Benthic Macroinvertebrate Bioassessment

Data Summary Memo

2020

January 13, 2021

Morro Bay National Estuary Program
601 Embarcadero, Suite 11
Morro Bay, CA 93442

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Morro Bay National Estuary Program's Benthic Macroinvertebrate Bioassessment Data Summary Memo 2020. Morro Bay National Estuary Program. January 2021.

List of Acronyms

Acronym	Definition
Cal Poly	California Polytechnic State University, San Luis Obispo
CDFW	California Department of Fish & Wildlife
CCRWQCB	Central Coast Regional Water Quality Control Board
MBNEP	Morro Bay National Estuary Program
BMI	Benthic Macroinvertebrate
EPT	Ephemeroptera, Plecoptera, and Trichoptera
SoCal IBI	Southern California Coastal Index of Biotic Integrity
SWAMP	Surface Water Ambient Monitoring Program
WY	Water Year (Oct 1st – Sep 30th, named for year in which it ends)

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Introduction

The Morro Bay National Estuary Program (MBNEP) is a nonprofit organization that brings together citizens, local governments, nonprofits, agencies, and landowners to protect and restore the Morro Bay estuary and the surrounding watershed. The monitoring conducted by staff and volunteers has three main goals: 1) assess long-term ambient trends, 2) track the effectiveness of specific implementation projects, and 3) to establish protection and restoration targets.

This report summarizes the results of aquatic bioassessment using benthic macroinvertebrates (BMIs) during the 2020 water year (WY2020). BMIs are organisms that live in the bottoms of streams and rivers, are composed mainly of insects, and are a reliable indicator of biological health (SWAMP 2017).

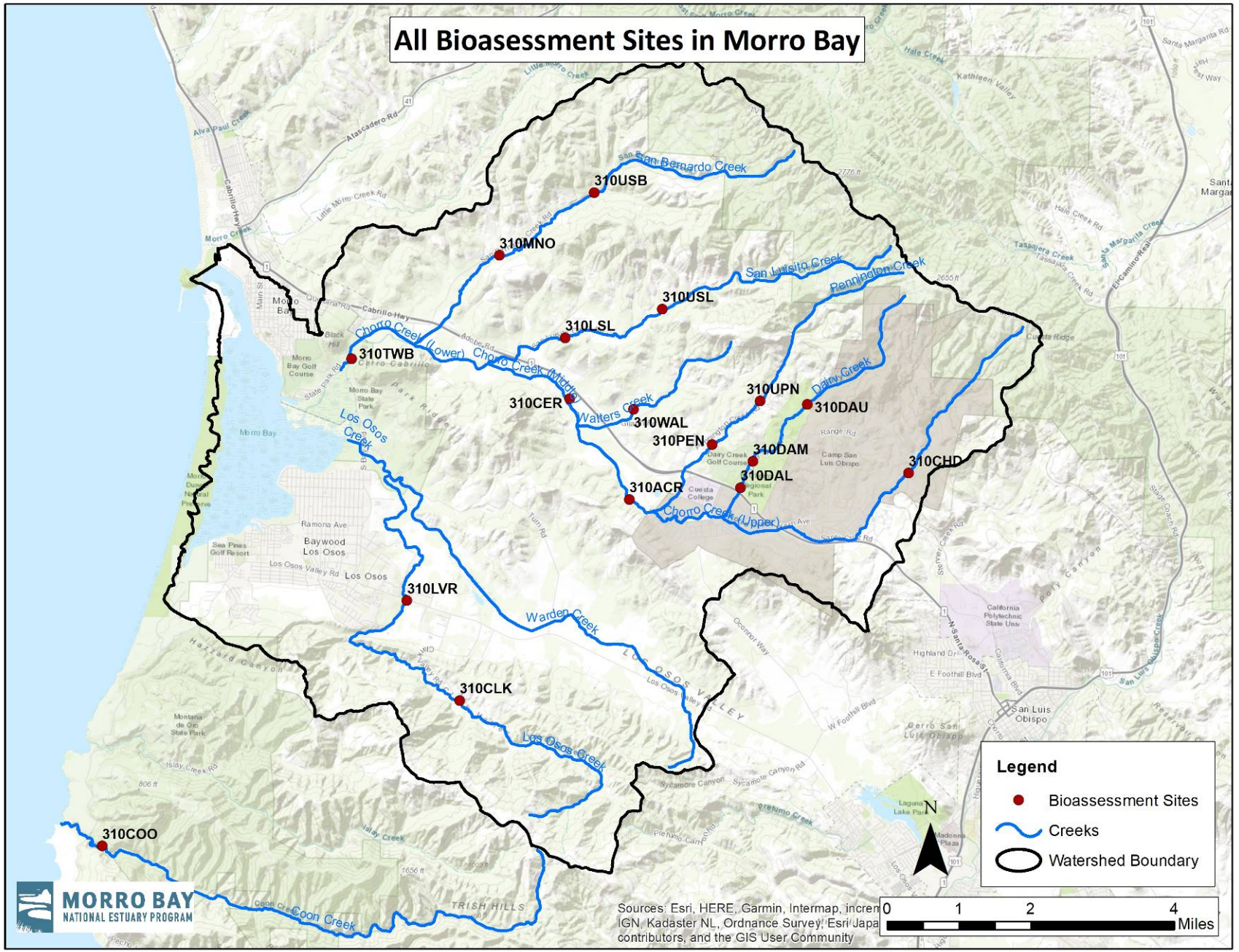
Bioassessment monitoring incorporates physical, chemical, and biotic factors into a quantitative measurement of the overall ecological health of a waterbody. The results of these surveys can be used to measure and assess impacts to surface water ecosystems over time.

