El Dorado Hydroelectric Project
FERC Project No. 184

2013 Water Temperature Monitoring Report

EL DORADO IRRIGATION DISTRICT
2890 Mosquito Road
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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 Program[1] 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 2013 represents the fifth continuous year of water temperature monitoring performed in accordance with the Plan. Results of the 2013 water temperature monitoring effort are presented herein.

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 2012, the District conducted monitoring at additional sites not specified in the Plan. In accordance with recommendations contained within the 2012 monitoring report (EID 2013), thermographs were deployed in 2013 at the following sites along the Silver Fork American River and Caples Creek in order to better understand the water temperature characteristics along the length of the Silver Fork:

- 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 25 and 26, 2013, with the exception of Pyramid Creek below Lake Aloha (T1) and locations along the Silver Fork of the American (T27 – T31), which were not accessible due to snow. T1 at Lake Aloha was installed in Pyramid Creek on May 2, 2013. Thermographs for locations T27 – T31 were installed on May 13, 2013.

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 transferred to a laptop computer.

Temperature recorders were left in place throughout the entire study period and removed in early November.

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:

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 2013 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. Logger B data was used for analysis at T1 because the battery in logger A expired and the logger did not record a complete data set. There were no anomalies in the data between loggers A and B at T2.

Daily average water temperatures at T1 and T2 are shown in Figure 2. Figure 3 shows the daily maximum and minimum water temperatures at T1, while Figure 4 shows the daily maximum and minimum water temperatures at T2.

Water temperatures recorded in Pyramid Creek at water temperature monitoring sites T1 and T2 were within the optimal and suitable range for trout and other coldwater species, including amphibians.

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 B data was used for analysis at T3 because the battery in logger A expired and the logger did not record a complete data set. 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, while Figure 7 shows the daily maximum and minimum water temperatures at T4.

Water temperatures recorded in Echo Creek downstream of Echo Lake Dam (T3) and upstream of the Upper Truckee River (T4) were within the optimal and suitable range for trout and other cold water species, including amphibians.

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 confluence of the Silver Fork upstream of the footbridge. 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 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. Water temperature recorders at T5, T6, and T7 were installed in late March. Water temperature recorders T27 - T31 were installed on May 14, 2013 after snowmelt and runoff conditions allowed safe access. There were no anomalies in the data between loggers A and B at T5, T6, T7, T27, T28, T30, and T31.

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.

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 T9 and T26. The batteries of Logger A failed at sites T10 and T25;

therefore logger B was used for the data analysis at these sites. The period of record for T8 site begins on July 25 because both loggers were missing and not recovered.

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), while 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 0.1°C from April to October 1, 2012. The maximum difference during this time period was 0.5°C. October was excluded from this analysis because there were the daily maximum values recorded at site T26 indicates the loggers may have been in very shallow water and/or exposed to ambient air temperatures. Additionally, there are no Project-related effects above and below the Kyburz Diversion during this time because no diversions occurred in October due to the annual canal maintenance outage.

As expected, water temperatures in the SFAR increased with the drop in elevation from T8 to T10. Water temperatures at T8, T26, T9, and T25 were within the optimal and suitable range for coldwater species, including amphibians. Water temperatures upstream of the powerhouse (T10) were appropriate for the warmer water transitional species assemblage present in this reach (Moyle 2002).

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.

5.0 RECOMMENDATIONS

EID recommends continuing monitoring at the following locations in 2014 to better understand the water temperature characteristics throughout the Silver Fork:

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

EID plans to install new water temperature loggers at all sites in 2014 because existing loggers are near end of estimated battery-life.

6.0 REFERENCES

Central Valley Regional Water Quality Control Board. 2011. 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.

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Appendix A:
Figures

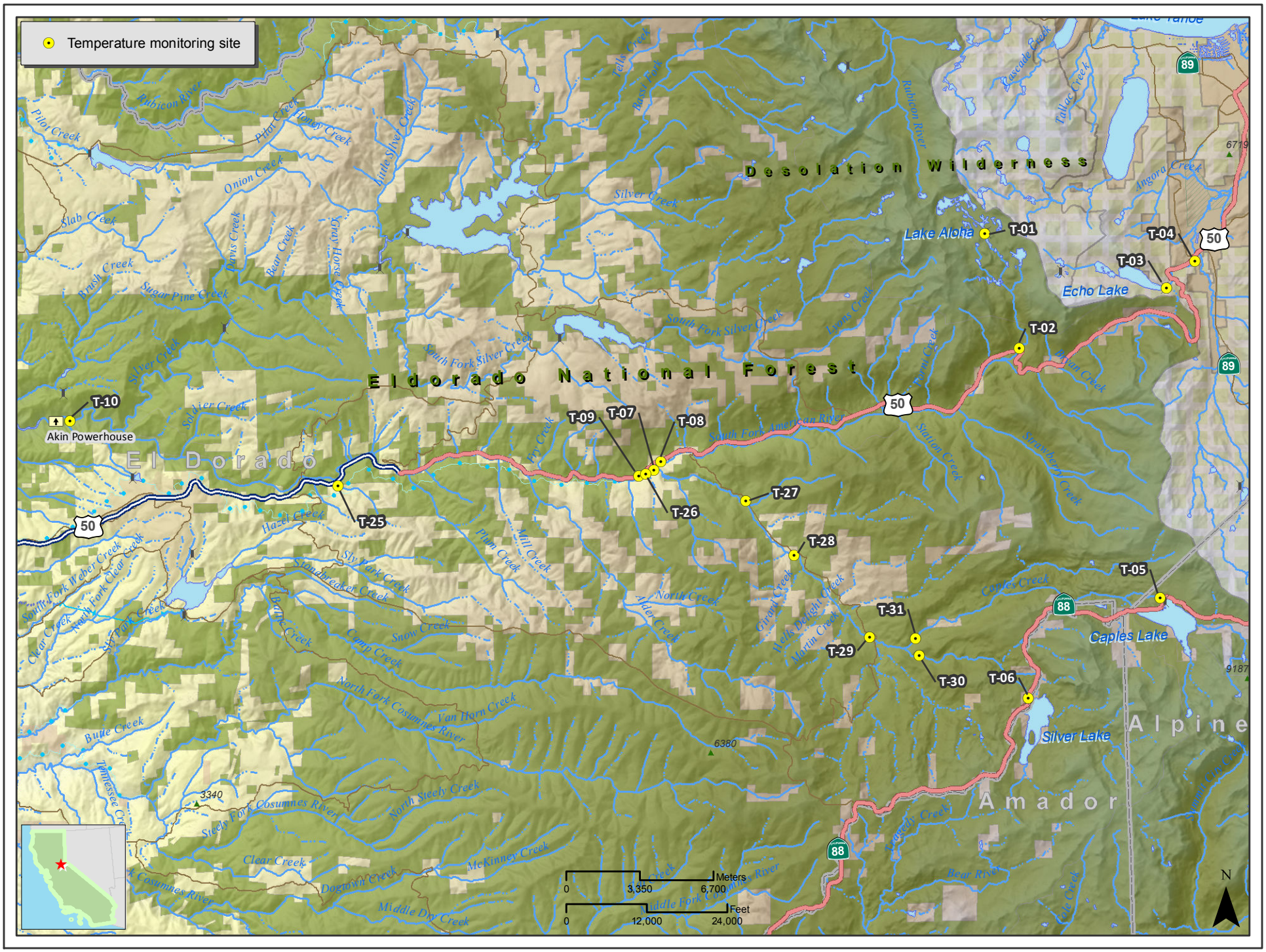

Figure 1. Locations of Annual Temperature Monitoring Stations, 2013. FERC Project 184. El Dorado Irrigation District.

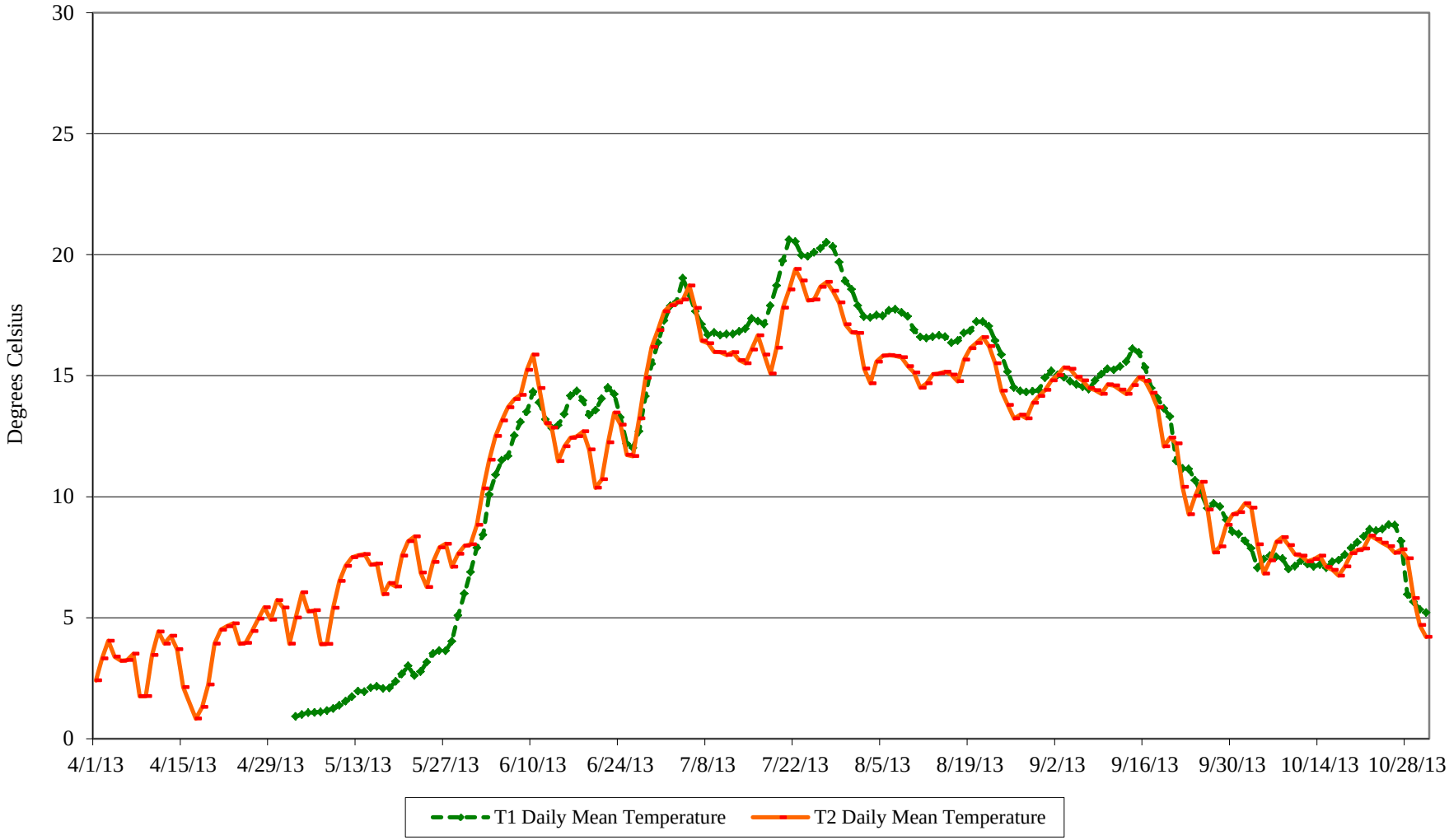

Figure 2. Daily Mean Temperature in Pyramid Creek at
Pyramid Creek below Lake Aloha (T1) & Pyramid Creek upstream of the SFAR (T2)

