



Morro Bay Estuary Bacteria and Dissolved Oxygen Analysis Water Year 2020

Date Range: Water Year 2020 (October 1, 2019 to September 30, 2020)

Analytes: Dissolved Oxygen, enterococci

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 the EPA and the State Water Resources Control Board. This quality control 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 is available upon request.

Bay Bacteria

The Estuary Program’s goal for bay bacteria monitoring is to assess the safety of the bay shoreline waters for recreational contact. Since 2005, program volunteers have sampled monthly at eight bay shoreline sites and analyzed the samples for the indicator bacteria enterococci. The samples are collected using sterile technique and analyzed by volunteers at the Morro Bay-Cayucos Wastewater Treatment Plant lab using the IDEXX method.

Enterococci Monitoring Specifications:

Specification	Value
Method	IDEXX Enterolert
Detection Range	10 to 24,190 MPN/100 mL
Hold Time	24 hours
Sample storage conditions	4°C in the dark

To ensure data quality, volunteers analyze blanks to check for sterility, split samples to check for precision, and certified reference materials to check for accuracy.

For this analysis, a random value between 0.1 and 10 was assigned for all samples that had a result of <10 MPN/100 mL, which is the detection limit for this method. This approach affects the calculated geomeans for past years and thus, graphs will not match previous reports. This method of handling non-

detect data is utilized by the Central Coast Regional Water Quality Control Board (CCRWQCB) in their own analysis.

Monitoring Locations

The eight bay shoreline monitoring sites were selected because they represent the areas with the most recreational contact. The sites are (from north to south) Coleman Beach (site code COL), Tidelands Park (TID), Windy Cove (WIN), State Park Marina (SPM), Pasadena Point (PAS), Baywood Pier (BAY), Cuesta Inlet (CIN), and Sharks Inlet (SIN).

Figure 1 indicates the monitoring locations.

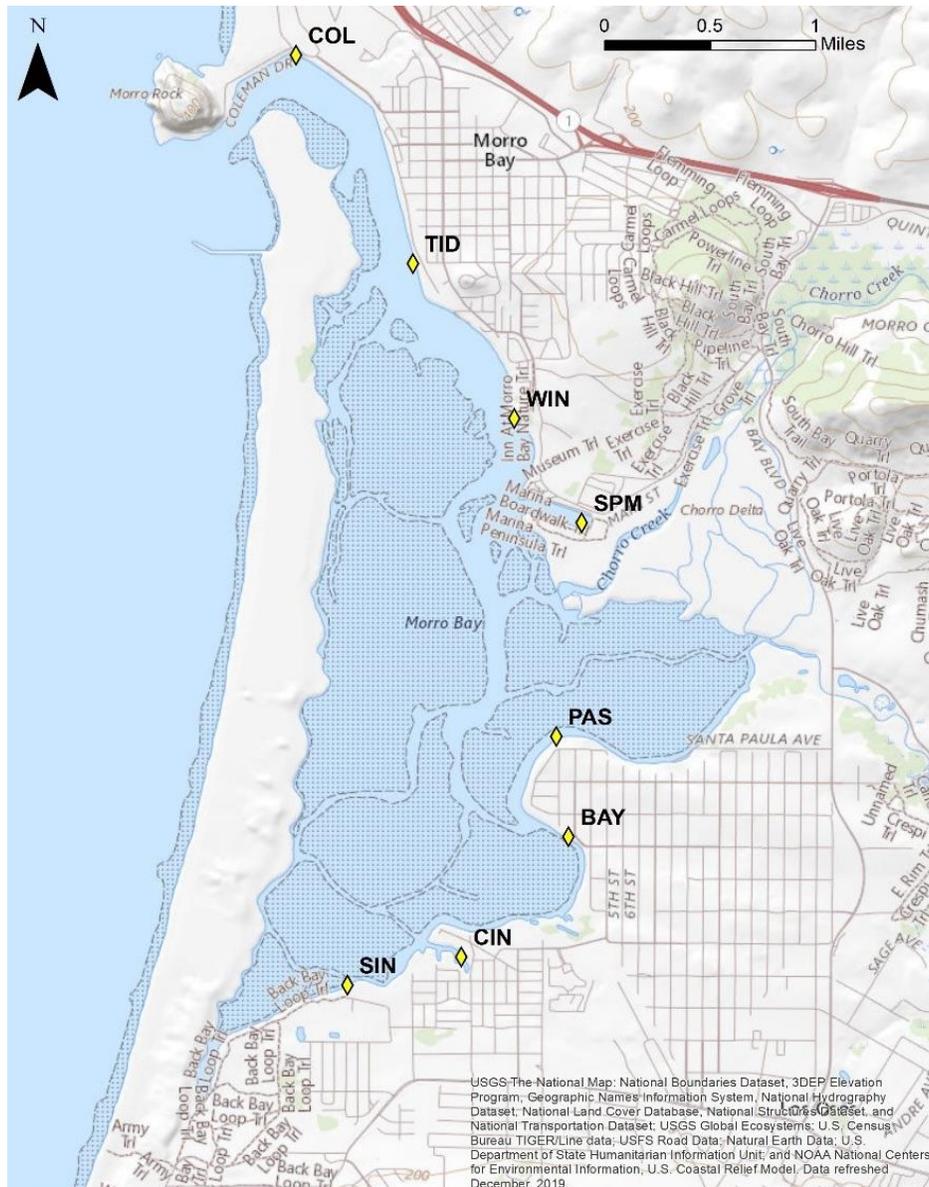


Figure 1. Locations of shoreline bacteria monitoring sites in the Morro Bay estuary.

