



Morro Bay Watershed Creek Health For Water Year 2022

Date Range: October 1, 2021 to September 30, 2022

Analytes: Water temperature, nitrates as nitrogen, orthophosphates as phosphorus, dissolved oxygen, pH, specific conductance

1. Background

The Morro Bay National Estuary Program conducts monitoring in the Morro Bay estuary and surrounding watershed to track ambient water quality trends and to assess the impacts of specific implementation projects.

Estuary Program staff and volunteers collect data under the guidance of a Quality Assurance Project Plan (QAPP) which is reviewed and approved by EPA and the State Water Resources Control Board. This QAPP document contains the monitoring locations, protocols, equipment specifications, and other details that allow users to assess the quality of the collected data. The full QAPP document is available at <https://www.mbnep.org/qapp/>.

2. Water Temperature

The Estuary Program wanted to assess how often local creeks had water temperature conditions that were supportive of sensitive wildlife like the Central California Coast steelhead (*Oncorhynchus mykiss*) during water year 2022 (WY2022), which is defined as October 1, 2021 through September 30, 2022.

The Estuary Program deploys [HOBO TidbiT MX 2203](#) temperature data loggers at sites throughout the watershed. These loggers monitor daily fluctuations and seasonal trends of creek water. Loggers are deployed year-round, and the loggers are programmed to collect readings at 30-minute intervals.

2.1 Equipment Specifications

Specifications for the TidbiT temperature loggers are as follows:

Specification	Value
Measurement/Operating Range	-20° to 70°C in air -20° to 50°C in water
Accuracy	±0.25°C from -20° to 0°C ±0.2°C from 0° to 70°C

Specification	Value
Resolution	0.01°C

While the TidbiT temperature loggers do not require calibration, staff collected an independent temperature measurement from a second meter at time of deployment for comparison. These duplicate readings were repeated periodically throughout the deployment for quality assurance.

2.2 Monitoring Locations

The Estuary Program monitored continuous temperature in WY2022 at six sites in the Chorro Creek subwatershed (Figure 1).

Three of the six monitoring sites are located along the mainstem of Chorro Creek, which is known to support *O. mykiss*. Historic data indicates elevated temperatures on Chorro Creek, above levels preferred by these sensitive fish. The remaining sites were chosen along tributaries to Chorro Creek: Pennington Creek, San Luisito Creek, and Dairy Creek. These tributaries have historically provided spawning ground for *O. mykiss*.

Continuous Temperature Monitoring Sites for WY2022

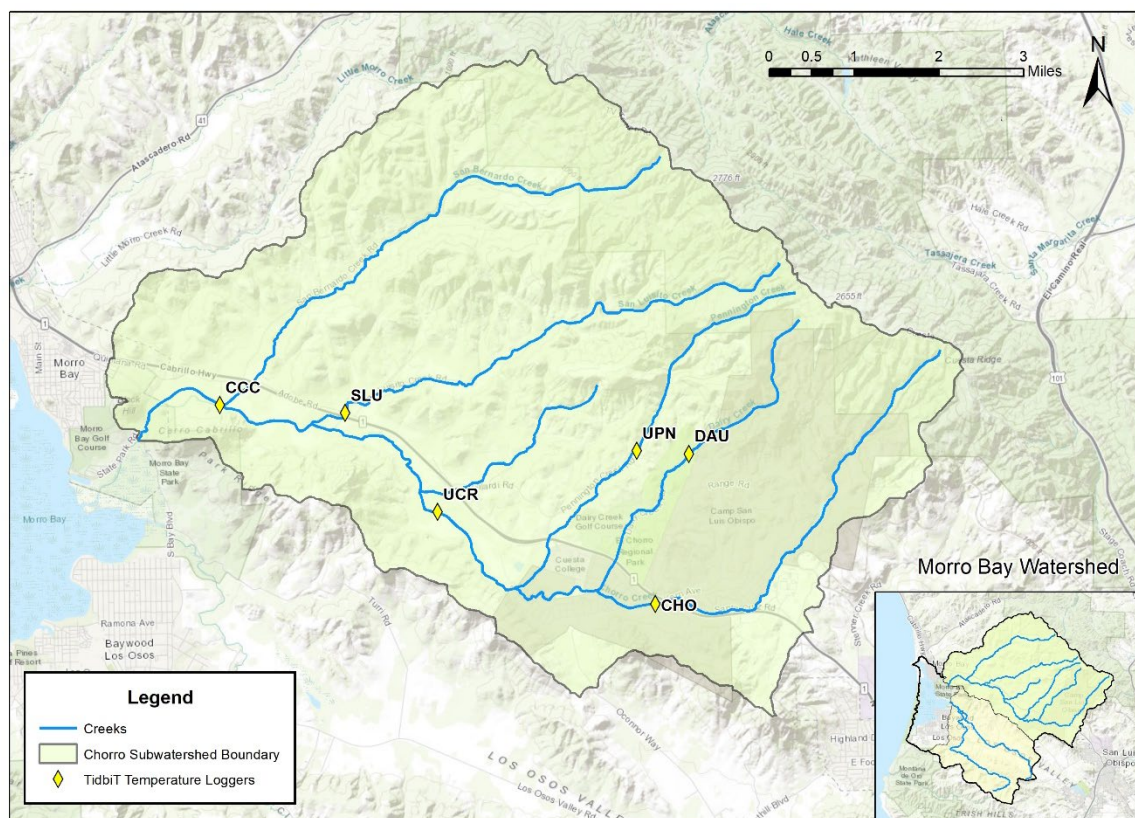


Figure 1: Continuous temperature monitoring sites in the Chorro Creek subwatershed during WY2022.

2.3 Results

Continuous temperature data is of value because it shows the time of day and duration of elevated temperatures, defined as water temperatures above 18°C. This threshold was selected based on research that identified the optimal temperature range for *O. mykiss* as between 13 and 21°C. Prolonged exposure to temperatures above 18°C can negatively impact *O. mykiss* reproduction, growth, migration timing, stress levels, and survival (Moyle 2002).

The following datasets illustrate water temperature data collected at 30-minute intervals throughout WY2022, compared to the 18°C threshold. Temperatures were analyzed for the water year and on a seasonal basis. Dates used to define the WY2022 seasons can be found in Appendix B.

2.3.1 Chorro Creek

Water temperature data was collected at three sites along Chorro Creek:

- The uppermost monitoring site is located at Camp San Luis Obispo (site code CHO) at the Highway 1 bridge.
- The middle Chorro Creek site is downstream of the California Men's Colony Wastewater Treatment Plant (CMC WWTP) outfall and just upstream of the Chorro Creek Ecological Reserve. The site is referred to as Upper Chorro Reserve (site code UCR).
- The furthest downstream site is at Chorro Creek Road (site code CCC) near the bottom of Chorro Creek, just upstream of Chorro Flats. It is above the zone of tidal influence from the bay.

The following graphs show water temperatures at CHO, UCR, and CCC mainstem sites. The graphs illustrate water temperatures for the entire water year, color coded by season. The multi-colored line indicates water temperature in degrees Celsius (°C) recorded at 30-minute intervals, and the horizontal red line indicates the 18°C threshold protective of steelhead and other sensitive species.

2.3.1a. Camp San Luis Obispo (CHO)

The following graph (Figure 2) shows water temperatures at Chorro Creek near Camp San Luis Obispo (CHO). The temperature logger at CHO was deployed from the start of WY2022 (October 1, 2021) until December 13, 2021. Due to a large storm that pushed the logger out of the water, late winter and early spring data is not available. The logger was placed back in the water on February 9, 2022 and was active until the end of WY2022 (September 30, 2022).