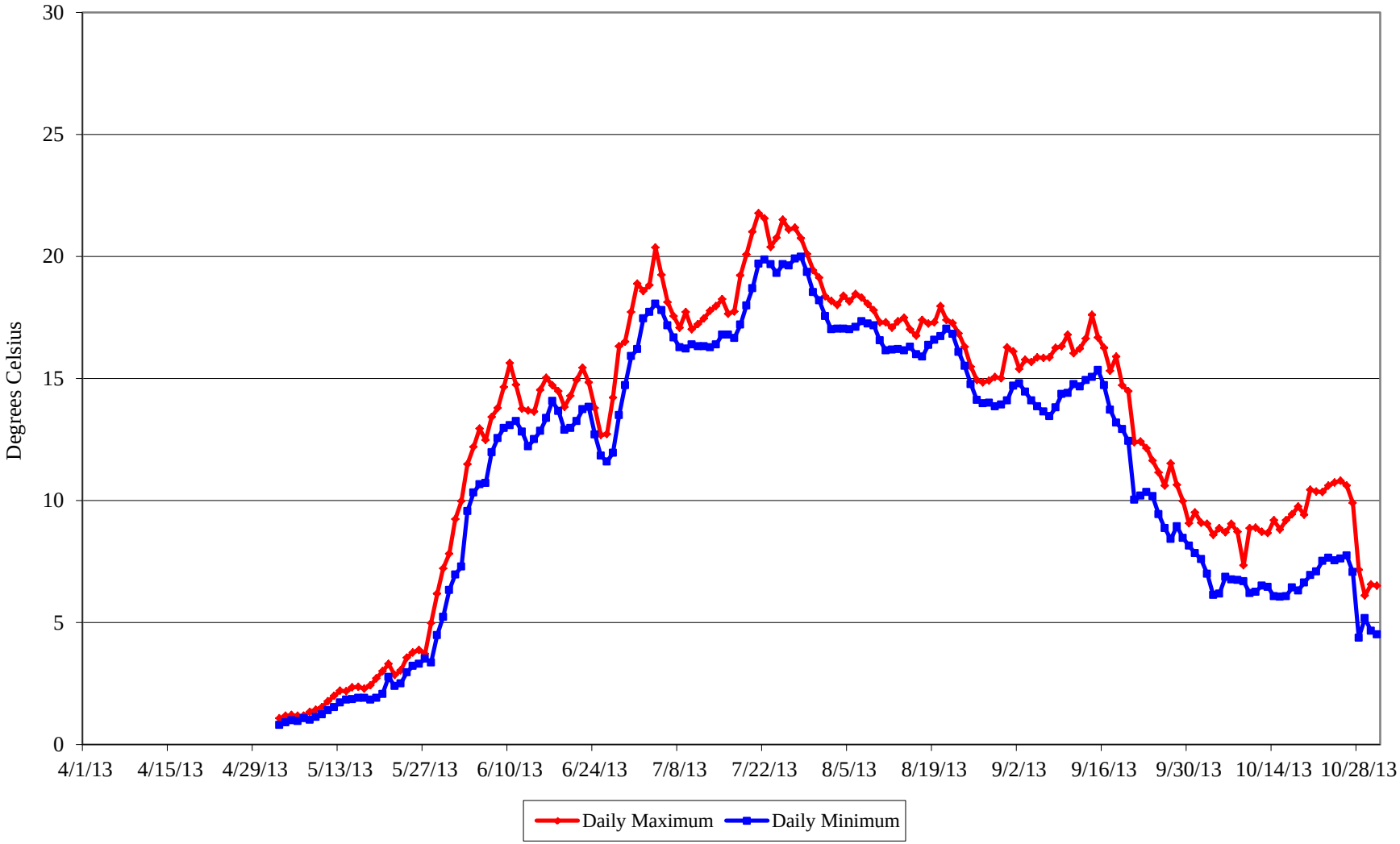

Figure 3. Daily Maximum and Minimum Water Temperatures in Pyramid Creek below Lake Aloha, T1

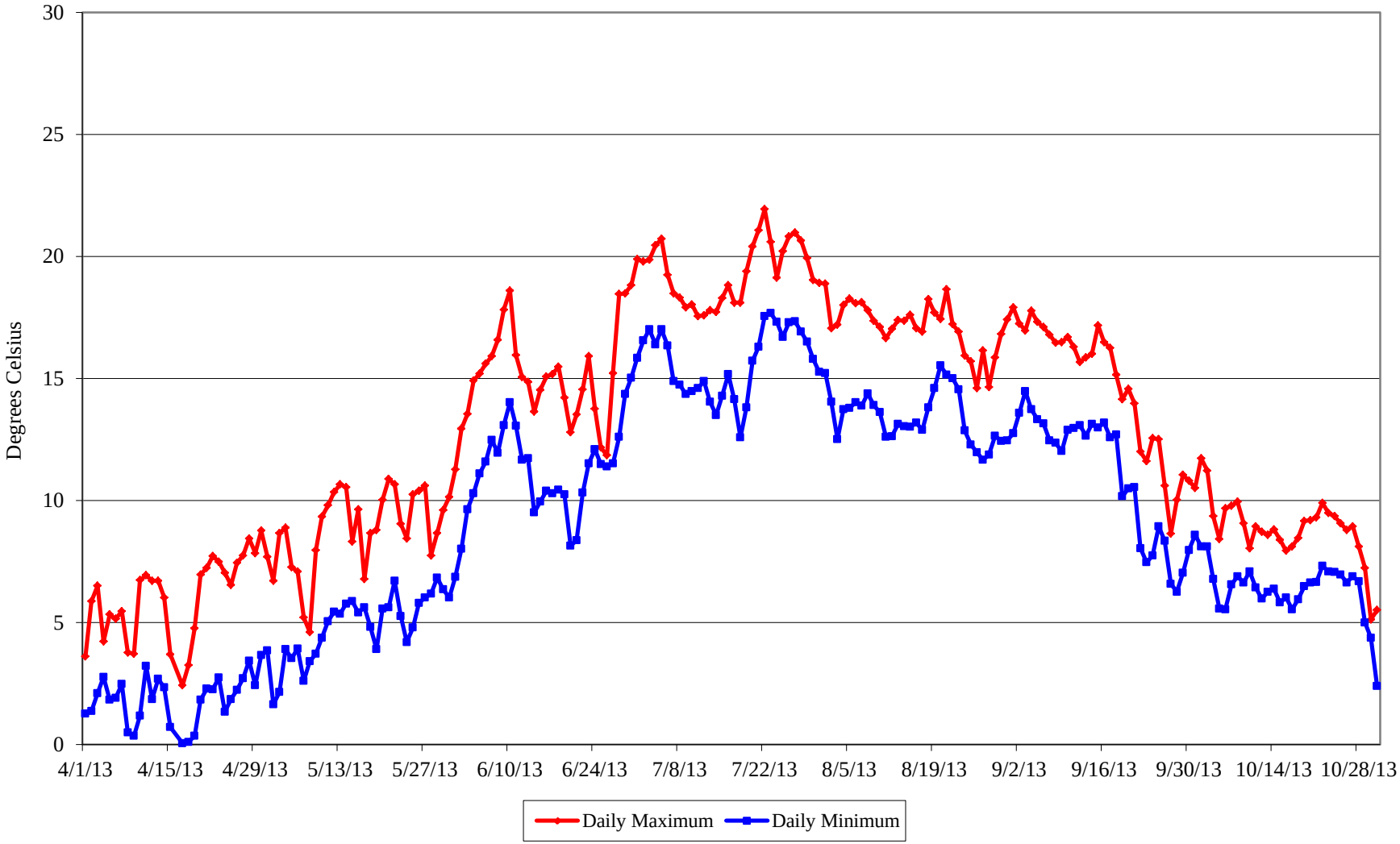

Figure 4. Daily Maximum and Minimum Water Temperatures in Pyramid Creek upstream of the SFAR, T2

