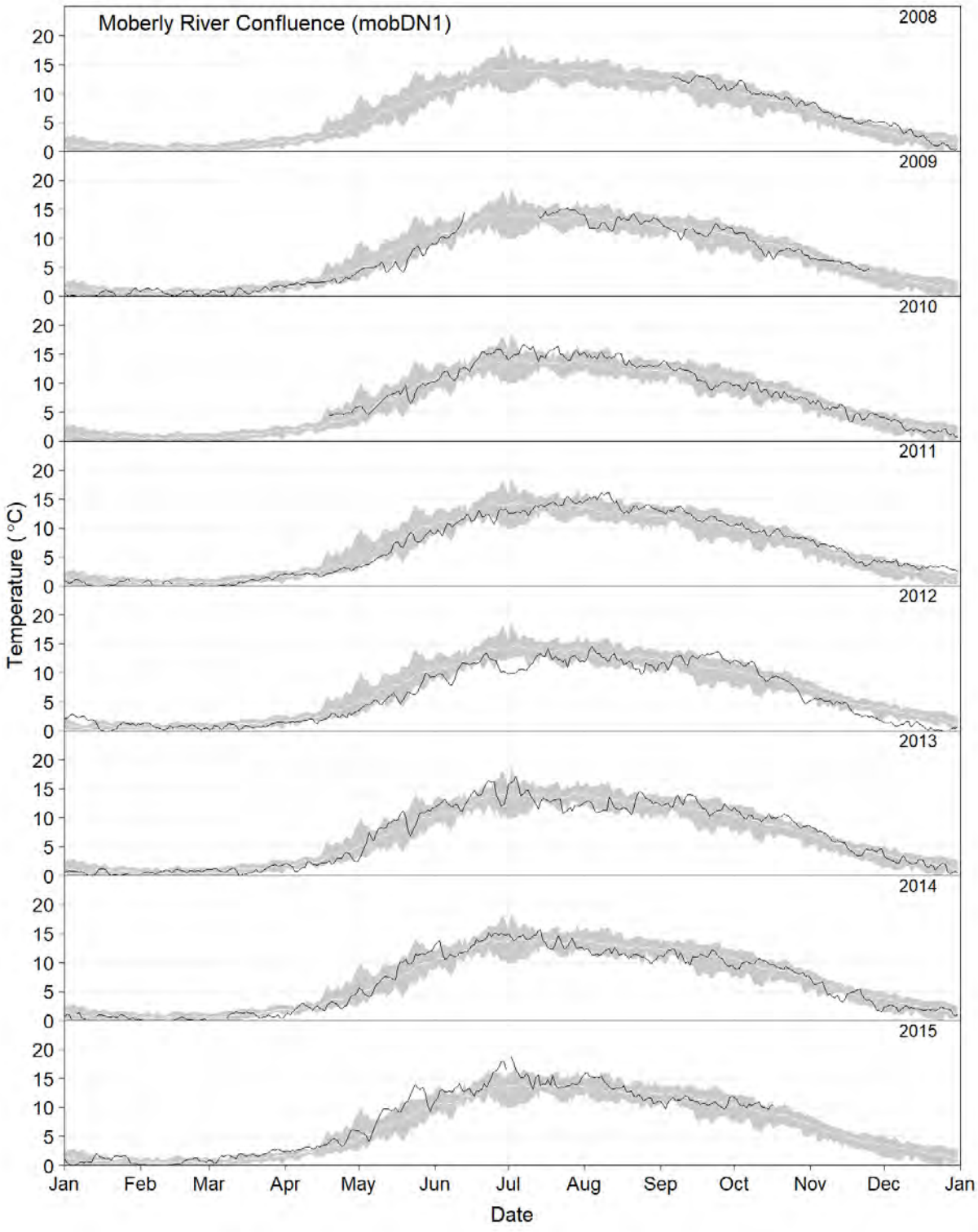


Figure B11 Mean daily water temperature (°C) for the left bank (as viewed facing downstream) of the Peace River upstream of the Moberly River's confluence with the Peace River (mobUP2; black line), 2008 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2008 and 2020. The white line represents average mean daily water temperatures over the same period.


Moberly River Confluence (mobDN1)
2008
2009
2010
2011
2012
2013
2014
2015
Temperature (°C)
0
5
10
15
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Date

