



**El Dorado Hydroelectric Project
FERC Project No. 184**

2016 Water Temperature Monitoring Report

**EL DORADO IRRIGATION DISTRICT
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1.0 INTRODUCTION

1.1 Project Background

The El Dorado Irrigation District (District) owns and operates the El Dorado Hydroelectric Project (Project No. 184), which is licensed by the Federal Energy Regulatory Commission (FERC). The Project No. 184 Monitoring Program¹ requires water temperature monitoring in stream reaches associated with Project No. 184 facilities. The specific monitoring requirements for water temperature monitoring are defined in the approved Project 184 Water Temperature Monitoring Plan (Plan; EID 2012).

Temperature monitoring is required during spring months to help evaluate breeding conditions for amphibians. Monitoring is also required during summer to determine if coldwater beneficial uses are being met in designated Project reaches. Therefore, temperature data obtained for selected stream segments during this study will be used to meet the following objectives:

1. Characterize the temperature in stream segments by continuously monitoring from April to October;
2. Gather and analyze data to determine if water temperatures in the Project Area protect coldwater habitat beneficial uses; and,
3. Identify any project-controllable temperature resource measures that may be necessary for the protection, mitigation, and enhancement of beneficial uses, if applicable.

The majority of the Project Area lies within the South Fork American River (SFAR) drainage, part of the larger Sacramento River Basin. According to the Central Valley Region Basin Plan (CVRWQCB 2011), the designated beneficial uses for this basin include municipal water supply, power supply, contact recreation, non-contact recreation, canoeing and rafting, warm water fish habitat, coldwater fish habitat, coldwater fish spawning, and wildlife habitat. The designated beneficial uses for Lake Aloha, Silver Lake, and Caples Lake include municipal water supply, irrigation, stock watering, industrial process supply, power production, contact recreation, non-contact recreation, warm water and coldwater fish habitat, coldwater fish spawning, and wildlife habitat.

¹ Section 7 of the El Dorado Relicensing Settlement Agreement, U.S. Forest Service 4(e) Condition No. 37, and California State Water Resources Control Board Section 401 Clean Water Act Water Quality Certification Condition No. 13

Echo Lake and Echo Creek lie within the Lahontan Basin. The designated beneficial uses for these facilities include municipal water supply, groundwater recharge, navigation, recreation, commercial and sport fishing, coldwater fisheries, wild trout, and fish spawning (LRWQCB 2005).

Stream flow characteristics in watersheds within the Project Area are highly variable due to annual variations in both precipitation and air temperature, which result in variations in surface water temperatures. This temperature monitoring program has been designed to provide information regarding water temperature in the vicinity of the Project and identify any project-controllable temperature concerns that can be addressed by project management to protect coldwater beneficial uses.

Monitoring conducted in 2016 represents the eighth continuous year of water temperature monitoring performed in accordance with the Plan. Results of the 2016 water temperature monitoring effort are presented herein. 2016 monitoring spreadsheet data (i.e., hourly, daily minimum, daily maximum and average daily water temperatures) is available online at: <http://www.eid.org/our-services/hydroelectric/project-184/project-184-document-library>.

2.0 METHODS

2.1 Site Selection

This water temperature monitoring program was designed to monitor surface water temperatures above and below Project diversions throughout the Project Area. The current Plan requires continuous recording temperature probes at various locations from April 1 through October 31, provided safe access was possible. These sites include:

- T1 Pyramid Creek downstream of Lake Aloha Dam
- T2 Pyramid Creek upstream of South Fork American River
- T3 Echo Creek downstream of Echo Lake Dam
- T4 Echo Creek upstream of Upper Truckee River
- T5 Caples Creek downstream of Caples Lake Dam
- T6 Silver Fork American River downstream of Silver Lake Dam
- T7 Silver Fork American River upstream of South Fork American River
- T8 South Fork American River upstream of Silver Fork Confluence

- T9 South Fork American River downstream of Kyburz Diversion
- T10 South Fork American River upstream of Powerhouse
- T25 South Fork American River at Bridal Veil Picnic Area

In 2016, the District continued monitoring at additional sites not specified in the Plan. These sites are located along the Silver Fork American River and Caples Creek and are intended to provide additional information regarding the water temperature characteristics along the length of the Silver Fork American River:

- T26 South Fork American River downstream of the confluence with the Silver Fork American River and upstream of the Kyburz Diversion Dam
- T27 Silver Fork American River near China Flat Campground
- T28 Silver Fork American River near Devils Gulch Road (Owens Camp)
- T29 Silver Fork American River near Silver Fork Campground (near Fitch Rantz Bridge)
- T30 Silver Fork American River upstream of the confluence of Caples Creek
- T31 Caples Creek upstream of the confluence with Silver Fork American River

2.2 Temperature Recorders

Two ONSET HOBO Water Temperature Pro V2 Data Loggers were installed at each of the above locations on March 22 and 24, 2016, with the exception of Pyramid Creek below Lake Aloha (T1) and locations along the Silver Fork of the American (T7, T27 – T31). T1 at Lake Aloha was installed in Pyramid Creek on June 20, 2016, when the site could be safely accessed following snowmelt. Thermographs for locations T27 – T31 were installed on June 24, 2016, following the opening of Silver Fork Road. Thermographs were installed at T7 on the Silver Fork American River on July 22, 2016 when river conditions allowed safe installation.

All temperature loggers were programmed to record water temperature at 1-hour intervals, 24-hours per day. At each location, one recorder was designated as logger A and the other as logger B, and the two were deployed immediately adjacent to each other for redundancy purposes in the event one logger wasn't reading accurately. Recorders were housed in protective copper sleeves and secured to the stream bank using stainless steel cable. Data were downloaded

from recorders using a HOBO waterproof data shuttle and/or transferred to a laptop computer. All temperature recorders were removed in early November, with the exception of Pyramid Creek below Lake Aloha (T1), which remains installed at the site because the onset of winter weather conditions prevented recovery of dataloggers in 2016. T1 dataloggers will be downloaded as soon as the site can be safely accessed in 2017.

2.3 Data Analysis

Hourly data were initially downloaded using HOBOWare Pro (version 3.1.2) software from which daily maximum, minimum, and average temperatures were calculated. Data were exported and compiled using Microsoft Excel. Daily average, minimum, and maximum temperatures for the each recorder deployed at a given location were compared graphically to search for anomalies. If data anomalies were observed for one recorder, then data from the other recorder were used in the analysis. When no data anomalies were present, the data from logger A were used in the analysis.

For each location, the daily minimum and maximum temperatures and daily average temperatures between upstream and downstream sites were compared.

The thermal preference literature for salmonids (trout and salmon) is vast and widely variable depending upon genetic race of fish, acclimation temperatures, oxygen levels, food supply, and myriad other factors (McCullough 1999, Myrick and Cech 2004, Mathews and Berg 1997, Kupferberg et al. 2009). Based on this information, the generalized criteria for evaluating water temperatures for trout and other coldwater species including amphibians in this report is provided in Table 1.

Table 1. Criteria for evaluating water temperatures for trout and other coldwater species including amphibians in this report

Mean Daily Water Temperatures	Coldwater Species Response
< 20 °C	Optimal growth and survival
20 - 23 °C	Suitable; increased susceptibility to stressors
>23 - 26 °C	Physiological stress and behavioral shifts to compensate
> 26 °C	Adverse effects and potential mortality

3.0 RESULTS AND DISCUSSION

Results of 2016 temperature monitoring are summarized below for each monitoring location along with a general description of characteristics associated with each location. Figures showing the daily mean, maximum, and minimum water temperatures are presented in Appendix A. Daily Mean, maximum and minimum water temperatures are provided in electronic format in Appendix B.

3.1 Pyramid Creek (T1 & T2)

Pyramid Creek is a south-facing watershed located along the Sierra crest. Pyramid Creek drains Lake Aloha and is the highest elevation watershed monitored in this study. T1 is located in Pyramid Creek in the outflow channel just below the dam at Lake Aloha. T2 is located in Pyramid Creek upstream of the Highway 50 crossing. T1 remains installed at the site because the onset of winter weather conditions prevented recovery of dataloggers in 2016. T1 dataloggers will be downloaded as soon as the site can be safely accessed in 2017. There were no anomalies in the data between loggers A and B at T2.

Daily average water temperatures at T2 are shown in Figure 2 (T1 data will be added to Figure 2 when dataloggers are recovered in 2017). Figure 3 will also be updated to show the daily maximum and minimum water temperatures at T1 when the dataloggers are recovered in 2017. Figure 4 shows the daily maximum and minimum water temperatures at T2.

Water temperatures recorded in Pyramid Creek at water temperature monitoring site T2 were within the optimal and suitable range for trout and other coldwater species, including amphibians throughout the monitoring period.

3.2 Echo Creek (T3 & T4)

Echo Creek flows out of Echo Lake and into the Upper Truckee River near the town of Myers, CA. This east-facing watershed is the only watershed in the Project Area that is not within the American River drainage. T3 is located near the Echo Creek gage station approximately 100 meters downstream of the Echo Lake Dam. T4 is located upstream of the confluence with the Upper Truckee River near the town of Myers. Logger A data was used for site T3 because

logger B did not successfully record data for the entire monitoring season. There were no anomalies in the data between loggers A and B at T4.

Daily average water temperatures at T3 and T4 are shown in Figure 5. Figure 6 shows the daily maximum and minimum water temperatures at T3 and Figure 7 shows the daily maximum and minimum water temperatures at T4.

Water temperatures recorded in Echo Creek at monitoring sites T3 and T4 were within the optimal and suitable range for trout and other cold water species, including amphibians throughout the monitoring period.

3.3 Silver Fork American River Watershed (T5, T6, T30, T31, T29, T28, T27, & T7)

The Silver Fork of the American River watershed is the largest tributary in the Project Area. This north-facing watershed near the Sierra crest drains the Kirkwood area between the South Fork American and Mokelumne watersheds. T5 was located in Caples Creek near the gage station below Caples Lake Dam. T6 was located in the Silver Fork American River downstream of Silver Lake Dam. T31 was located in Caples Creek upstream of the footbridge near the confluence of the Silver Fork. T30 was located in Silver Fork American River upstream of the confluence with Caples Creek near Forgotten Flat. T29 was installed in the Silver Fork near Silver Fork Campground (near Fitch Rantz Bridge). T28 was located in the Silver Fork at Devils Gulch Road Bridge downstream of the bridge. T27 was located in the Silver Fork upstream of the foot bridge at China Flat Campground. T7 was located in Silver Fork just above the confluence with the SFAR. There were no anomalies in the data between loggers A and B at T5, T6, T30, T31, T29, T27 and T7. There were no anomalies in the data between loggers A and B at these sites.

Daily average water temperatures at T5, T6, T30, T31, T29, T28, T27 and T7 are shown in Figure 8. The daily maximum and minimum water temperatures at T5, T6, T30, T31, T29, T28, and T27, and T7 are shown in Figures 8-16.

Water temperatures recorded throughout the Silver Fork American River watershed were within the optimal range and suitable range for trout and other coldwater species, including amphibians throughout the monitoring period.

3.4 South Fork American River (T8, T26, T9, T25, and T10)

The SFAR drains the west side of the Sierra Nevada, and is the mainstem river within the Project Area. T8 is located approximately 0.5 miles upstream of the Kyburz Diversion, upstream of the SFAR confluence with the Silver Fork, and is the upstream-most study location in the mainstem. T26 is located immediately upstream of the Kyburz Diversion. T9 is located just downstream of the Kyburz Diversion. T25 is located in the SFAR at Bridal Veil Picnic Area. T10 is located at the downstream end of the Project Area, upstream of the Akin Powerhouse. There were no data anomalies between temperature recorders A and B at T8, T26, T9, T25, and T10. The period of record for T25 site begins on June 24 when river flows allowed safe access for logger installation.