This report summarizes five primary metrics used to determine waterbody health: taxa richness, Ephemeroptera, Plecoptera, and Trichoptera (EPT) richness, percent EPT, percent sensitive EPT and Index of Biotic Integrity (IBI) Score. Bioassessment surveys were conducted by MBNEP staff at seven locations throughout the Morro Bay watershed during WY2020. Table 1 highlights these seven sites in blue and identifies the rest of the bioassessment sites where monitoring has occurred in the past. The watershed, as shown in Figure 1, is approximately 77 square miles and is largely dominated by agricultural uses but does have urban land use, primarily along the coast. Rainfall records from the nearby California Polytechnic State University, San Luis Obispo (Cal Poly) report that the area surrounding San Luis Obispo receives an average of 21.83 inches of rain per year (Cal Poly San Luis Obispo 2017). This gauge is located approximately nine miles from the center of the Morro Bay watershed. Figure 1 also shows the locations of all bioassessment sites surveyed by the MBNEP between the years of 2002 to 2020.

Table 1. MBNEP Bioassessment Sites, with WY2020 sites in blue.

Site Code	Site Description
TWB	Lower Chorro Creek
CER	Middle Chorro Creek
ACR	Middle Chorro Creek, Above Ecological Reserve
CHD	Upper Chorro Creek
MNO	San Bernardo Creek
USB	Upper San Bernardo Creek
LSL	Lower San Luisito Creek
USL	Upper San Luisito Creek
WAL	Walters Creek
PEN	Lower Pennington Creek
UPN	Upper Pennington Creek
DAL	Lower Dairy Creek
DAM	Middle Dairy Creek
DAU	Upper Dairy Creek
LVR	Los Osos Creek
CLK	Upper Los Osos Creek
COO	Coon Creek

Figure 1. Watershed boundary, mainstem creek segments and bioassessment sites in the Morro Bay Watershed surveyed between 2002 - 2020.



Methods

All sampling followed the *Standard Operating Procedures (SOP) for the Collection of Field Data for Bioassessments of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habitat* (Ode, P.R., A.E., Fetscher, and L.B. Busse. 2016) established by the Surface Water Ambient Monitoring Program (SWAMP). Due to limited sampling resources, the MBNEP does not conduct the algae collection module.

This method involves monitoring a 150-meter reach at each creek site using the reach-wide benthos procedure. Measurements and observations on substrate, water depth, canopy cover, bank stability, and other physical parameters were taken at each of 11 equidistant transects and ten inter-transects. Macroinvertebrate samples were collected from each transect, rotating between the margins and center of the creek. The samples were composited into a single sample and sent to EcoAnalysts, Inc. for analysis according to SWAMP SAFIT Level 2 taxonomy protocols. The samples were sorted and counted until 600 organisms were identified, and a count was provided of the individual taxa as well as several calculated metrics.

The calculated metrics included in this memo are as described follows:

- Taxa richness is a measure of the number of different species of organisms in the sample.
- EPT richness is a measure of the total number of taxa within the sensitive orders of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies).
- EPT% is the percentage of EPT individuals within the total number of individuals in the sample.
- Percent EPT is the percentage of EPT individuals with tolerance values 0-3.
- The Index of Biotic Integrity (IBI) score used in this report is the Southern California Coastal IBI (SoCal IBI) developed by the Aquatic Bioassessment Laboratory of the California Department of Fish and Wildlife (CDFW). Seven uncorrelated biotic measurements were selected to be included in the calculation. They include collector-gatherer and collector-filterer individuals, percent non-insect taxa, percent tolerant taxa, coleoptera richness, predator richness, percent intolerant individuals, and EPT richness. The SoCal IBI score is applicable in a range from San Diego to Monterey and closely tracks the jurisdictions of Regional Water Quality Control Boards 3, 4, 8, and 9. As shown in Table 4, IBI scores of 0–19.99 are considered to be very poor, 20–39.99 are poor, 40–59.99 are fair, 60–79.99 are good, and 80–100 are very good.

The MBNEP has 15 bioassessment sites. Due to funding as well as stream flow and site access, the maximum number monitored each year is typically ten. In 2019, after meeting with a Technical Advisory Committee, the MBNEP decided to try a monitoring approach of dividing the existing and proposed new sites into two categories: Core and Rotating. Each year, the same six Core sites will be monitored and four of the Rotating sites will be monitored. Rotating sites will be monitored approximately every other year. The approach had to be modified slightly for 2020 due to COVID-19 limitations. The sites were chosen based on whether staff members could maintain a minimum of six feet of social distance during the survey. Sites that were highly overgrown or had very narrow stream channels were omitted. Because of this, some Rotating sites that were monitored in 2019 were repeated in 2020, and one Core site had to be eliminated. Of the seven sites monitored in 2020, six are regularly monitored each year.

This monitoring effort must be conducted under a CDFW Scientific Collection Permit (SCP). The MBNEP holds the appropriate permit and conducts all required notifications and reporting.

Results

The following tables, graphs, and maps summarize the results of the WY2020 bioassessment monitoring and provide context for the results by comparing them to historical bioassessment metrics. Taxa richness, EPT richness, EPT %, % Sensitive EPT, and IBI scores from the most recent three-year period (2018–2020) are displayed below in Table 2. These are specific to the seven sites monitored in 2020. An "x" indicates that no monitoring occurred.

