Doyle Crossing – Last Chance Creek

East Branch North Fork Kern River Watershed

Excerpt from 2021 Sierra Meadows Hydrology Monitoring Annual Report

Doyle Crossing – Last Chance Creek

Last Chance Creek is tributary to Indian Creek in the East Branch North Fork Feather River watershed, with a drainage area of approximately 96.5 square miles (Plumas Corporation, 2016). Basin statistics are not available through the USGS StreamStats application because the Last Chance Creek watershed is in an exclusion area (extending to the state of Nevada). Using a subbasin of the Last Chance Creek watershed, which encompasses 75% of the drainage area above Doyle Crossing, the average annual precipitation in the watershed is 26.2" (StreamStats, 2019). Plumas County data for the 1971 through 2000 period support the StreamStats precipitation data, showing that the watershed receives average annual precipitation of 23 to 31 inches (Plumas County, 2012). The California Department of Water Resources (DWR) Climate Stations have a 50- to 60-year period of record and report between 17.4" and 22.2" of precipitation in the Last Chance Basin (DWR, 2020).

The Last Chance Creek watershed has been the focus of meadow and channel restoration activities since 1995, with the majority of restoration occurring between 2002 and 2007. Figures 47 and 48 illustrate pre- and post- restoration conditions in the Alkali Flat area of Last Chance Creek. In total, approximately 11 miles of channel have been reconnected to the floodplain above the Doyle Crossing station. A continuous recording unit (CRS) unit was installed in Last Chance Creek in 1999. Continuing the long-term data collection at this location is important for evaluating the cumulative impact of multiple meadow restoration projects across a variety of water year types, including severe multi-year droughts. Appendix G provides a map of restoration projects and gage location for the Last Chance Creek monitoring station. Table 11 summarizes the data record for this gage (data gaps exist due to occasional equipment errors). Table 12 provides an overview of field data collected during the 2021 water year.

Figure 47. *Last Chance Creek- Alkali Flat overview, 2003.*

Figure 48. *Last Chance Creek- Alkali Flat overview, 2010.*

Table 11. *Data continuity for the Last Chance Creek/Doyle Crossing Monitoring Station.*

Water Year	Data Availability
2000	DG: 11/19- 1/6, 2/25- 3/17
2001	All
2002	All
2003	All
2004	DG: 9/5-9/30
2005	DG: 10/1, 1/7-1/18
2006	All
2007	All
2008	All
2009	All
2010	All
2011	DG: 11/3-7/17
2012	All
2013	All
2014	All
2015	DG:2/3-3/13
2016	1/4-2/12
2017	12/6-12/31
2018	All
2019	All
2020	All
2021	All except 1 hr on 12/23/20 due to querying sensor
Water Year = 10/1 through 9/30 DG = Data Gap All = All year-round data	

Table 12. *Summary of 2021 Water Year Data Collection at Last Chance Creek/Doyle Crossing Station.*

Parameter measured	Site visit dates	Data collected by	Comments
Stream Flow Measurement	10/29/20 12/23/20 4/29/21 5/28/21 6/18/21	Plumas Corporation	July through September visits not possible due to fires, forest closure order, and/or fire rehabilitation work to address hazard trees along access route.
Temperature (Air, Water)	All dates	Plumas Corporation	Continuous water temperature also available from gage site; air temperature from DWR Station at Doyle Crossing (available via CDEC)
Electrical conductivity (Stream)	All dates	Plumas Corporation	Grab sample

Geologic Characterization:

Last Chance Creek is bordered by a long, narrow set of meadows at an elevation of 5,500' with an average of 20" of precipitation per year. Precipitation at this location is a mix of rain and snow. The geology here is more complex than the other meadows discussed so far. The rock types vary locally from Permian to Neogene granodiorites and quartz monzonite, to Neogene andesite and basalt deposits and rhyolite. In some locations nearer to the stream Pliocene alluvium terrace deposits may be found. Adding to the complexity of the area is the presence of multiple NW-SE trending faults to the north and south of the study area, with a possible NE-SW trending fault that crosses the stream channel in the western portion of the study area.

Hydrology:

The data reported for Last Chance Creek at Doyle Crossing are for water year 2021 (October 1, 2020 – September 30, 2021).

