Benthic Macroinvertebrate Bioassessment

Data Summary Memo

2018

November 9, 2018
Updated July 16, 2020

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

Acknowledgements

The Morro Bay National Estuary Program would like to thank the following individuals and organizations for their time, effort, and support, all of which made this monitoring possible:

- The Harold J. Miossi Charitable Trust for their generous grant that funded the 2018 monitoring effort.
- Karissa Willits, MBNEP, for spearheading the effort for the organization.
- The dedicated MBNEP volunteers who donated their time to ensuring the success of this project.
- EcoAnalysts, Inc. for analyzing the samples.
- The landowners who granted access for the monitoring.

This report should be cited as follows:

Morro Bay National Estuary Program's Benthic Macroinvertebrate Bioassessment Data Summary Memo 2018. Morro Bay National Estuary Program. November 2018.

List of Acronyms

Acronym	Definition
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
SAFIT	Southwest Association of Freshwater Invertebrate Taxonomists
SCP	Scientific Collection Permit
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)

Table of Contents

List of Figures

List of Tables

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 lands that surround it. 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) establish protection and restoration targets.

This report summarizes the results of aquatic bioassessment using benthic macroinvertebrates (BMIs) during the 2018 water year (WY2018). 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 four primary metrics used to determine waterbody health: taxa richness, Ephemeroptera, Plecoptera, and Trichoptera (EPT) richness, percent EPT, and Index of Biotic Integrity (IBI) Score. Bioassessment surveys were conducted by MBNEP staff and volunteers at ten locations throughout the Morro Bay watershed during WY2018. Table 1 highlights these ten sites in blue and identifies 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 university, California Polytechnic State University, San Luis Obispo, reports 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 2 shows the locations of all bioassessment sites surveyed by the MBNEP between the years of 2002 to 2018.

Table 1. MBNEP Bioassessment Sites, with WY2018 sites in blue.

Site Code	Site Description
TWB	Lower Chorro Creek
CER	Middle Chorro Creek
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