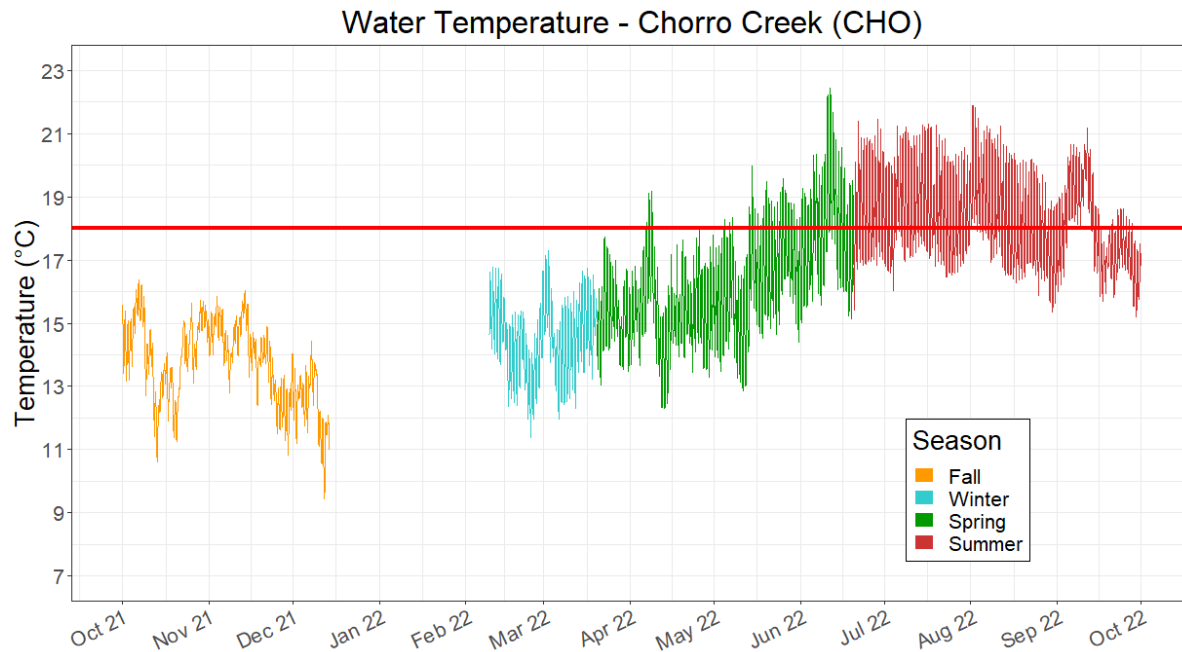


Figure 2: Water temperature at Chorro Creek (CHO) during WY2022, colored by season. Data was not available from December 13, 2021 to February 9, 2021.

2.3.1b. Upper Chorro Reserve (UCR)

The following graph (Figure 3) shows water temperatures at Chorro Creek upstream of the Chorro Creek Ecological Reserve (UCR). The temperature logger at UCR was deployed for the entire water year: October 1, 2021 to September 30, 2022.

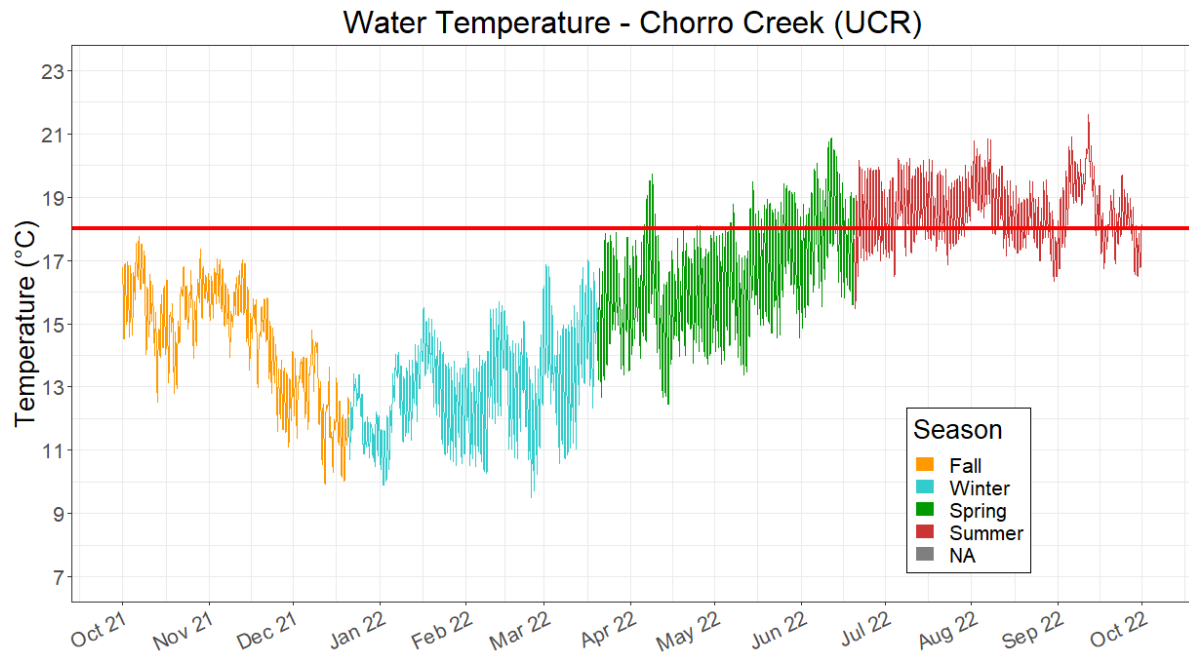


Figure 3: Water temperature at Chorro Creek (UCR) during WY2022, colored by season.

2.3.1c. Chorro Creek Road (CCC)

The following graph (Figure 4) shows water temperatures at Chorro Creek near Chorro Creek Road (CCC). The temperature logger at CCC was deployed for the entire water year: October 1, 2021 to September 30, 2022.

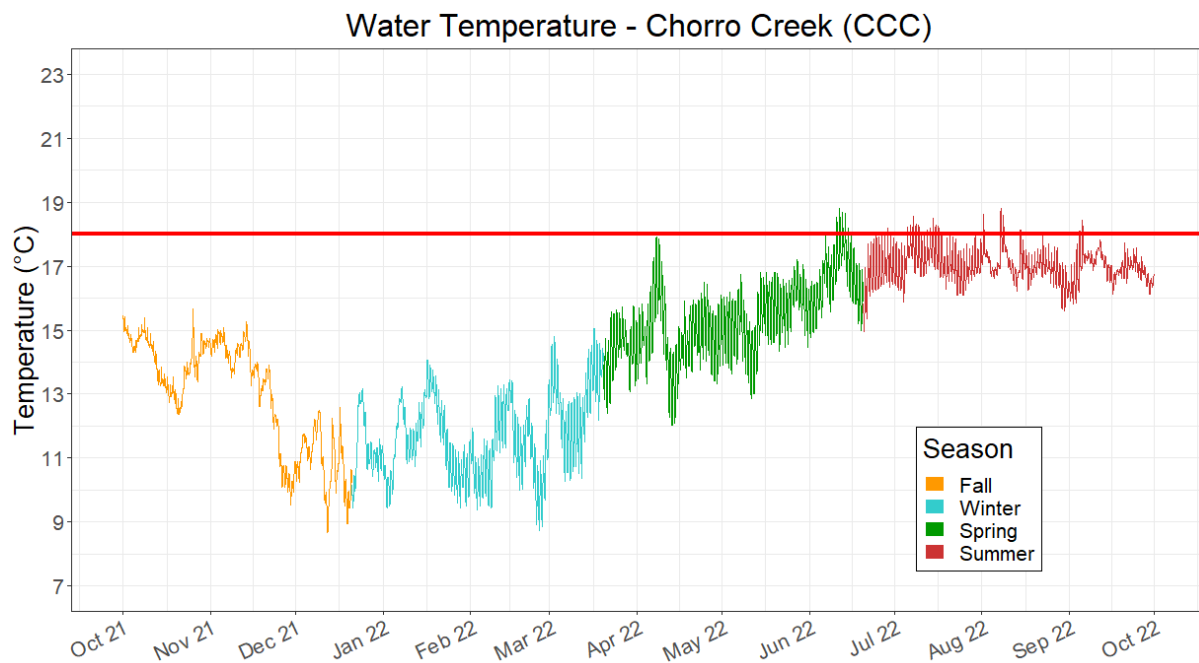


Figure 4: Water temperature at Chorro Creek (CCC) during WY2022, colored by season.

2.3.2 Chorro Creek Tributaries

Water temperature data was collected from three tributaries to Chorro Creek:

- San Luisito Creek: this site is located on Adobe Road, about 0.5 miles upstream of the confluence with Chorro Creek (site code SLU).
- Pennington Creek: located about 2.5 miles upstream of the confluence with Chorro Creek, upstream of the former Rancho El Chorro Outdoor School campus and near the Cal Poly Beef Center at Escuela Ranch (site code UPN).
- Dairy Creek: located within El Chorro Regional Park, approximately 2 miles upstream of the confluence of Dairy and Chorro Creek (site code DAU).