Results

Indicator bacteria data shows how often the waters in specific locations along the bay shoreline have levels greater than those safe for recreational contact.

The following graph (Figure 2) shows the percent of samples from Water Year 2020 (WY2020) that exceeded the Statistical Threshold Value (STV) criteria. Ideally, no more than 10% of samples exceed this value of 110 Most Probable Number per 100 milliliter (MPN/100 mL) sample. This guiding value is from the [State Water Resources Control Board's Bacterial Objectives](#) and is lower than the [previous EPA guiding value](#) of 130 MPN/100 mL.

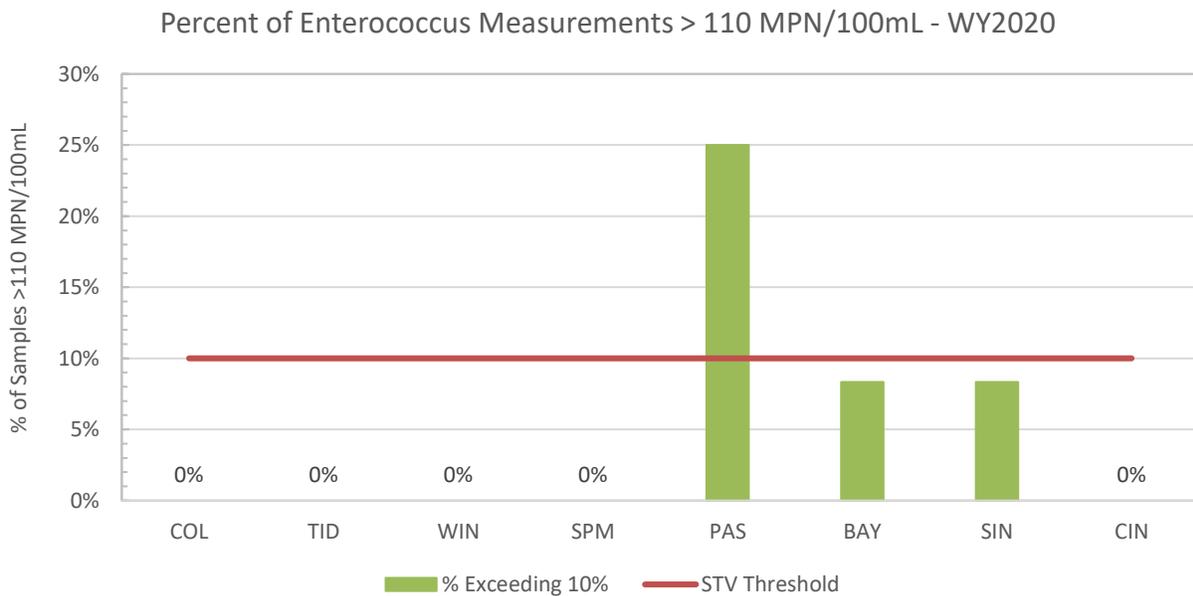


Figure 2. Percent of enterococci measurements greater than 110 MPN/100 mL for WY2020. The red line indicates the Statistical Threshold Value (STV) criteria at 10% of samples exceeding 110 MPN/100mL. Ideally no more than 10% of results exceed the STV criteria.

Figure 3 shows the geomean of all WY2020 data for each site. Ideally, the sample geomean remains below the guideline of 30 MPN/100 mL. This guideline is from the [State Water Resources Control Board's Bacterial Objectives](#). This is lower than the previous guideline of 35 MPN/100 mL from [EPA guidance](#).

