El Dorado Hydroelectric Project
FERC Project No. 184

2014 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 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 2014 represents the sixth continuous year of water temperature monitoring performed in accordance with the Plan. Results of the 2014 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 and 2013, the District conducted monitoring at additional sites not specified in the Plan. In accordance with recommendations contained within the 2012 and 2013 monitoring reports (EID 2013; EID 2014), thermographs were deployed in 2014 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 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 25 and 27, 2014, with the exception of Pyramid Creek below Lake Aloha (T1) and locations along the Silver Fork of the American (T27 – T31). T1 at Lake Aloha was installed in Pyramid Creek on May 31, 2014 when the site could be safely accessed following snowmelt. Thermographs for locations T27 – T31 were installed on May 8, 2014 following the opening of Silver Fork Road.

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. Temperature recorders were removed in late October.

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 2014 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. There were no anomalies in the data between loggers A and B at T1 or 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 and 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 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. There were no anomalies in the data between loggers A and B at T3 or 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 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 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, T27, T30, and T31. Logger T28 A was used because logger B recorded ambient air temperatures from October 16 to October 24. Data from logger T7 B was used because logger A failed.

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.

The maximum water temperature recorded along the Silver Fork was 23.4°C measured the Silver Fork just above the confluence of the SFAR (T7). There were four days (July 14, 17, 18, and 19th) when water temperatures exceeded 23°C in the afternoon hours at T7. These measurements occurred during a period of high ambient air temperatures, including a measurement of 104°F recorded on July 14, which was the highest air temperature recorded at the California Department of Water Resources Pacific House weather station in 2014. The ambient air temperature recorded at the Pacific House weather station during the monitoring period is provided in Figure 23. Twenty three degrees Celsius is the water temperature identified in this report as the threshold between suitable conditions (<23°C) and water temperatures where trout and other coldwater species may begin to experience physiological stress and make behavioral shifts to compensate (>23 - 26°C). It is anticipated that trout and other coldwater species experienced no measureable physiological stress associated with these water temperatures because temperatures were only slightly elevated for short periods (i.e. 2 - 4 hours) in the afternoon.

Additionally, coldwater species would likely make behavioral shifts if experiencing physiological stress, which could include moving to locations with more favorable water temperature conditions in the channel during these extreme heat conditions.

Overall, 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 July 10 because loggers A and B during the spring were found to be missing during a data download 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) 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 0.02°C from April 1 to October 31, 2014. The maximum difference during this time period was 0.5°C. This comparison excludes one outlier data point (23.6°C) that was recorded at 1300

hours on June 17, 2014, which is likely the result of the probes being exposed to ambient air temperature during a data download, which occurred on that day.

As expected, water temperatures in the SFAR increased with the drop in elevation from T8 to T10. The maximum water temperature measured at each site was recorded on July 14, 2014, which was the hottest day of the year in the region with a high temperature of 104°F recorded at the California Department of Water Resources Pacific House weather station. The maximum water temperature at T8, T26, and T9 was 23.9°C; the maximum water temperature at T25 was 27.6°C, and 26.5°C at T10. It is anticipated that trout and other coldwater species experienced no measureable physiological stress associated with these water temperatures in the upper reaches of the SFAR (T8, T26, and T9) because temperatures were only slightly elevated for short periods (i.e. 2 - 4 hours) in the afternoon during these extreme heat conditions. Additionally, coldwater species would likely make behavioral shifts if experiencing physiological stress, which could include moving to locations with more favorable water temperature conditions in the channel.

Overall, water temperatures at T8, T26, and T9 were within the optimal and suitable range for coldwater species, including amphibians. 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).

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 RECOMMENDATIONS

The District recommends continuing monitoring at the following locations in 2015 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

The District recommends amending the Project No. 184 Water Temperature Monitoring Plan (Plan) to discontinue monitoring at the following locations because six years of water temperature monitoring has demonstrated that project operations do not adversely affect water temperature at these locations and because other existing monitoring stations provide adequate information for monitoring Project affected stream reaches. These stations include:

- T1 – Pyramid Creek downstream of Lake Aloha Dam
- T4 – Echo Creek upstream of Upper Truckee River

The District also recommends amending the monitoring period. The current Plan requires the loggers be deployed from April 1 – October 31 each year. The District proposes to deploy loggers from June 1 – October 1 each year. This amendment would continue to provide water temperature data during the season of greatest importance for this ecosystem attribute as identified in identified in relicensing documentation. Additionally, this is the time period (following the spring snowmelt) when Project operations have the potential to affect water temperatures.

The District plans to distribute a proposal and draft amended Plan incorporating these recommendations in the future for consideration by the FS, SWRCB, and Project No. 184 Ecological Resources Committee. The District is not seeking approval of these recommendations for the 2015 monitoring season

because extreme drought conditions in the Project No. 184 project area may require implementation of temporary variances from license-specified minimum streamflows in order to conserve and manage reservoir storage and maintain consumptive water supplies. Water temperature monitoring would be conducted in affected river reaches to help monitor instream conditions in the event streamflow variances are required.

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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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

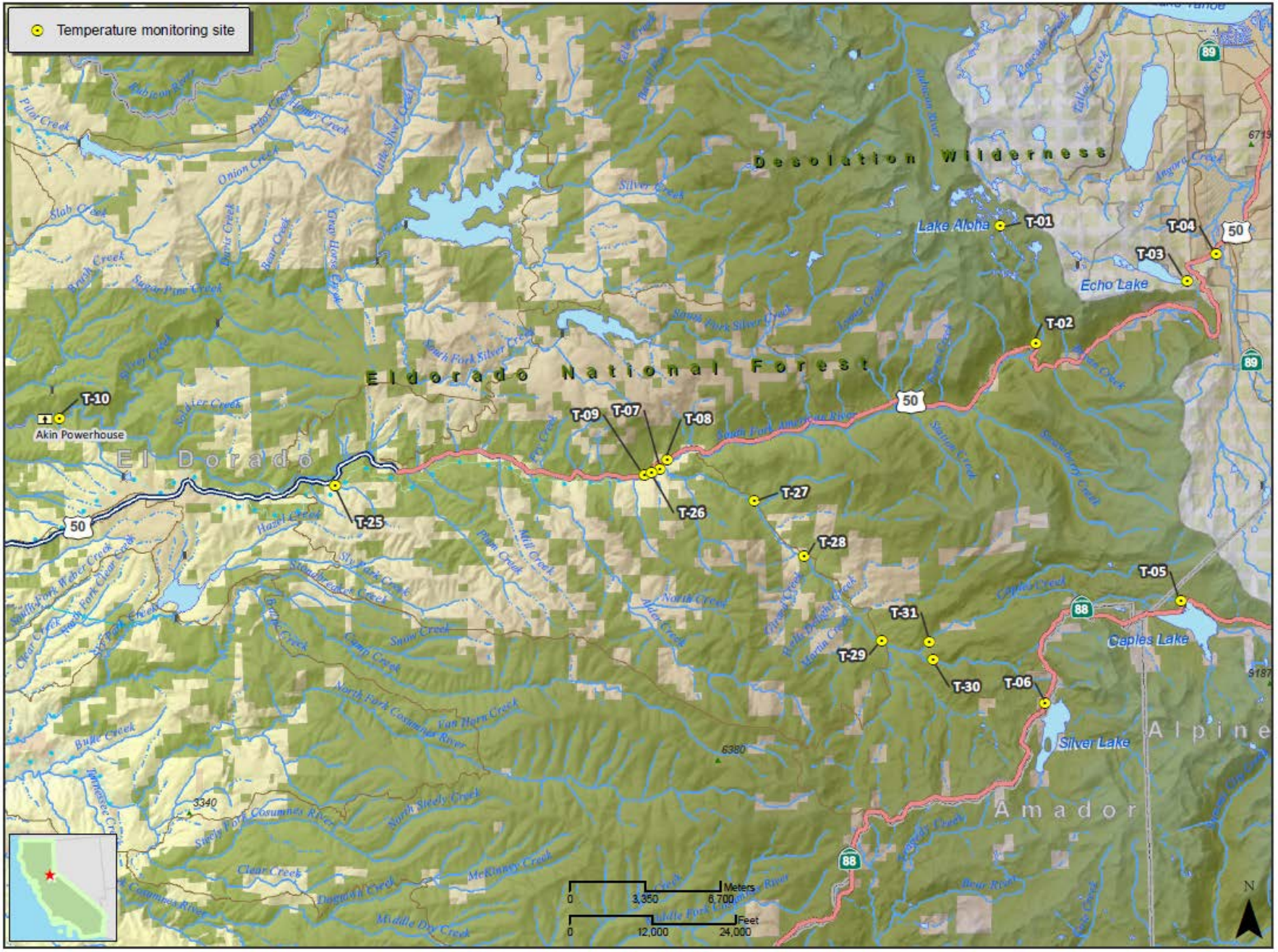


Figure 1. Locations of Annual Temperature Monitoring Stations, 2014. FERC Project No. 184.

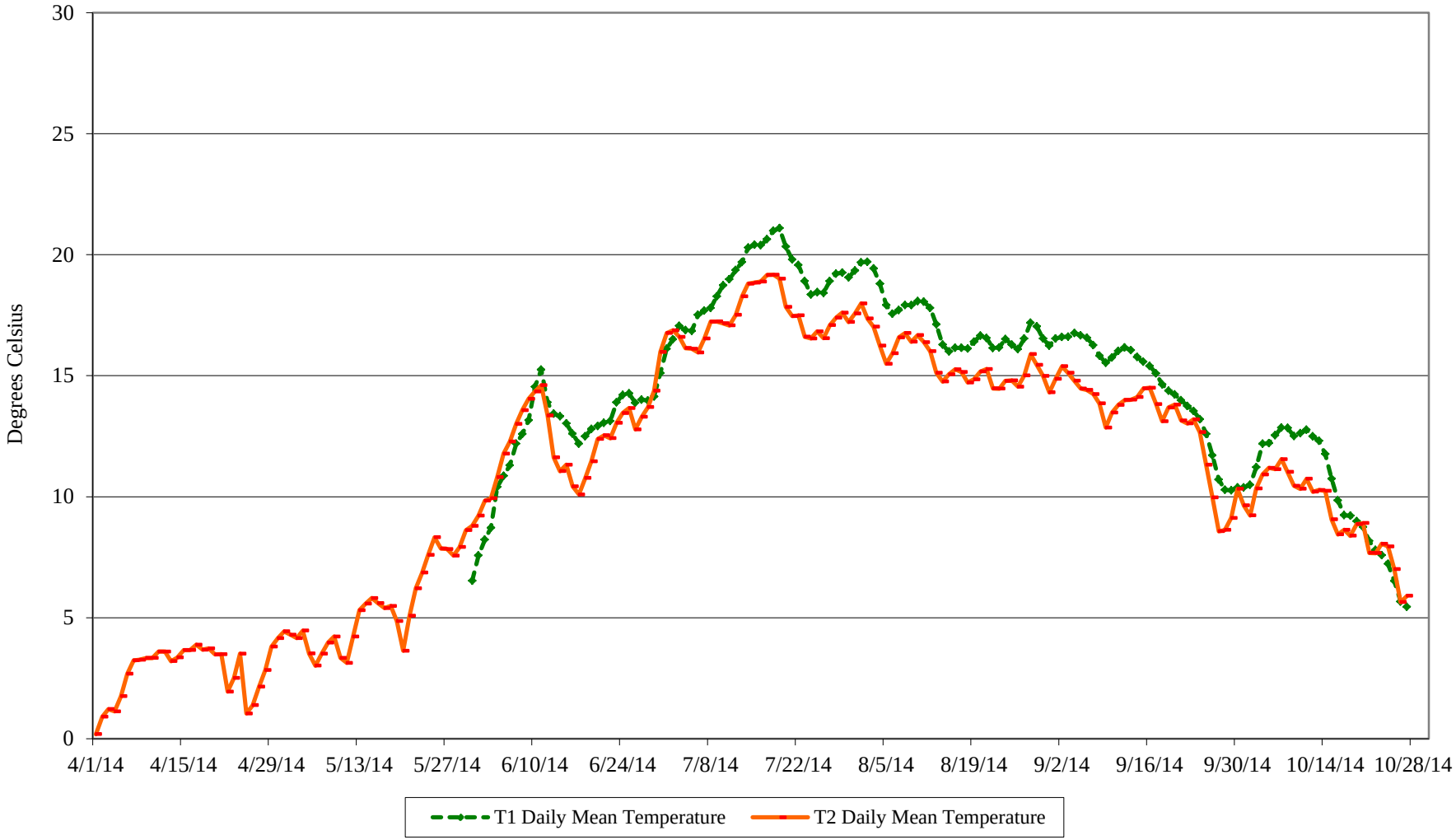


Figure 2. Daily Mean Temperature in Pyramid Creek at
Pyramid Creek below Lake Aloha T1 & Pyramid Creek upstream of the SFAR T2

