

Water Temperature Monitoring Report

Sacramento Municipal Utility District

Hydro License Implementation • June 2017
Upper American River Project
FERC Project No. 2101

TABLE OF CONTENTS

1.0 TEMPERATURE PLAN REVIEW	4
1.1 Background.....	4
1.2 Monitoring Objectives.....	4
1.3 Study area and Sampling Locations.....	7
2.0 MODIFICATIONS AND METHODS.....	7
2.1 Temperature recording at fixed-stations.....	7
2.2 Temperature recording at datalogger stations.....	7
2.3 QA/QC.....	8
2.4 Problems Encountered.....	8
2.5 Adaptive Management	9
3.0 ANALYSIS AND RESULTS	10
4.0 LITERATURE CITED.....	10

LIST OF TABLES

Table 1 - UARP Water Temperature Monitoring Site Locations and Parameters.....	5
Table 2 – Specifications for the various monitoring equipment	6
Table 3 – Crossed Thresholds	9

LIST OF PHOTOS

Photo 1 – Typical install for the ONSET HOBO water temperature sensors.	8
Photo 2 – Recovered datalogger: South Fork American River at Mosquito Road Bridge (SFAR7).	9

LIST OF FIGURES

Figure 1 – Little Rubicon River Immediately below Ruicon Reservoir Dam (RR5)	11
Figure 2 – Little Rubicon River Immediately below Buck Island Reservoir Dam (LRR3)	12
Figure 3 – Gerle Creek Immediately below Loon Lake Reservoir Dam (GC7)	13
Figure 4 – Gerle Creek immediately below Gerle Creek Reservoir Dam (GC8)	14
Figure 5 – Gerle Creek Immediately below Gerle Creek Reservoir Dam (GC8)	15
Figure 6 – South Fork Silver Creek immediately below Ice House Reservoir Dam (SFSC7)	16

Figure 7 – South Fork Silver Creek immediately upstream of Junction Reservoir (SFSC8)	17
Figure 8 – Silver Creek immediately below Junction Reservoir Dam (SC5).....	18
Figure 9 – Silver Creek immediately above Camino Reservoir Dam (SC6)	19
Figure 10 – Silver Creek immediately below Camino Reservoir Dam (SC7).....	20
Figure 11 – Silver Creek immediately upstream of SF American River (SC8)	21
Figure 12 – Brush Creek immediately below Brush Creek Reservoir Dam (BC4).....	22
Figure 13 – SF American River immediately below Slab Creek Reservoir Dam (SFAR13)	23
Figure 14 – SF American River at Mosquito Rd Bridge (SFAR7).....	24
Figure 15 – SF American River approximately ½ mile upstream of White Rock Powerhouse (SFAR15)	24
Figure 16 – SF American River to record White Rock Powerhouse discharge temps (SFAR16)	25
Figure 17 - Location Map	27

1.0 TEMPERATURE PLAN REVIEW

1.1 BACKGROUND

This Water Temperature Monitoring Report addresses monitoring set forth in the Water Temperature Monitoring Plan (Plan) for the Upper American River Project (SMUD 2015). The requirements for this Plan are found in State Water Resources Control Board (SWRCB) Condition 8.I, and U.S. Forest Service (USFS) 4(e) Condition 31.9, located in Appendices A and B, respectively, of the Federal Energy Regulatory Commission's (FERC) Order Issuing New License for the Upper American River Project (UARP), dated July 23, 2014. The Plan was developed in consultation with the SWRCB, USFS, California Department of Fish and Wildlife, and U.S. Fish and Wildlife Services. FERC approved the Plan on September 30, 2015.

The UARP lies within El Dorado and Sacramento counties, primarily within lands of the Eldorado National Forest. The UARP consists of three major storage reservoirs—Loon Lake, Union Valley and Ice House (with a combined capacity of approximately 379,000 acre-feet), eight smaller regulating or diversion reservoirs, and eight powerhouses. The UARP has an authorized installed capacity of 637.3 megawatts (MW). The UARP also includes recreation facilities containing over 700 campsites, five boat ramps, hiking paths, and bicycle trails at the reservoirs.

1.2 MONITORING OBJECTIVES

The primary objectives and rationale for the water temperature monitoring program, as described in the Plan are as follows:

Annual water temperature monitoring at specified stream sites will provide information needed to determine whether cold freshwater resource objectives are being met and will provide an evaluation of breeding conditions for sensitive amphibian species. Stream temperature monitoring results will also be used to determine whether water temperature profiles within the reservoirs are needed to better understand cold water availability. An adaptive approach to water temperature monitoring will allow the removal of specific monitoring sites if results indicate water temperatures are adequate at those specific locations (Condition 8.I.).

This monitoring will help determine if water temperatures in UARP waters meet the Basin Plan beneficial use of Cold Freshwater Habitat (CVRWQCB 1998) and other identified habitats/species needs. If such a study is inconclusive, reservoir temperature profile monitoring may be required to assist in the decision making process. Currently, the Plan requires water temperature monitoring in stream reaches throughout the duration of the license term or until *“the Licensee can demonstrate to the satisfaction of the Deputy Director that operation of the UARP reasonably protects the “cold freshwater” beneficial use at any site for which the Licensee seeks modification to the temperature monitoring requirement.”*

These data are also utilized to direct the following requirements of the new license:

- Adaptive management decisions regarding initiation of foothill yellow legged frog (FYLF) breeding
- Cancellation of recreational boating releases due to FYLF breeding
- Temperature monitoring related to the 'block of water' releases on Silver Creek
- Response of aquatic resources to spill events and pulse flows after thresholds have been reached.
- Requirement of the Basin Plan that "At no time or place shall the temperature of COLD or WARM intrastate waters be increased more than 5° F above the natural receiving water temperature.

Table 1 - UARP Water Temperature Monitoring Site Locations and Parameters

Site Name	Site Description	UTM (NAD 83)		Sensor Type	Data Transfer	Threshold Trigger	Complete Data
		Easting	Northing				
RR5	Rubicon River immediately below Rubicon Reservoir Dam	740501	4319200	CS450L	Telemetry	None	Yes
LRR3	Little Rubicon River immediately below Buck Island Reservoir Dam	737558	4320907	CS450L	Telemetry	None	Yes
RR1	Rubicon River below confluence of Little Rubicon River at the Project boundary	736593	4323887	Onset datalogger	Manual	None	No
GC7	Gerle Creek immediately below Loon Lake Reservoir Dam	732455	4320776	CS450L	Telemetry	None	Yes
GC8	Gerle Creek immediately below Gerle Creek Reservoir Dam	725745	4316219	CS107 or CS450L	Telemetry	None	Yes
SFRR5	South Fork Rubicon River immediately below Robbs Peak Reservoir Dam	726202	4314316	CS450L	Fiber Optic Network	None	No
SFRR6	SF Rubicon River below confluence of Gerle Creek at the Project boundary	725256	4314907	CS450L	Telemetry	None	Yes
SFRR0.5	SF Rubicon River immediately upstream of the confluence with the Rubicon River	719438	4316236	Onset datalogger	Manual	None	No

Site Name	Site Description	UTM (NAD 83)		Sensor Type	Data Transfer	Threshold Trigger	Complete Data
		Easting	Northing				
SFSC7	South Fork Silver Creek immediately below Ice House Reservoir Dam [†]	728745	4299871	CS450L	Telemetry	None	Yes
SFSC8	South Fork Silver Creek immediately upstream of Junction Reservoir	721498	4303358	CS450L	Telemetry	7DMAVG	Yes
SC5	Silver Creek immediately below Junction Reservoir Dam	720466	4303467	CS 450L	Fiber Optic Network	None	Yes
SC6	Silver Creek immediately above Camino Reservoir Dam	714119	4301407	CS450L	Telemetry	DAVG	Yes
SC7	Silver Creek immediately below Camino Reservoir Dam [†]	713631	4300155	CS450L	Fiber Optic Network	None	Yes
SC8	Silver Creek immediately upstream of SF American River	709310	4296208	CS450L	Telemetry	DAVG	Yes
BC4	Brush Creek immediately below Brush Creek Reservoir Dam	706407	4298536	CS451	Fiber Optic Network	None	Yes
SFAR13	SF American River immediately below Slab Creek Reservoir Dam	699644	4294054	CS450L	Fiber Optic Network	7DMAVG	Yes
SFAR7	SF American River at Mosquito Rd Bridge	695572	4294304	Onset datalogger	Manual	None	Yes
SFAR15	SF American River approximately ½ mile upstream of White Rock Powerhouse	692576	4292875	CS450L	Telemetry	7DMAVG	Yes
SFAR16	SF American River – to record White Rock Powerhouse discharge temps	692212	4293046	CS450L	Fiber Optic Network	None	Yes

Table 2 – Specifications for the various monitoring equipment

Sampling Equipment	Accuracy	Range	Calibration Interval
Campbell Scientific 107L	<±0.2°C from 0° to 50° C	-35° to +50°C	Annual
Campbell Scientific 450L	±0.2°C from 0° to 50° C	0° to 60°C	Biennial
Onset Computer Corp. HOBO®	±0.2°C from 0° to 50°C	-40° to 50°C	Annual
Campbell Scientific CR 1000 Datalogger	±3 min. per year	Not Applicable	Annual

1.3 STUDY AREA AND SAMPLING LOCATIONS

Continuous water temperature monitoring of stream reaches occurred in 2016 at 18 sites throughout the UARP area utilizing fixed stations or dataloggers. In general, these sites measured water temperatures in diverted stream reaches downstream of UARP reservoirs. Table 1 describes the locations and characteristics of each site. Final site development at a local scale was determined using proximity to release point, presence of isothermal water column, logistics, and channel morphology. Appendix A depicts the monitoring site locations relative to the UARP and primary streams and rivers.