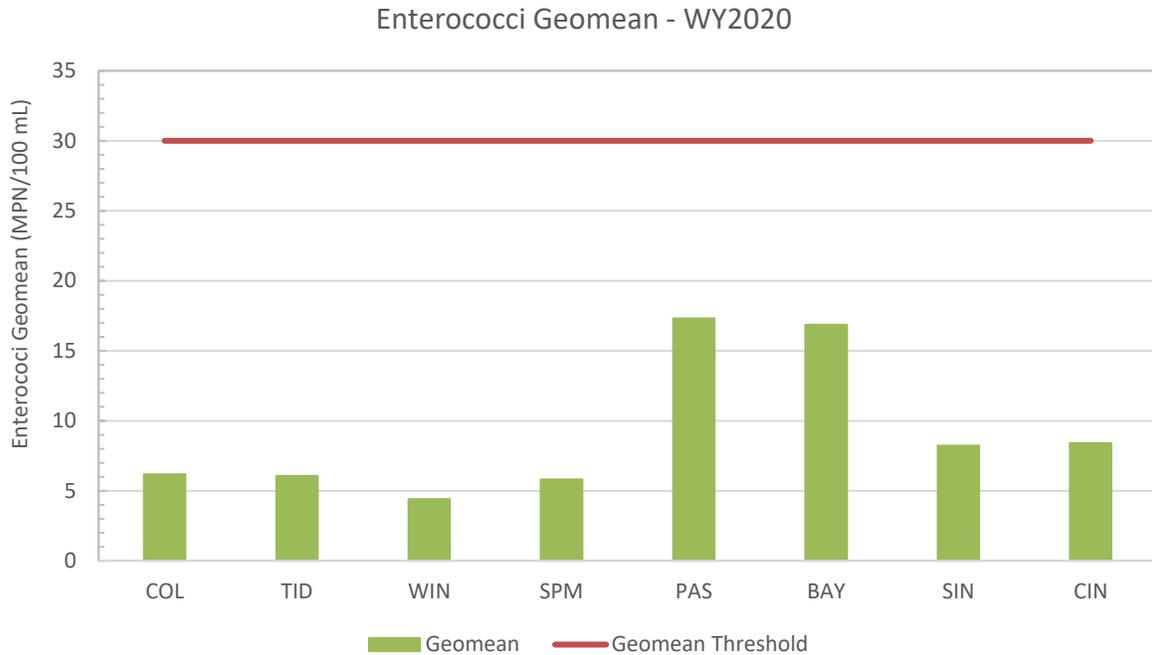


Figure 3. Geomean values from WY2020 collected from Morro Bay estuary shorelines sites. The red line indicates the geomean threshold value of 30 MPN/100 mL. Ideally the geomean result for each site remains below this threshold.

Discussion

Of the eight sites monitored, historical trends have shown six sites only rarely exceeding recreational contact standards. The four sites toward the mouth of the bay (COL, TID, WIN, and SPM) have historically had very few elevated bacteria results. These sites are along the well-mixed main channel and are thought to be primarily influenced by ocean water entering the bay with the incoming tide. The two sites furthest back in the bay, Cuesta Inlet (CIN) and Sharks Inlet (SIN), also have had minimal exceedances of recreational standards. These sites may be impacted by water circulation issues, as the back bay is shallow and experiences minimal mixing with the incoming tides during certain times of year. We hypothesize that few exceedances occur at these sites because despite the poor circulation, there are minimal inputs of bacteria at those locations.

Two sites, Baywood Pier (BAY) and Pasadena Point (PAS), have had frequent exceedances of recreational standards historically, although these trends did not apply to WY2018 or WY2019. During WY2020, PAS had three exceedances and BAY had one. Figures 4 and 5 illustrate historic exceedances of the safe swimming criteria of 110 MPN/100 mL with data from WY2008 to WY2020.

Figure 4 shows the percent of exceedances of the recreational standard for data from the last 13 years. For both BAY and PAS, nine of the 13 years had percent exceedances greater than 10%, although these did not always occur during the same year. In some years such as WY2008, PAS and BAY did not exceed 110 MPN/100 mL. This is represented in the graph below with the absence of a bar and 0% noted.

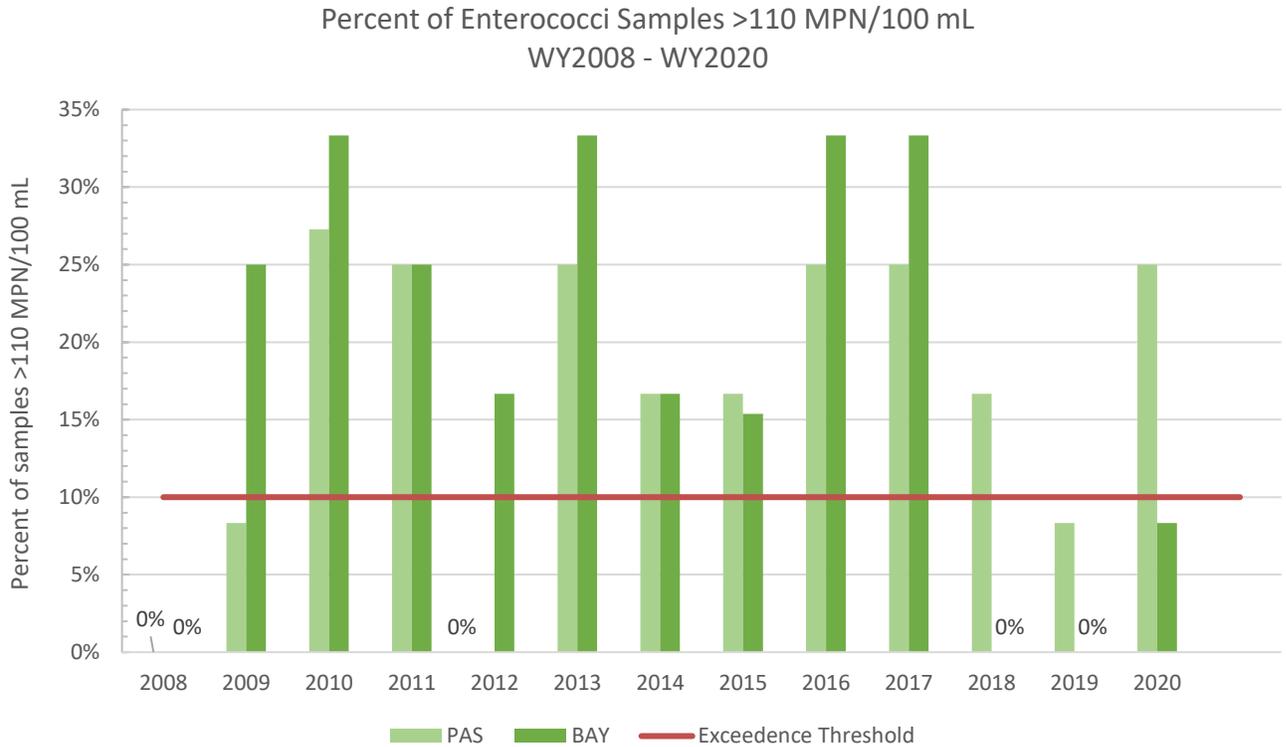


Figure 4. Percent of enterococci samples greater than the Statistical Threshold Value (STV) of 110 MPN/100 mL over the last 13 years. Note: the absence of a bar indicates that 0% of samples exceeded the threshold for the year. The red line indicates the STV, or Exceedance Threshold.