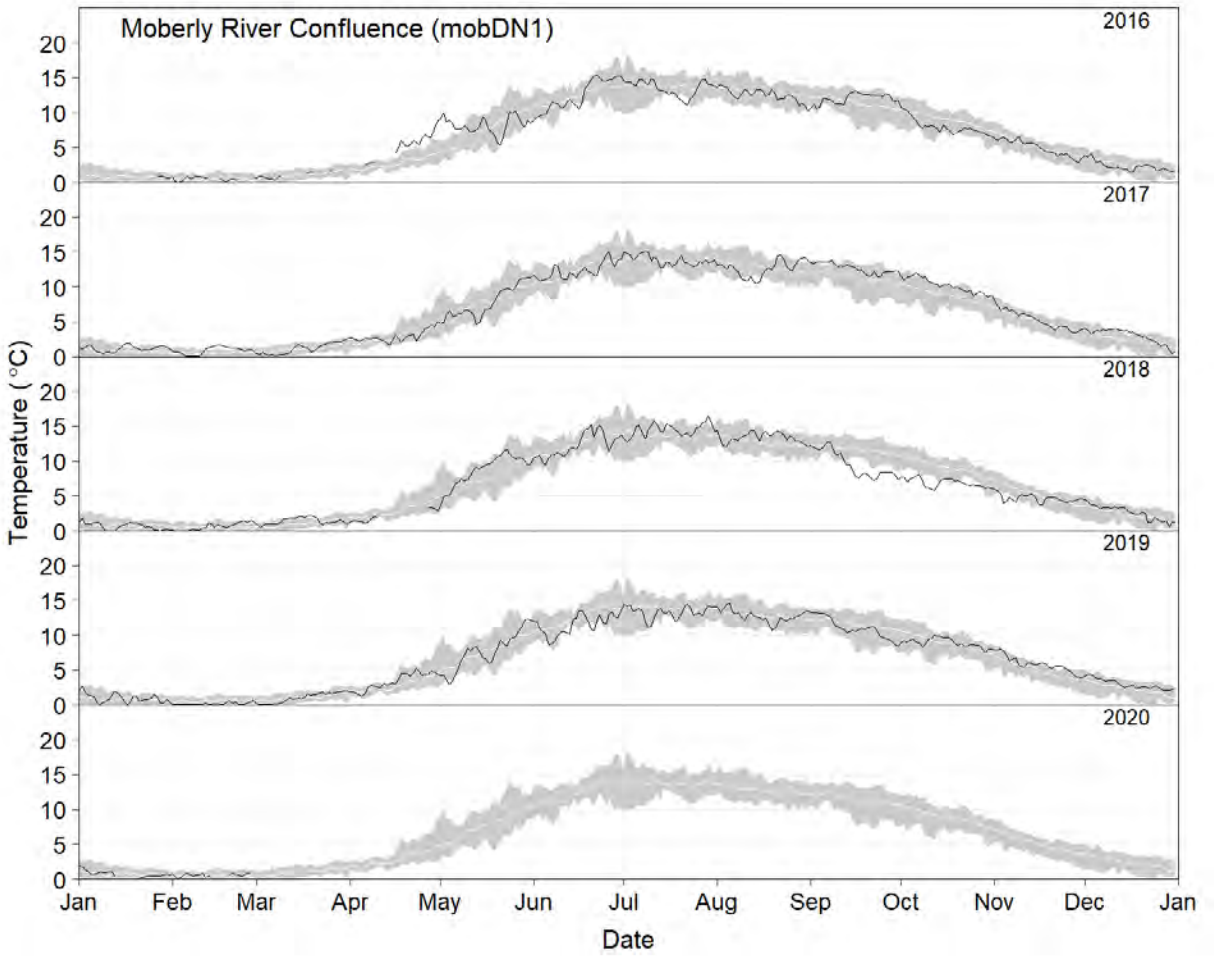
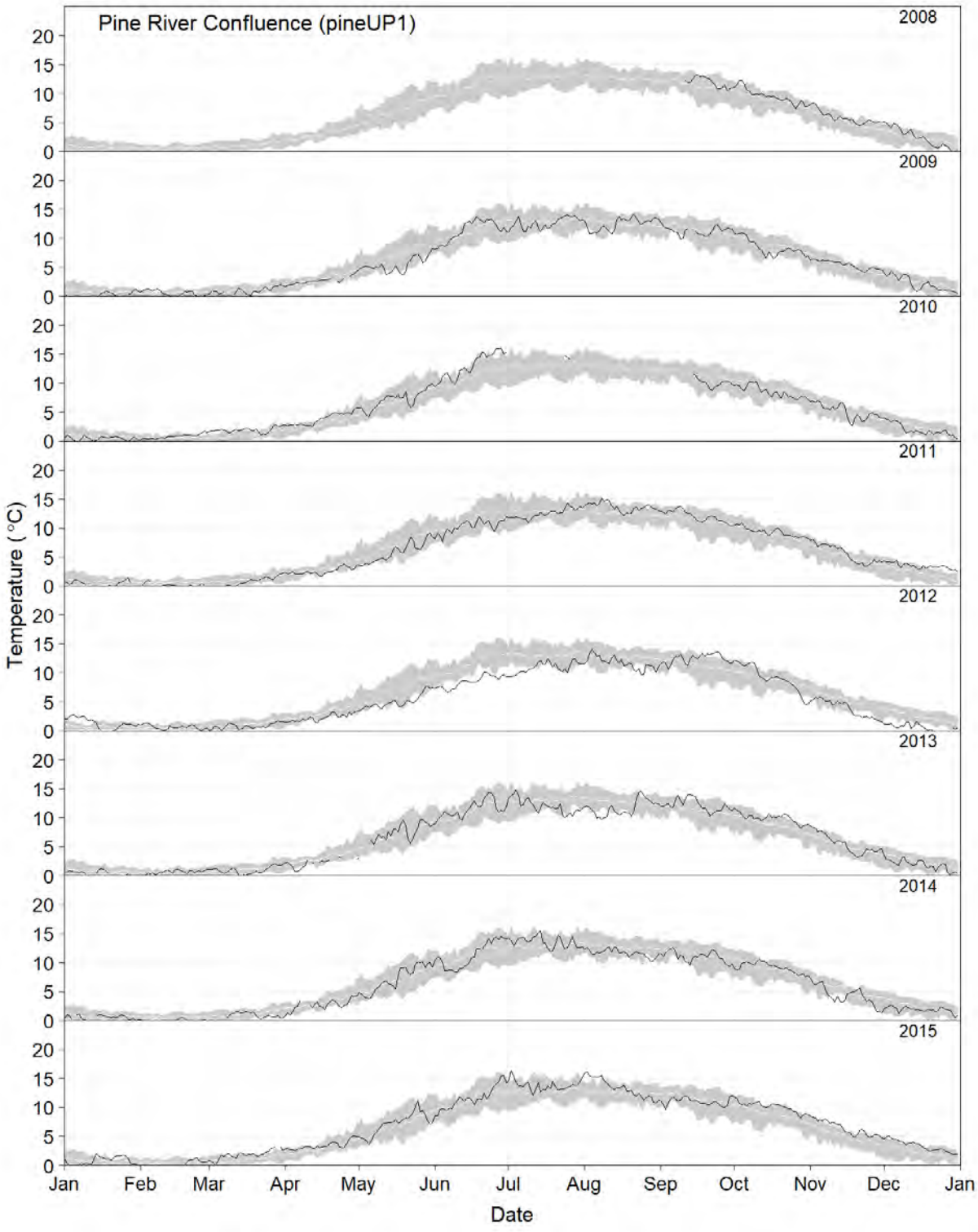


Figure B12 Mean daily water temperature (°C) for the right bank (as viewed facing downstream) of the Peace River downstream of the Moberly River's confluence with the Peace River (mobDN1; black line), 2008 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2008 and 2020. The white line represents average mean daily water temperatures over the same period.


Pine River Confluence (pineUP1)
2008
2009
2010
2011
2012
2013
2014
2015
Temperature (°C)
0
5
10
15
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Date