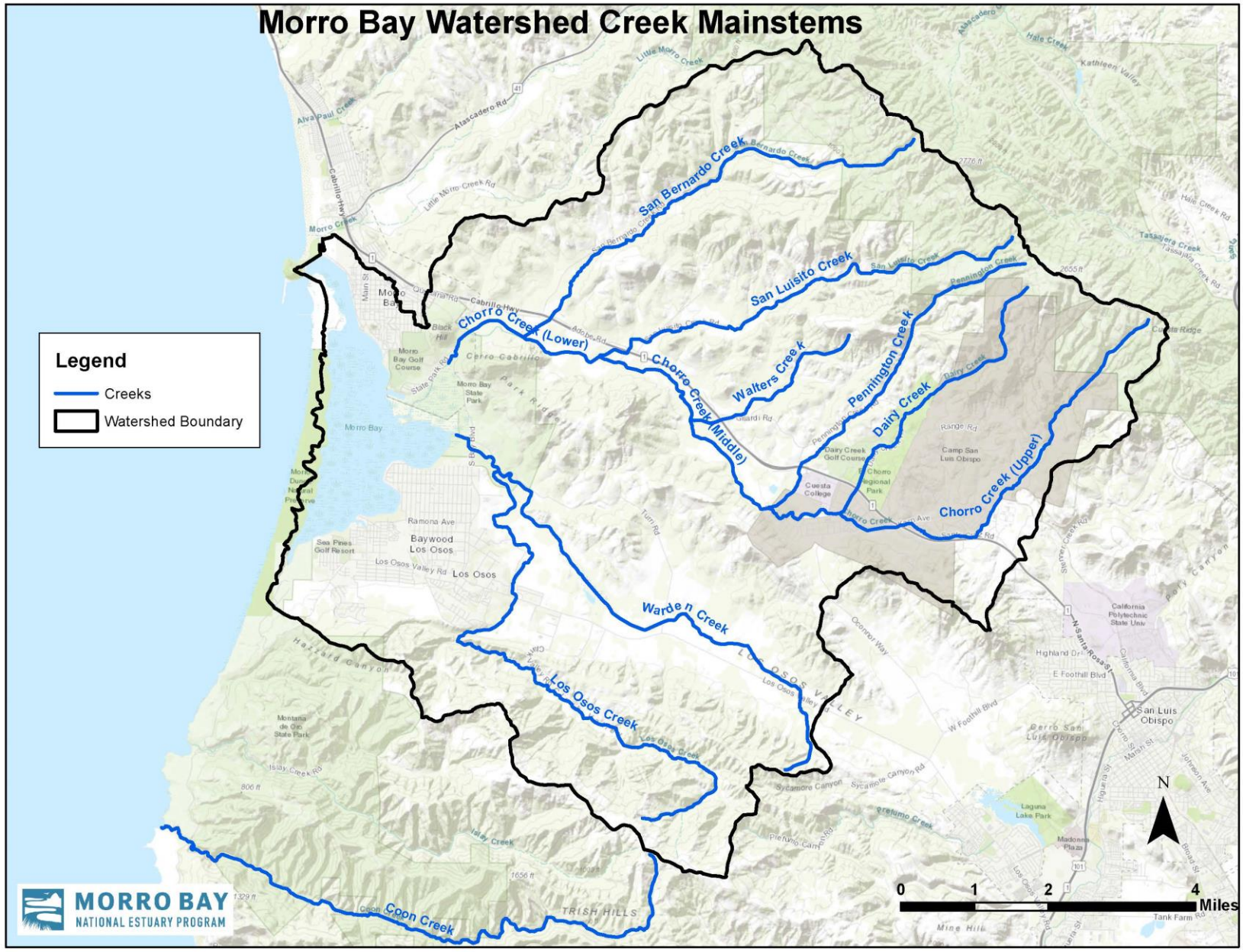

Figure 1. Morro Bay Watershed boundary and the mainstem creek segments.