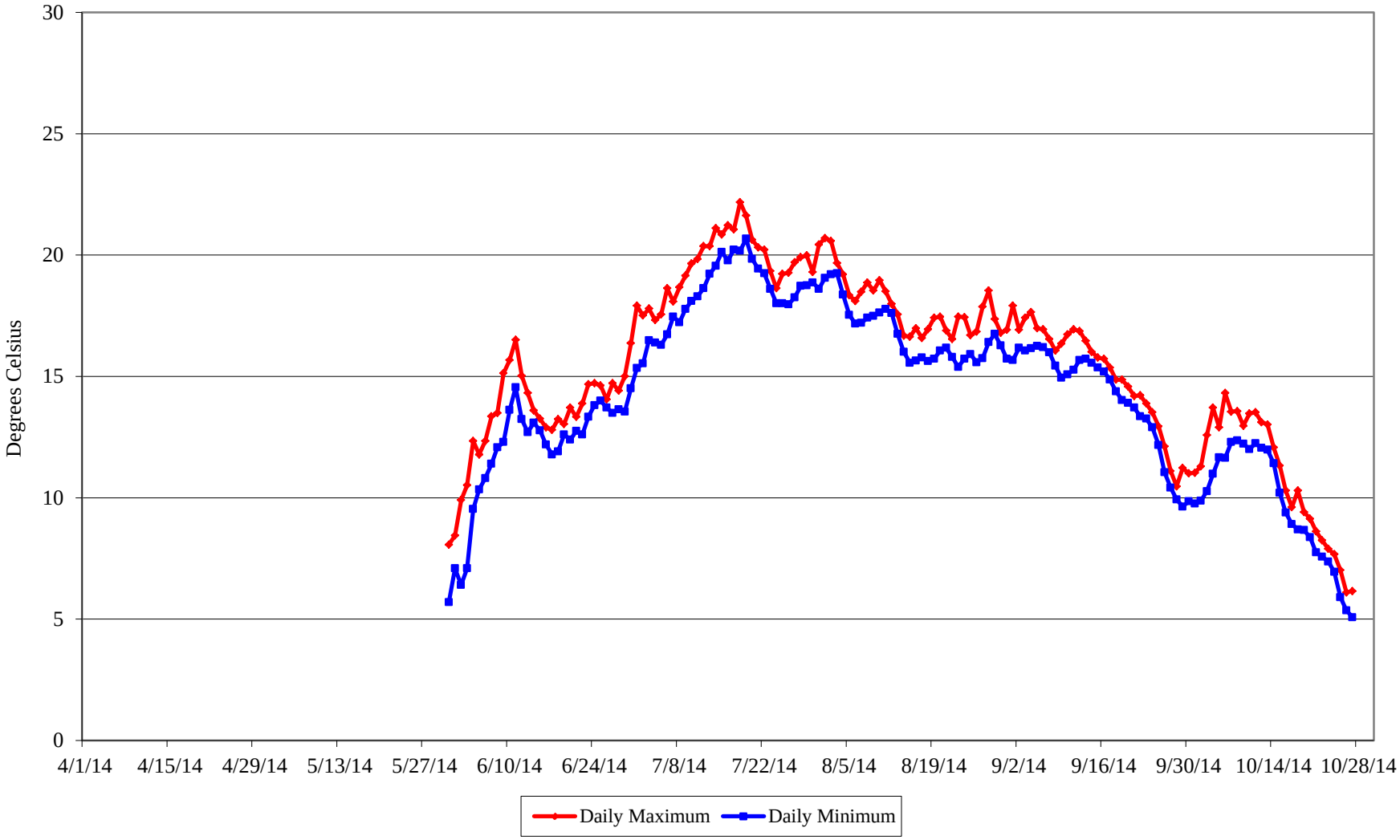


Figure 3. Daily Maximum and Minimum Water Temperatures in Pyramid Creek below Lake Aloha T1

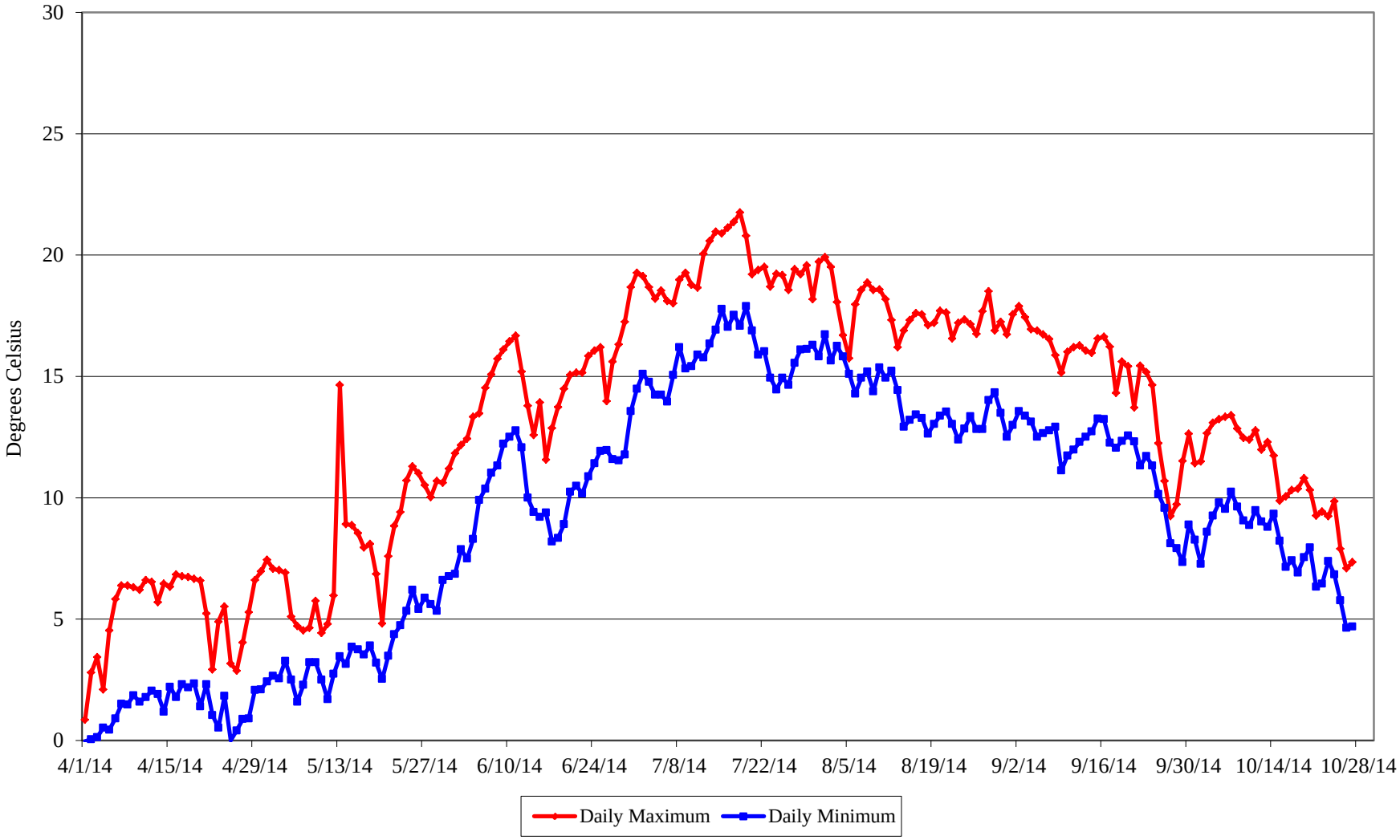


Figure 4. Daily Maximum and Minimum Water Temperatures in Pyramid Creek upstream of the SFAR T2