Site	Year	Taxa Richness	EPT Richness	% EPT	% Sensitive EPT	SoCal B-IBI
MNO (San Bernado Creek)	2018	52.00	19.00	21.19	9.70	75.71
	2019	52.00	17.00	32.17	7.50	67.14
	2020	61.00	14.00	25.90	8.75	71.43
LSL (Lower San Luisito Creek)	2018	55.00	21.00	51.36	22.18	78.57
	2019	52.00	19.00	39.74	6.53	68.57
	2020	55.00	15.00	7.73	5.25	61.43
USL (Upper San Luisito Creek)	2018	59.00	22.00	56.53	48.63	87.14
	2019	x	x	x		x
	2020	32.00	14.00	13.58	51.37	68.57
UPN (Upper Pennington Creek)	2018	57.00	21.00	44.95	34.27	87.14
	2019	60.00	16.00	26.43	9.62	82.86
	2020	67.00	20.00	24.85	26.41	77.14
TWB (Lower Chorro Creek)	2018	46.00	11.00	14.61	2.75	52.86
	2019	43.00	10.00	22.81	1.26	31.43
	2020	47.00	9.00	26.72	7.01	52.86
ACR (Above Chorro Reserve)	2018	x	x	x	x	x
	2019	46.00	13.00	30.39	0.94	32.86
	2020	36.00	10.00	53.81	1.16	48.57
CLK (upper Los Osos Creek)	2018	59.00	10.00	21.55	4.55	61.43
	2019	40.00	11.00	23.43	3.69	52.86
	2020	59.00	15.00	51.75	12.16	74.29

Table 2. Results of Taxa Richness, EPT Richness, EPT%, % Sensitive EPT and SoCal IBI scores for 2018-2020

Figures 2 to 6 illustrate taxa richness, EPT richness, % Sensitive EPT, and SoCal IBI data. These metrics all typically decrease in response to disturbance. For Figures 3 to 7, the absence of a bar indicates that monitoring was not conducted at the site that year.

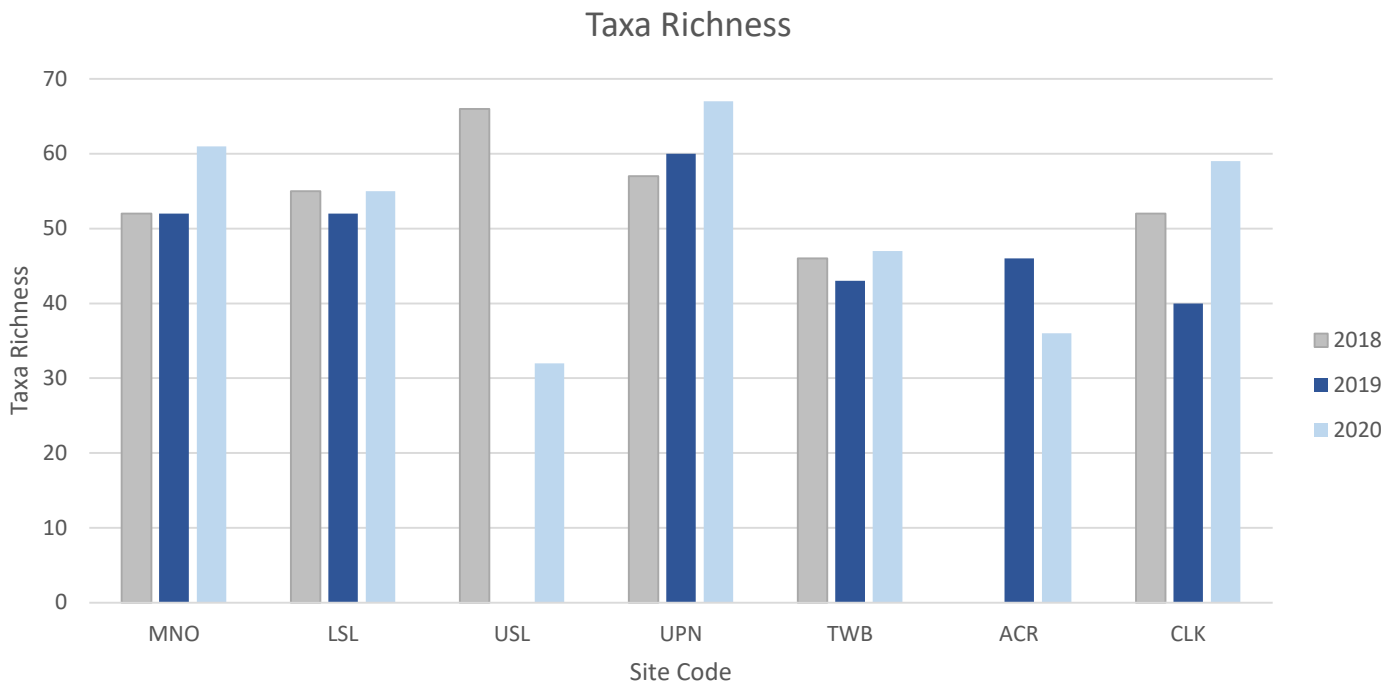


Figure 2. Taxa richness data for 2018 – 2020 bioassessment monitoring.