The following graphs show water temperatures at San Luisito, Pennington, and Dairy Creek tributary sites. The graphs illustrate water temperatures for the entire water year, color coded by season. In each graph, the multi-colored line indicates water temperature in degrees Celsius (°C), recorded at 30-minute intervals, and the horizontal red line indicates the 18°C threshold protective of steelhead and other sensitive species.

2.3.2a. San Luisito Creek (SLU)

The following graph (Figure 5) shows water temperatures at San Luisito Creek at Adobe Road (SLU) during WY2021. The temperature logger at SLU was deployed for the entire water year: October 1, 2021 to September 30, 2022.

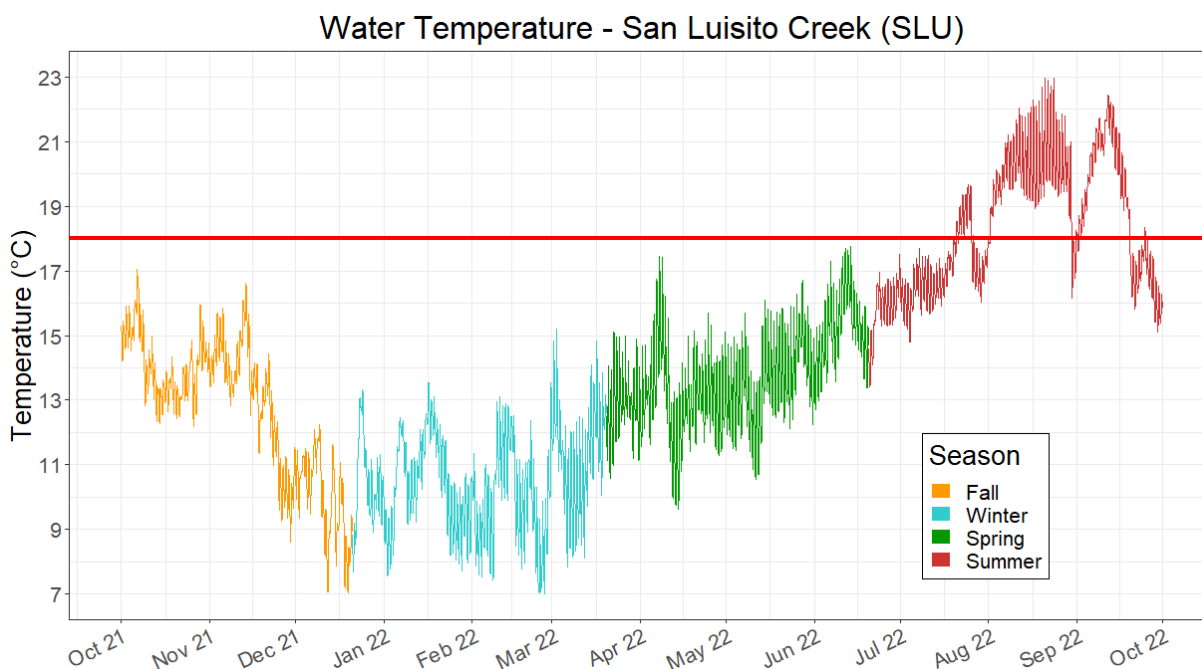


Figure 5: Water temperature at San Luisito Creek (SLU) during WY2022, colored by season.

2.3.2b. Pennington Creek (UPN)

The following graph (Figure 6) shows water temperatures at Pennington Creek near the Cal Poly Beef Center (UPN) during WY2021. The temperature logger at UPN was deployed for the entire water year: October 1, 2021 to September 30, 2022.

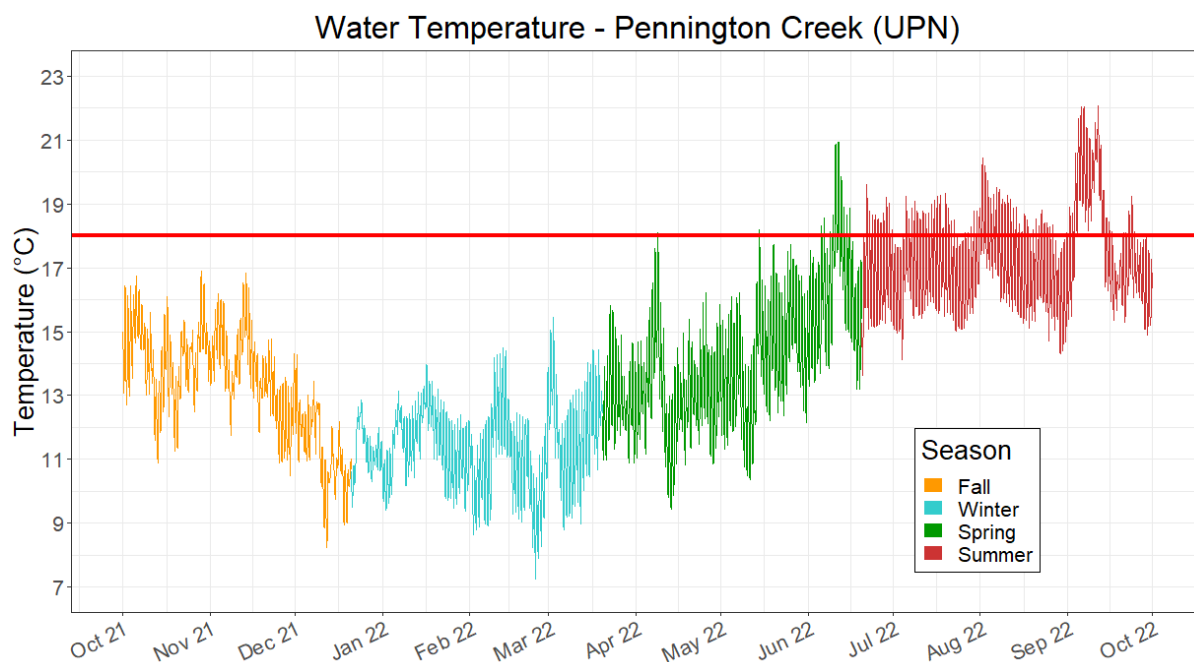


Figure 6: Water temperature at Pennington Creek (UPN) during WY2022, colored by season.

2.3.2c. Dairy Creek (DAU)

The following graph (Figure 7) shows water temperatures at upper Dairy Creek above El Chorro Regional Park (DAU) during WY2022. The site was dry at the start of WY2022, so the temperature logger at DAU was deployed on January 6, 2022 after flows resumed. Data collected after June 10, 2022 was excluded because the site went dry again.