2.0 MODIFICATIONS AND METHODS

2.1 TEMPERATURE RECORDING AT FIXED-STATIONS

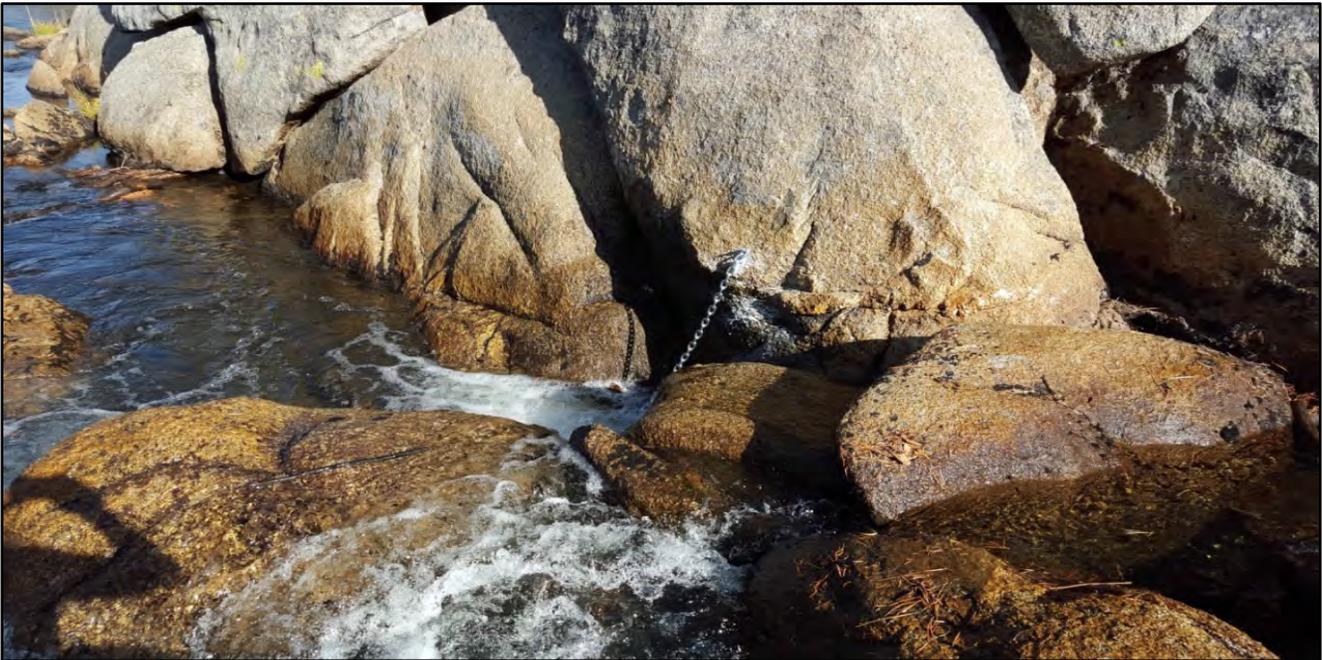
The majority of sites (15) were monitored for water temperature using fixed stations. Monitoring compliance at these sites were accomplished using gaging stations located at weirs, stilling wells, or tailraces. Each fixed station site utilized a Campbell Scientific datalogger and temperature sensor. Redundant sensors were installed at all locations. Sensor cables were contained inside conduit, and the sensors were placed as close as possible to the stream thalweg where water is well mixed. A solar shield helped prevent exposure to direct sunlight. Depending on the site, power was supplied either by photovoltaic panels and DC batteries or through an existing power supply. Data transfer occurred through either radio telemetry or fiber optic network. At the fixed stations, temperature readings were collected at 15 minute intervals, logged by the datalogger, summarized to hourly means, and transmitted every 24 hours.

2.2 TEMPERATURE RECORDING AT DATALOGGER STATIONS

Simple, non-permanent, calibrated temperature dataloggers (ONSET HOBO Water Temperature Pro V2) were deployed prior to March 15, 2016 at the remaining three sites ('Manual' sites in Table 1). The sensors were inserted into perforated metal framed housings that allowed for water movement throughout. Each housing was secured to large boulders or bedrock using hardened 3/8" chain and placed to assure that the sensor remained submerged and was not exposed to direct sunlight (Photos 1, 2). Two dataloggers were installed at each site to protect against data loss in the event of equipment failure or drift. Dataloggers were deployed in habitat strata where the water was well-mixed, typically at the head of a pool just below a riffle input.

Hourly data from HOBO loggers were manually downloaded using Onset Computer Corporation software. All water temperature data is stored in a Microsoft SQL database designed for this purpose.

Photo 1 – Typical install for the ONSET HOBO water temperature sensors. Sensors were installed in a metal housing secured to bedrock by heavy chain.



2.3 QA/QC

Raw data is reviewed on a routine basis. Temperature trends inspected include physical range limits, practical range limits, and rates of temperature change. Data obtained from the fixed stations were checked for validity using procedures that run every 24 hours following data download. A report is generated and sent to pertinent SMUD staff via e-mail for any suspected erroneous data. The same procedures are run manually following download from the data loggers. Erroneous temperature values were adjusted manually; however the original raw data was maintained in the database.

This review, along with graphical analysis and routine equipment inspection, ensured that sensors were functioning and recording properly throughout the monitoring period. For fixed stations, this allowed for a timely response if the need arose. Any equipment malfunction that required a field visit was addressed during normal business hours, under safe conditions. Repairs were made in as timely a manner as possible

2.4 PROBLEMS ENCOUNTERED

Of the eighteen sites, three were planned to have ONSET HOBO water temperature loggers installed and collected annually (Table 1). Two sites were not successfully recovered due to uncontrollable circumstances. The Rubicon River below confluence of Little Rubicon River at the Project boundary (RR1) dataloggers were likely lost during a

storm event. The South Fork Rubicon River immediately upstream of the confluence with the Rubicon River (SFRR0.5) is currently heavily buried with debris. Recovery will occur once conditions are safe to do so.

2.5 ADAPTIVE MANAGEMENT

Three thresholds that are connected to various UARP adaptive management conditions were crossed during the monitoring period (Table 3).

Table 3 – Crossed Thresholds

Site Name	Site Description	Threshold Type	Threshold Value	Date Crossed
SC8	Silver Creek immediately upstream of SF American River	7DMAVG	12° C	5/14/2016
SFAR15	SF American River approximately ½ mile upstream of White Rock Powerhouse	7DMAVG	12° C	5/14/2016
SFSC8	South Fork Silver Creek immediately upstream of Junction Reservoir	7DMAVG	12° C	6/3/2016

Photo 2 – Recovered datalogger: South Fork American River at Mosquito Road Bridge (SFAR7). This demonstrates the standard metal housing that the HOBO dataloggers were installed in.



3.0 ANALYSIS AND RESULTS

Data was analyzed at varying frequencies depending on the format of data retrieval (real-time opposed to manually retrieved/downloaded). All data was summarized to include values for daily mean, minimum and maximum temperatures. Further analysis included calculating the highest seven-day moving average temperature (7DMAVG). For sites associated with trigger thresholds (Table 1), daily minimum, maximum, average and seven day moving average values were determined to notify SMUD staff if these thresholds were being exceeded. These processes are automated in the SMUD License Implementation database, which include a notification process when threshold triggers have been reached.

Water temperature data is presented graphically in Appendix A. It is impractical to place hourly and daily data for all sites into this report, although this data will be made available upon request.

4.0 LITERATURE CITED

Central Valley Regional Water Quality Control Board. (CVRWQCB). 1998. Water Quality Control Plan (Basin Plan) for the Central Valley Region. Sacramento River and San

Joaquin River Basins (Basin Plan). Published by the California Regional Water Quality Control Board, Central Valley Region and the State Water Resources Control Board, Sacramento, CA.

Federal Energy Regulatory Commission (FERC). 2014. New License for the continued operation of the Upper American River Project, No. 2101. Federal Energy Regulatory Commission, Washington, D.C.

Sacramento Municipal Utility District (SMUD et al.). 2007. Relicensing Settlement Agreement for the Upper American River Project and Chili Bar Hydroelectric Project. Sacramento Municipal Utility District, Sacramento, CA.

Sacramento Municipal Utility District (SMUD et al.). 2015. Temperature Monitoring Plan (Plan) for the Upper American River Project. Sacramento Municipal Utility District, Sacramento, CA.

State Water Resources Control Board (SWRCB, 2013). 2013. Water Quality Certification for the Upper American River Project. FERC Project No. 2101. State Water Resources Control Board. Sacramento, CA

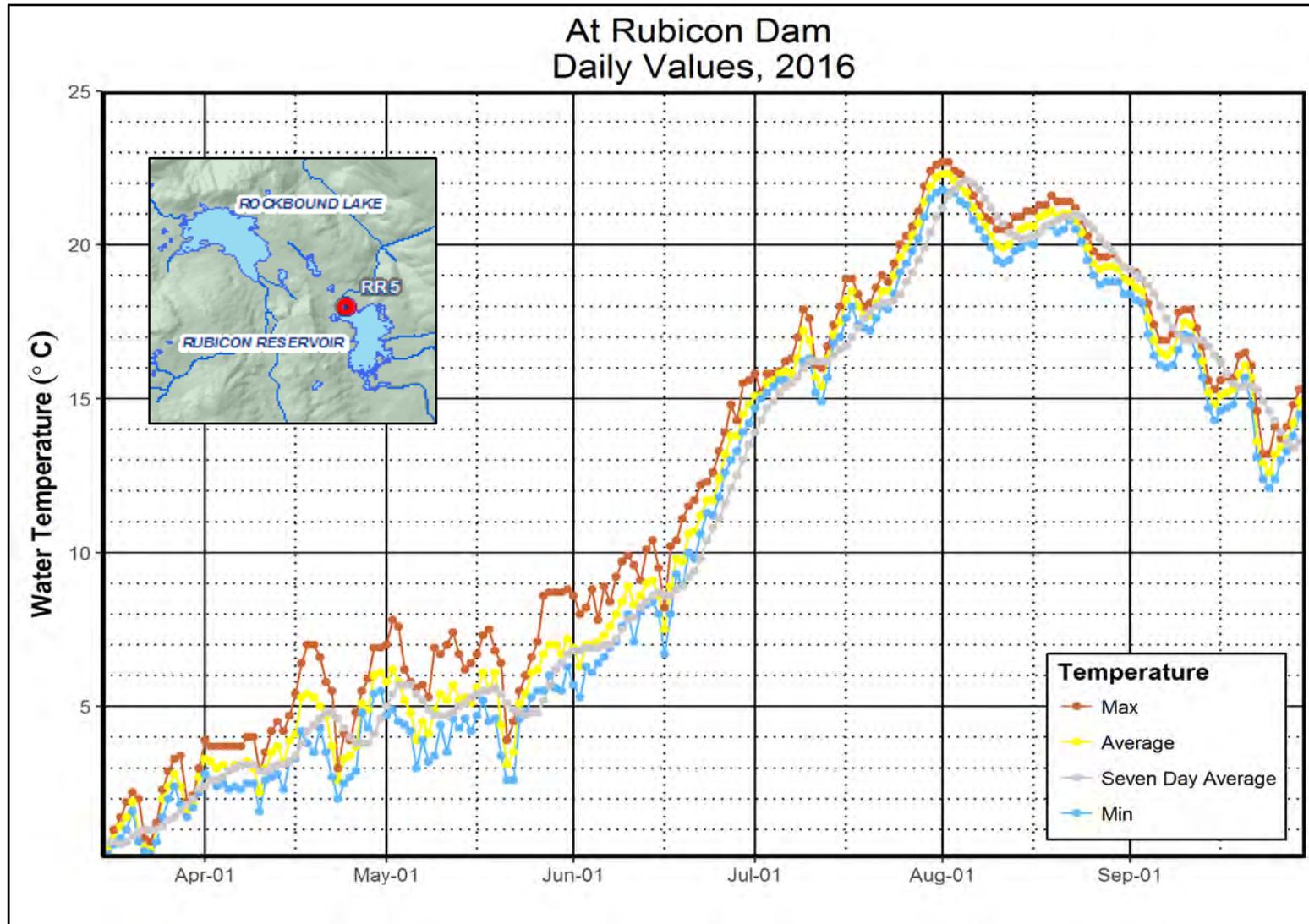


Figure 1 – Little Rubicon River immediately below Rubicon Reservoir Dam (RR5)

