Morro Bay Watershed Creek Health
For Water Year 2017

Date Range: October 1, 2016 to September 30, 2017
Analytes: Dissolved oxygen, water temperature, nitrates as N, orthophosphates as P

Background

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

Monitoring data is collected by Estuary Program staff and volunteers, under the guidance of a Quality Assurance Project Plan (QAPP) which is reviewed and approved by EPA and the Central Coast Regional Water Quality Control Board (CCRWQCB). This document contains the monitoring locations, protocols, equipment specifications, and other details that allow users to assess the quality of the collected data. The full document is available upon request.

Creek Oxygen and Water Temperature

The Estuary Program wanted to be able to assess how often local creeks had water quality conditions that were supportive of sensitive wildlife such as steelhead.

Equipment Specification: The Estuary Program deploys the HOBO Dissolved Oxygen Data Logger, part Number U26-001. These continuous monitoring meters were deployed for a week at a time to assess diurnal cycles in dissolved oxygen concentration (in mg/L) and water temperature (in °C). The equipment specifications are as follows:

Dissolved Oxygen (DO) Concentration at Sites UCR and CCC

Specification	Value
Sensor Type	Optical
Measurement Range	0 to 30 mg/L
Calibrated Range	0 to 20 mg/L; 0 to 35°C
Accuracy	+/- 0.2 mg/L up to 8 mg/L, +/- 0.5 mg/L from 8 to 20 mg/L
Resolution	0.02 mg/L

Water Temperature (HOBO) at Site UCR

Specification	Value
Temperature Measurement/Operating Range	-5 to 40°C
Temperature Accuracy	+/- 0.2°C

Specification	Value
Temperature Resolution	0.02°C

The HOBO meters are calibrated at the start and end of each one-week deployment by placing them in a water-saturated air environment and using the manufacturer's calibration software. A second dissolved oxygen meter is used to collect DO and temperature readings at the beginning and end of the deployment that correct for normal sensor drift. The DO sensor cap is replaced every six months, and it automatically expires seven months after initialization.

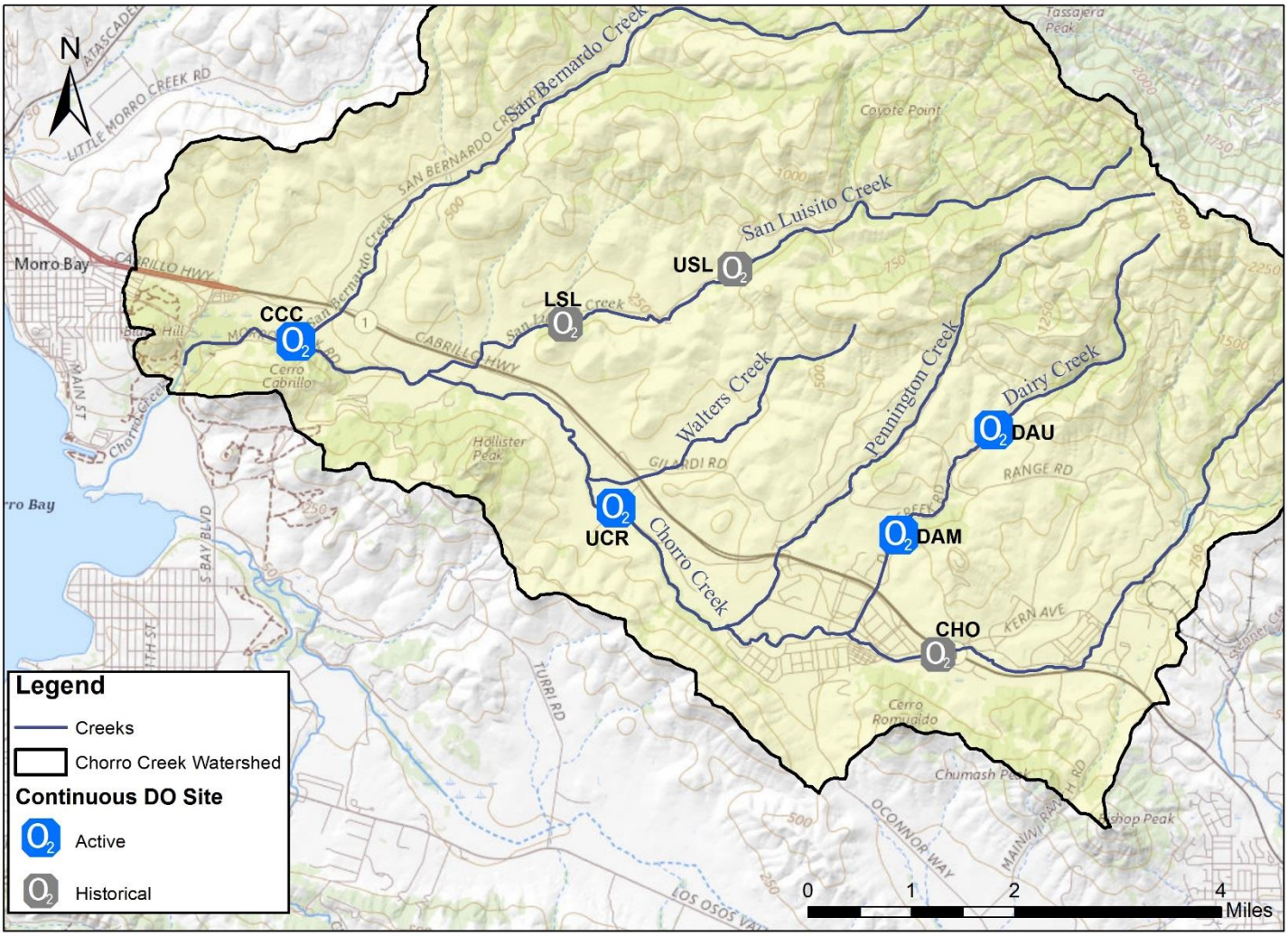
For some sites, water temperature is measured using the continuous temperature monitoring sensors in pressure transducers. The Estuary Program uses an In-Situ Level Troll 500, which continuously measures water depth and water temperature.

Water Temperature (Level Troll 500) at CCC

Specification	Value
Temperature Measurement/Operating Range	-5 to 50°C
Temperature Accuracy	+/- 0.1°C
Temperature Resolution	0.01°C

Monitoring Locations: The sensors are deployed in pairs to obtain upstream/downstream sets of data. During WY2017, they were deployed in pairs on Chorro Creek and on Dairy Creek. The Chorro Creek sites were selected because Chorro Creek is known to support sensitive steelhead. The Dairy Creek sites were selected because of extensive restoration work (i.e., off creek water, riparian fencing, and native plantings). Although DAM and DAU were monitored in this water year, their record is less complete due to low flows and so were excluded from this report. For Dairy Creek data, please contact the Estuary Program.