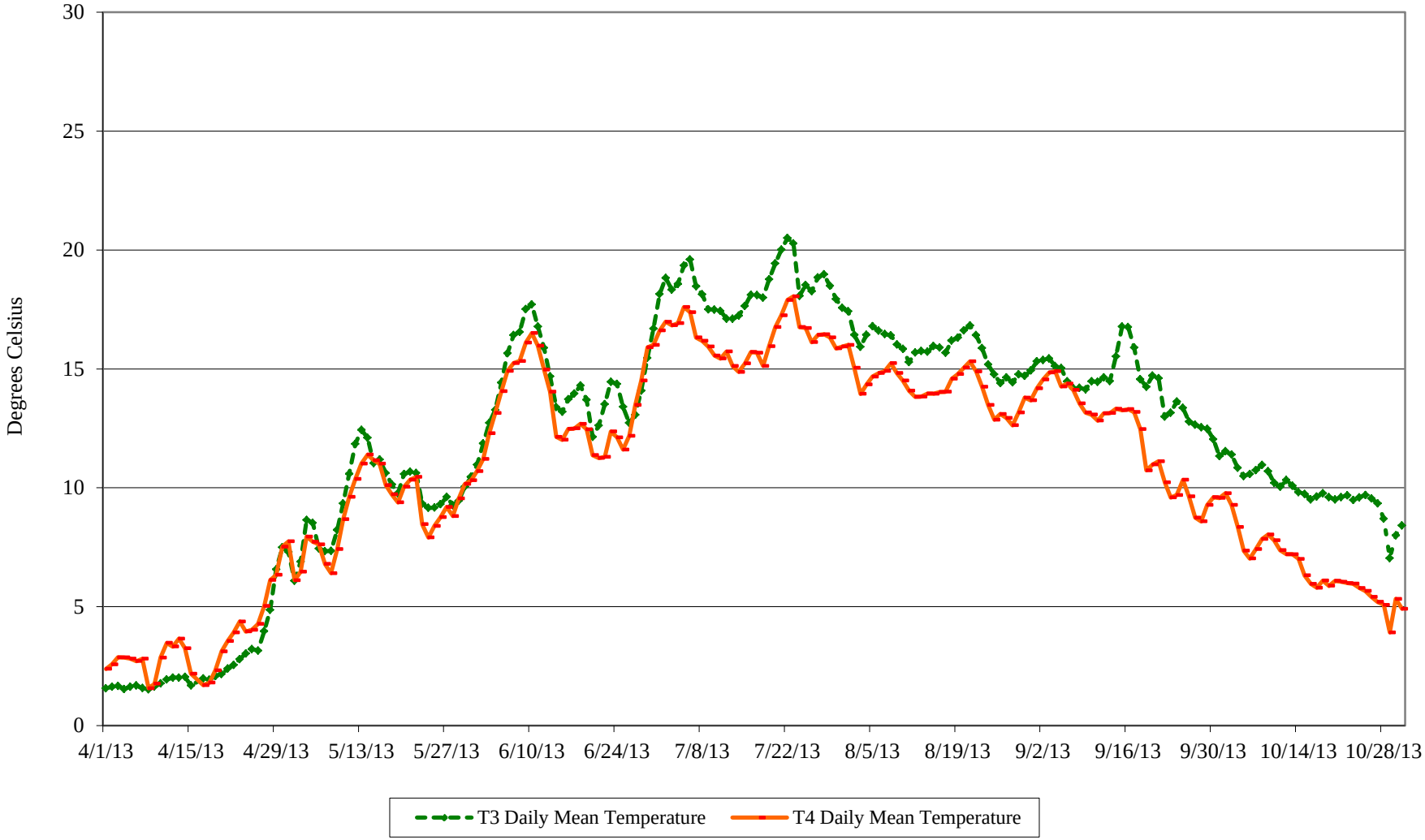

Figure 5. Daily Mean Temperature in Echo Creek at T3 & T4

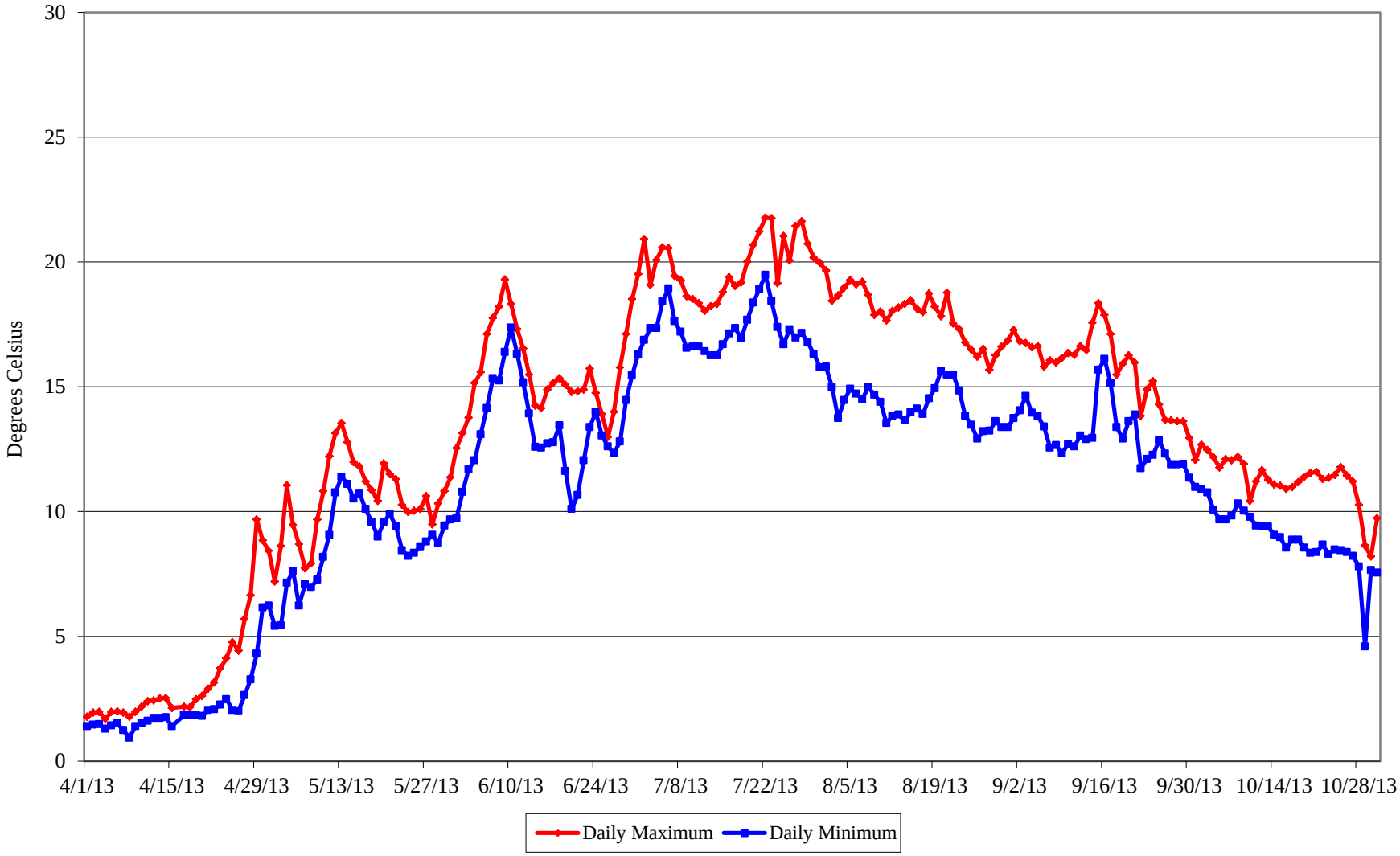

Figure 6. Daily Maximum and Minimum Water Temperatures Echo Creek downstream of dam , T3

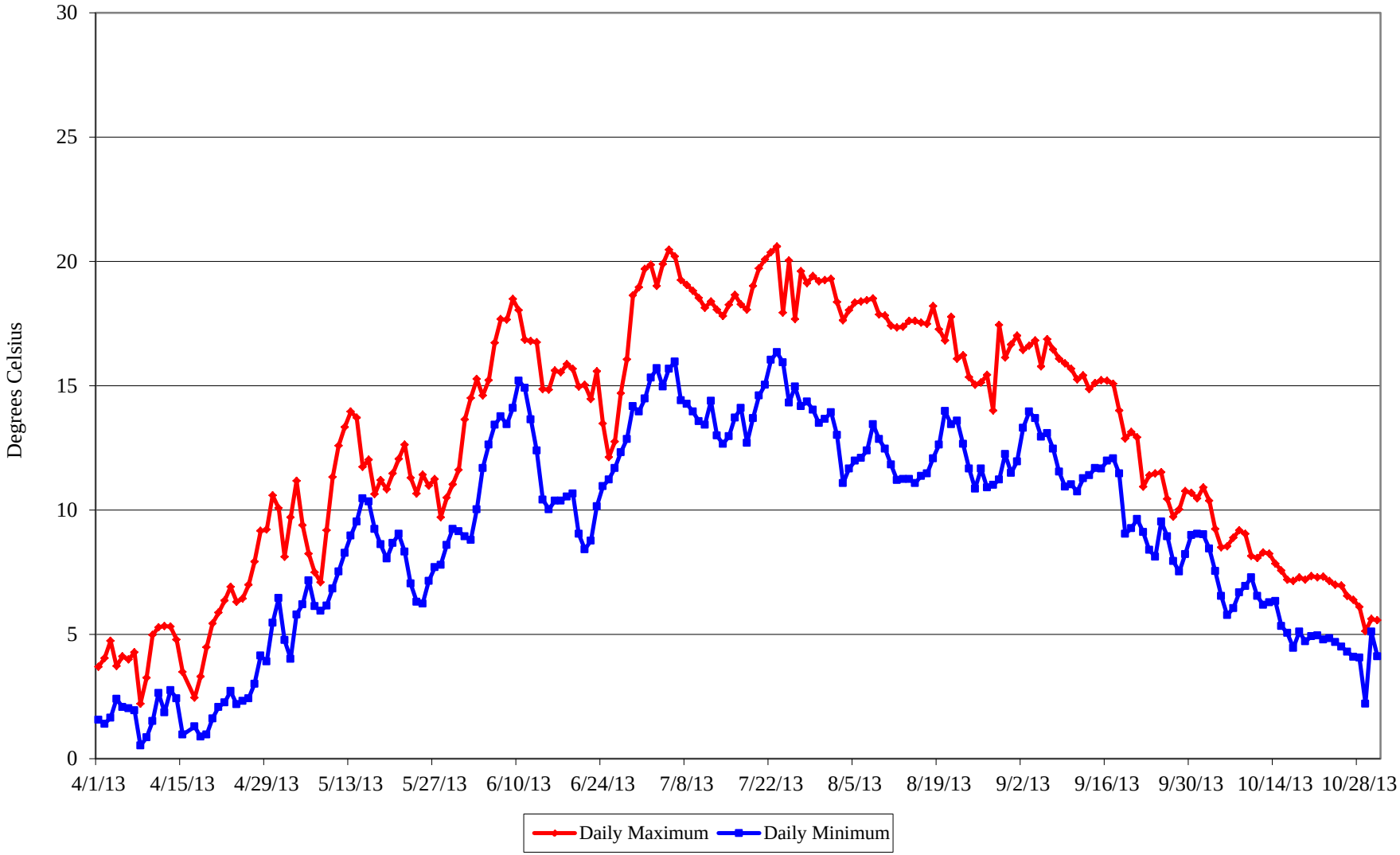

Figure 7. Daily Maximum and Minimum Water Temperatures in Echo Creek upstream of Upper Truckee R. T4

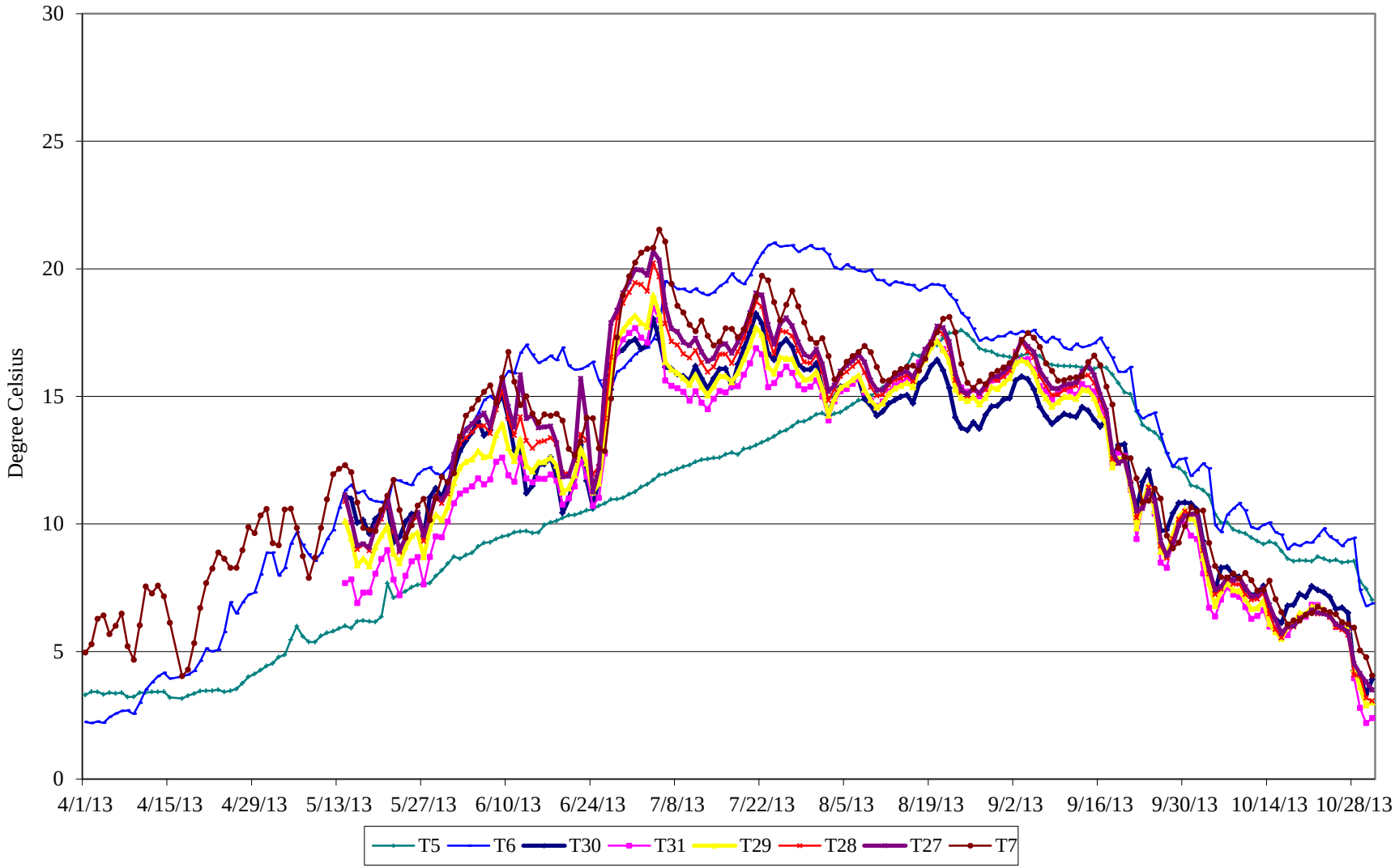

Figure 8. Daily Mean Temperature in Silver Fork of the American River and Caples Creek at T5, T6, T30, T29, T28, T27 and T7