Daily average water temperatures in the SFAR (sites T8, T26, T9, T25, and T10) are shown in Figure 17. Figure 18 shows the daily maximum and minimum water temperatures in the SFAR above the confluence with the Silver Fork (T8). Figure 19 shows the daily maximum and minimum water temperatures in the SFAR above the Kyburz Diversion (T26) and Figure 20 shows the daily maximum and minimum water temperatures in the SFAR below the Kyburz Diversion Dam (T9). Figure 21 shows the daily maximum and minimum water temperatures in the SFAR near the Bridal Veil Picnic Area in the middle of the Project reach. Figure 22 shows the daily maximum and minimum water temperatures in the SFAR upstream of the Akin Powerhouse (T10) at the downstream end of the Project reach.

Using hourly data, the average temperature difference above and below the Kyburz Diversion (between T26 and T9) was 0.03°C from April 1 to October 31, 2016. The maximum difference during this time period was 0.8°C.

As expected, water temperatures in the SFAR increased with the drop in elevation from T8 to T10. Water temperatures at T8, T26, and T9 were within the optimal and suitable range for coldwater species. Water temperatures in the middle (T25) and lower (T10) reaches of the Project were appropriate for the warmer water transitional species assemblage present in this reach (Moyle 2002). The maximum water temperature measured at T10 was recorded on July 30, 2016 (23.3°C) and at T25 on August 3, 2016 (23.6°).

4.0 CONCLUSION

Overall, water temperatures measured in the Project area were within the optimal and suitable range for trout and other coldwater species, including amphibians throughout the study period.

Water temperatures in the middle (T25) and lower (T10) reaches of the Project area begin to warm naturally at lower elevations. The upper reaches of the Project area support cold water species assemblages (e.g., rainbow trout assemblage; Moyle 2002), while the middle and lower reaches are grading into warmer water, and have a transitional species assemblage (pikeminnow-hardhead-sucker assemblage) reflective of this natural change and incrementally warmer water caused by higher ambient air temperatures.

5.0 REFERENCES

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Reference to Chinook Salmon. EPA 910-R-99-010. U.S. Environmental Protection Agency, Portland OR. 279 pp.

Moyle, P. B. 2002. Inland Fishes of California. Second Edition. University of California Press. Berkeley. 502pp

Myrick, C., and J. Cech Jr. 2004. Temperature Effects on Juvenile Anadromous Salmonids in California's Central Valley: What Don't We Know. Reviews in Fish Biology and Fisheries 14: 113-123.

Appendix A:

Figures



Figure 1. Locations of Annual Temperature Monitoring Stations, 2016. FERC Project No. 184.

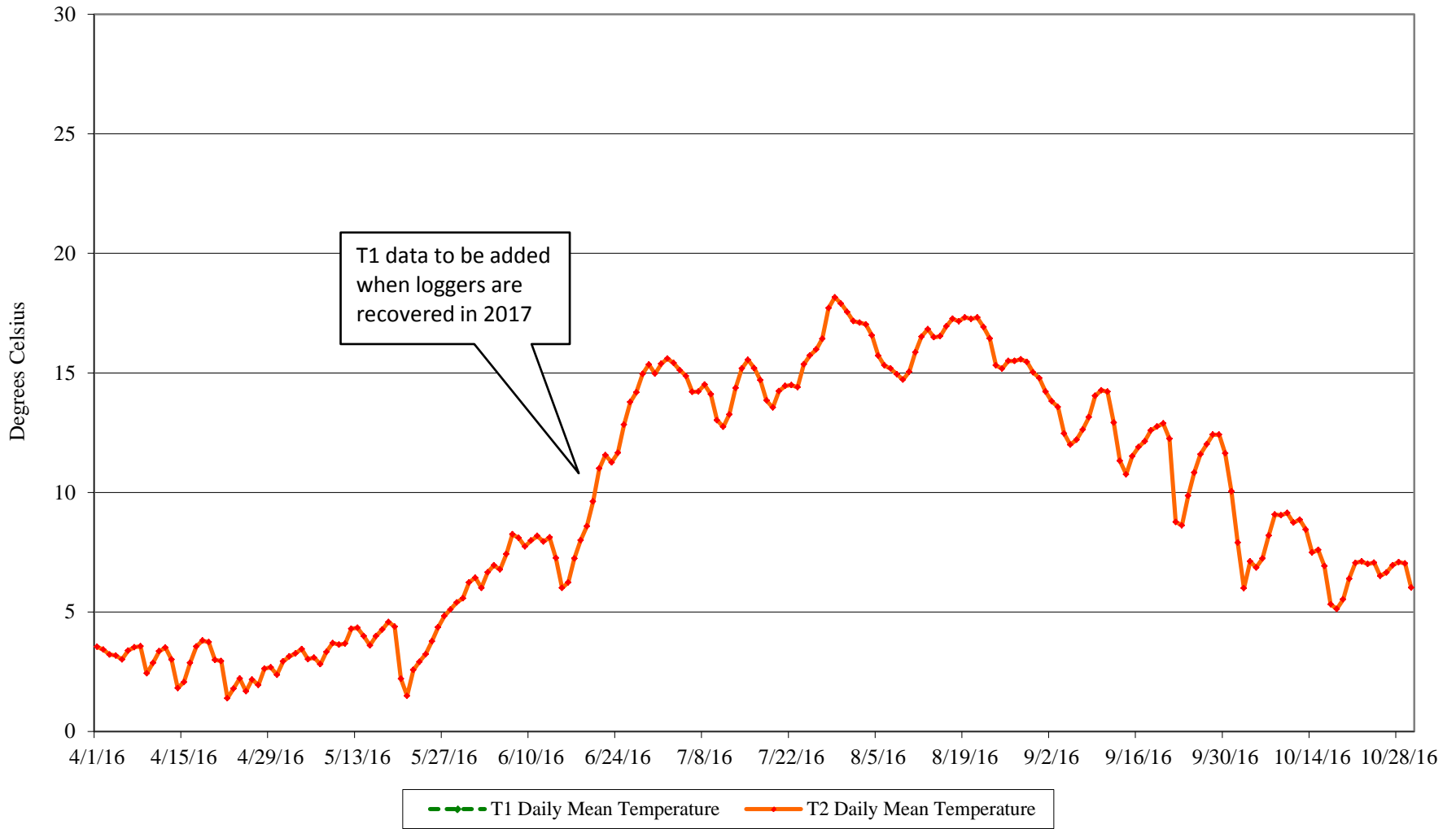


Figure 2. Daily Mean Temperature in Pyramid Creek at Pyramid Creek below Lake Aloha (T1) & Pyramid Creek upstream of the SFAR (T2)

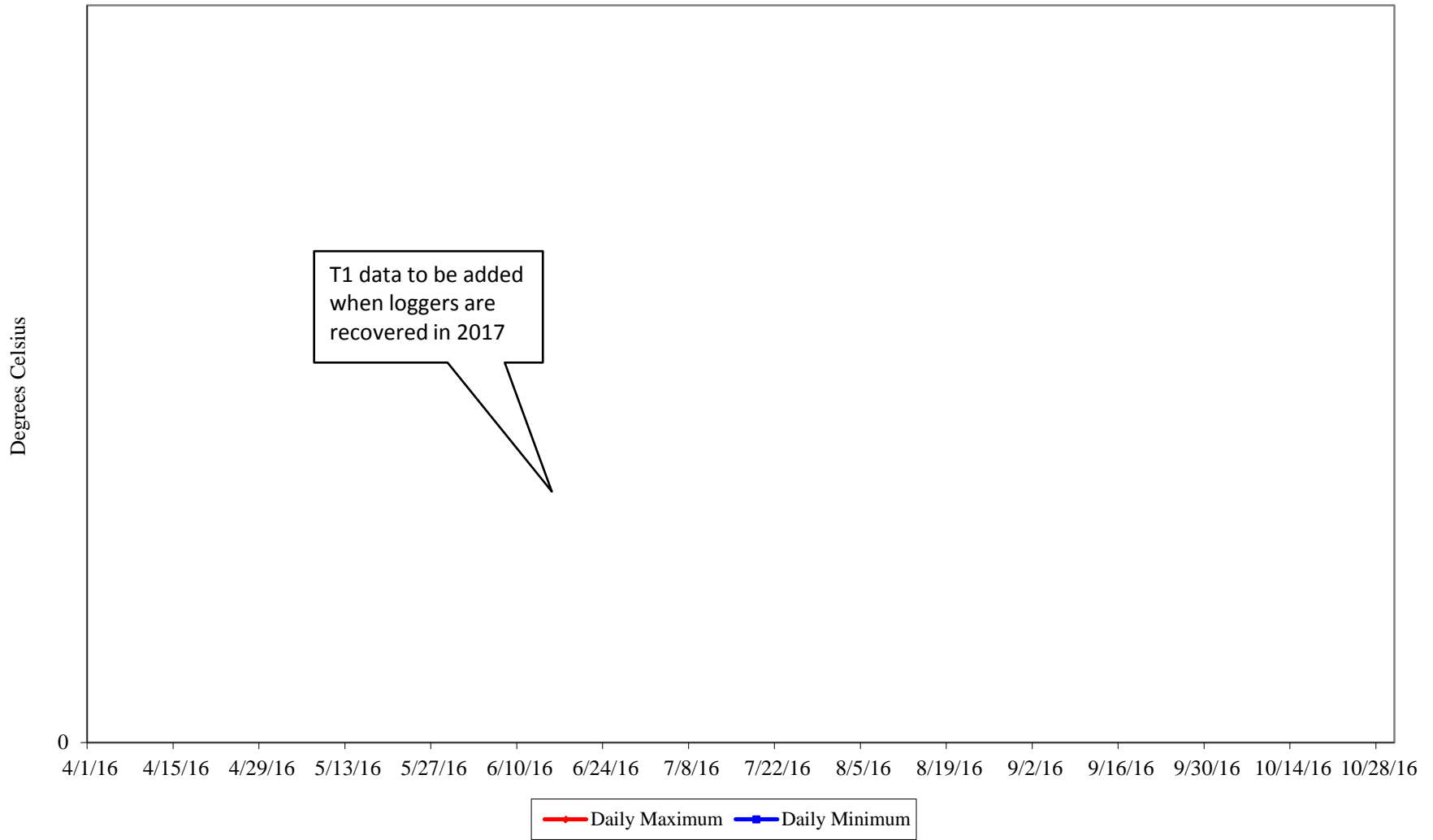


Figure 3. Daily Maximum and Minimum Water Temperatures in Pyramid Creek below Lake Aloha, T1