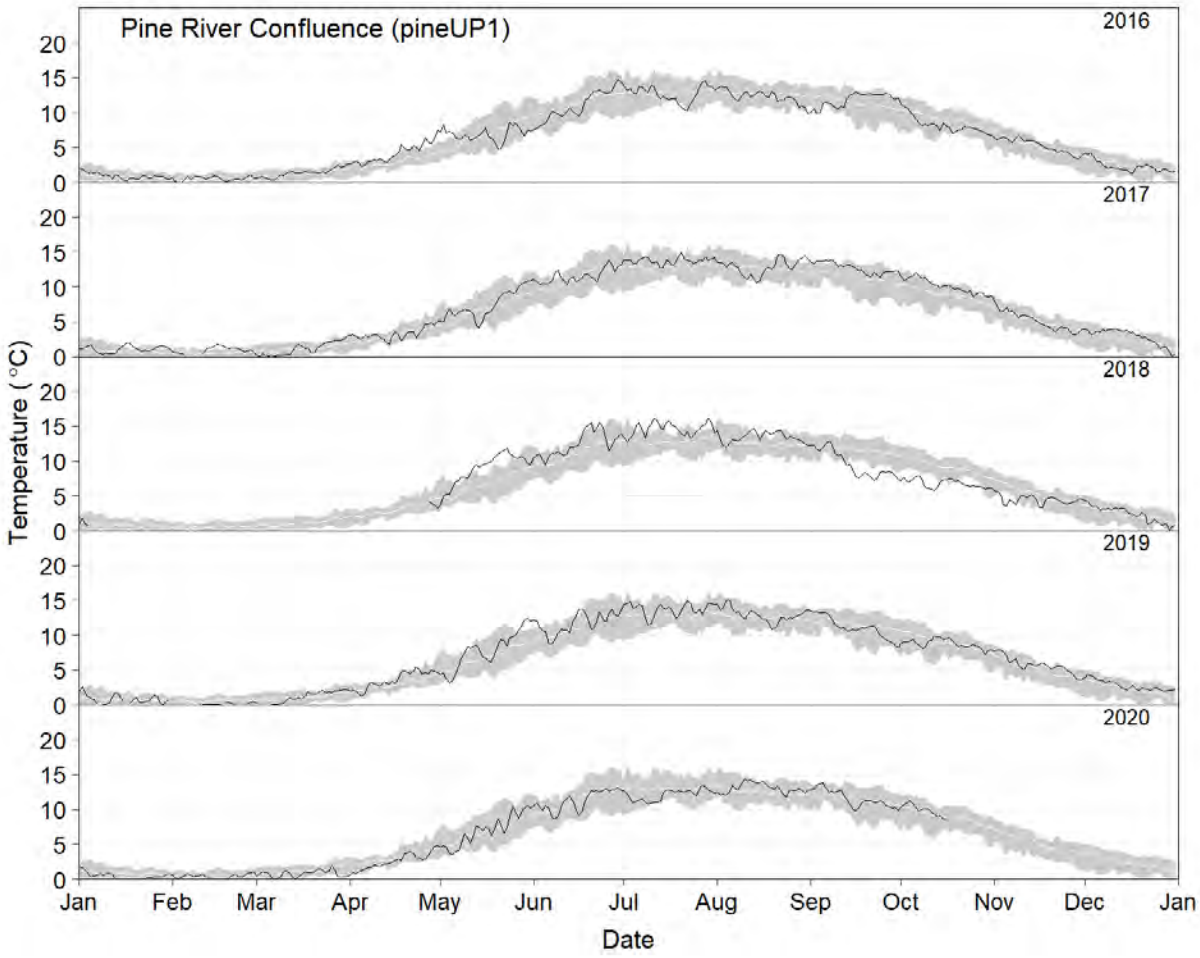
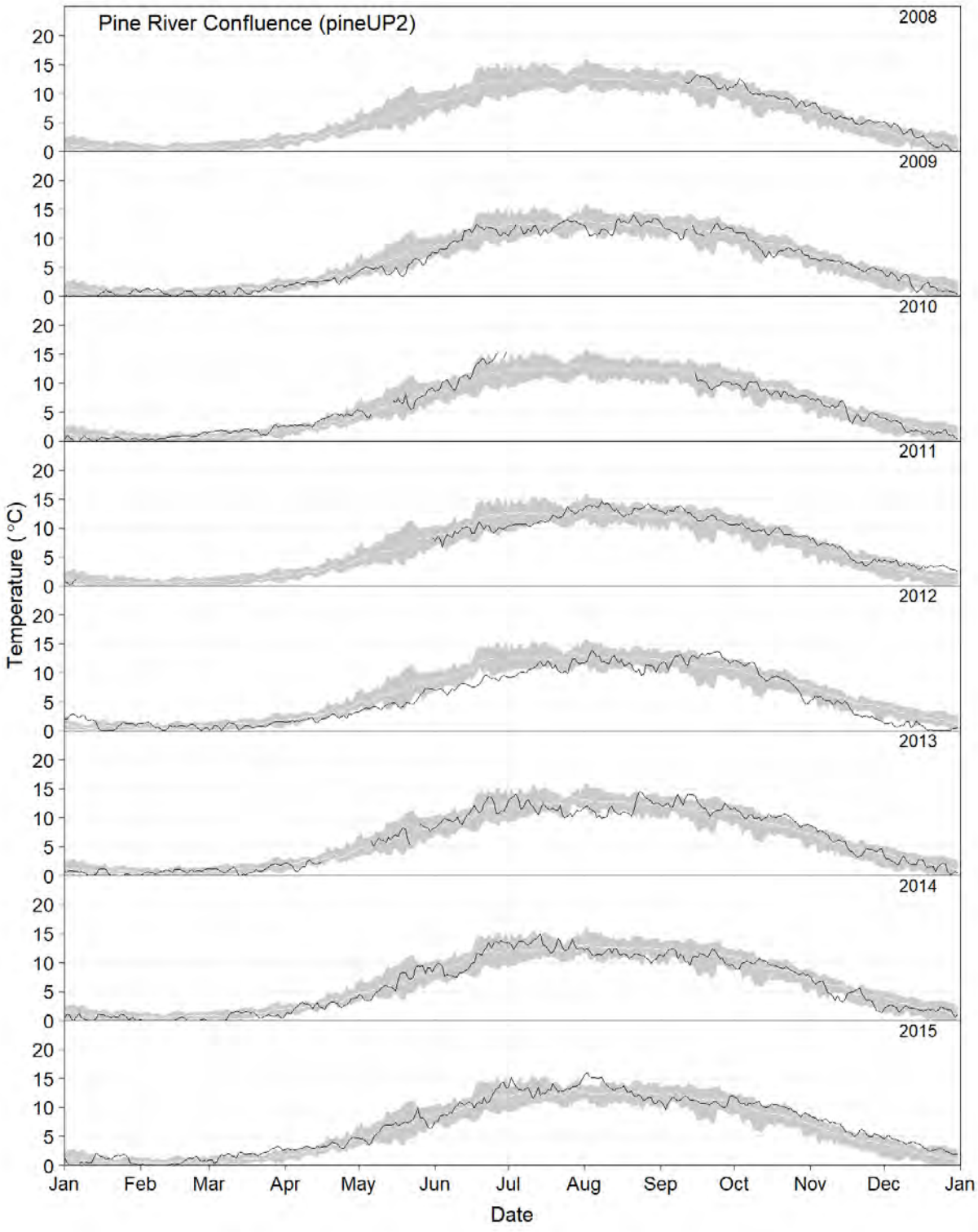


Figure B13 Mean daily water temperature (°C) for the right bank (as viewed facing downstream) of the Peace River upstream of the Pine River's confluence with the Peace River (pineUP1; black line), 2008 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2008 and 2020. The white line represents average mean daily water temperatures over the same period.


Pine River Confluence (pineUP2)
2008
2009
2010
2011
2012
2013
2014
2015
Temperature (°C)
0
5
10
15
20
Jan
Feb
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May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Date