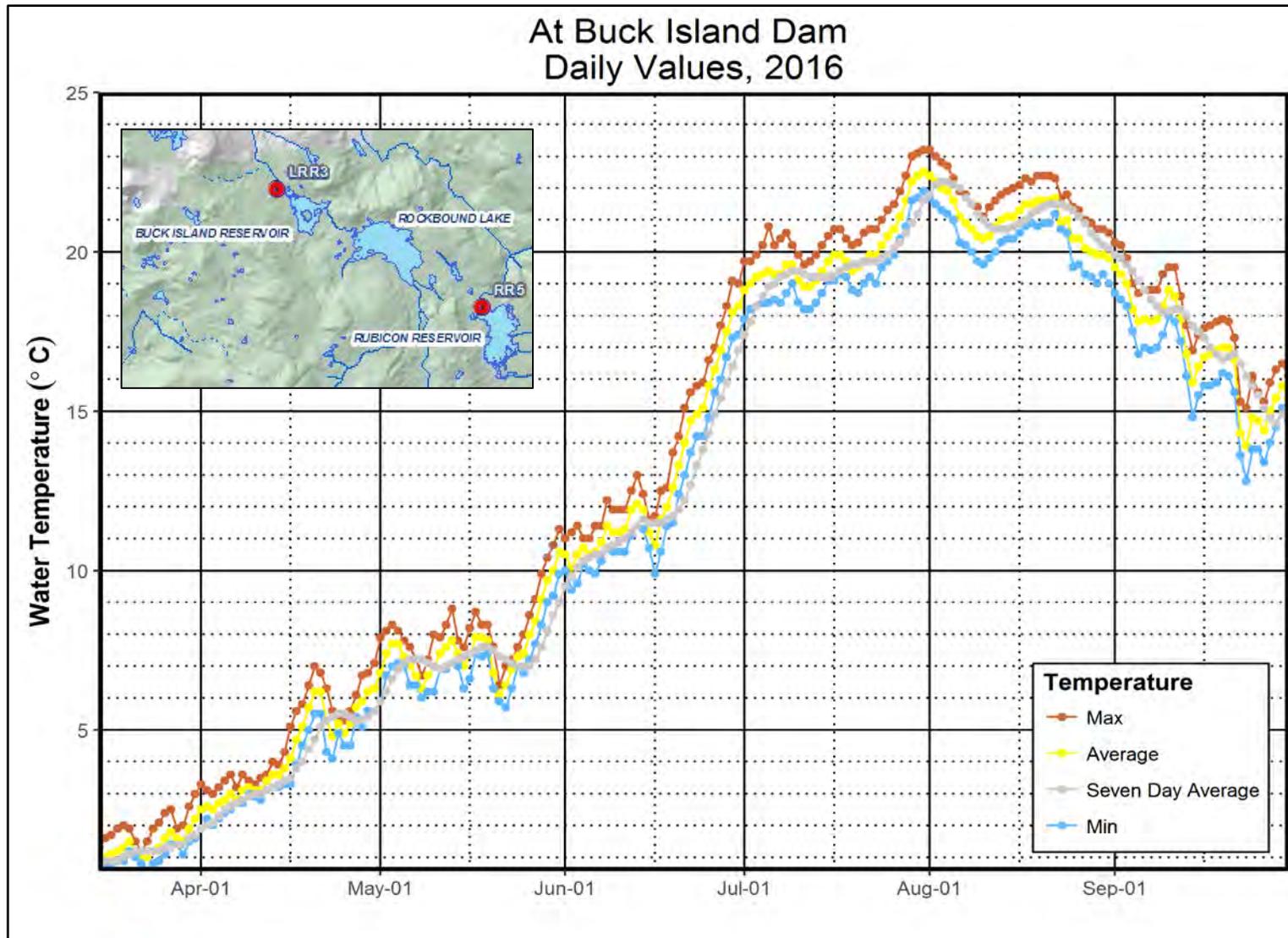


Figure 2 – Little Rubicon River Immediately below Buck Island Reservoir Dam (LRR3)

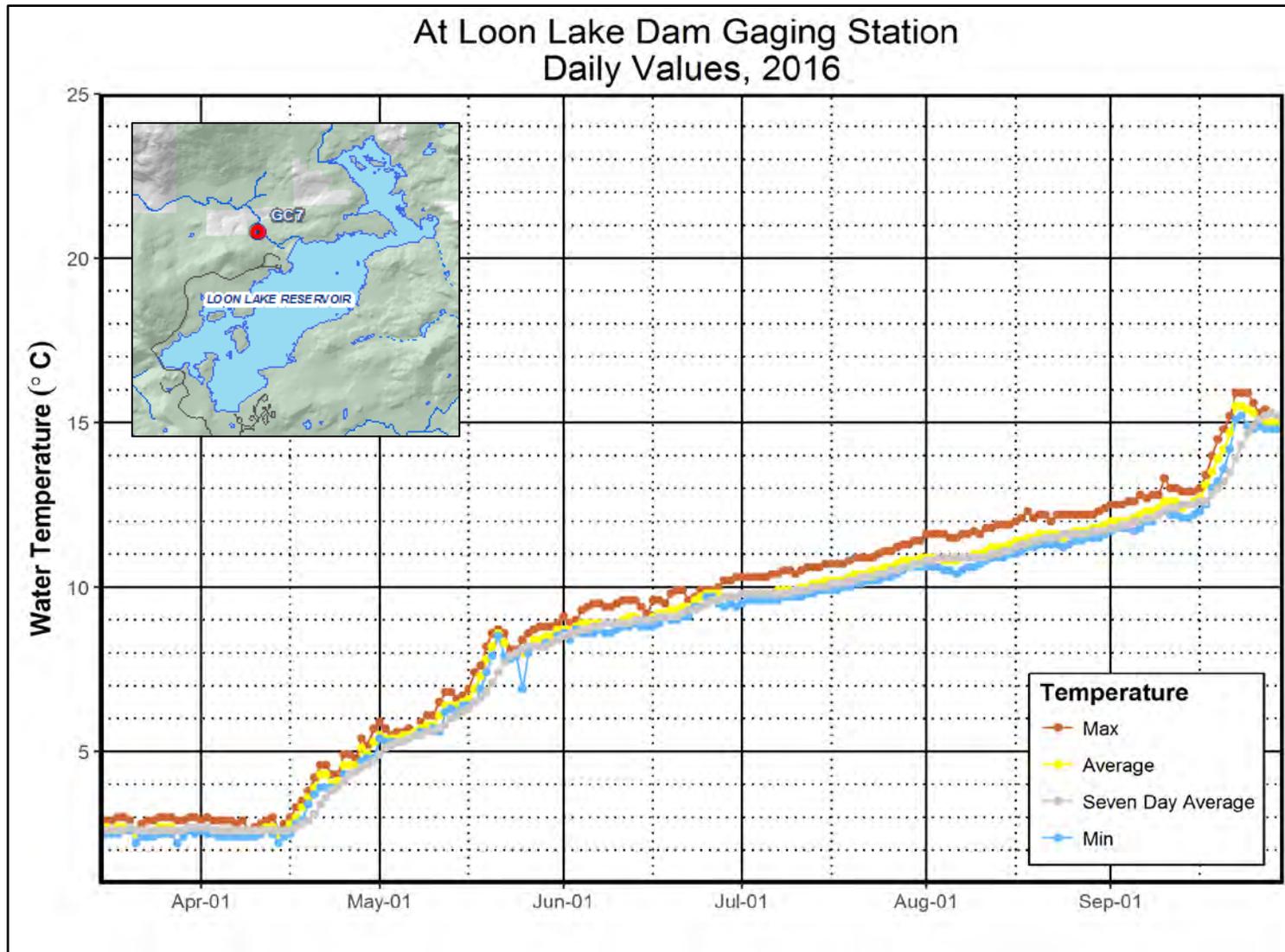


Figure 3 – Gerle Creek Immediately below Loon Lake Reservoir Dam (GC7)