Figure 5 shows the geomean of bacteria results by water year from WY2008 to WY2020. For PAS, four of 13 years exceeded the criteria of 30 MPN/100 mL. For BAY, seven of 13 years exceeded the criteria of 30 MPN/100 mL.

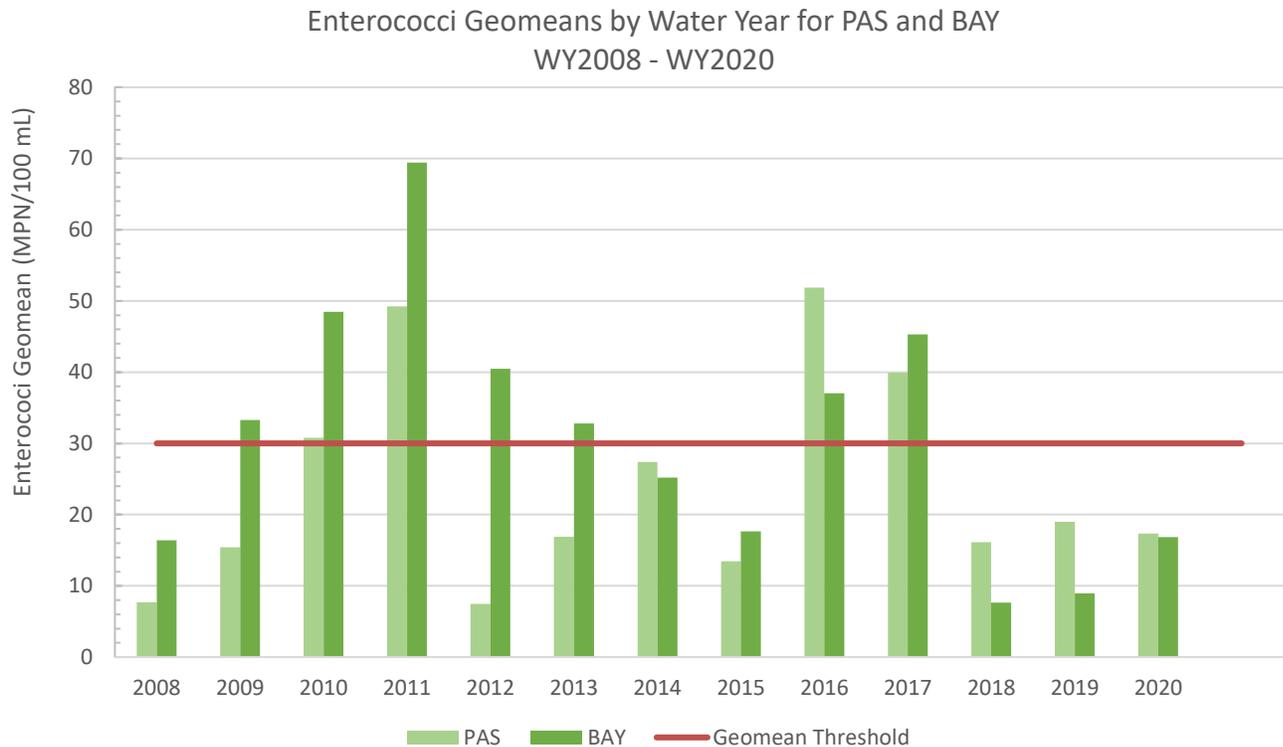


Figure 5. Enterococci geomean by year for PAS and BAY. The red line indicates the geomean threshold of 30 MPN/100 mL. Ideally, geomean values remain below this threshold.

The consistently elevated results of BAY and PAS merit additional attention to potential sources and how to address them. Potential sources of bay bacteria could include inputs from the watershed transported by Chorro and Los Osos Creeks, runoff from urbanized areas, improperly managed boat waste, contaminated groundwater, and wildlife. The California Department of Public Health (CDPH) monitoring of the freshwater seeps along the back bay has also indicated elevated levels of the fecal coliform indicator bacteria. Additional information on this seeps data set is available on the [Estuary Program website](#).

Bay Dissolved Oxygen

The Estuary Program wanted to assess the dissolved oxygen (DO) concentrations at the lowest levels in the diurnal cycle. Since 2002, program volunteers monitor monthly at seven bay sites and collect surface measurements for DO concentration, temperature, and salinity. The monitoring occurs in the early morning hours within two hours of sunrise on an adequate tide for safe access.

Equipment Specification

The Estuary Program uses a [YSI Pro 2030](#) meter, which measures DO concentration (mg/L), DO percent saturation (%), temperature (°C), specific conductance (µS/cm), and salinity (ppt).

The equipment specifications for DO concentration are as follows:

Specification	Value
Sensor Type	Polarographic
Measurement Range	0 to 50 mg/L
Calibrated Range	0 to 20 mg/L; 0 to 35°C
Accuracy	$\pm 2\%$ of reading for 0 to 20 mg/L; $\pm 6\%$ of reading for 20 to 50 mg/L
Resolution	0.01 mg/L

To ensure data quality, the Estuary Program calibrates the meters weekly for DO using an internal calibration. They are tested against a Winkler titration twice a month.