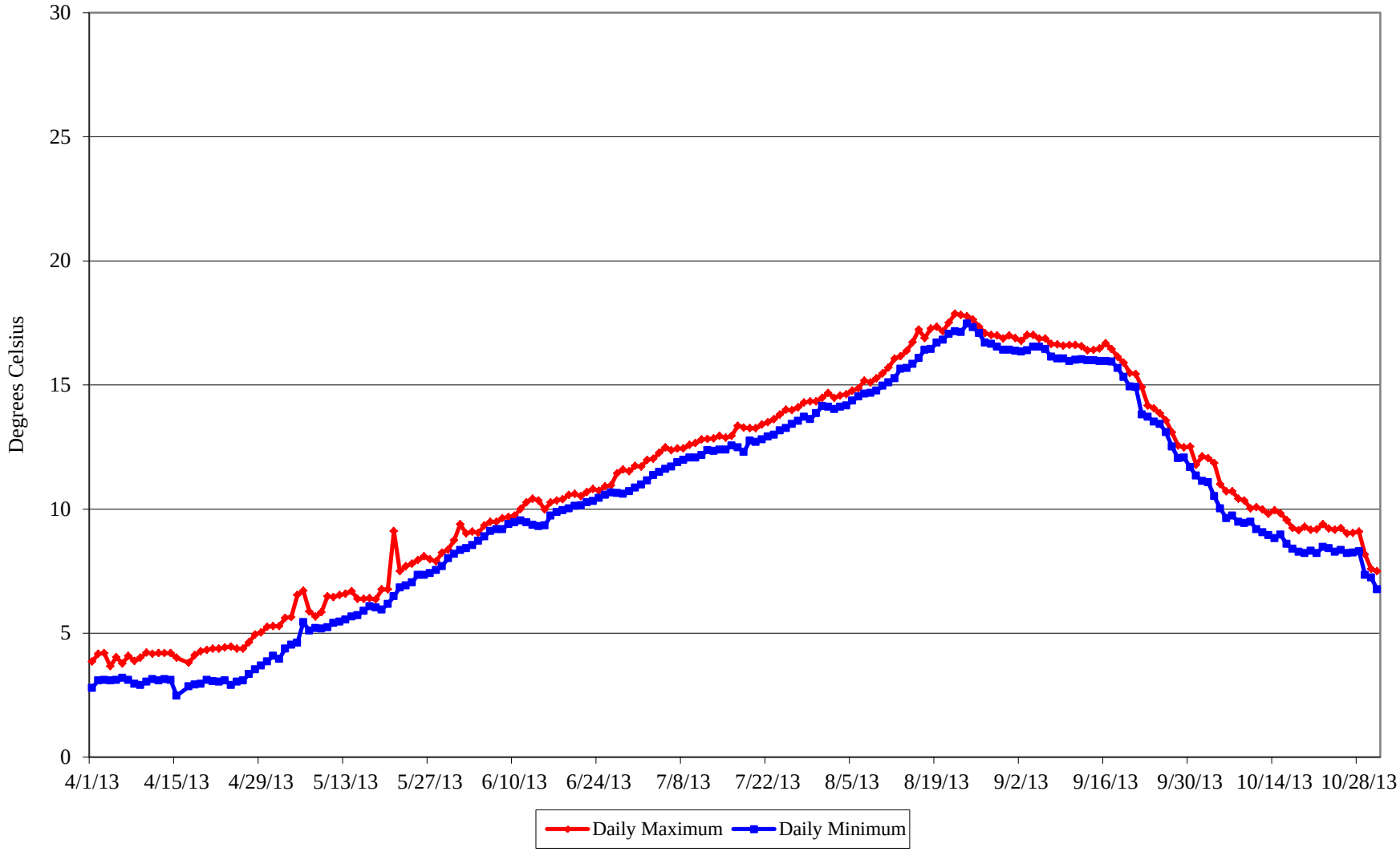

Figure 9. Daily Maximum and Minimum Water Temperatures in Caples Creek below Caples Lake T5

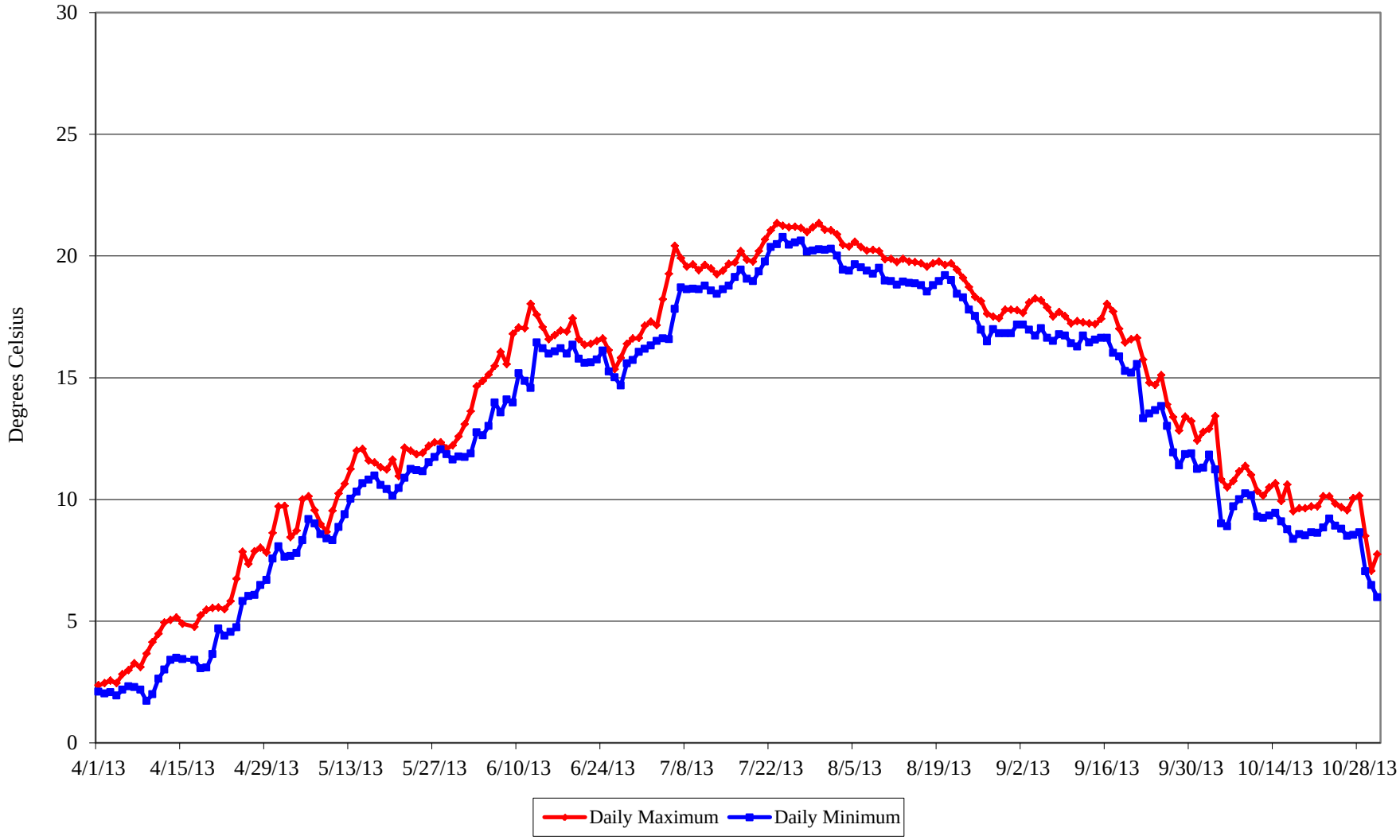

Figure 10. Daily Maximum and Minimum Water Temperatures in Silver Fork below Silver Lake T6