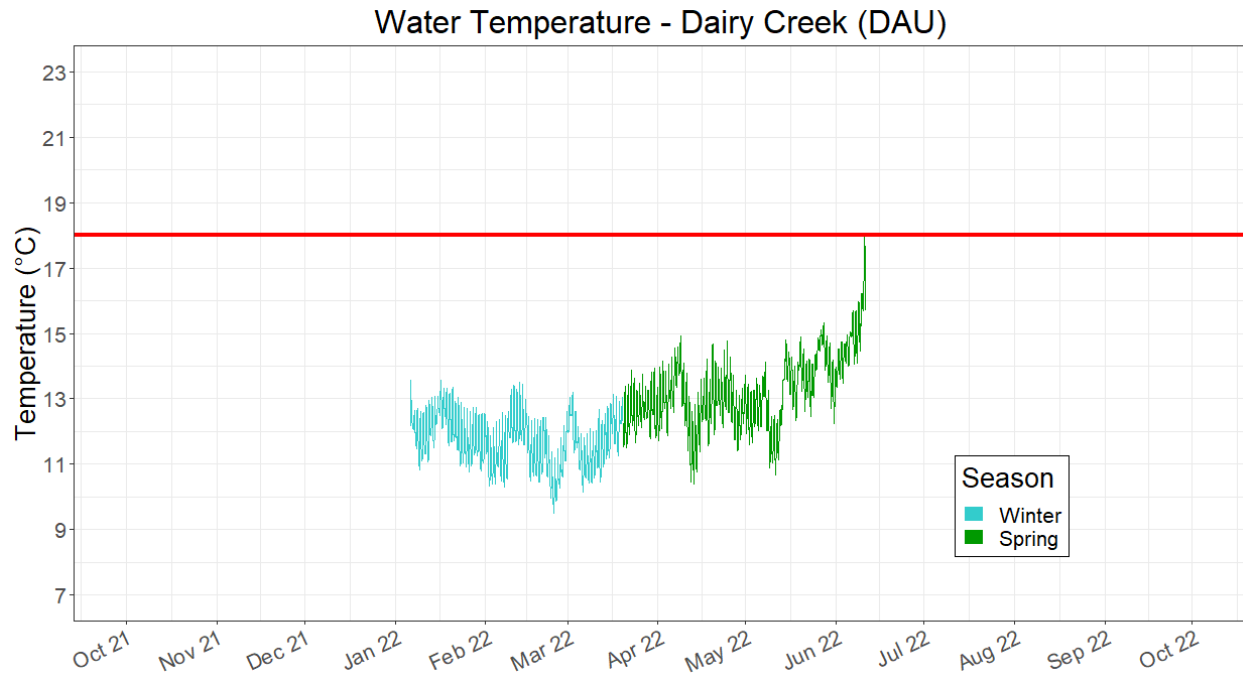


Figure 7: Water temperatures at Dairy Creek (DAU) during WY2022, colored by season. Data is not available before January 6, 2022 or after June 10, 2022 due to lack of surface flows.

2.4 Discussion

Water temperatures during WY2022 were analyzed using a variety of metrics. First, percent exceedance was calculated to see how frequently sites had water temperatures higher than 18°C. Exceedance was calculated for the entire deployment period of the logger, which varied by site, and on a seasonal basis (Table 1). Because deployment periods for each logger varied, percent exceedance for each site cannot be directly compared between sites. Deployment periods for each temperature logger are outlined in Appendix A.

Table 1: Percent exceedance of the 18°C threshold for sensitive species at each monitoring site for WY2022. The deployment periods vary based on site locations. See Appendix A for more details.

Percent of Readings above the 18°C Threshold						
Timeframe	Site					
	CHO	UCR	CCC	UPN	DAU	SLU
Full Deployment Period	22.5%	24.5%	1.2%	9.1%	0.0%	14.5%
Fall	0.0%	0.0%	0.0%	0.0%	-	0.0%
Winter	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Spring	15.9%	17.8%	1.4%	3.7%	0.0%	0.0%
Summer	52.8%	70.8%	3.1%	28.8%	-	51.4%
Number of days deployed in WY2022	308	365	365	365	156	365

The U.S. Environmental Protection Agency (EPA) set forth water temperature criteria in the [1986 Quality Criteria for Water](#) (also known as the “Gold Book”), where it recommends the use of a maximum weekly

average temperature (MWAT) as an index for assigning protective temperature standards for fisheries. The MWAT is the highest single temperature value of the seven-day moving average. This index is calculated relative to an upper limit, such as the 18°C threshold mentioned previously.

Despite being a standard outlined by the EPA, several case studies have found the MWAT to be inadequately protective ([McCullough, 2010](#)). Because high daily maximum temperatures are often accompanied by low daily minimums, averages may remain relatively constant even if the daily maxima are much higher than ideal ([Beschta et al. 1987](#)). For a more protective metric, the maximum weekly maximum temperature (MWMT), also known as the seven-day average of the daily maximum temperatures (7-DADM), has been adopted more recently in some watersheds for assessing temperature regimes. The MWMT is defined as the maximum seasonal or yearly value of the daily maximum temperatures over a running seven-day consecutive period ([Welsh et al., 2001](#)).

In addition to percent exceedance of the 18°C threshold, both MWAT and MWMT were calculated on a monthly basis to further assess thermal suitability for sensitive species. These values were compared to thermal thresholds for salmon and trout life stages, as designated by the [EPA](#) (Table 2).

Table 2: Maximum weekly average temperatures (MWAT) and maximum weekly maximum temperatures (MWMT) for monitoring sites during WY2022. Salmon and trout life stage thresholds adapted from [EPA, 2003](#).

Maximum Weekly Average Temperature (MWAT) - WY 2022												
Site	Oct '21	Nov '21	Dec '21	Jan '22	Feb '22	Mar '22	Apr '22	May '22	Jun '22	Jul '22	Aug '22	Sep '22
CHO	15.0	14.8	13.0	-	15.2	15.4	16.2	17.2	18.9	19.0	19.3	19.5
UCR	16.3	15.9	13.5	14.0	13.9	15.7	16.6	17.4	18.5	18.8	19.5	19.8
CCC	14.8	14.6	11.7	12.9	12.4	14.6	15.8	16.1	17.3	17.4	17.3	17.3
UPN	14.9	14.7	12.1	12.5	12.4	13.0	14.2	15.1	17.6	17.2	18.2	20.2
DAU	-	-	-	12.5	12.2	12.7	13.4	14.2	15.2	-	-	-
SLU	15.4	14.5	11.1	12.0	11.6	13.0	14.2	14.5	16.1	18.5	20.7	21.4

Maximum Weekly Maximum Temperature (MWMT) - WY 2022												
Site	Oct '21	Nov '21	Dec '21	Jan '22	Feb '22	Mar '22	Apr '22	May '22	Jun '22	Jul '22	Aug '22	Sep '22
CHO	15.7	15.4	13.6	-	16.3	16.9	17.8	19.1	21.2	21.1	21.3	20.6
UCR	17.2	16.6	14.1	15.0	15.4	17.4	18.6	19.1	20.2	20.0	20.5	20.6
CCC	15.0	14.8	12.1	13.5	13.2	15.4	17.0	16.8	18.4	18.2	17.7	17.7
UPN	16.3	15.8	13.0	13.3	13.9	14.9	16.3	17.1	19.5	19.0	19.7	21.6
DAU	-	-	-	13.3	13.2	13.6	14.3	14.8	15.9	-	-	-
SLU	16.1	15.3	11.7	12.7	12.8	14.7	16.3	16.0	17.2	19.1	23.2	21.9

	> 20°C, Exceeds EPA Threshold for Salmon/Trout Migration
	> 18°C, Exceeds EPA Threshold for Salmon/Trout Migration plus Non-Core Juvenile Rearing
	> 16°C, Exceeds EPA Threshold for Salmon/Trout "Core" Juvenile Rearing
	> 14°C, Exceeds EPA Threshold for Steelhead Smoltification
	> 13°C, Exceeds EPA Threshold of Salmon/Trout Spawning and Egg Incubation
	< 13°C, EPA Optimal Range for Salmon/Trout Egg Incubation
-	= insufficient data

Table 2 illustrates how MWMT is a more protective metric than the MWAT. All temperature monitoring sites show elevated summer temperatures that exceeded a MWMT of 18°C, including the tributaries to Chorro Creek. The MWAT table similarly shows elevated temperatures during this time, however Chorro Creek at CCC never exceeded the 18°C threshold using this metric. This site is located the furthest

downstream of the Chorro mainstem sites and is directly below the confluence of San Bernardo Creek and Chorro Creek. During the winter months, the MWAT table shows tributary temperatures that could support all salmonid life stages from December to February, while the MWMT table shows little sustained viability for salmonid egg incubation during the most crucial time of year.

The highest MWAT and MWMT values from WY2022 occurred on Chorro Creek at CHO (upstream of the CMC WWTP at the Highway 1 overcrossing), followed by Chorro Creek at UCR, which is located approximately two miles downstream of CHO. Both sites have had frequent and sustained issues with elevated temperature. CHO is the furthest upstream of the three mainstem sites. This site is more exposed to sunlight when compared to downstream sites and does not receive cooler incoming water from tributaries. Water temperatures at UCR could be also affected from incoming treated effluent from the CMC WWTP. Warmer temperatures are less frequent downstream at CCC, likely due to increased canopy cover and cooler water coming in from tributaries.

3. Bimonthly Nutrient Monitoring

The Estuary Program wanted to assess ambient nutrient levels throughout the Morro Bay watershed. This information provides long-term trend data and assists in targeting restoration and conservation efforts.