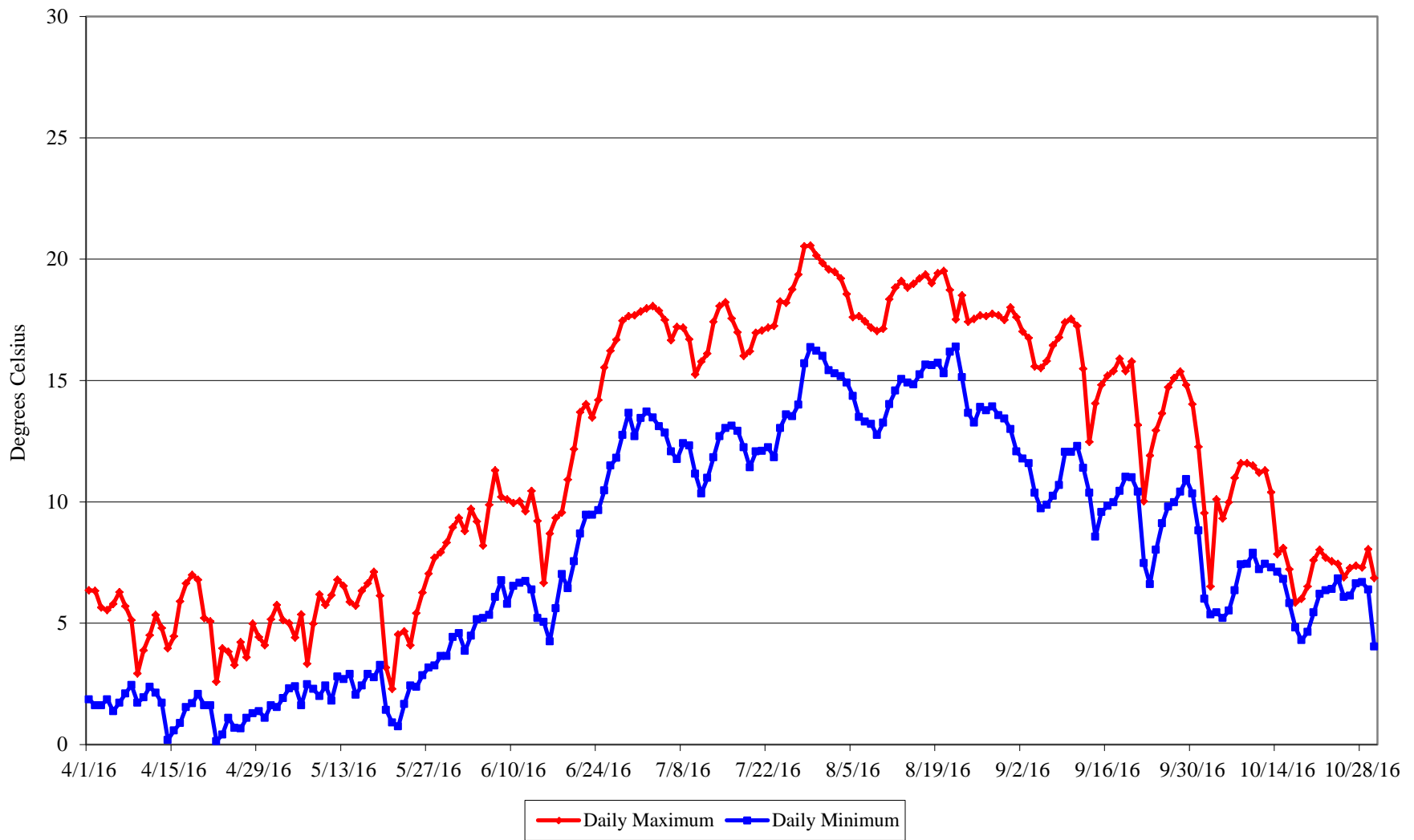


Figure 4. Daily Maximum and Minimum Water Temperatures in Pyramid Creek upstream of the SFAR, T2

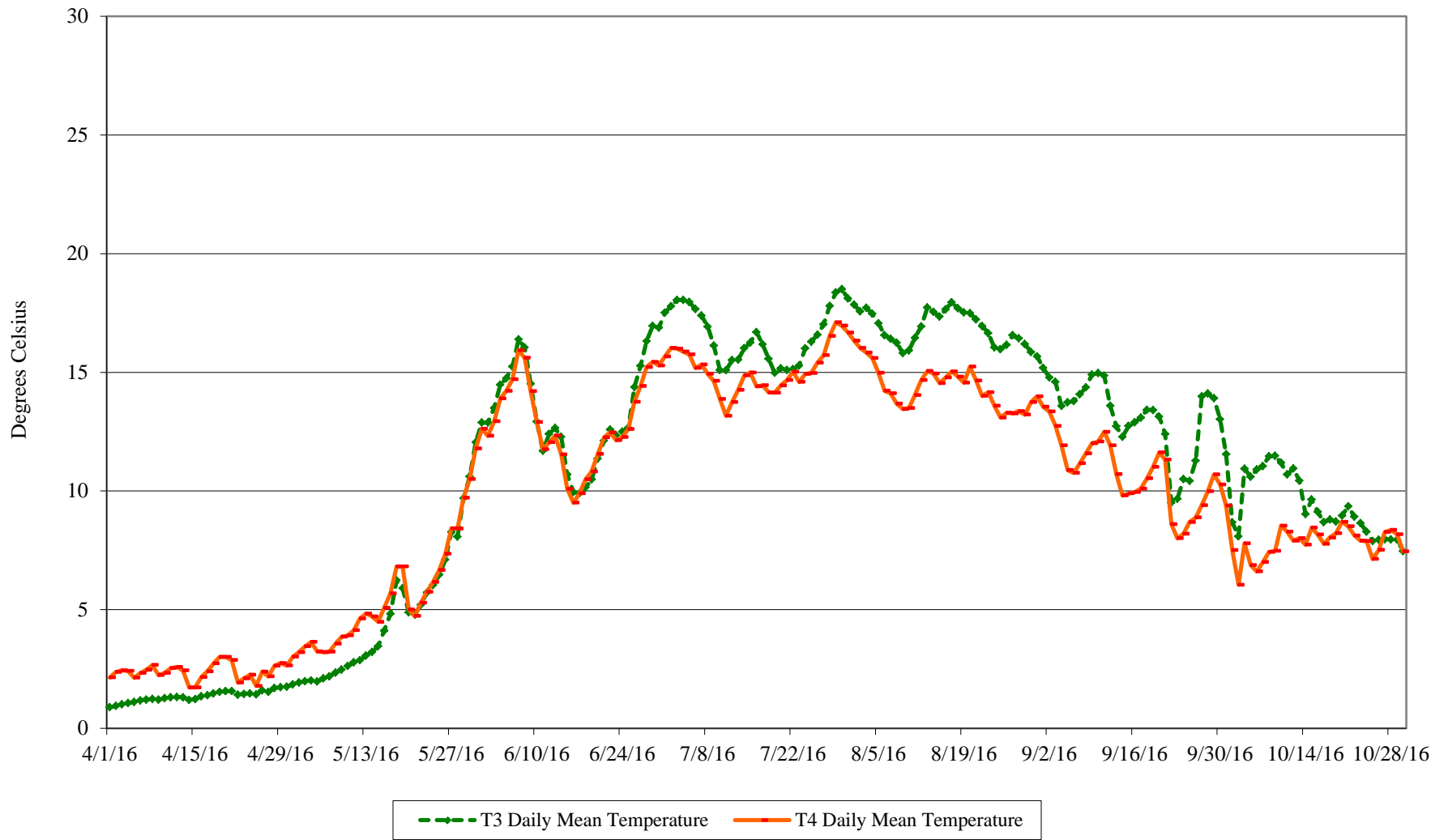


Figure 5. Daily Mean Temperature in Echo Creek at T3 & T4

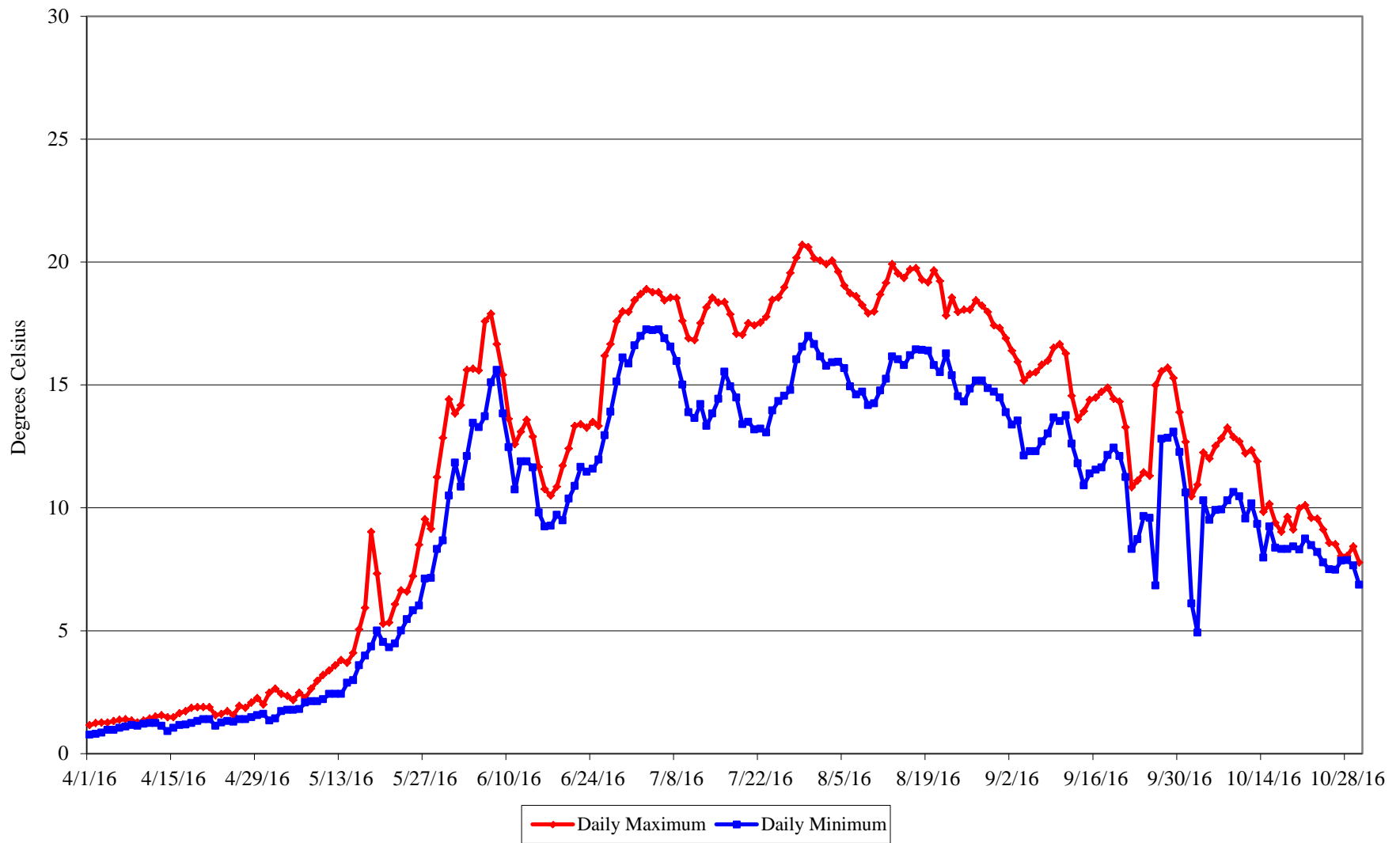


Figure 6. Daily Maximum and Minimum Water Temperatures Echo Creek downstream of dam , T3

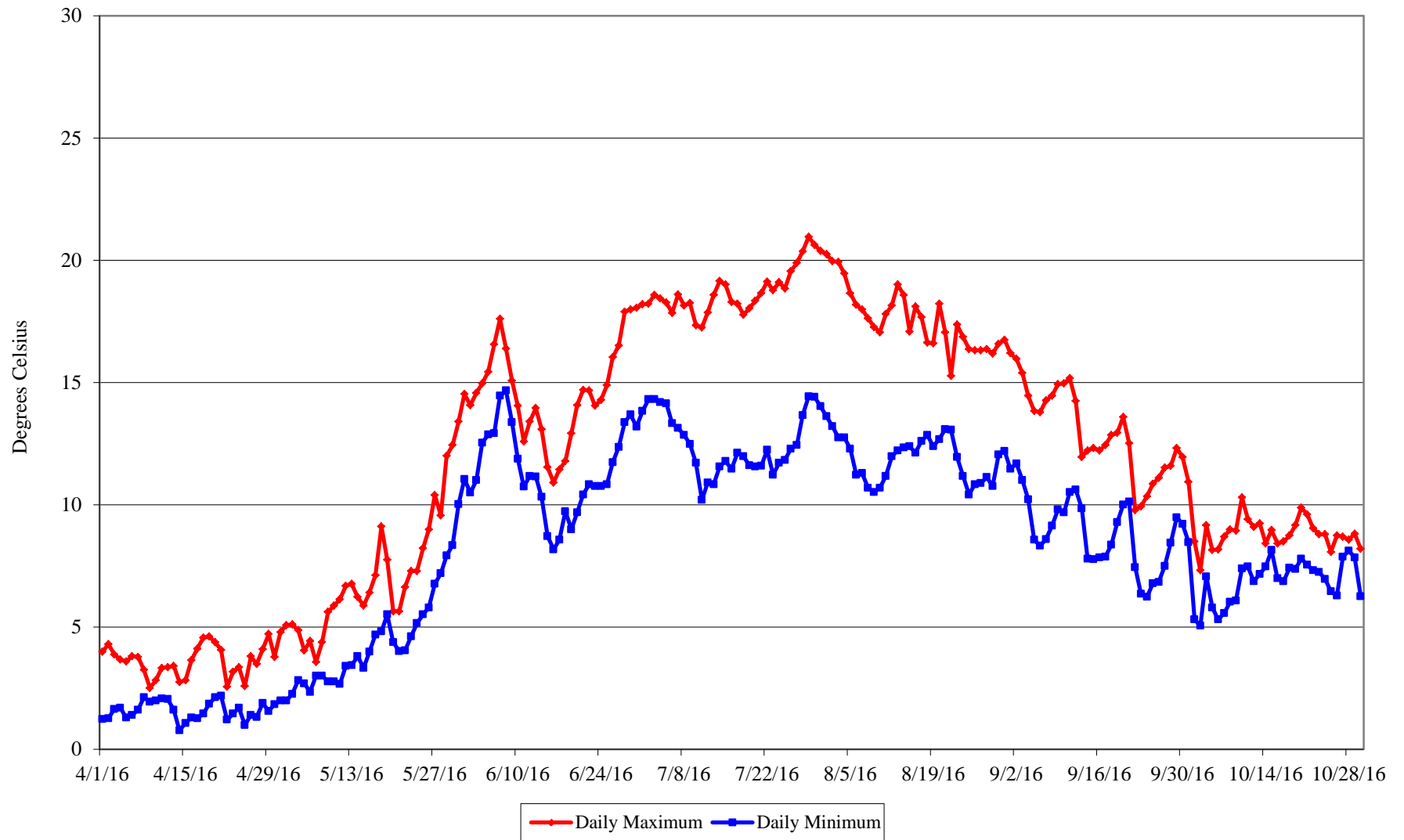


Figure 7. Daily Maximum and Minimum Water Temperatures in Echo Creek upstream of Upper Truckee R. T4