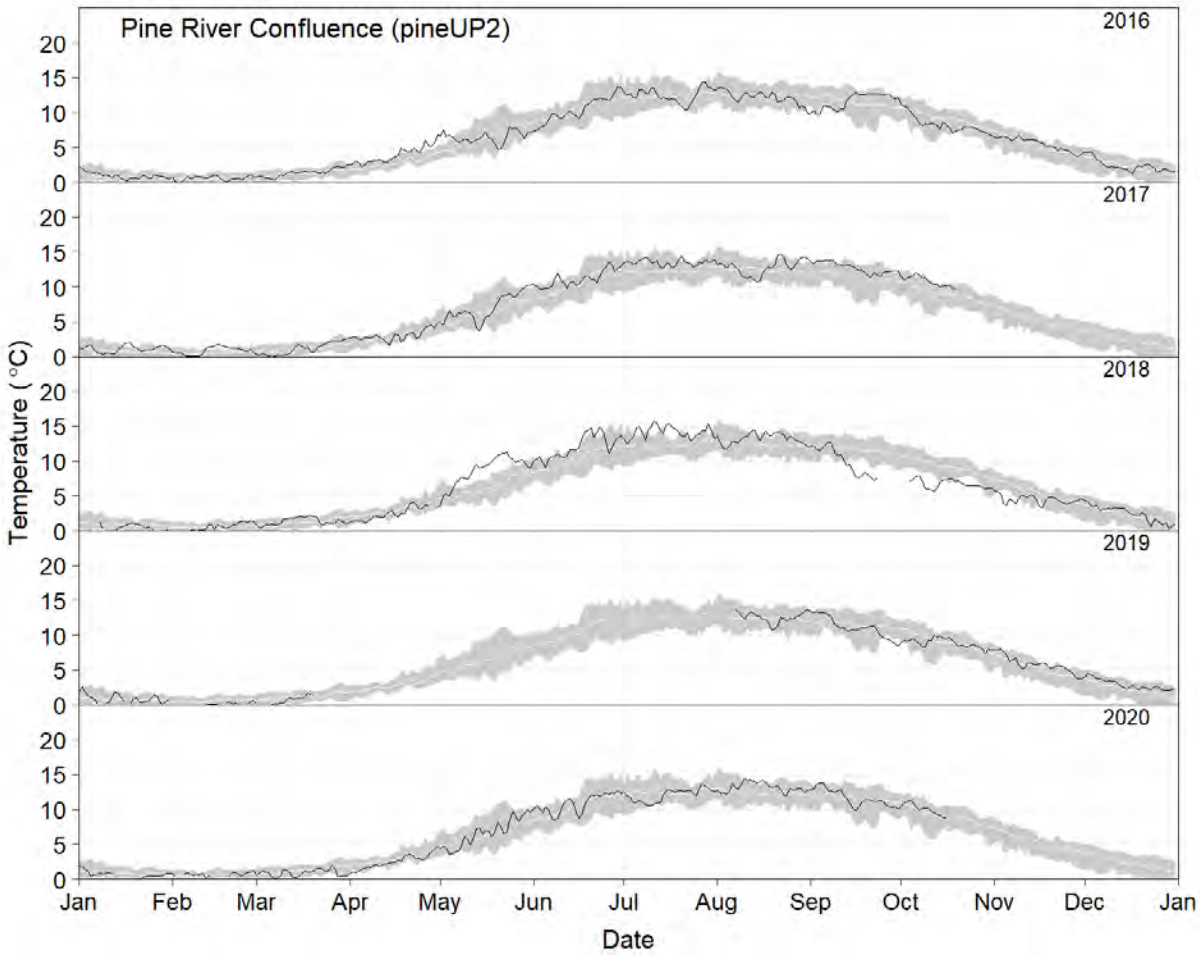
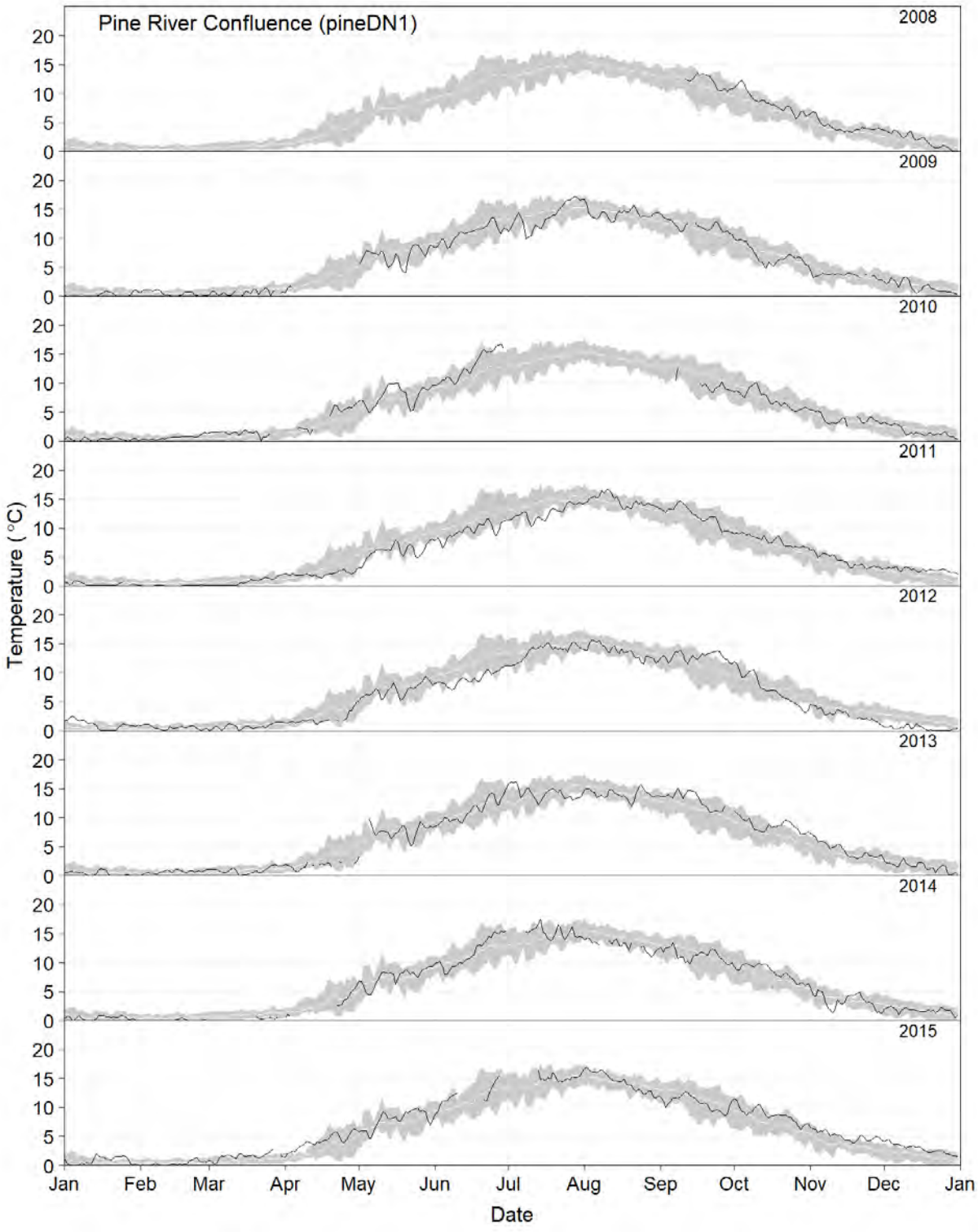


Figure B14 Mean daily water temperature (°C) for the left bank (as viewed facing downstream) of the Peace River upstream of the Pine River's confluence with the Peace River (pineUP2; black line), 2008 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2015 and 2020. The white line represents average mean daily water temperatures over the same period.


Pine River Confluence (pineDN1)
2008
2009
2010
2011
2012
2013
2014
2015
Temperature (°C)
0
5
10
15
20
Jan
Feb
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Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Date