Estuary Program staff collect samples for laboratory analysis for nitrate as nitrogen ($\text{NO}_3\text{-N}$, mg/L), and for orthophosphate as phosphorus ($\text{PO}_4\text{-P}$, mg/L) at various locations throughout the watershed. Sites were initially visited on a quarterly basis, or four times each year. As of June 2019, sites are now visited on a bimonthly basis, or six times each year. As such, this effort was previously referred to as Quarterly Nutrient Monitoring (QNM) and is now referred to as Bimonthly Nutrient Monitoring (BNM).

3.1 Analytical Specifications

The Estuary Program collects samples using standard sampling techniques. The samples are stored in the dark on ice and then delivered by a courier to a certified laboratory for analysis within the specified hold time. The analysis specifications are as follows:

Nitrate as Nitrogen (mg/L):

Specification	Value
Method Number	EPA 300.0
Minimum Detection Limit (MDL)	0.024 mg/L
Project Quantitation Limit (PQL)	0.10 mg/L
Hold Time	48 hours
Sample storage conditions	4°C in the dark

Orthophosphate as Phosphorus (mg/L):

Specification	Value
Method Number	EPA 365.1
Minimum Detection Limit (MDL)	0.017 mg/L
Project Quantitation Limit (PQL)	0.050 mg/L
Hold Time	48 hours

Specification	Value
Sample storage conditions	4°C in the dark

The laboratory occasionally dilutes the sample prior to analysis if the nutrient concentrations are elevated, which impacts the minimum detection limit and project quantitation limit for the results. For each result that is less than the Project Quantitation Limit (PQL), a random number between zero and the PQL is generated in R and used for analysis. This is the same method utilized by the Central Coast Regional Water Quality Control Board (CCRWQCB) to manage non-detects in their own analysis.

3.2 Monitoring Locations

Eight sites were selected to represent Chorro and Los Osos Creeks and their respective tributaries (Figure 8). The sites include upper Chorro Creek (site code CHO), middle Chorro Creek (UCR), lower Chorro Creek (TWB), middle Dairy Creek (DAM), Pennington Creek (UPN), San Luisito Creek (SLU), Warden Creek (TUR), and upper Los Osos Creek (CLV).

Morro Bay Watershed Bimonthly Nutrient Monitoring Sites

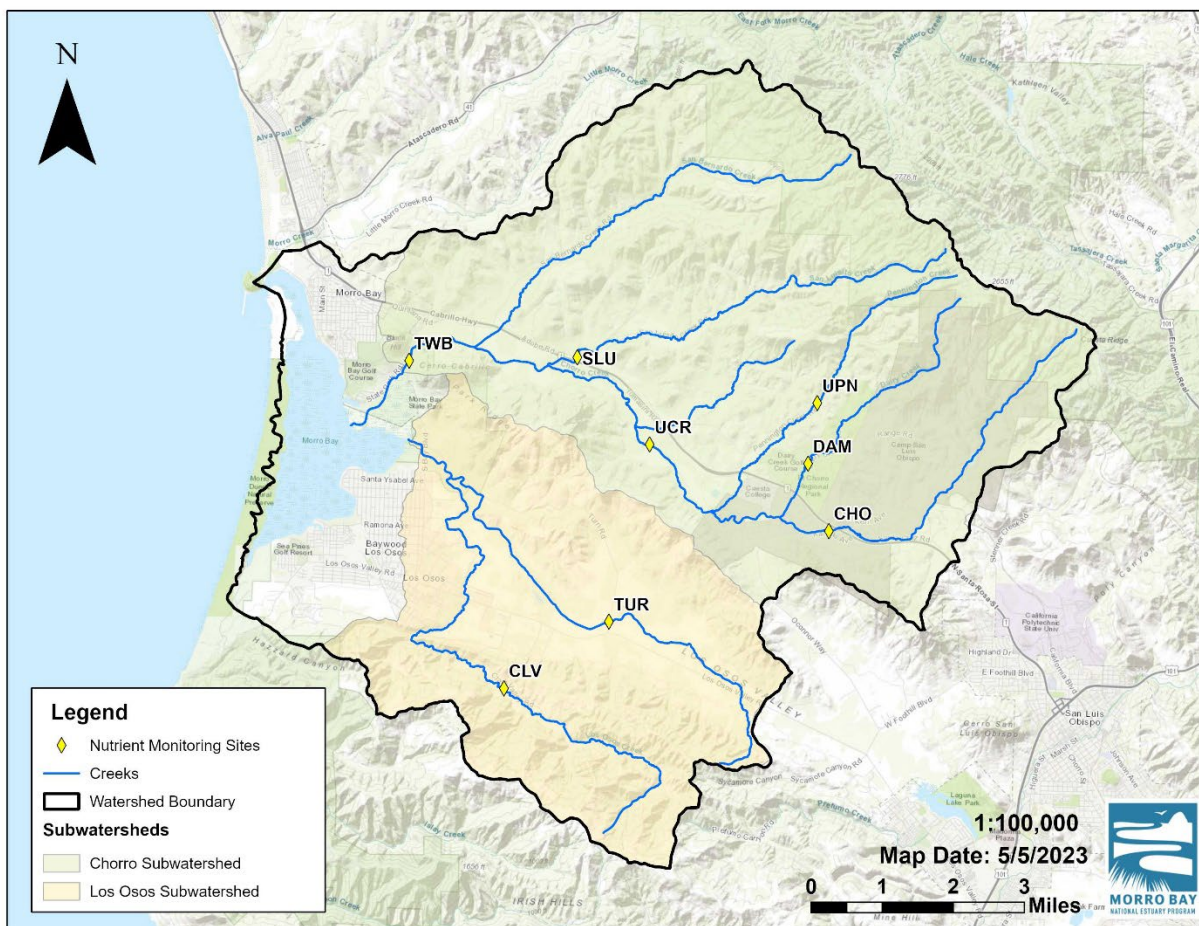


Figure 8: Bimonthly nutrient monitoring locations in the Morro Bay watershed.

3.3 Results

3.3.1 Nitrate as Nitrogen

Nitrate results are compared to two standards. In freshwater systems, the CCRWQCB considers a water body to be impaired by nitrates if $\text{NO}_3\text{-N}$ concentrations are greater than or equal to 1 mg/L as N and if the site shows other signs of impact such as widespread algal growth and excessively low or high dissolved oxygen concentrations. The EPA has a maximum contaminant level (MCL) of 10 mg/L $\text{NO}_3\text{-N}$ for drinking water for protection of human health.

The Estuary Program assessment utilized the following scores:

Good	- for $\text{NO}_3\text{-N}$ concentrations < 1 mg/L (protective of aquatic and human health)
Fair	- for $\text{NO}_3\text{-N}$ concentrations \geq 1 mg/L and < 10 mg/L
Poor	- for $\text{NO}_3\text{-N}$ concentrations \geq 10 mg/L (exceeds level protective of human health)

Figure 9 indicates the average $\text{NO}_3\text{-N}$ concentration for sites monitored in WY2022. The number of samples varies by site, as some sites go dry during the summer. For sites with year-round flow, this represents six readings.