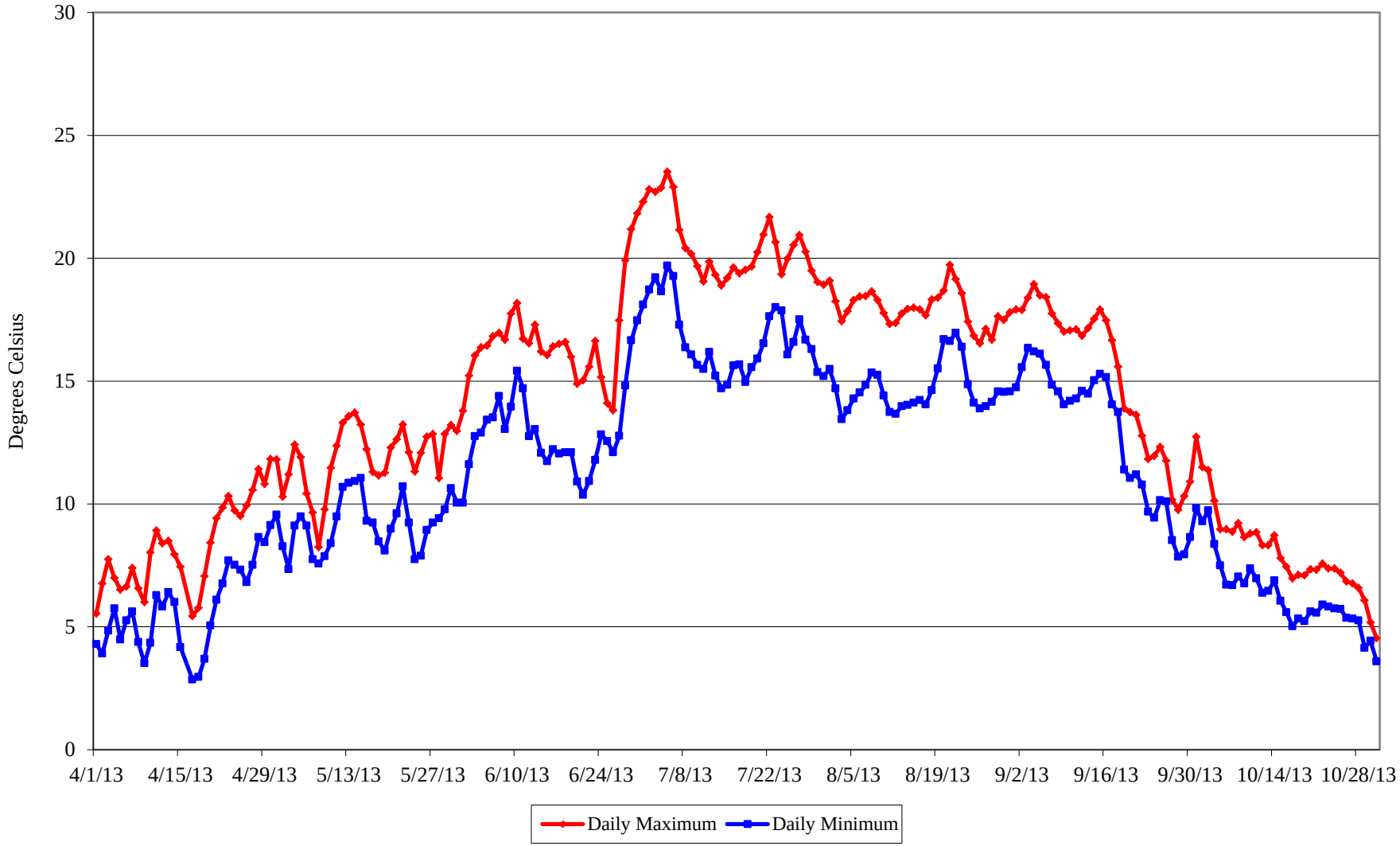

Figure 11. Daily Maximum and Minimum Water Temperatures in Silver Fork above SF American, T7

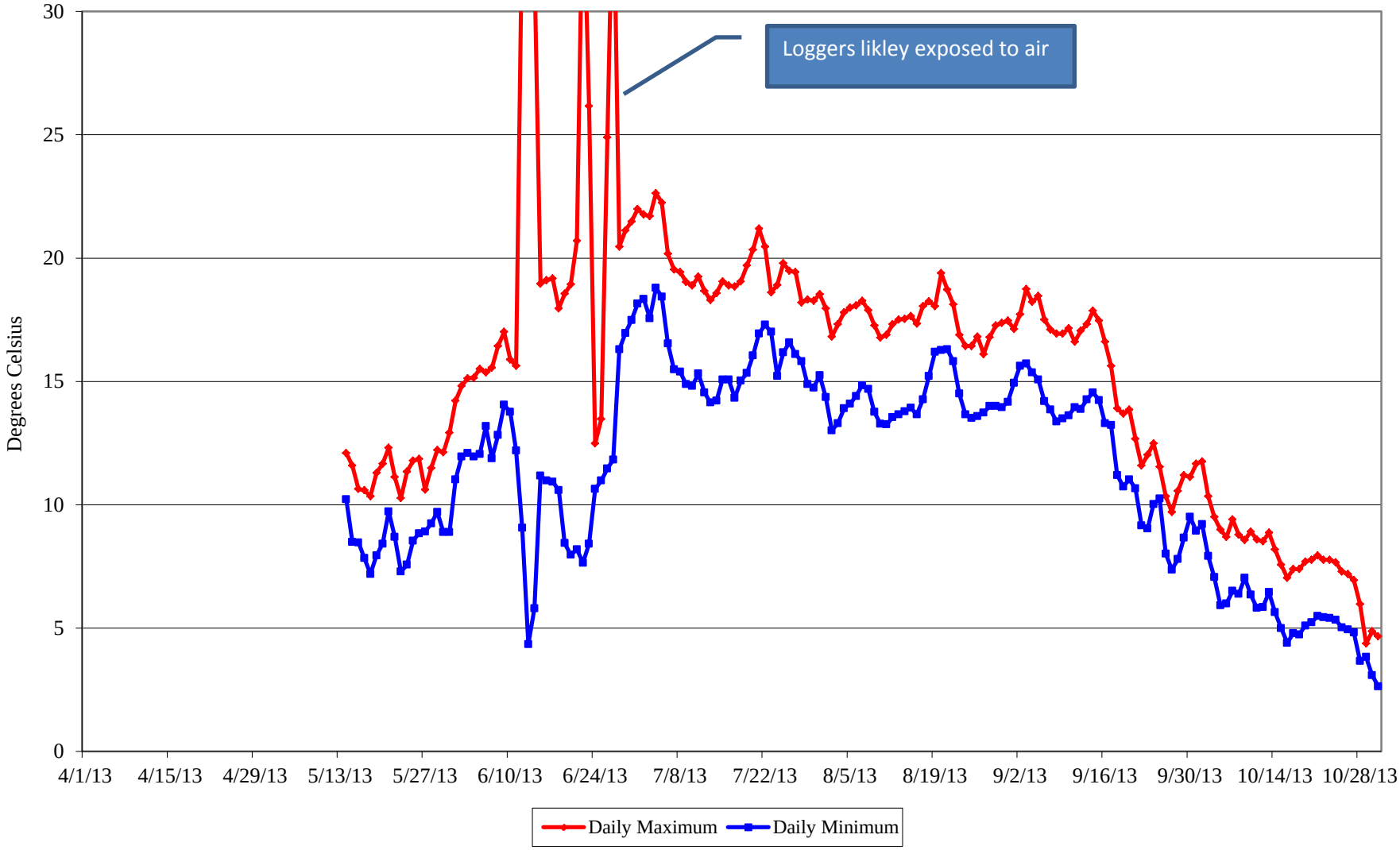

Figure 12. Daily Maximum and Minimum Water Temperatures in Silver Fork at China Flat Campground, T27

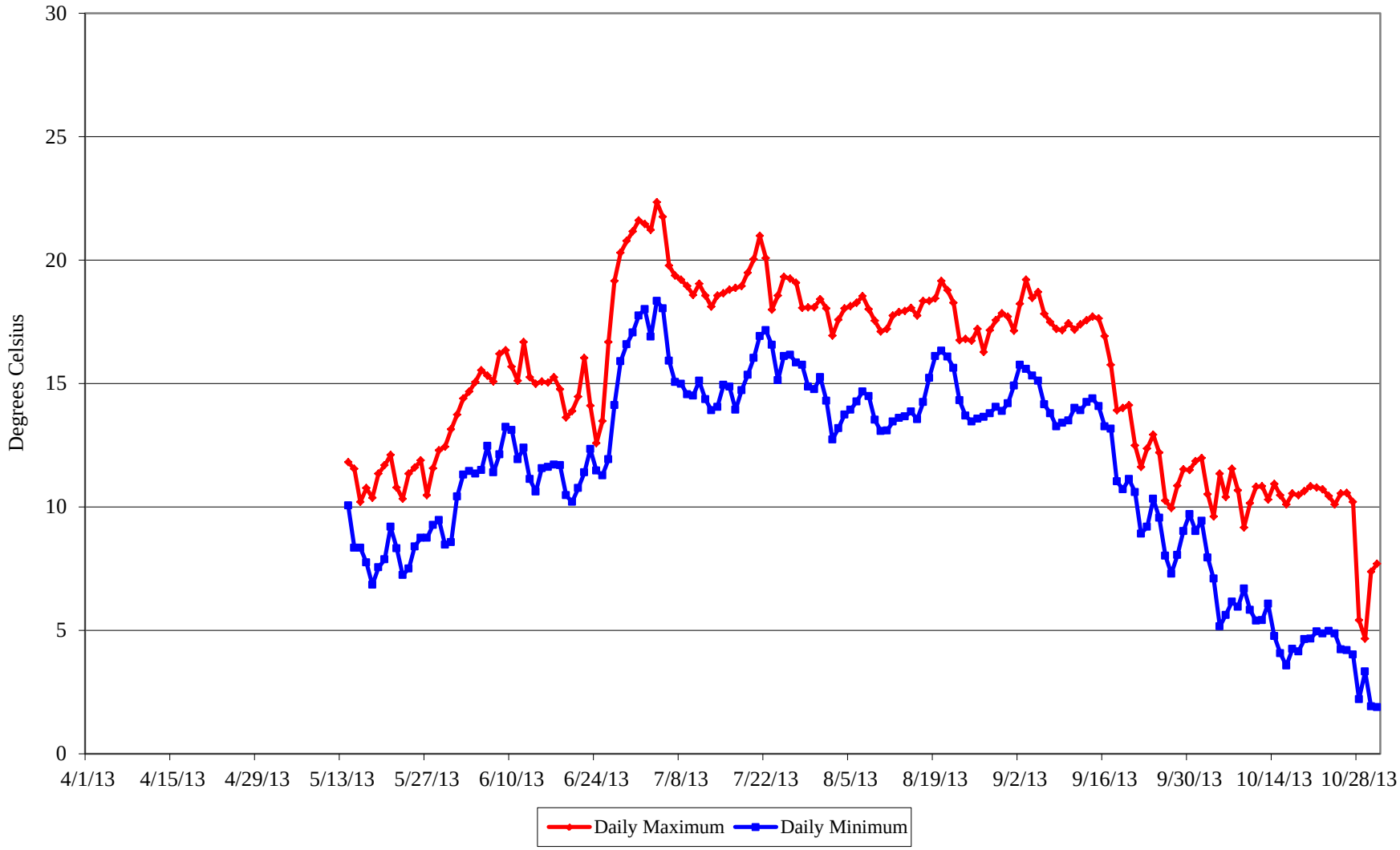

Figure 13. Daily Maximum and Minimum Water Temperatures in Silver Fork at Devils Gulch, T28