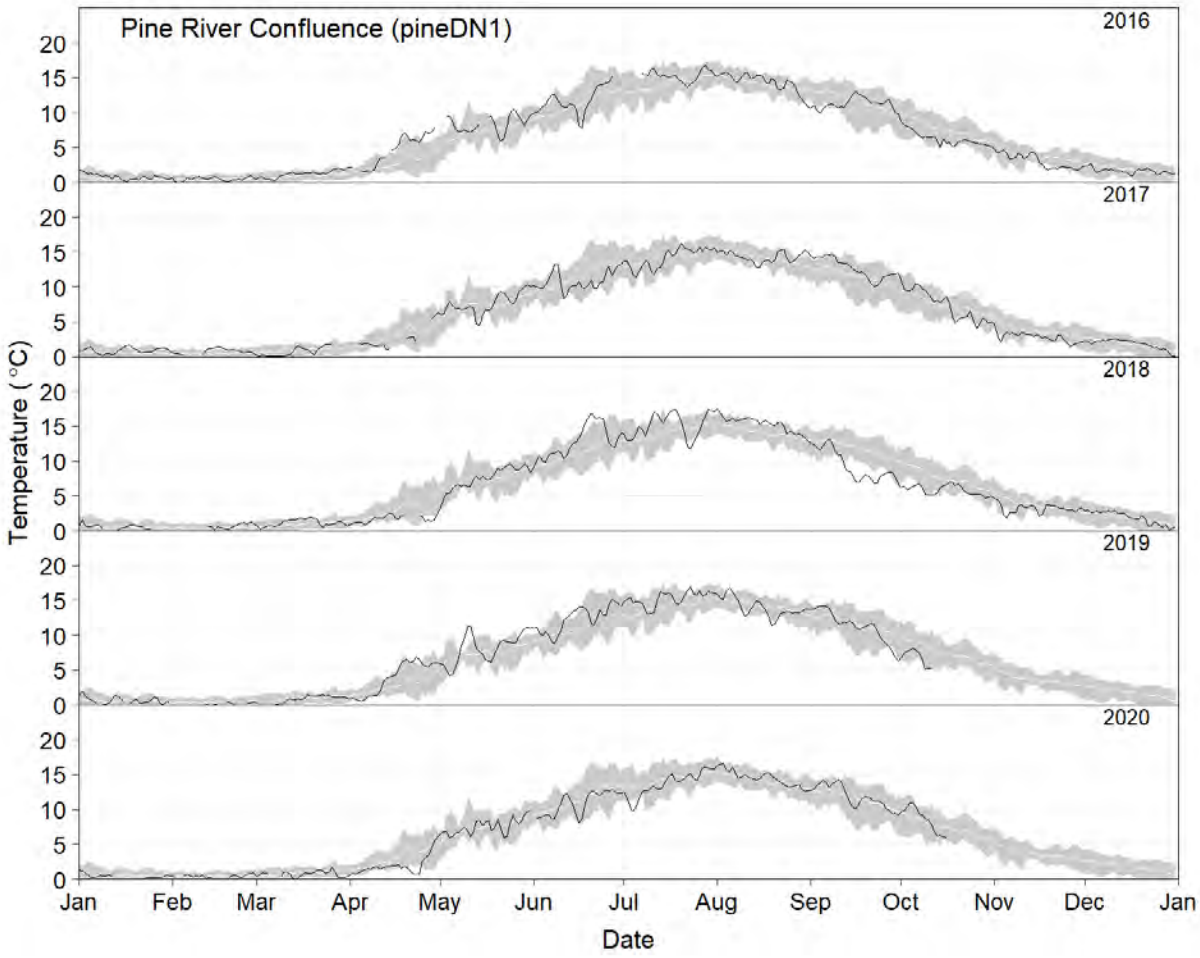

Figure B15 Mean daily water temperature (°C) for the right bank (as viewed facing downstream) of the Peace River downstream of the Pine River's confluence with the Peace River (pineDN1; black line), 2008 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2015 and 2020. The white line represents average mean daily water temperatures over the same period.

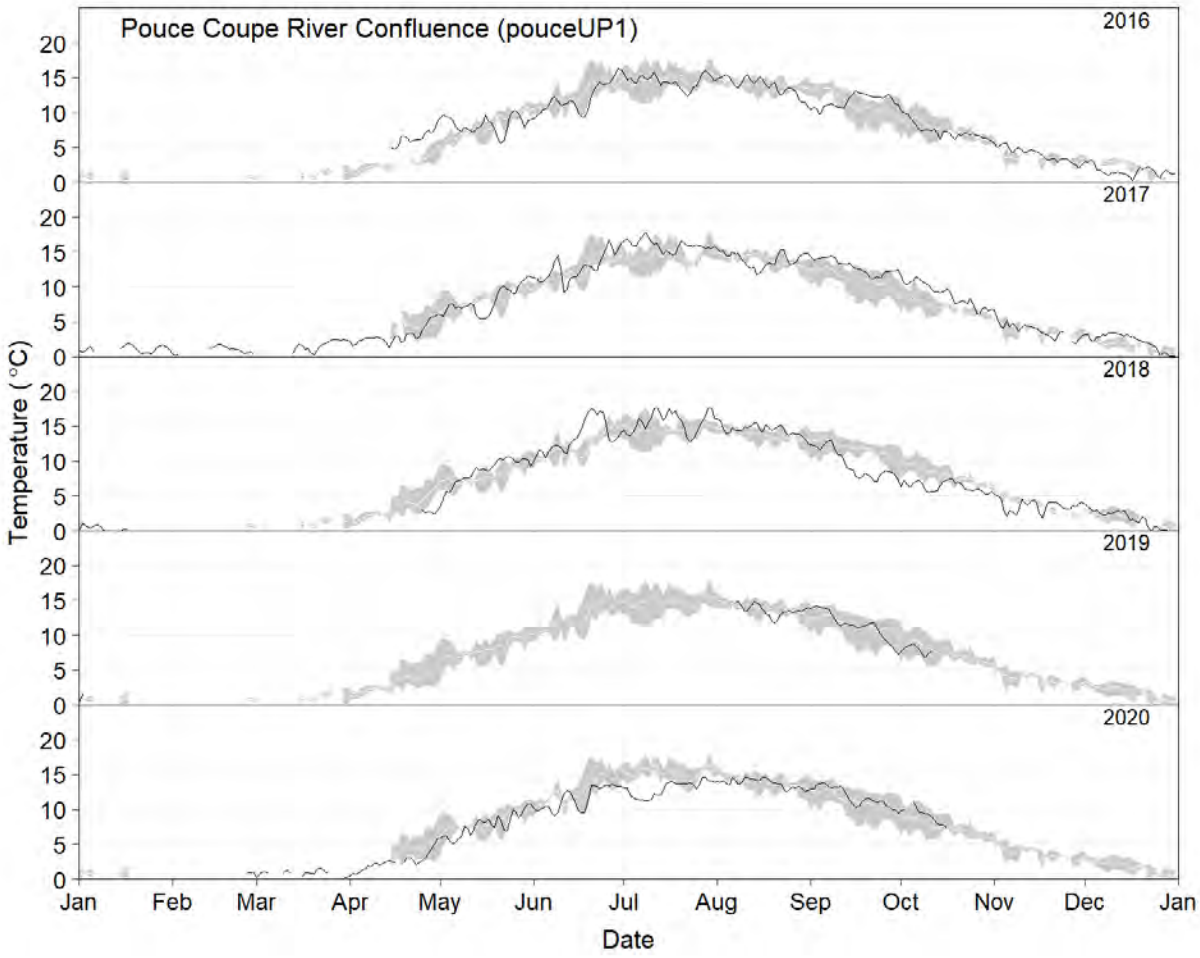

Figure B16 Mean daily water temperature (°C) for the right bank (as viewed facing downstream) of the Peace River upstream of the Pouce Coupe River's confluence with the Peace River (pouceUP1; black line), 2016 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2016 and 2020. The white line represents average mean daily water temperatures over the same period.