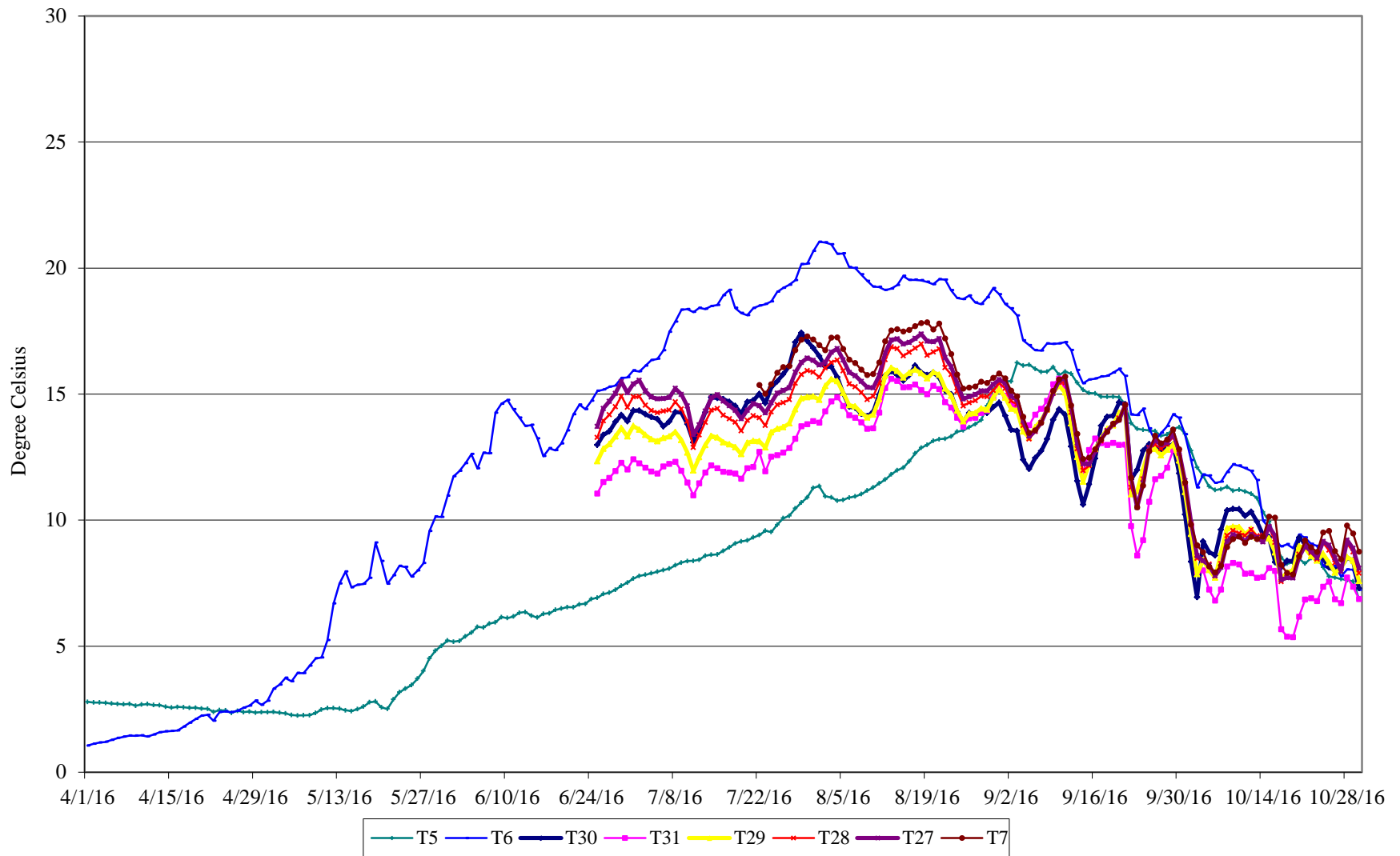


Figure 8. Daily Mean Temperature in Silver Fork of the American River and Caples Creek at T5, T6, T30, T29, T28, T27 and T7

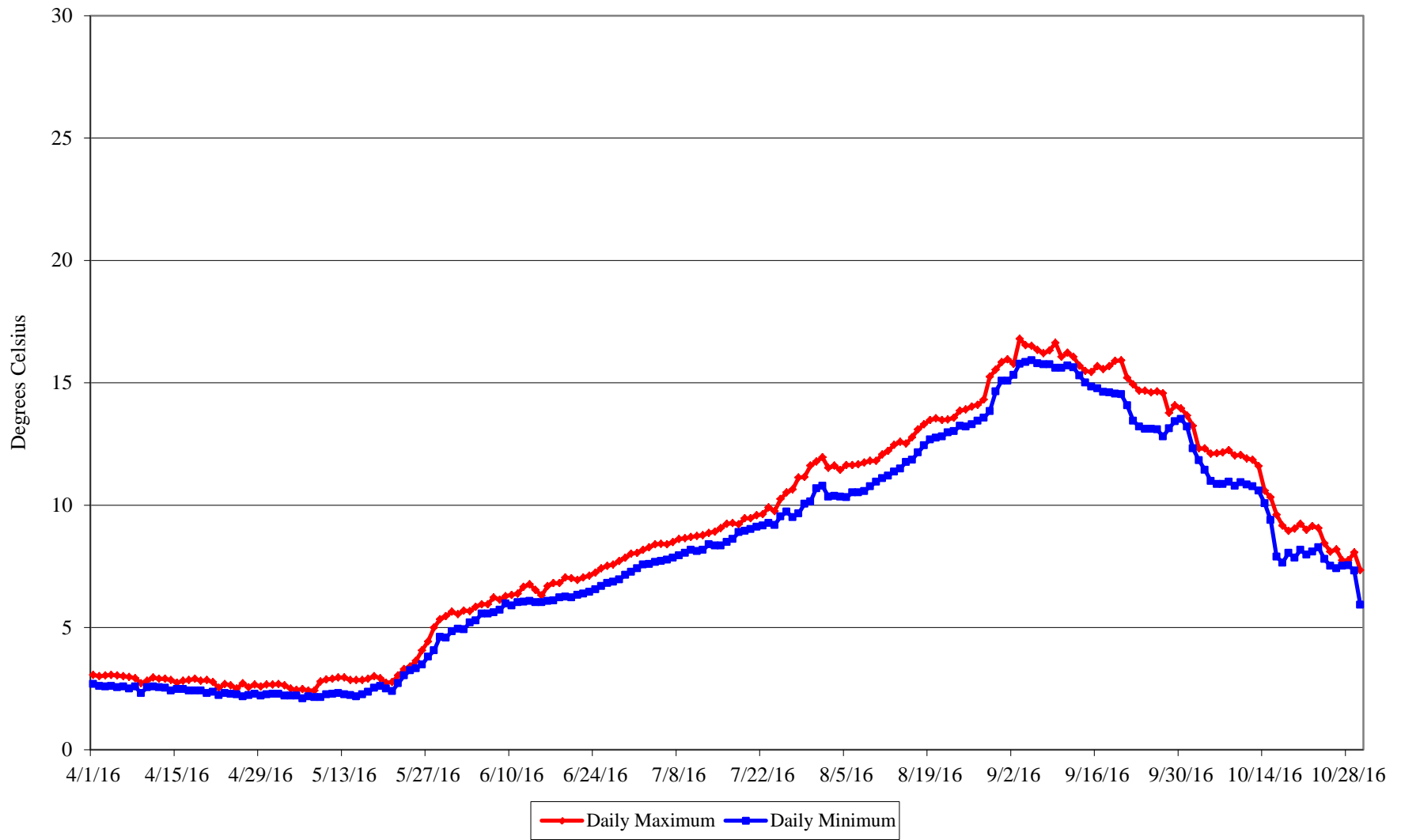


Figure 9. Daily Maximum and Minimum Water Temperatures in Caples Creek below Caples Lake T5

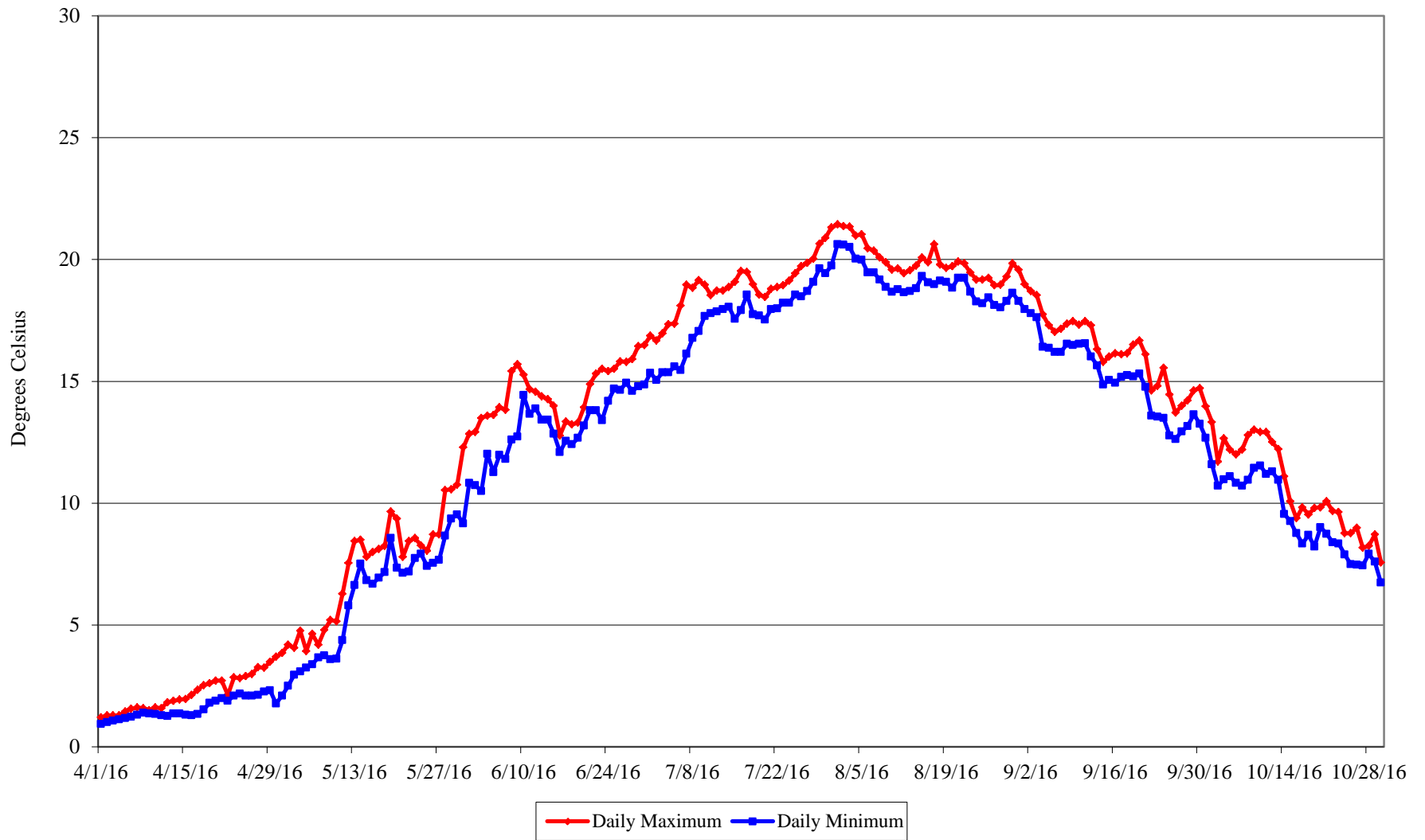


Figure 10. Daily Maximum and Minimum Water Temperatures in Silver Fork below Silver Lake T6