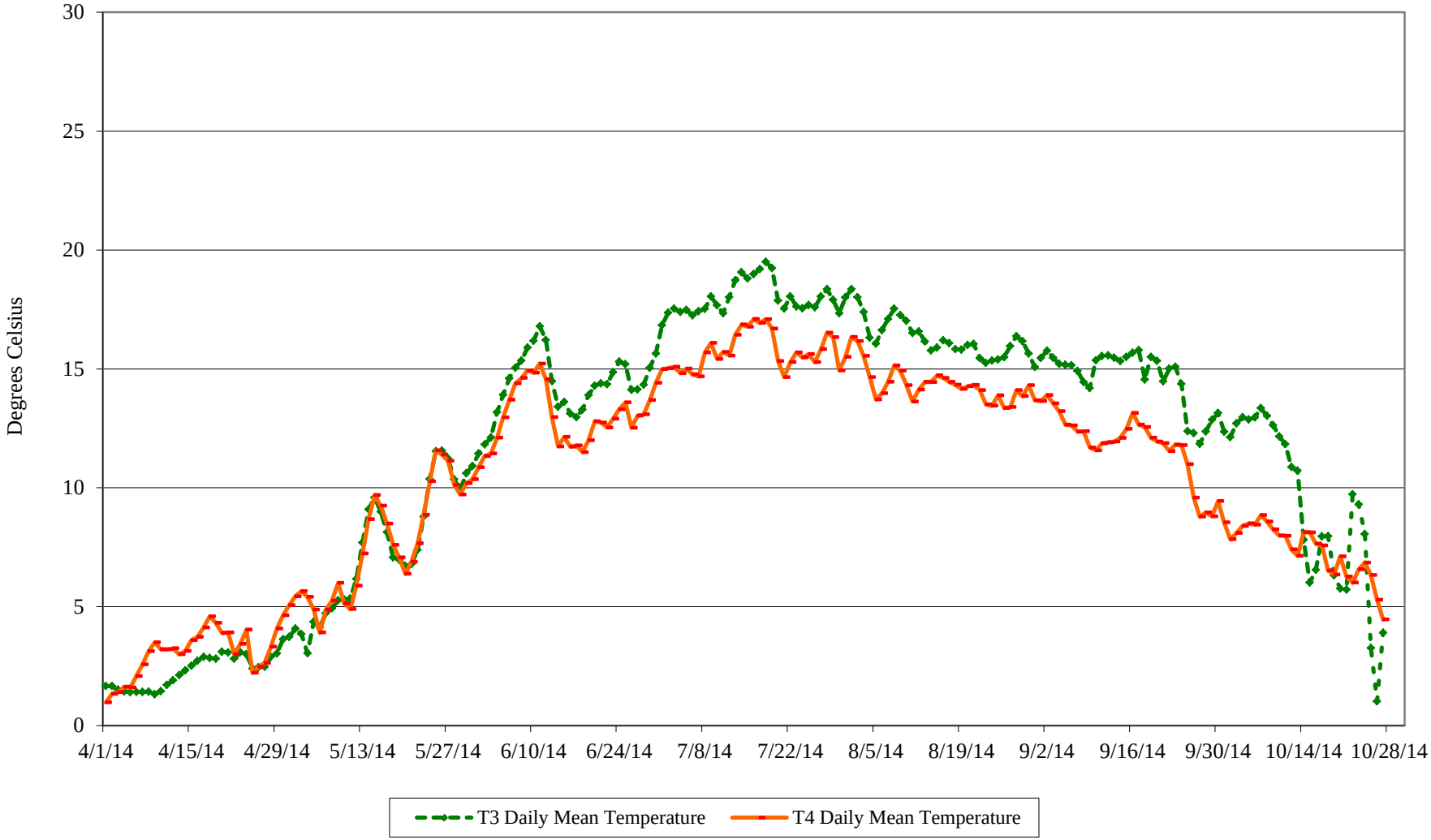


Figure 5. Daily Mean Temperature in Echo Creek at T3 & T4

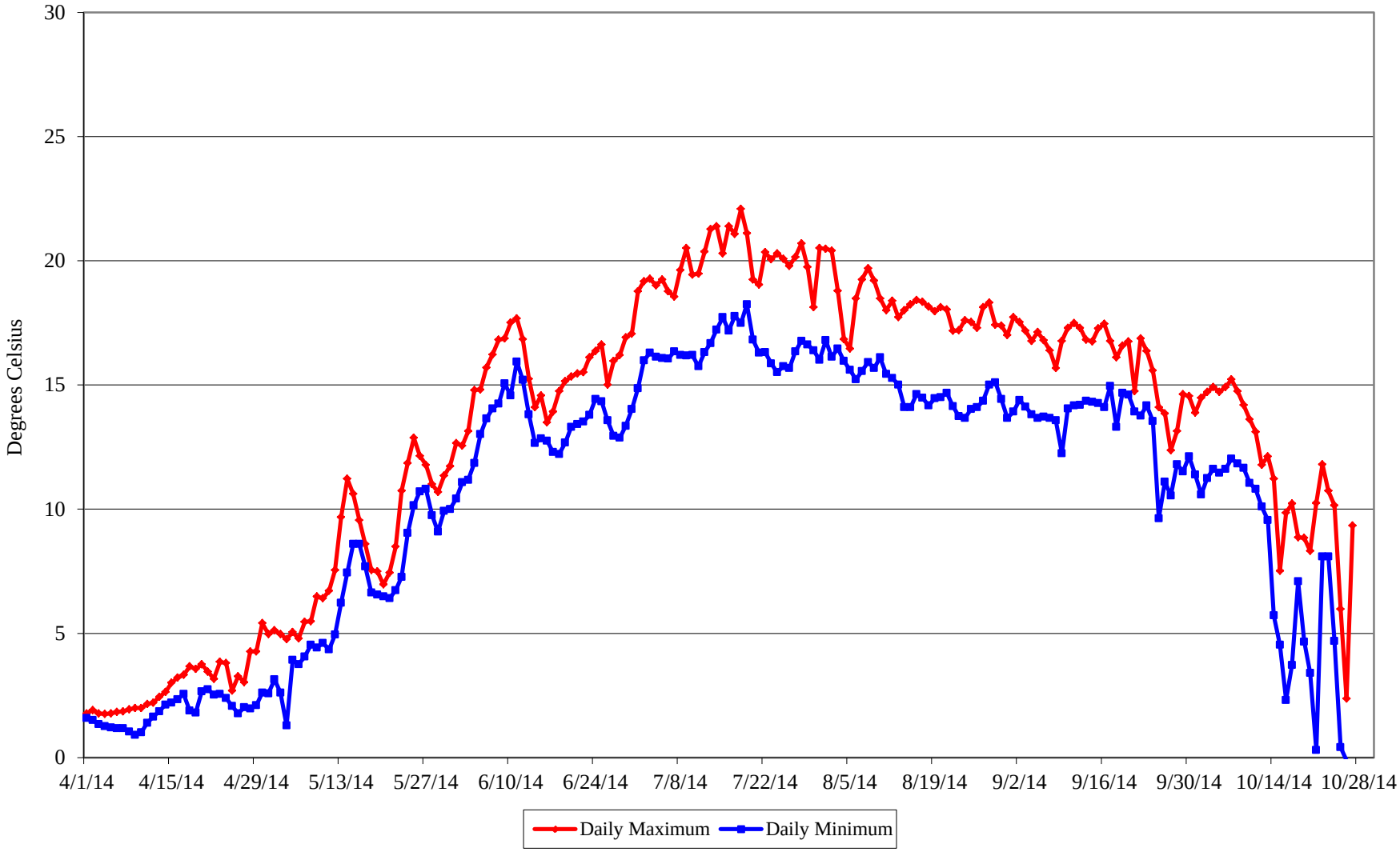


Figure 6. Daily Maximum and Minimum Water Temperatures Echo Creek downstream of dam T3

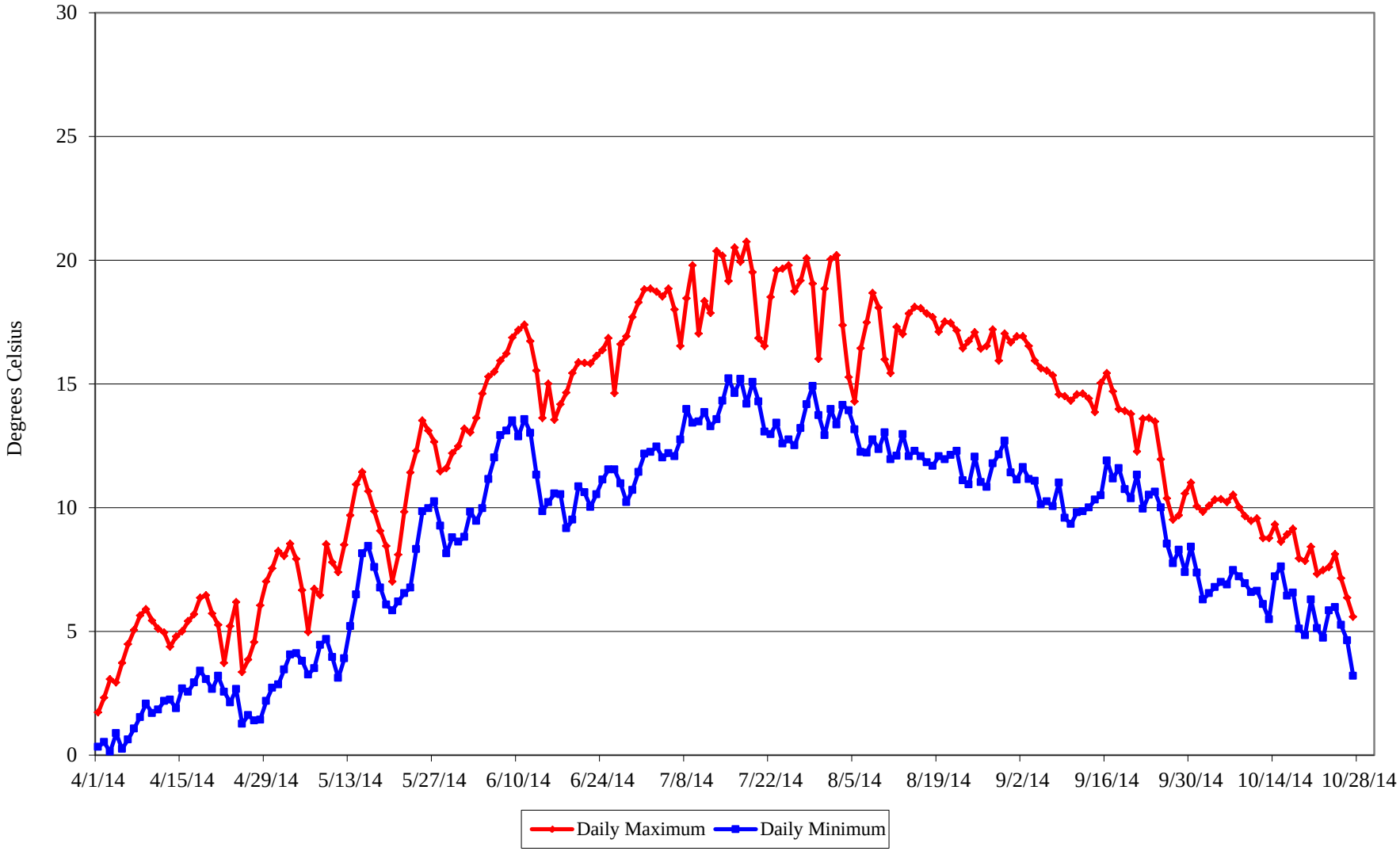


Figure 7. Daily Maximum and Minimum Water Temperatures in Echo Creek upstream of Upper Truckee R.T4

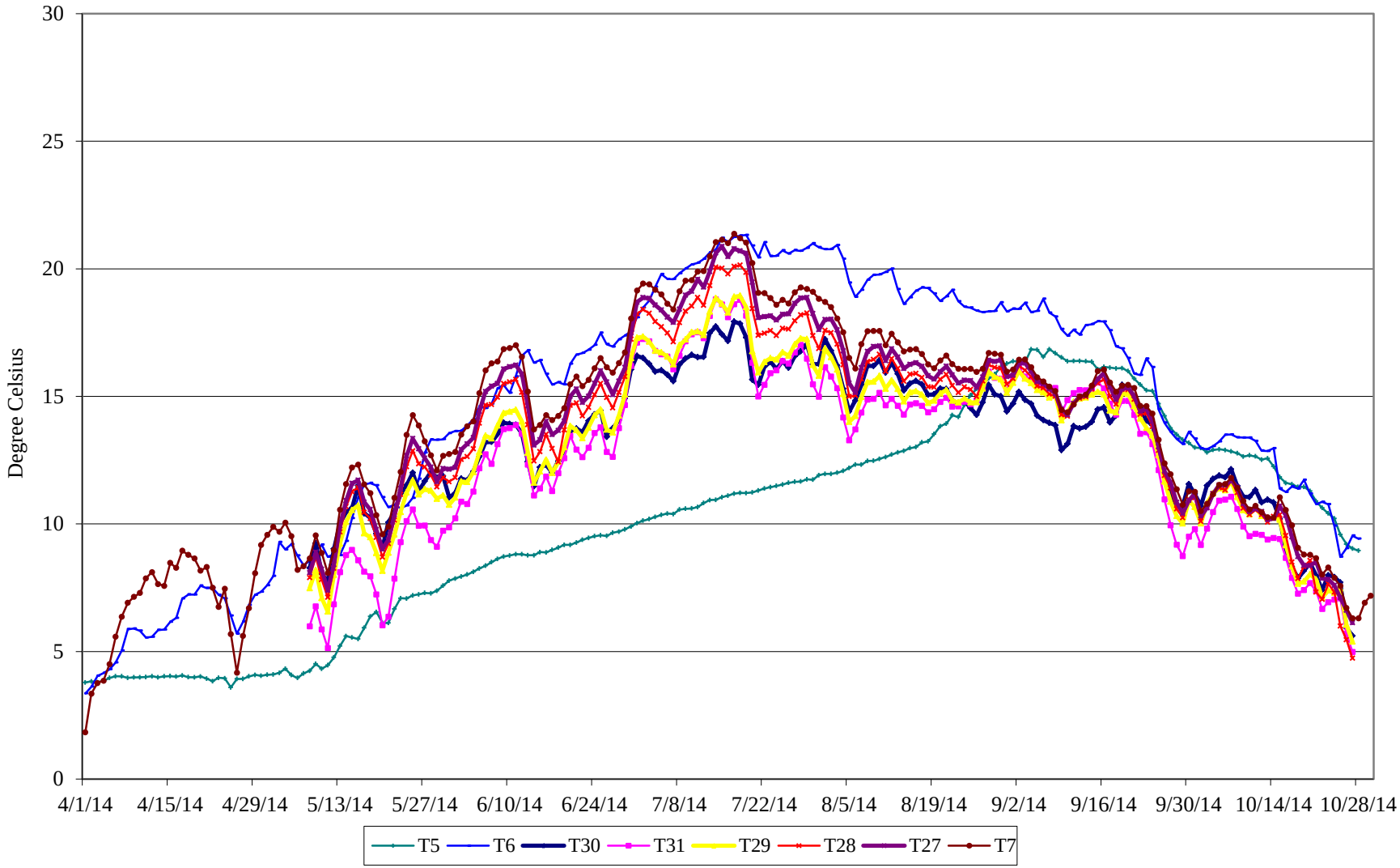


Figure 8. Daily Mean Temperature in Silver Fork of the American River and Caples Creek at T5, T6, T30, T29, T28, T27 and T7