Average Nitrate as Nitrogen (mg/L) Concentrations for WY2022

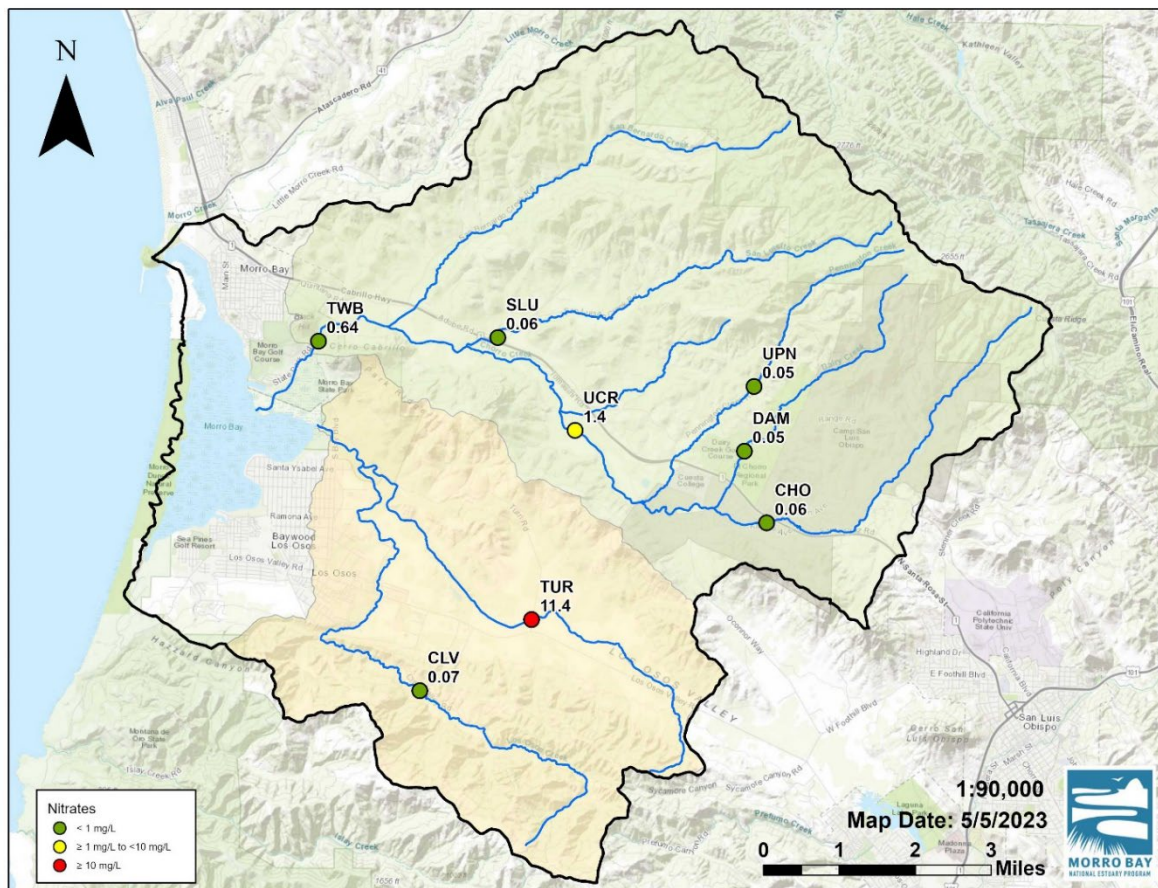


Figure 9: Average $\text{NO}_3\text{-N}$ concentrations for WY2022 at eight representative monitoring locations.

Historical $\text{NO}_3\text{-N}$ averages were compared to results from WY2022 (Table 3). Historic data includes nutrient monitoring data from WY2016 through WY2022. Values highlighted in green indicate concentrations which are protective of aquatic and human health (<1 mg/L $\text{NO}_3\text{-N}$). Values highlighted in yellow indicate values that fall under the EPA MCL but are greater than CCRWQCB's level of protection of aquatic life (≥ 1 mg/L and < 10 mg/L $\text{NO}_3\text{-N}$). Values highlighted in red exceed the drinking water level protective of human health (≥ 10 mg/L $\text{NO}_3\text{-N}$). The relative percent difference (RPD) was then calculated to compare WY2022 data to historical data. Sites with higher RPDs indicate greater differences between WY2022 and historical data.

Table 3: Historical NO₃-N averages compared to WY2022 averages.

Site Code	CHO	CLV	DAM	SLU	TUR	TWB	UCR	UPN
Historical Average, NO ₃ -N mg/L	0.13	0.08	0.06	0.09	12.74	0.69	2.22	0.07
WY2022 Average, NO ₃ -N mg/L	0.06	0.07	0.05	0.06	11.40	0.64	1.40	0.05
Relative Percent Difference (%)	0.68	13.3%	18.9%	48.7%	11.1%	7.7%	45.6%	39.5%

3.3.2 Orthophosphate as Phosphorus

Orthophosphate as phosphorus (PO₄-P) results are compared to targets outlined in the Pajaro River nutrient objectives guidance document (Williamson, 1994). A value of 0.12 mg/L is used for comparison since freshwater systems with concentrations less than 0.12 mg/L are at low risk for eutrophication. To date, there is no standard protective of human health for orthophosphates.

The Estuary Program assessment utilized the following scores:

Good	- for PO ₄ -P concentrations < 0.12 mg/L
Fair	- for PO ₄ -P concentrations ≥ 0.12 mg/L

Figure 10 indicates the average PO₄-P concentrations for sites monitored in WY2022. The number of samples varies by site, as some sites go dry during the summer. For sites with year-round flow, this represents six readings.

Average Orthophosphate as Phosphorus (mg/L) Concentrations for WY2022

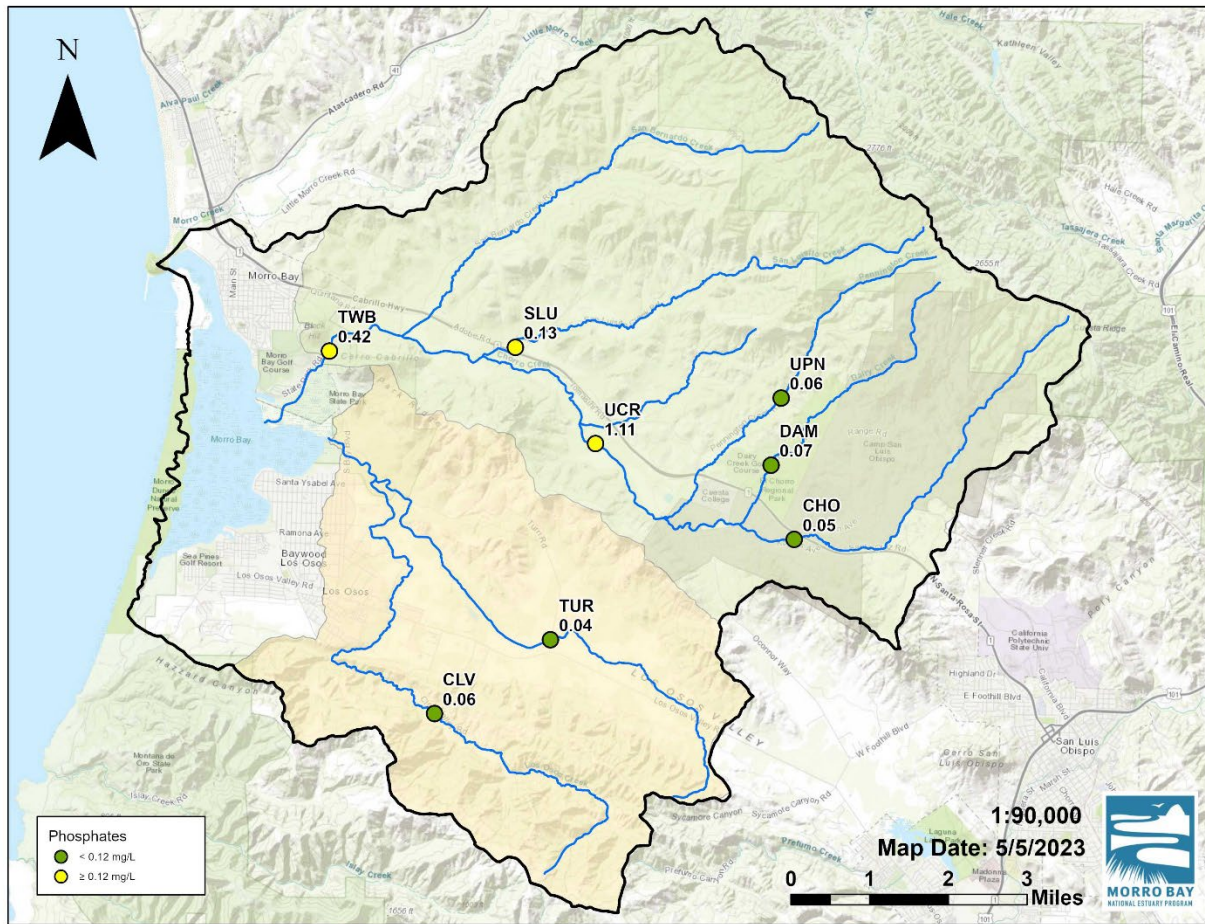


Figure 10: Average PO_4 -P concentrations for WY2022 at eight representative monitoring locations

Historical PO_4 -P averages were compared to results from WY2022 (Table 4). Historical data includes nutrient monitoring data from WY2016 through WY2022. Values highlighted in green indicate those that are at a low risk for eutrophication (< 0.12 mg/L PO_4 -P). Values highlighted yellow are at a higher risk for eutrophication (≥ 0.12 mg/L PO_4 -P). The relative percent difference (RPD) was then calculated to compare WY2022 data to historical data. Sites with higher RPDs indicate greater differences between WY2022 and historical data.

