

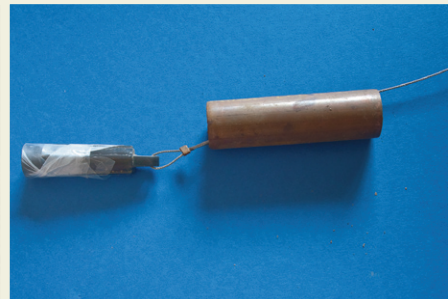


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# Water Temperature Monitoring

EL DORADO HYDROELECTRIC PROJECT (FERC No.184)

**Garcia and Associates**  
Natural and Cultural Resource Consultants



2010



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**Submitted to:**

El Dorado Irrigation District  
2890 Mosquito Road  
Placerville, CA 95677

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*Submitted to:*

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## 1.0 INTRODUCTION

### 1.1 Project Background

The El Dorado Irrigation District (EID) developed the Project 184 Water Temperature Monitoring Plan (Plan; EID 2007) to satisfy requirements set forth in the Federal Energy Regulatory Commission (FERC) Project 184 License, El Dorado Relicensing Settlement Agreement (EID 2003), U.S. Forest Service 4(e) License Condition No. 37 (USFS 2003), and the California State Water Resources Control Board Section 401 Clean Water Act Water Quality Certification Condition No. 15 (SWRCB 2006).

Temperature monitoring is needed during spring months to help evaluate breeding conditions for amphibians. Monitoring is also needed during summer to determine if coldwater beneficial uses as defined by the Central Valley and Lahontan Regional Water Quality Control Boards 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 drainage, part of the larger Sacramento River Basin. According to the Central Valley Region Basin Plan (CVRWQCB 1998), 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. 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 1995).

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. Results of 2009 temperature monitoring efforts 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. As stipulated in the study plan, continuous recording temperature probes were deployed at 25 locations (see Appendix A, Figure 1) where representative temperature data could be obtained throughout the entire monitoring period (April 1<sup>st</sup> through October 31<sup>st</sup>) provided safe access was possible. These 25 monitoring locations were as follows:

- 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
- T11 Alder Creek upstream of Diversion Dam
- T12 Alder Creek upstream of South Fork American River
- T13 No Name Creek upstream of Diversion Dam
- T14 No Name Creek upstream of South Fork American River
- T15 Mill Creek upstream of Diversion Dam

- T16 Mill Creek upstream of South Fork American River
- T17 Bull Creek upstream of Diversion Dam
- T18 Bull Creek upstream of South Fork American River
- T19 Ogilby Creek upstream of Diversion Dam
- T20 Ogilby Creek upstream of South Fork American River
- T21 Esmeralda Creek upstream of Diversion Dam
- T22 Esmeralda Creek upstream of South Fork American River
- T23 Carpenter Creek upstream Diversion Dam
- T24 Carpenter Creek upstream of South Fork American River
- T25 South Fork American River at Bridal Veil Picnic Area

## 2.2 Temperature Recorders

Two ONSET HOBO Water Temperature Pro V2 Data Loggers were installed at each of the above locations in late March, 2009 (with the exception of site T1 below Lake Aloha, which were not installed until June 19<sup>th</sup> because this high-elevation site was inaccessible due to snow). 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. Each site location was GPS located and photo documented. Data were downloaded monthly from all 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 mid November, unless streams went dry. Upper Mill Creek (T15), Upper Ogilby Creek (T19), and Lower Bull Creek (T18) went dry in July, so these recorders were removed. All other sites were remained wet throughout the entire study period.

## 2.3 Data Analysis

Data were initially processed using HOBOWare Pro (version 2.7.3) software to calculate daily maximum, minimum, and average temperatures. Monthly data were exported and compiled using Microsoft Excel. Daily average temperatures for the two recorders deployed at a given location were compared graphically to search for anomalies (*e.g.*, indications of where one of the recorders had been out of the water). 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. In one case (site T3), logger T3A consistently read 0.6°C lower than T3B. In this case, representative data was compared for loggers T3A, T3B, T4A, and T4B during a period of exposure to the same temperatures, where it was determined loggers T3B, T4A and T4B were consistent with each other, while T3A was reading low; therefore, data from T3B was used for the analysis.

At each location, the daily minimum and daily maximum temperatures were compared graphically to identify heating and cooling trends. Daily average temperatures were compared between upstream and downstream sites (*e.g.*, T1 & T2) to identify trends and potential effects of project operations on meeting Basin Plan standards.

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 2009 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 presented in tabular form 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. Upper Pyramid Creek (T1) is located in the outflow channel just below the dam at Lake Aloha. Temperature recorders were installed on June 19<sup>th</sup> because of limited access to the lake due to snow pack. Lower Pyramid Creek (T2) is located near the Highway 50 crossing and was installed in late March.

Daily average water temperature in upper and lower Pyramid Creek is shown in Figure 2. Figure 3 shows the daily maximum and minimum water temperatures in upper Pyramid Creek, while Figure 4 shows the daily maximum and minimum water temperatures in lower Pyramid Creek.

There were no data anomalies between temperature recorders A and B at either site. Water temperatures recorded in Pyramid Creek were within the optimal 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. Upper Echo Creek (T3) is located near the gage station approximately 100 meters downstream of the dam at Echo Lake. Lower Echo Creek (T4) is located near the confluence with the Upper Truckee River near the town of Myers.

Daily average water temperatures in upper and lower Echo Creek is shown in Figure 5. Figure 6 shows the daily maximum and minimum water temperatures in upper Echo Creek, while Figure 7 shows the daily maximum and minimum water temperatures in lower Echo Creek.

Logger A in upper Echo Creek (T3) read 0.6°C lower than Logger B, and therefore was not used. In lower Echo Creek (T4), Logger A had a data anomaly in August, suggesting that the recorder was possibly out of the water, and therefore was not used (the rest of the data at T4 was consistent with Logger B). Water temperatures recorded in Echo Creek were within the optimal range for trout and other cold water species, including amphibians.

### **3.3 Silver Fork American River (T5, T6 & T7)**

The Silver Fork of the American River 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. Caples Creek (T5) is located near the gage station below Caples Lake (at 7,806 feet). Upper Silver Fork (T6) is located below Silver Lake (at 7,261 feet). Lower Silver Fork (T7) is located just above the confluence with the South Fork American River. These three loggers were installed in late March 2009.

Daily average water temperatures in Caples Creek, upper Silver Fork, and lower Silver Fork are shown in Figure 8. Figure 9 shows the daily maximum and minimum water temperatures in Caples Creek, Figure 10 shows the daily maximum and minimum water temperatures in upper Silver Fork, and Figure 11 shows the daily maximum and minimum water temperatures in lower Silver Fork.

There were no anomalies in the data between Loggers A and B at any of these three sites. Water temperatures recorded in Caples Creek and lower Silver Fork are within the optimal range for trout and other coldwater species. Water temperatures measured in Upper Silver Fork below Silver Lake slightly exceeded 20°C for approximately two weeks during late July and early August; however, these temperatures were still adequate for coldwater species, including amphibians.

### **3.4 Alder Creek (T11 & T12)**

Alder Creek is a steep, north-facing, forested watershed that, and is the westernmost tributary watershed with an extensive snow pack during the winter. Alder Creek is the next major tributary downstream (west) of Silver Fork. Upper Alder Creek (T11) is located in the diversion pool. Lower Alder Creek (T12) is located near the bottom of Alder Creek, above the confluence with the South Fork American River.

Daily average water temperatures in upper and lower Alder Creek are shown in Figure 12. Figure 13 shows the daily maximum and minimum water temperatures in upper Alder Creek, while Figure 14 shows the daily maximum and minimum water temperatures in lower Alder Creek.

In upper Alder Creek (T11), there was a difference of approximately 0.8°C between logger A and B during mid-summer, which most likely reflects a difference in the logger's position in the water column, rather than a calibration error. The two loggers were consistent in the spring and fall. Logger A, the shallower, and therefore warmer of the two, was used for the analysis since this better represented the temperature of the outflow. In lower Alder Creek (T12) there was a slight discrepancy in the August data, with logger A appearing muted as if buried; therefore, the data from Logger B was used for analysis.

The average temperature difference above and below the Alder Creek Diversion was 0.8°C (1.4°F) over the course of the study period based upon the hourly temperature data. There was a maximum difference of 2.8°C – 3.2°C (5.0°F – 5.8°F) for a total of 35 hours over 14 days between August 19<sup>th</sup> and September 11<sup>th</sup>. This warming is attributed to natural warming of the stream water and is not project-related, since water is diverted from Alder Creek between January and June, and is not diverted during late summer. Water temperatures recorded in Alder Creek were within the optimal range for trout and other coldwater species.

### **3.5 No Name Creek (T13 & T14)**

No Name Creek is a small, densely forested and shaded north-facing watershed east of Alder Creek (between Alder Creek and Silver Fork). Upper No Name Creek (T13) is located just above the flume. Lower No Name Creek (T14) is located just upstream of the confluence with the South Fork American River.

Daily average water temperatures in upper and lower No Name Creek are shown in Figure 15. Figure 16 shows the daily maximum and minimum water temperatures in upper No Name Creek, while Figure 17 shows the daily maximum and minimum water temperatures in lower No Name Creek.

There were no data anomalies between temperature recorders A and B at either site. Water temperatures recorded in No Name Creek were within the optimal range for trout and other coldwater species, including amphibians.

### **3.6 Mill Creek (T15 & T16)**

Mill Creek is a small, steep, north-facing watershed west of Alder Creek. The Mill Creek watershed is vegetated with a chaparral community instead of the

mixed conifer forest typical in the neighboring watersheds. Upper Mill Creek (T15) is located beneath a large waterfall upstream of the flume. Upper Mill Creek was subsurface in early July (~ July 3<sup>rd</sup>) and the temperature loggers were removed. Lower Mill Creek (T16) is located behind a residential subdivision near the confluence with the South Fork American River.

Daily average water temperatures in upper and lower Mill Creek are shown in Figure 18. Figure 19 shows the daily maximum and minimum water temperatures in upper Mill Creek, while Figure 20 shows the daily maximum and minimum water temperatures in lower Mill Creek.

There were no data anomalies between temperature recorders A and B at either site. The daily maximum temperatures in late August and September reached stressful levels for coldwater species. However, the mean daily water temperatures in lower Mill Creek were within the optimal range for trout and other coldwater species, including amphibians. The late summer warming was not project related, as there were no project diversions in 2009.

### **3.7 Bull Creek (T17 & T18)**

Bull Creek is a small, steep, densely forested north-facing watershed west of Mill Creek. Upper Bull Creek (T17) is located upstream of the flume near Camp 2. Lower Bull Creek (T18) is located near the confluence with the South Fork American River. The lower reaches of Bull Creek in the vicinity of T18 went dry in mid-July.

Daily average water temperatures in upper and lower Bull Creek are shown in Figure 21. Figure 22 shows the daily maximum and minimum water temperatures in upper Bull Creek, while Figure 23 shows the daily maximum and minimum water temperatures in lower Bull Creek.

There were no data anomalies between temperature recorders A and B at either site. Water temperatures recorded in Bull Creek were within the optimal range for trout and other cold water species, including amphibians.

### **3.8 Ogilby Creek (T19 & T20)**

Ogilby Creek is a small, north-facing, forested watershed west of Bull Creek. Upper Ogilby Creek (T19) is located upstream of the Forest Service Road.

Lower Ogilby Creek (T20) is located near the confluence with the South Fork American River, near the Bridalveil Picnic Area.

Daily average water temperatures in upper and lower Ogilby Creek are shown in Figure 24. Figure 25 shows the daily maximum and minimum water temperatures in upper Ogilby Creek, while Figure 26 shows the daily maximum and minimum water temperatures in lower Ogilby Creek.

There were no data anomalies between temperature recorders A and B at either site. Water temperatures recorded in Ogilby Creek were within the optimal range for trout and other coldwater species, including amphibians.

### **3.9 Esmeralda Creek (T21 & T22)**

Esmeralda Creek is a small, north-facing, forested watershed west of Ogilby Creek, and is the downstream-most tributary in this study. Upper Esmeralda Creek (T21) is located just downstream of the Forest Service Road. Lower Esmeralda Creek (T22) is located at the base of Bridalveil Falls at Highway 50.

Daily average water temperatures in upper and lower Esmeralda Creek are shown in Figure 27. Figure 28 shows the daily maximum and minimum water temperatures in upper Esmeralda Creek, while Figure 29 shows the daily maximum and minimum water temperatures in lower Esmeralda Creek.

There were no data anomalies between temperature recorders A and B at either site. Water temperatures recorded in Esmeralda Creek are within the optimal range for trout and other coldwater species, including amphibians.

### **3.10 Carpenter Creek (T23 & 24)**

Carpenter Creek is a small, densely shaded, north-facing, forested watershed west of Silver Fork (between Silver Fork and No Name Creek), and runs through Sand Flat Campground. Upper Carpenter Creek (T23) is located just upstream of the flume. Lower Carpenter Creek (T24) is located in the campground downstream of the flume.

Daily average water temperatures in upper and lower Carpenter Creek are shown in Figure 30. Figure 31 shows the daily maximum and minimum water temperatures in upper Carpenter Creek, while Figure 32 shows the daily maximum and minimum water temperatures in lower Carpenter Creek.

There were no data anomalies between temperature recorders A and B at either site. Water temperatures recorded in Carpenter Creek were within the optimal range for trout and other coldwater species, including amphibians.

### **3.11 South Fork American River (T8, T9, T25 & T10)**

The South Fork of the American River drains the west side of the Sierra Nevada, and is the mainstem river within the study area. T8 is located approximately 0.5 miles upstream of the Kyburz Diversion, upstream of the South Fork's confluence with the Silver Fork, and is the upstream-most study location in the mainstem. T9 is located just downstream of the Kyburz Diversion. T25 is located in the middle of the affected Project mainstem, near the Bridalveil Picnic Area. T10 is located at the downstream end of the Project Area, in the pool immediately upstream of the Akin Powerhouse.

Daily average water temperatures in the South Fork American River (sites T8, T9, T25, and T10) are shown in Figure 33. Figure 34 shows the daily maximum and minimum water temperatures in the South Fork American River above the Kyburz Diversion, while Figure 35 shows the daily maximum and minimum water temperatures in the South Fork American River below the Kyburz Diversion. Figure 36 shows the daily maximum and minimum water temperatures in the South Fork American River near the Bridal Veil Picnic Area in the middle of the Project reach. Figure 37 shows the daily maximum and minimum water temperatures in the South Fork American River upstream of the Akin Powerhouse at the downstream end of the Project reach.

Temperature logger 8B was buried in sediment during the spring snowmelt in early May, and consequently recorded a muted temperature range until it was freed in June and, therefore data from logger A was used for analysis. Temperature logger 25B was exposed to the air (i.e., tangled in the willows by either an animal or person) twice in late summer and, therefore temperature logger 25A was used for analysis. There were no anomalies in the data between loggers A and B at Sites T9 and T10.

The average temperature difference above and below the Kyburz Diversion (between T8 and T9) was 0.5°C (0.9°F) over the course of the study period based upon the hourly temperature data. The maximum difference was 1.5°C (2.7°F). This difference is within the 5°F difference above and below diversions stipulated by the CVRWQCB (1998). Furthermore, the water temperatures

recorded above and below the Kyburz Diversion (T8 and T9) were still within the optimal range for trout and other coldwater species, including amphibians.

Water temperatures in the main stem South Fork American River continued to warm with a drop in elevation from Site 9 to Site 25 to Site 10. Based upon monitoring locations, average stream temperature throughout the reach are suitable for coldwater fisheries, including amphibians.

#### **4.0 CONCLUSION**

The CVRWQCB (1998) mandate to maintain cold- and warm- water temperature objectives stipulates that “at no time or place shall the temperature of COLD or WARM intrastate waters be increased more than 5°F (2.8°C) above natural receiving water temperature”. Two stream diversions (Kyburz and Alder Creek) were operational during at least a portion of the 2009 monitoring period (April 1 – October 31). Water temperatures measured below these diversions were within 5°F of the receiving waters while diversions occurred; therefore, the condition for maintaining coldwater beneficial uses was met. Furthermore, the daily water temperatures above and below these two diversions (T8-T9 Kyburz; T11-T12 Alder Creek) were suitable for trout and other coldwater species.

The four Project storage reservoirs affected water temperatures in the outflow streams by effectively muting the daily temperature fluctuations measured below the outflow. During the summer months, spring and tributary influences apparently cooled Pyramid and Echo creek water from upstream to downstream before it reached the South Fork American and Truckee rivers, respectively. Water temperatures measured below each of these storage reservoirs were suitable for coldwater species.

Caples Lake releases have a pronounced influence on the temperature of the Silver Fork American River. Water released from Caples Lake (T5) during July and August was significantly cooler than was measured at other high-elevation locations, and cooled the Silver Fork during the hottest part of the summer (late July and early August). Water temperatures measured below the Kyburz Diversion (T9) were actually colder (-0.3°C) than the receiving waters measured above the diversion (T8) between July 23<sup>rd</sup> and August 22<sup>nd</sup>.



Water temperatures within the project tributaries were suitable for trout and other cold water species throughout the study period. These tributaries are well-shaded by vegetation (i.e., mixed conifer forest) and orientation.

Water temperatures in the middle (T25) and lower (T10) reaches of the Project Area begin to warm 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.

At all sites water temperatures measured during 2009 as related to project operations demonstrated that the water temperatures were within the suitable range for cold water species throughout the monitoring period.

## **5.0 RECOMMENDATIONS**

There is no functional diversion structure at Mill Creek (T15 & T16) and Carpenter Creek (T23 & T24); therefore, the District recommends to remove these two sites from future monitoring efforts.

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# Appendix A: Figures

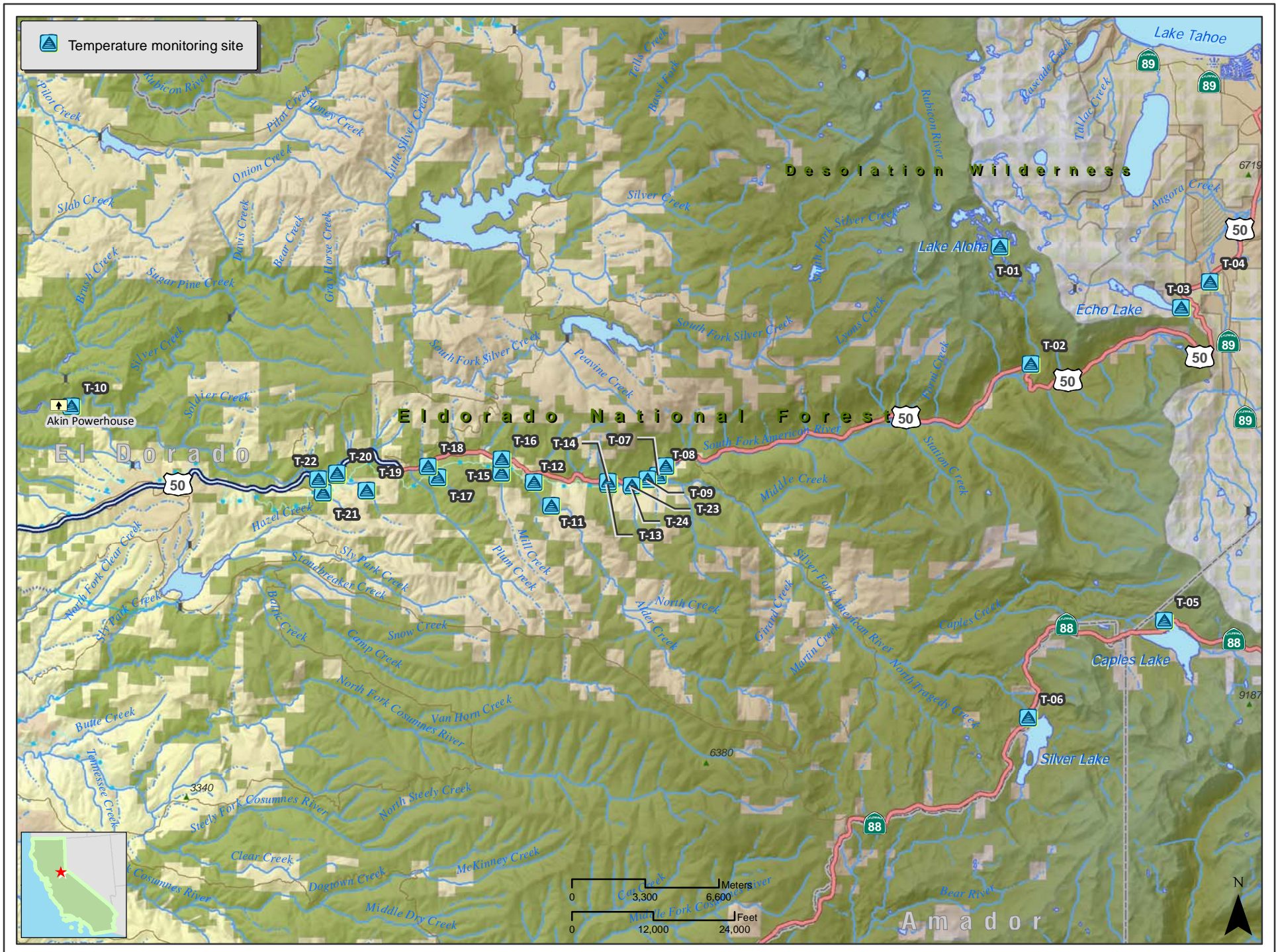


Figure 1. Locations of Annual Temperature Monitoring Stations, 2009. FERC Project 184. El Dorado Irrigation District.