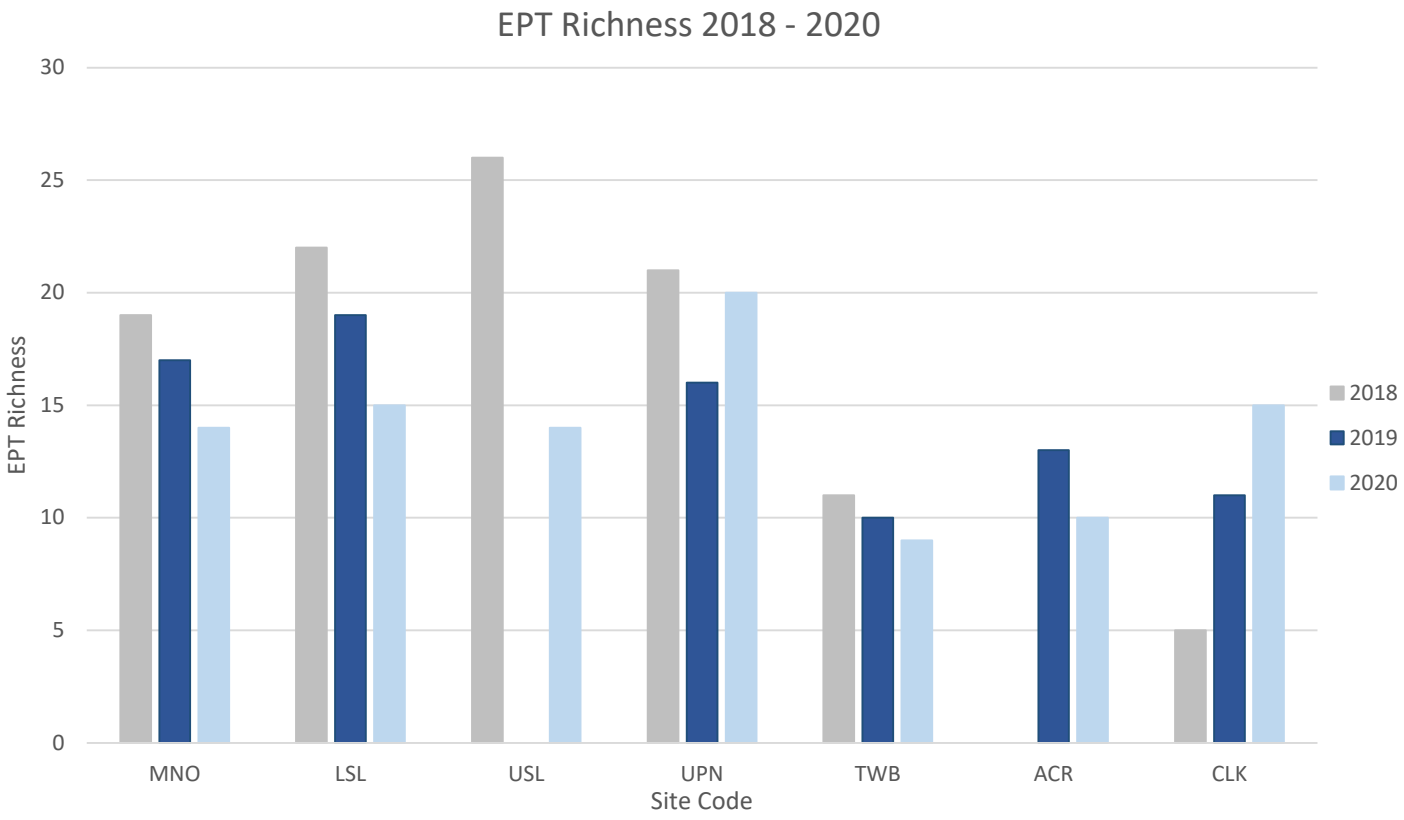


Figure 3. EPT Richness data for 2018-2020 bioassessment monitoring.

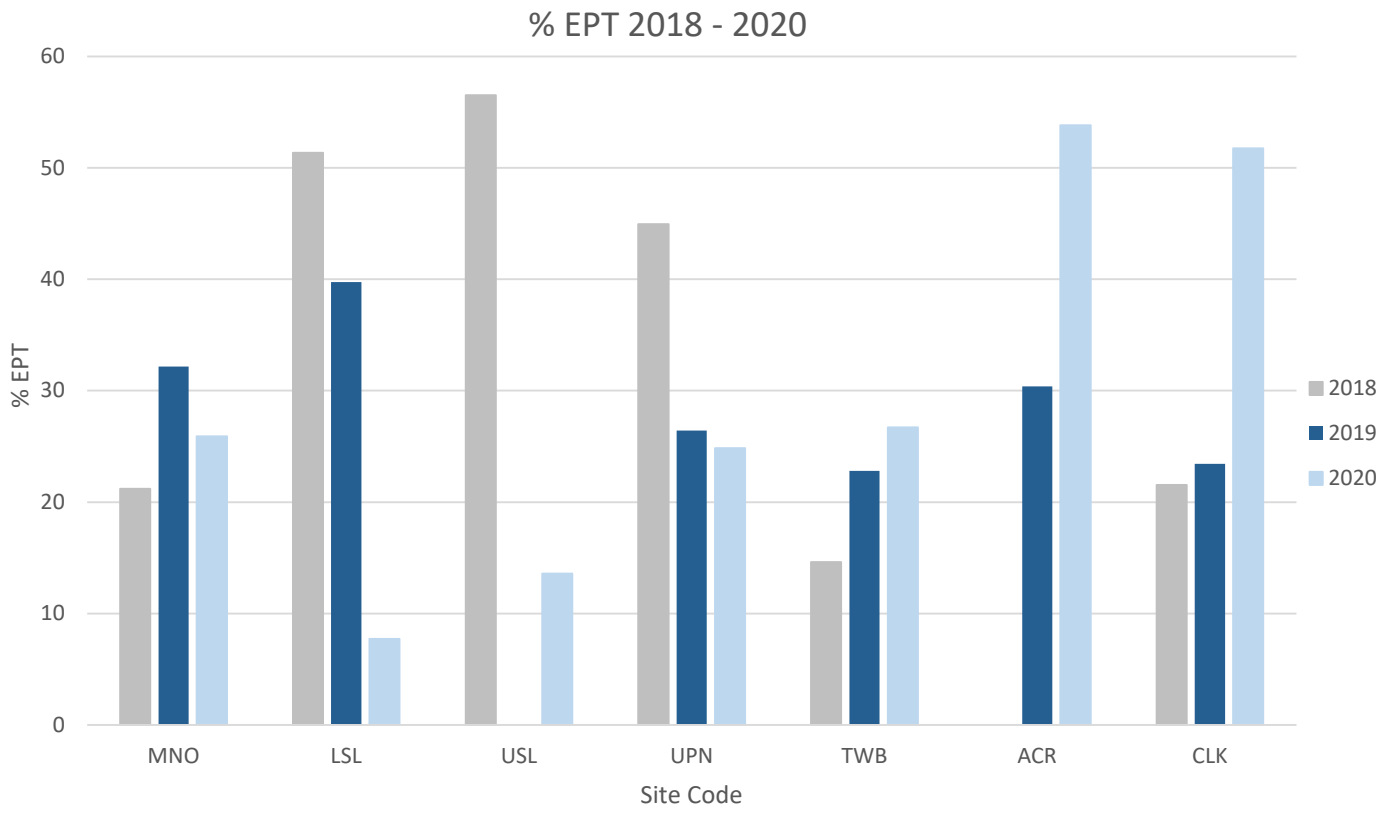


Figure 4. Percent EPT data for 2018-2020 bioassessment monitoring.