Chorro Creek Continuous Dissolved Oxygen Monitoring - Present and Historic

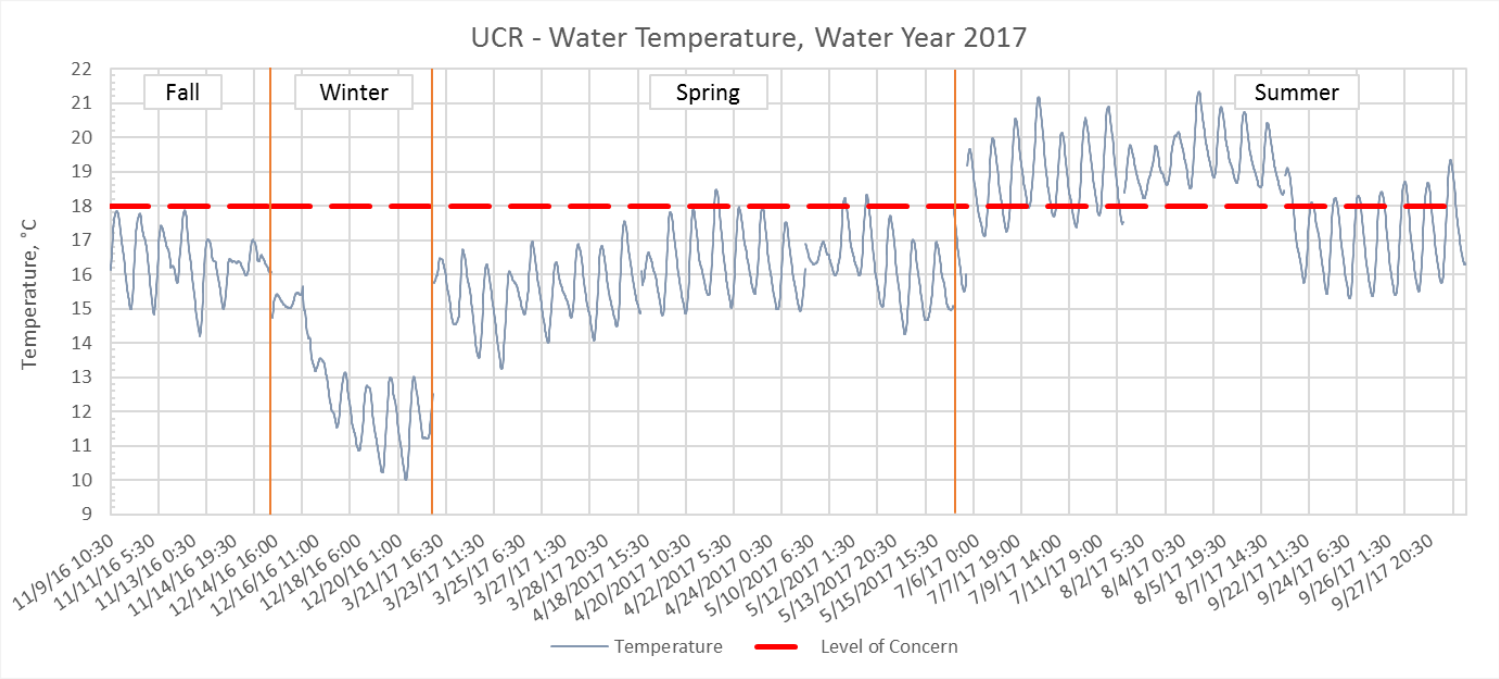


Results:

Temperature

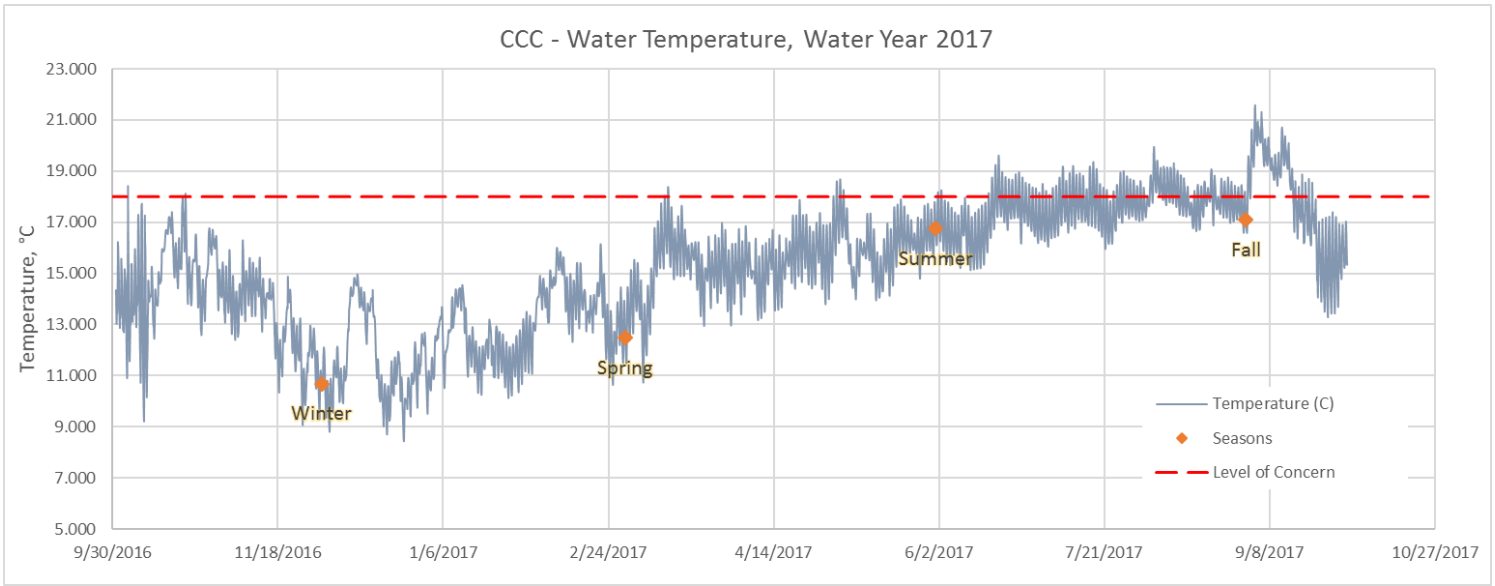
Continuous temperature data is of value because it shows the time of day when temperatures are elevated and the duration of the high temperatures. We wanted to determine how often and for how long temperatures were greater than 18°C, a level protective of sensitive fish such as steelhead.

The following graph shows temperatures at the Chorro Creek Road (site code CCC) and at Upper Chorro Reserve (UCR) on Chorro Creek. UCR is located downstream of the California Men's Colony (CMC) Wastewater Treatment Plant (WWTP) outfall into Chorro Creek. CCC is near the bottom of Chorro Creek, just upstream of Chorro Flats. The presence of steelhead has been confirmed at both locations in recent years.



At UCR, the HOBO sensor recorded temperatures that exceeded the 18°C threshold for 24.97% of the measurements taken. Sensitive fish such as the Southern Steelhead prefer temperatures in the range of 13 to 21°C (Moyle 2002). Note that temperature data collected from dissolved oxygen sensors is not continuous throughout the year as they are deployed for one-week time periods each month.

The pressure transducer installed at CCC measures temperature year-round and recorded water temperatures exceeding 18°C for 12.31% of the measurements taken.