Table 4: Historical PO_4 -P averages compared to WY2022 averages.

Site Code	CHO	CLV	DAM	SLU	TUR	TWB	UCR	UPN
Historical Average, PO_4 -P mg/L	0.03	0.04	0.08	0.10	0.04	0.43	0.94	0.04
WY2022 Average, PO_4 -P mg/L	0.05	0.06	0.07	0.13	0.04	0.42	1.11	0.06
Relative Percent Difference (%)	56.7%	48.4%	14.7%	21.1%	15.3%	3.9%	16.9%	35.4%

3.4 Discussion

The highest NO₃-N values in the Morro Bay watershed have consistently been detected on Warden Creek (TUR), which is heavily impacted by surrounding agricultural cropland. Elevated NO₃-N values from Warden Creek have consistently exceeded the level of protection for aquatic health and for human health. Data collected from Chorro Creek immediately downstream of the CMC WWTP outfall (UCR) has also indicated elevated NO₃-N concentrations relative to upstream and downstream levels. These levels have historically exceeded the level of protection for aquatic health but not the level of protection for human health.

PO₄-P concentrations are typically higher in the Chorro Creek subwatershed than in the Los Osos Creek subwatershed. The sites located along the mainstem of Chorro Creek tend to track with higher PO₄-P concentrations than the surrounding tributaries. Chorro Creek at UCR represents the higher end of PO₄-P concentrations in the watershed, followed by lower Chorro Creek at TWB.

Elevated nutrient levels often track with large dissolved oxygen (DO) fluctuations and excess algae. Since continuous DO data is not available year-round for WY2022, temperature can be used as a proxy to estimate when DO levels were likely low. For example, UCR had the second highest number of elevated temperatures during the summer season. Thus, it is likely that less-than-ideal DO conditions occurred during the summer at this site, and nutrient enrichment may have further contributed to the impairment.

The presence of algae is also an indicator of nutrient impairment. Although the Estuary Program collects observational algal data when conducting bimonthly nutrient monitoring, data collected to date is too limited to report. The Estuary Program hopes to share a more robust dataset in the future.

4. Continuous Water Quality Monitoring

The Estuary Program deploys [YSI EXO3 multiparameter sondes](#) to collect continuous water quality data throughout the watershed. The sondes are deployed for approximately one-week at a time, year-round, and data is collected at 15-minute intervals. The Estuary Program began using the sondes for discrete deployments in WY2022 prior to developing a regular deployment schedule. The data presented details of these short-term deployments and is not meant to serve as a continuous time series.

4.1 Equipment Specifications

Specifications for the YSI EXO3 multiparameter sondes are as follows:

Specification	Value
Measurement/Operating Range	Dissolved Oxygen: 0 to 50 mg/L Specific Conductance: 0 to 100,000 µS/cm Temperature: -5 to 50°C pH: 0 to 14 units
Accuracy	Dissolved Oxygen: 0-20 mg/L: ±0.1 mg/L or 20-50 mg/L: ± 5% of reading Specific Conductance: ± 2 µS/cm Temperature: ± 0.2°C

Specification	Value
	pH: ± 0.2 pH units
Resolution	Dissolved Oxygen: 0.01 mg/L Specific Conductance: 0.1 $\mu\text{S}/\text{cm}$ Temperature: 0.001°C pH: 0.01 units

4.2 Monitoring Locations

The Estuary Program deployed EXO3 sondes intermittently at several sites during WY2022. The most comprehensive dataset comes from a site on lower Chorro Creek located near Chorro Creek Road (site code CCC). This site is located approximately two miles upstream of the mouth of Chorro Creek (Figure 11).

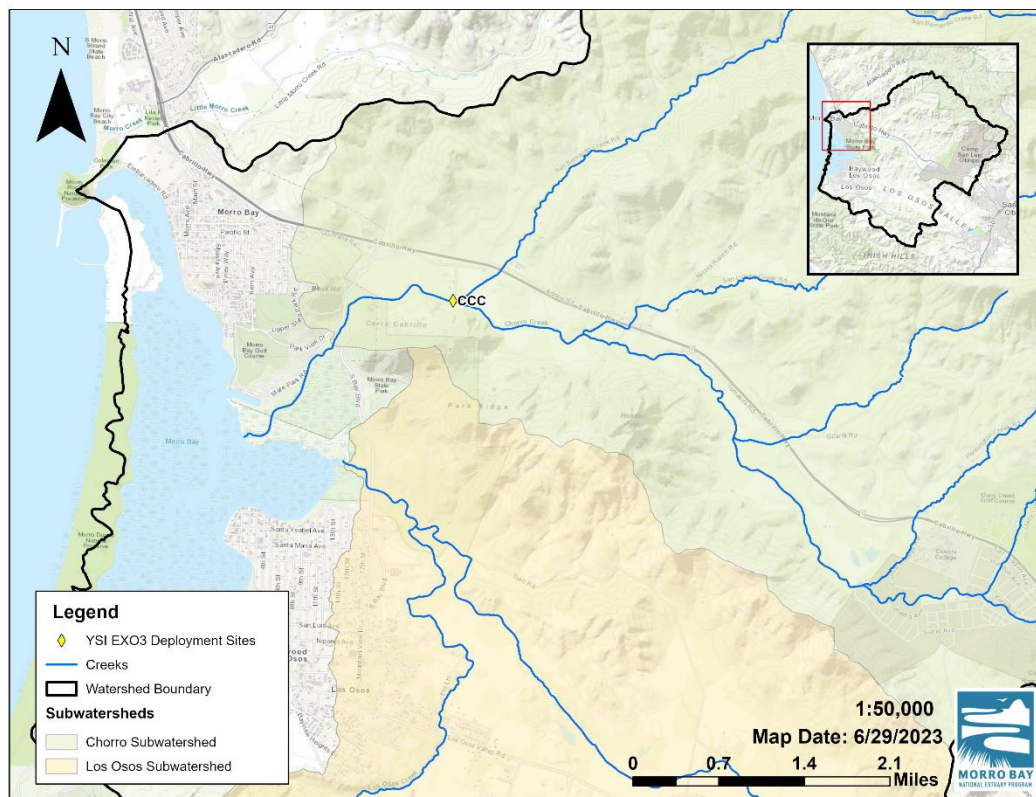


Figure 11: YSI EXO3 multiparameter sonde deployment location on Chorro Creek (CCC) during WY2022.

4.3 Results

The EXO3 sonde was deployed at CCC during four discrete time periods in WY2022. One deployment took place in the winter (mid-January), and the other three were in the summer (early July, late July, and

late August). The following data detail the dissolved oxygen, pH, and conductivity (measured as specific conductance) during these four time periods.

4.3.1 Dissolved Oxygen

The following graphs detail continuous DO concentrations during four discrete deployments in WY22. Each deployment lasted seven days, and measurements were collected every 15 minutes. The red line on each graph indicates a regulatory standard set by the State Water Board (Central Coast RWQCB, 2019). This standard designates that DO concentrations should remain above 7 mg/L to be protective of aquatic life.