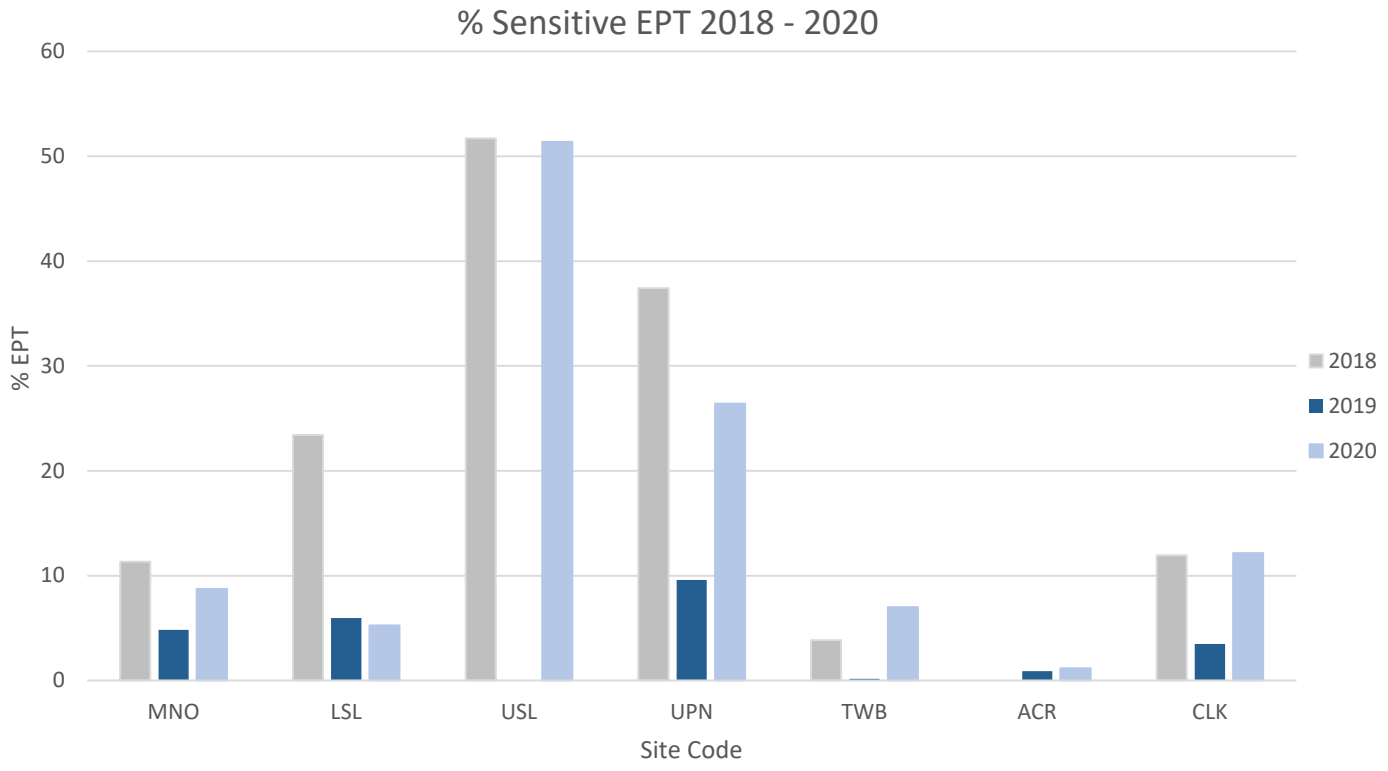


Figure 5. Percent Sensitive EPT data for 2018 – 2020 bioassessment monitoring.