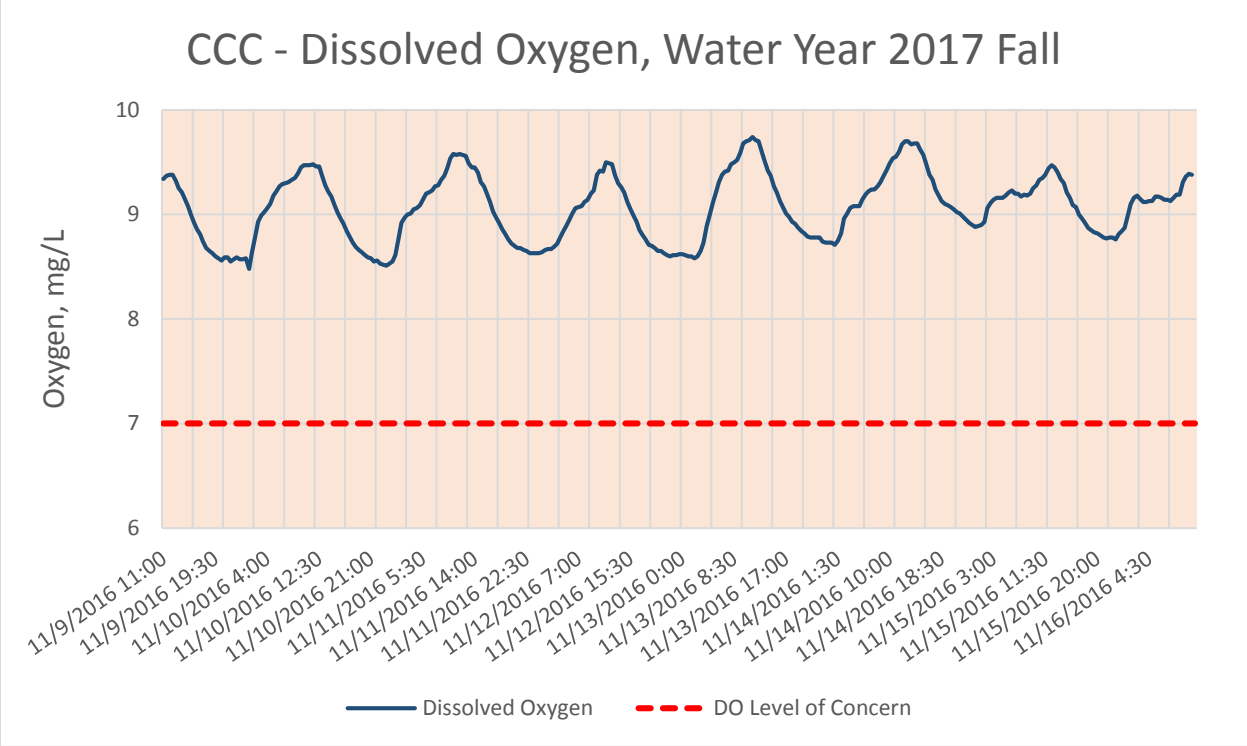
Dissolved Oxygen

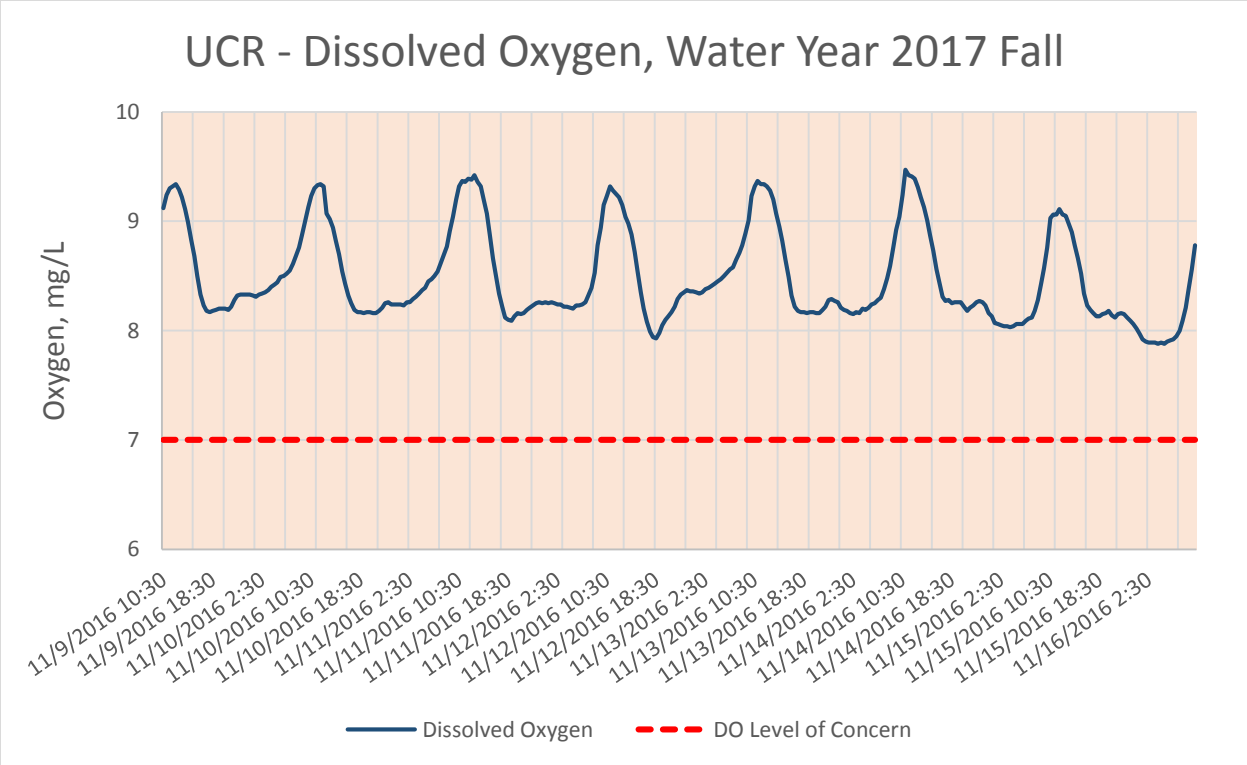
As with temperature data, continuous DO data provides information on how often and for how long DO levels are below levels protective of sensitive wildlife. The CCRWQCB Central Coast Basin Plan designated Chorro Creek and its watershed as the COLD and SPAWN beneficial uses, which means that DO levels must remain greater than 7 mg/L to be protective of cold-water fish and spawning habitat.

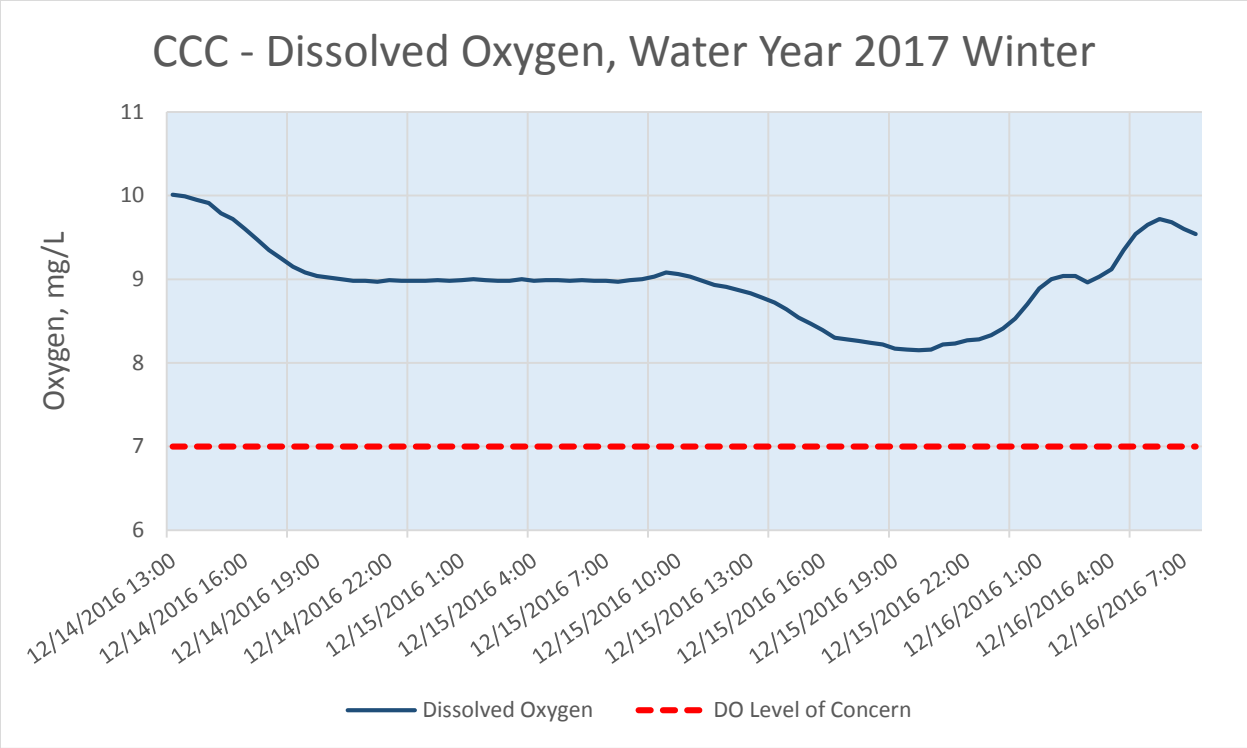
The following graphs show data with date gaps condensed on the horizontal axis. The dissolved oxygen meters are deployed approximately a week at a time, and the elapsed time between these deployments is not reflected in the horizontal scale. The length of deployments varied depending on field conditions, concerns about storms that could damage equipment, etc. There are some months where no data was collected due to high flows or equipment malfunction.