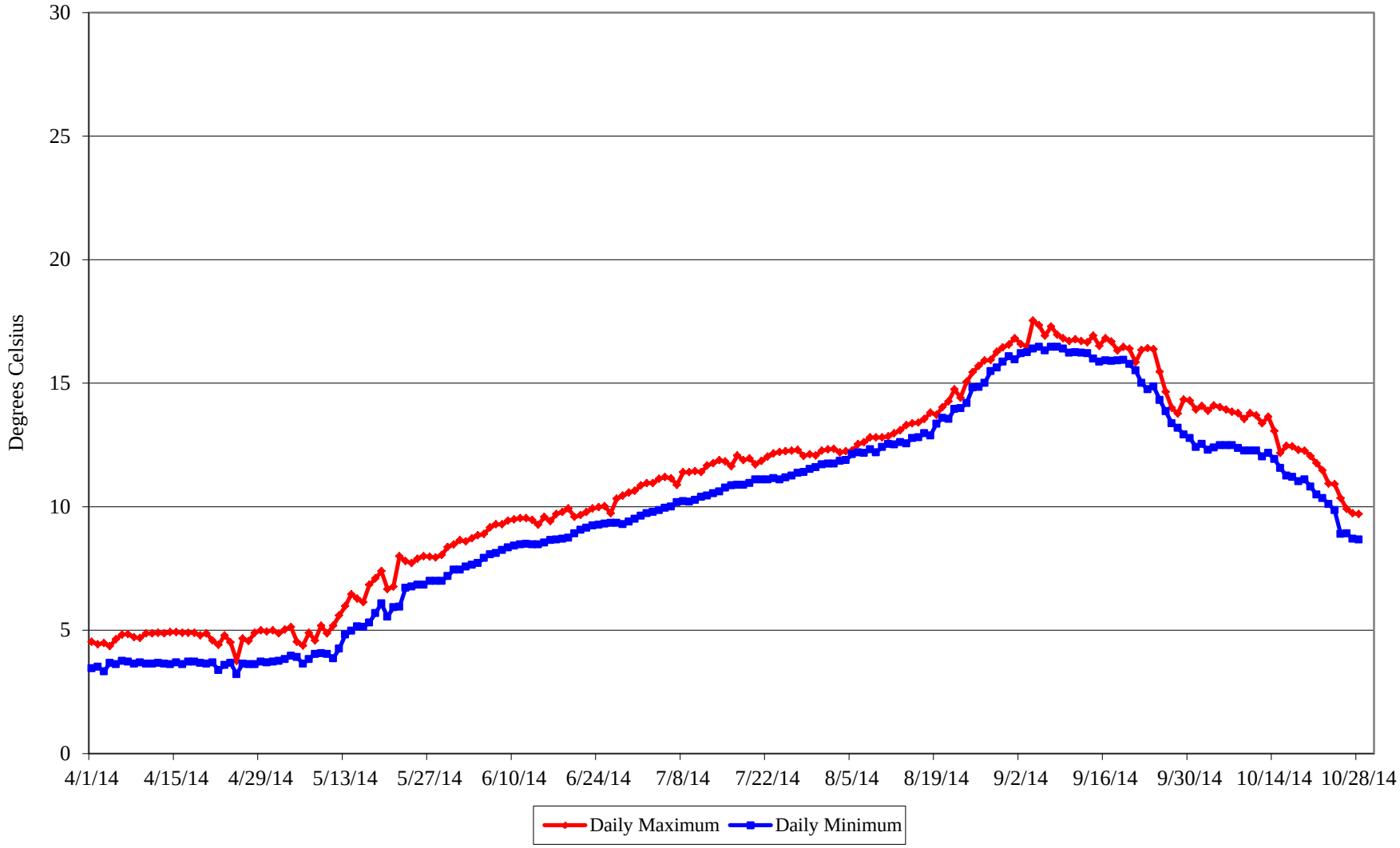


Figure 9. Daily Maximum and Minimum Water Temperatures in Caples Creek below Caples Lake T5

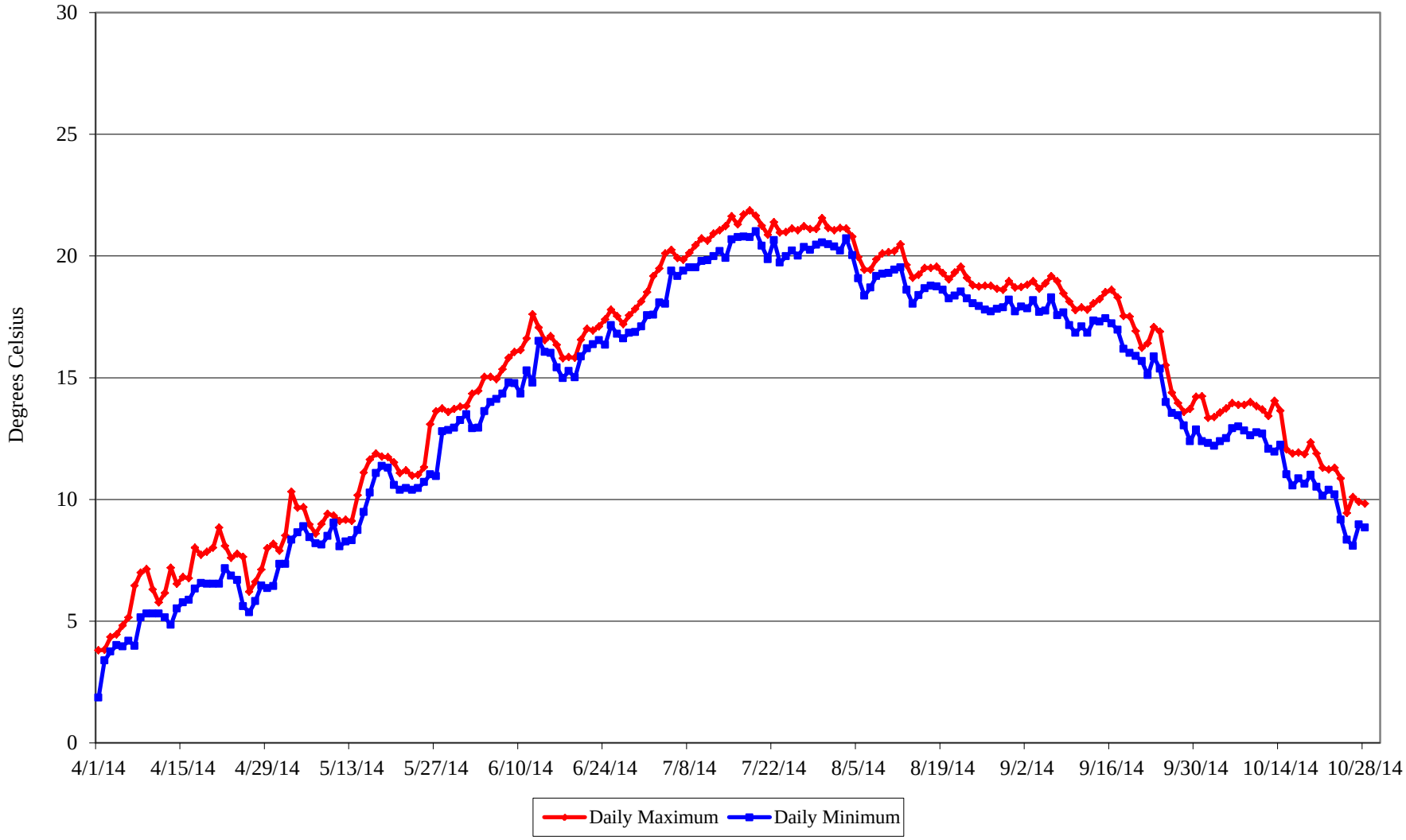


Figure 10. Daily Maximum and Minimum Water Temperatures in Silver Fork below Silver Lake T6

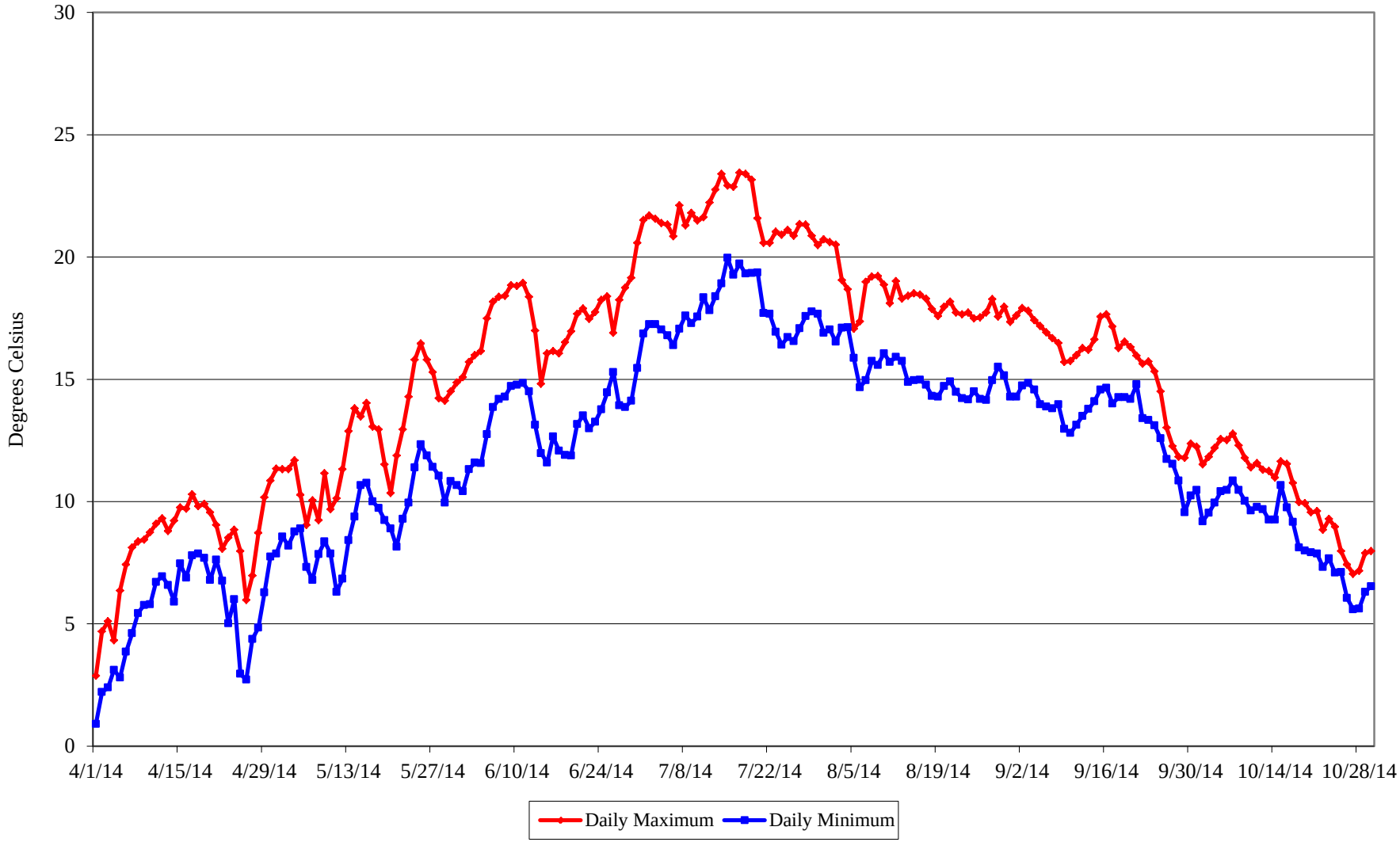


Figure 11. Daily Maximum and Minimum Water Temperatures in Silver Fork above SF American T7