Overview

The gage pool and downstream flow measurement cross-section are characterized by a bedrock substrate and tend to remain stable throughout the season. Aquatic vegetation and ice buildup can cause minor shifts in the cross-section and gage pool, and flow calibration measurements were used to adjust the transducer data as needed. Similar to the Notson Bridge station, no peak runoff measurements were obtained due to low flow conditions and access was prevented during summer due to wildfires, forest closure orders, and fire rehabilitation work. The Doyle Crossing CDEC station recorded 12.02" of precipitation in water year 2021, marking a second consecutive dry year and the driest year monitored in the 21-year history of the station. The upper Last Chance Creek basin also burned in the Dixie Fire starting about 10 stream miles above Doyle Crossing.

Stream Flow

Stream flow was manually measured in October and December 2020 and monthly from April through June 2021. Manual flow measurements were used to evaluate the stream stage rating curve and verify the continuously recorded transducer data. Manually-measured stream flows ranged from 4.15 cfs (4/29/21) to 0.39 cfs (6/18/21). Daily average flows (Figure 49) from the CRS ranged from sustained flow below the rated low flow of 0.10 cfs in October and throughout the summer months, to a maximum of 31.4 cfs (3/5/21). Peak flow in water year 2021 was less than half of that observed in water year 2020 (68.2 cfs), and only one-tenth of peak flow observed in 2016, a year with 109% of average precipitation (Northern Sierra 8-station Index).

To illustrate the magnitude of low flows observed in water year 2021, the Last Chance Creek hydrograph was plotted for three dry years (2014, 2020, and 2021) and three years with nearly average precipitation (2004, 2010, and 2016). Dry versus average year classification was based on the Northern Sierra 8-station Index (8SI), which uses 1991-2020 as the period of record for average precipitation. For the hydrographs shown in Figure 50, the total dry year precipitation ranged from 45.1% to 59.6% of average, while average year precipitation ranged from 87.8% to 108.8% of average. As shown in Figure 50, dry year flows are substantially less than average year flows, with water years 2014 and 2021 showing peak flows of smaller magnitude than early summer flows observed in average years 2010 and 2016.