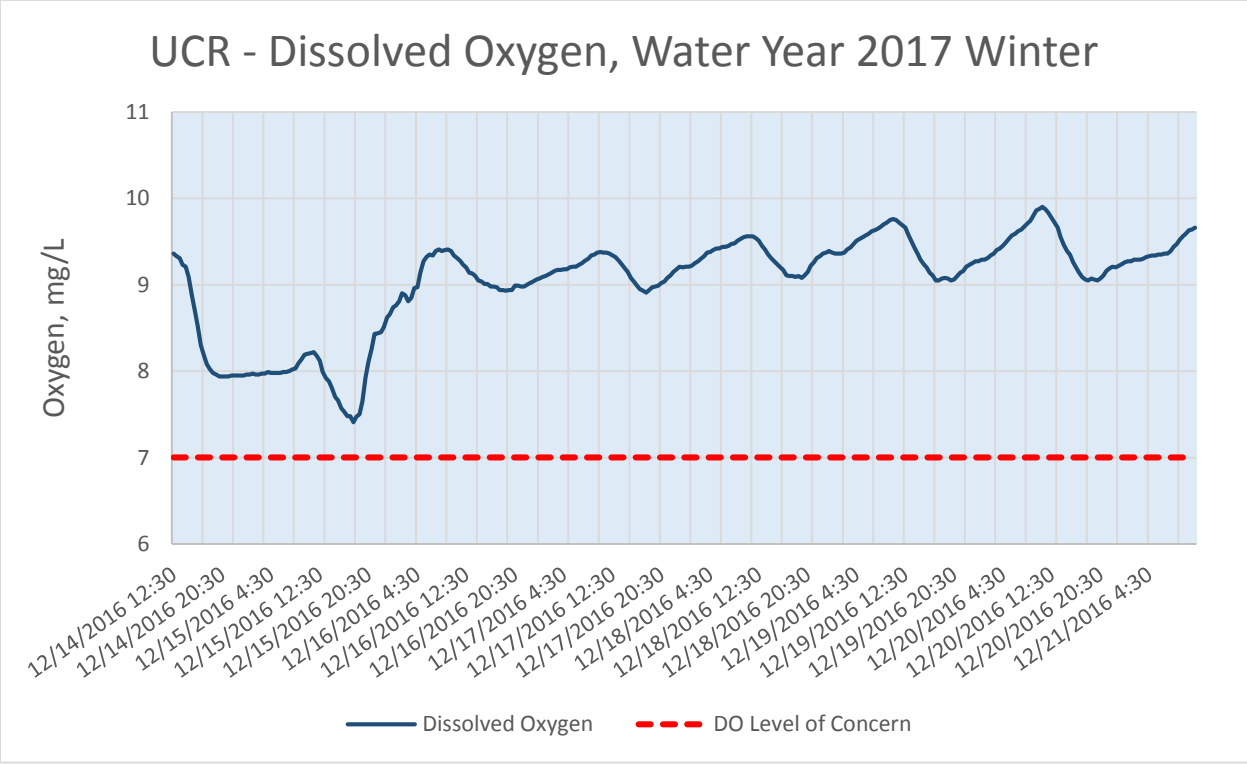
Also note that we have extended the duration of the summer data collection season to the end of September to compensate for the early fall cut-off that occurs in the water year.

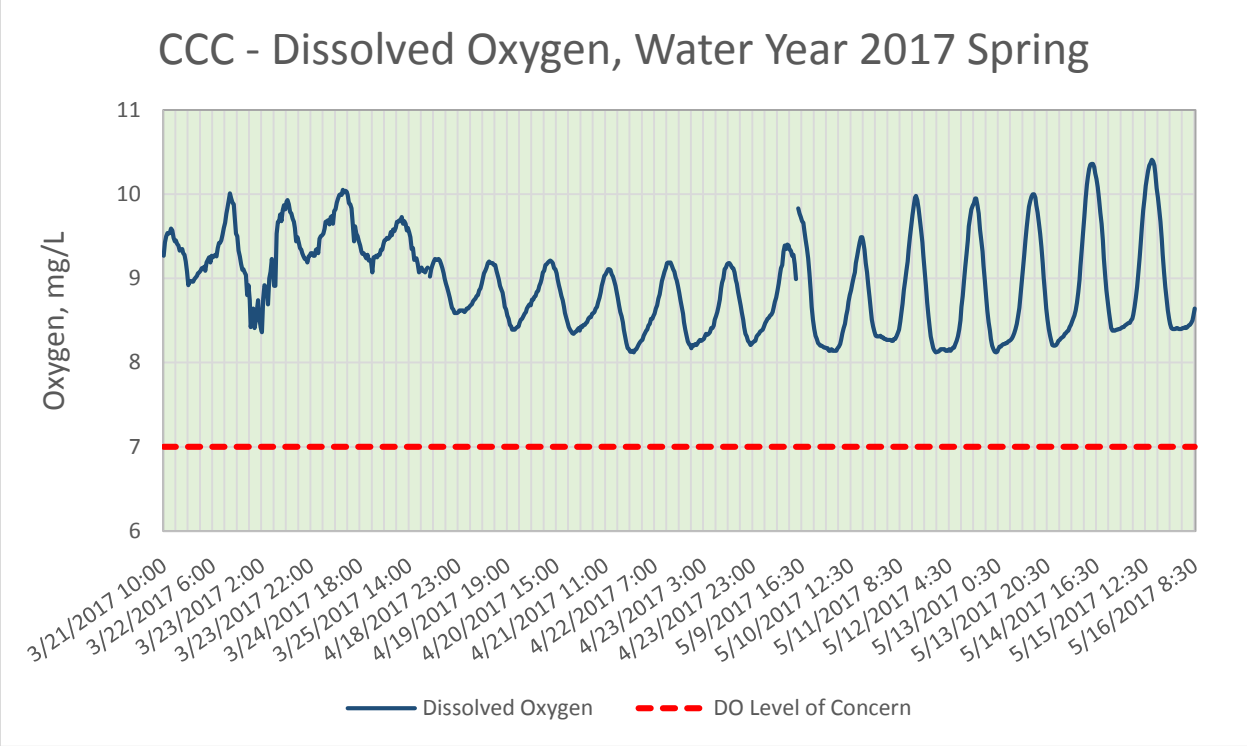
Data from the winter season at CCC was limited due to equipment issues and high flows.