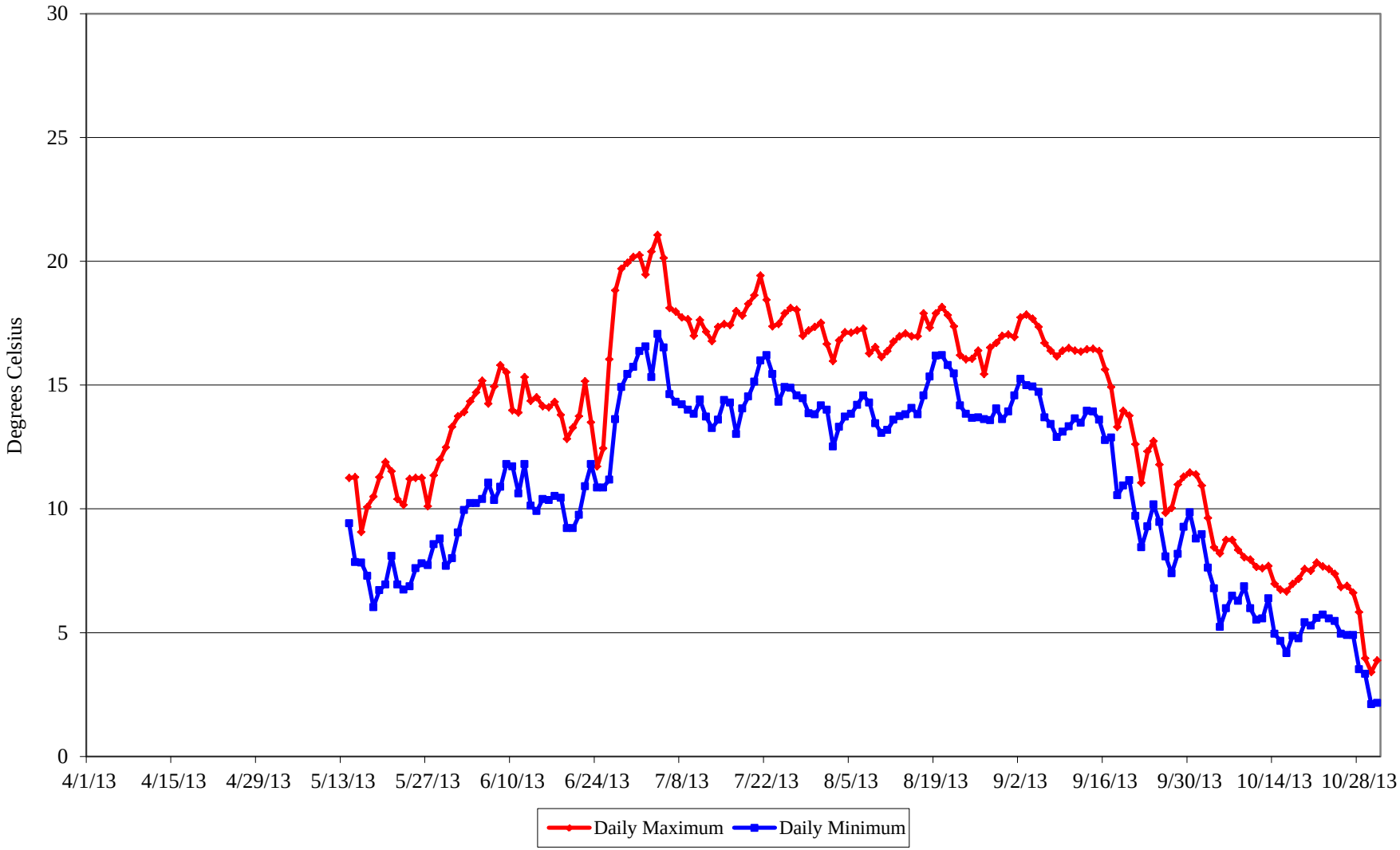

Figure 14. Daily Maximum and Minimum Water Temperatures in Silver Fork near Fitch Rantz Bridge, T29

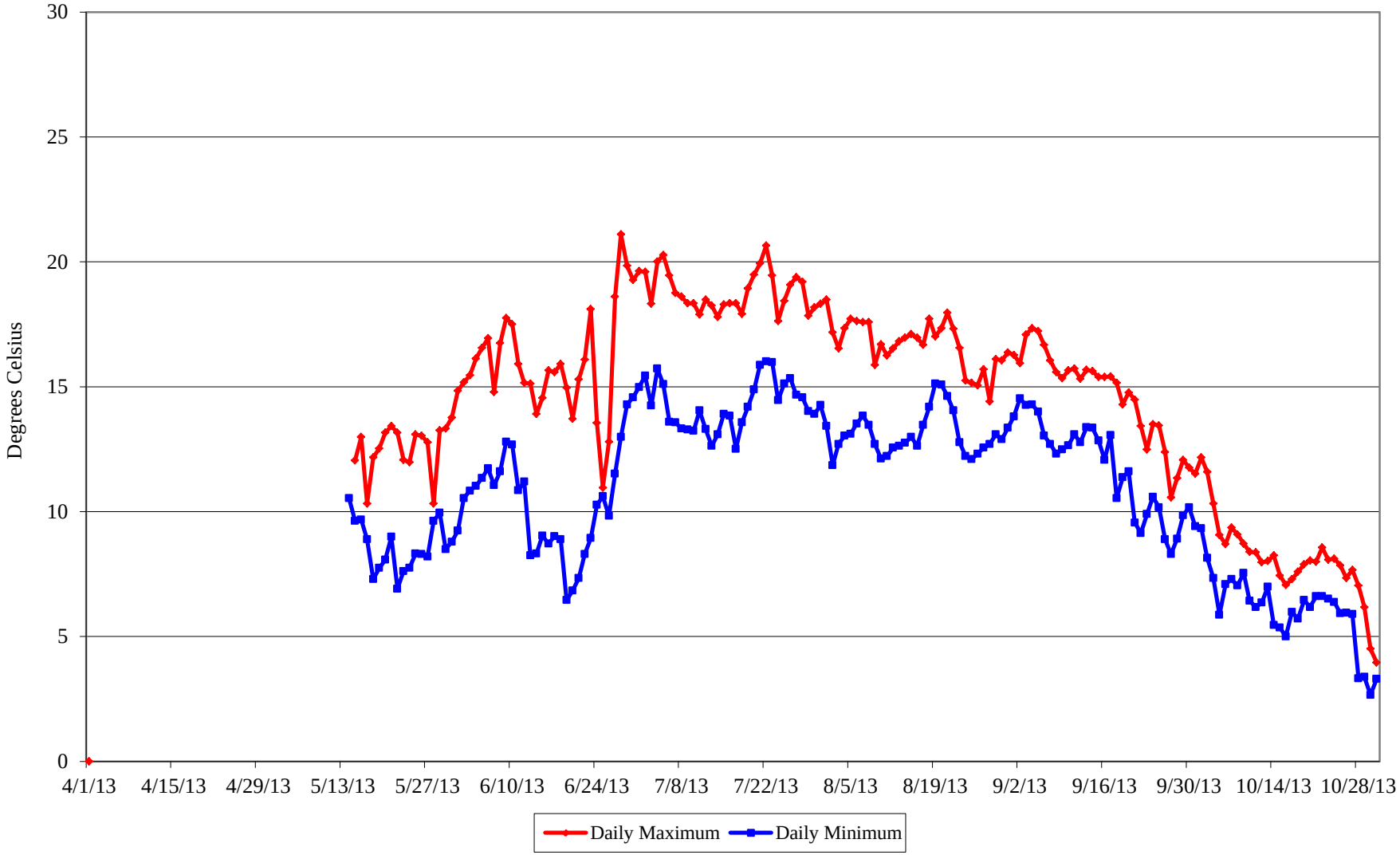

Figure 15. Daily Maximum and Minimum Water Temperatures in Silver Fork upstream of the confluence with Caples Creek, T30

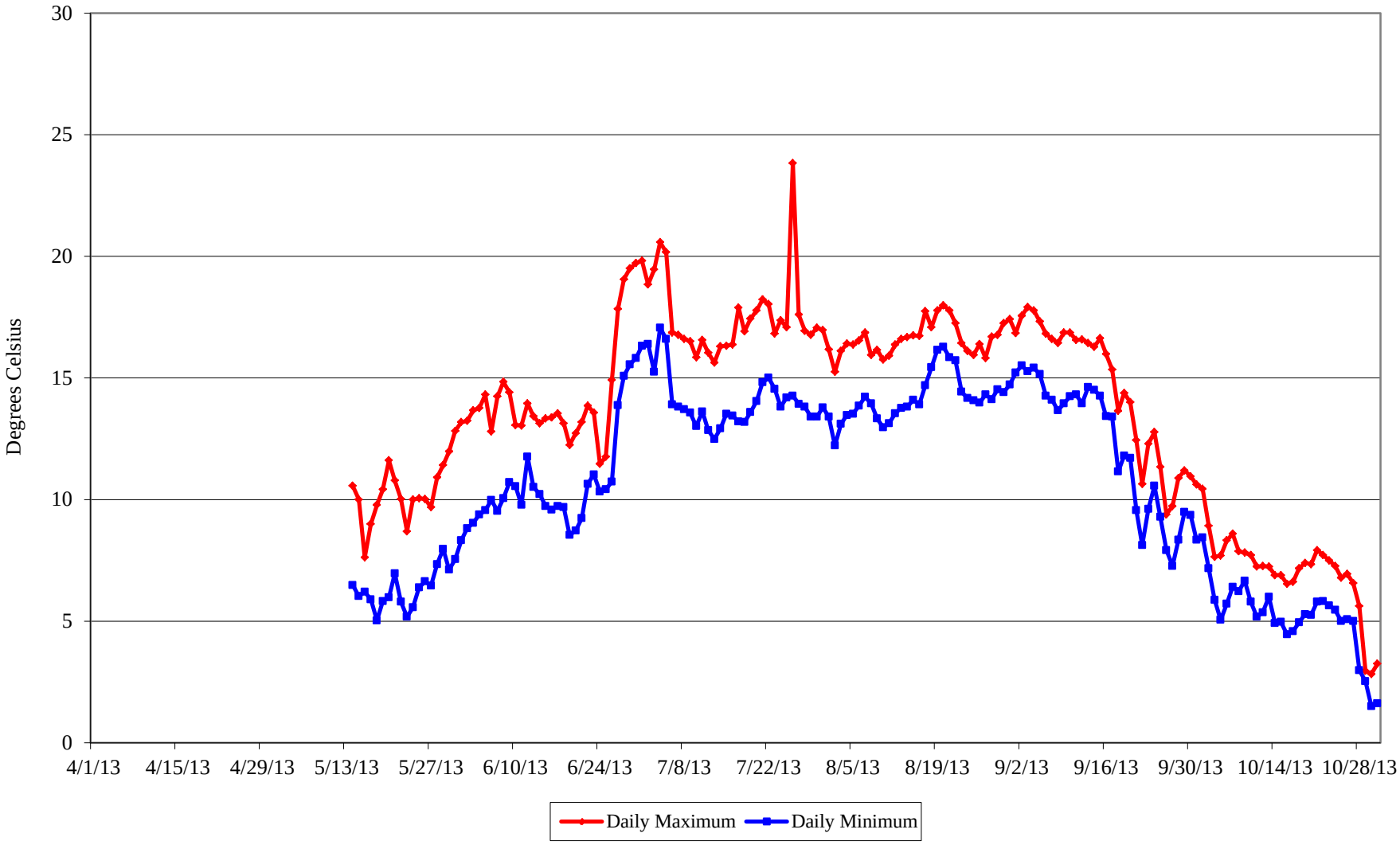

Figure 16. Daily Maximum and Minimum Water Temperatures Caples Creek upstream of the confluence with Silver Fork American River, T31