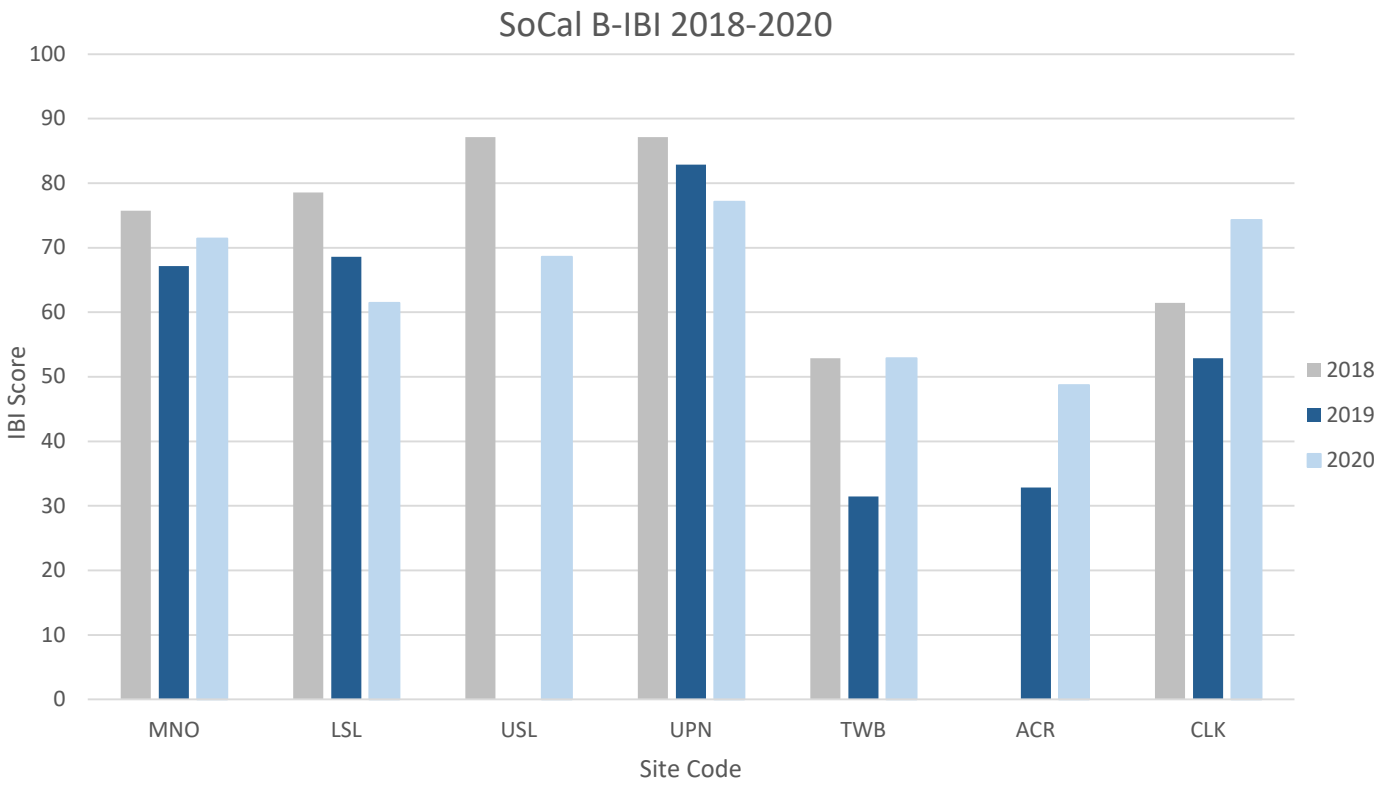


Figure 6. SoCal IBI scores for 2018 – 2020 bioassessment monitoring.

Table 3 shows IBI scores for all Morro Bay watershed creek sites, as well as the average IBI scores for each site. Monitoring began in 1994 and has continued nearly every year since. Monitoring prior to 2002 was conducted by the Central Coast Regional Water Quality Control Board (CCRWQCB). Each year, the number of measurable sites is determined by available resources, staffing, and surface flow conditions. As previously noted, IBI scores are grouped into categories that typically describe the ecological health of each site, shown in Table 4.

The bottom row of Table 3 shows the average of all scores for that site. Scores are color coded based on the ecological health designations in Table 4.

Table 3. IBI scores for Morro Bay watershed creek sites from 1994 – 2020.

	TWB	CER	ACR	CHD	MNO	USB	USL	LSL	WAL	UPN	PEN	DAU	DAM	DAL	CLK	LVR	COO
1994	*	*	*	44.0	*	*	*	*	*	*	82.0	80.0	63.0	*	*	*	*
1995	*	*	*	23.00	*	*	*	*	*	*	*	46.00	43.00	*	*	*	*
1996	*	*	*	33.00	*	*	*	*	*	*	89.00	*	73.00	*	73.00	77.00	*
1997	39.00	*	*	44.00	*	*	*	*	*	*	84.00	76.00	59.00	74.00	90.00	*	*
1998	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1999	*	*	*	*	*	*	*	*	*	*	79.00	9.00	60.00	62.00	70.00	*	*
2000	*	*	*	*	*	*	*	*	*	*	*	69.00	*	*	*	*	*
2001	54.00	*	*	27.00	*	*	*	*	*	*	62.00	*	*	72.00	*	*	*
2002	36.00	*	*	*	*	*	*	*	*	*	*	*	*	*	70.00	*	66.00
2003	34.00	51.00	*	*	*	*	*	*	*	*	*	*	*	*	81.00	*	80.00
2004	32.00	41.00	*	50.00	*	*	*	*	*	*	66.00	*	*	*	79.00	*	*
2005	36.00	31.00	*	*	*	*	*	*	*	*	*	*	*	*	60.00	46.00	83.00
2006	46.00	*	*	46.00	*	*	*	*	*	84.00	70.00	*	*	*	51.00	*	87.00
2007	49.00	30.00	*	49.00	*	*	*	*	*	70.00	*	*	*	*	*	*	83.00
2008	55.80	30.00	*	44.30	75.80	*	*	67.20	38.60	78.70	*	80.10	50.10	50.10	58.60	*	81.50
2009	*	*	*	57.20	*	*	*	70.07	*	*	*	91.52	74.36	*	*	*	*
2010	*	*	*	*	67.21	77.22	91.52	75.79	28.60	*	*	71.50	52.91	60.06	65.78	41.47	*
2011	*	34.29	*	54.29	62.86	*	58.57	54.29	*	85.71	*	58.57	65.71	*	57.14	48.57	*
2012	45.71	47.14	*	*	74.29	*	*	72.86	*	84.29	*	*	*	*	70.00	*	*
2013	54.29	22.86	*	*	71.43	*	60.00	40.00	*	80.00	*	*	*	*	*	*	*
2014	41.43	30.00	*	*	44.29	*	65.71	55.71	*	78.57	*	*	*	*	*	*	*
2015	24.29	32.86	*	50.00	48.57	*	68.57	67.14	*	61.43	*	*	*	*	*	*	*
2016	30.00	18.57	*	50.00	71.43	*	80.00	65.71	*	72.86	54.29	*	*	*	*	*	*
2017	48.57	31.43	*	44.29	40.00	*	*	50.00	54.29	77.14	*	80.00	50.00	*	51.43	28.57	71.43
2018	52.86	25.71	*	55.71	75.71	*	87.14	78.57	*	87.14	*	82.86	*	*	61.43	*	62.86
2019	31.43	18.57	32.86	*	67.14	*	*	68.57	*	82.86	*	65.71	48.57	*	52.86	35.71	*
2020	52.86		48.57		71.43		68.57	61.43		77.14					74.29		
Average IBI	42.4	31.7	40.7	44.8	64.2	77.2	72.5	63.6	40.5	78.4	73.3	67.5	58.2	63.6	66.6	46.2	76.8

Table 4. General Ecological Health Designations for IBI scores.