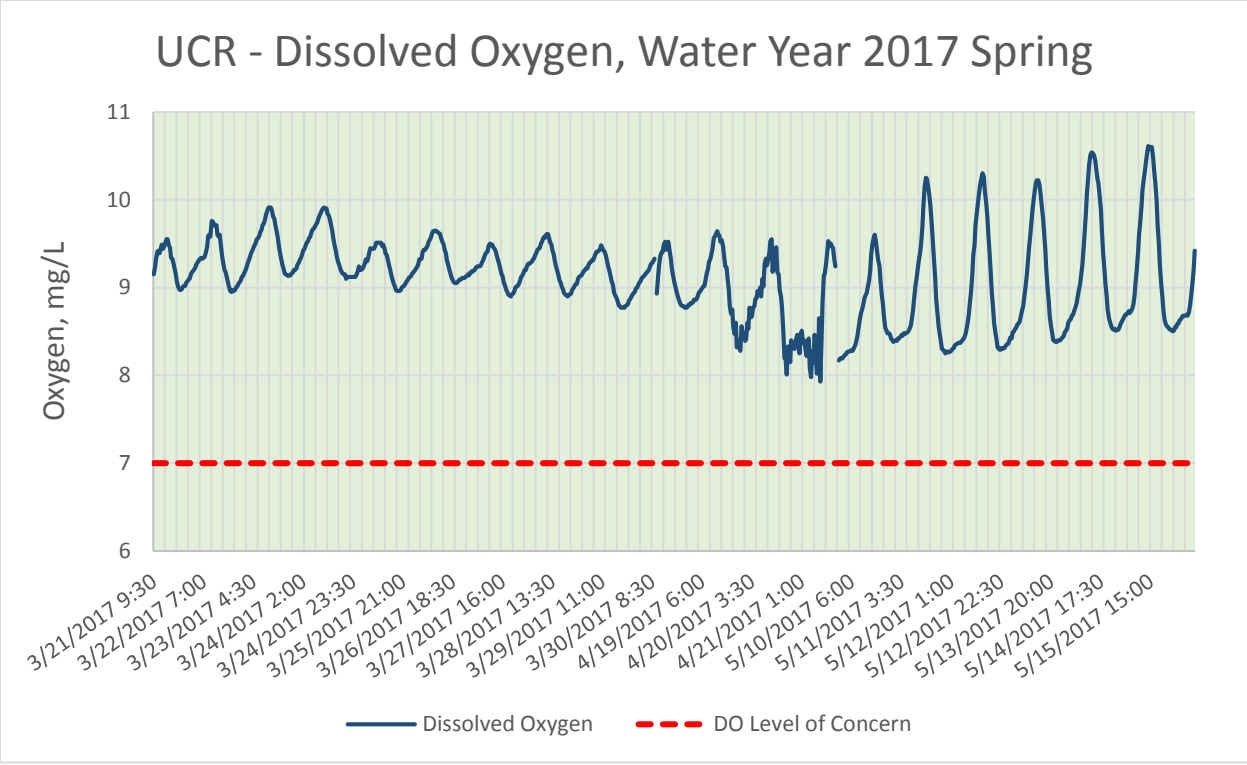

CCC - Dissolved Oxygen, Water Year 2017 Fall
Oxygen, mg/L
10
9
8
7
6
11/9/2016 11:00
11/9/2016 19:30
11/10/2016 4:00
11/10/2016 12:30
11/10/2016 21:00
11/11/2016 5:30
11/11/2016 14:00
11/11/2016 22:30
11/12/2016 7:00
11/12/2016 15:30
11/13/2016 0:00
11/13/2016 8:30
11/13/2016 17:00
11/14/2016 1:30
11/14/2016 10:00
11/14/2016 18:30
11/15/2016 3:00
11/15/2016 11:30
11/15/2016 20:00
11/16/2016 4:30
Dissolved Oxygen
DO Level of Concern

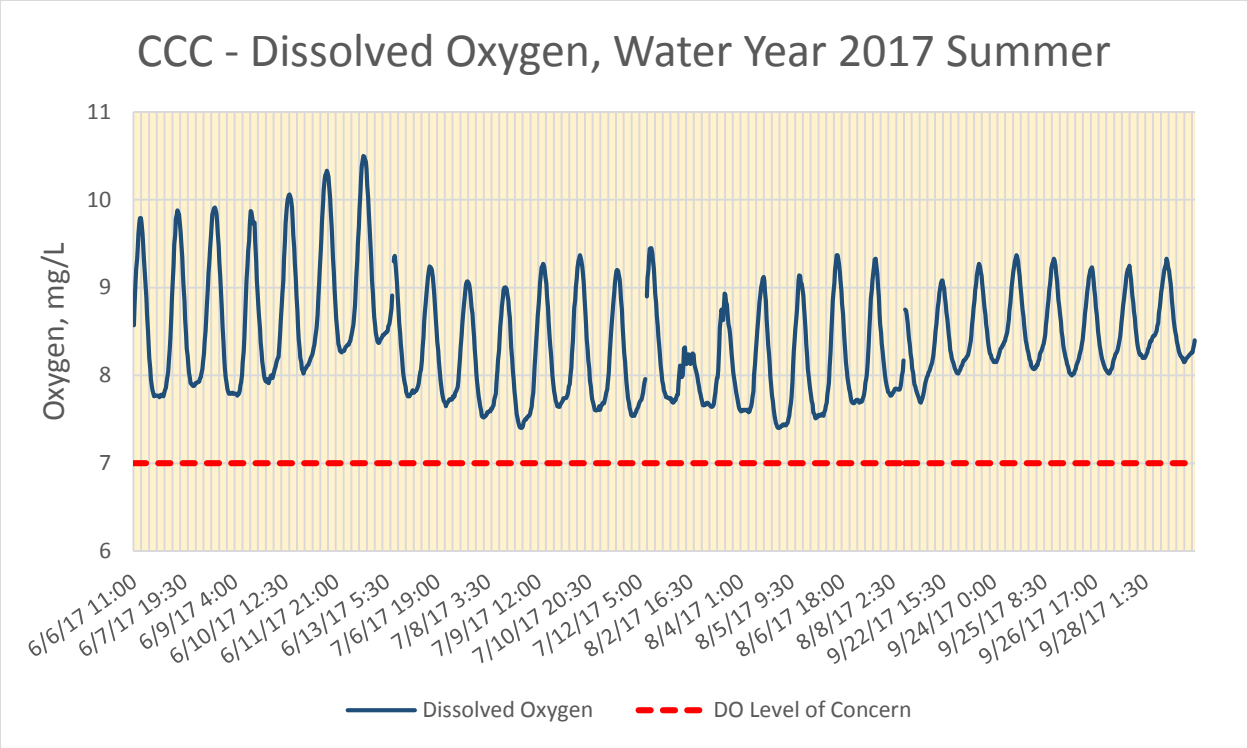

UCR - Dissolved Oxygen, Water Year 2017 Fall
Oxygen, mg/L
10
9
8
7
6
11/9/2016 10:30
11/9/2016 18:30
11/10/2016 2:30
11/10/2016 10:30
11/10/2016 18:30
11/11/2016 2:30
11/11/2016 10:30
11/11/2016 18:30
11/12/2016 2:30
11/12/2016 10:30
11/12/2016 18:30
11/13/2016 2:30
11/13/2016 10:30
11/13/2016 18:30
11/14/2016 2:30
11/14/2016 10:30
11/14/2016 18:30
11/15/2016 2:30
11/15/2016 10:30
11/15/2016 18:30
11/16/2016 2:30
Dissolved Oxygen
DO Level of Concern