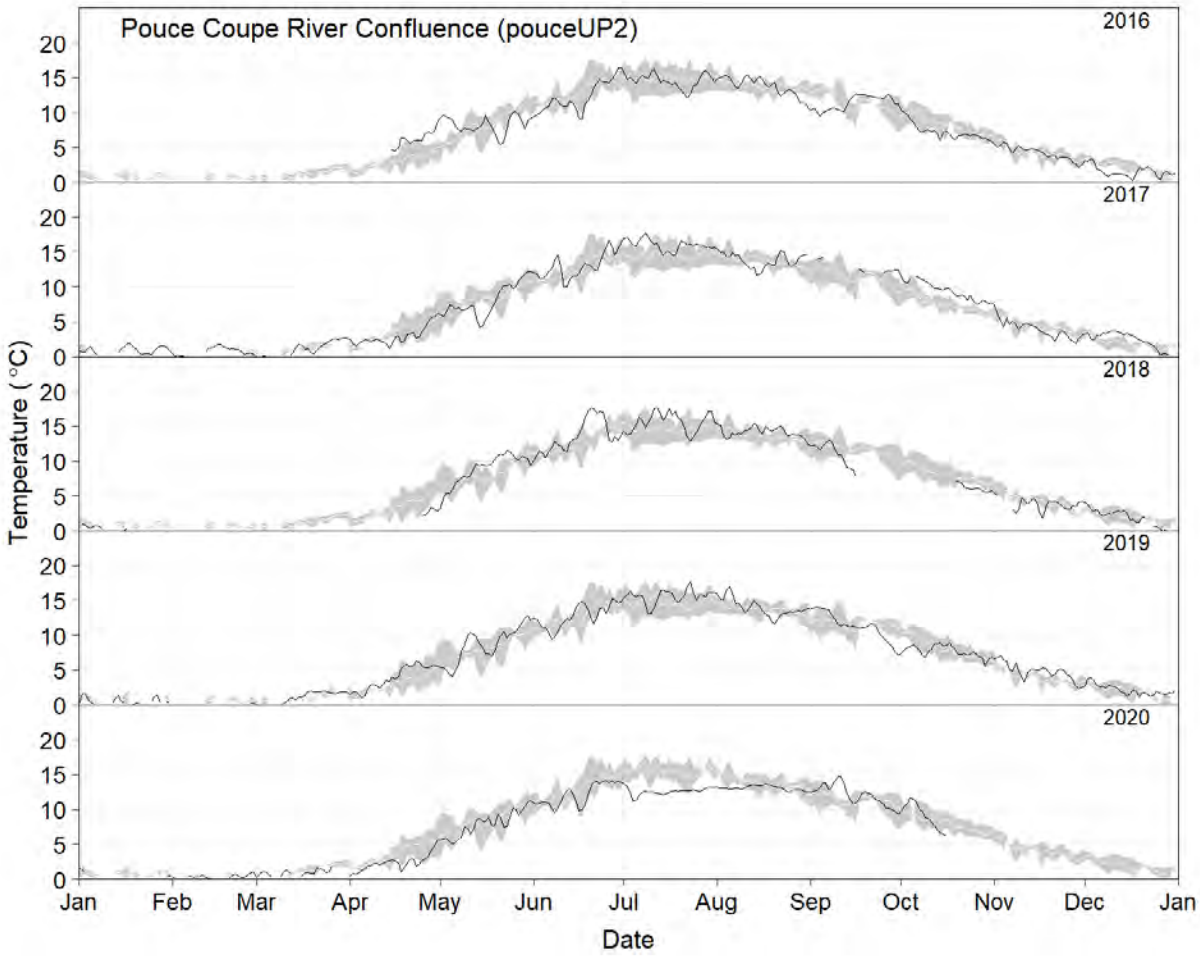

Figure B17 Mean daily water temperature (°C) for the left bank (as viewed facing downstream) of the Peace River upstream of the Pouce Coupe River's confluence with the Peace River (pouceUP2; black line), 2016 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2016 and 2020. The white line represents average mean daily water temperatures over the same period.

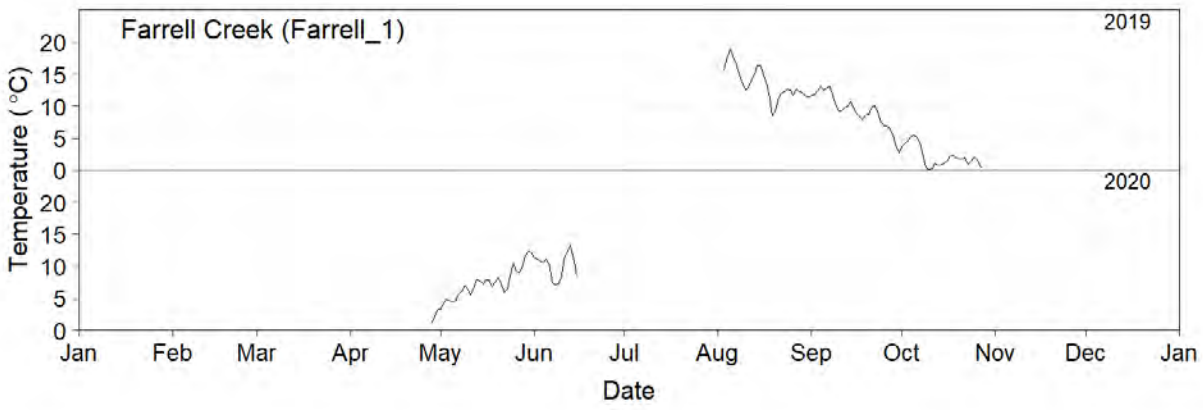

Figure B18 Mean daily water temperature (°C) for Farrell Creek (Farrell_1), 2019 to 2020.

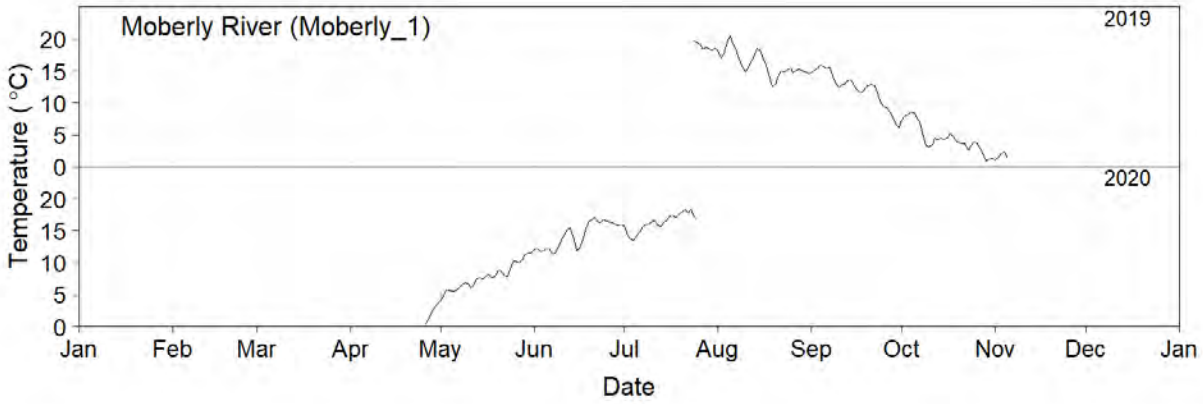

Figure B19 Mean daily water temperature (°C) for the Moberly River (Moberly_1), 2019 to 2020.