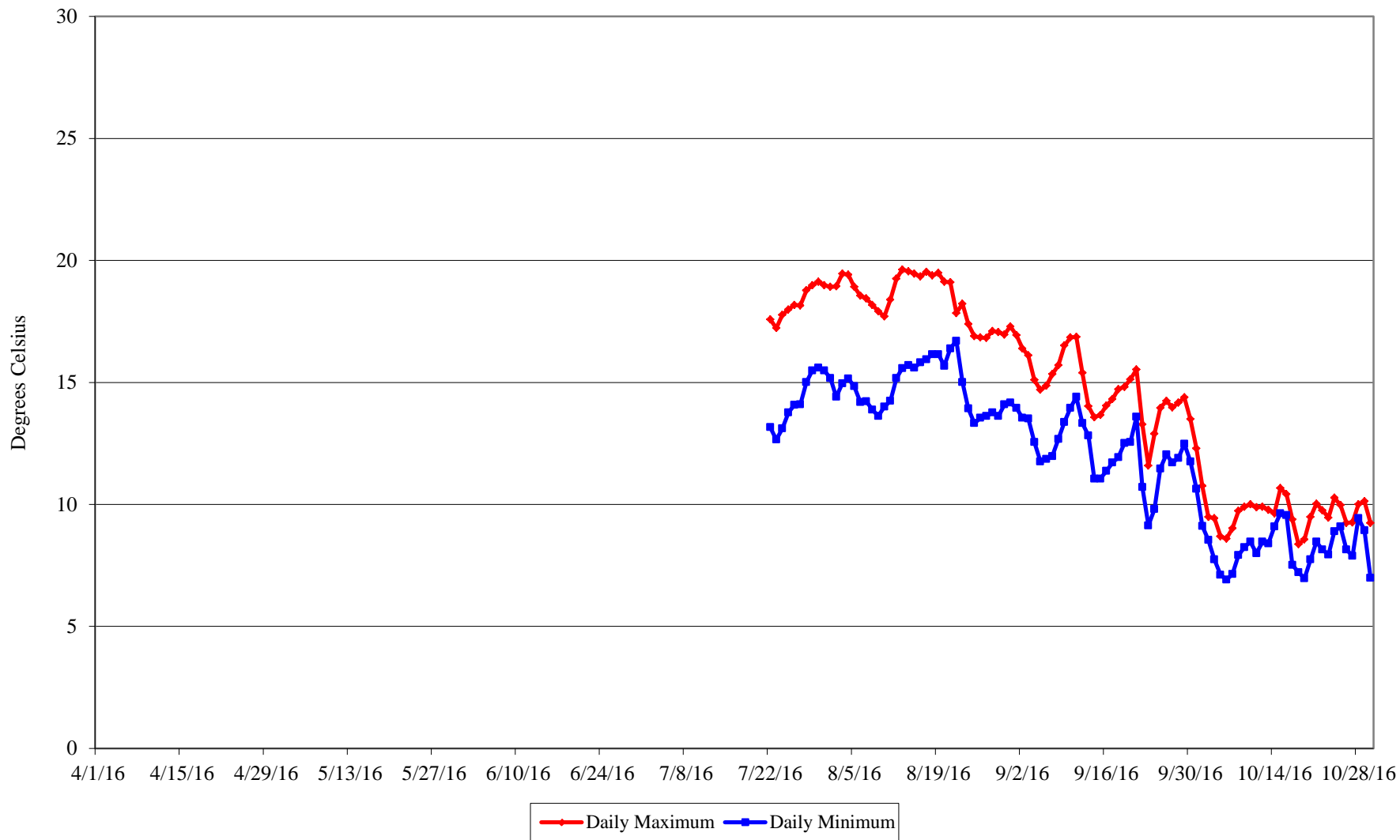


Figure 11. Daily Maximum and Minimum Water Temperatures in Silver Fork above SF American, T7

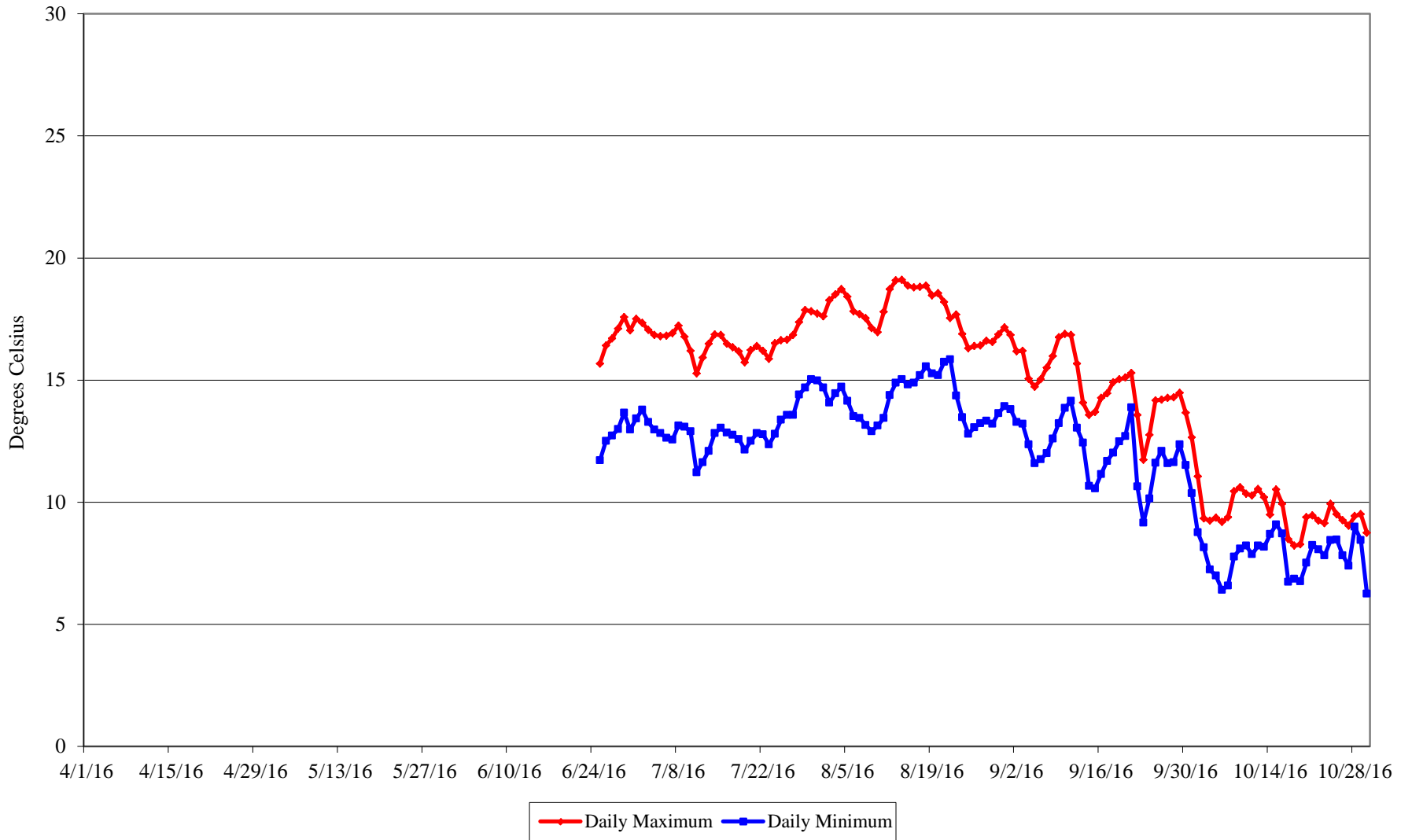


Figure 12. Daily Maximum and Minimum Water Temperatures in Silver Fork at China Flat Campground, T27

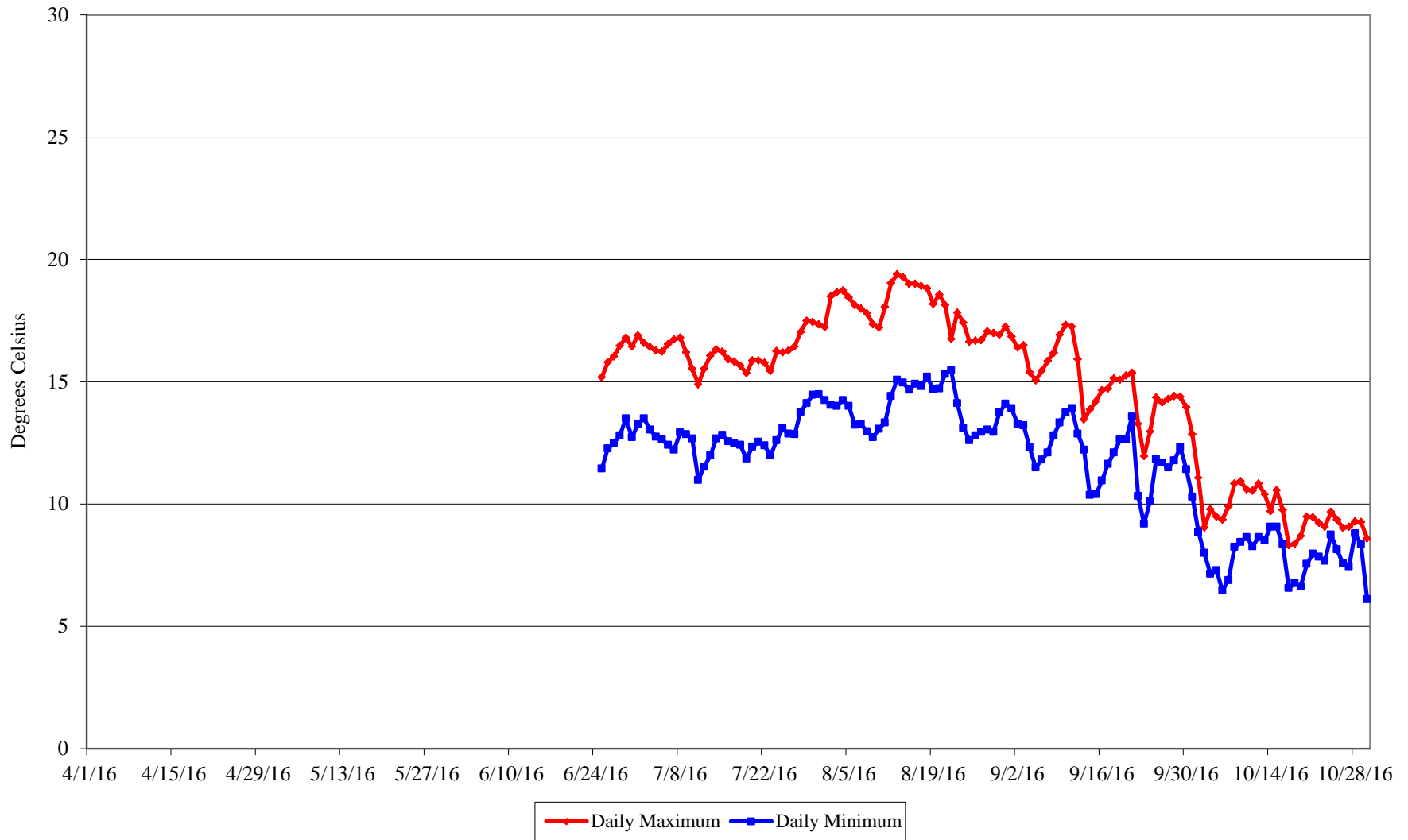


Figure 13. Daily Maximum and Minimum Water Temperatures in Silver Fork at Devils Gulch, T28