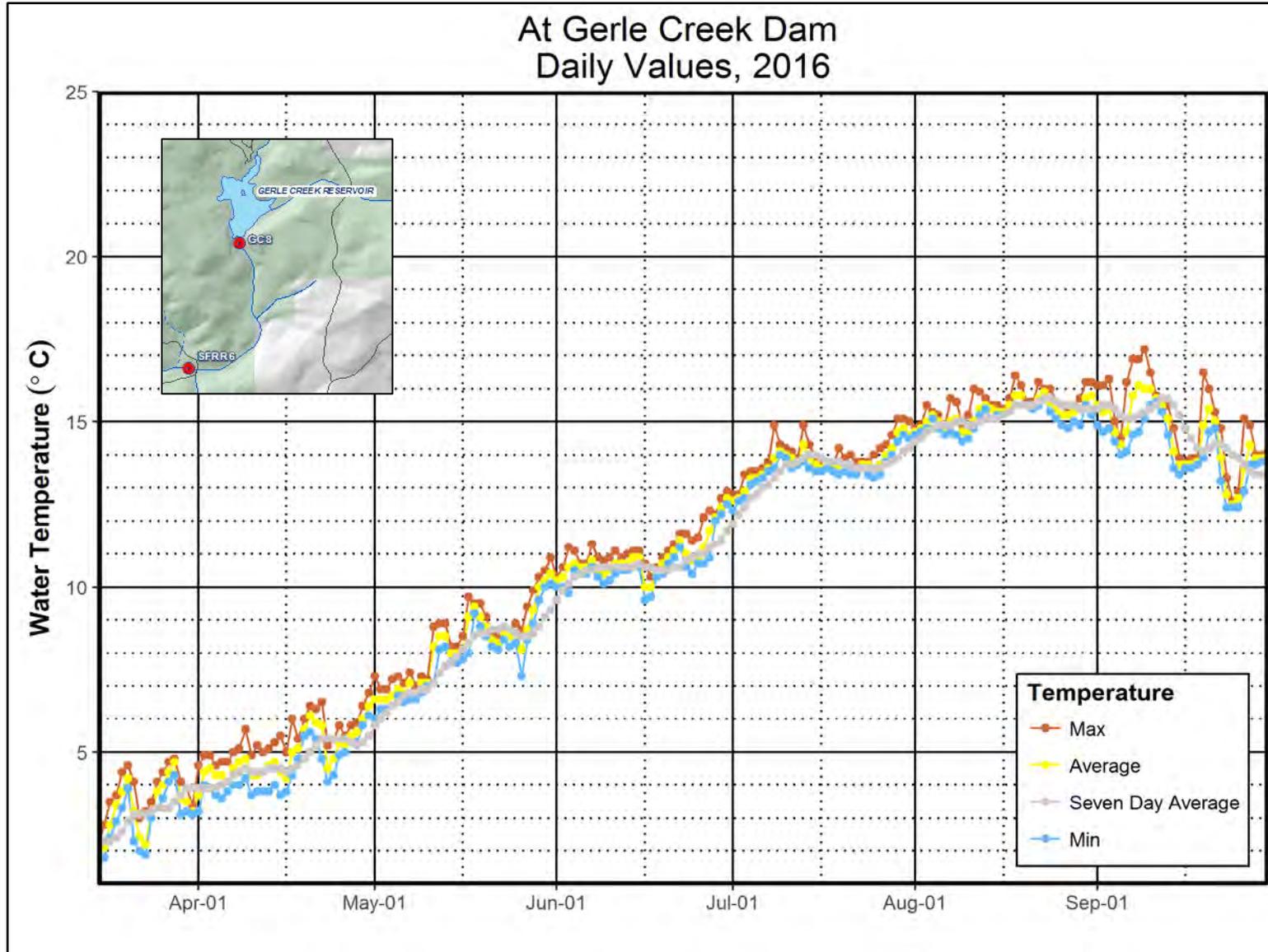


Figure 4 – Gerle Creek immediately below Gerle Creek Reservoir Dam (GC8)

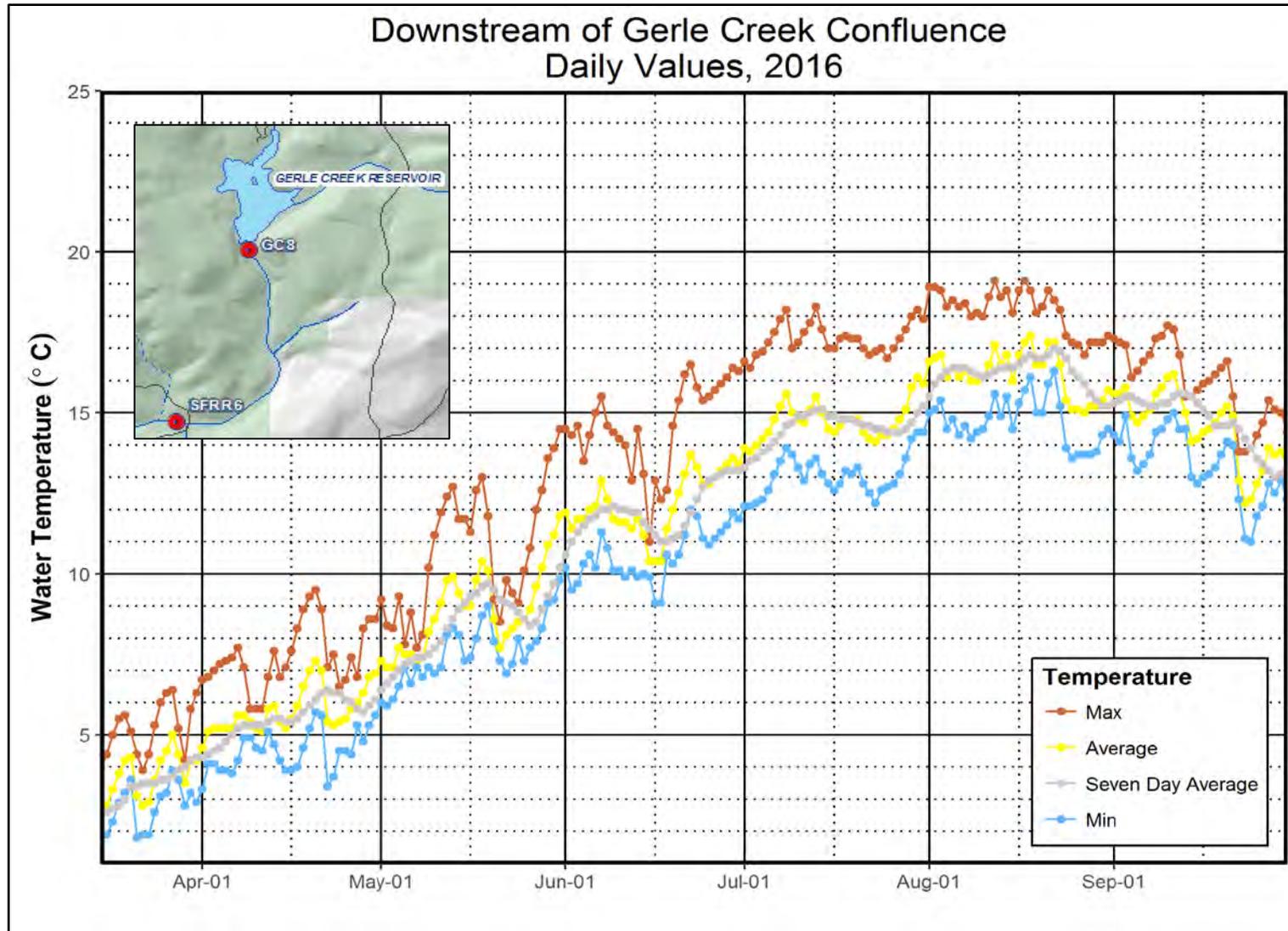


Figure 5 – SF Rubicon River below confluence of Gerle Creek (SFRR6)

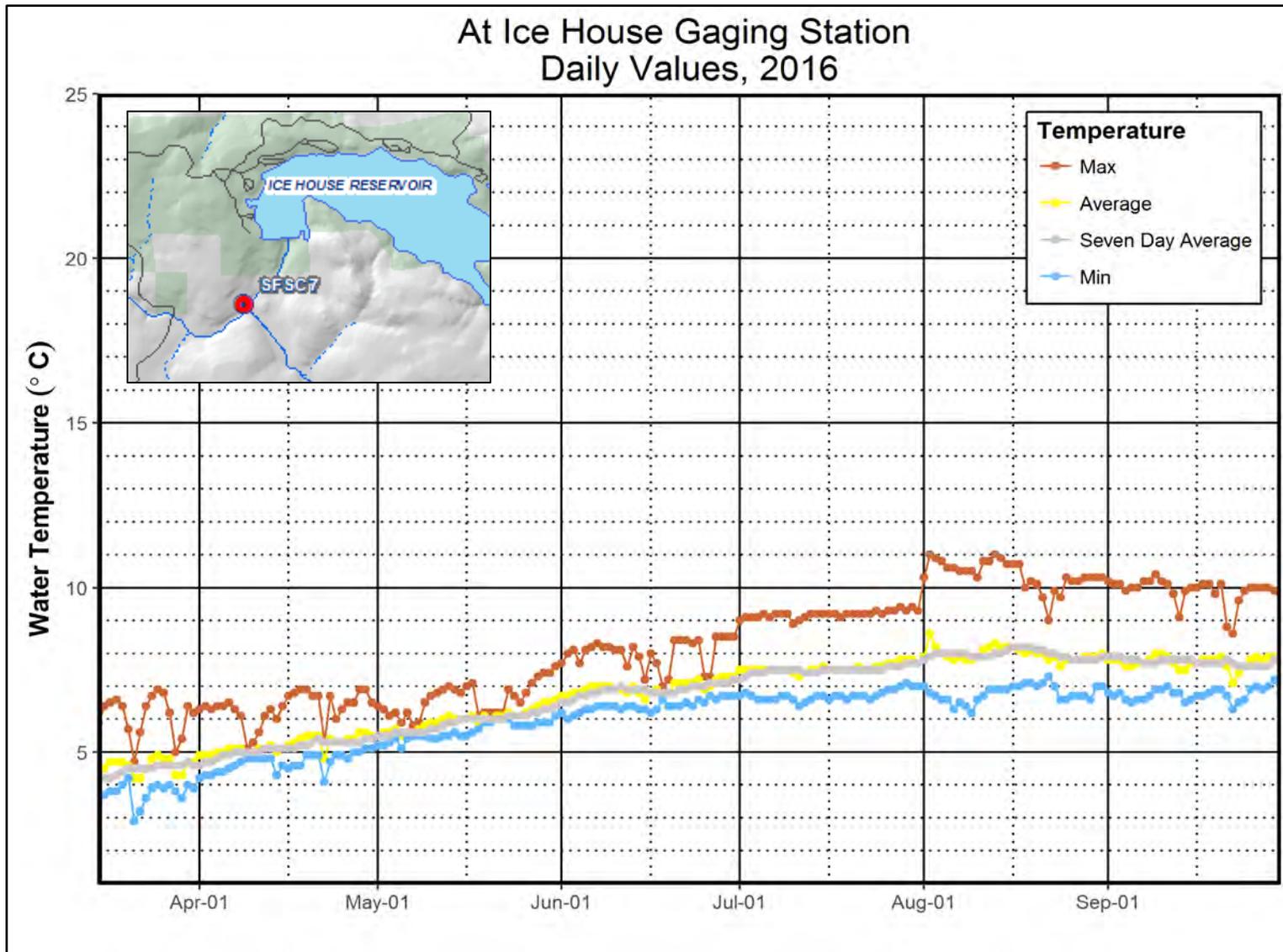


Figure 6 – South Fork Silver Creek immediately below Ice House Reservoir Dam (SFSC7)