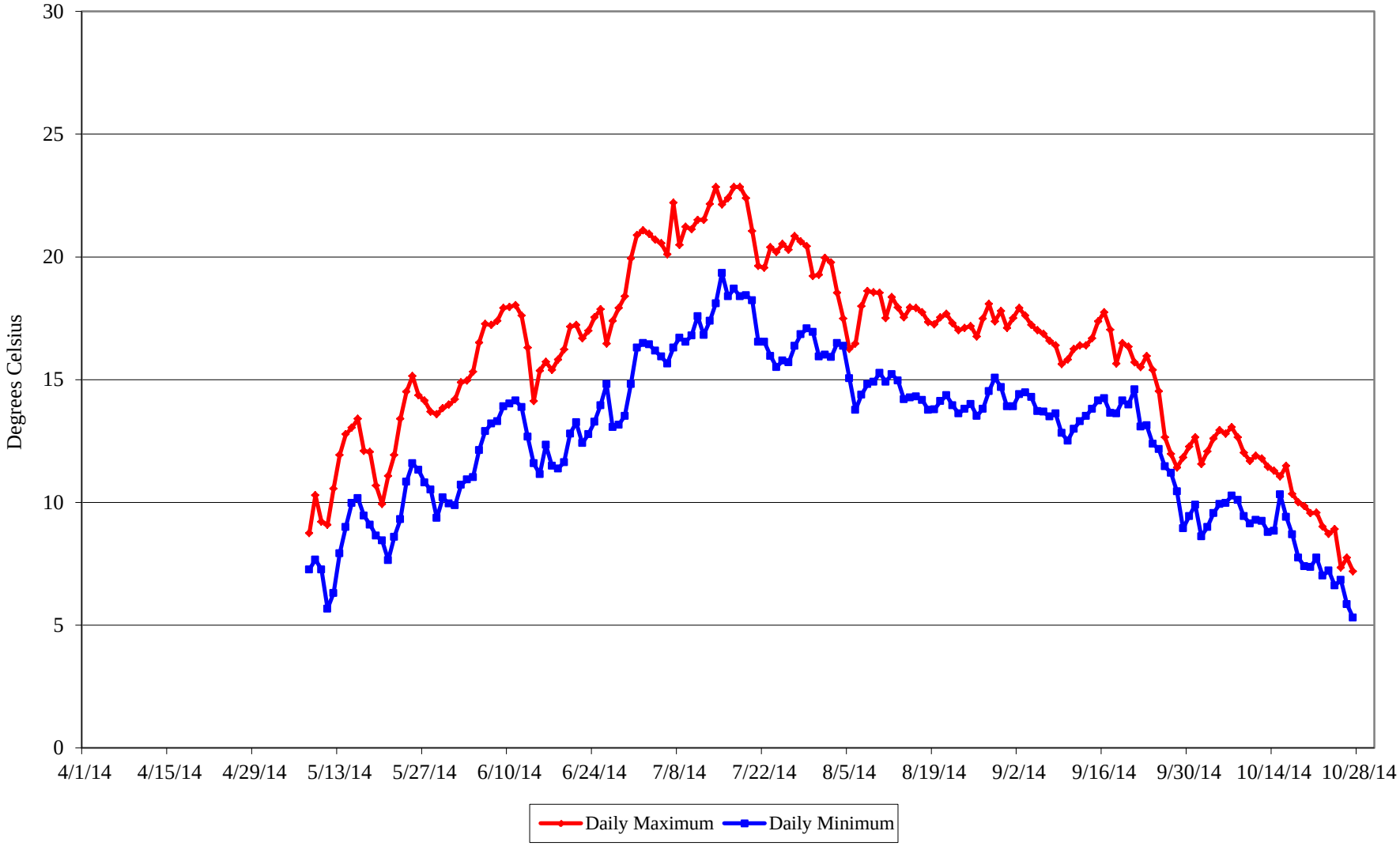


Figure 12. Daily Maximum and Minimum Water Temperatures in Silver Fork at China Flat Campground T27

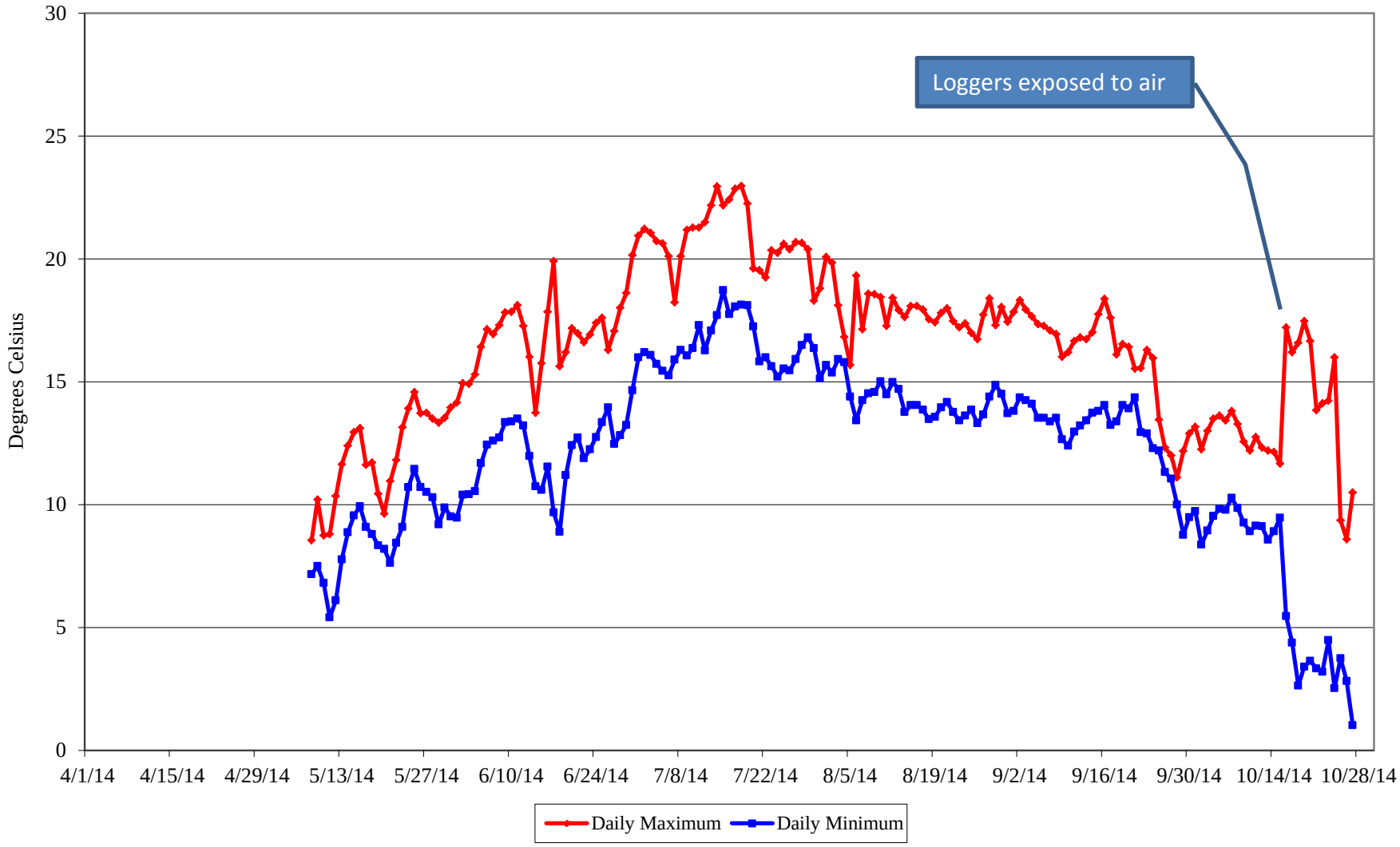


Figure 13. Daily Maximum and Minimum Water Temperatures in Silver Fork at Devils Gulch T28

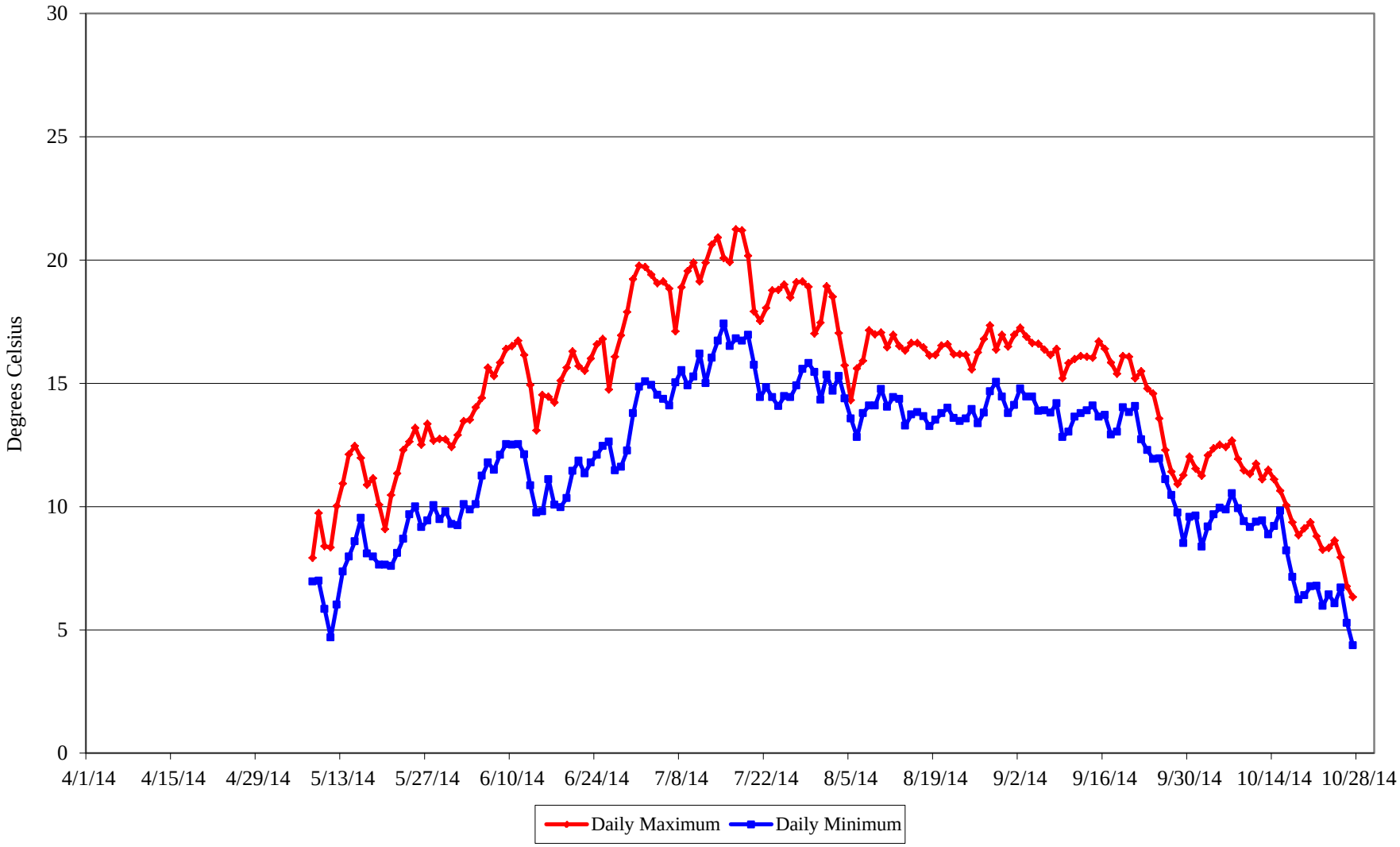


Figure 14. Daily Maximum and Minimum Water Temperatures in Silver Fork near Fitch Rantz Bridge T29