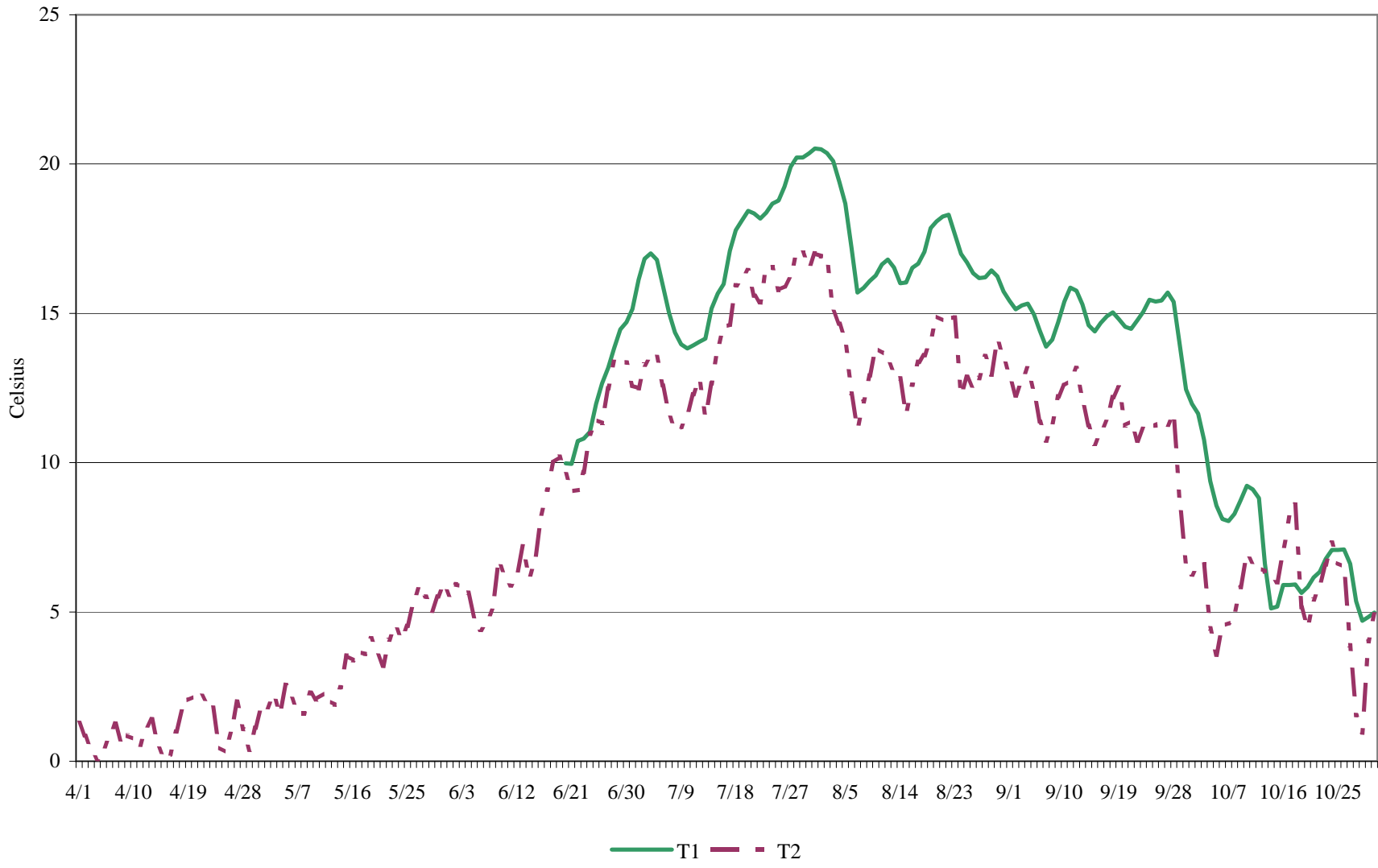


Figure 2. Daily Average Water Temperatures in Upper and Lower Pyramid Creek T1 & T2.

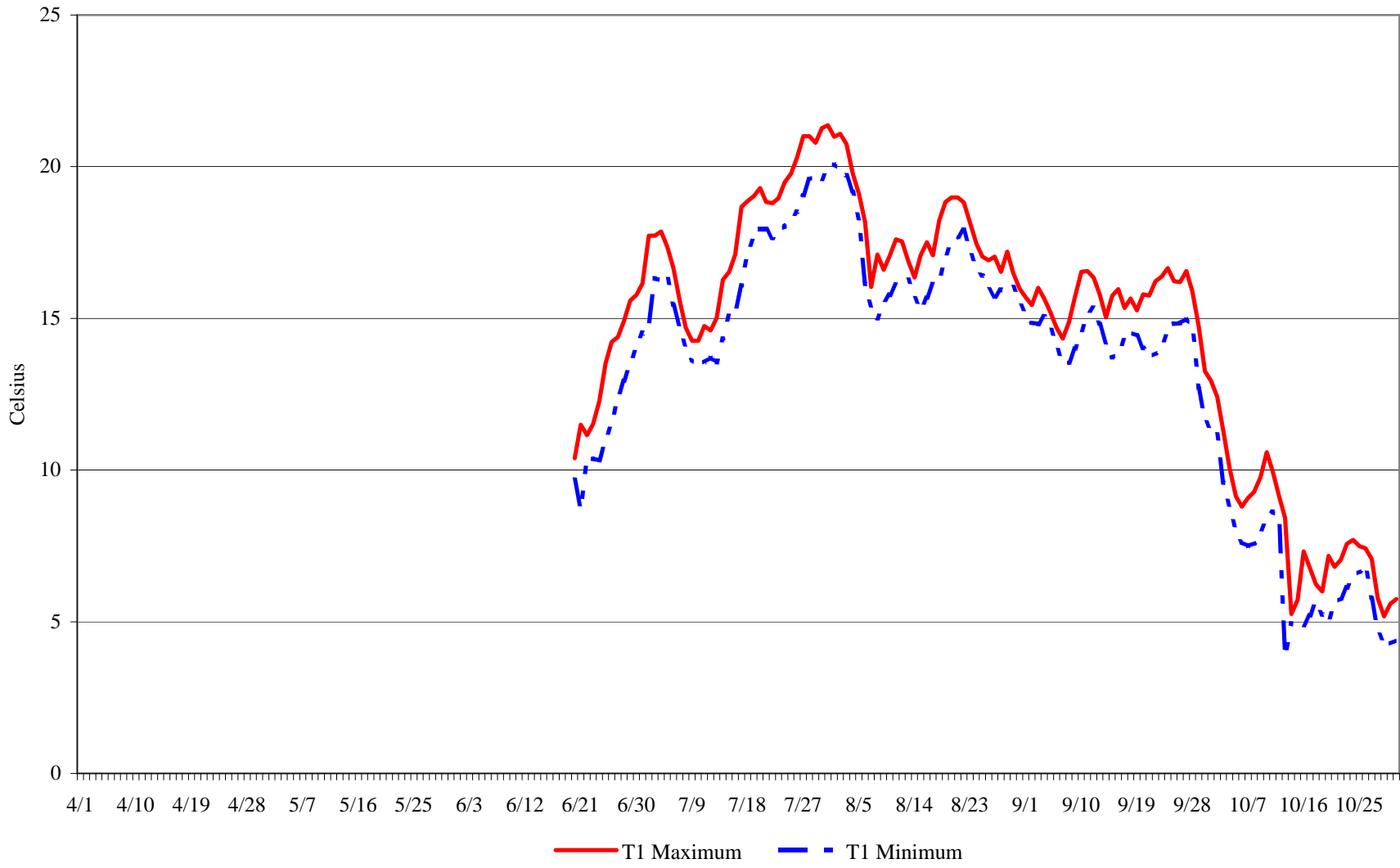


Figure 3. Daily Maximum and Minimum Water Temperatures in Upper Pyramid Creek (T1).

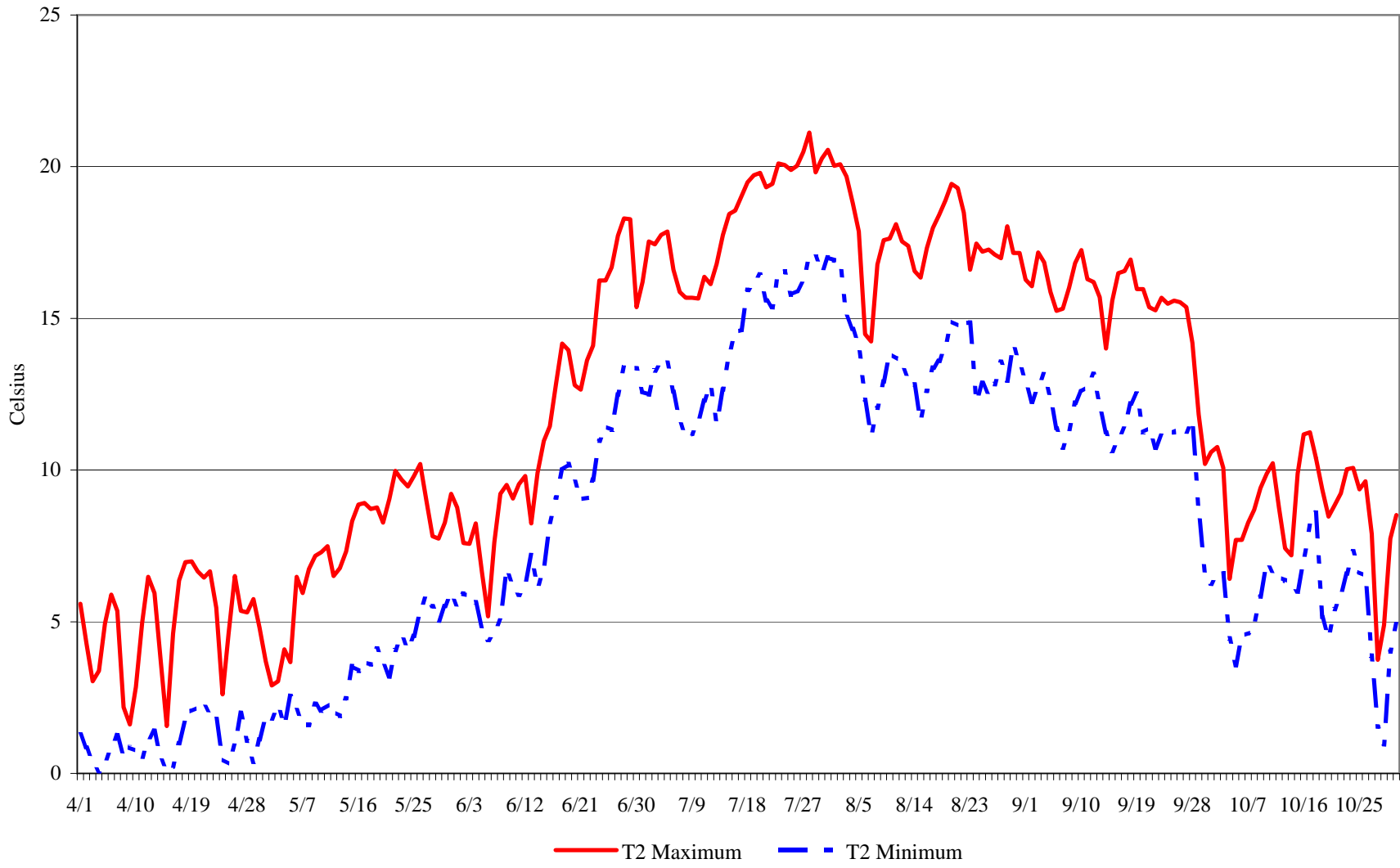


Figure 4. Daily Maximum and Minimum Water Temperatures in Lower Pyramid Creek (T2).

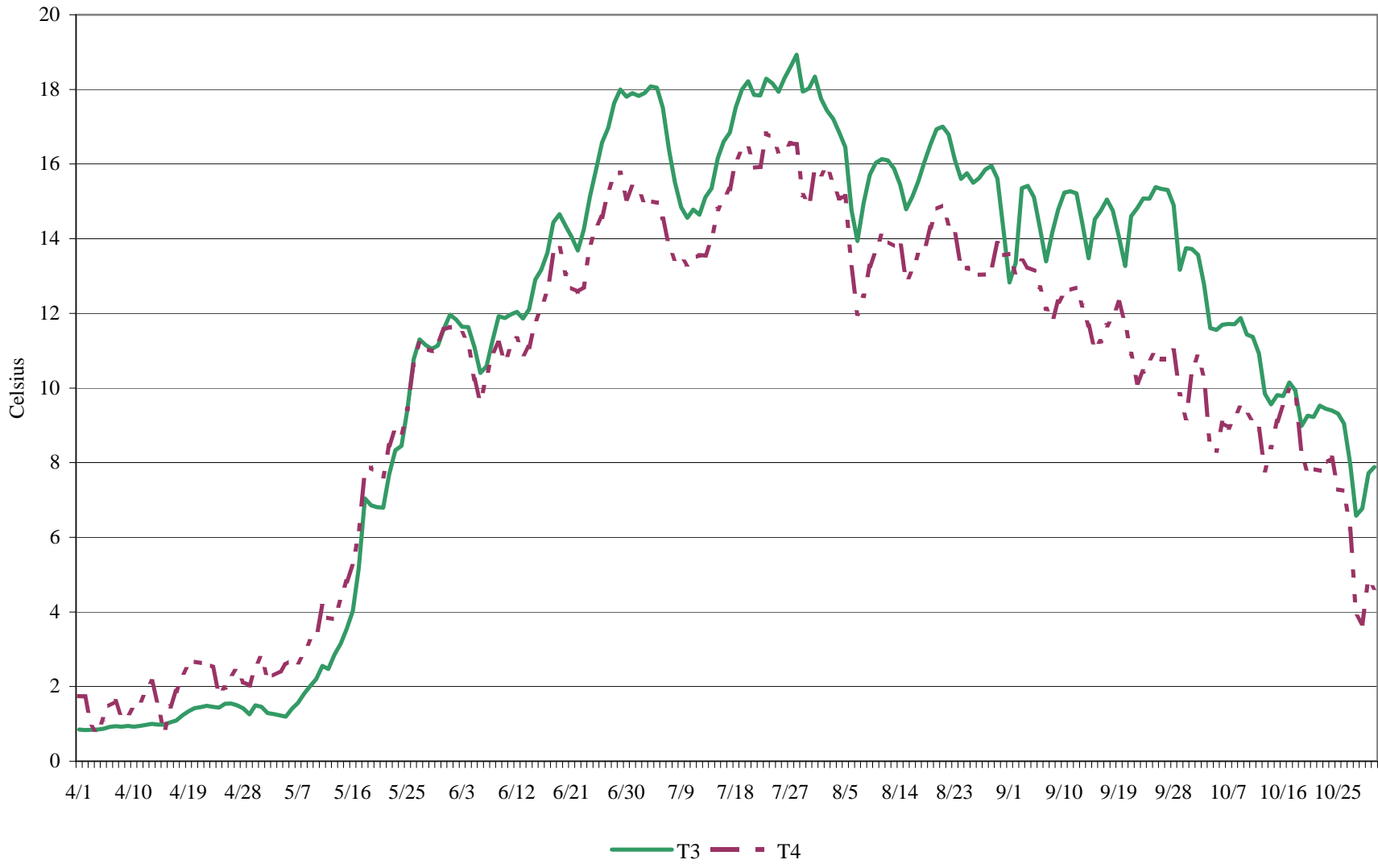


Figure 5. Daily Average Water Temperatures in Upper and Lower Echo Creek T3 & T4.



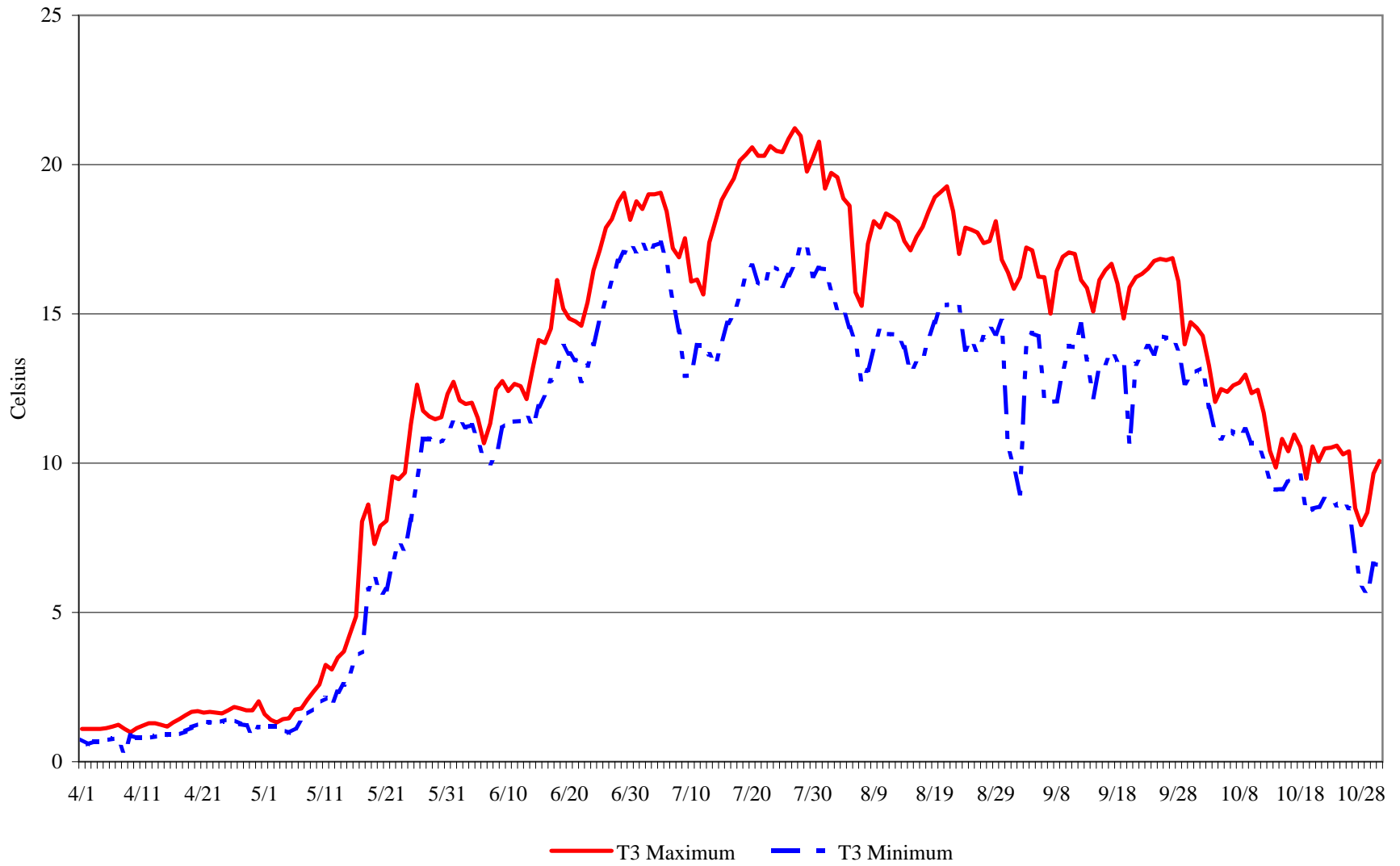


Figure 6. Daily Maximum and Minimum Water Temperatures in Upper Echo Creek (T3).