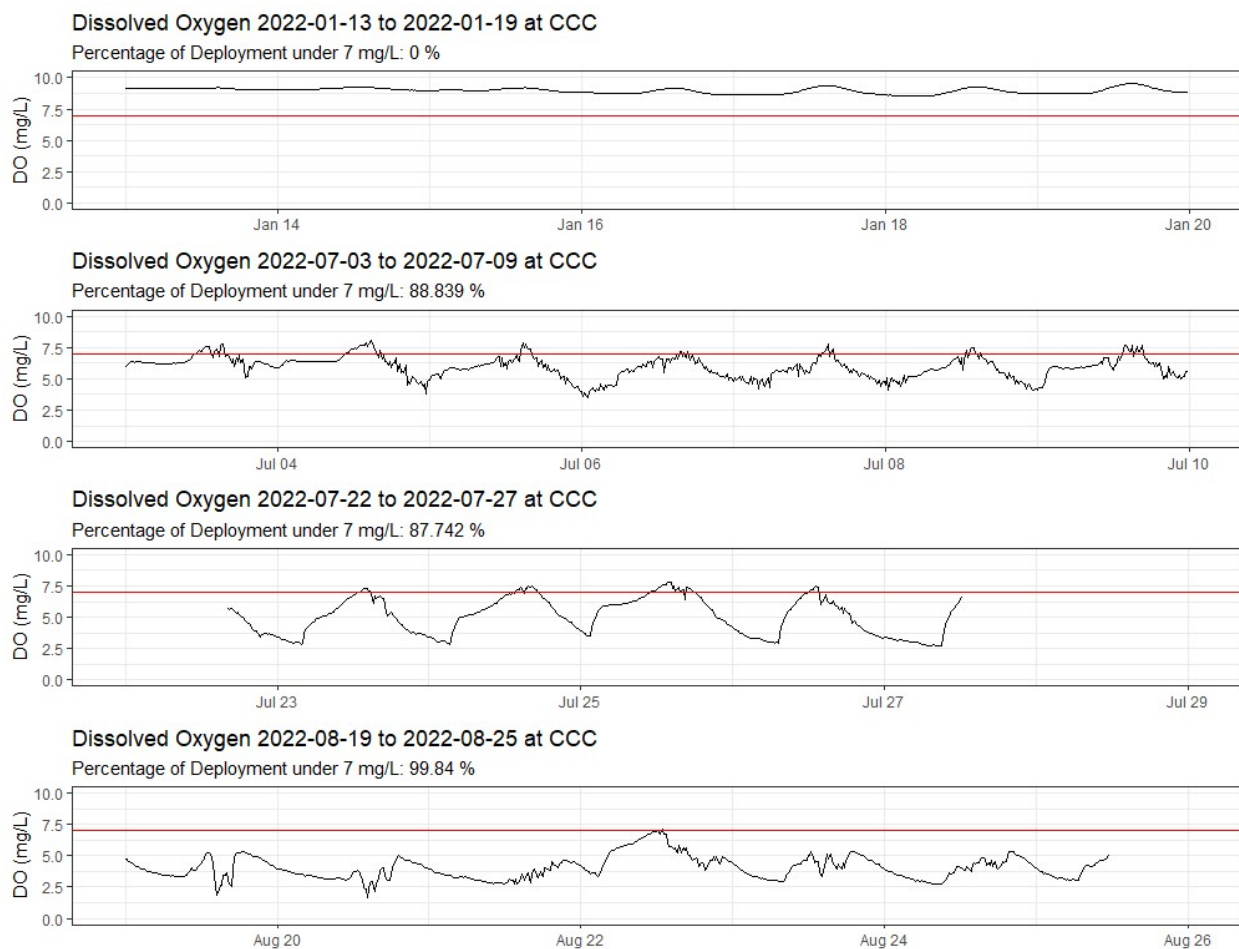


Figure 12: Time series plots of dissolved oxygen concentration (mg/L) from each deployment at Chorro Creek at Chorro Creek Road (CCC) during WY2022. The horizontal red line represents the 7 mg/L regulatory threshold. The percentage of time during the deployment that DO concentrations were below this threshold are displayed in the subtitles of each plot. Typical deployments consisted of seven-day periods, however the late July deployment was cut short at five days.

4.3.2 Temperature, pH, and Conductivity

The Estuary Program deploys multiparameter sondes that collect dissolved oxygen, as well as temperature, pH, and conductivity. The following data detail the average continuous temperature (°C), pH, and specific conductance (µS/cm) at CCC during four discrete deployment periods.

Table 5: Average values of temperature (°C), pH, and specific conductance (µS/cm) from each deployment in WY2022.

Site Code	Timeframe	Average Temperature (°C)	Average pH	Average Sp. Conductivity (µS/cm)
CCC	Mid-January	12.9	8.23	925
CCC	Early July	17.2	8.21	986
CCC	Late July	16.8	7.91	984
CCC	Late August	17.1	7.84	1002

The [Central Coast Basin Plan](#) sets the acceptable range for pH between 7 and 8.5 in cold freshwater habitat and fish spawning habitat. For each of the four deployments, pH was within this range for the entirety of the deployment.

Specific conductivity fell within the typical range observed in the Morro Bay watershed during the WY2022 deployments. While the Basin Plan does not set conductivity standards, the EPA has set a maximum threshold for potable water at 1,055 µS/cm and irrigation water at 3,000 µS/cm. The average specific conductivity values for all deployments remained below these thresholds.

4.4 Discussion

Dissolved oxygen (DO) concentrations in freshwater systems have immediate implications for the health of aquatic organisms. DO concentrations fluctuate throughout the day, making instantaneous measurements less effective at fully capturing oxygen dynamics in the creeks. Continuous deployments allow for a more complete characterization of oxygen availability.

During the winter, cold water and high flow rates help create a sufficiently oxygenated environment. However, higher temperatures and reduced flows in summer can cause oxygen concentrations to drop below the regulatory standard of 7 mg/L. The preliminary results from the WY2022 deployments indicate that DO in Chorro Creek is lowest and most variable in the summer, when the creeks are warmer, near stagnant, and algae strong influence the diurnal cycle of DO concentration.

Table 6: Average and Standard Deviation (SD) of dissolved oxygen (DO) concentration (mg/L) from each deployment in WY2022. DO concentrations below the 7 mg/L regulatory threshold are highlighted orange, and those above are highlighted green.

Site Code	Timeframe	Average DO Concentration (mg/L)	Standard Deviation of DO Concentration
CCC	Mid-January	9.0	0.2
CCC	Early July	5.9	1.0
CCC	Late July	5.1	1.5
CCC	Late August	4.1	1.0

4.5 Future Efforts

Funding has been secured to purchase four additional EXO3 sondes in the coming year. The increased number of sondes will allow for paired deployments within the Chorro and Los Osos subwatersheds. The Estuary Program will also add chlorophyll pigment sensors to further investigate the effects of biologic activity on water quality. The resulting dataset will enhance our understanding of water quality conditions across the watershed.

5. Data Availability

Bimonthly nutrient monitoring data is publicly available from the California Environmental Data Exchange Network (CEDEN), a State Water Resources Control Board managed data portal. For all continuous monitoring data, please contact the Estuary Program.

To retrieve Nutrient data, visit www.CEDEN.org

- Click on “Find Data”
- Choose the “CEDEN Query Tool”
- Under “Select Program,” choose the Morro Bay National Estuary Program, then choose “Done”
- Under “Select Stations,” choose Dairy Creek within cattle enclosure (site code DAM), Pennington Creek upstream from horse corral (UPN), Chorro Creek at Camp SLO (CHO), Chorro Creek at upper Chorro Creek Ecological Reserve (UCR), Chorro Creek at South Bay Boulevard (TWB), San Luisito Creek @ Adobe Rd (SLU), Warden Creek at Turri Road (TUR), and Los Osos Creek Clark Valley Road (CLV)
- Click on “Retrieve Data”

For any additional details, please contact the Estuary Program at 805-772-3834 or staff@mbnep.org.

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This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement CE-98T25101 to the Bay Foundation of Morro Bay. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does the EPA endorse trade names or recommend the use of commercial products mentioned in this document.

Appendix A. WY2022 Tidbit Deployment Timelines

Site	Deployment
CHO	10/1/2021 - 12/13/2021 and 2/9/2022 - 9/30/2022
UCR	10/1/2021 - 9/30/2022
CCC	10/1/2021 - 9/30/2022
DAU	1/6/2022 - 6/10/2022 (site went dry after 6/10/2022)
UPN	10/1/2021 - 9/30/2022
SLU	10/1/2021 - 9/30/2022

Appendix B. WY2022 Dates for each Seasonal Period

Time Period	Start	End
Water Year 2022	10/1/2021	9/30/2022
Fall Season	10/1/2021	12/20/2021
Winter Season	12/21/2021	3/19/2022
Spring Season	3/20/2022	6/19/2022
Summer Season	6/20/2022	9/30/2022

Appendix C. WY2022 EXO3 Deployment Timelines

Site	Deployment
CCC	1/12/2022 - 1/20/2022
	7/1/2022 - 7/11/2022
	7/22/2022 - 7/27/2022
	8/18/2022 - 8/25/2022
CPN	3/17/2022 - 3/24/2022
DAU	4/1/2022 - 4/11/2022