Monitoring Locations

Seven bay monitoring sites were selected to represent different regions of the bay. The sites are (from north to south) Tidelands (site code ATP), State Park Marina (SPO), Los Osos Channel (LO2), Pasadena Point (PSP), Cuesta Channel (CHI), Cuesta Inlet (CSI), and Sharks Inlet (SHI).

Figure 6 shows the seven monitoring locations. Sites are grouped into two sets of sites: front bay and back bay. Sites within each group are sampled on the same day, but the two groups are generally not sampled on the same day. Sites are accessed via kayak.

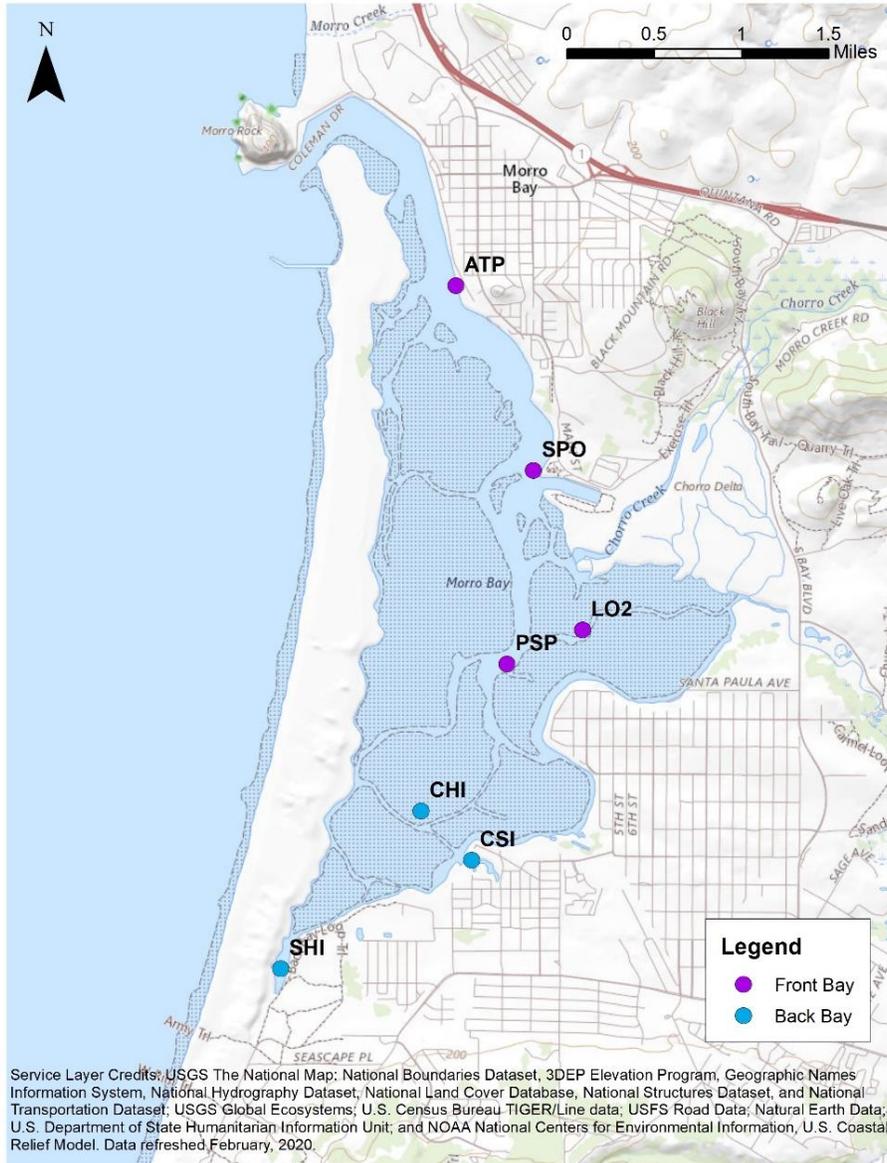


Figure 6. Map of bay dissolved oxygen monitoring locations.

Results

Analysis gives an indication of DO levels relative to standards protective of aquatic life. The [CCRWQCB](#) has designated the Morro Bay estuary as Marine Habitat (code MAR) and lists an objective that DO concentrations must not fall below 7 mg/L to be protective of aquatic life.

The following graphs show the DO concentration data for WY2020 at each of the seven sites.

Figure 7 shows the distribution of measurements for each site over WY2020 using a box-and-whisker plot. Sites highlighted in purple indicate front bay sites, and sites highlighted in blue indicate back bay sites. The boxes in the box-and-whisker plot represent the 25th to 75th percentile of collected DO measurements during WY2020. The horizontal line in each box represents the median DO concentration. The vertical lines above and below the box (known as the “whisker”), represent the maximum and minimum values measured. The taller boxes, such as for SHI, represent a wider range of DO measurements over the year as compared to the smaller boxes, such as for ATP.