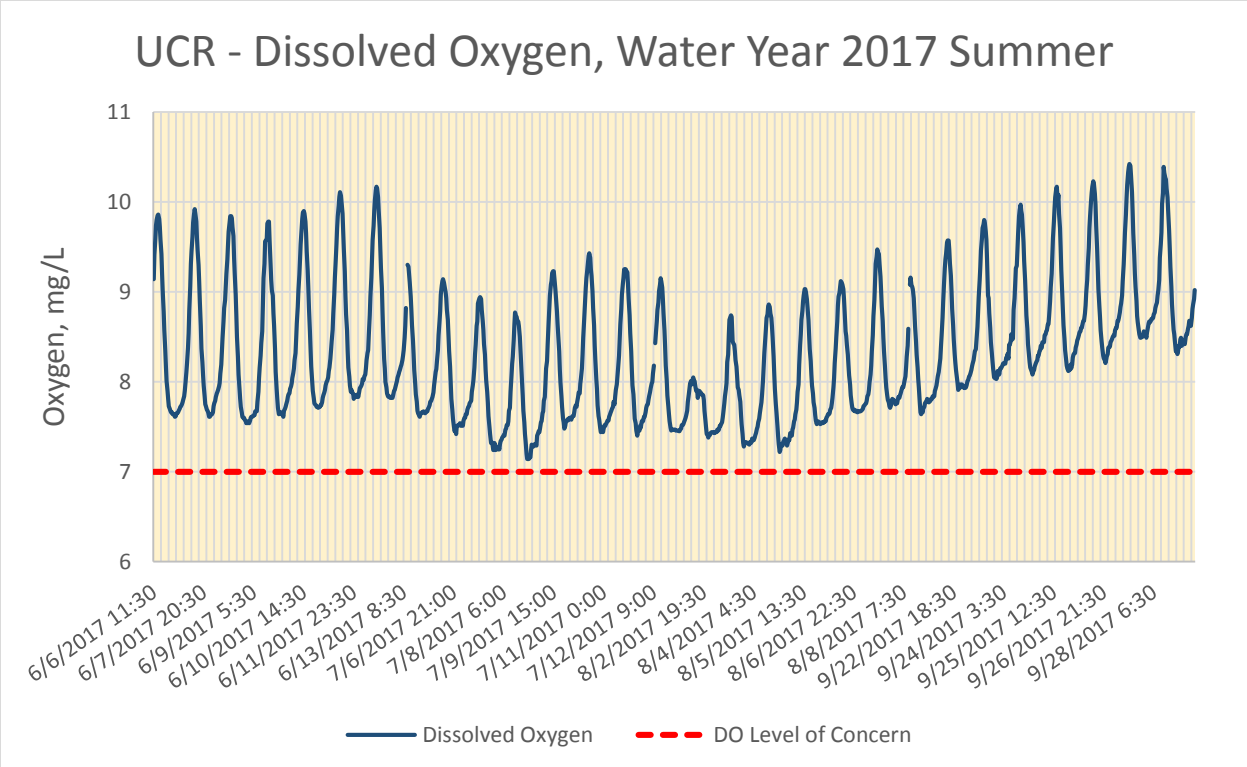

CCC - Dissolved Oxygen, Water Year 2017 Winter
Oxygen, mg/L
11
10
9
8
7
6
12/14/2016 13:00
12/14/2016 16:00
12/14/2016 19:00
12/14/2016 22:00
12/15/2016 1:00
12/15/2016 4:00
12/15/2016 7:00
12/15/2016 10:00
12/15/2016 13:00
12/15/2016 16:00
12/15/2016 19:00
12/15/2016 22:00
12/16/2016 1:00
12/16/2016 4:00
12/16/2016 7:00
Dissolved Oxygen
DO Level of Concern


UCR - Dissolved Oxygen, Water Year 2017 Winter
Oxygen, mg/L
11
10
9
8
7
6
12/14/2016 12:30
12/14/2016 20:30
12/15/2016 4:30
12/15/2016 12:30
12/15/2016 20:30
12/16/2016 4:30
12/16/2016 12:30
12/16/2016 20:30
12/17/2016 4:30
12/17/2016 12:30
12/17/2016 20:30
12/18/2016 4:30
12/18/2016 12:30
12/18/2016 20:30
12/19/2016 4:30
12/19/2016 12:30
12/19/2016 20:30
12/20/2016 4:30
12/20/2016 12:30
12/20/2016 20:30
12/21/2016 4:30
Dissolved Oxygen
DO Level of Concern


CCC - Dissolved Oxygen, Water Year 2017 Spring
Oxygen, mg/L
11
10
9
8
7
6
3/21/2017 10:00
3/22/2017 6:00
3/23/2017 2:00
3/23/2017 22:00
3/24/2017 18:00
3/25/2017 14:00
4/18/2017 23:00
4/19/2017 19:00
4/20/2017 15:00
4/21/2017 11:00
4/22/2017 7:00
4/23/2017 3:00
4/23/2017 23:00
5/9/2017 16:30
5/10/2017 12:30
5/11/2017 8:30
5/12/2017 4:30
5/13/2017 0:30
5/13/2017 20:30
5/14/2017 16:30
5/15/2017 12:30
5/16/2017 8:30
Dissolved Oxygen
DO Level of Concern


UCR - Dissolved Oxygen, Water Year 2017 Spring
Oxygen, mg/L
11
10
9
8
7
6
3/21/2017 9:30
3/22/2017 7:00
3/23/2017 4:30
3/24/2017 2:00
3/24/2017 23:30
3/25/2017 21:00
3/26/2017 18:30
3/27/2017 16:00
3/28/2017 13:30
3/29/2017 11:00
3/30/2017 8:30
4/19/2017 6:00
4/20/2017 3:30
4/21/2017 1:00
5/10/2017 6:00
5/11/2017 3:30
5/12/2017 1:00
5/12/2017 22:30
5/13/2017 20:00
5/14/2017 17:30
5/15/2017 15:00
Dissolved Oxygen
DO Level of Concern


CCC - Dissolved Oxygen, Water Year 2017 Summer
Oxygen, mg/L
11
10
9
8
7
6
6/6/17 11:00
6/7/17 19:30
6/9/17 4:00
6/10/17 12:30
6/11/17 21:00
6/13/17 5:30
7/6/17 19:00
7/8/17 3:30
7/9/17 12:00
7/10/17 20:30
7/12/17 5:00
8/2/17 16:30
8/4/17 1:00
8/5/17 9:30
8/6/17 18:00
8/8/17 2:30
9/22/17 15:30
9/24/17 0:00
9/25/17 8:30
9/26/17 17:00
9/28/17 1:30
Dissolved Oxygen
DO Level of Concern


UCR - Dissolved Oxygen, Water Year 2017 Summer
Oxygen, mg/L
11
10
9
8
7
6
6/6/2017 11:30
6/7/2017 20:30
6/9/2017 5:30
6/10/2017 14:30
6/11/2017 23:30
6/13/2017 8:30
7/6/2017 21:00
7/8/2017 6:00
7/9/2017 15:00
7/11/2017 0:00
7/12/2017 9:00
8/2/2017 19:30
8/4/2017 4:30
8/5/2017 13:30
8/6/2017 22:30
8/8/2017 7:30
9/22/2017 18:30
9/24/2017 3:30
9/25/2017 12:30
9/26/2017 21:30
9/28/2017 6:30
Dissolved Oxygen
DO Level of Concern

Discussion:

In WY2017 there were no measured oxygen levels that fell below 7 mg/L. The lowest dissolved oxygen concentrations were measured in summer for both UCR and CCC.

As expected, months with cooler average water temperatures tended to have higher average dissolved oxygen values. The peaks and dips in the graphs correspond with diurnal fluctuations in temperature and sunlight. Some sections of the graphs appear to have noise over short periods of time, as in April at UCR. Biofouling, especially the growth of microalgae near the sensors, can influence the dissolved oxygen levels locally and cause erratic fluctuations in the measurements. Those noisy data included in this report are have been determined by staff to fall within the expected range.

At several times, dissolved oxygen levels approached 7 mg/L. It is conceivable that a change in flow regime (lower dry season flows, for example), warmer air temperatures, or algae growth could cause dissolved oxygen levels to fall below this threshold in years with lower rainfall totals, changes in CMC effluent water quality, and other factors.

Quarterly Nutrient Monitoring

The Estuary Program wanted to be able to assess nutrient levels at sites throughout the watershed. The information provides long-term trend data and assists in targeting efforts such as restoration or conservation.

Estuary Program staff visit nine sites four times a year to collect samples for analysis by a laboratory for nitrate as nitrogen (NO_3-N, mg/L) and for orthophosphate as phosphorus (PO_4-P, mg/L).