Rating	Score Range	Color Code
Very Good	80-100	Dark Green
Good	60-79.9	Green
Fair	40-59.9	Yellow
Poor	20-39.9	Orange
Very Poor	0-19.9	Red

To provide a spatial overview of the WY2020 IBI scores as well as historical averages, two maps were created, shown in Figures 8 and 9. Figure 8 shows mainstem stream segments and their ecological health designations based on WY2020 IBI scores. Figure 9 shows the same designations based on averages from 1994 to 2020. Stream segments containing multiple monitoring sites used the average IBI of all sites within that segment to determine the ecological health designation. This applies to both Figure 8 and Figure 9. Coon Creek (site code COO), while not directly draining to Morro Bay, has been used as a nearby reference site to demonstrate the potential conditions in the Morro Bay watershed without human disturbance. This site was eliminated as a monitoring location in 2019. A new site will be established within the watershed to serve as a reference site

Conclusions

Based on available resources and stream conditions, seven sites were monitored by the MBNEP in WY2020. Of these sites, five are regularly monitored. Rather than following the 'Core' and 'Rotating' site framework established in 2019, sites were chosen based on the ability to survey the sites while maintaining adequate social distancing due to the COVID-19 pandemic. Because of this, one Core site was skipped (DAU) and one Rotating site was surveyed that was also surveyed in 2019 (ACR). One additional Rotating site was monitored (USL).

Some sites had dramatic improvement in WY2020 compared to WY2019, while other sites were similar or slightly lower than in WY2019. Four sites showed slight to substantial improvement from WY2019, while three had slightly lower scores. In WY2020, sampling was conducted slightly later in the season than usual (May 14 June 4, 2020) due to the logistics of conducting fieldwork during the COVID-19 pandemic. Because stream flows were down and water temperatures were becoming elevated in some streams, it is possible that some macroinvertebrates had already started to emerge at some sites.

An overview of WY2020 scores in comparison to WY2019 is as follows:

- The largest increase in scores from WY2019 was seen on Lower Chorro Creek (TWB), which was 68% higher than in WY2019, and at the newest site, Above Chorro Reserve (ACR), which was 48% higher. Both sites improved a category, going from "Poor" to "Fair." Upper Los Osos Creek (CLK) also showed a large improvement with a score 41% higher than in WY2019. A fourth site, San Bernardo (MNO), was higher by 6%. CLK and MNO both remained in the same category of "Good."
- Two sites had slight decreases in scores compared to WY2019 - Lower San Luisito Creek (LSL) with a 10% decrease, and Upper Pennington Creek (UPN) with a 7% decrease. UPN did decrease from the "Very Good" category in WY2019 to the "Good" category in WY2020.
- The remaining site, Upper San Luisito Creek (USL), was last sampled in WY2018. The WY2020 score was moderately lower, with a decrease of 21%. USL decreased from the "Very Good" category in WY2018 to "Good" in WY2020.

Sites were on par with the historic average or higher than the historic average:

- Upper Pennington (UPN) was about average (-2%) and remained in the "Good" category. The two sites on San Luisito Creek were also above average. LSL was -3% and USL -5%.

- Two sites had a slight improvement from average. San Bernardo (MNO) and Upper Clark Valley (CLK) were 11% and 12% higher than average, respectively.
- Lower Chorro Creek (TWB) had the largest deviation from average, with an increase of 25%, although it remained in the "Fair" category. The other Chorro Creek site, ACR, was first sampled in WY2019, and thus lacks adequate data to calculate an average.

Due to drought conditions experienced in California from 2011 to 2017, IBI scores have tended to be lower than average. WY2019 appears to be one of the first years to show an upward trend in scores, despite the lasting effects of the drought. After higher rainfall totals in recent years, scores are now returning to pre-drought levels.

Future Efforts

More conventional methods of water quality monitoring capture instantaneous conditions but do not always allow an assessment of the overall aquatic health of a water body. Biotic data such as bioassessment allows for a more complete picture of creek health. The CCRWQCB utilizes this data to assess impairment in Central Coast waterbodies. Due to the value of this data set to the MBNEP and its partners, we plan to continue this effort into the future.

Figure 7. Mainstem stream segments and their ecological health designations based on 2020 IBI scores.