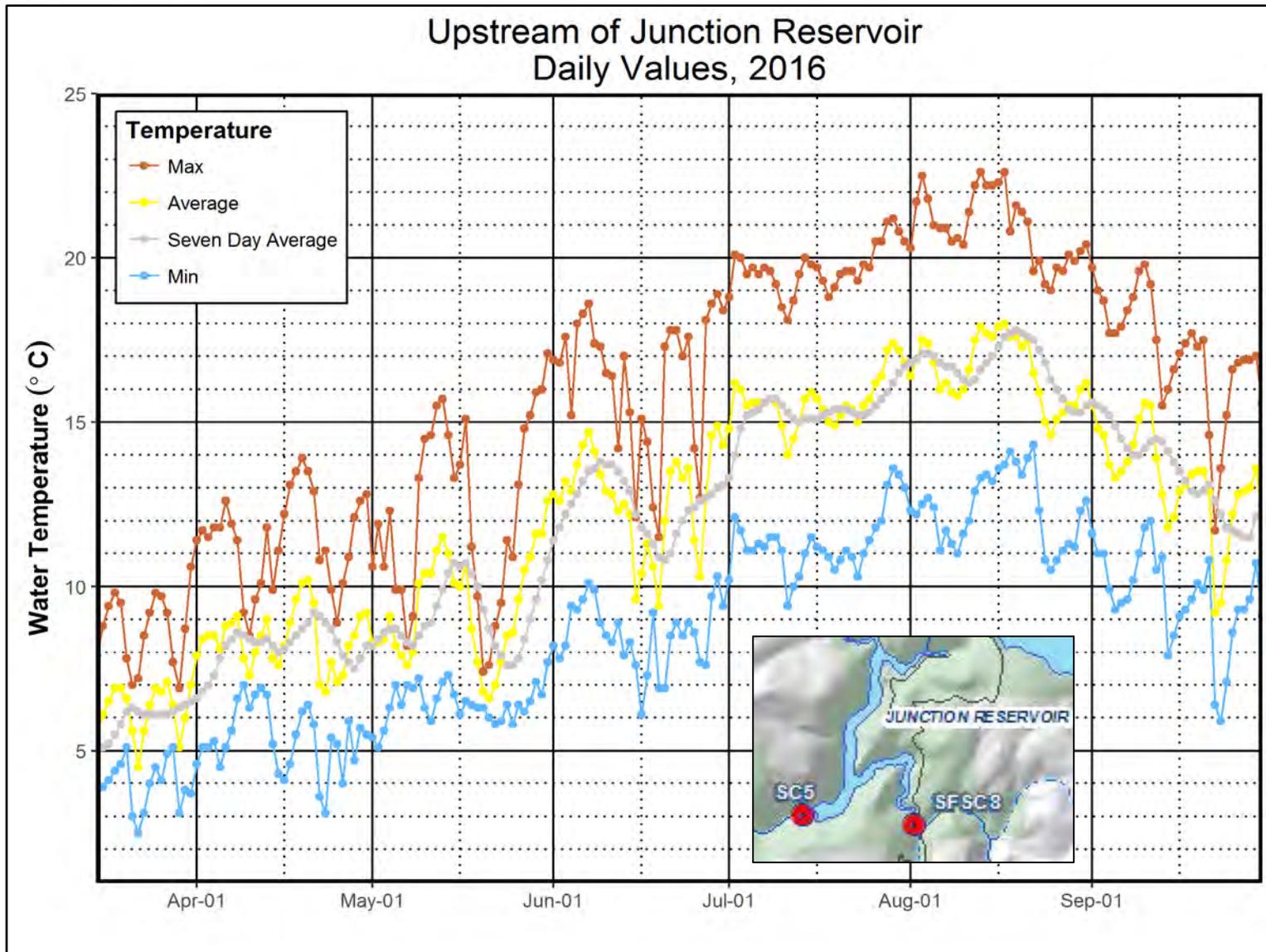


Figure 7 – South Fork Silver Creek immediately upstream of Junction Reservoir (SFSC8)

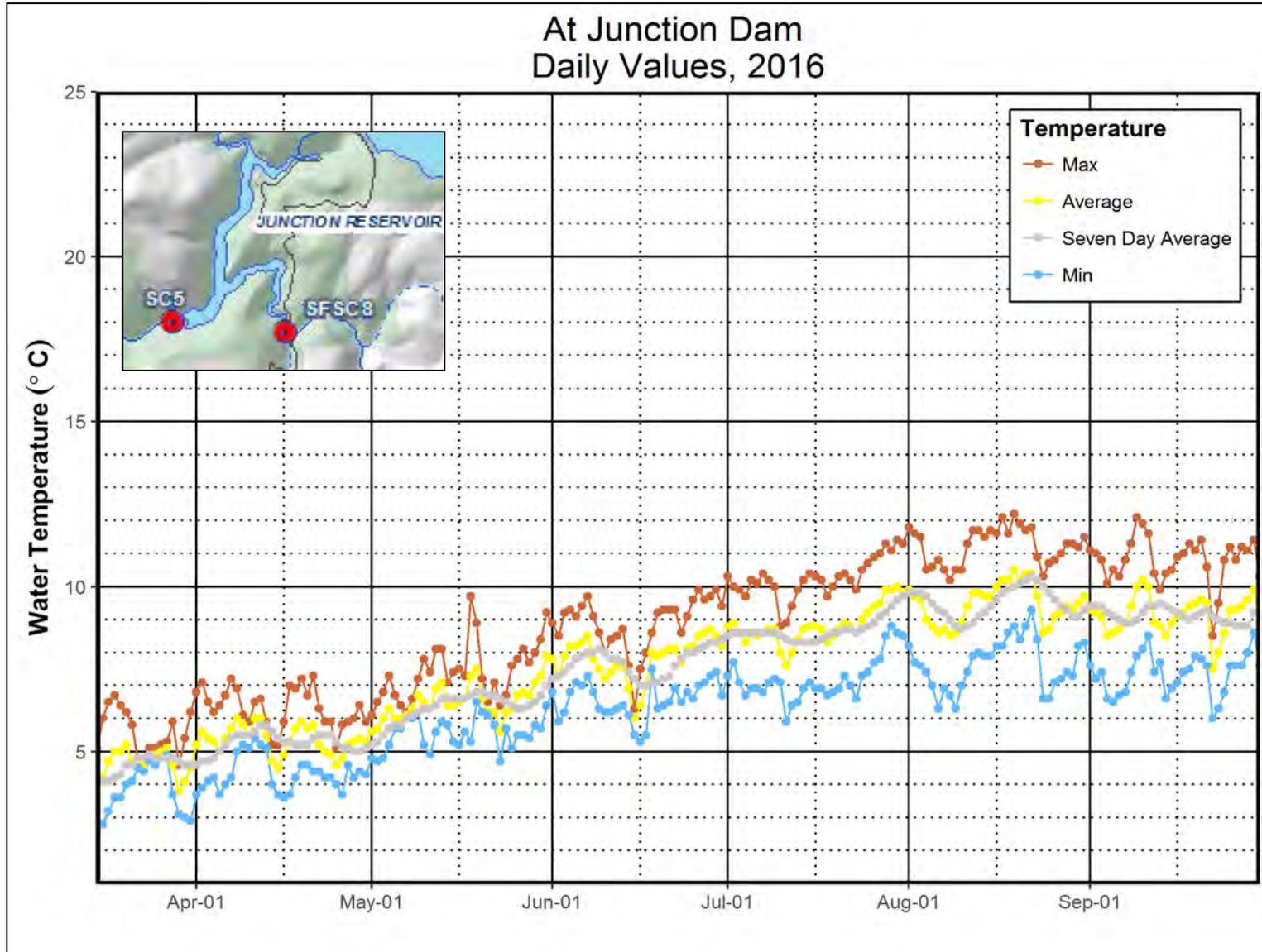


Figure 8 – Silver Creek immediately below Junction Reservoir Dam (SC5)

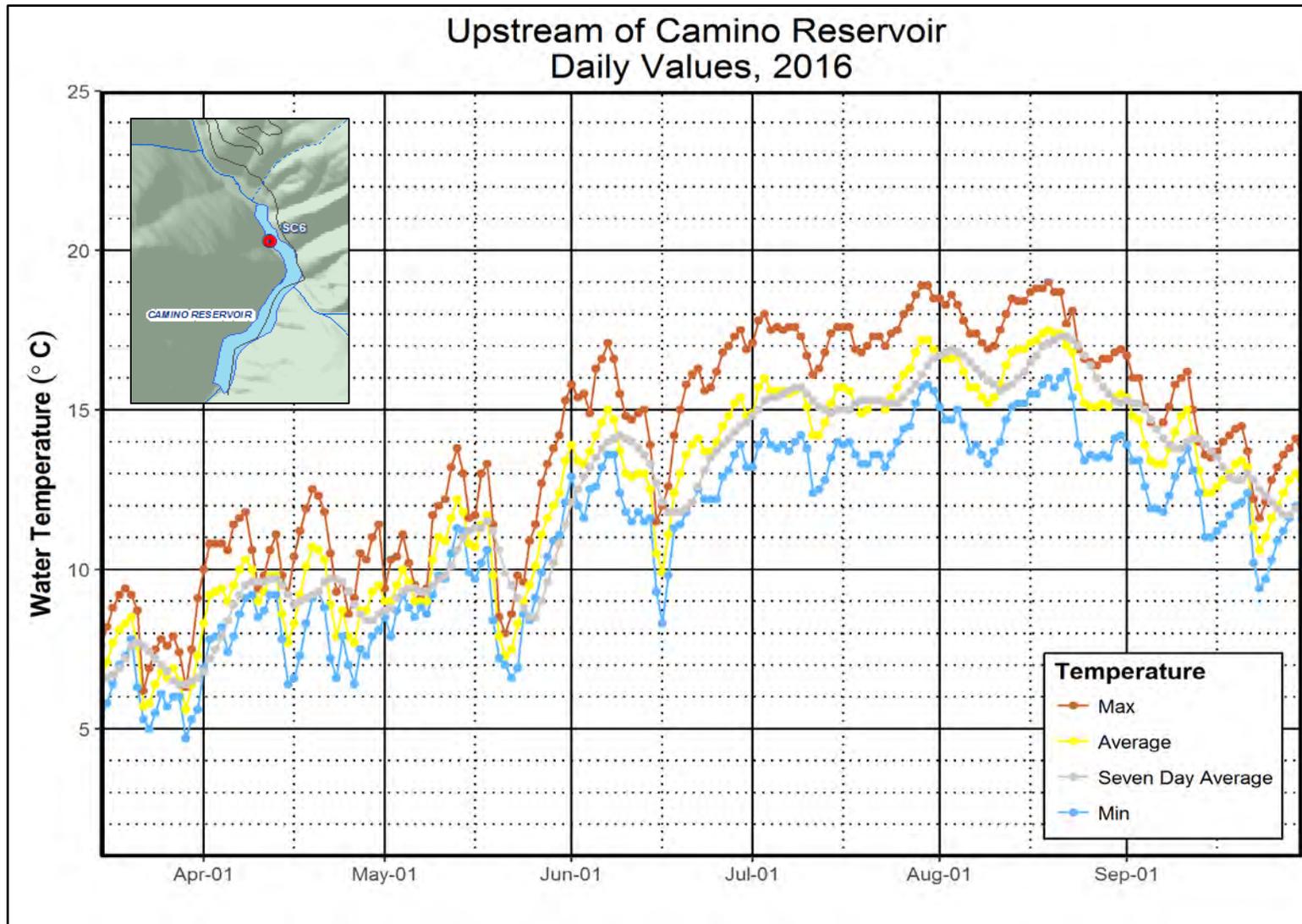


Figure 9 – Silver Creek immediately above Camino Reservoir Dam (SC6)