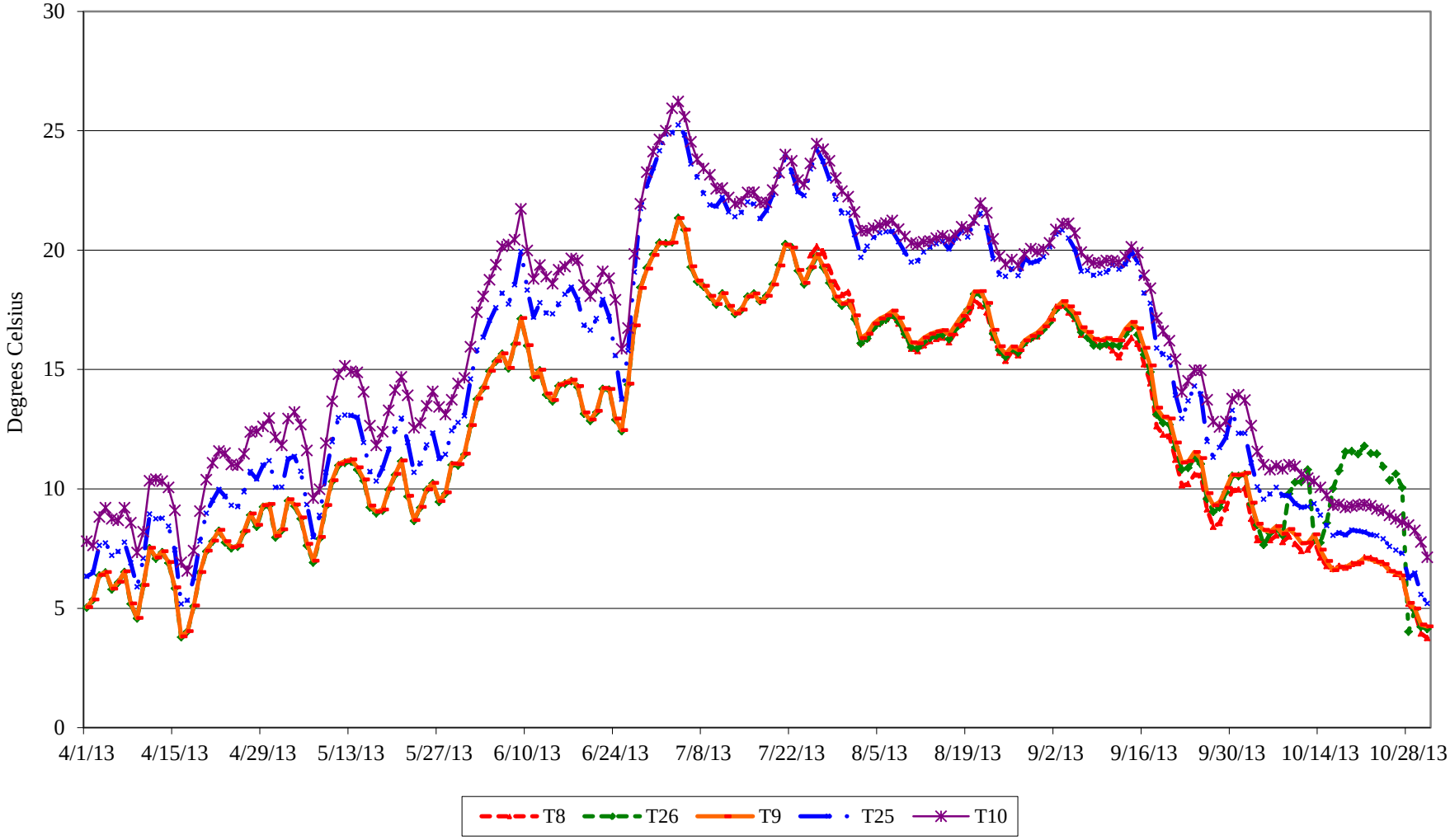

Figure 17. Daily Mean Temperature in the SF American River T8, T26, T9, T25, & T10

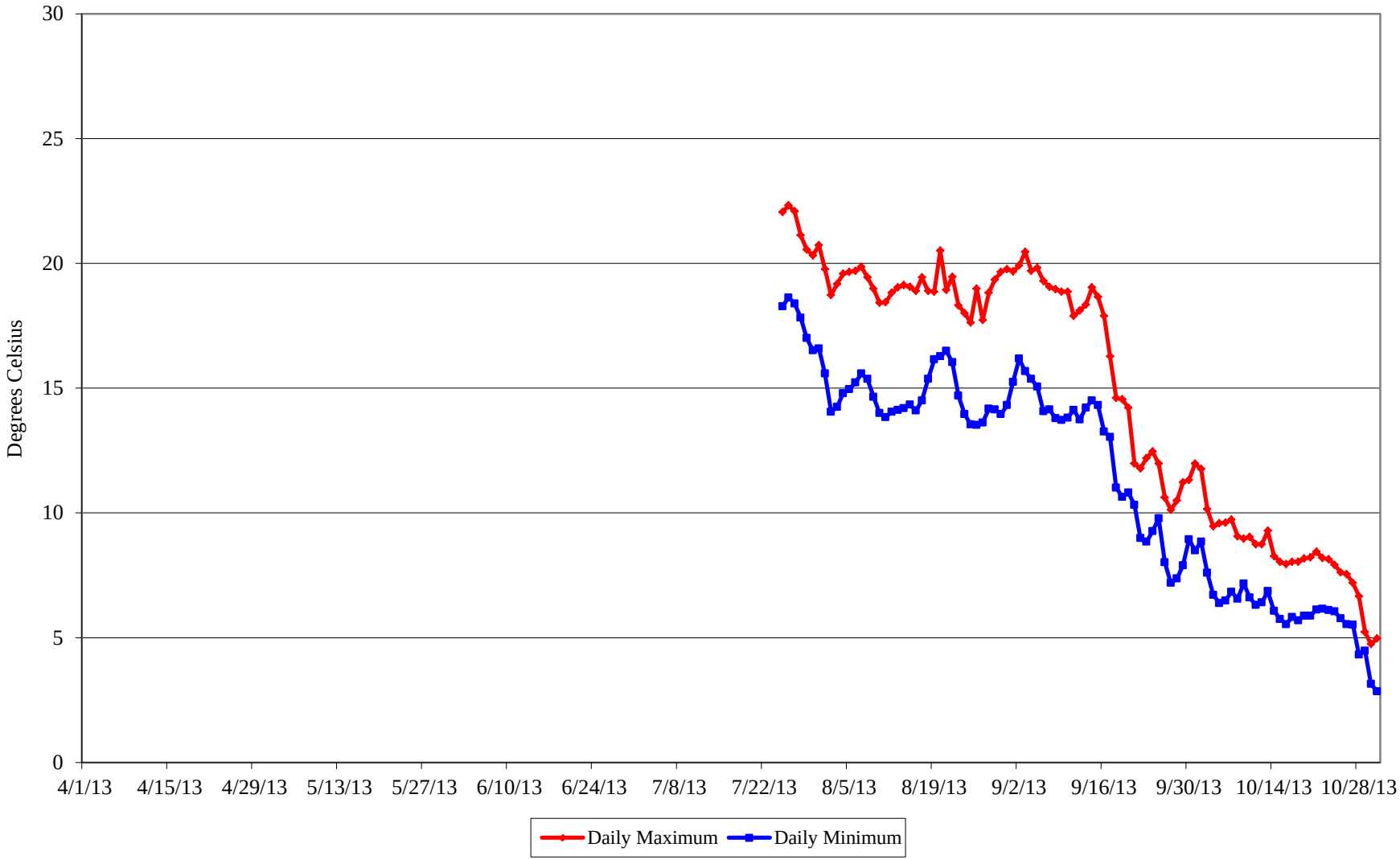

Figure 18. Daily Maximum and Minimum Water Temperatures in the SF American above Silver Fork, T8

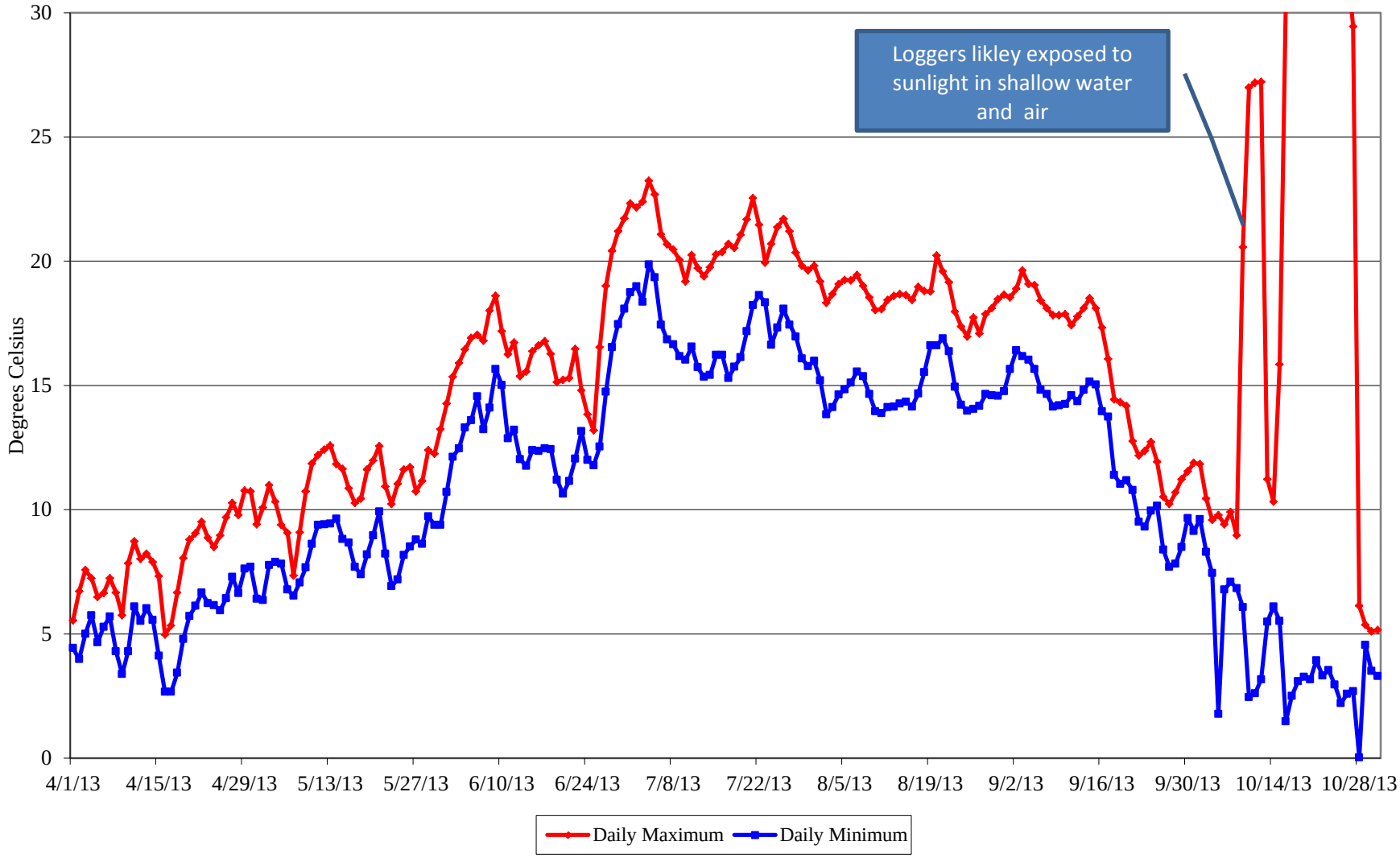

Figure 19. Daily Maximum and Minimum Water Temperatures in the SFAR above Kyburz Diversion, T26