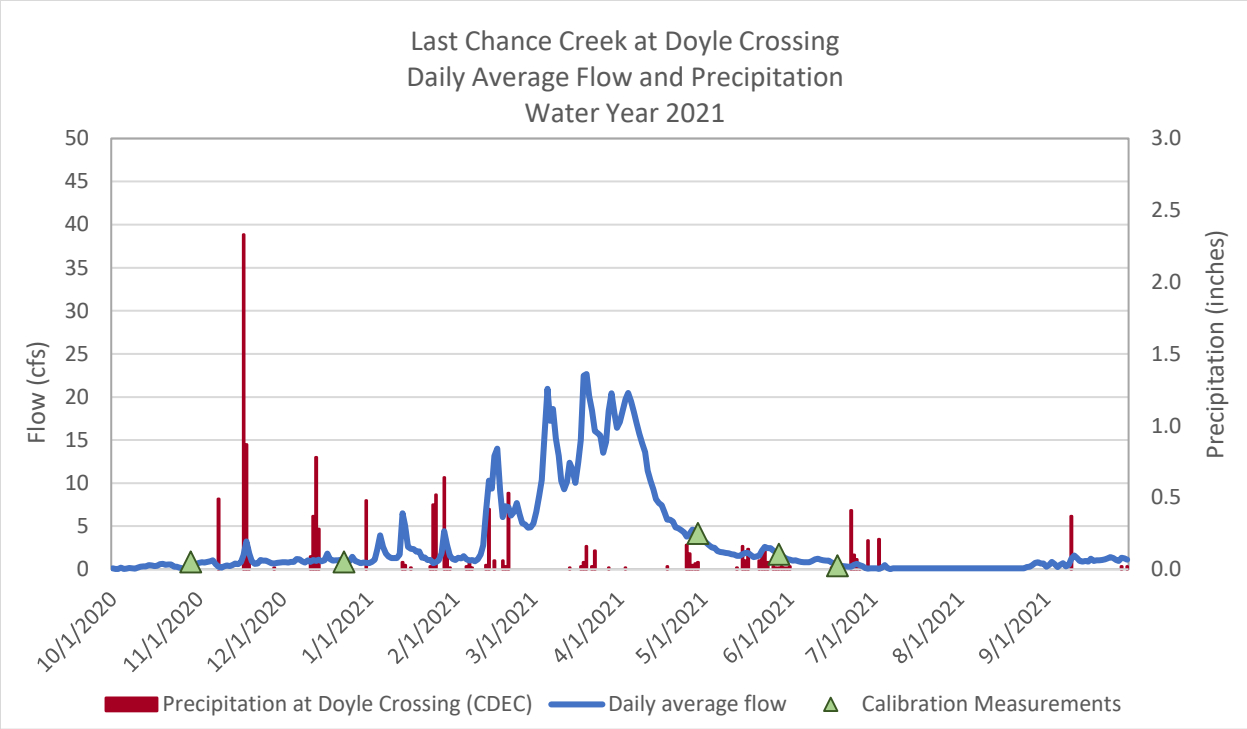

Figure 49. *Daily average flow in Last Chance Creek at Doyle Crossing (Source: CRS Keller Model 700 Transducer) and precipitation (Source: Doyle Crossing CDEC), water year 2021.*

Summer baseflows exhibit less of a range across water year types (Figure 51). Dry years tend to have a flow at or below the minimum rating for Last Chance Creek at Doyle Crossing. When recorded gage heights are analyzed (data not shown), daily average flows did not cease in 2014 or 2020, the other dry years evaluated in this comparison, nor in any of the average years evaluated. The point of zero flow (PZF) for Last Chance Creek at Doyle Crossing occurs at a gage height of 0.60'. Daily average gage heights did not fall below this level until 2021, where the average gage height reached 0.60' on 7/12/21 and gradually dropped to a height ranging from 0.12' to 0.16' through 8/23/21, and flow resuming on 8/25/21. Although the site could not be visited during this time due to Dixie Fire operations, it is likely that the USFS was using Last Chance Creek above the gage site for drafting purposes, as there is an established drafting site just upstream of the gage pool.

Figure 51 also illustrates that 2021 late-season baseflows (once flow had resumed) were similar to average years 2010 and 2016 (2004 had a data gap during this period and cannot be compared). This is a striking pattern given that the other dry years did not increase in flow until late September, when there is typically a rise in flow from autumn rain or when riparian ET decreases in response to cooler weather. One suspected cause of this pattern is that a large proportion of the Willow Creek watershed (tributary to Last Chance Creek) burned in the Dixie Fire, from the uplands down to the riparian corridor. The initial rise in flow may be indicative of the reduced riparian ET draw, while the second rise in flow may represent the reduced ET draw from the uplands, which would have a greater lag before impacting channel flow due to increased travel time for groundwater discharge. Baseflow monitoring in 2022 may provide data to help understand this late season flow pattern, because it will take several years for upland vegetation to reestablish.