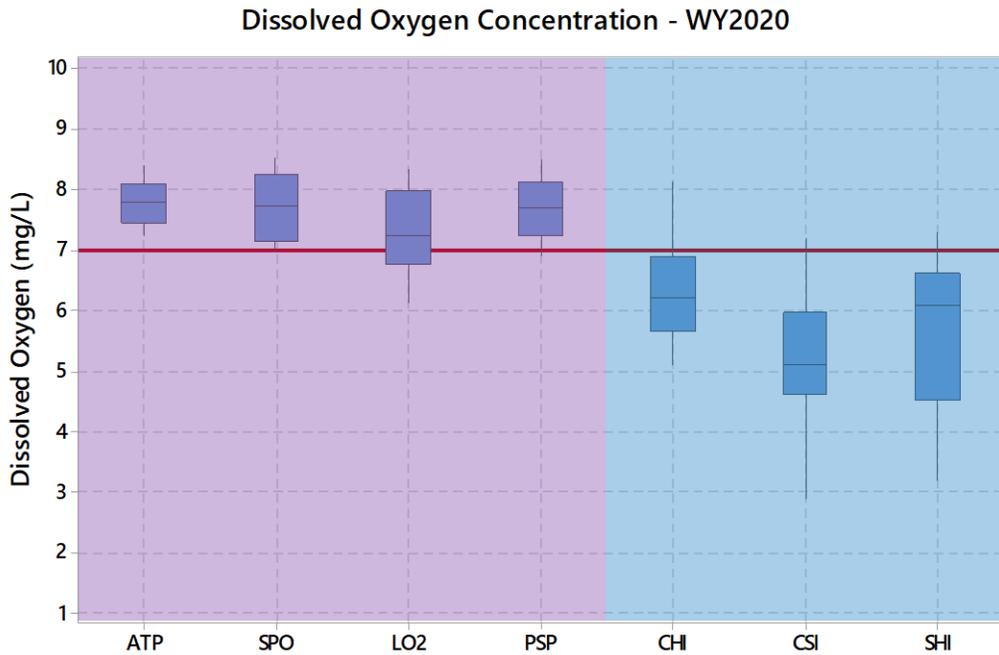


Figure 7. Dissolved oxygen concentration distribution at seven sites during WY2020. Sites highlighted in purple indicate front bay sites. Sites highlighted in blue indicate back bay sites.

Figure 8 shows the percent of DO concentration readings in WY2020 that were less than 7 mg/L, meaning that the recorded DO measurements did not meet the numeric objective set by the [CCRWQCB](#) to be protective of aquatic life in marine waters. Ideally, only 10% or less of results would not meet the standard.

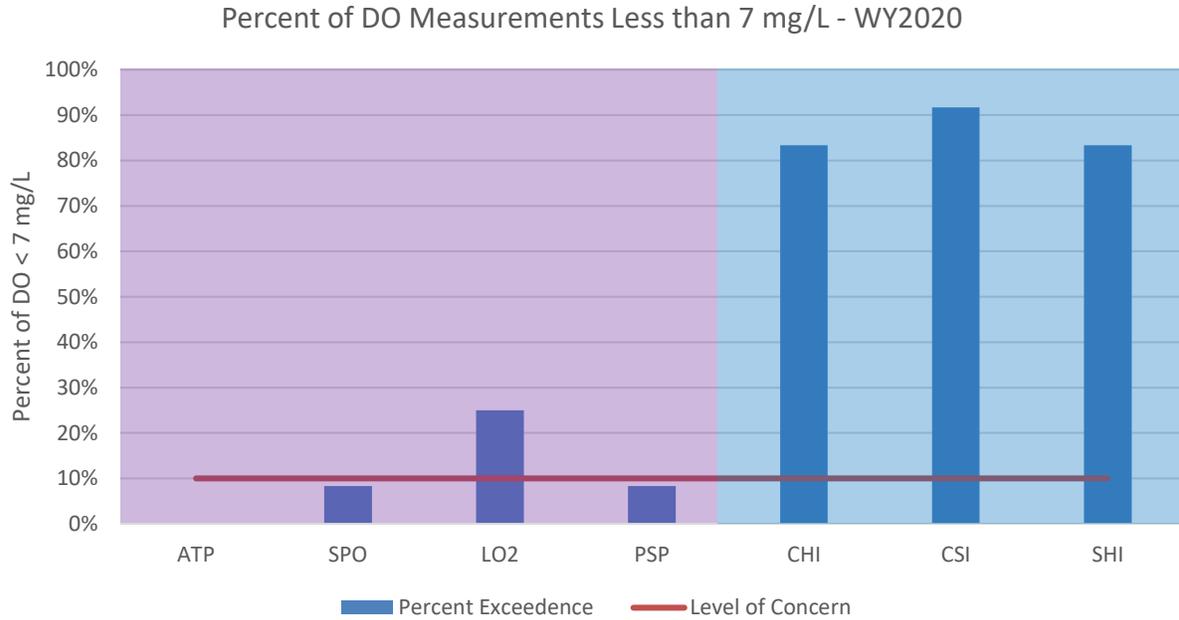


Figure 8. Percent of DO measurements less than 7 mg/L during WY2020. ATP, SPO and PSP all had less than 10% of samples falling below 10%, an improvement from WY2019, where ATP was the only site meeting this criteria. Sites highlighted in purple indicate front bay sites. Sites highlighted in blue indicate back bay sites.

Figure 9 shows the average DO values for WY2020 data. Ideally, all readings are higher than 7 mg/L to ensure adequate oxygen to be protective of aquatic life and to comply with CCRWQCB standards.