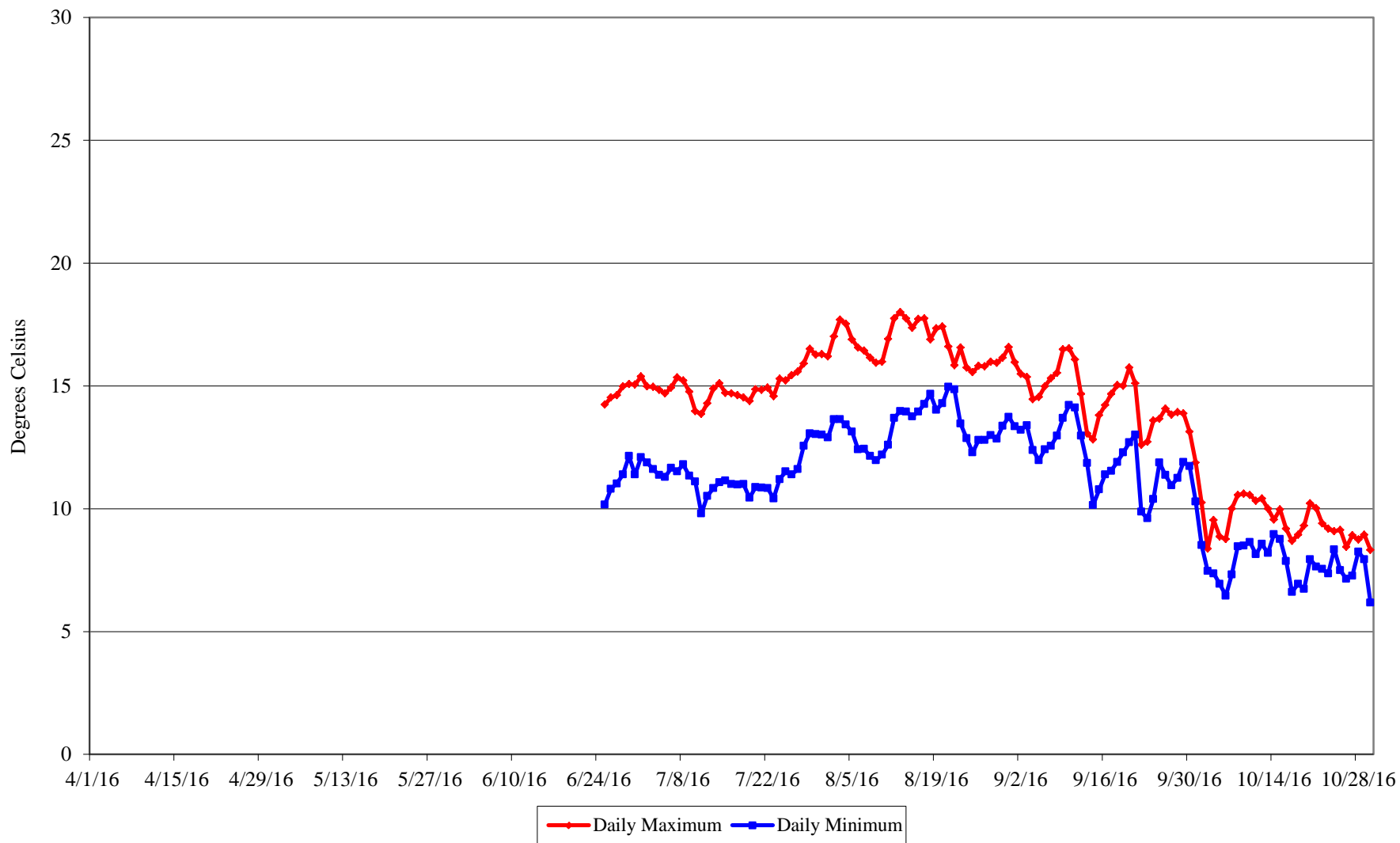


Figure 14. Daily Maximum and Minimum Water Temperatures in Silver Fork near Fitch Rantz Bridge, T29

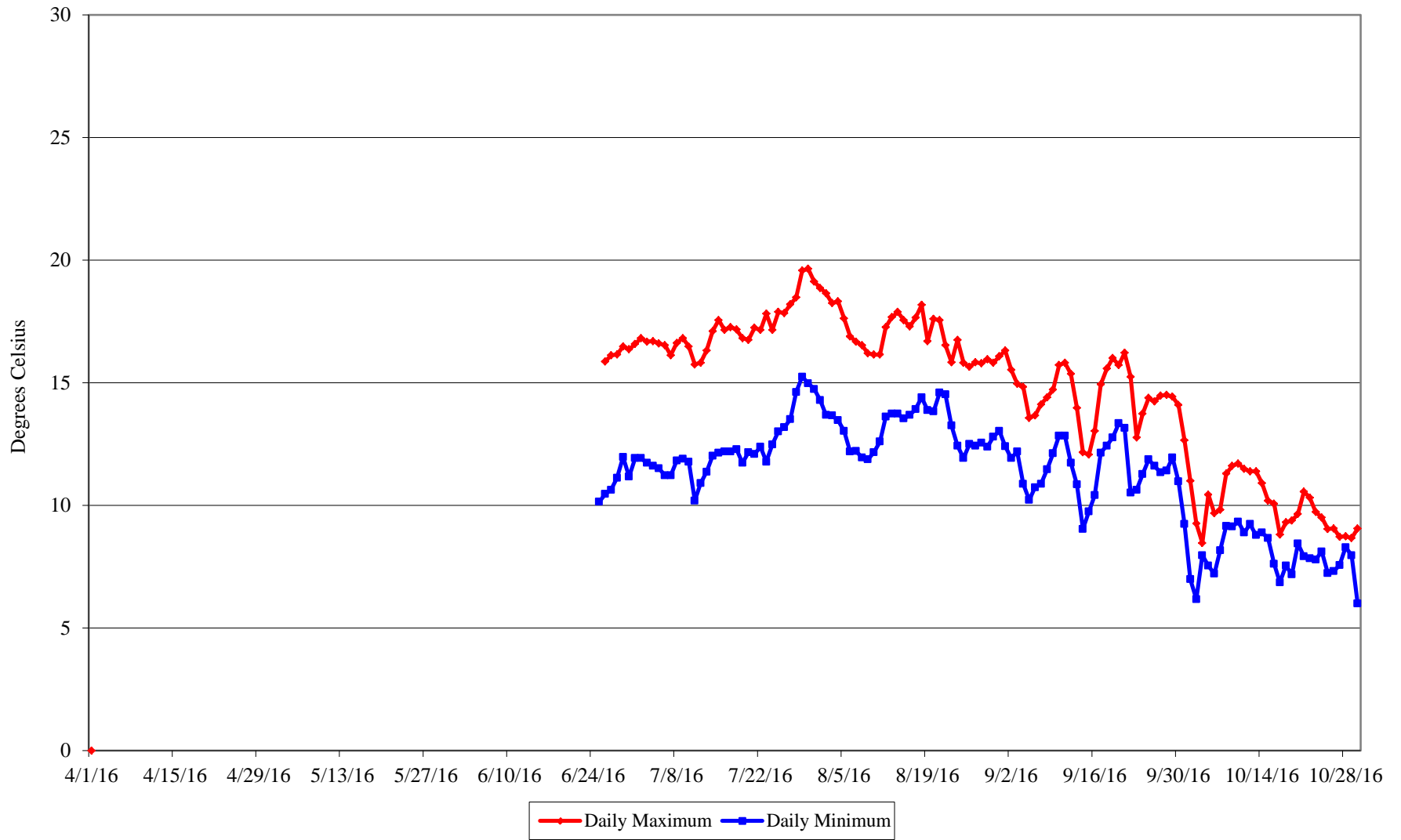


Figure 15. Daily Maximum and Minimum Water Temperatures in Silver Fork upstream of the confluence with Caples Creek, T30

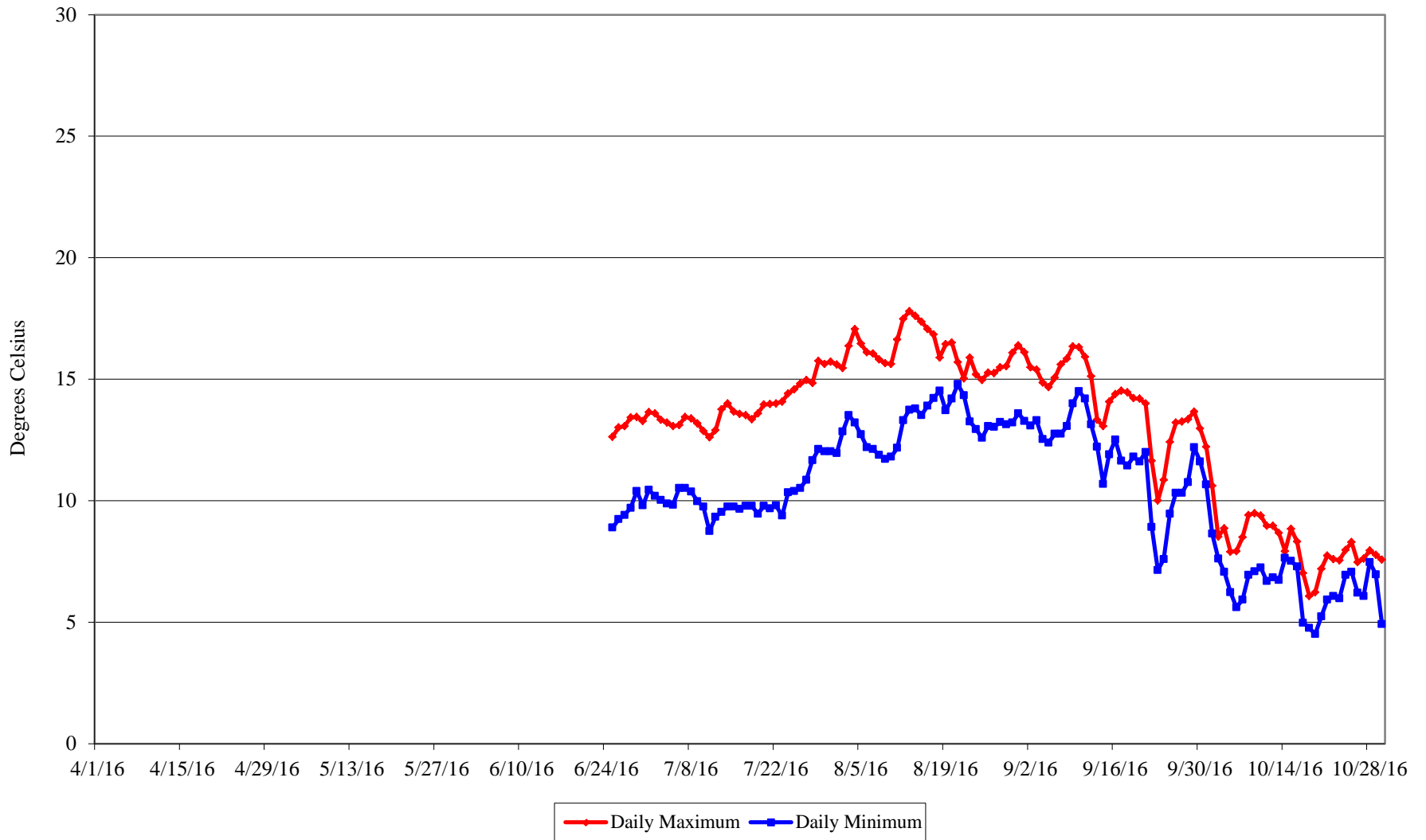


Figure 16. Daily Maximum and Minimum Water Temperatures Caples Creek upstream of the confluence with Silver Fork American River, T31