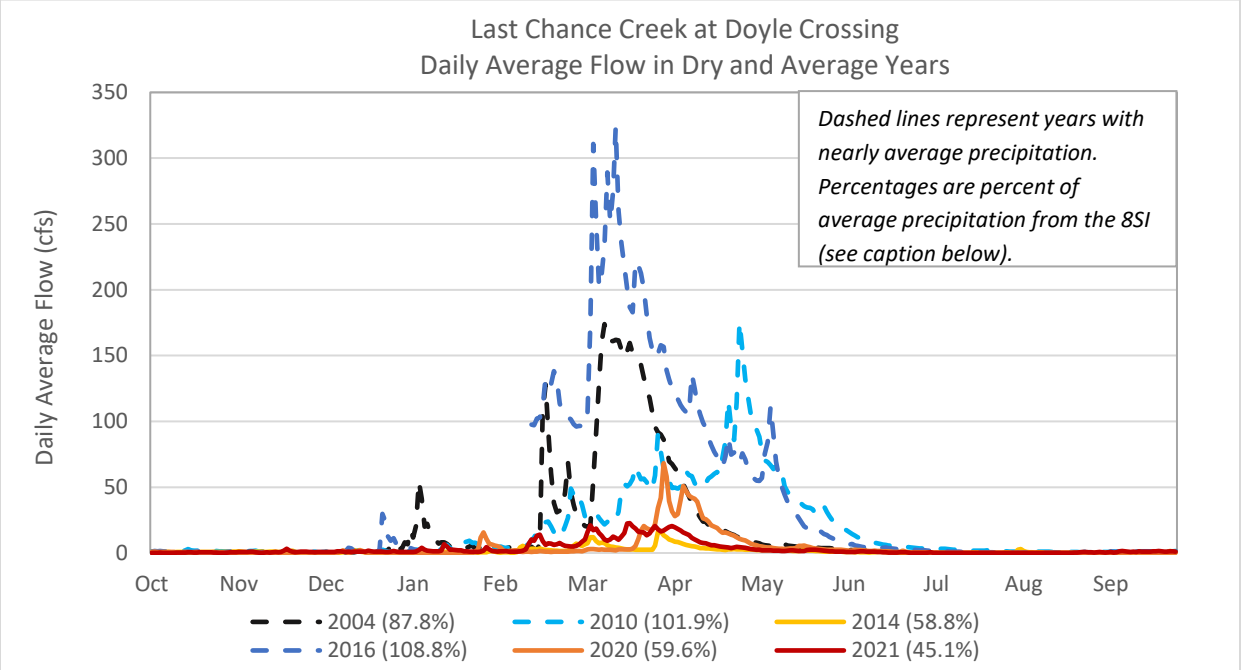

Figure 50. *Daily average flow in Last Chance Creek at Doyle Crossing (Source: CRS Keller Model 700 Transducer) water years 2018 and 2020. for dry (2014, 2020, and 2021) and average (2004, 2010, and 2016) water years. Percentages of average precipitation are shown in parentheses and are based on the Northern Sierra 8-station Index (8SI), available at https://cdec.water.ca.gov/precipapp/get8SIPrecipIndex.action. The 8SI currently uses 1991 through 2020 as the period of record for calculating average precipitation.*

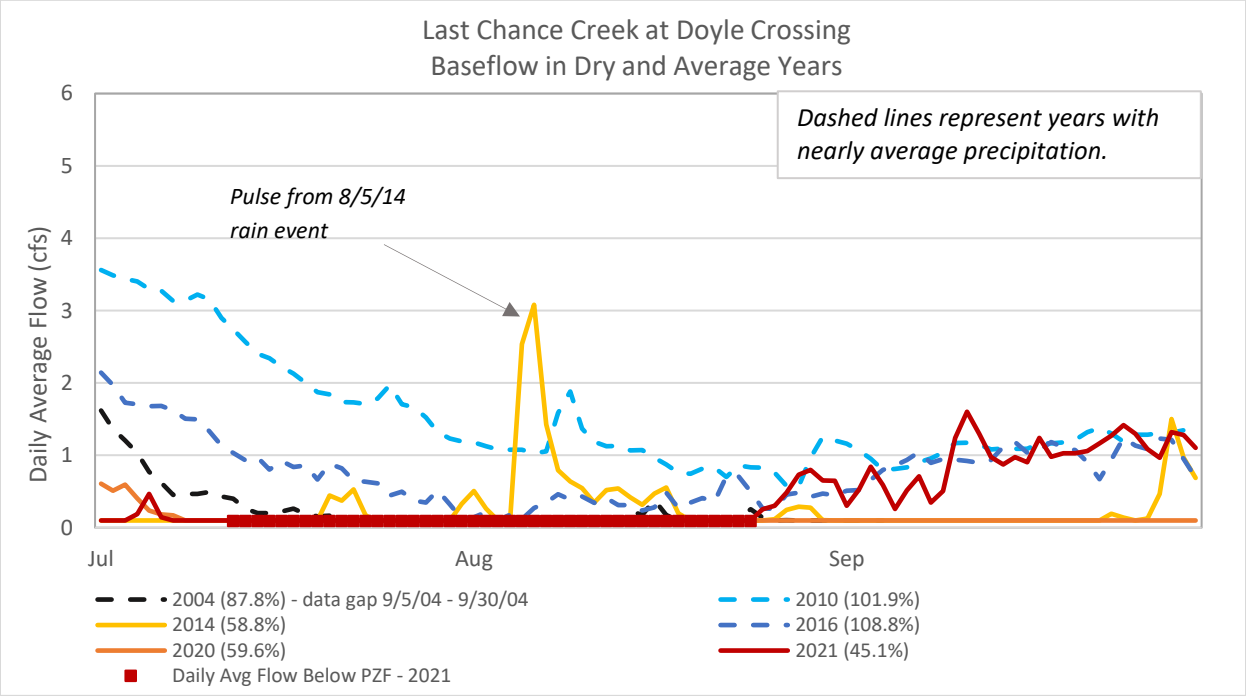

Figure 51. *Daily average flow in Last Chance Creek at Doyle Crossing (Source: CRS Keller Model 700 Transducer) during the summer baseflow period (July 1 through September 30) for dry and average water years. Refer to the caption for Figure 50 for a description of source data.*

Electrical Conductivity

Electrical conductivity (EC) was measured at the flow measurement cross-section during each monthly site visit. EC and stream flow continued to exhibit an inverse relationship, with EC values being lowest during peak flow events and highest during the low-flow season. This relationship illustrates the relative contribution of groundwater to stream flow, with a greater proportion of groundwater (higher EC due to higher mineral content of groundwater) during the low-flow period and a smaller contribution of groundwater during peak flows, where most of the flow volume is derived from overland flow. As shown in Figure 52, this relationship has been consistently expressed over a longer-term period of record.