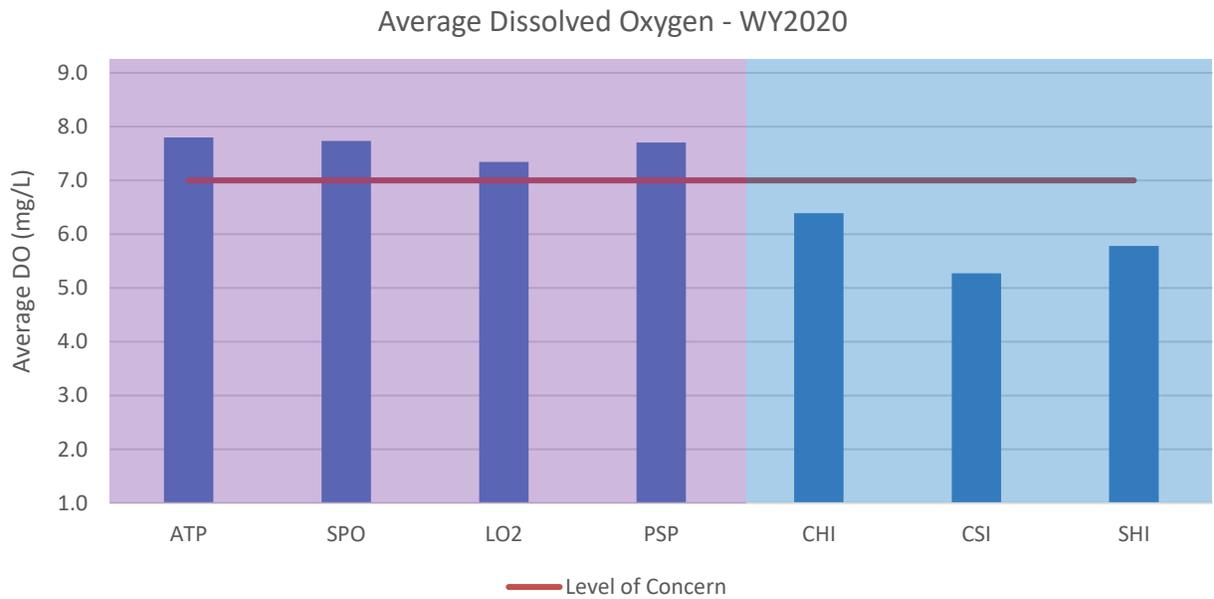


Figure 9. Average of dissolved oxygen levels measured during WY2020. Sites highlighted in purple indicate front bay sites. Sites highlighted in blue indicate back bay sites. Ideally DO concentration levels remain above 7 mg/L.

For Figure 10, readings from all front bay sites were combined (ATP, SPO, LO2, PSP) and results from all back bay sites were combined (CHI, CSI, SHI) to show how dissolved oxygen levels varied throughout WY2020 in the back bay compared to the front bay. The front bay did not meet the level of concern a few times during the late spring into the summer. The back bay did not meet the level of concern for all but two months in WY2020.

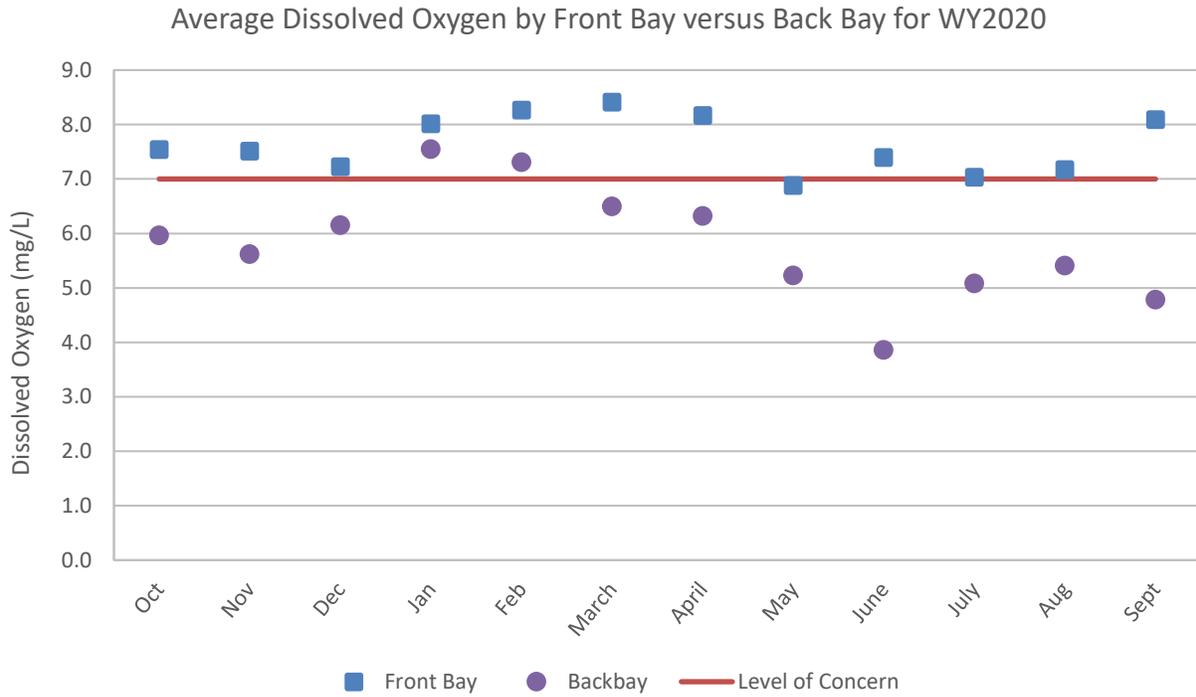


Figure 10. Average dissolved oxygen levels by month for all front and back bay sites during WY2020.