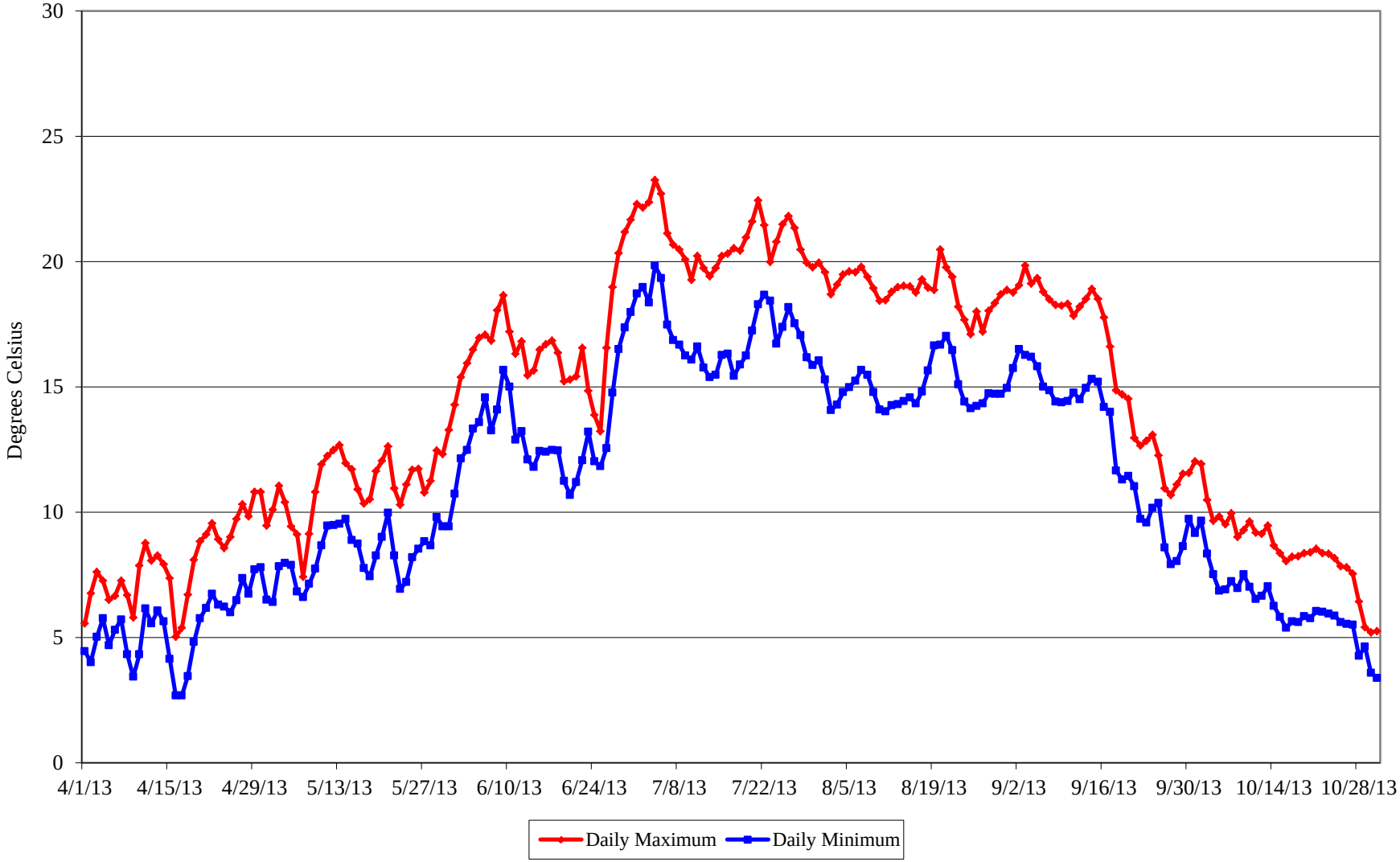

Figure 20. Daily Maximum and Minimum Water Temperatures in the SF American below Kyburz Diversion, T9

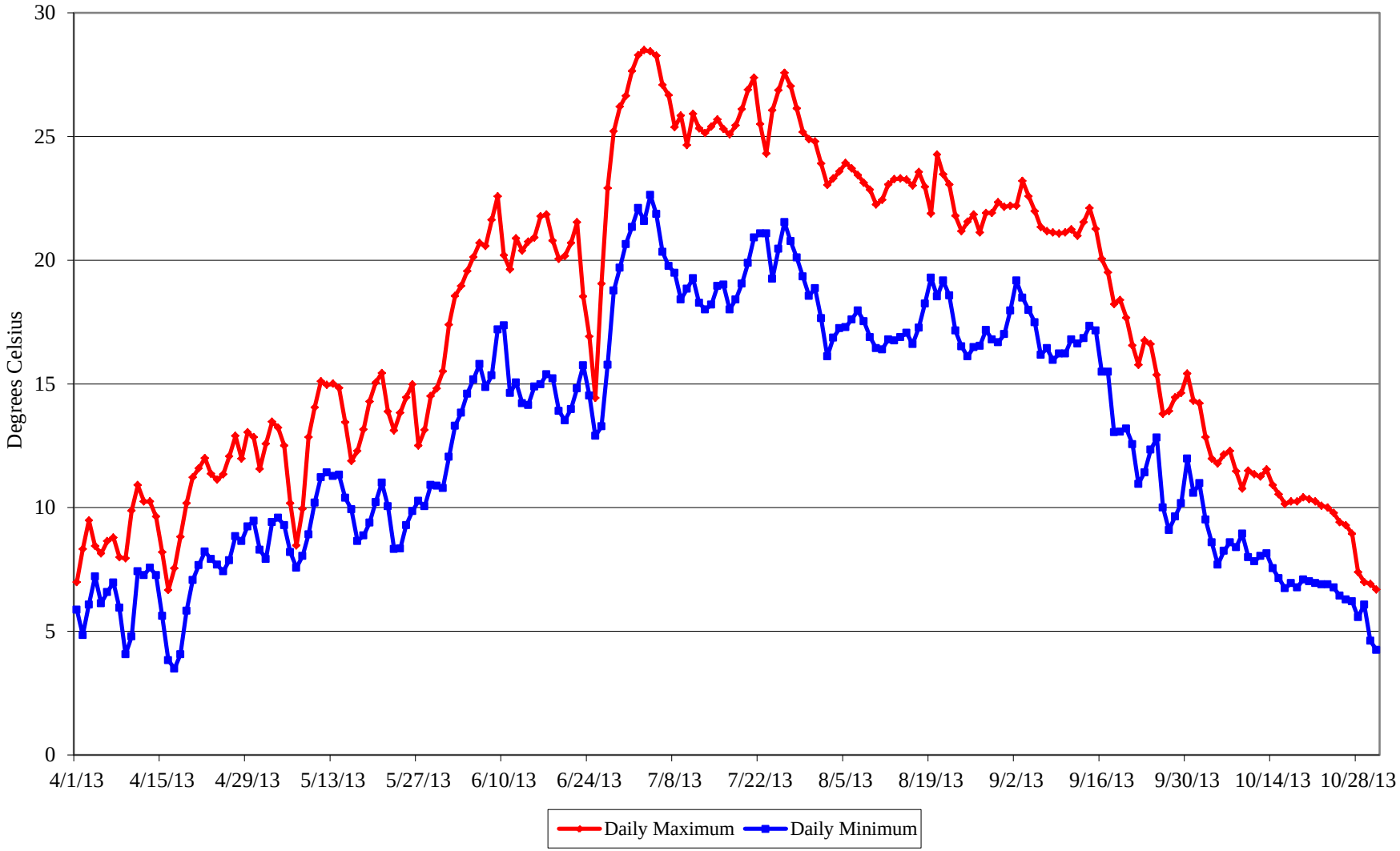

Figure 21. Daily Maximum and Minimum Water Temperatures in the SFAR at Bridalveil Picnic Area, T25

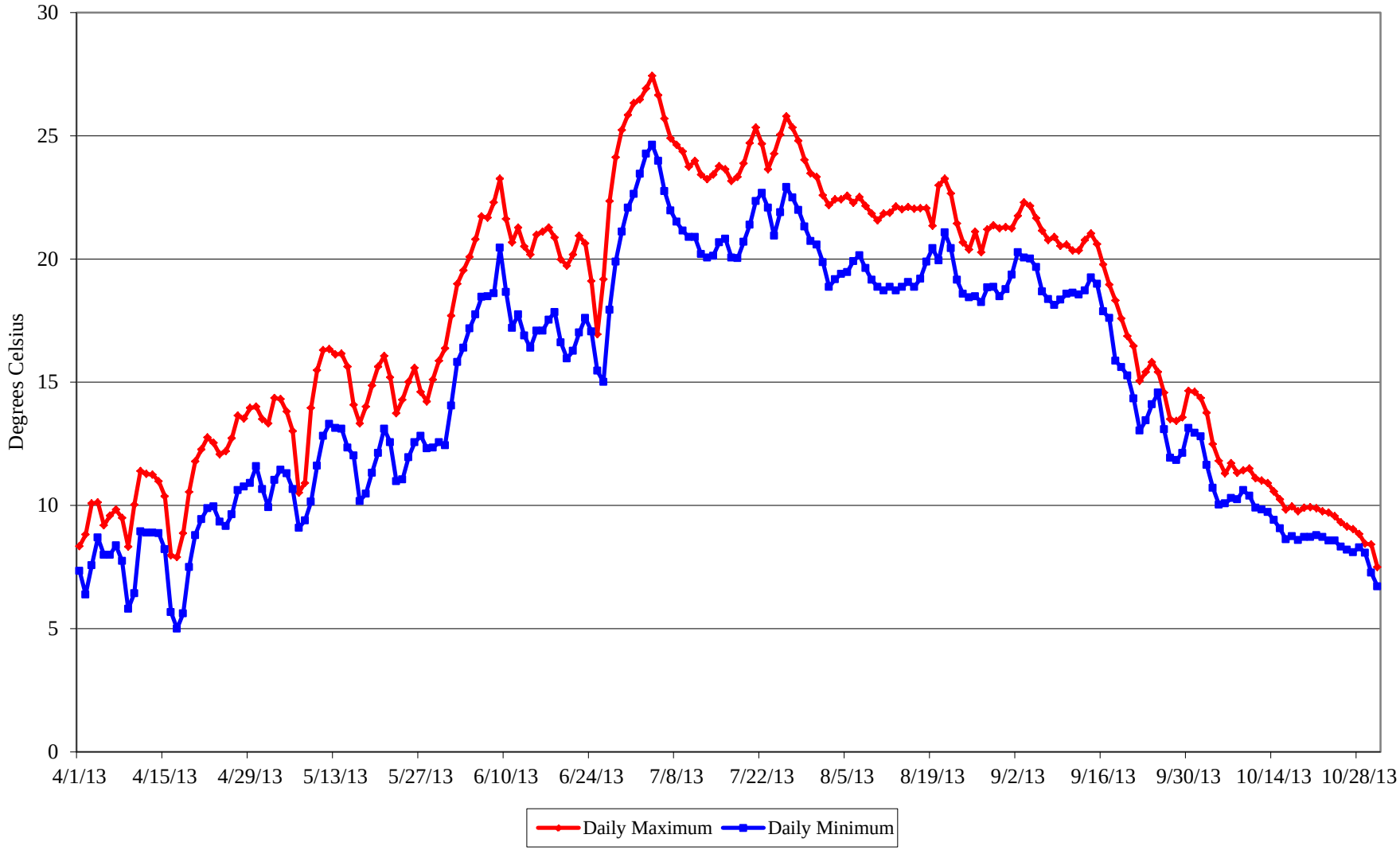

Figure 22. Daily Maximum and Minimum Water Temperatures in the SFAR at Akin Powerhouse, T10