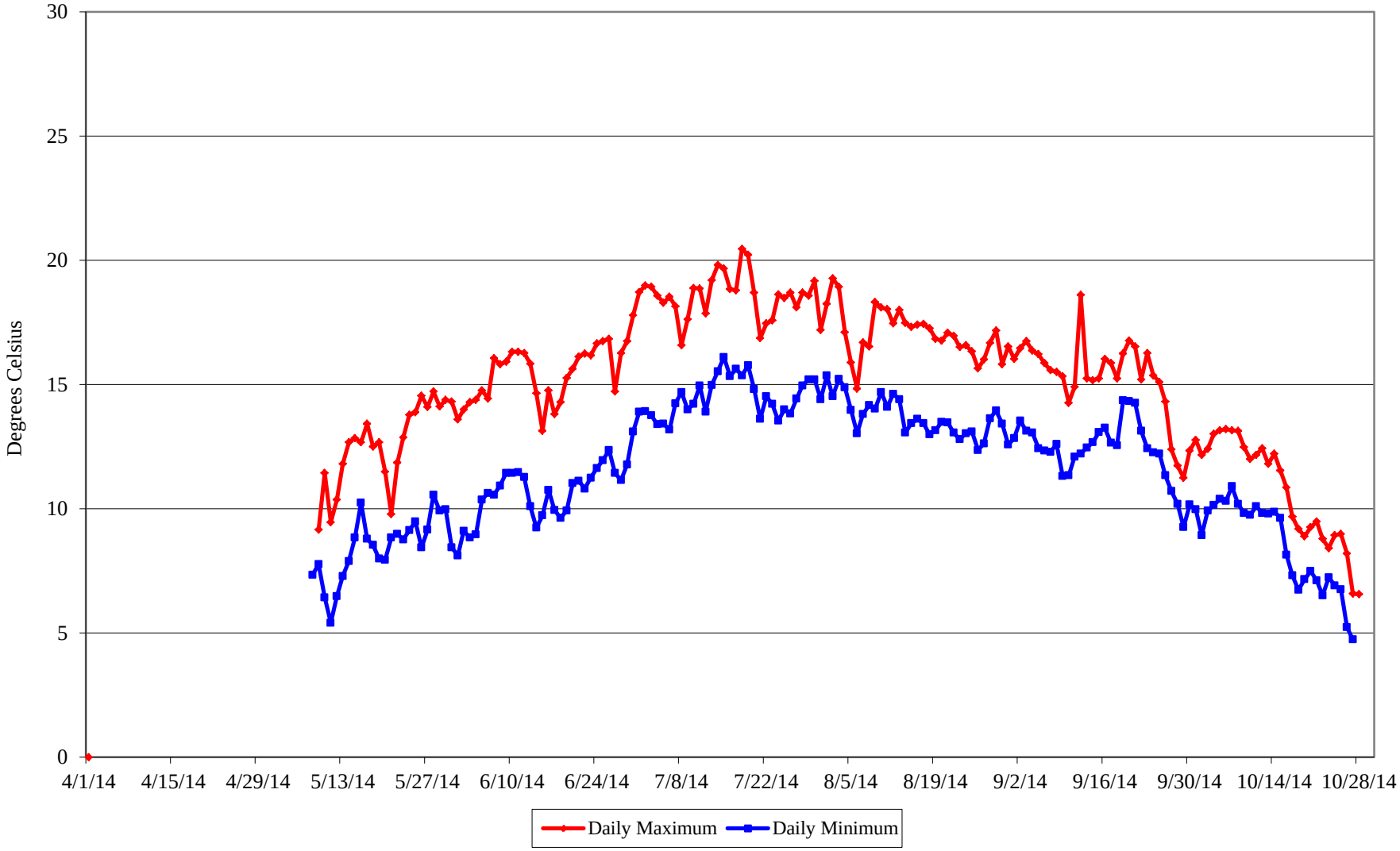


Figure 15. Daily Maximum and Minimum Water Temperatures in Silver Fork upstream of the confluence with Caples Creek T30

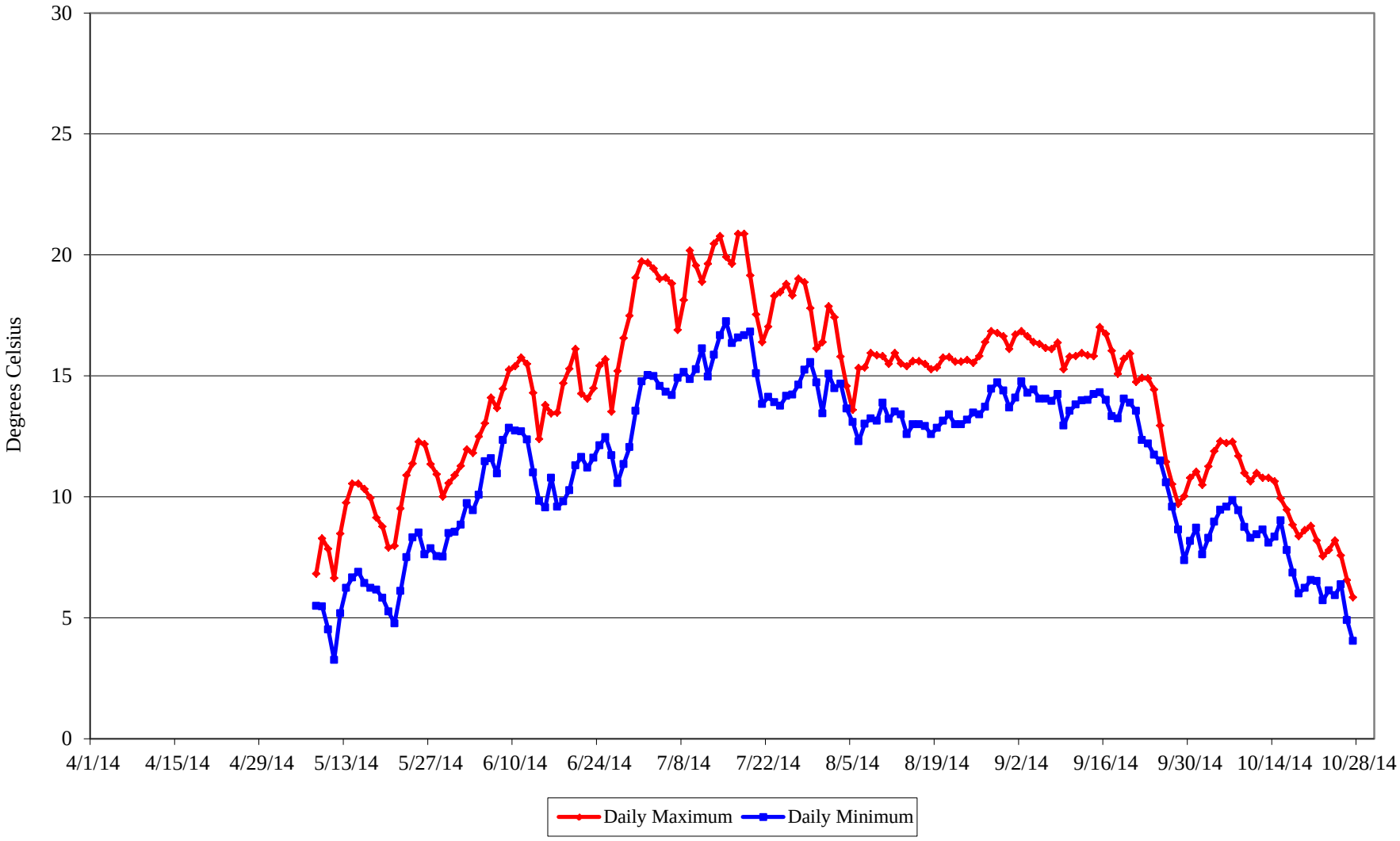


Figure 16. Daily Maximum and Minimum Water Temperatures Caples Creek upstream of the confluence with Silver Fork American River T31

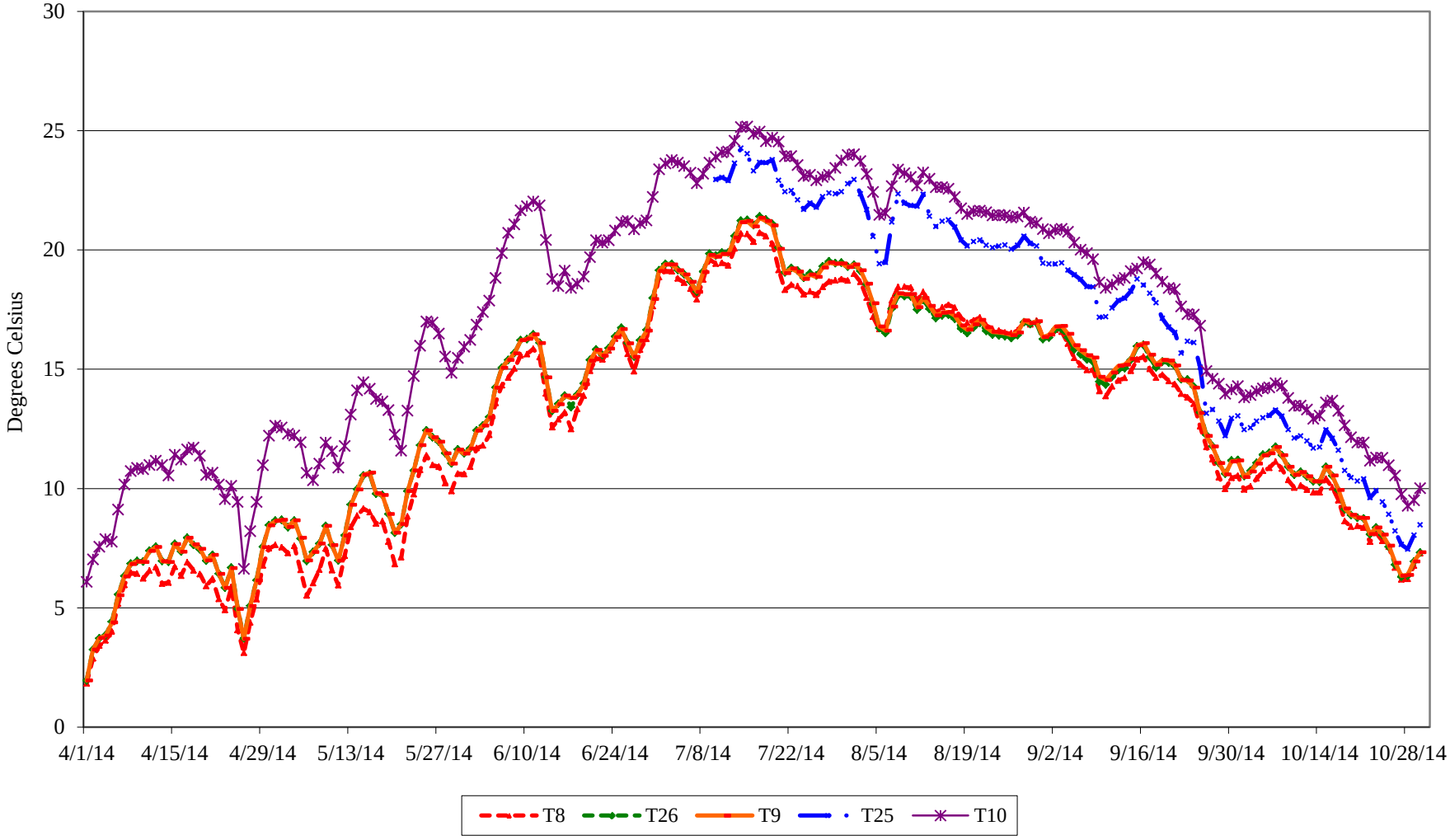


Figure 17. Daily Mean Temperature in the SF American River T8, T26, T9, T25, & T10