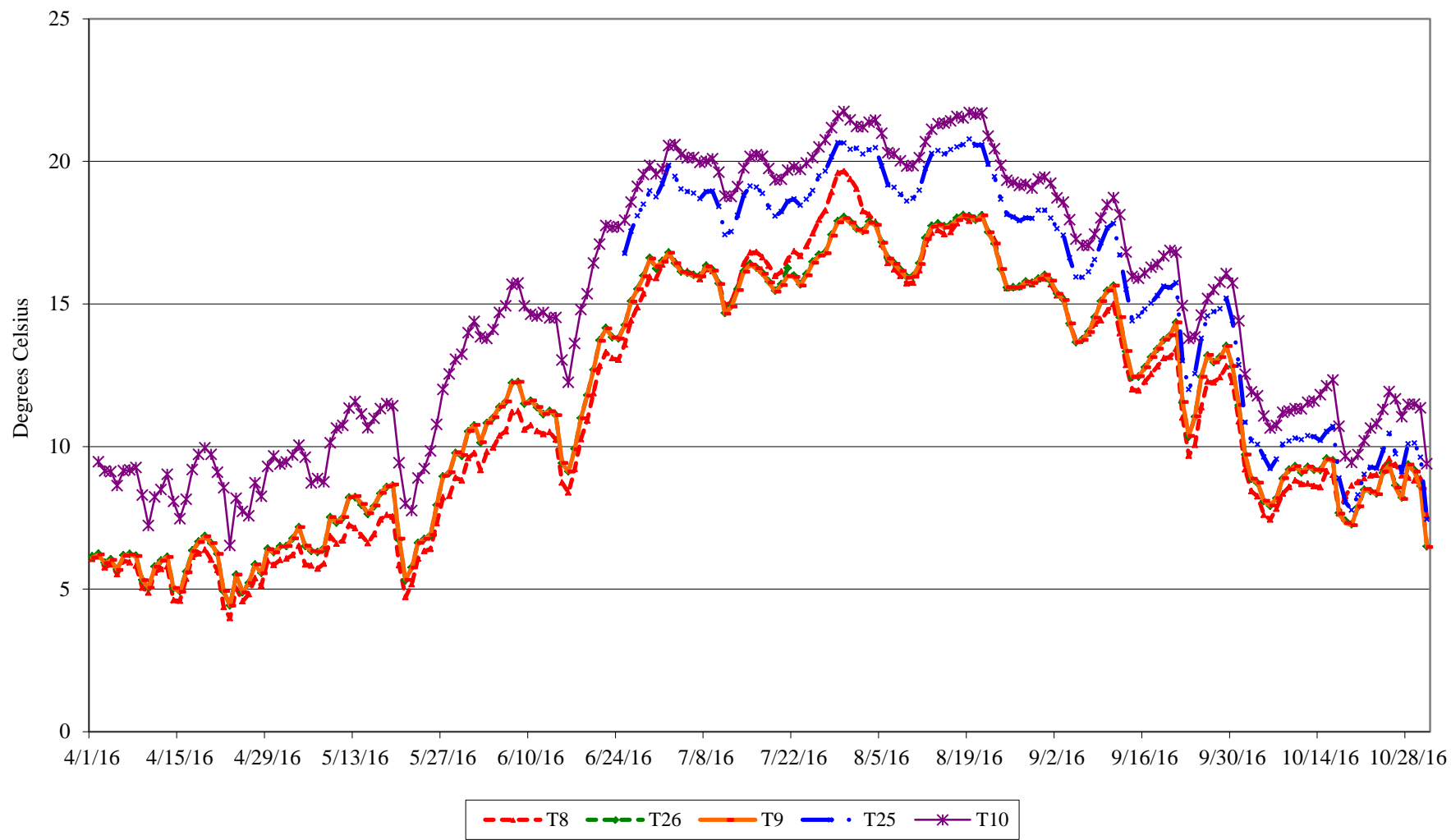


Figure 17. Daily Mean Temperature in the SF American River T8, T26, T9, T25, & T10

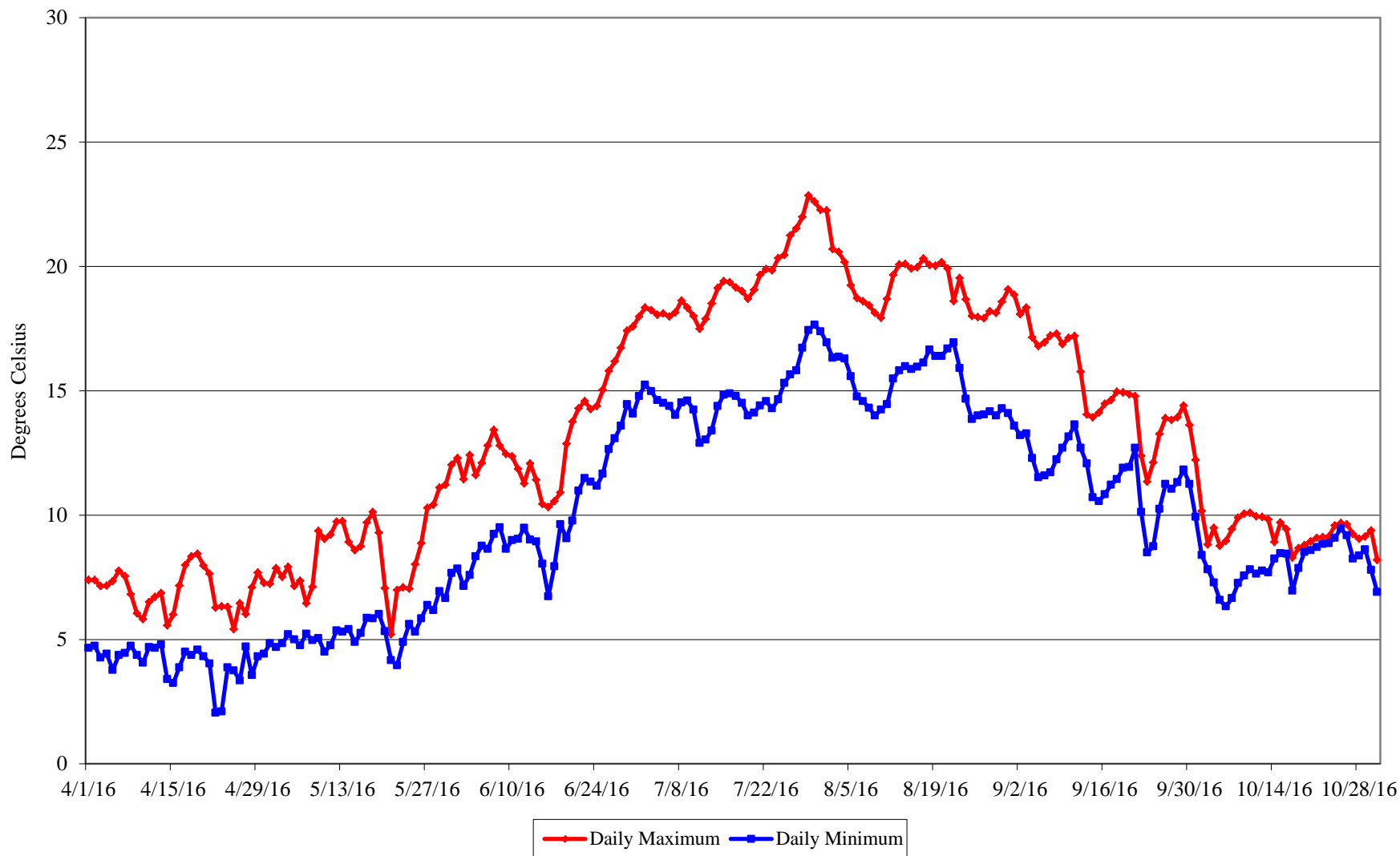


Figure 18. Daily Maximum and Minimum Water Temperatures in the SF American above Silver Fork, T8

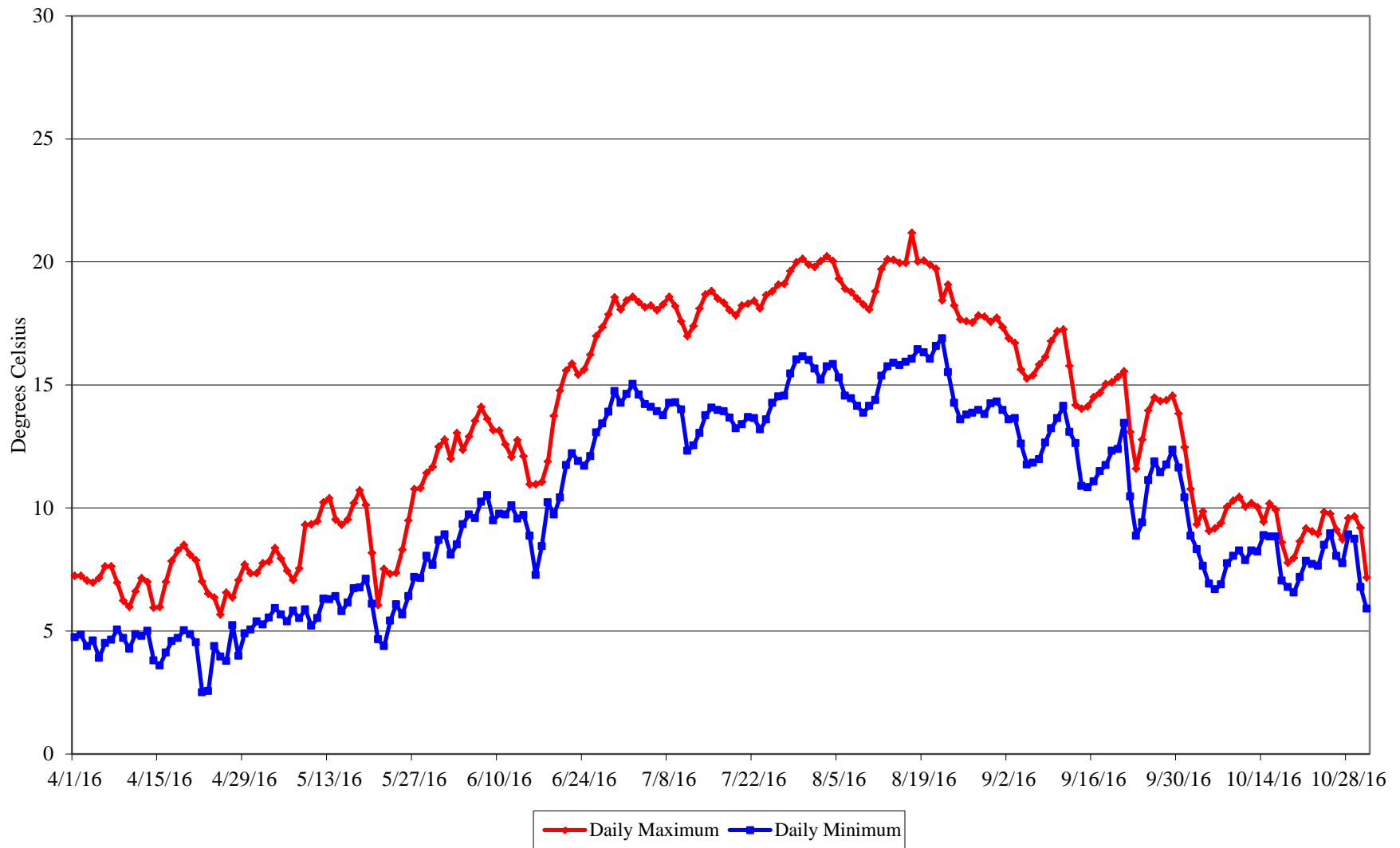


Figure 19. Daily Maximum and Minimum Water Temperatures in the SFAR above Kyburz Diversion, T26