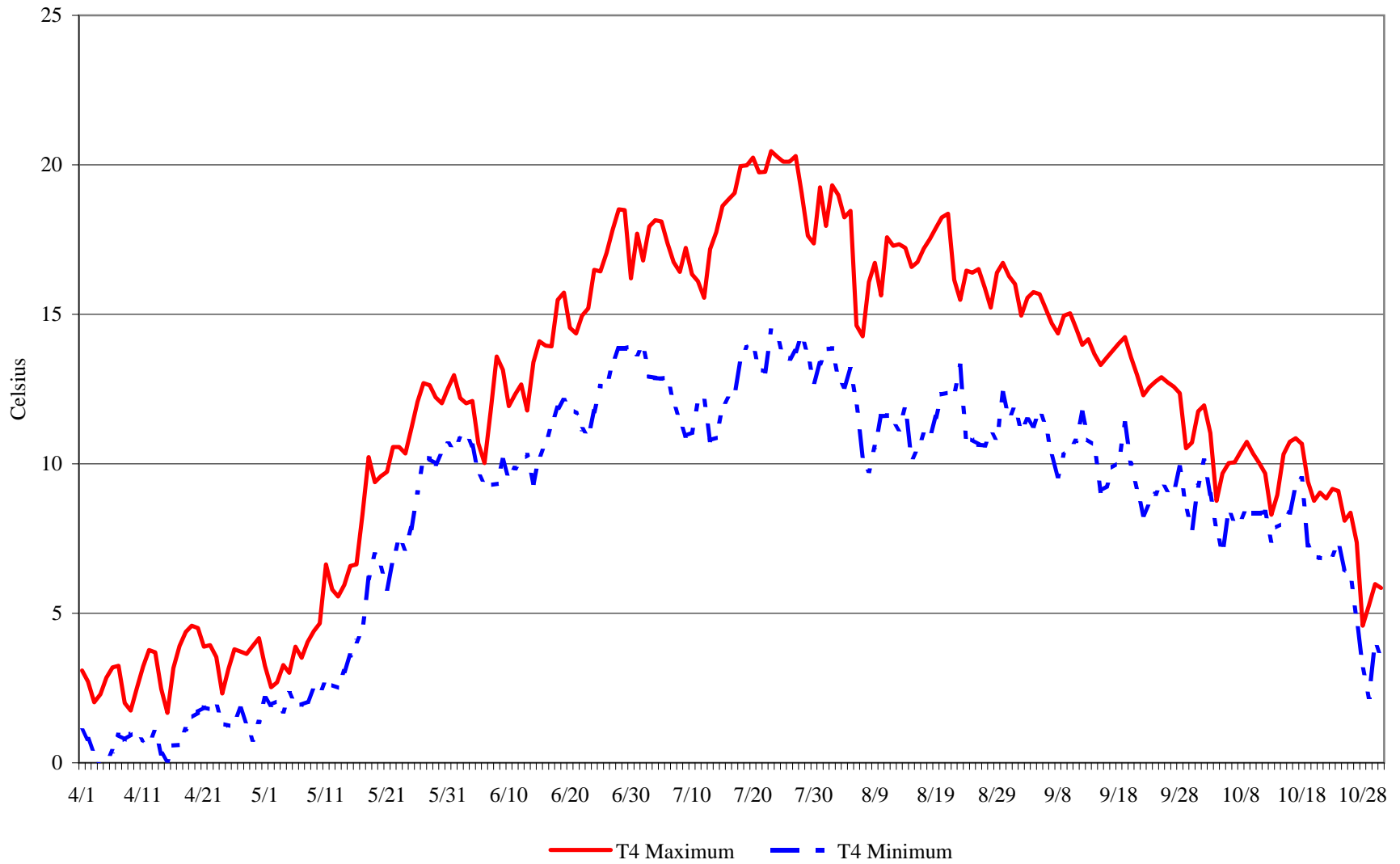


Figure 7. Daily Maximum and Minimum Water Temperatures in Lower Echo Creek (T4).

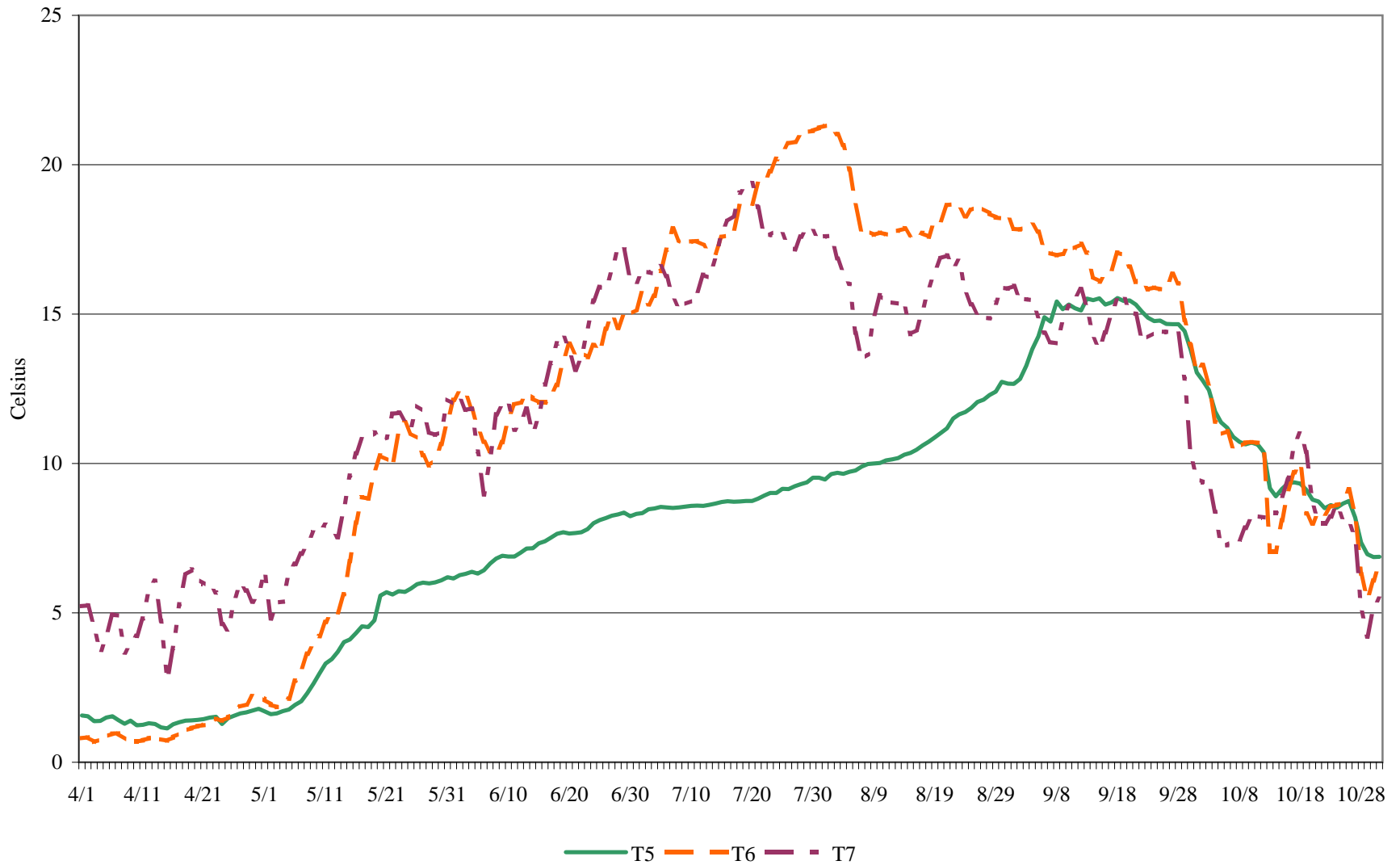


Figure 8. Daily Average Water Temperatures in Upper Caples Creek (T5), Upper Silver Fork (T6), and Lower Silver Fork (T7).

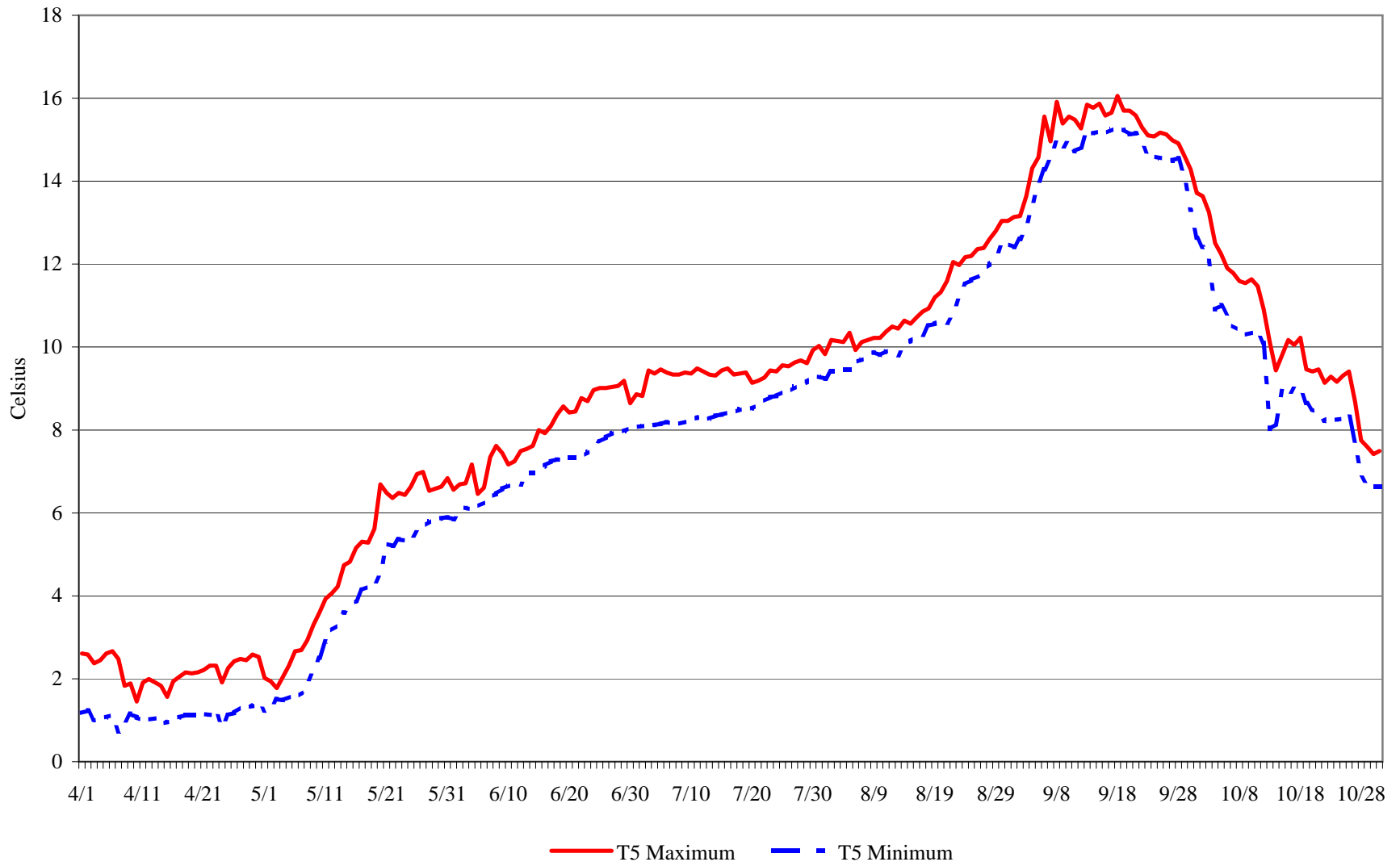
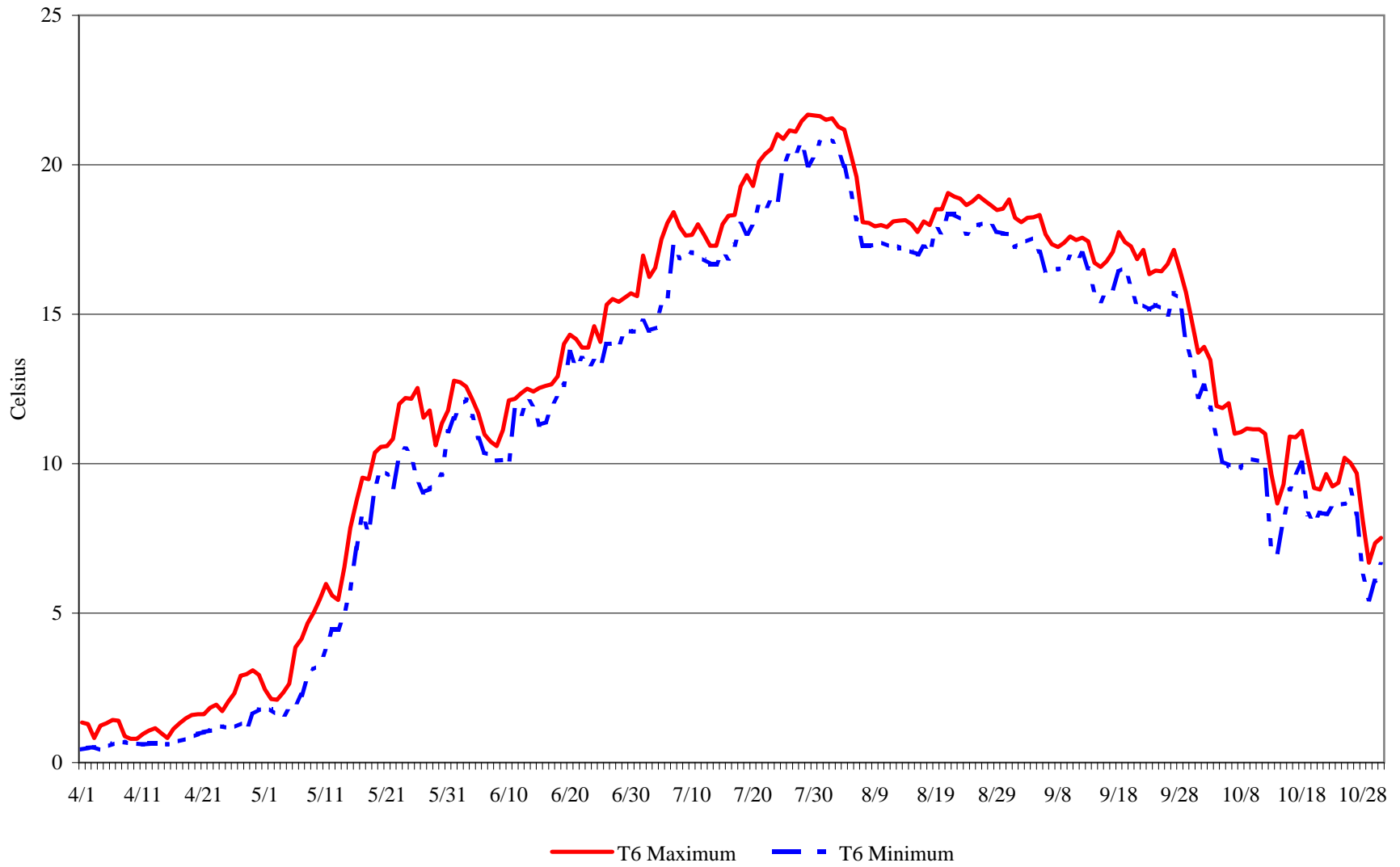


Figure 9. Daily Maximum and Minimum Water Temperatures in Upper Caples Creek (T5).



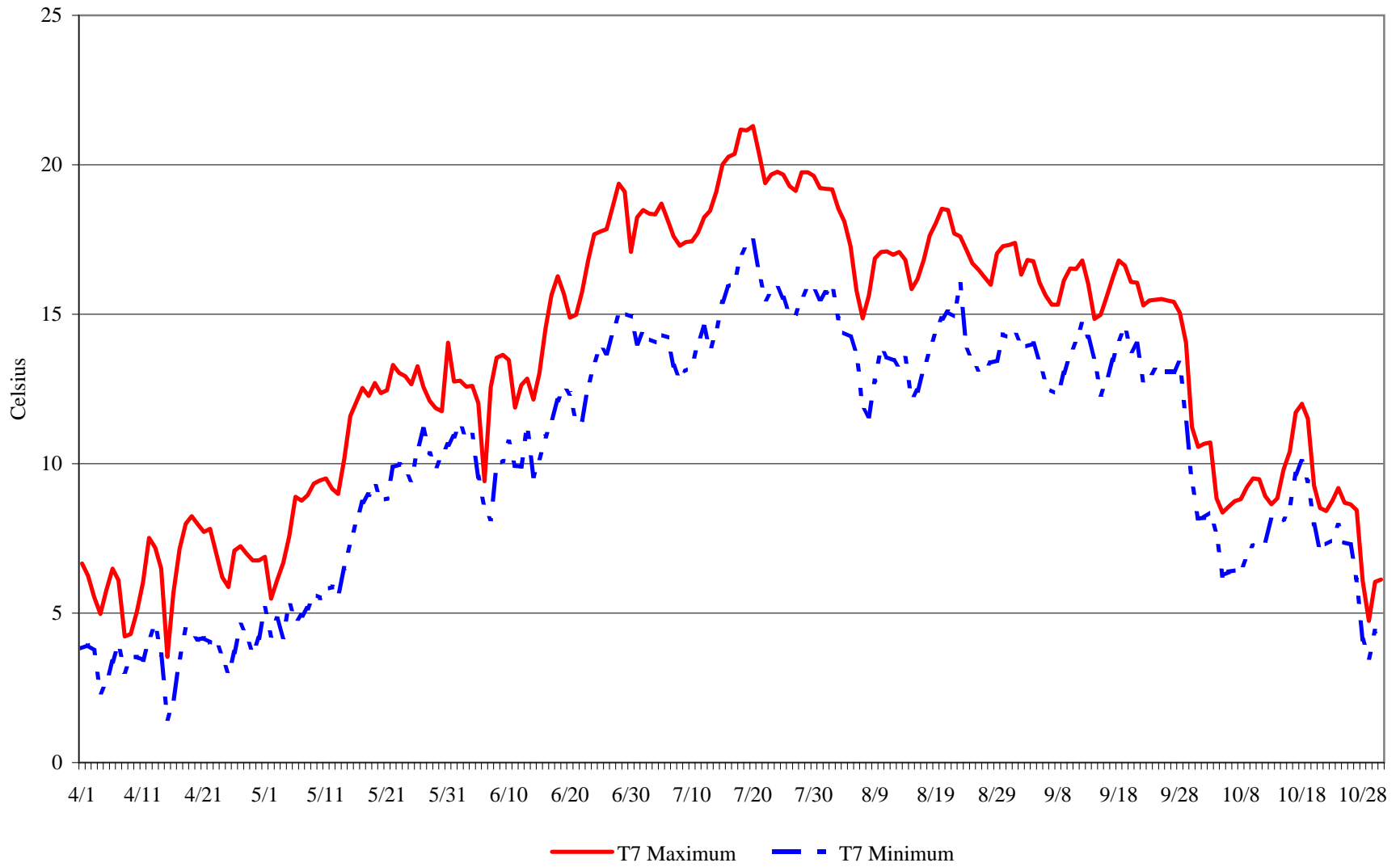


Figure 11. Daily Maximum and Minimum Water Temperatures in Lower Silver Fork (T7).