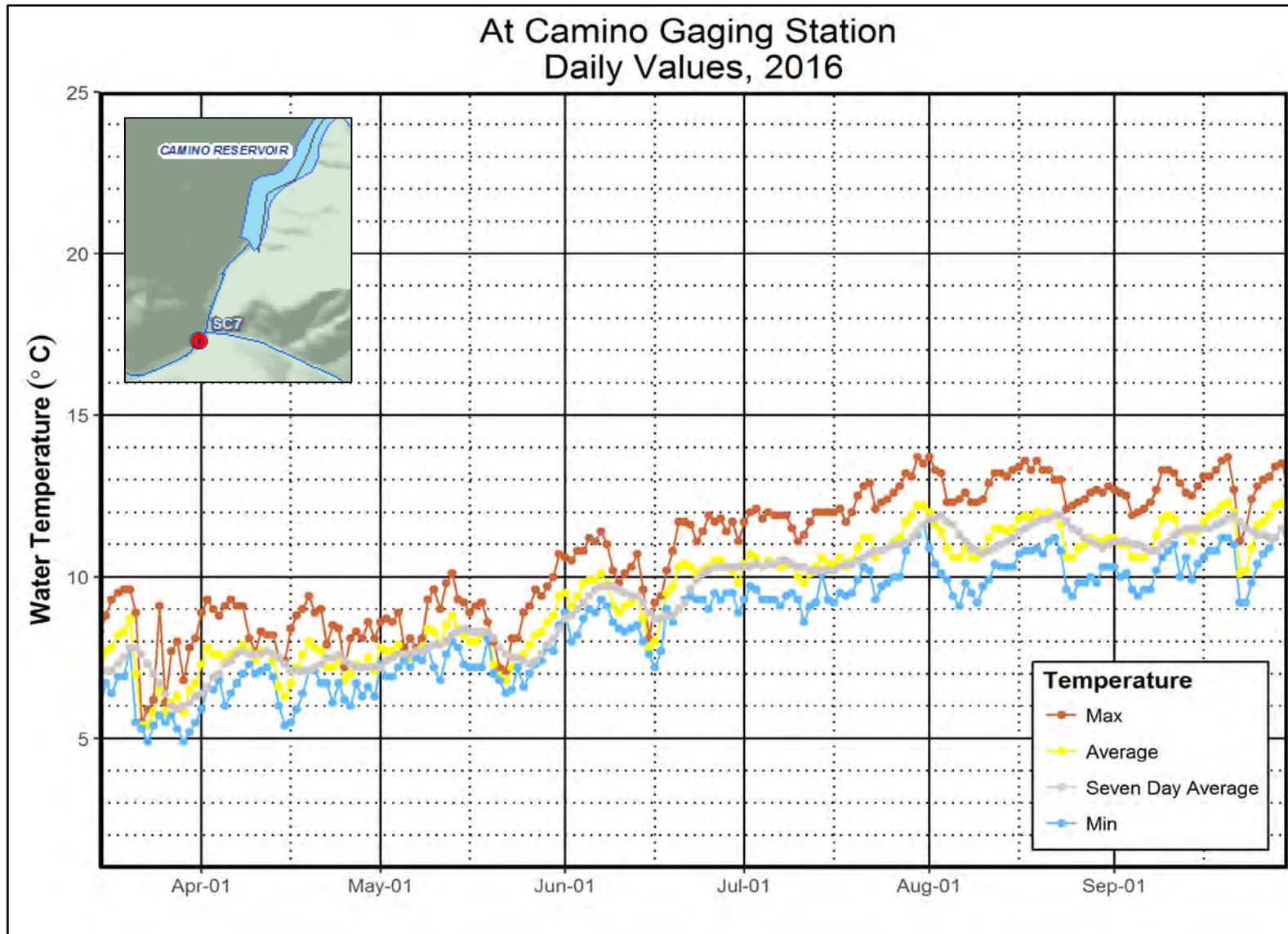


Figure 10 – Silver Creek immediately below Camino Reservoir Dam (SC7)

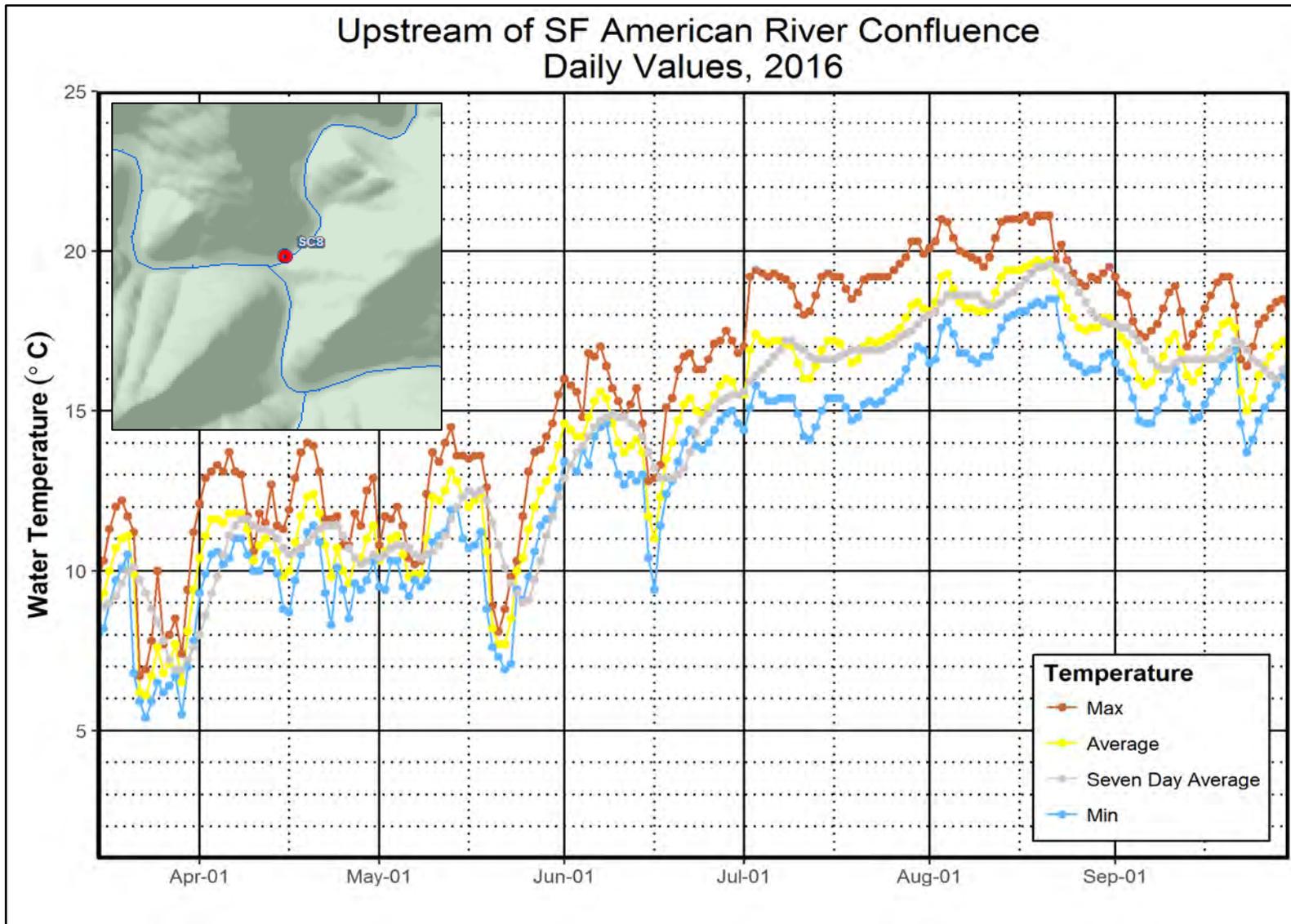


Figure 11 – Silver Creek immediately upstream of SF American River (SC8)