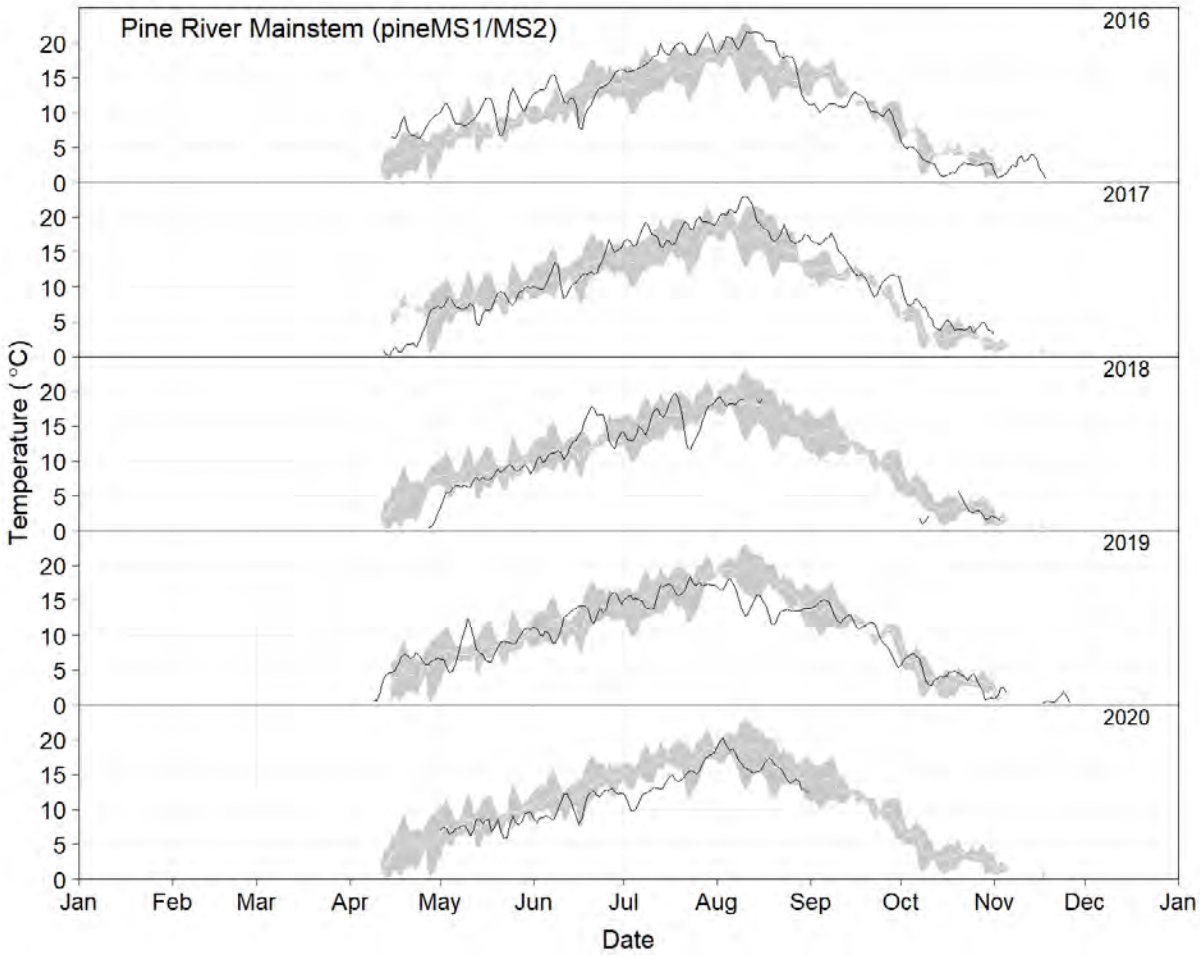

Figure B20 Mean daily water temperature (°C) for the Pine River (PineMS1 and PineMS2 combined; black line), 2016 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2016 and 2020. The white line represents average mean daily water temperatures over the same period.

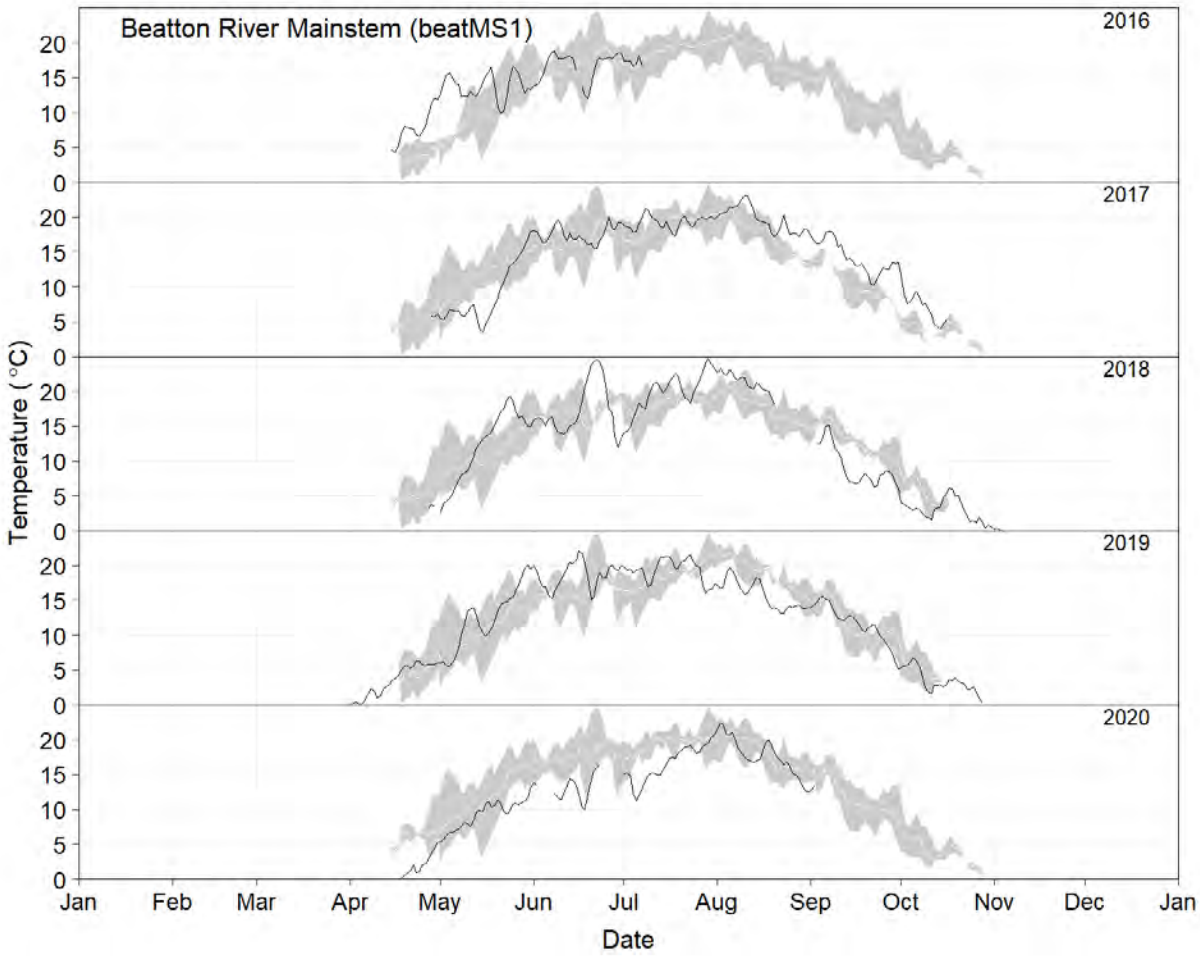

Figure B21 Mean daily water temperature (°C) for the Beatton River (beatMS1; black line), 2016 to 2020. The shaded area represents minimum and maximum water temperatures recorded at the station during other study years between 2016 and 2020. The white line represents average mean daily water temperatures over the same period.