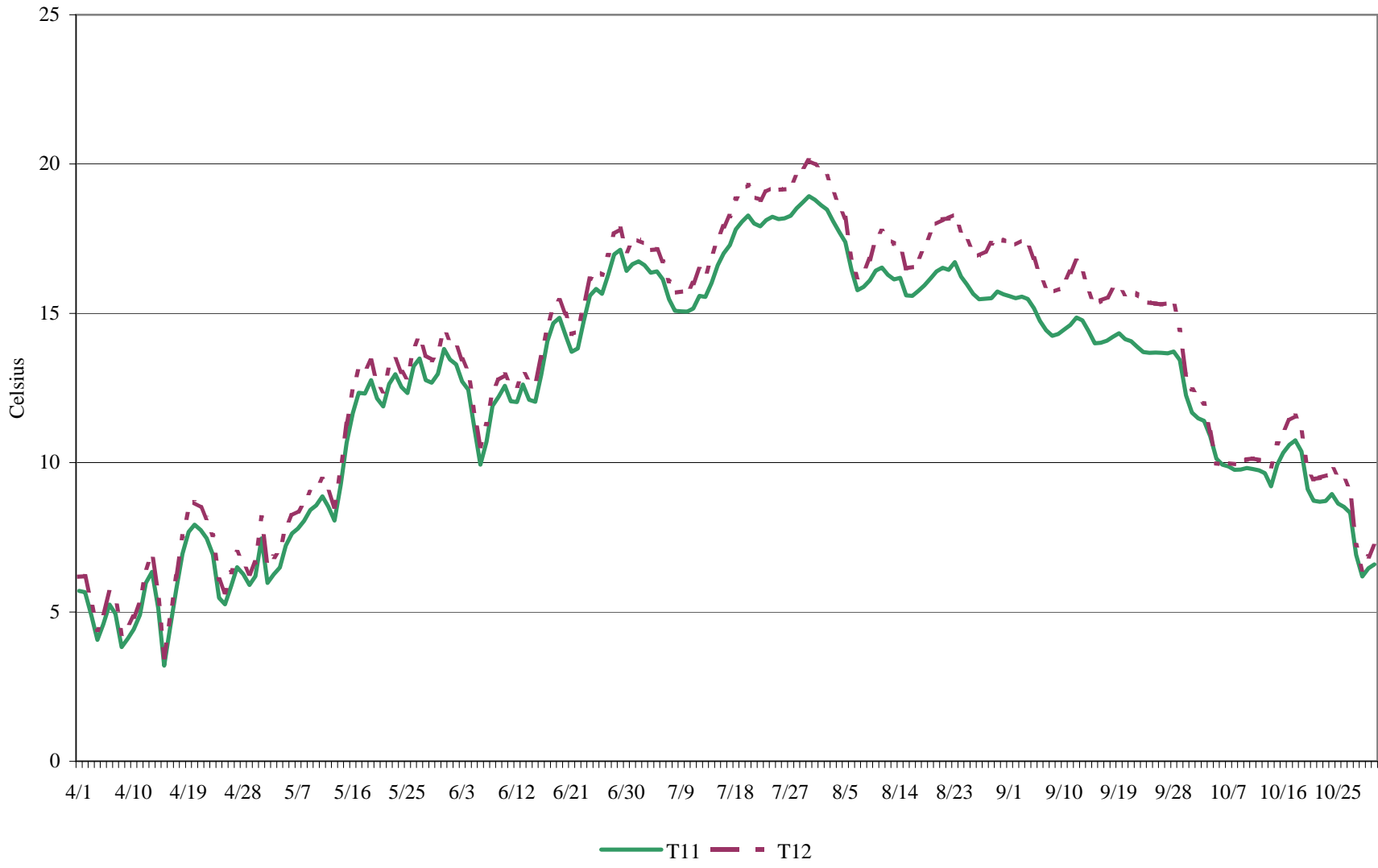


Figure 12. Daily Average Water Temperatures in Upper and Lower Alder Creek (T11 & T12).

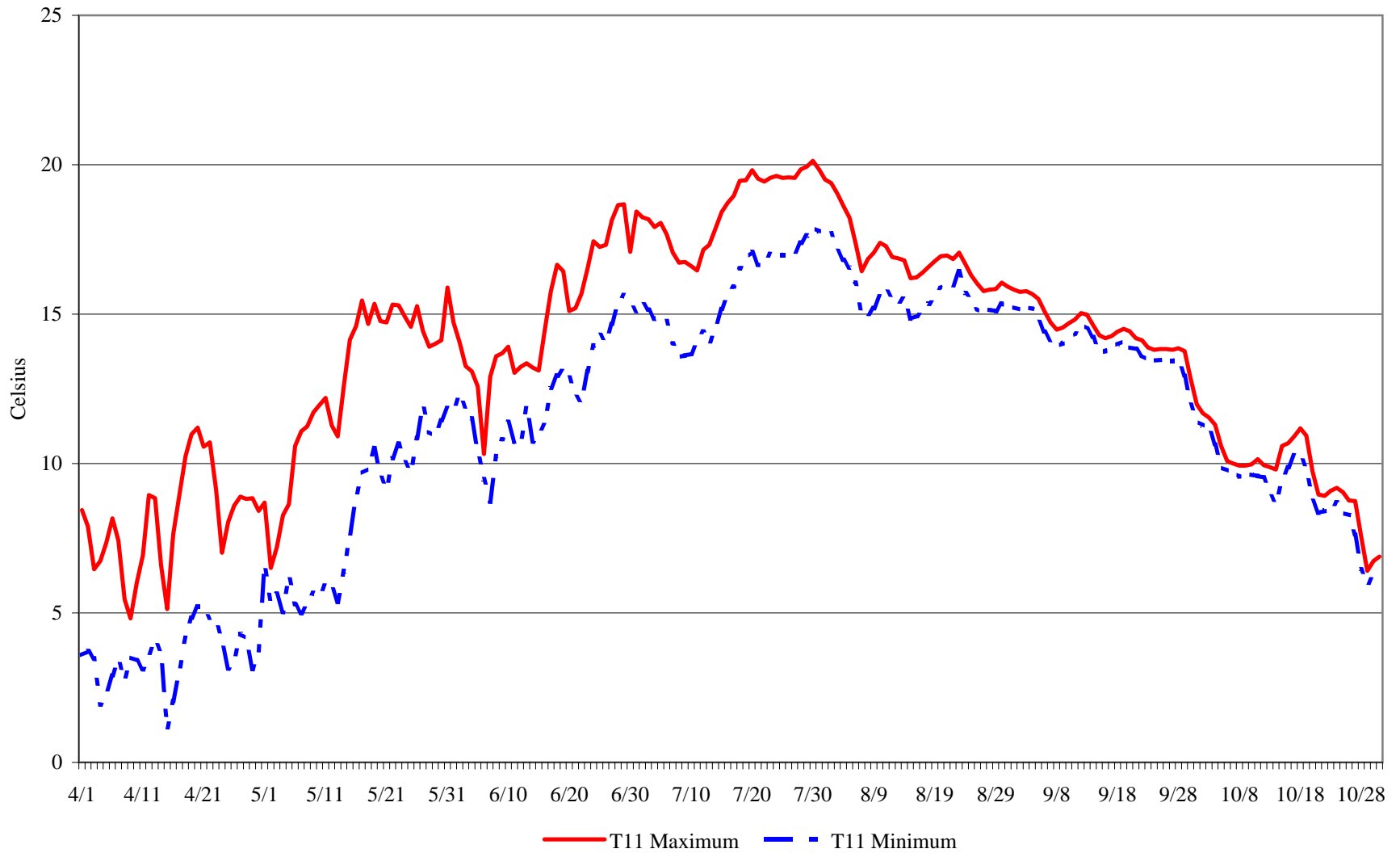


Figure 13. Daily Maximum and Minimum Water Temperatures in Upper Alder Creek (T11).



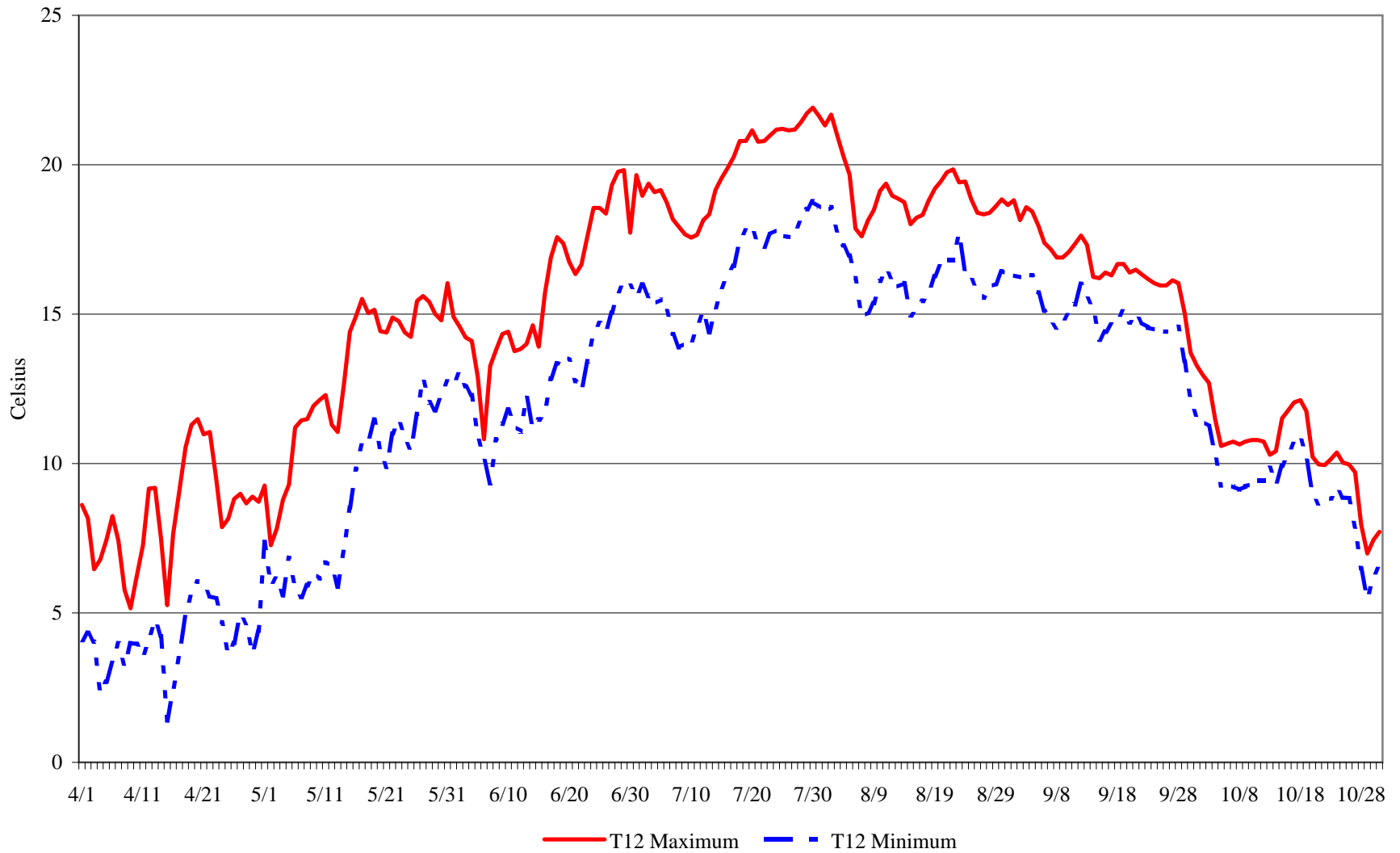


Figure 14. Daily Maximum and Minimum Water Temperatures in Lower Alder Creek (T12).

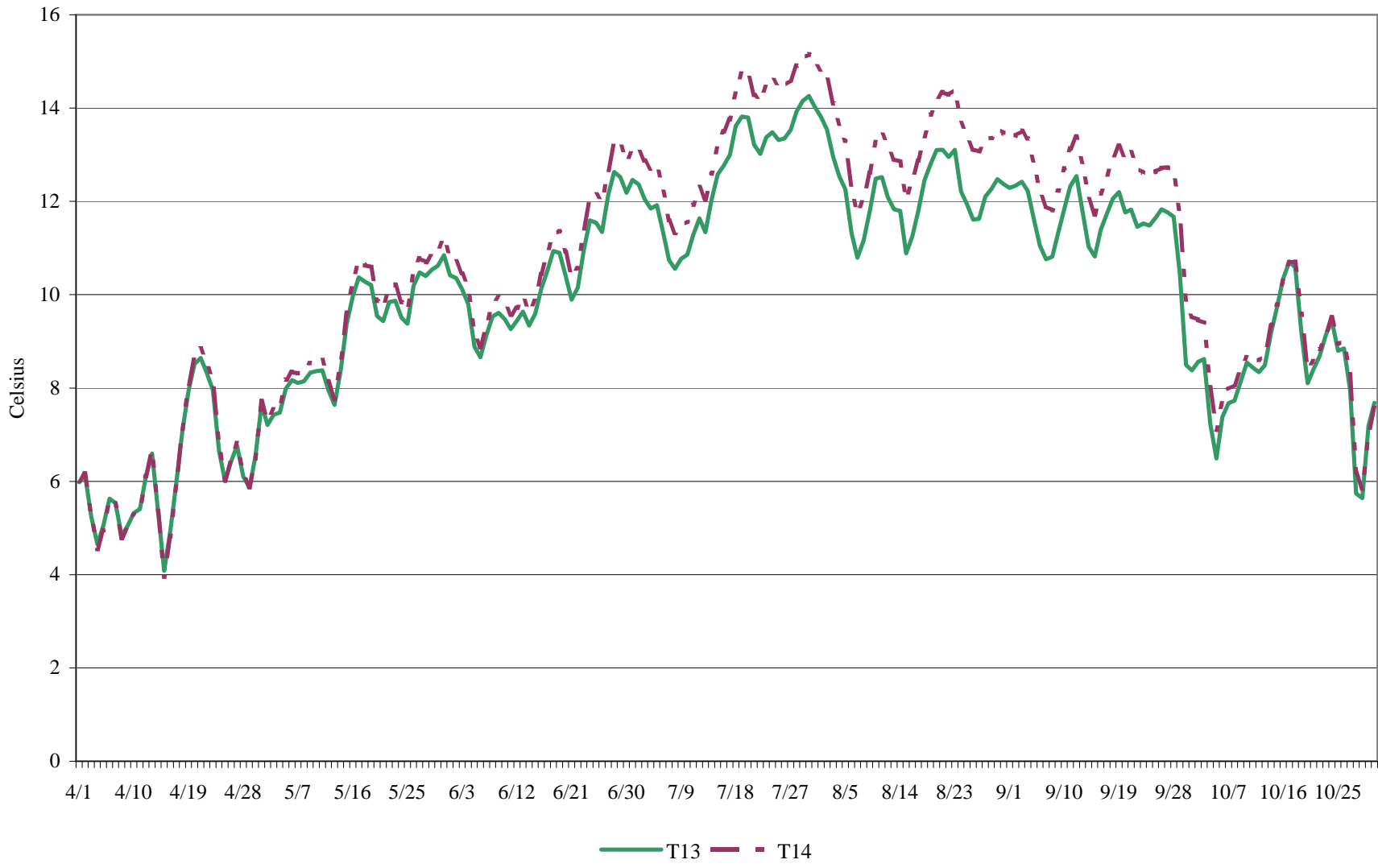


Figure 15. Daily Average Water Temperatures in Upper and Lower No Name Creek (T13 & T14).

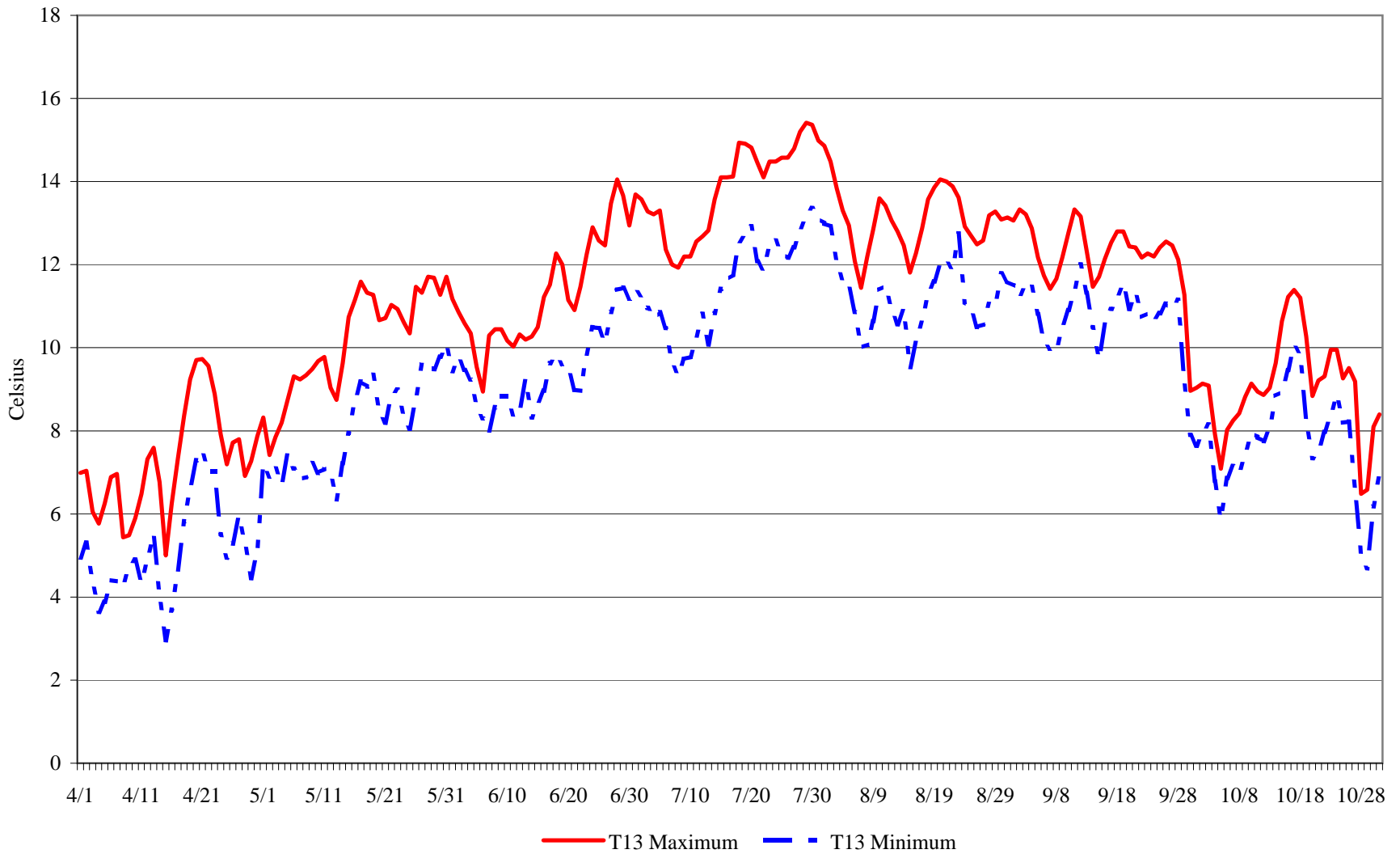


Figure 16. Daily Maximum and Minimum Water Temperatures in Upper No Name Creek (T13).