Figure 11 illustrates how the WY2020 trend in front bay and back bay sites is also shown in the five-year averages. Data for all front bay sites for WY2016 to WY2020 were combined for each month, and a similar calculation was conducted for back bay sites.

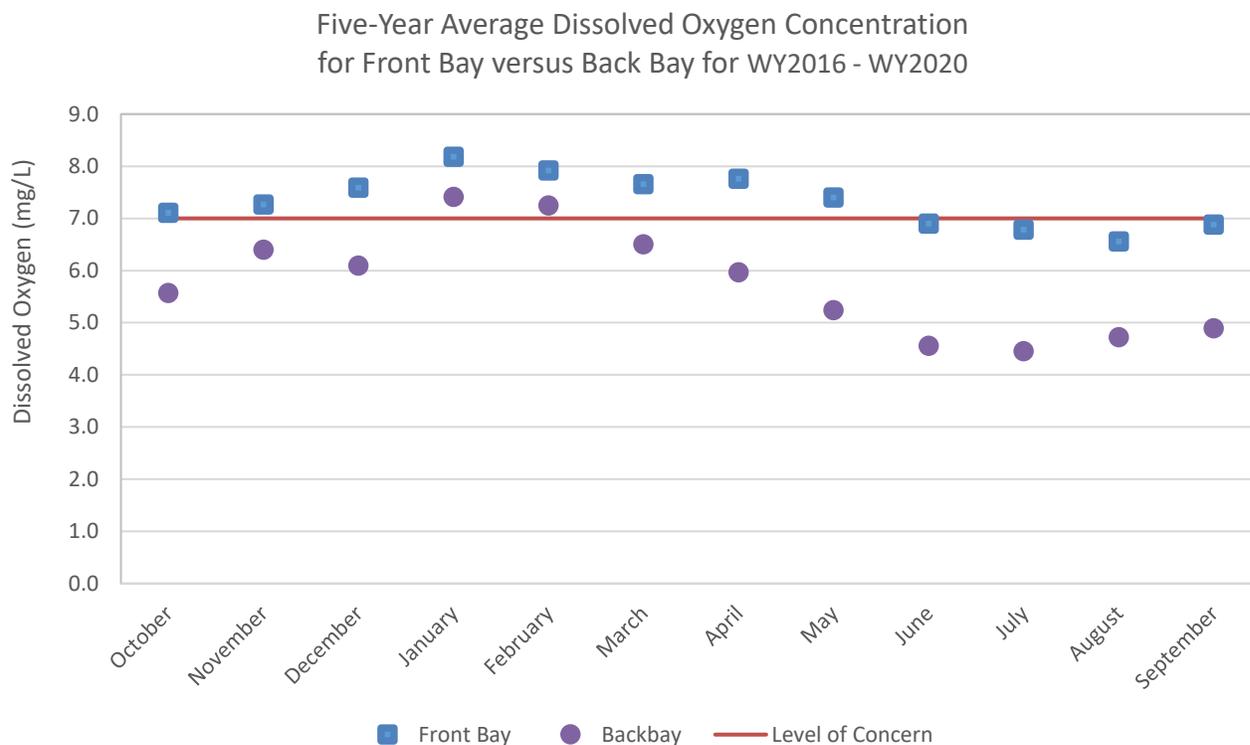


Figure 11. Five-year average of front bay DO concentrations and back bay DO concentrations with data from WY2016 to WY2020. Averages are shown here on a monthly basis to show seasonal trends. Ideally DO concentrations do not fall below the 7 mg/L level of concern (represented by the red line).

Discussion

Morro Bay’s waters frequently have DO levels below the 7 mg/L water quality objective protective of the beneficial uses of the estuary, as outlined by the [Water Quality Control Plan for the Central Coastal Basin](#). These trends also apply to data prior to WY2020. Sites located closer to well-mixed channels (ATP, SPO, LO2, and PSP) had fewer readings that fell below 7 mg/L, although all sites frequently violated the Basin Plan standard during WY2020.

The depressed DO levels may be due in part to bay circulation. Waters in the back bay are shallower, meaning they heat up faster in the sun. Warmer water cannot hold onto as much DO as cooler water. Sites toward the back of the bay seem to have lower DO concentrations on average than those located in the channel and towards the front of the bay. Macroalgae, which is typically more prevalent in the back bay than the front bay, could be contributing to the depressed DO levels as well.

Data Availability

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

- Visit www.CEDEN.org.
- Click on Find Data.
- Click on the CEDEN Query Tool.
- Click on Select Program, and choose Morro Bay National Estuary Program from the list. Click on Done.

For Bay Bacteria data:

- Click on Select Parameter. Choose “enterococcus” from the list. Click on Done.
- Click on Select Stations. Select Coleman Beach shoreline, Tidelands Park shoreline, Windy Cove, State Park Marina shoreline, Pasadena Point shoreline, Baywood Pier shoreline, Cuesta Inlet shoreline, and Sharks Inlet shoreline. Hold down the Control button to select multiple sites. Click on Done.
- Click on Retrieve Data.

For Bay DO data:

- Click on Select Parameter. Choose “Oxygen, Dissolved, Total” from the list. Click on Done.
- Click on Select Stations. Select Tidelands Park, State Park Marina bay, Sharks Inlet bay, Pasadena Point Bay, Near Cuesta Inlet, North of Cuesta Inlet Mouth, and Los Osos Creek Channel. Hold down the Control button to select multiple sites. Click on Done.
- Click on Retrieve Data.

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

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