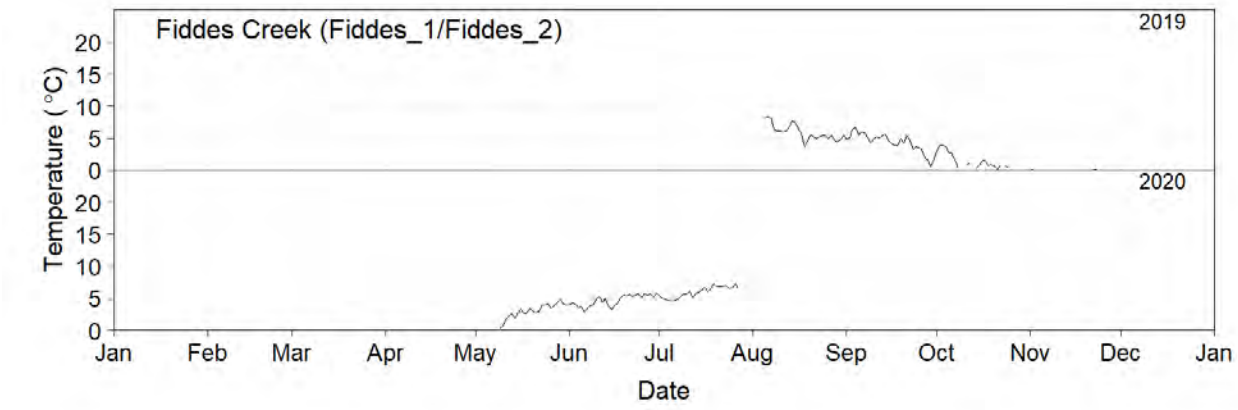

Figure B22 Mean daily water temperature (°C) for Fiddes Creek (Fiddes_1 and Fiddes_2 combined), 2019 to 2020.

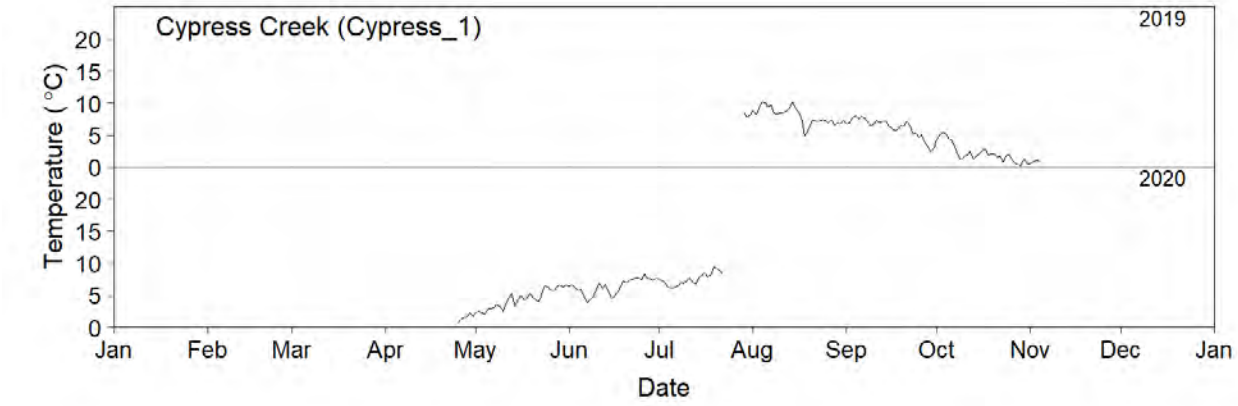

Figure B23 Mean daily water temperature (°C) for Cypress Creek (Cypress_1), 2019 to 2020.

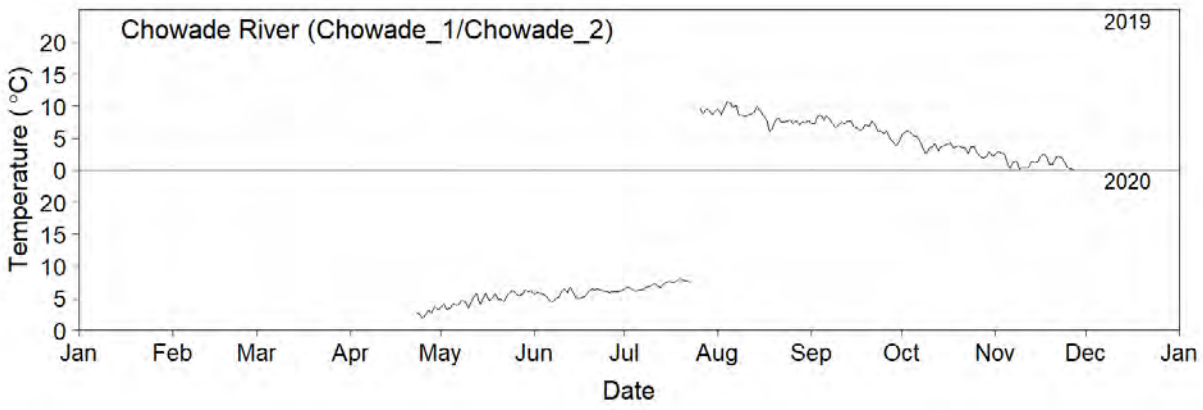

Figure B24 Mean daily water temperature (°C) for the Chowade River (Chowade_1 and Chowade_2 combined), 2019 to 2020.

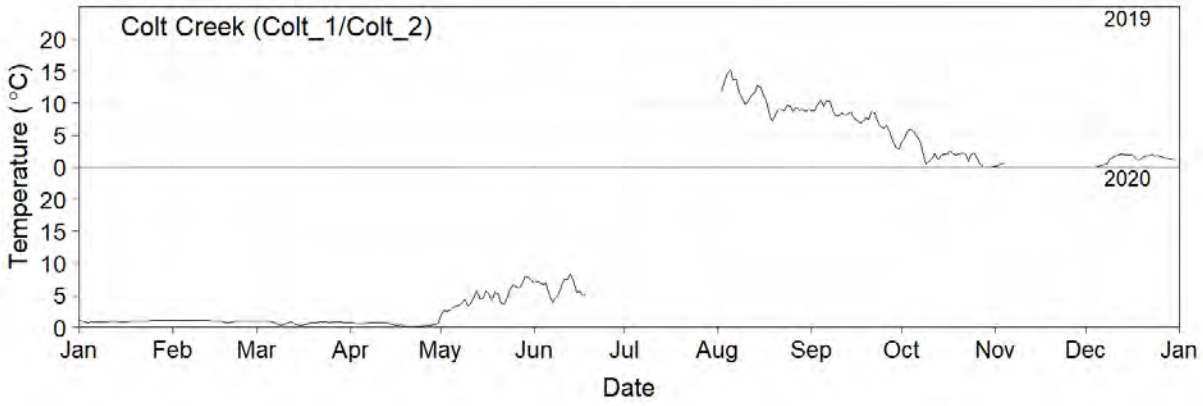

Figure B25 Mean daily water temperature (°C) for Colt Creek (Colt_1 and Colt_2 combined), 2019 to 2020.

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