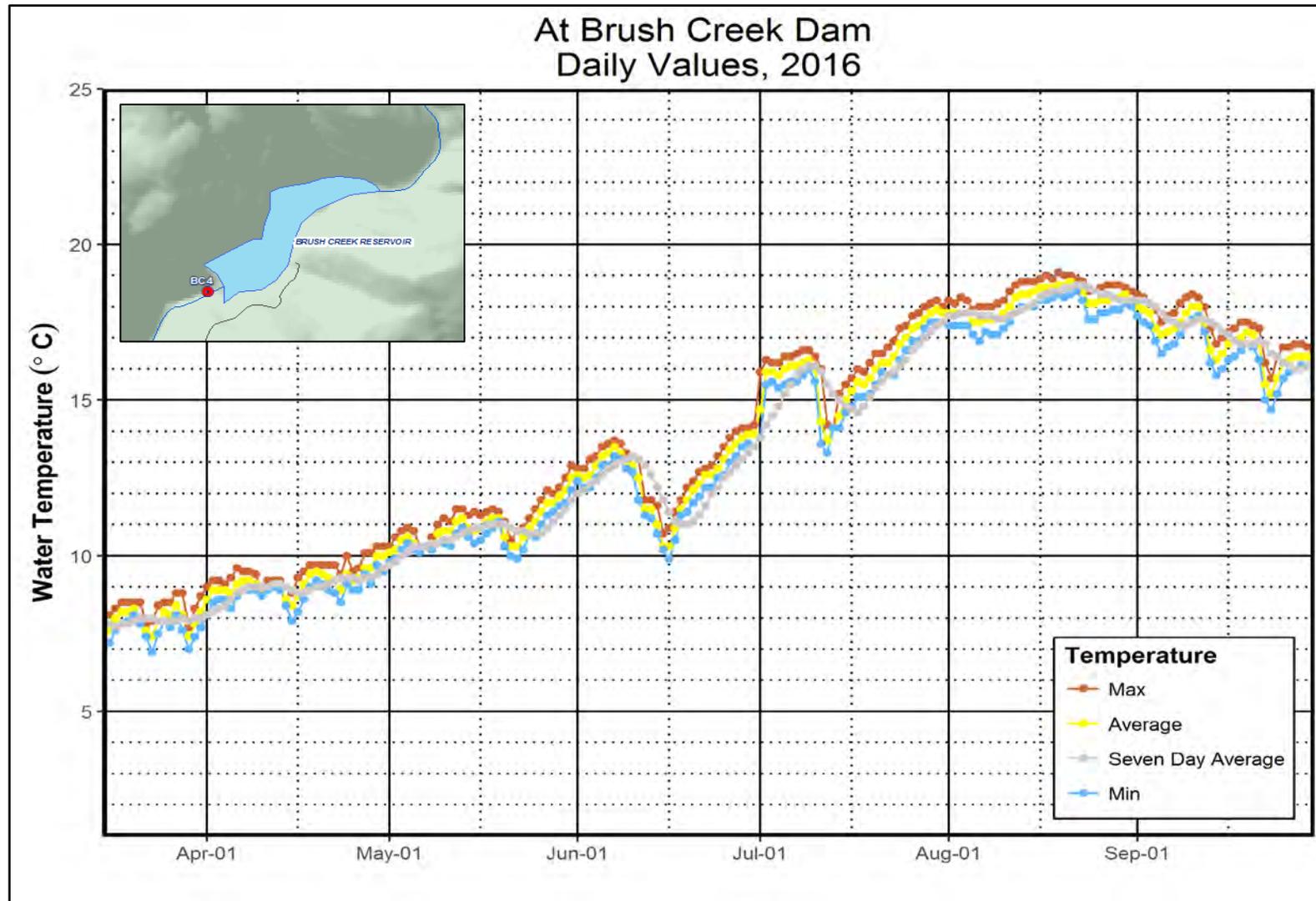


Figure 12 – Brush Creek immediately below Brush Creek Reservoir Dam (BC4)

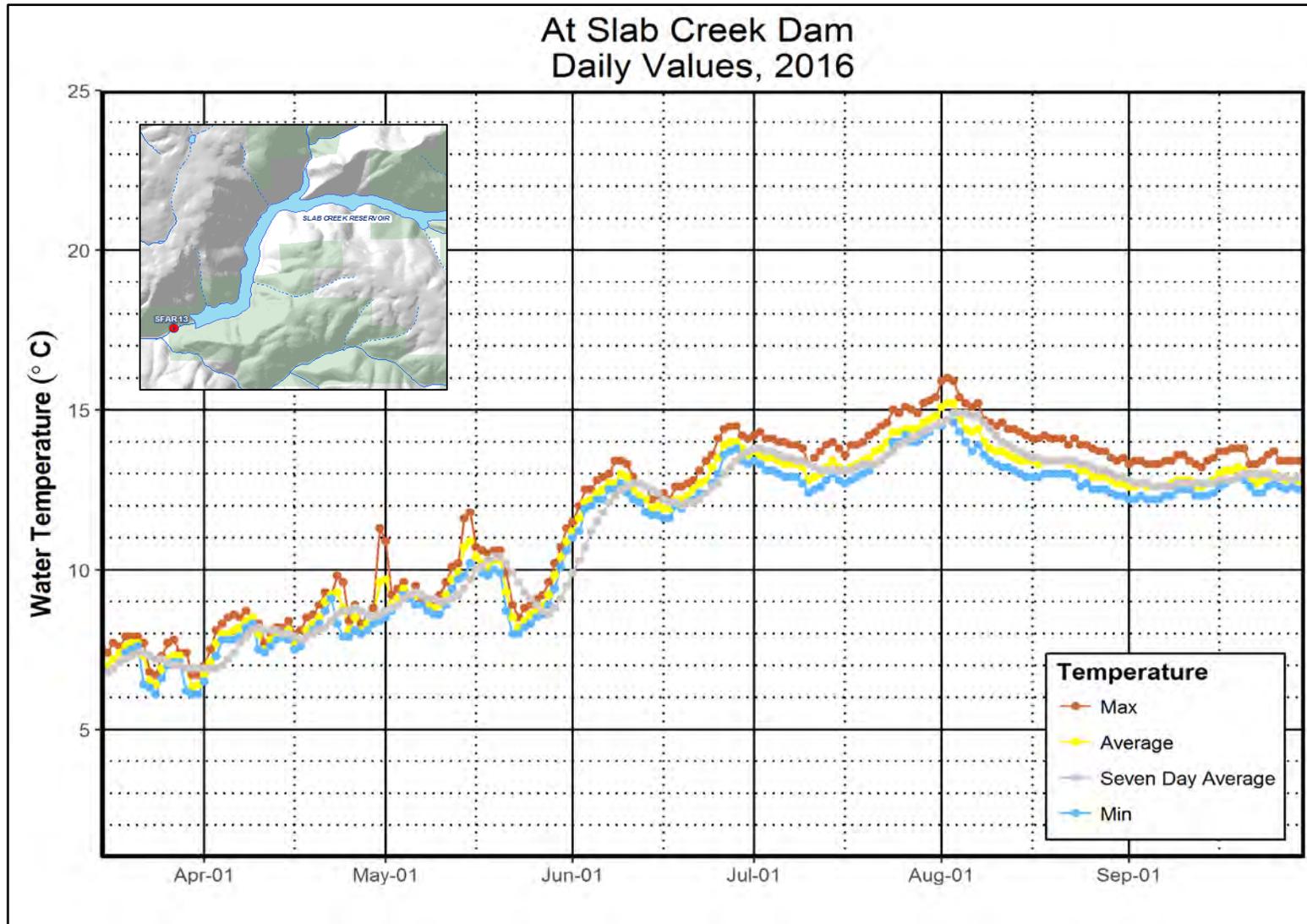


Figure 13 – SF American River immediately below Slab Creek Reservoir Dam (SFAR13)

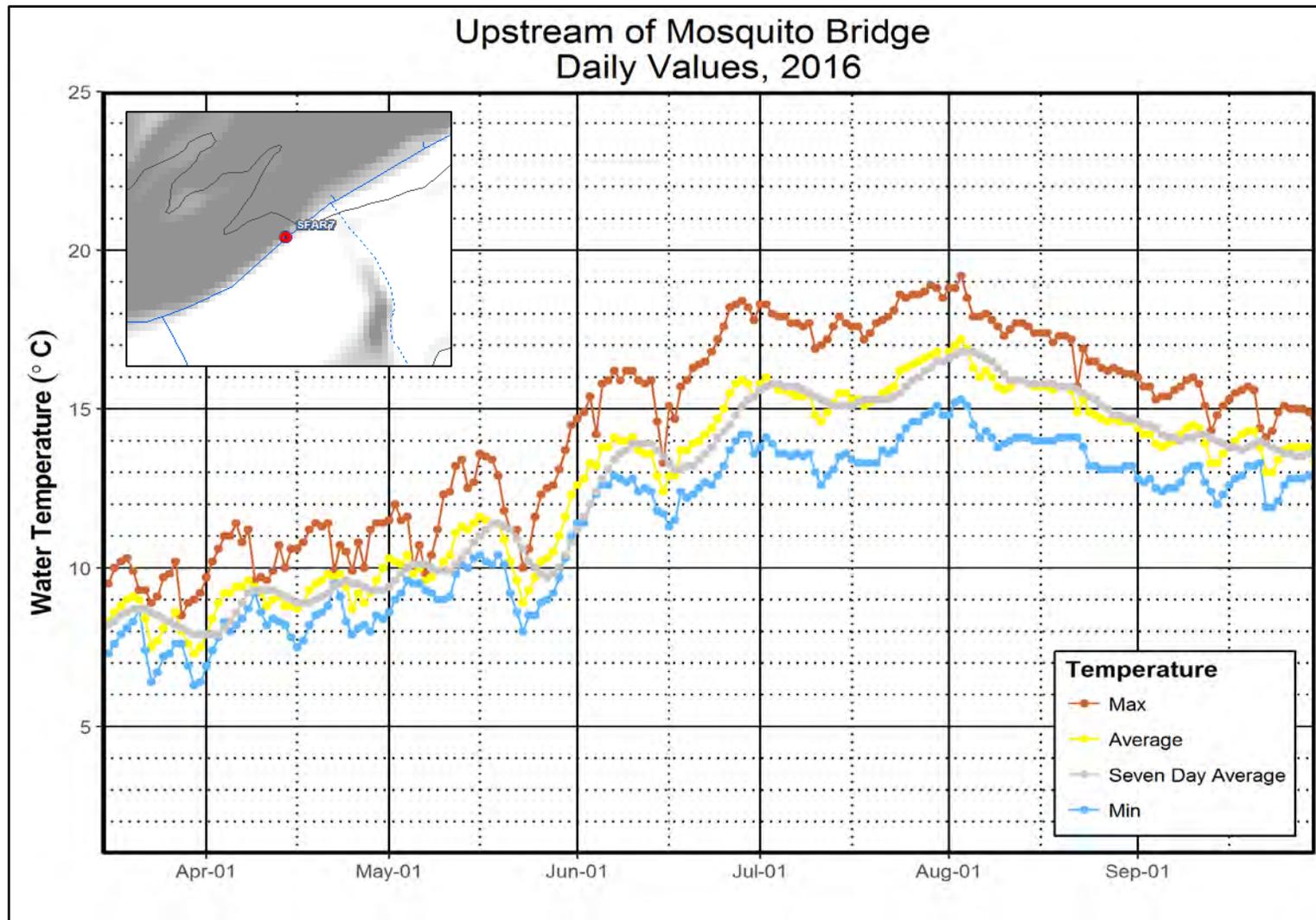


Figure 14 – SF American River at Mosquito Rd Bridge (SFAR7)