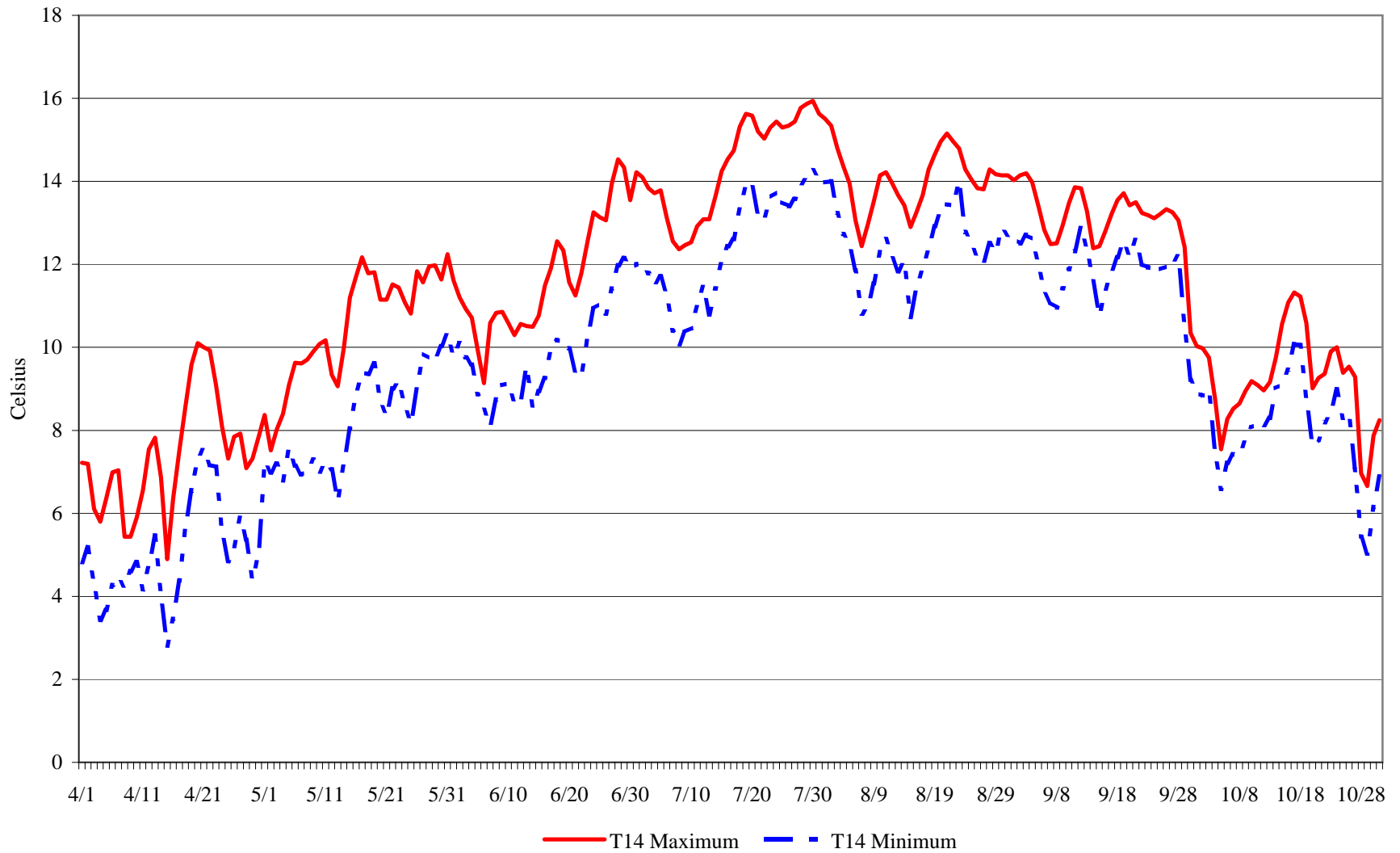


Figure 17. Daily Maximum and Minimum Water Temperatures in Lower No Name Creek (T14).

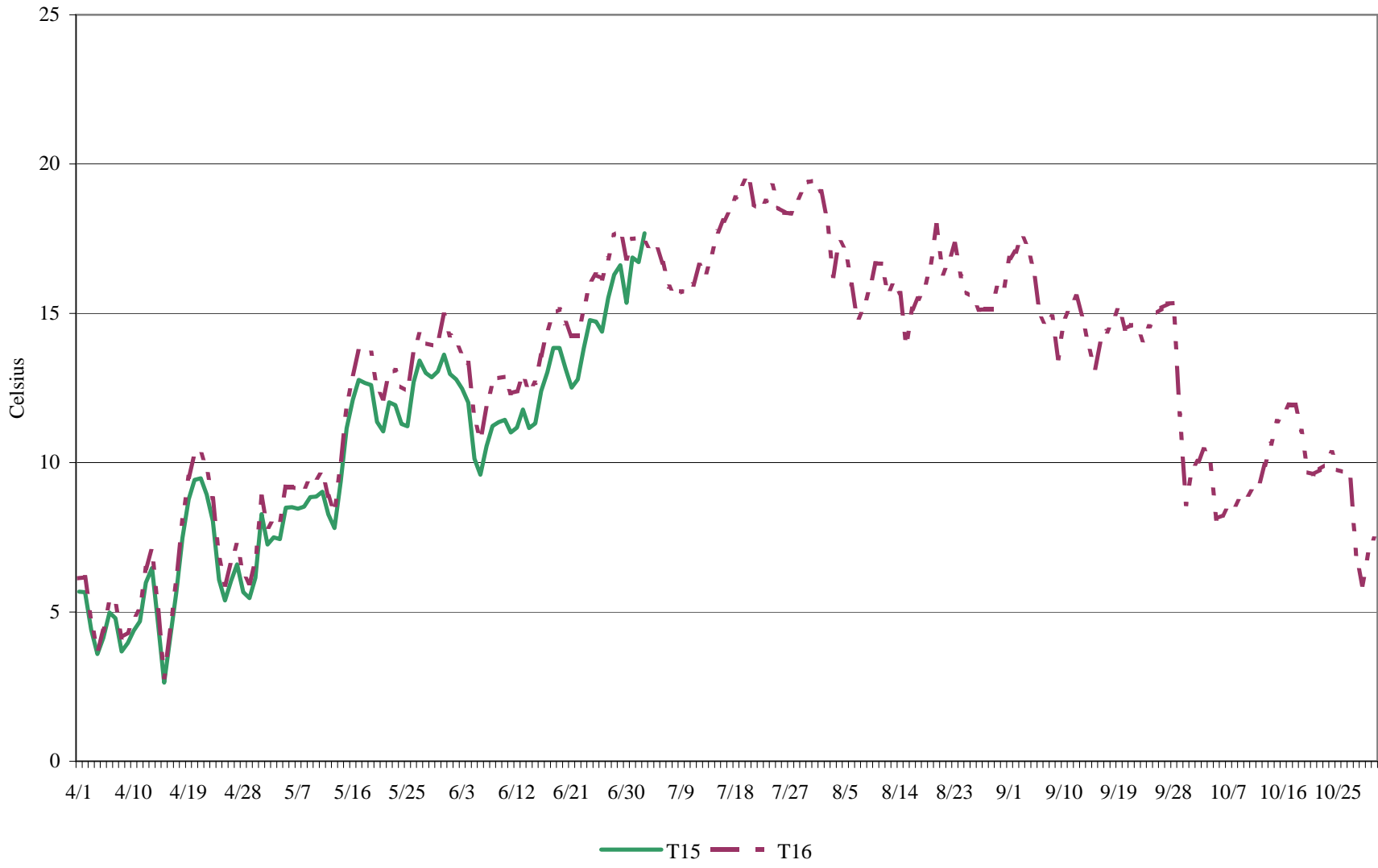


Figure 18. Daily Average Water Temperatures in Upper and Lower Mill Creek T15 & T16).

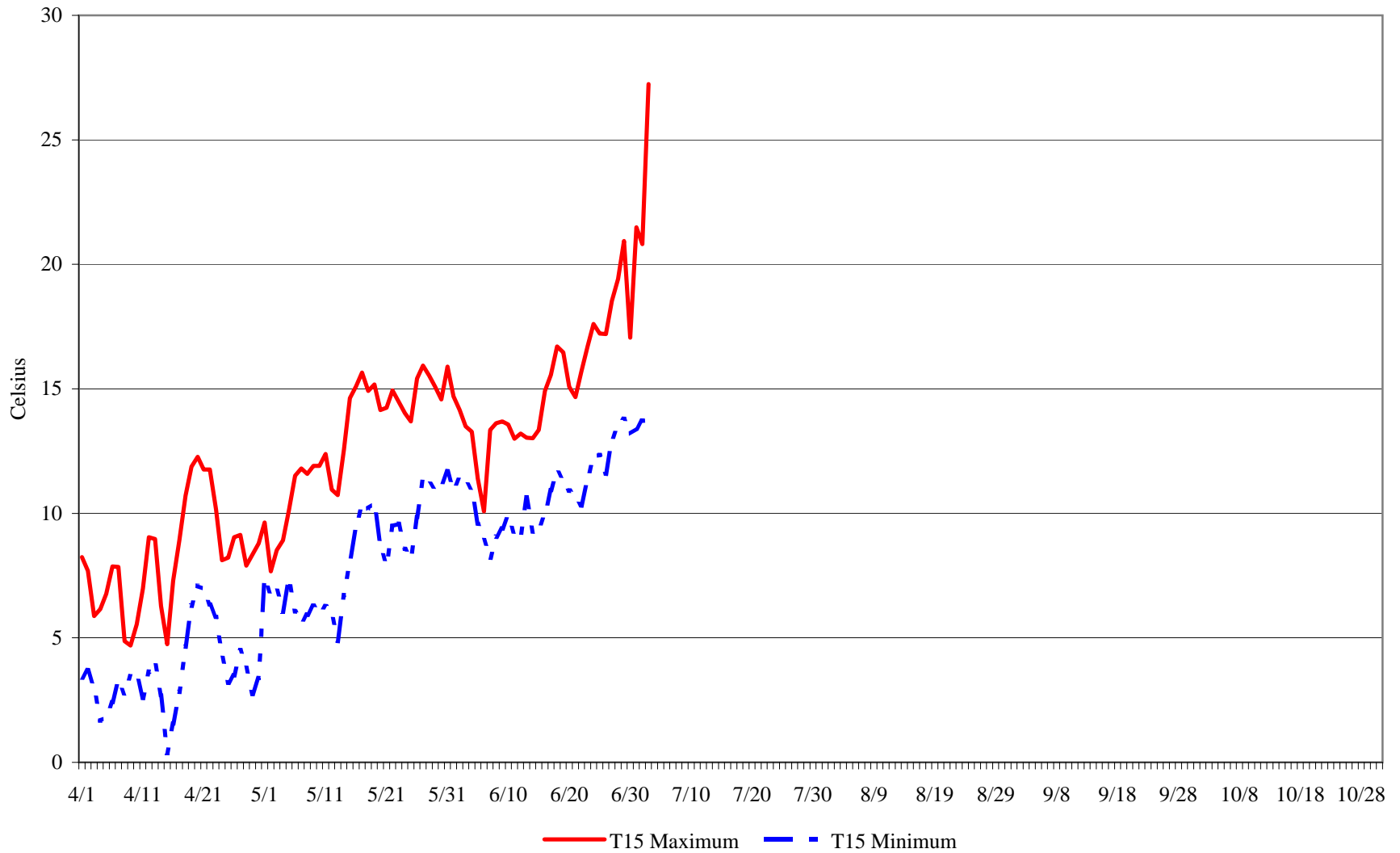


Figure 19. Daily Maximum and Minimum Water Temperatures in Upper Mill Creek (T15).

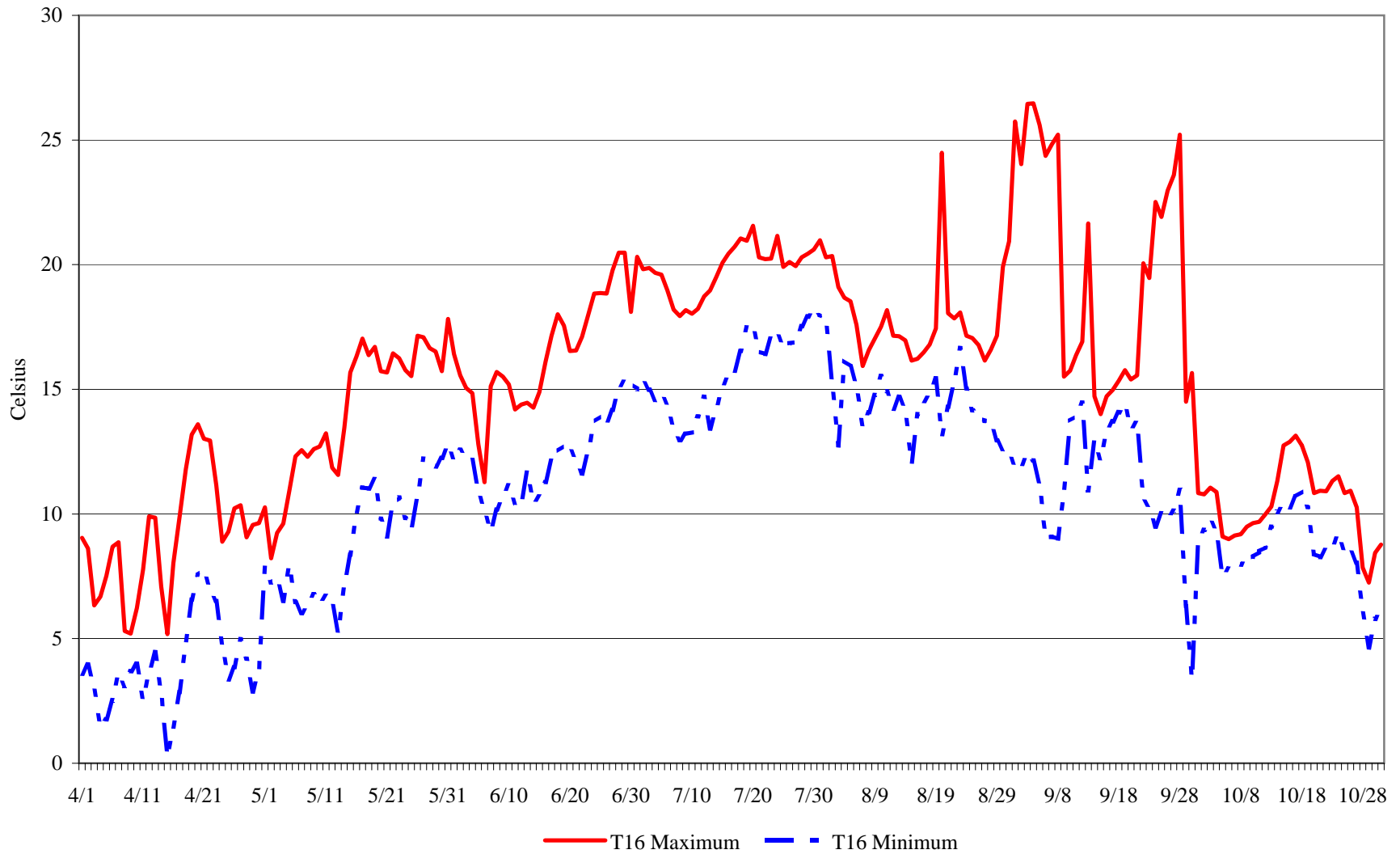


Figure 20. Daily Maximum and Minimum Water Temperatures in Lower Mill Creek (T16).

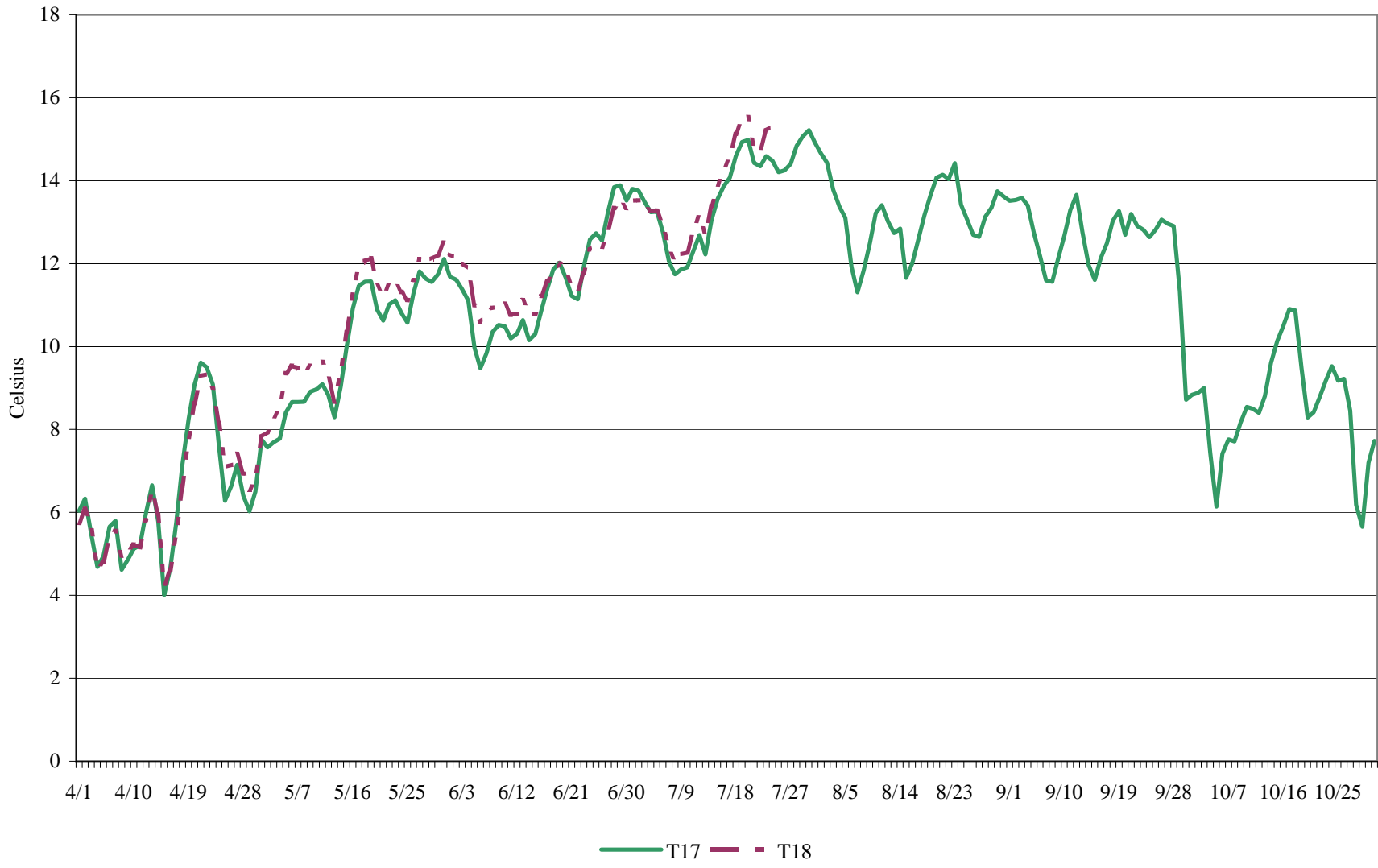


Figure 21. Daily Average Water Temperatures in Upper and Lower Bull Creek (T17 & T18).