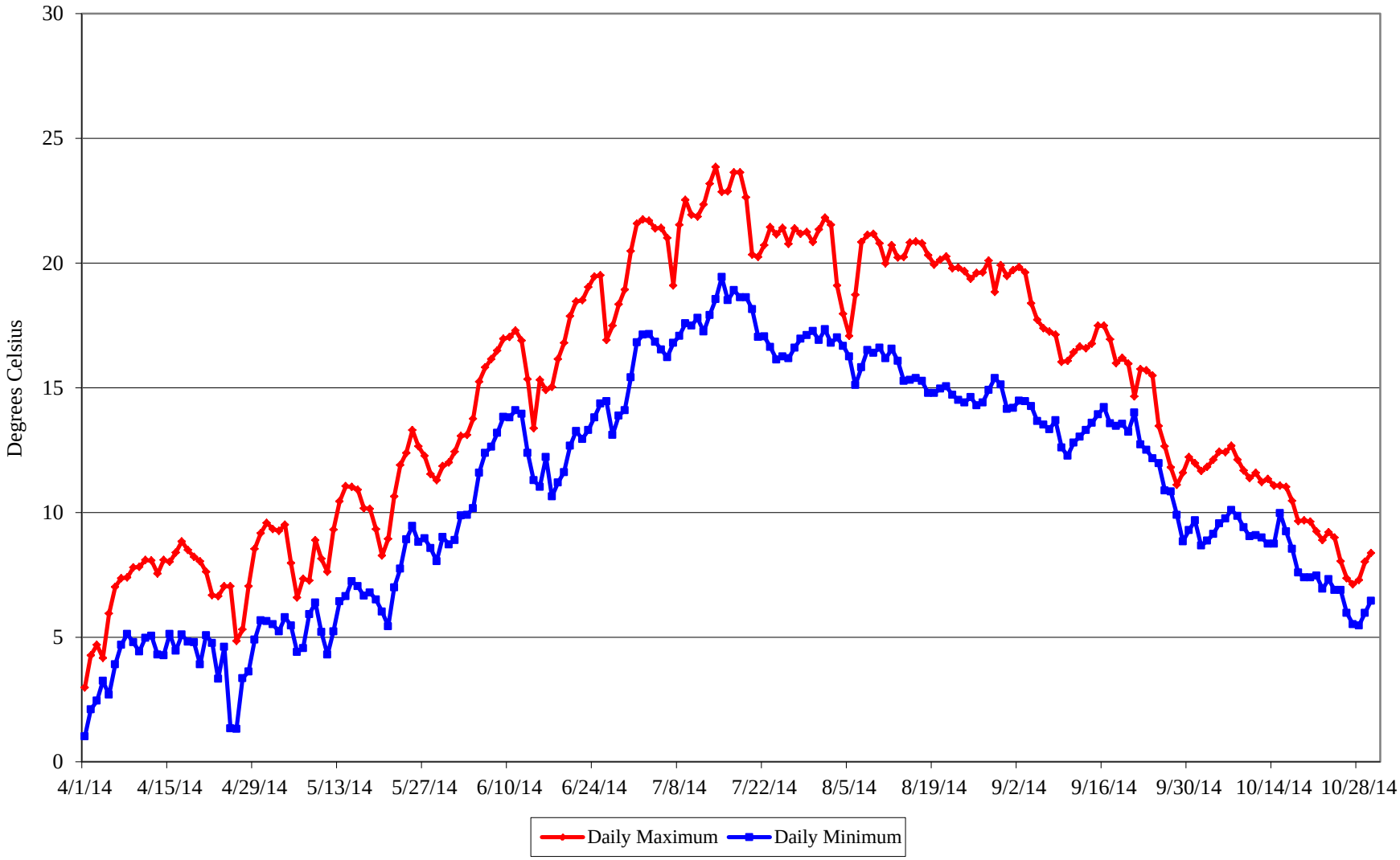


Figure 18. Daily Maximum and Minimum Water Temperatures in the SF American above Silver Fork, T8

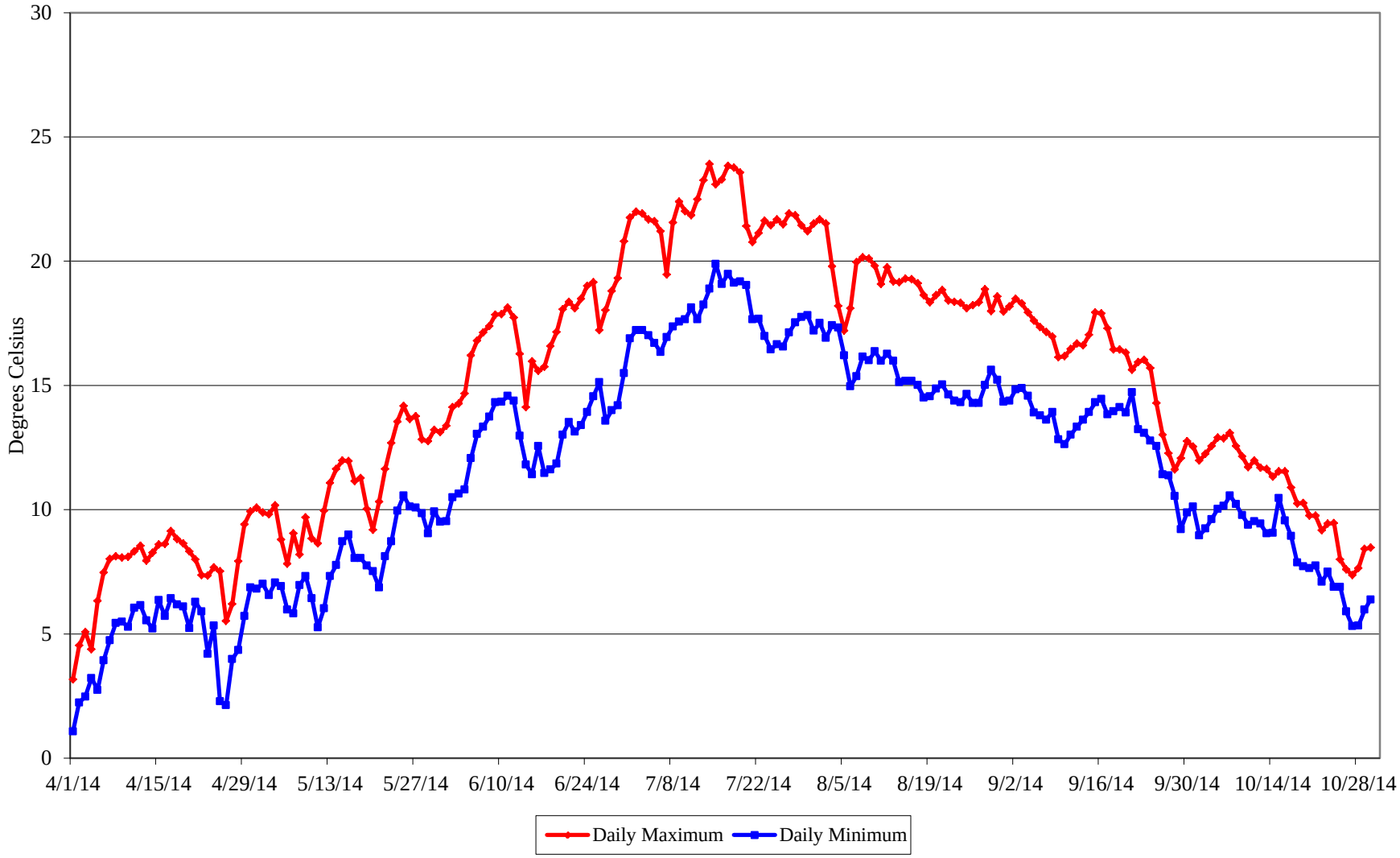


Figure 19. Daily Maximum and Minimum Water Temperatures in the SFAR above Kyburz Diversion T26

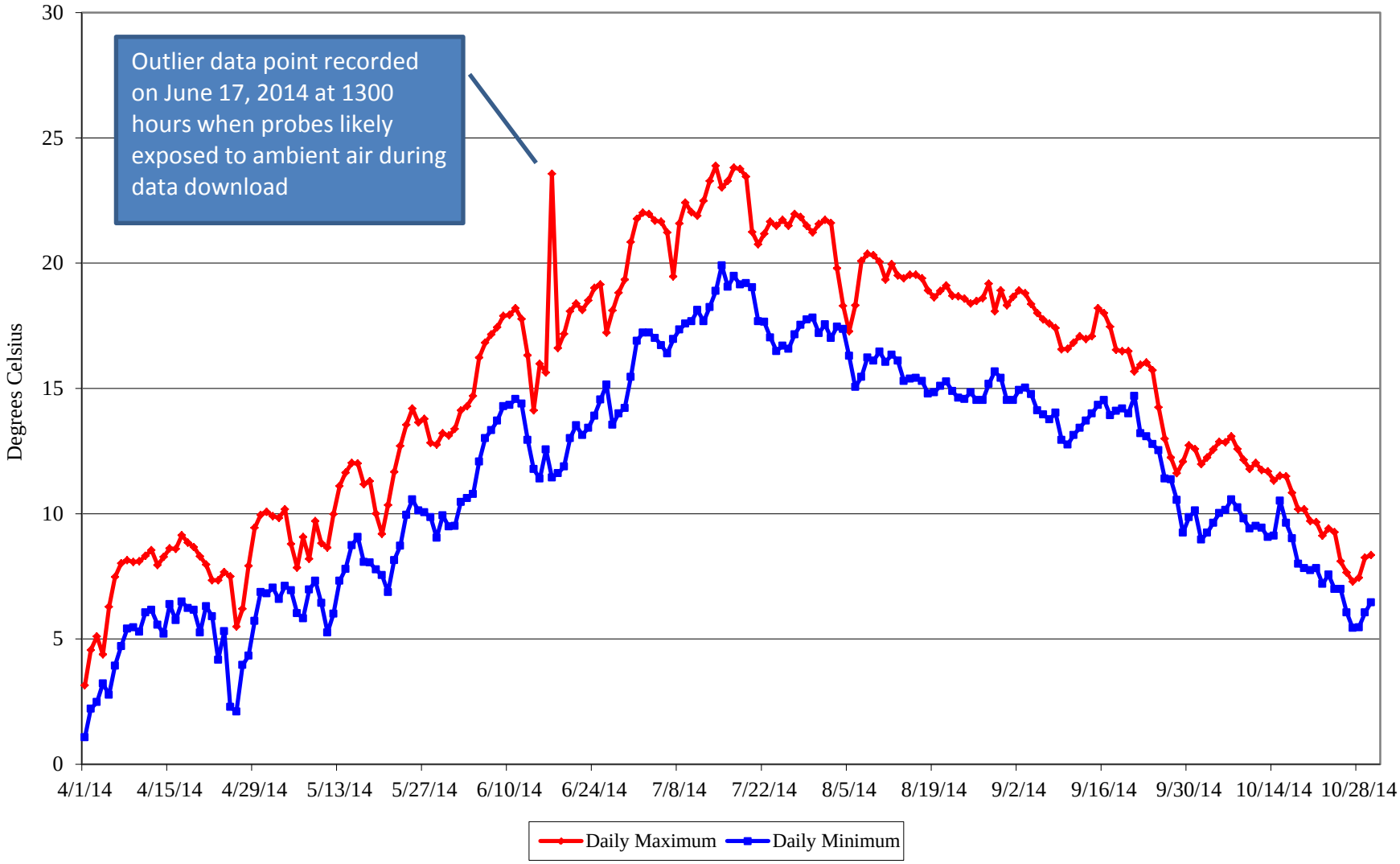


Figure 20. Daily Maximum and Minimum Water Temperatures in SFAR below Kyburz Diversion T9