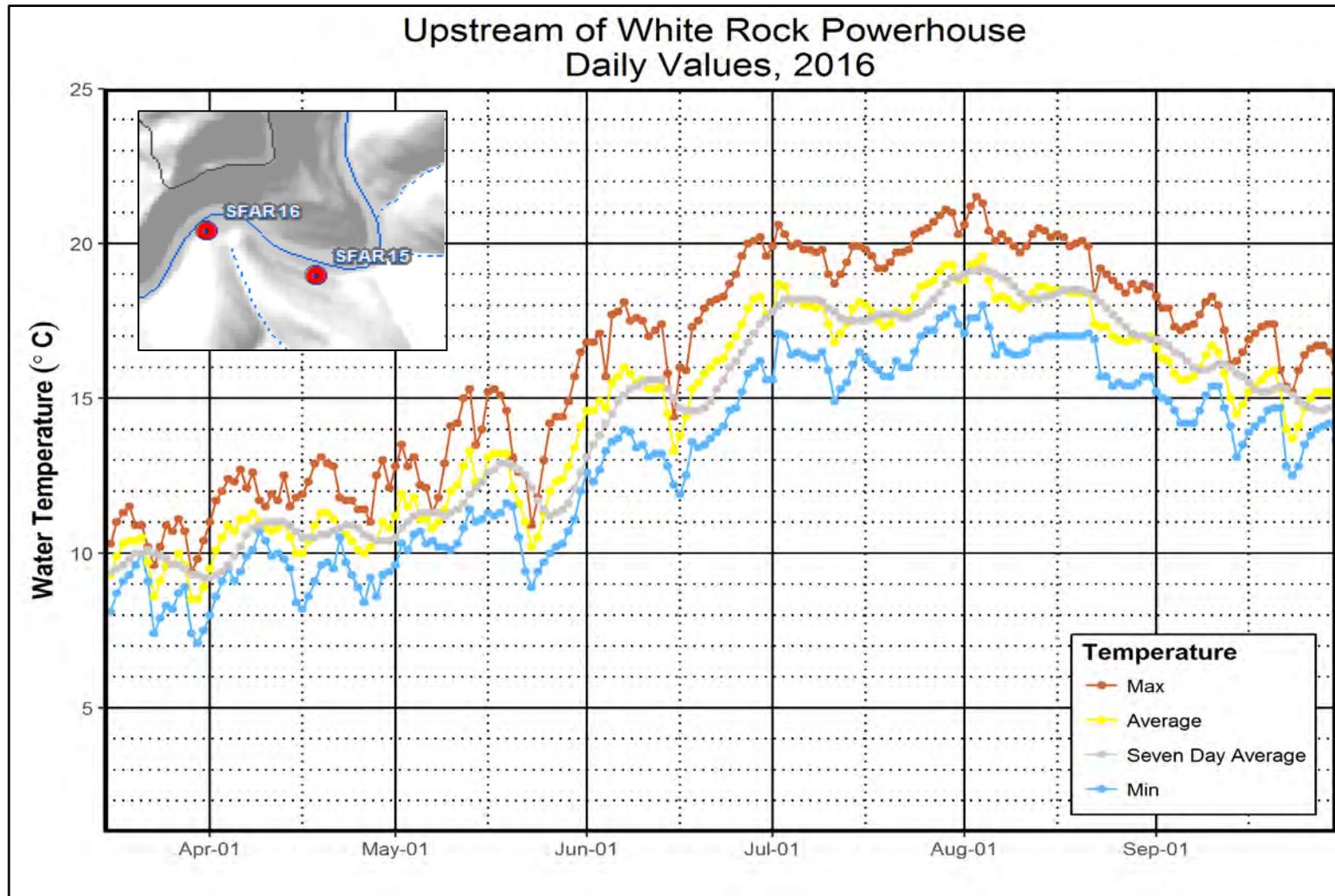


Figure 15 – SF American River approximately ½ mile upstream of White Rock Powerhouse (SFAR15)

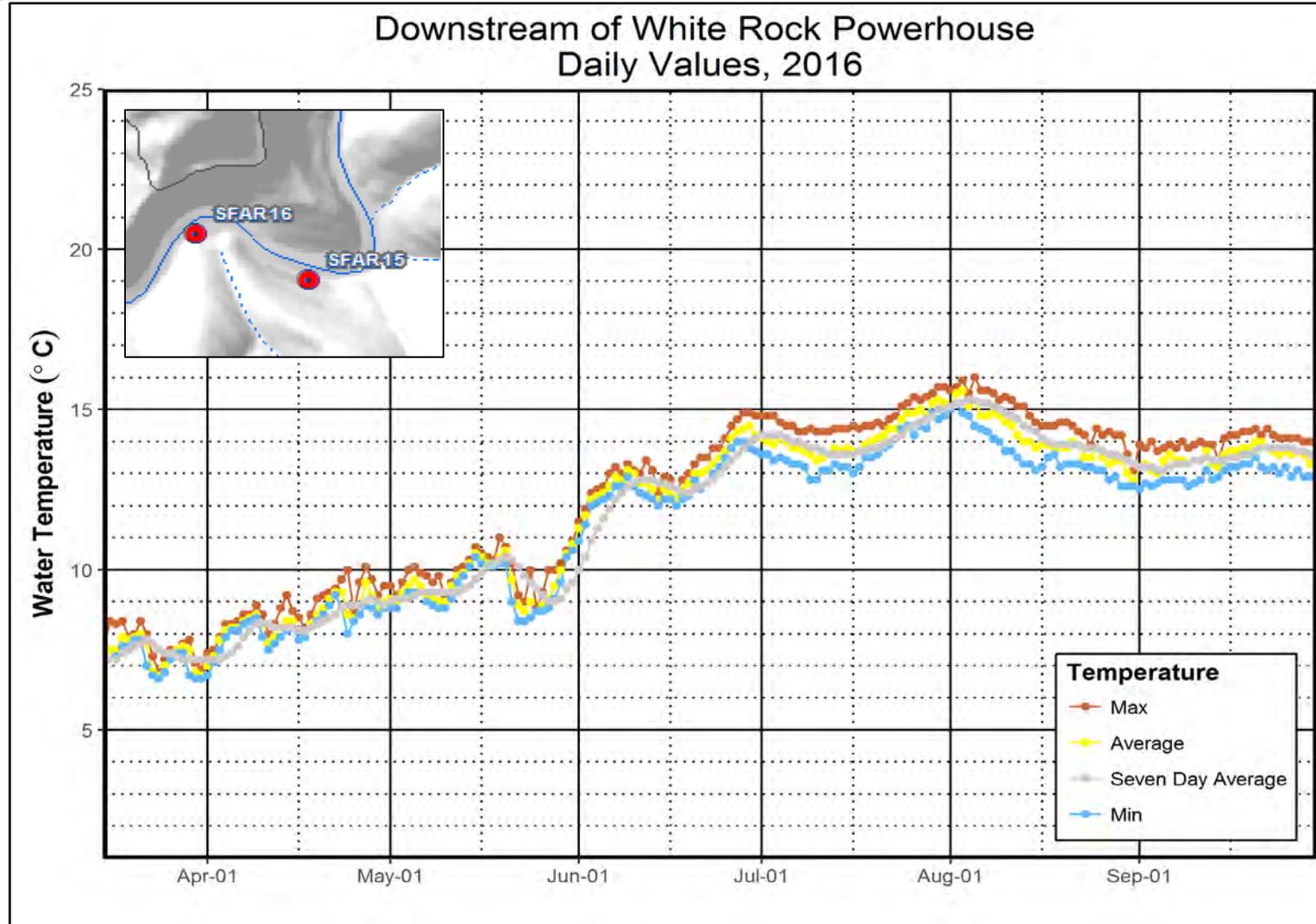


Figure 16 – SF American River to record White Rock Powerhouse discharge temps (SFAR16)

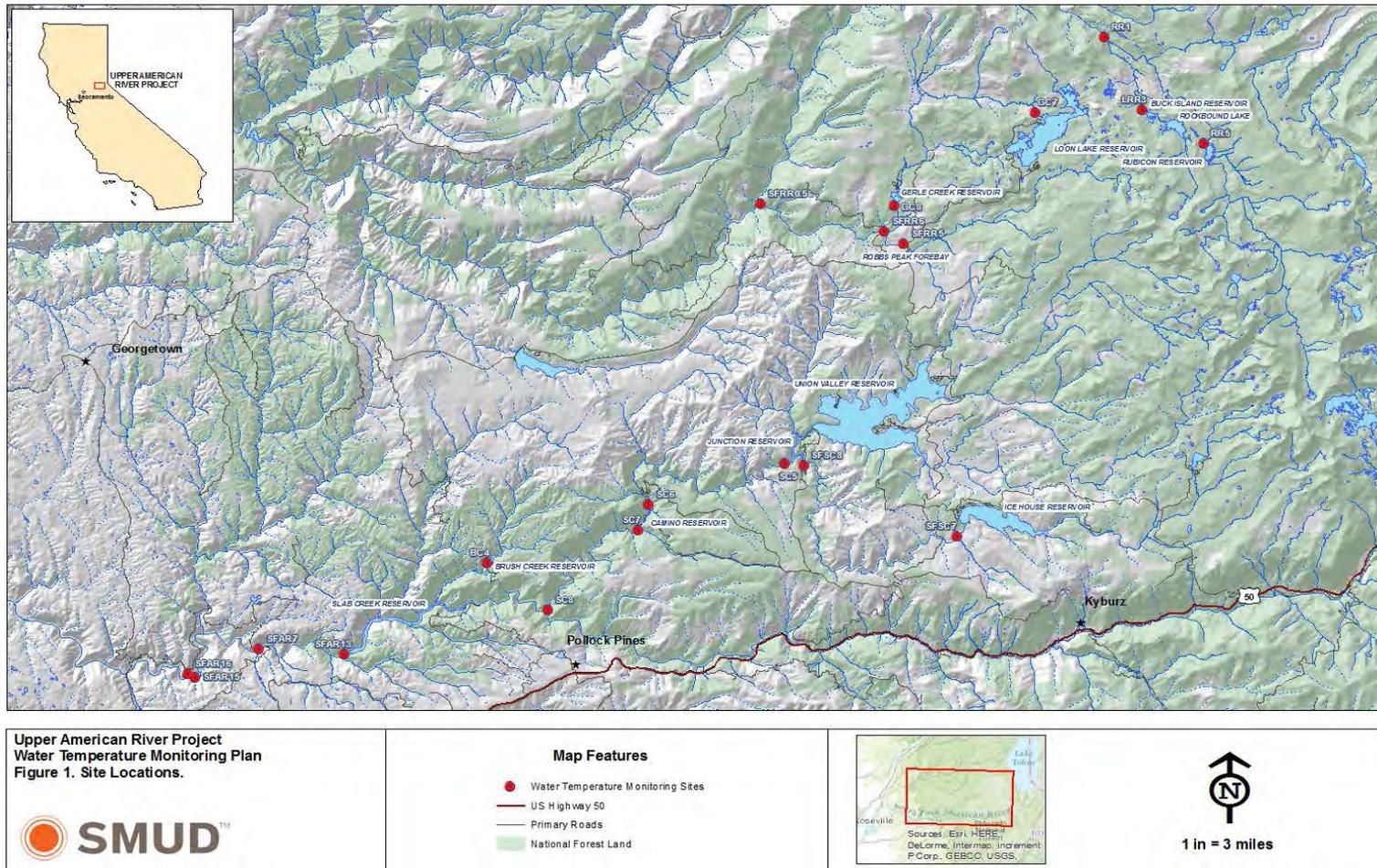


Figure 17 - Location Map