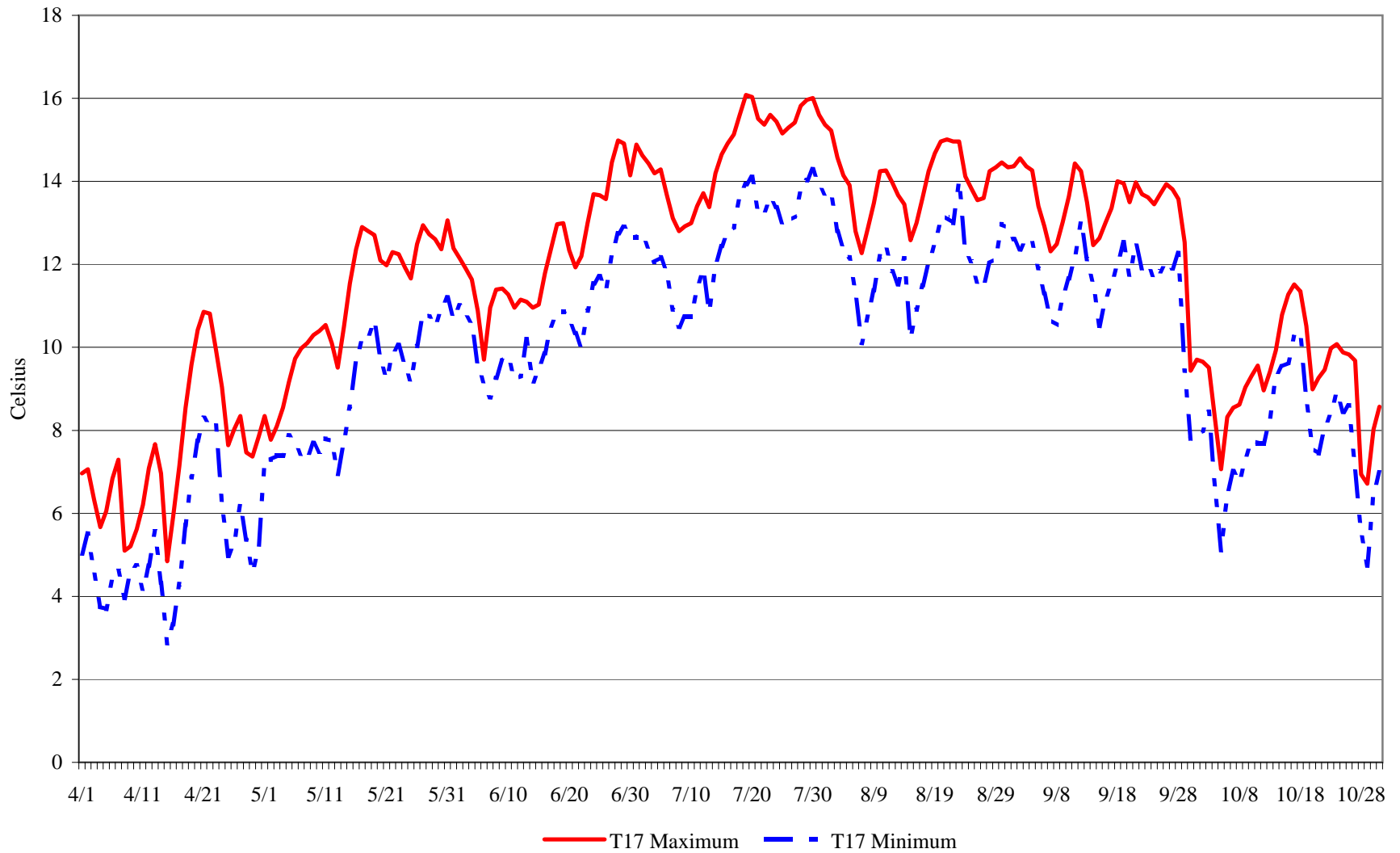


Figure 22. Daily Maximum and Minimum Water Temperatures in Upper Bull Creek (T17).

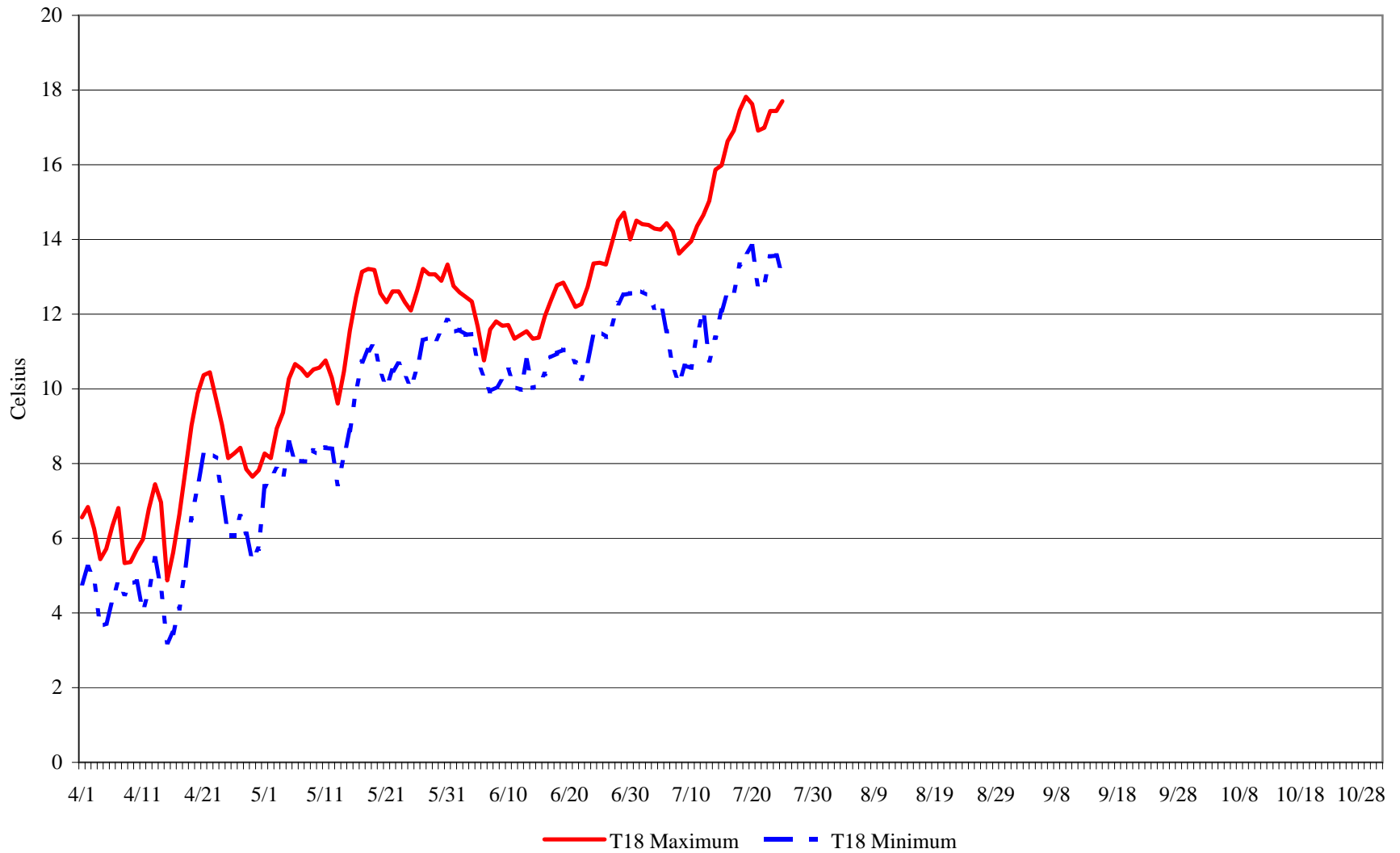


Figure 23. Daily Maximum and Minimum Water Temperatures in Lower Bull Creek (T18).

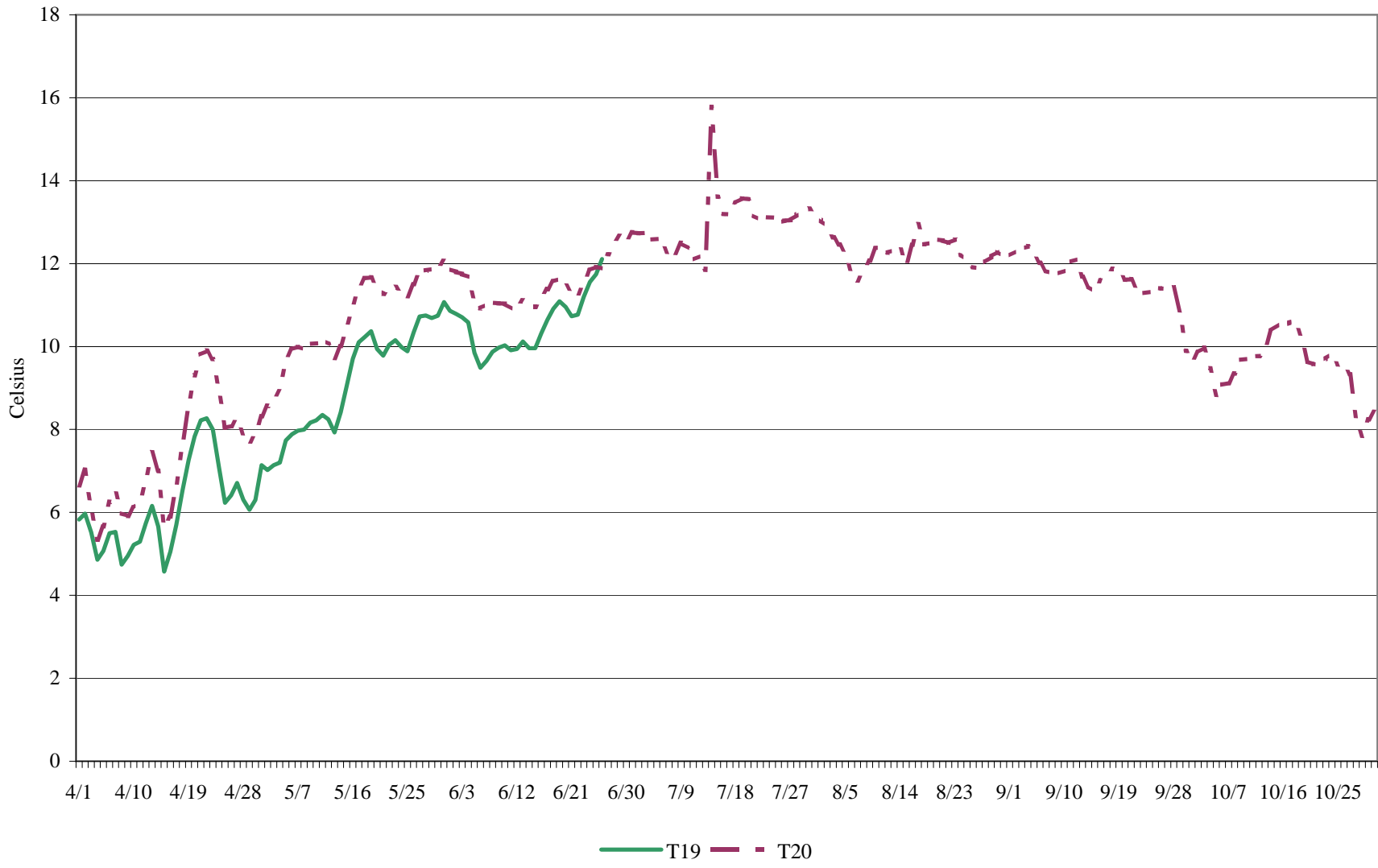


Figure 24. Daily Average Water Temperatures in Upper and Lower Olgilby Creek (T19 & T20).

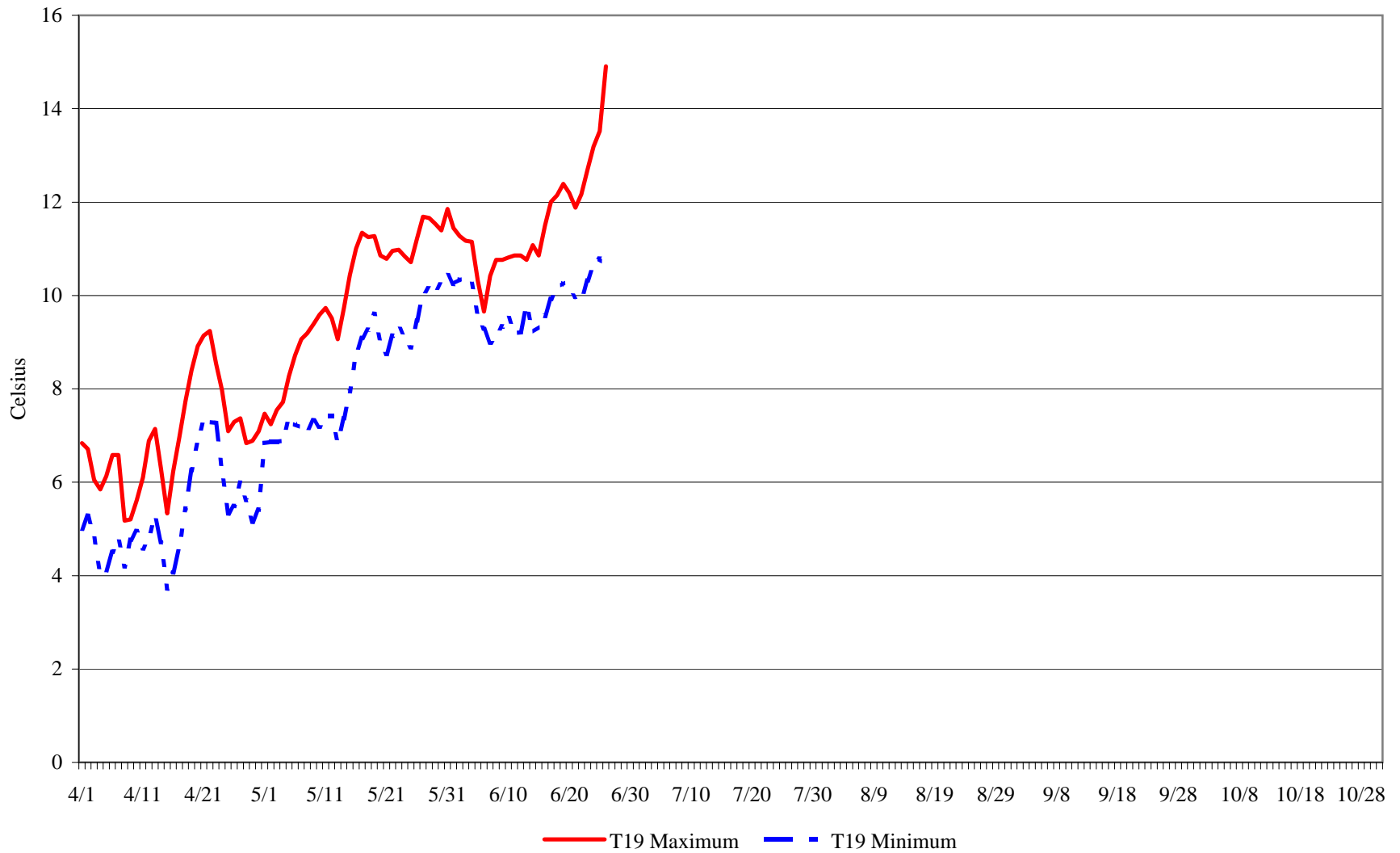


Figure 25. Daily Maximum and Minimum Water Temperatures in Upper Olgilby Creek (T19).

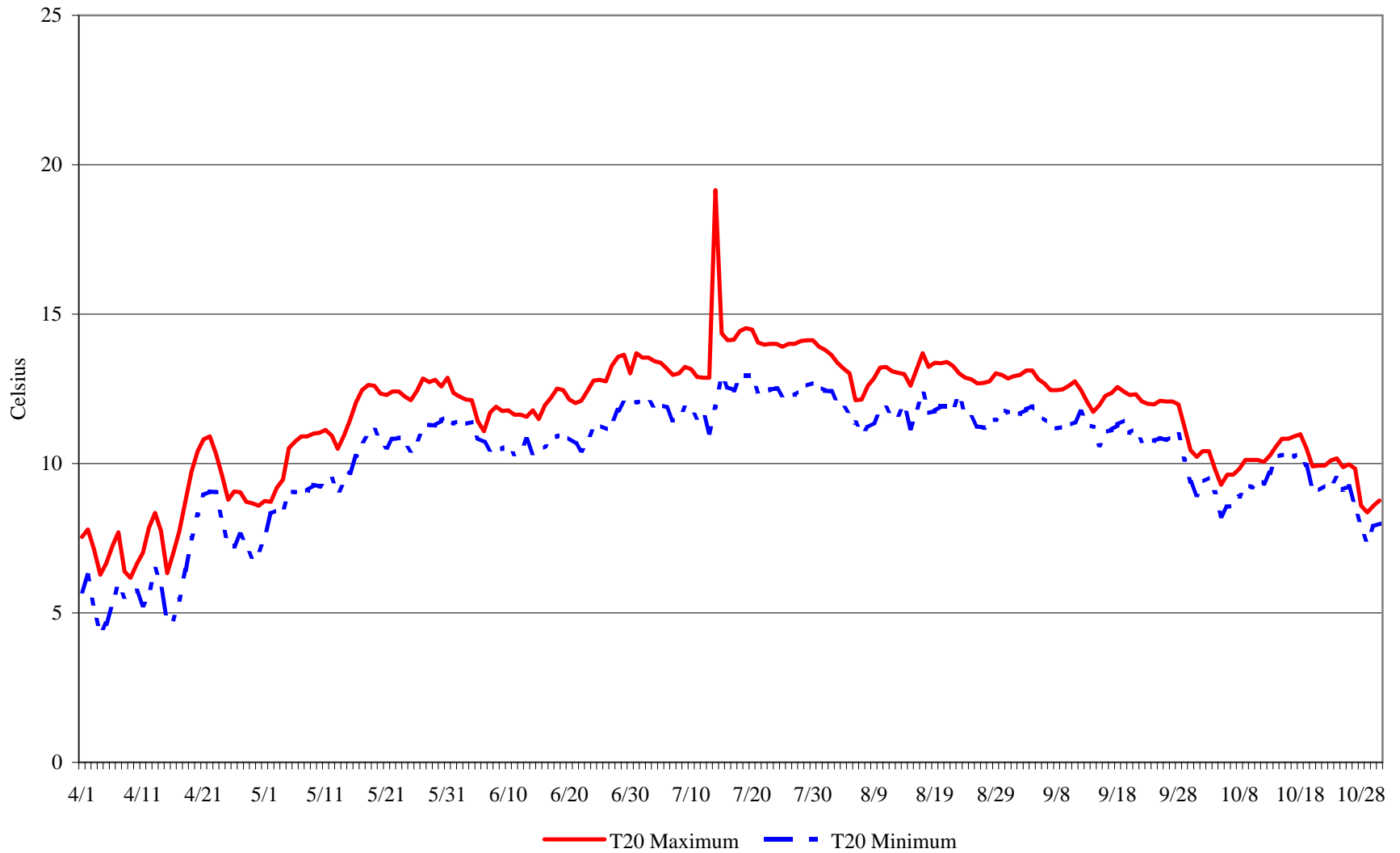


Figure 26. Daily Maximum and Minimum Water Temperatures in Lower Olgilby Creek (T20).

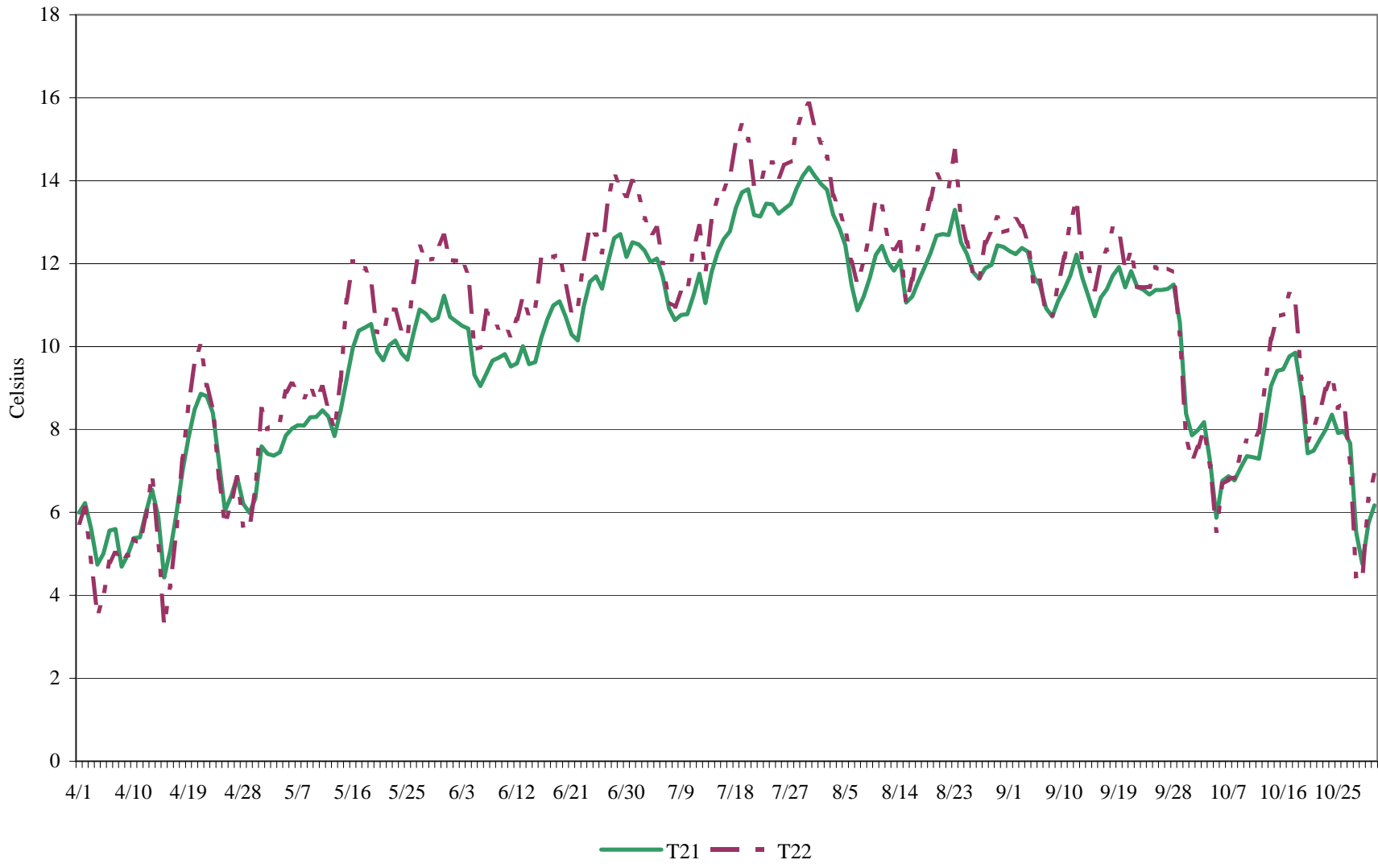


Figure 27. Daily Average Water Temperatures in Upper and Lower Esmeralda Creek (T21 & T22).