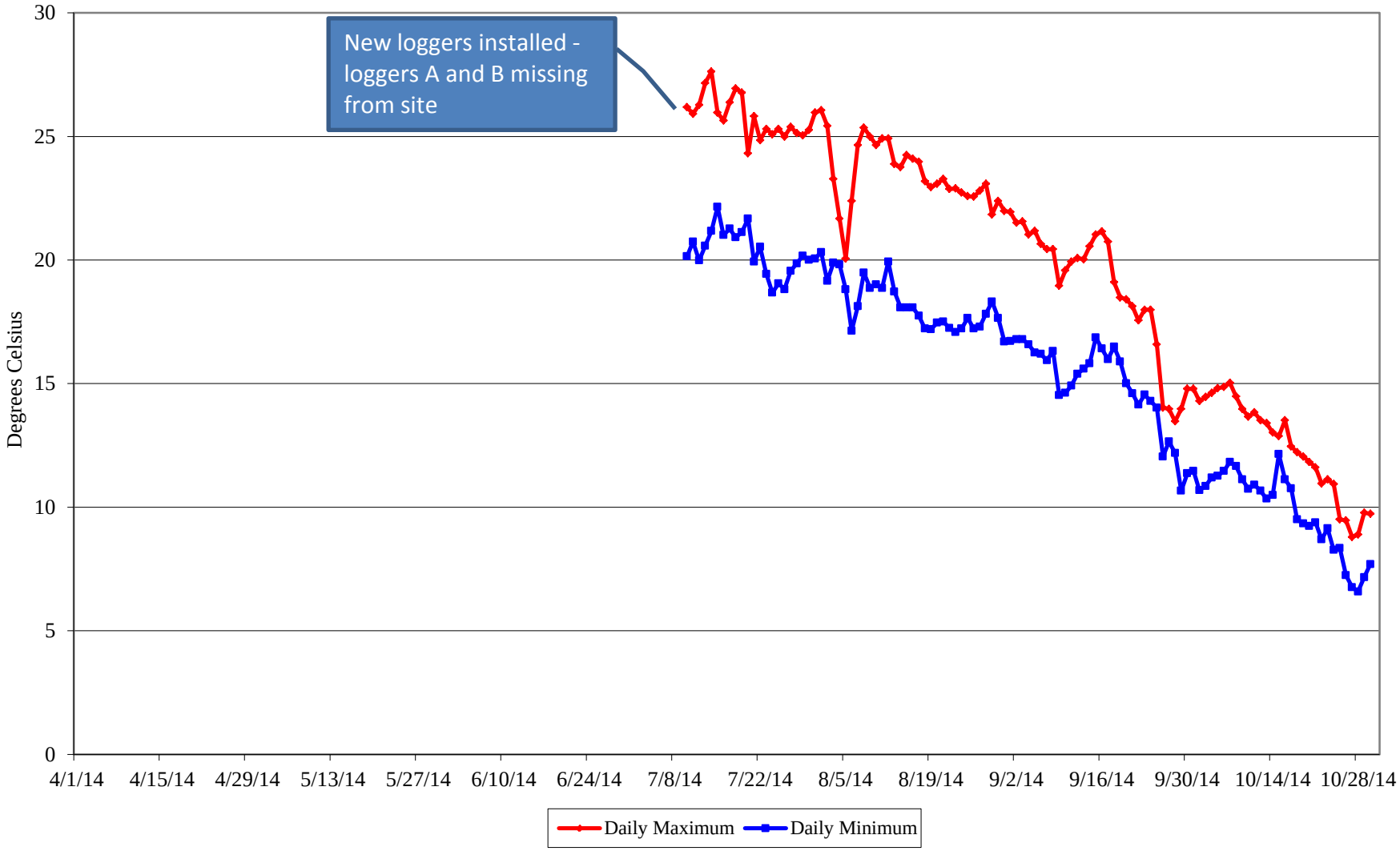


Figure 21. Daily Maximum and Minimum Water Temperatures in the SFAR at Bridalveil Picnic Area T25

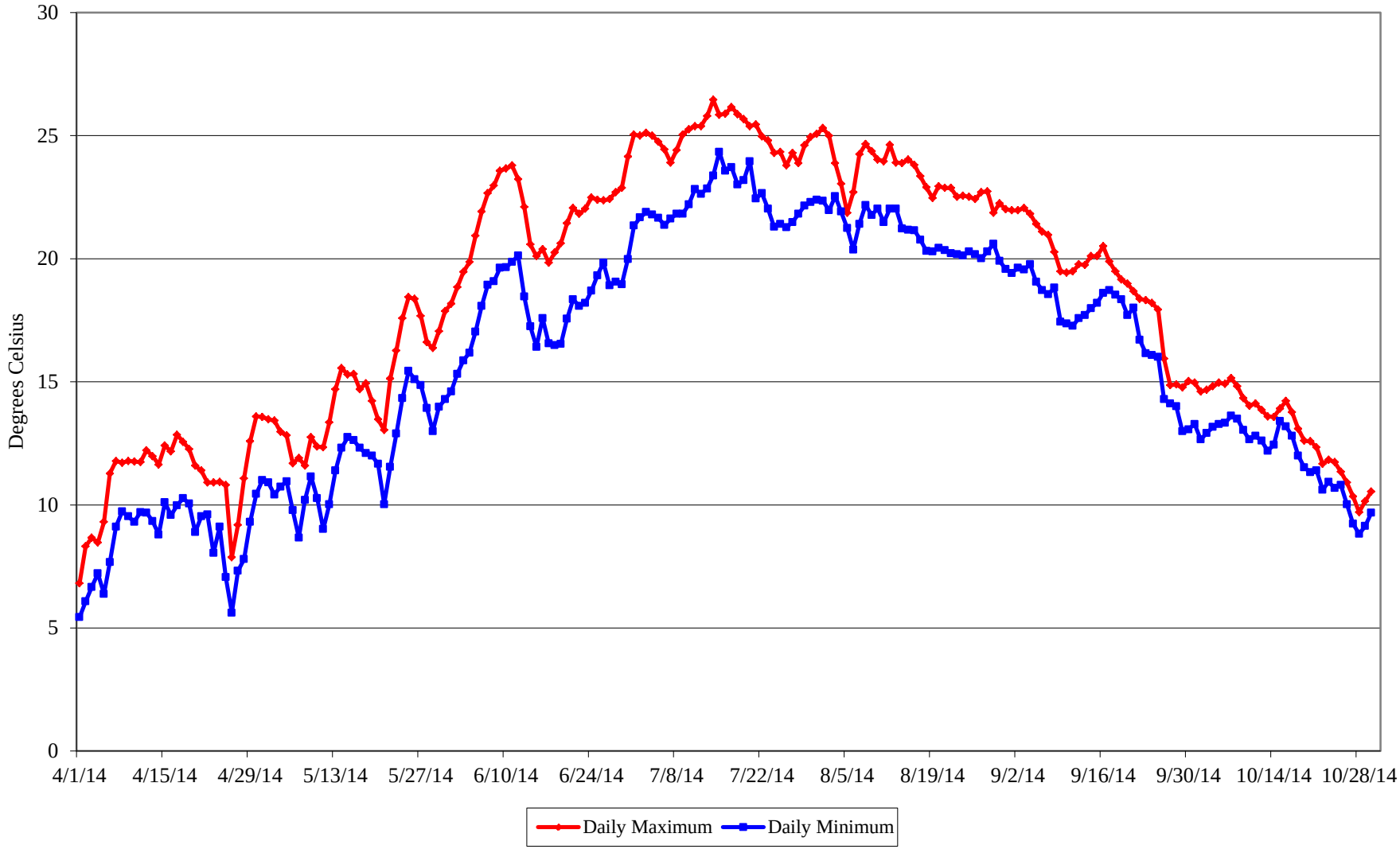
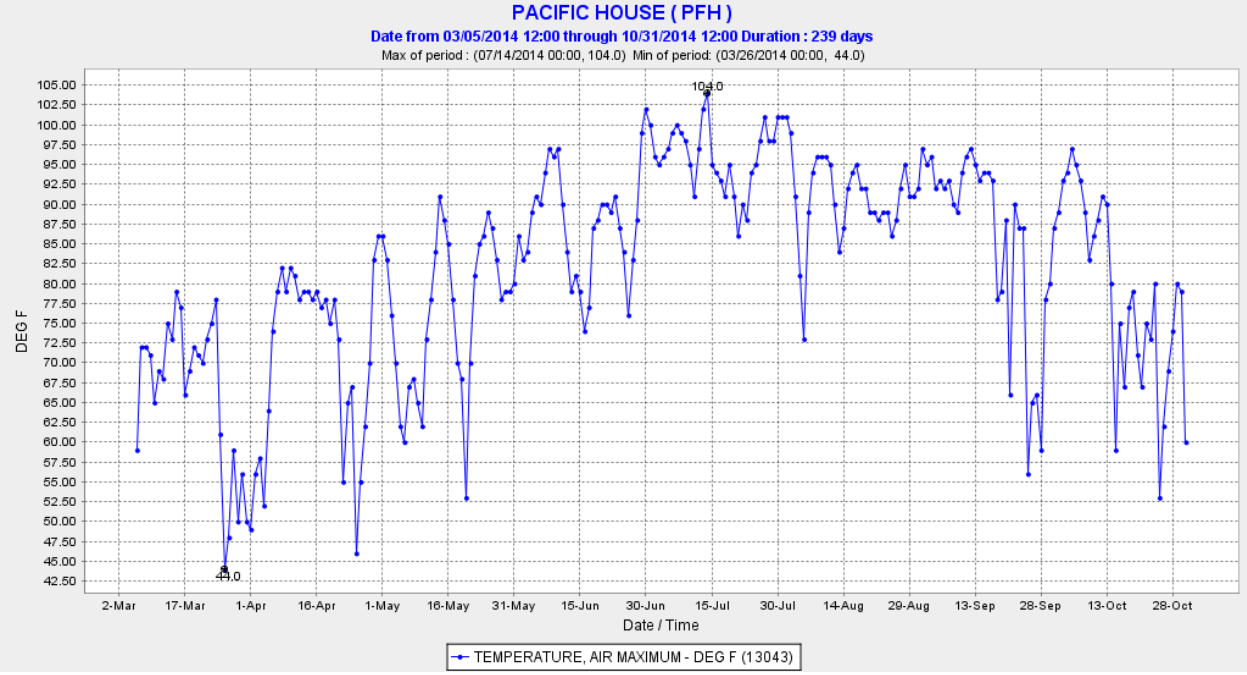


Figure 22. Daily Maximum and Minimum Water Temperatures in the SFAR at Akin Powerhouse T10

Figure 23. Maximum Air Temperature recorded at Pacific House, March – October 2014



Source: California Department of Water Resources – California Data Exchange Center http://cdec.water.ca.gov/jspplot/jspPlotServlet.jsp?sensor_no=13043&end=07%2F31%2F2014+12%3A00&geom=huge&interval=120&cookies=CDEC02 (Accessed on January 9, 2015).