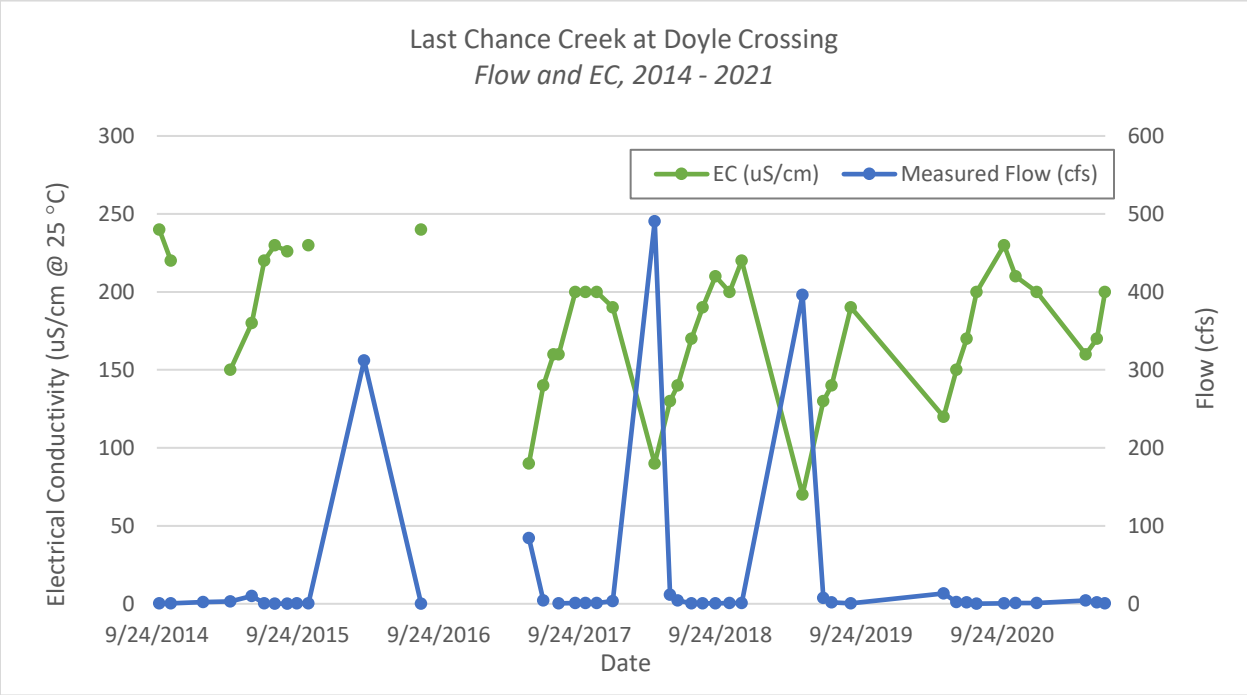

Figure 52. *Electrical Conductivity (grab sample) and stream flow (calibration measurement) in Last Chance Creek, water years 2014-2021.*

Temperature

Hourly average water temperatures in Last Chance Creek were obtained from the continuous recording station at Doyle Crossing and used to calculate daily average and maximum temperatures. Daily average water and air temperature data (Doyle Crossing CDEC Station) are shown in Figure 53. For 2021, several different analyses were conducted on temperature data. Although this reach of Last Chance Creek is not considered trout habitat, the temperature criteria for trout were considered as overall indicators of water quality. Additionally, trout are found in tributaries to Last Chance Creek, and trout may colonize Last Chance Creek when flow and temperature conditions are suitable.