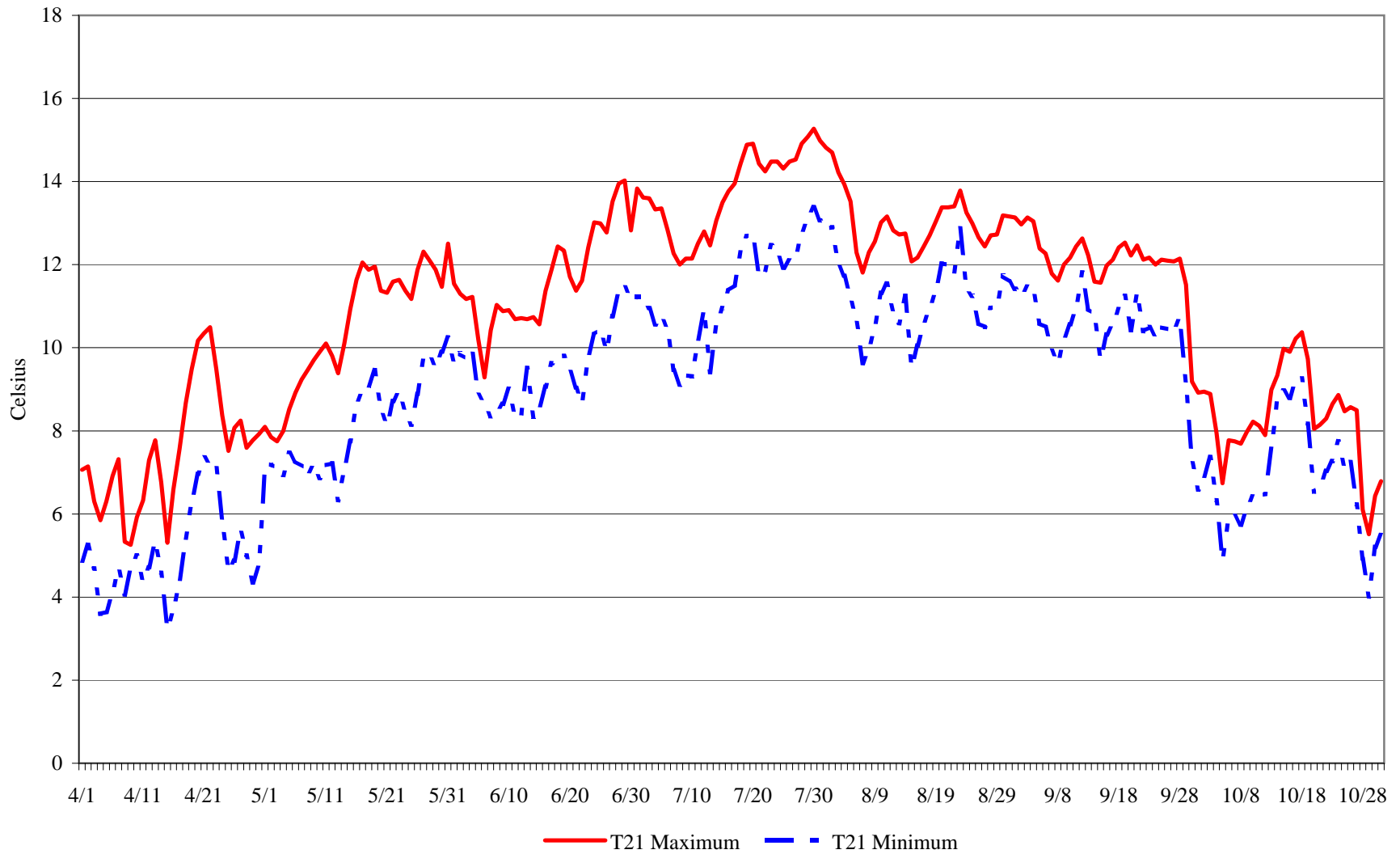


Figure 28. Daily Maximum and Minimum Water Temperatures in Upper Esmeralda Creek (T21).

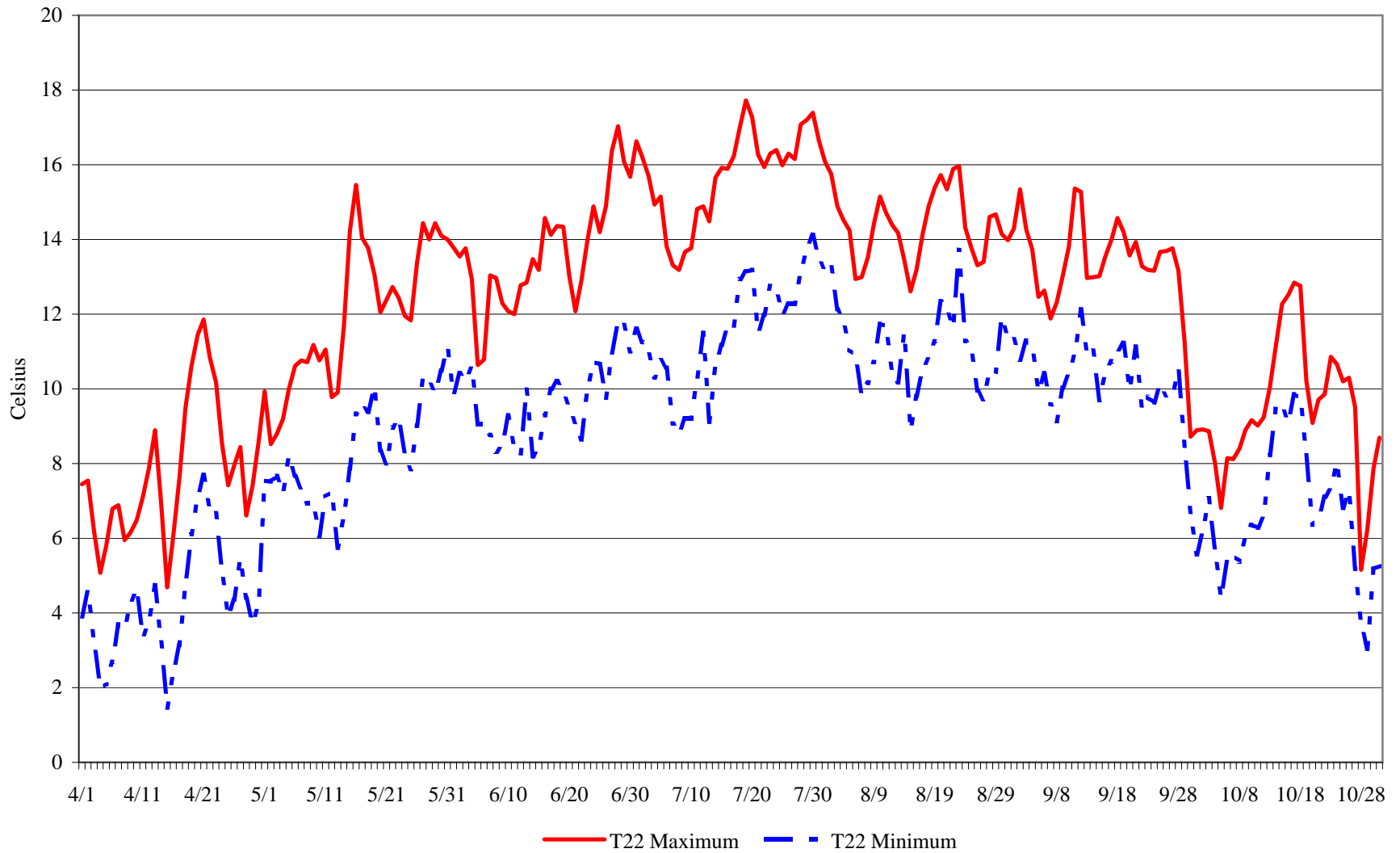


Figure 29. Daily Maximum and Minimum Water Temperatures in Lower Esmeralda Creek (T22).



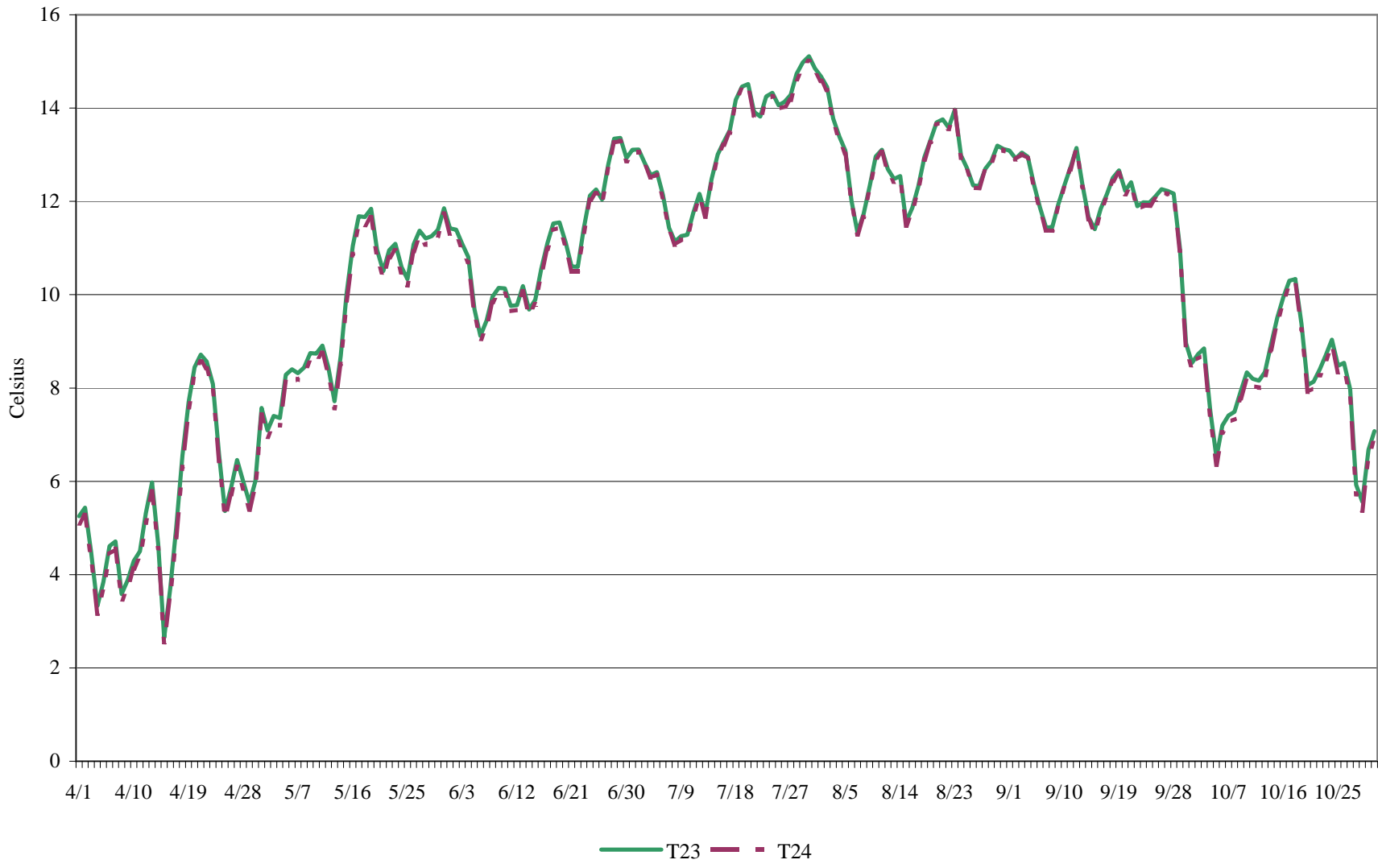


Figure 30. Daily Average Water Temperatures in Upper and Lower Carpenter Creek (T23 & T24).

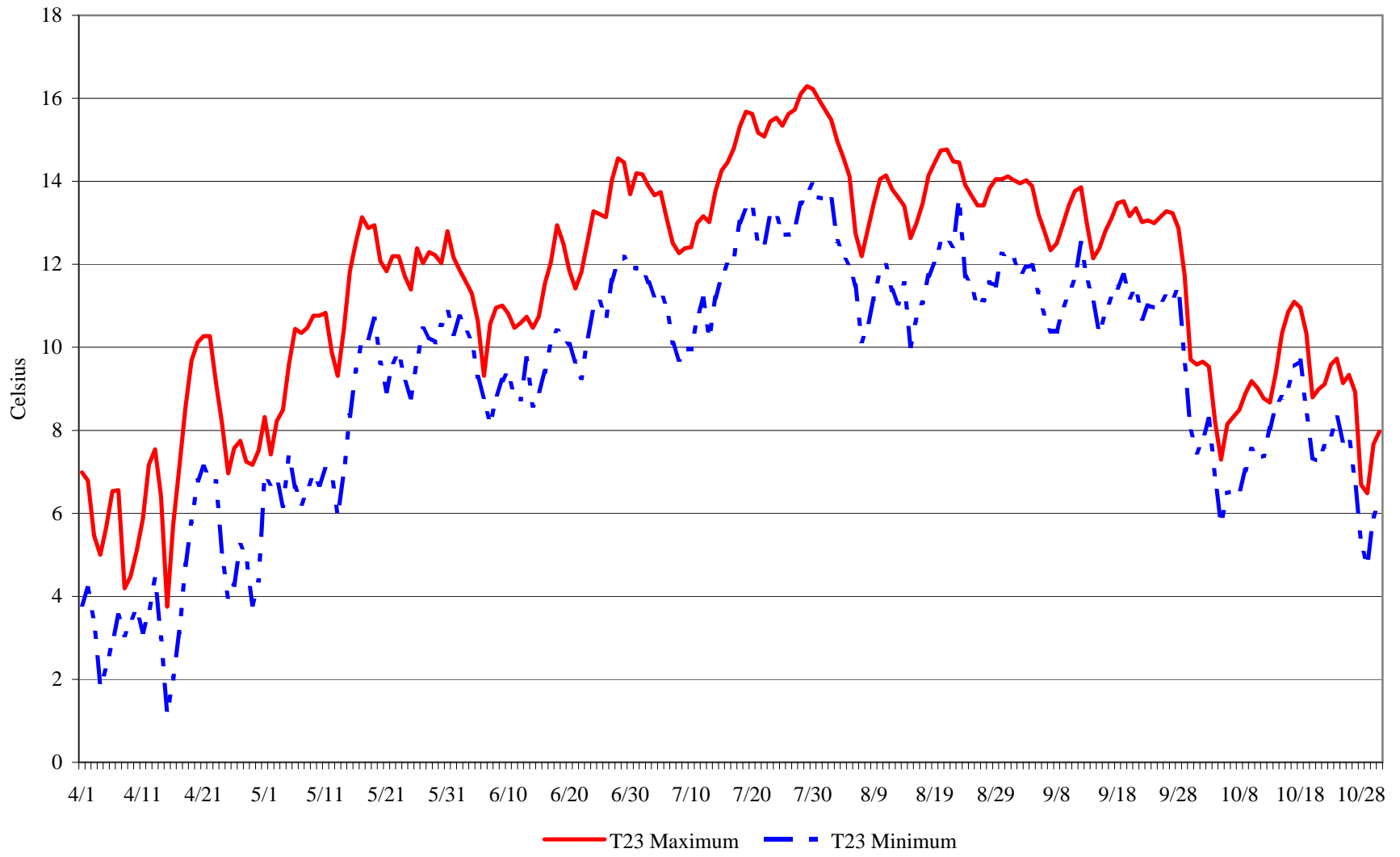


Figure 31. Daily Maximum and Minimum Water Temperatures in Upper Carpenter Creek (T23).

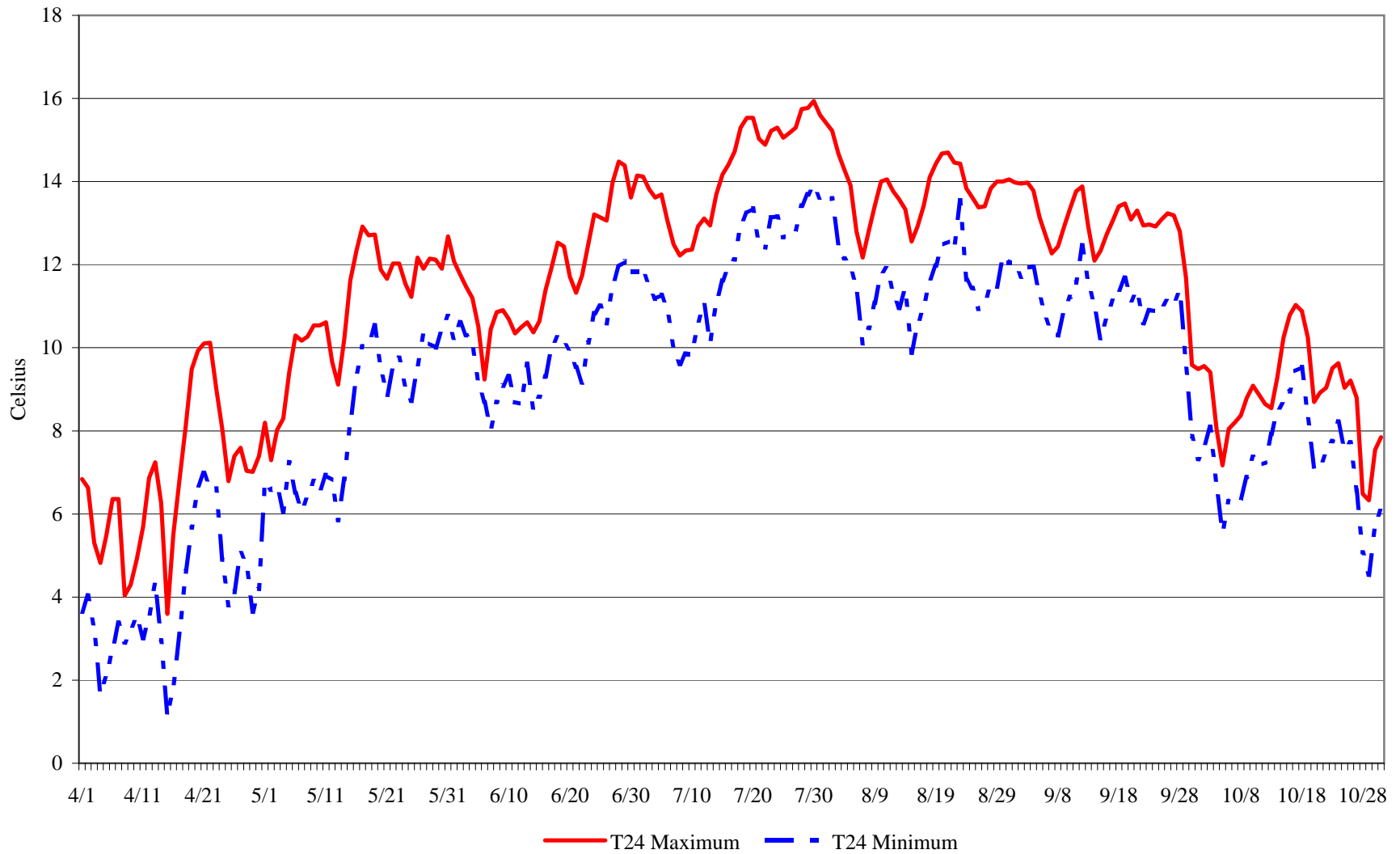


Figure 32. Daily Maximum and Minimum Water Temperatures in Lower Carpenter Creek (T24).