Analytical Specification: The Estuary Program collects samples using standard 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)

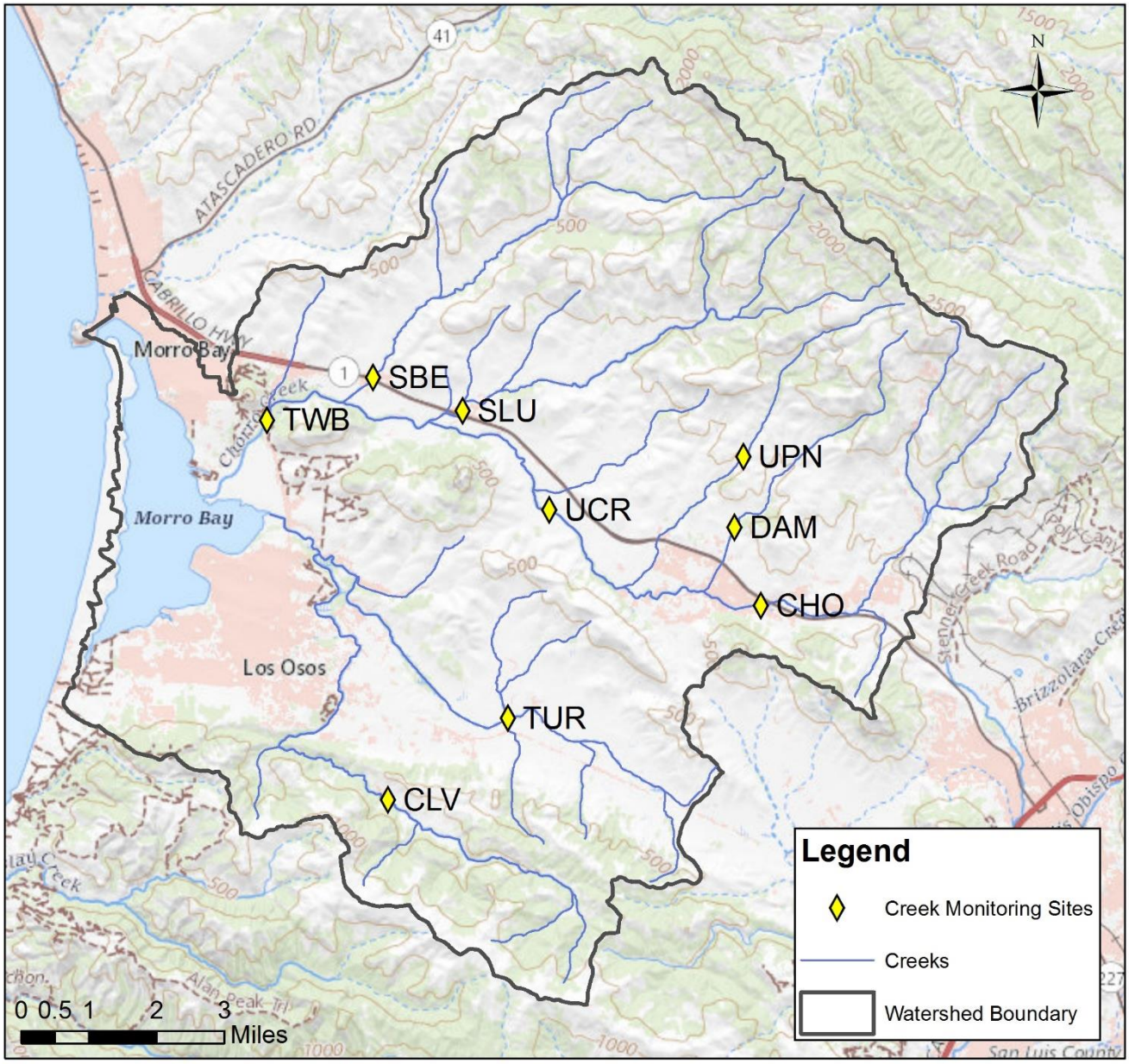
Specification	Value
Method Number	EPA 300.0
Minimum Detection Limit	0.022 mg/L
Project Quantitation Limit	0.10 mg/L
Hold Time	48 hours
Sample storage conditions	4°C in the dark

Orthophosphate as Phosphorus (mg/L)

Specification	Value
Method Number	EPA 365.1
Minimum Detection Limit	0.017 mg/L
Project Quantitation Limit	0.050 mg/L
Hold Time	48 hours
Sample storage conditions	4°C in the dark

Monitoring Locations: The sites were selected to represent Chorro and Los Osos Creeks, as well as their tributaries. The sites include Dairy Creek middle (site code DAM), Pennington Creek upper (UPN), Chorro Creek upper (CHO), Chorro Creek middle (UCR), Chorro Creek lower (TWB), San Luisito Creek lower (SLU), San Bernardo Creek lower (SBE), Warden Creek middle (TUR), and Los Osos Creek upper (CLV). See map for site locations.

Morro Bay Watershed Quarterly Nutrient Monitoring Sites



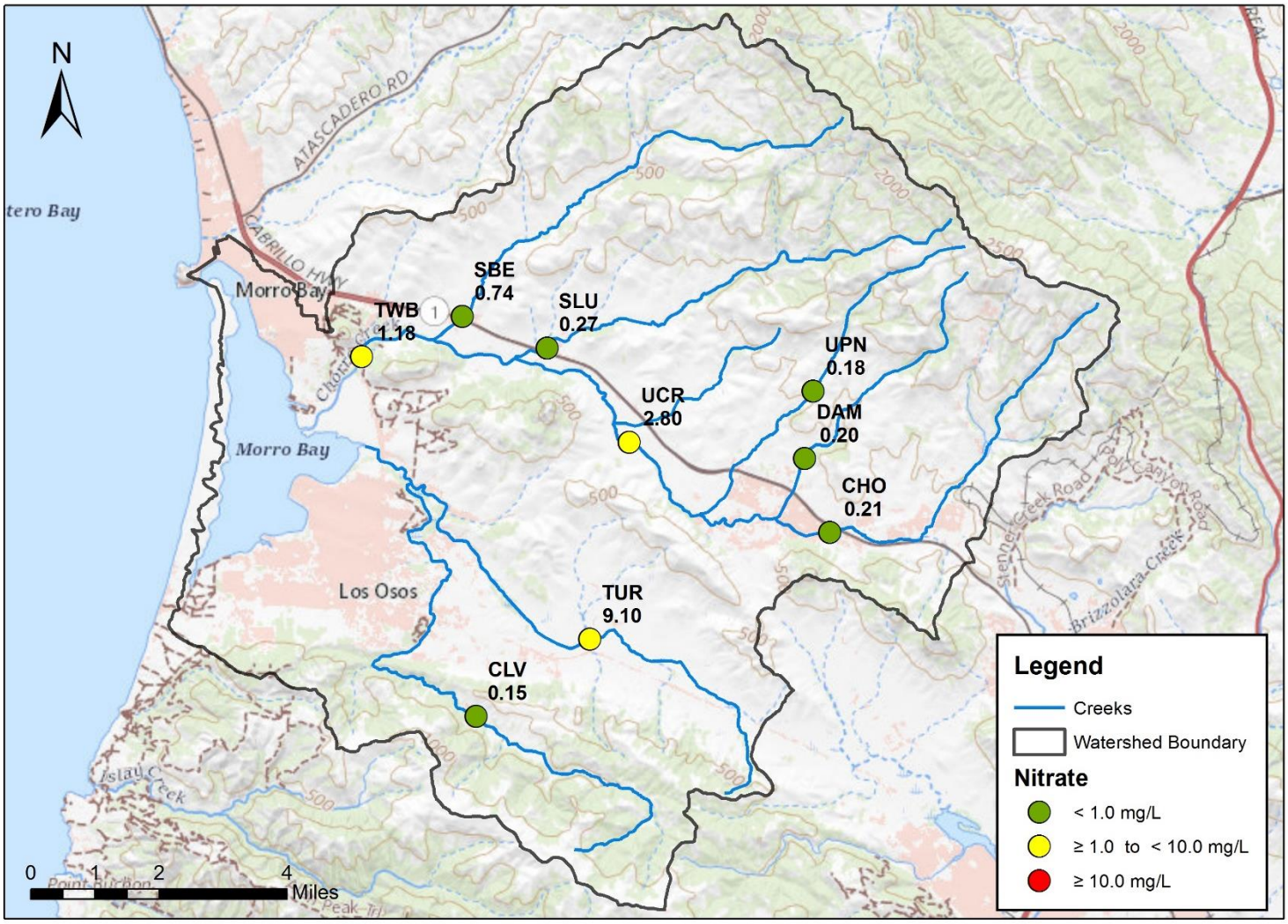
Nitrates

Nitrate results are compared to two standards. In freshwater systems, the CCRWQCB considers a water body to be impaired by nitrates if NO_3-N concentrations are greater or equal to 1 mg/L and if the site shows other signs of impact such as widespread algal growth and low DO concentrations. There is also a drinking water standard for nitrate to be protective of human health, which is less than or equal to 10 mg/L. The Estuary Program assessment utilized the following scores:

- Good (green) for nitrate as N concentrations < 1 mg/L (protective of aquatic and human health)
- Fair (yellow) for nitrate as N concentrations ≥ 1 mg/L and < 10 mg/L
- Poor (red) for nitrate as N concentrations ≥ 10 mg/L (exceeds level protective of human health)

The map below indicates the monitoring locations and the score for the average nitrate as N concentrations at each site. The data range varies by sites, as some sites go dry during the summer. This monitoring began in 2016, and data for WY2017 is included in this analysis.

Average Nitrate Concentrations for WY2017



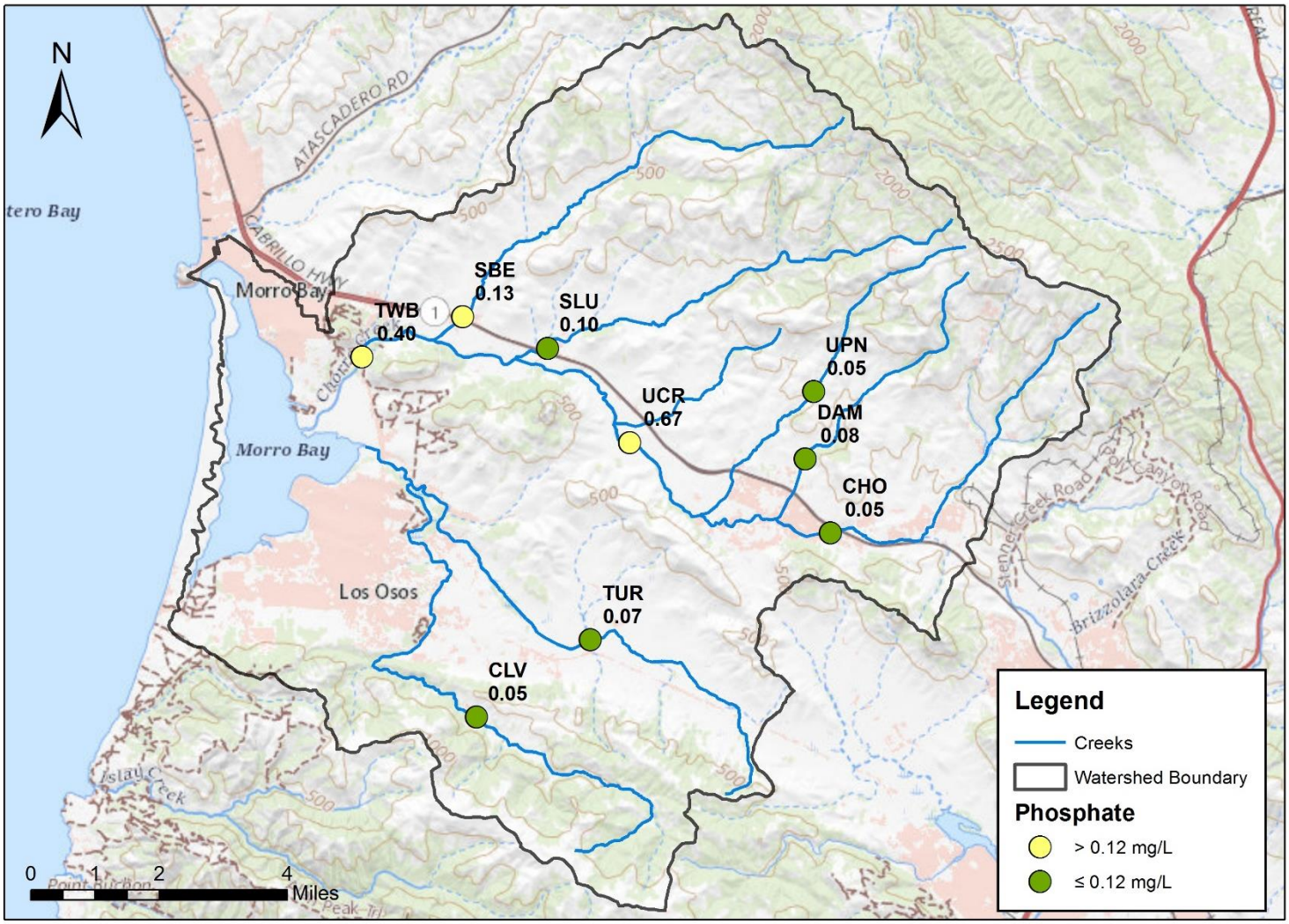
Orthophosphates

Data is compared to the targets in the Pajaro River nutrient objectives guidance document, as referenced on the CCAMP website. A value of 0.12 mg/L PO_4-P is used for comparison to Morro Bay watershed data. There is no standard protective of human health for orthophosphates. The Estuary Program assessment utilized the following scores:

- Good (green) for orthophosphate as P concentrations < 0.12 mg/L
- Fair (yellow) for orthophosphate as P concentrations ≥ 0.12 mg/L

The map below indicates the monitoring locations and the scores for the average orthophosphate as P concentrations at each site. The date range and sample count varies by site, as some sites go dry during the summer. This monitoring began in 2016, and data for WY2017 is included in this analysis.

Average Orthophosphate Concentrations for WY2017



Discussion of Quarterly Nutrient Monitoring Results: The highest nitrate values were measured on Warden Creek (TUR). Chorro Creek immediately downstream of the CMC WWTP outfall (UCR) also had elevated nitrate concentrations relative to upstream and downstream levels. Orthophosphate as P concentrations are higher in Chorro Creek than in Los Osos Creek, with UCR, SBE, and TWB above the screening level target.

Impairment in nutrients often tracks with large DO fluctuations and excess algae. The continuous monitoring deployments for DO at UCR did not indicate any time periods with DO less than 7 mg/L or greater than 13 mg/L. At TUR, which had elevated nitrate concentrations, eight monthly grab sample DO readings were collected in WY2017 from January through August. The readings varied from 4.77 to 11.66 mg/L, with a median value of 8.22 mg/L. The readings less than 7 mg/L could have been related to low flows rather than nutrient loading impacts.

The presence of algae is an indicator of nutrient impairment. Data collected to date was too limited to report. We collect observational data when we conduct quarterly nutrient monitoring data, so we will share this algae presence/absence information in the future.

Data Availability

The data is available from the California Environmental Data Exchange Network (CEDEN), a State Water Resources Control Board managed data portal. To retrieve Quarterly Nutrient data,

- Visit www.CEDEN.org
- Click on Find Data
- For Program, choose Morro Bay National Estuary Program
- For Quarterly Nutrient Monitoring: For 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), San Bernardo Creek at Adobe Rd (SBE), Warden Creek at Turi Road (TUR), and Los Osos Creek Clark Valley Road (CLV)
- Click on Retrieve Data

For continuous monitoring DO and temperature data, contact the Estuary Program.

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