First, the hourly maximum water temperatures in Last Chance Creek were evaluated relative to the EPA maxima of 75°F recommended for juvenile and adult trout survival (US EPA 1986). Maximum hourly water temperatures exceeded 75°F on 70 days in water year 2021 (Figures 53 and 55). In previous years, a more conservative threshold of 68°F was evaluated. Maximum hourly water temperatures exceeded 68°F on 105 days (with 95 days, 93 days, 99 days, and 104 days of exceedance in 2020, 2019,

2018, and 2017, respectively). The similarity in frequency of exceeding 68°F is likely due to the strong groundwater contribution to base flow at this location; base flows tend to be consistent across water year types. Further, the gage pool and channel have significant areas of exposed bedrock and full sun exposure (Figure 54). The bedrock provides a large thermal mass that radiates heat during the day and releases heat at night, moderating any cooling effect of lowered nighttime air temperatures.

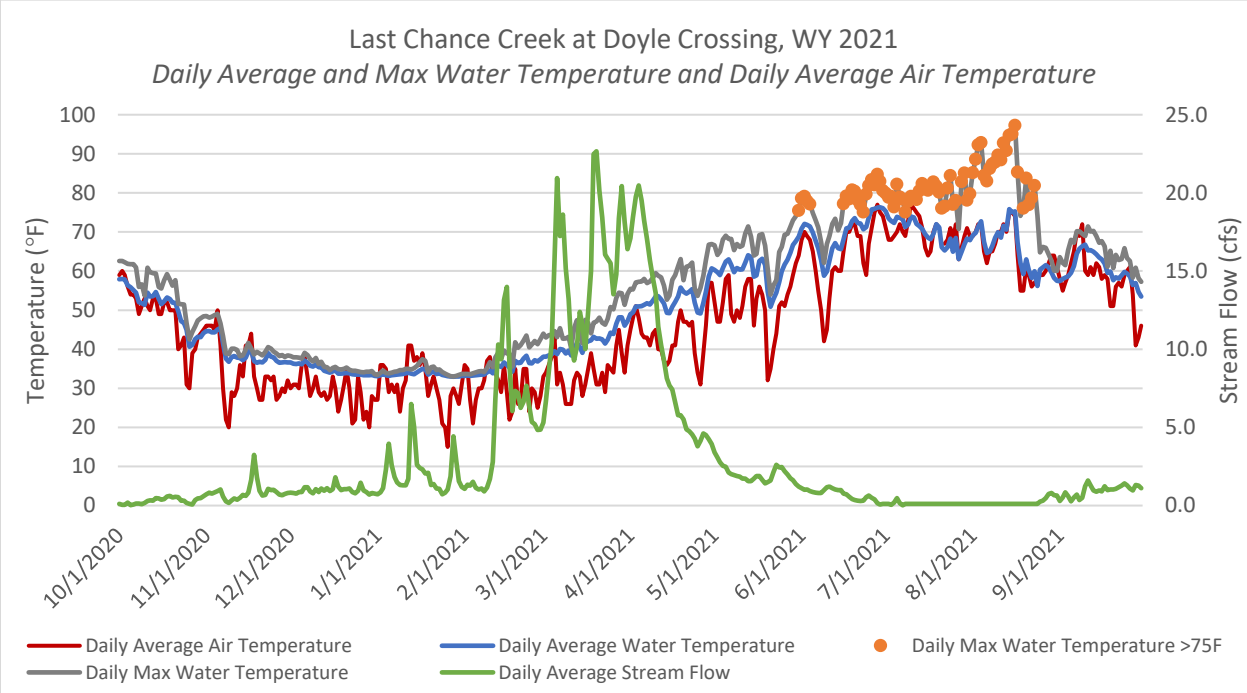

Figure 53. *Daily average and maximum water temperature in Last Chance Creek (Source: CRS Campbell Scientific Model 107 thermistor) and daily average air temperature (Source: Doyle Crossing CDEC), water year 2021. Also shown is daily average stream flow.*

Additionally, the long-term exposure threshold of 66°F was evaluated for trout growth and development by using the maximum weekly average water temperature (MWAT; US EPA 1986). The MWAT is determined by finding the maximum from a rolling 7-day average water temperature calculated throughout the year. Additionally, rolling 7-day averages were calculated for daily average flows. Figure 55 shows daily maximum water temperatures and 7-day average flow and water temperatures for water year 2021 alongside the EPA criteria. Using a 7-day average can help smooth data to facilitate interpretation of large data sets (Tate et al. 2005). From June 2 through August 20, the 7-day average daily average water temperature exceeded the long-term exposure threshold on most days; the MWAT for water year 2021 was 75.6°F.