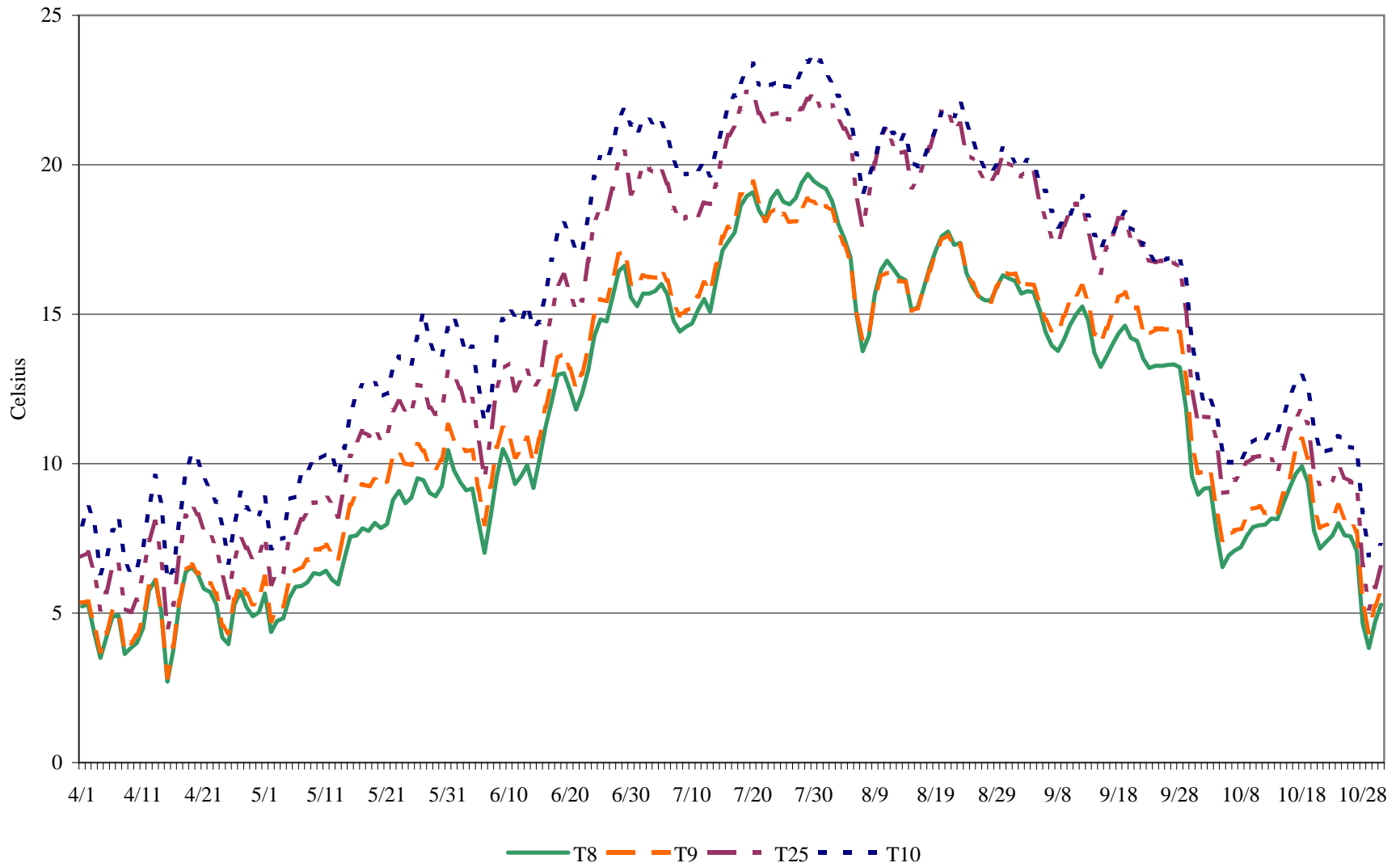


Figure 33. Daily Average Water Temperatures in the South Fork American River (T8, T9, T25 & T10).

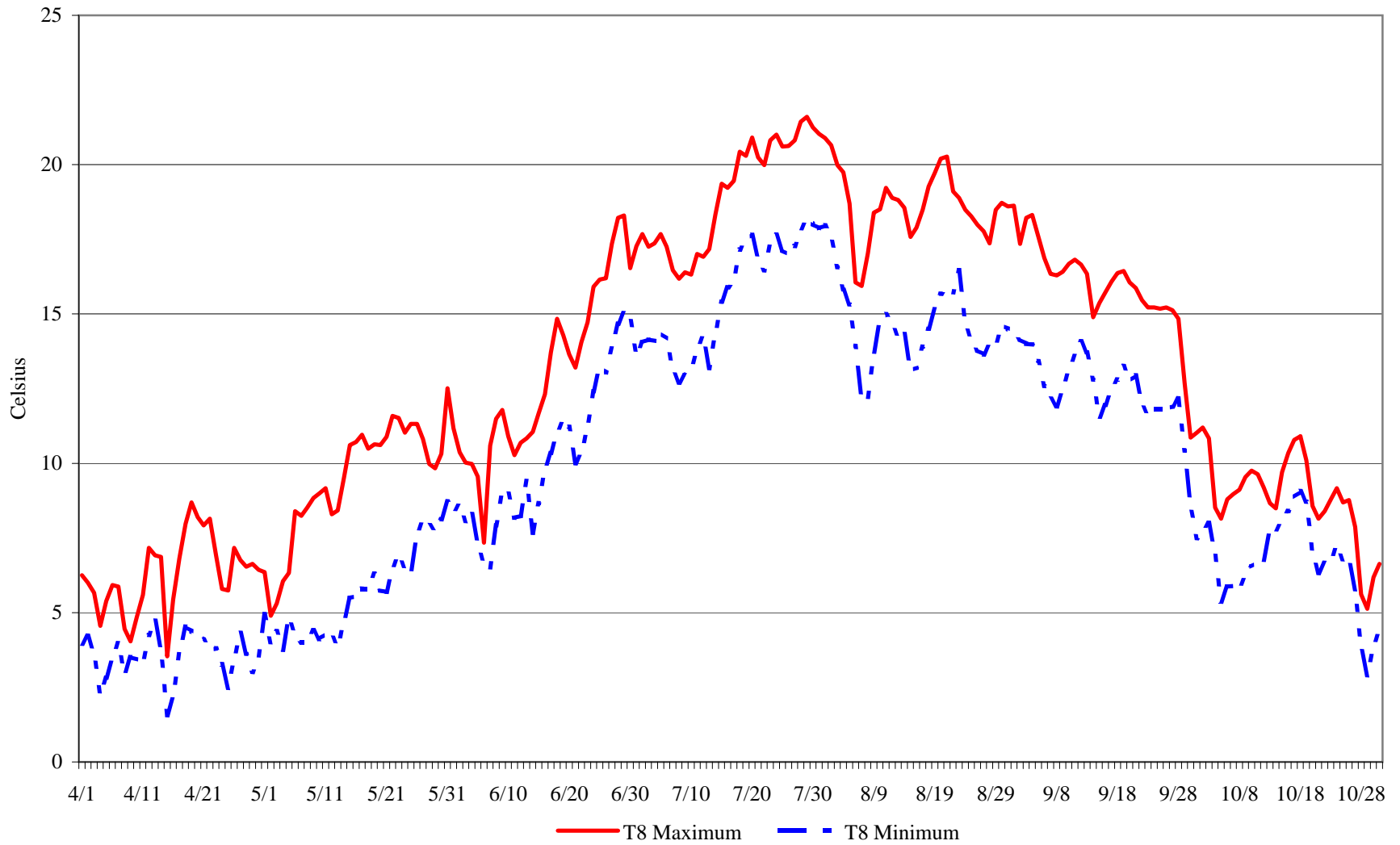


Figure 34. Daily Maximum and Minimum Water Temperatures in the South Fork American River above the Kyburx Diversion (T8).

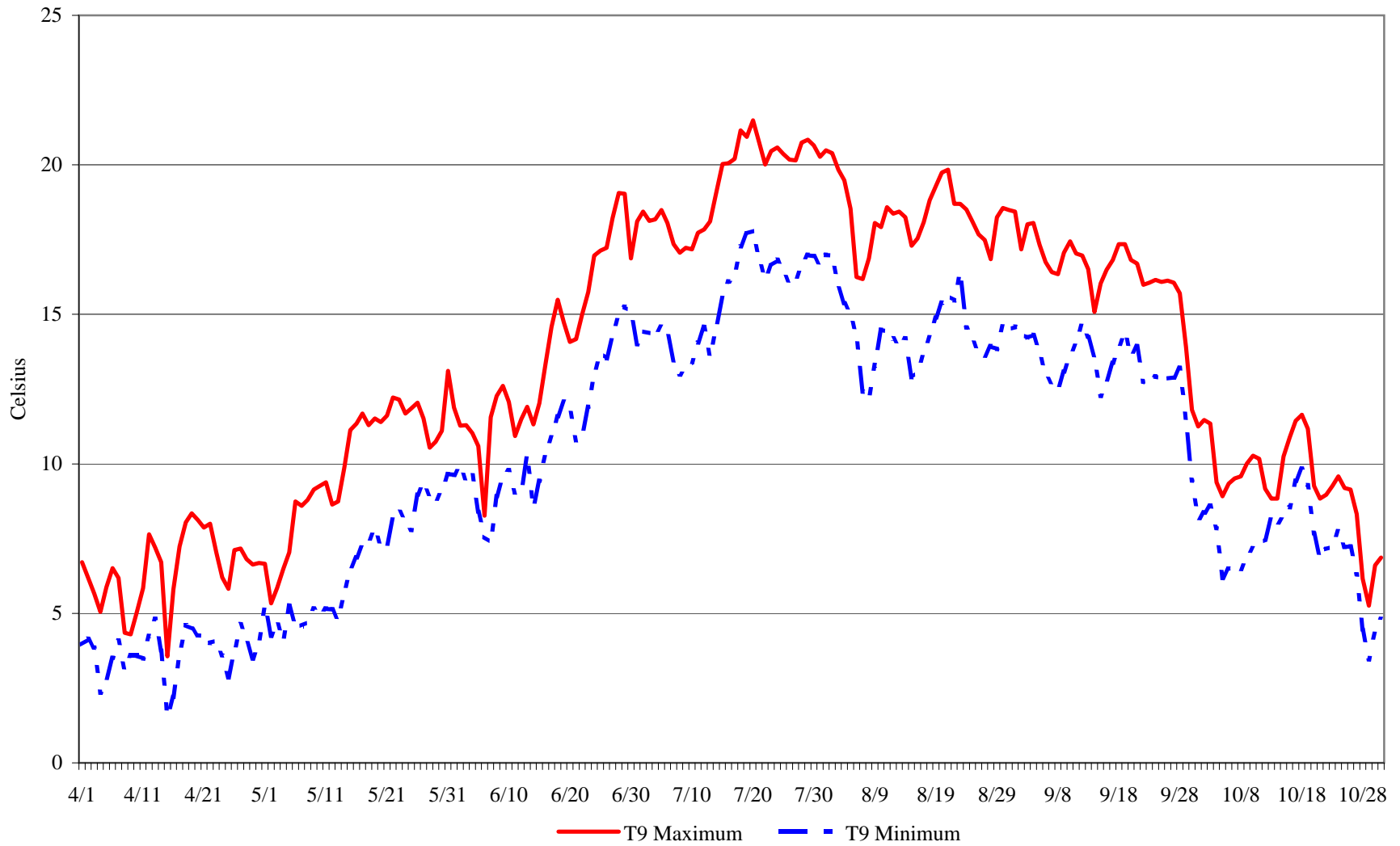


Figure 35. Daily Maximum and Minimum Water Temperatures in the South Fork American River below the Kyburx Diversion (T9).

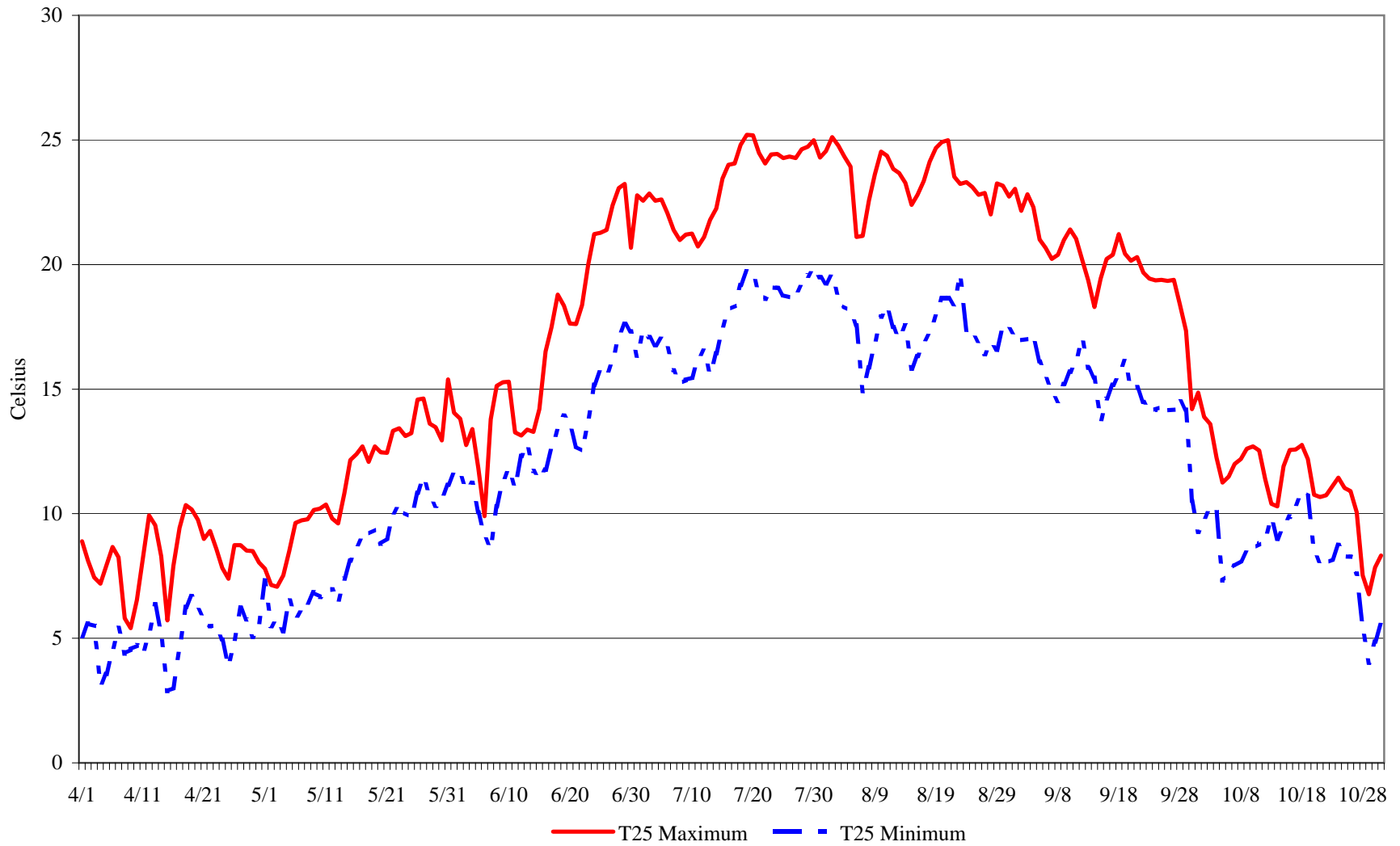


Figure 36. Daily Maximum and Minimum Water Temperatures in the South Fork American River near the Bridal Vail Picnic Area (T25).

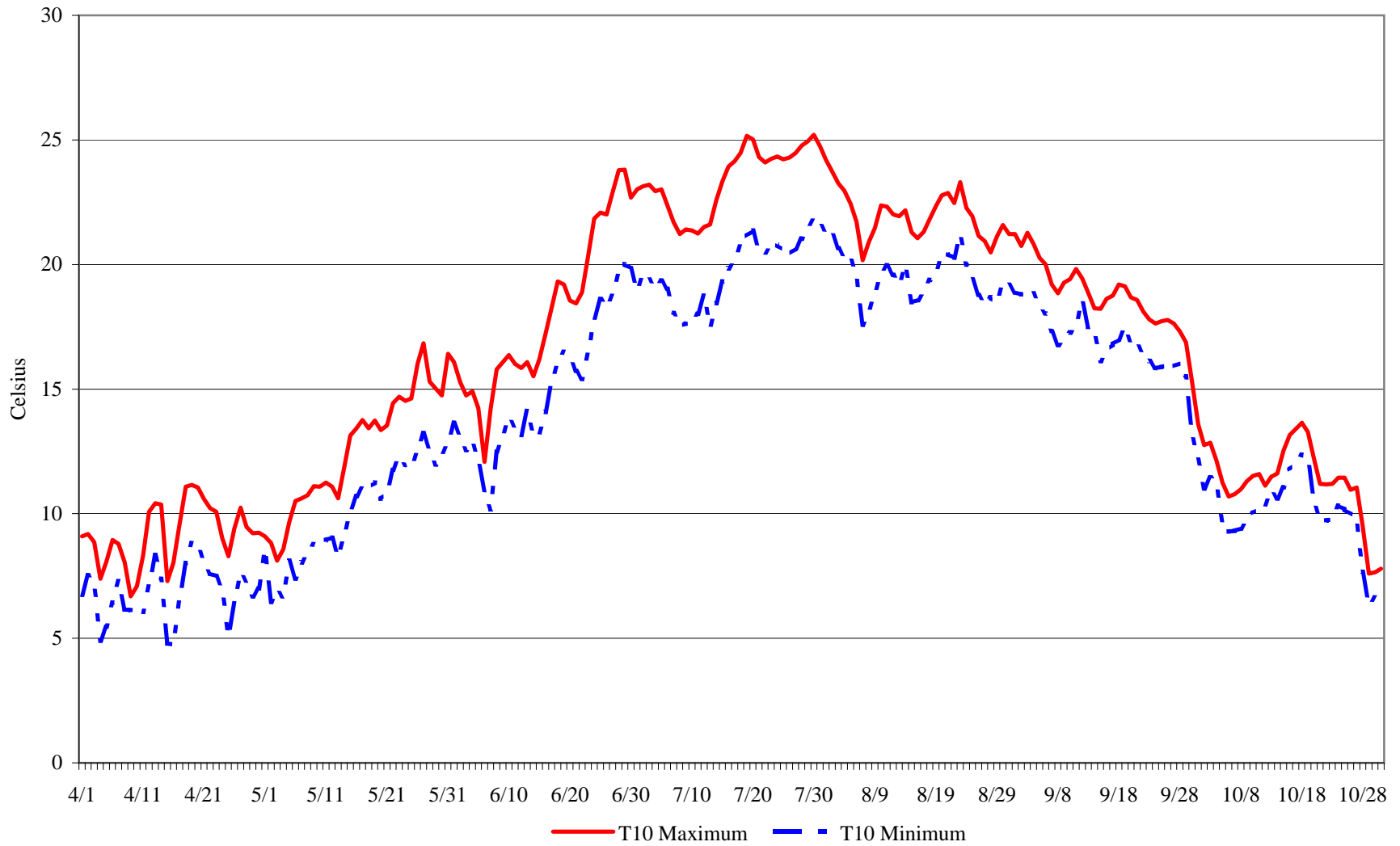


Figure 37. Daily Maximum and Minimum Water Temperatures in the South Fork American River above the Akin Powerhouse (T10).



# **Appendix B:**

## 2009 Daily Temperature Mean, Max, Min