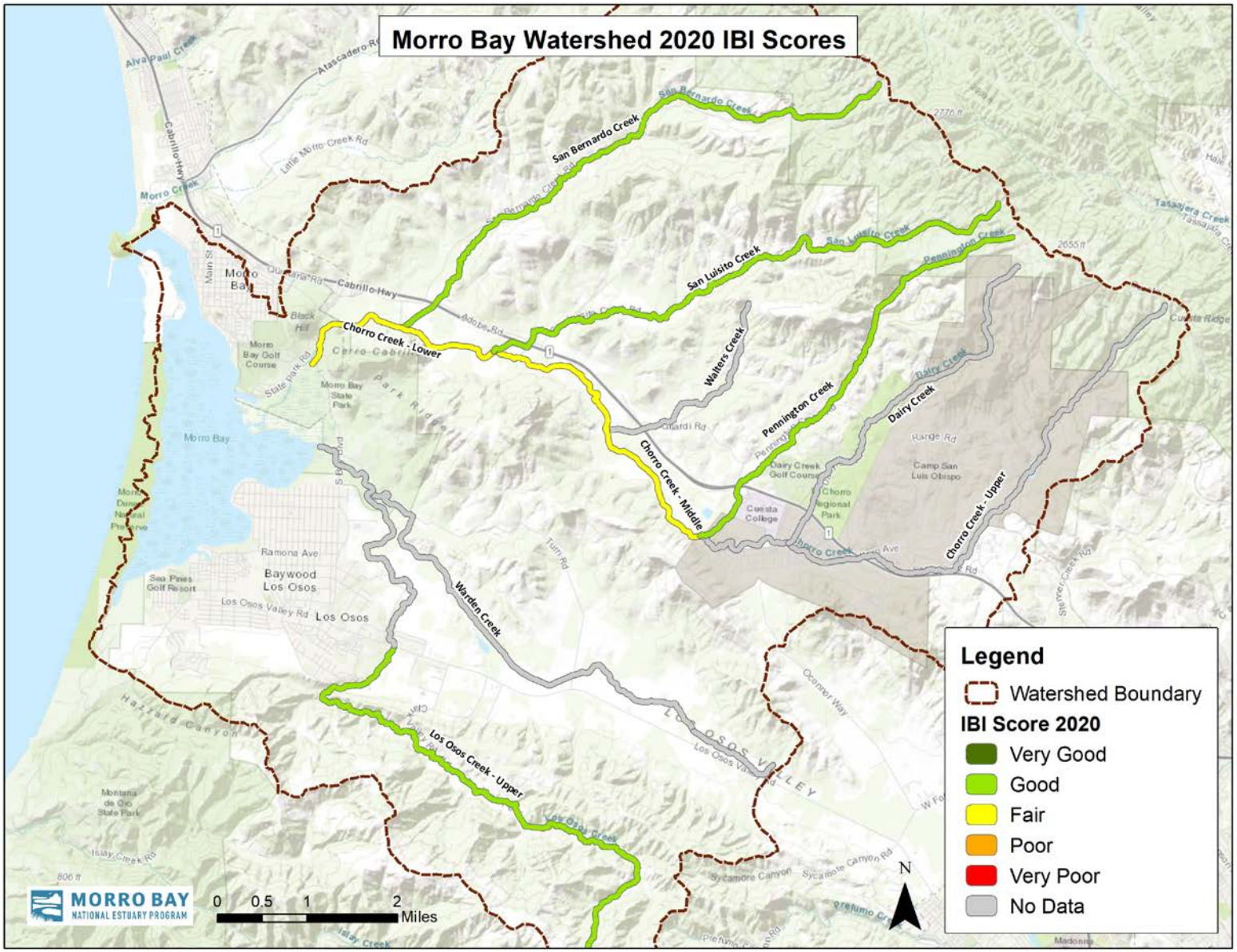
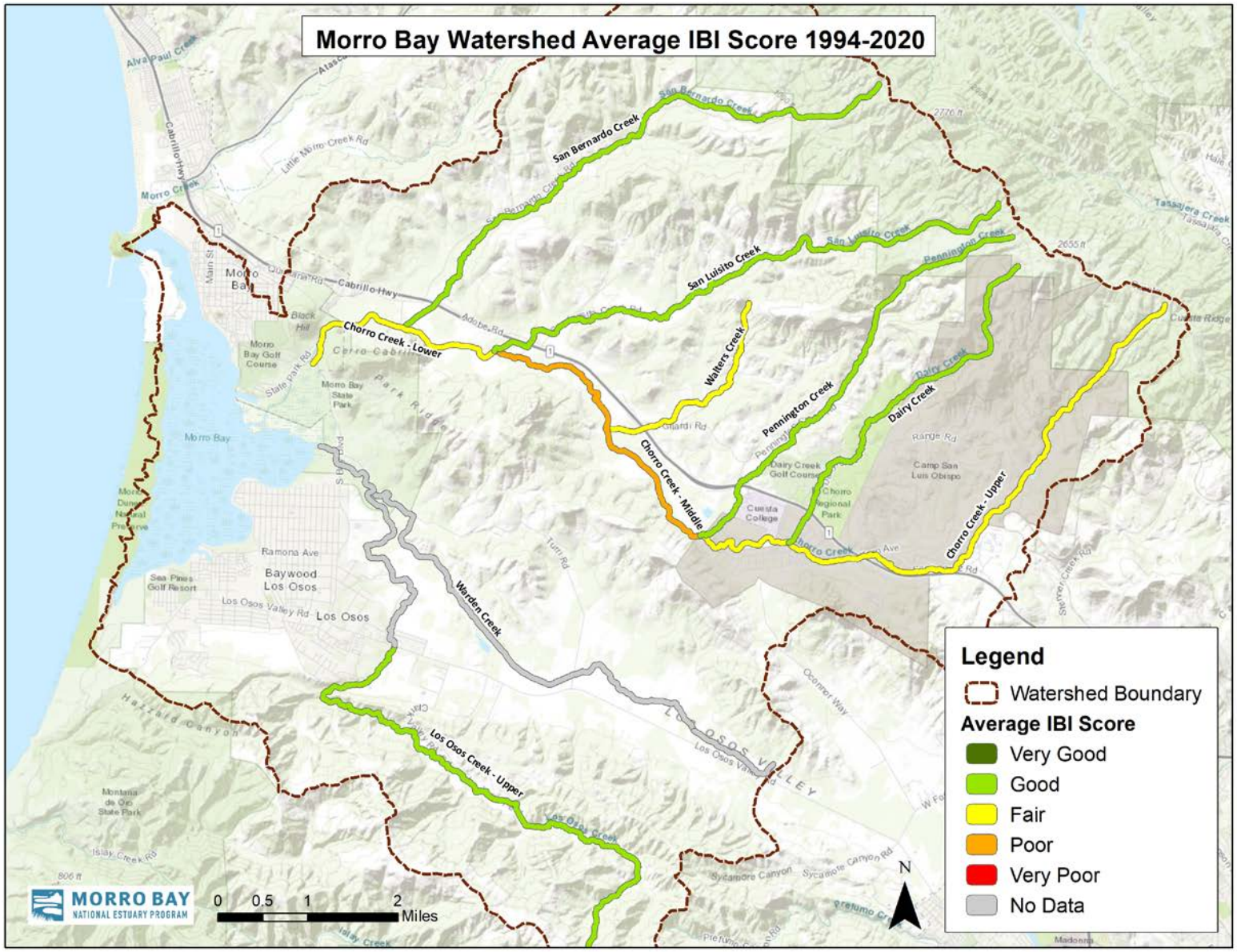


Figure 8. Mainstem stream segments and their ecological health designations based on average IBI scores from 1994 to 2020.



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