Figure 54. *Overview of bedrock floodplain along the left bank at the Last Chance Creek/Doyle Crossing stream gage site, April 25, 2019 (photo credit: T. Rust).*

Considering the short- and long-term exposure thresholds together, summer water temperature is too high in most years at Last Chance Creek to support a trout fishery. This is supported by historical fish surveys that have been done at the Doyle Crossing. Plumas Corporation compiled a summary of all fish surveys done on Last Chance Creek that spanned from 1952 through 2008 (Plumas Corporation 2013). While there were no older surveys done at Doyle Crossing, electroshocking was conducted at the gage site in 1997, 2001, 2005, and 2008 as part of a larger monitoring effort to evaluate changes in physical and biological indicators of watershed health and stability. Ten rainbow trout were sampled in 1997, and 2 were observed (but not captured in 2001), with no detections in the other survey years. A Jones

and Stokes report for the Genesee Hydroelectric project (summarized in Plumas Corporation 2013) noted that spawning habitat is poor in Last Chance Creek due to granitic sands covering potential spawning gravels. Thus, habitat suitability (and trout presence) may occur in some years with increased flow (e.g., 1997, which was wet), which can reduce water temperatures and provide flushing flows to move sands out of spawning beds.

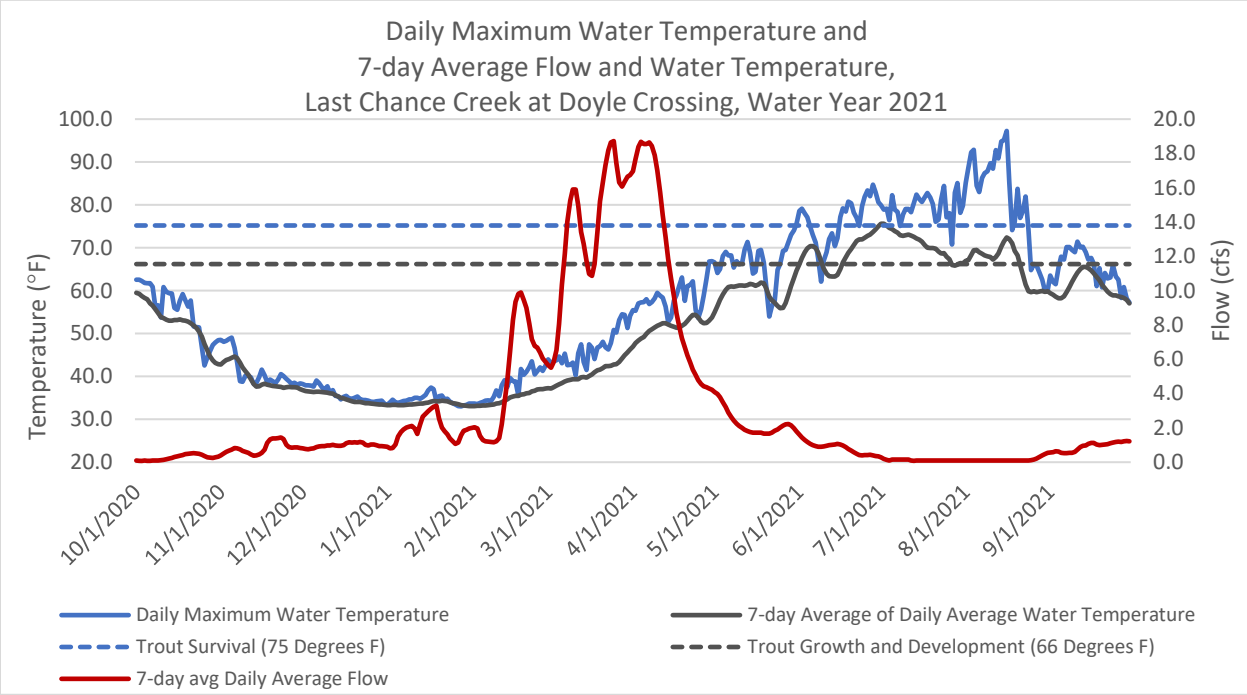

Figure 55. *Daily maximum water temperature and 7-day average of daily average flow and water temperature in Last Chance Creek (Source: CRS Campbell Scientific Model 107 thermistor), water year 2021.*

Cited references included in the complete "2021 Sierra Meadows Hydrology Monitoring Annual Report"