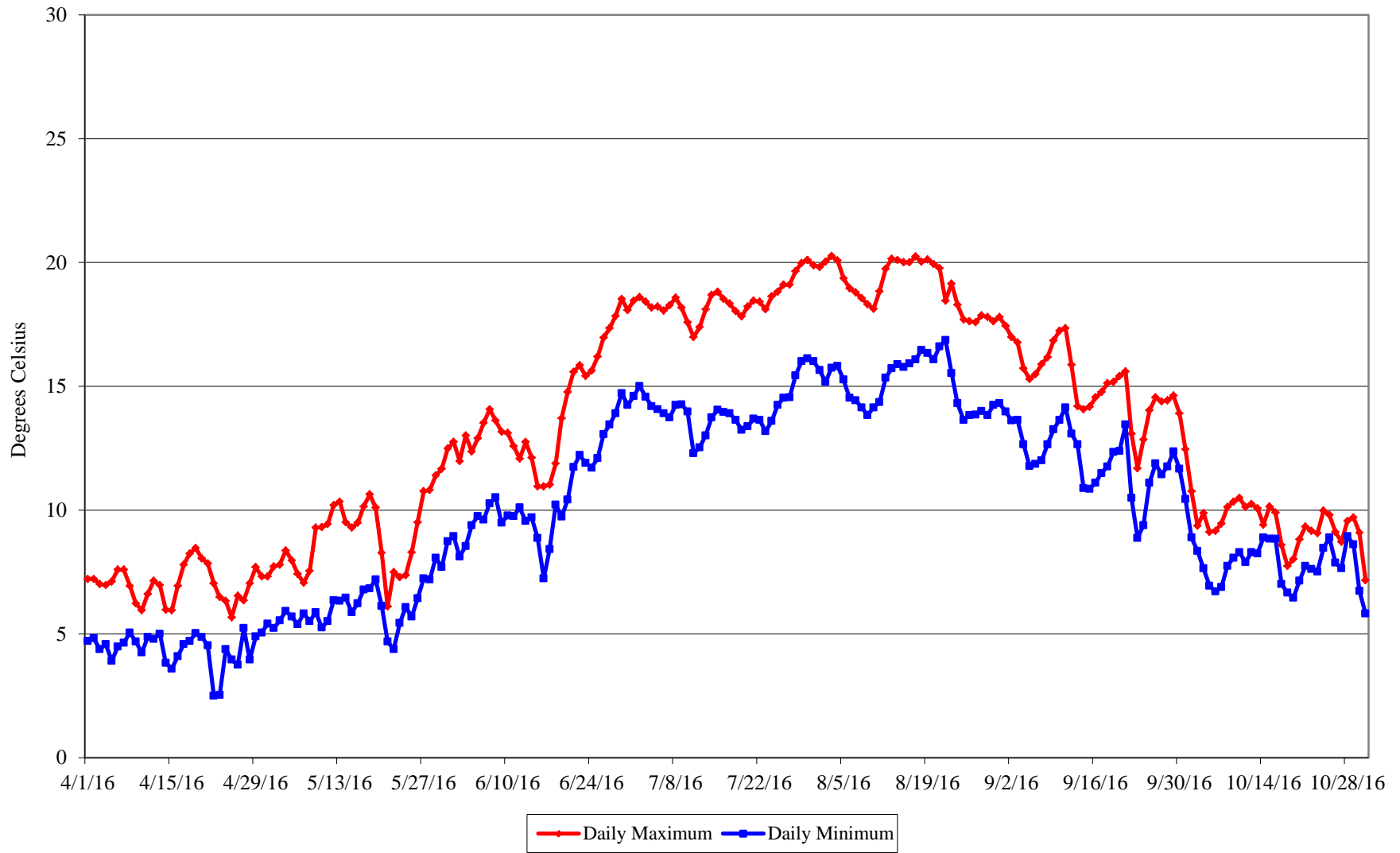


Figure 20. Daily Maximum and Minimum Water Temperatures in the SF American below Kyburz Diversion, T9

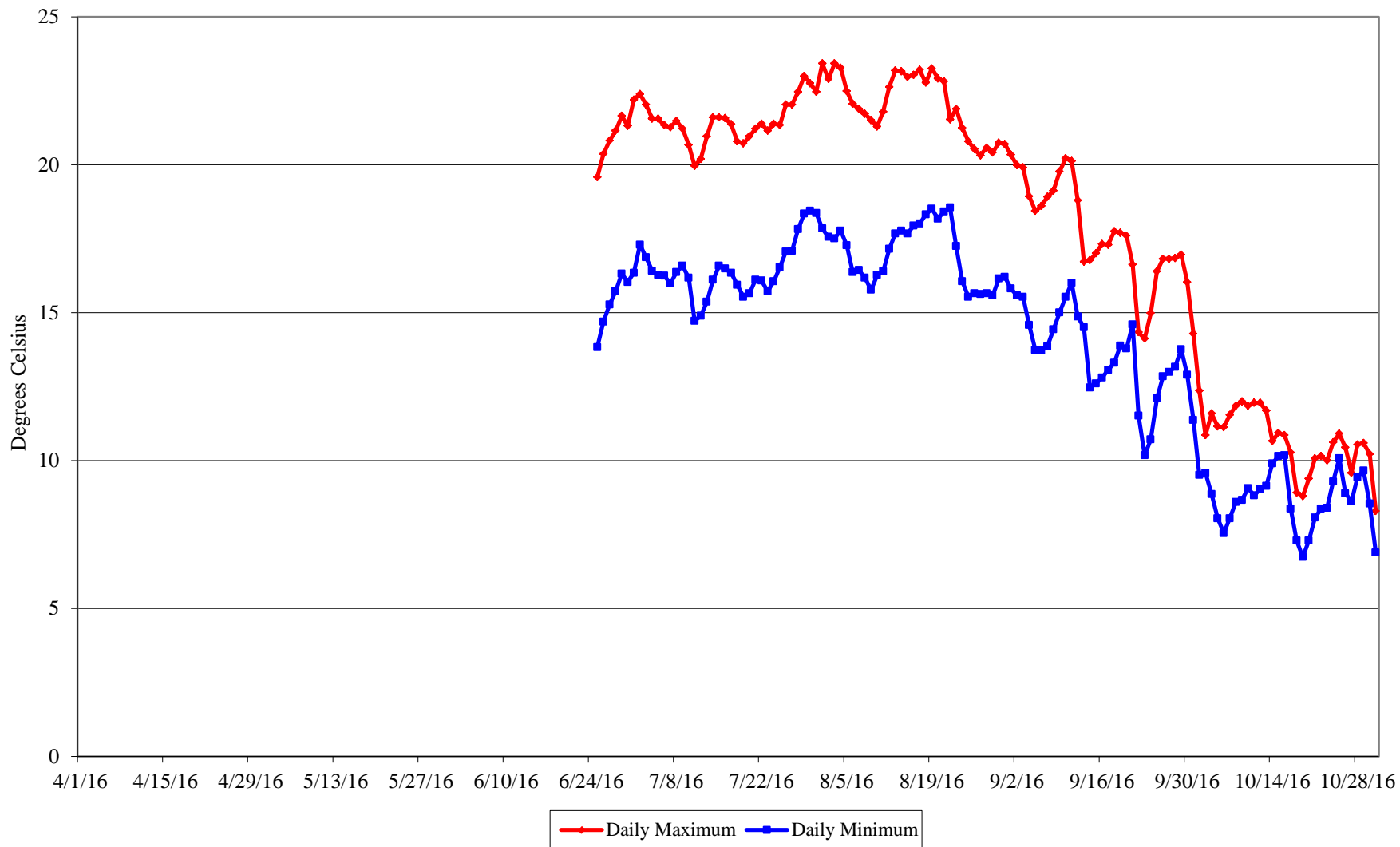


Figure 21. Daily Maximum and Minimum Water Temperatures in the SFAR at Bridalveil Picnic Area, T25

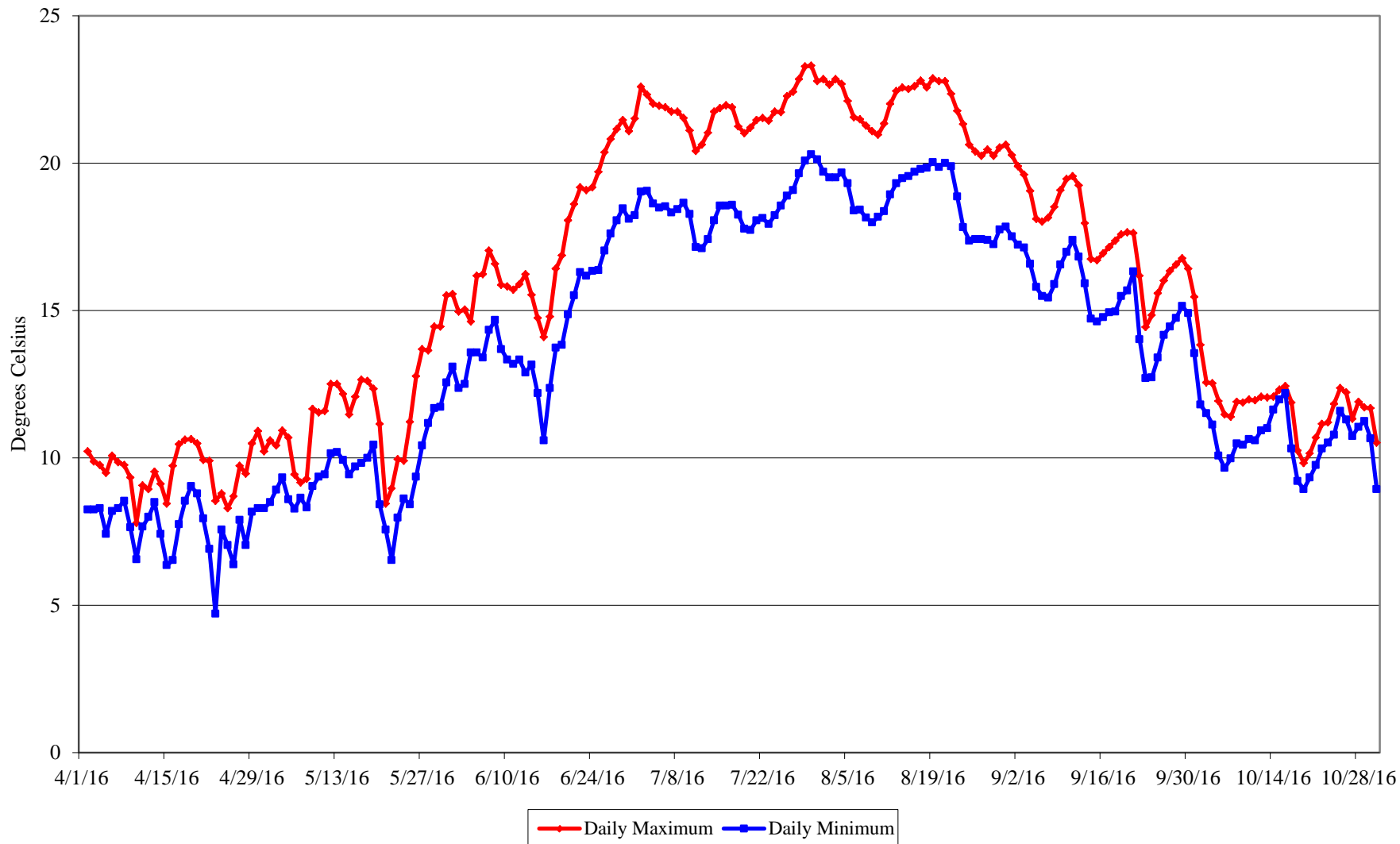


Figure 22. Daily Maximum and Minimum Water Temperatures in the SFAR at Akin Powerhouse, T10