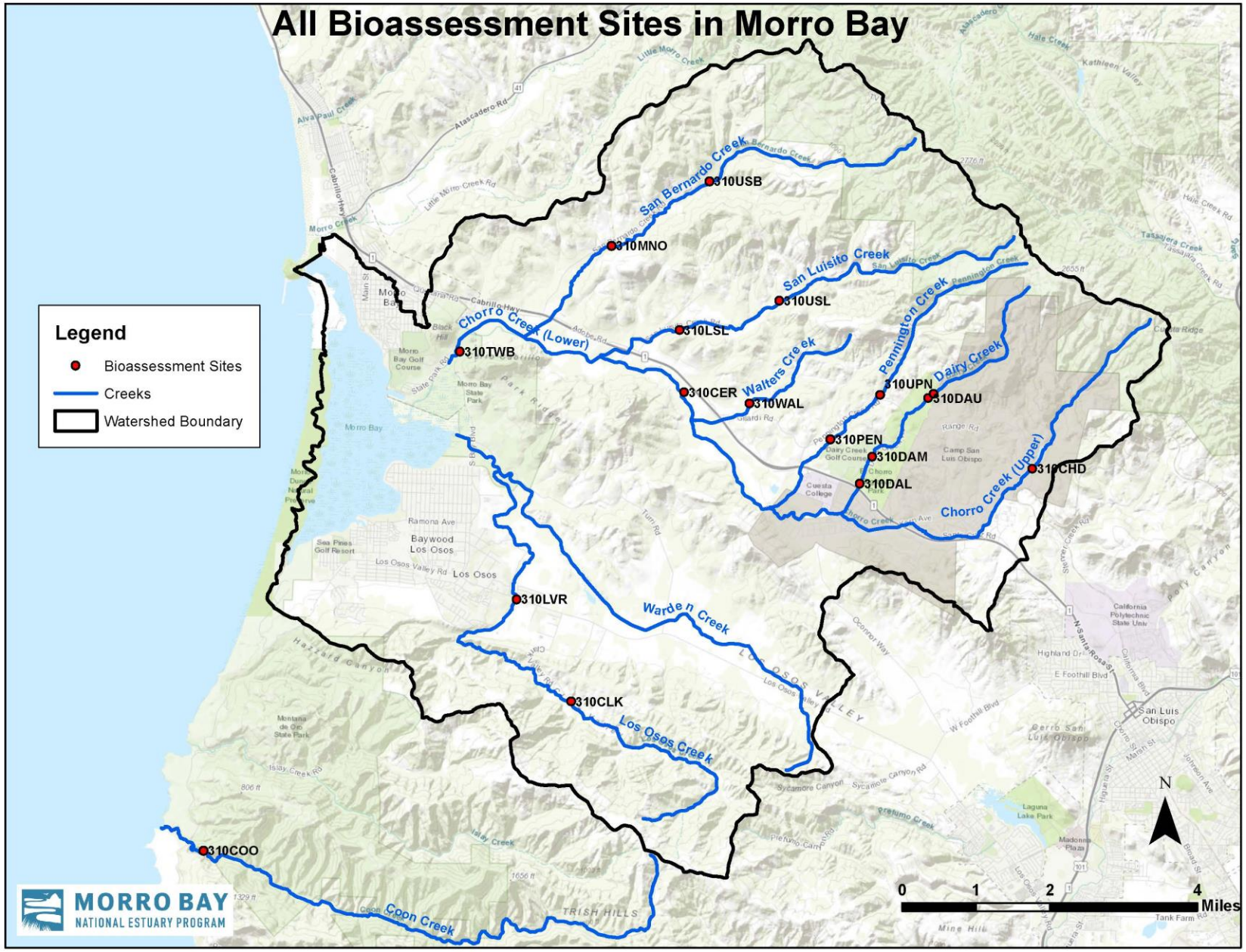

Figure 2. Bioassessment Sites in the Morro Bay Watershed surveyed between 2002 and 2018.

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 10 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 Southwest Association of Freshwater Invertebrate Taxonomists (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.

These calculated metrics include taxa richness, EPT richness, EPT%, and IBI score. 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. 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 are included in the calculation: 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.

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 WY2018 bioassessment monitoring and provide context for the results by comparing them to historical bioassessment metrics.

Taxa richness, EPT richness, EPT %, and IBI scores from the most recent three-year period (2016–2018) are displayed in Table 2. The table includes three years of scores for the ten sites monitored in 2018. An "X" indicates that no monitoring occurred. Additionally, Figures 3 to 6 show trends in these four metrics over the same time frame. Typically, taxa richness and EPT richness decrease with poor water quality.

Table 2. Results of Taxa Richness, EPT Richness, EPT%, and SoCal IBI scores for 2016 – 2018.

Site	Year	Taxa Richness	EPT Richness	% EPT	SoCal B-IBI
MNO (San Bernado Creek)	2016	70.00	16.00	23.59	71.4
	2017	37.00	12.00	52.70	40.00
	2018	52.00	19.00	21.19	75.71
UPN (Upper Pennington Creek)	2016	73.00	14.00	15.95	72.9
	2017	50.00	15.00	58.44	77.14
	2018	57.00	21.00	44.95	87.14
LSL (Lower San Luisito Creek)	2016	44.00	15.00	31.99	65.7
	2017	37.00	12.00	28.80	50.00
	2018	55.00	22.00	51.36	78.57
COO (Coon Creek)	2016	X	X	X	X
	2017	48.00	16.00	56.91	71.43
	2018	52.00	15.00	43.96	62.86
TWB (Lower Chorro Creek)	2016	42.00	2.00	2.92	30.0
	2017	31.00	9.00	34.07	48.57
	2018	46.00	11.00	14.61	52.86
DAU (Upper Dairy Creek)	2016	X	X	X	X
	2017	49.00	11.00	44.79	80.00
	2018	66.00	22.00	37.80	82.86
CER (Middle Chorro Creek)	2016	47.00	5.00	12.94	18.6
	2017	39.00	9.00	34.10	31.43
	2018	39.00	9.00	31.57	25.71
CHD (Upper Chorro Creek)	2016	58.00	15.00	24.66	50.0
	2017	43.00	15.00	37.07	44.29
	2018	55.00	16.00	39.06	55.71
CLK (upper Los Osos Creek)	2016	X	X	X	X
	2017	51.00	8.00	4.95	51.43
	2018	59.00	10.00	21.55	61.43
USL (Upper San Luisito Creek)	2016	66.00	23.00	27.63	80.00
	2017	X	X	X	X
	2018	59.00	22.00	56.53	87.14

The following figures contain the taxa richness data. For Figures 3 to 6, the absence of a bar indicates that monitoring was not conducted that year.

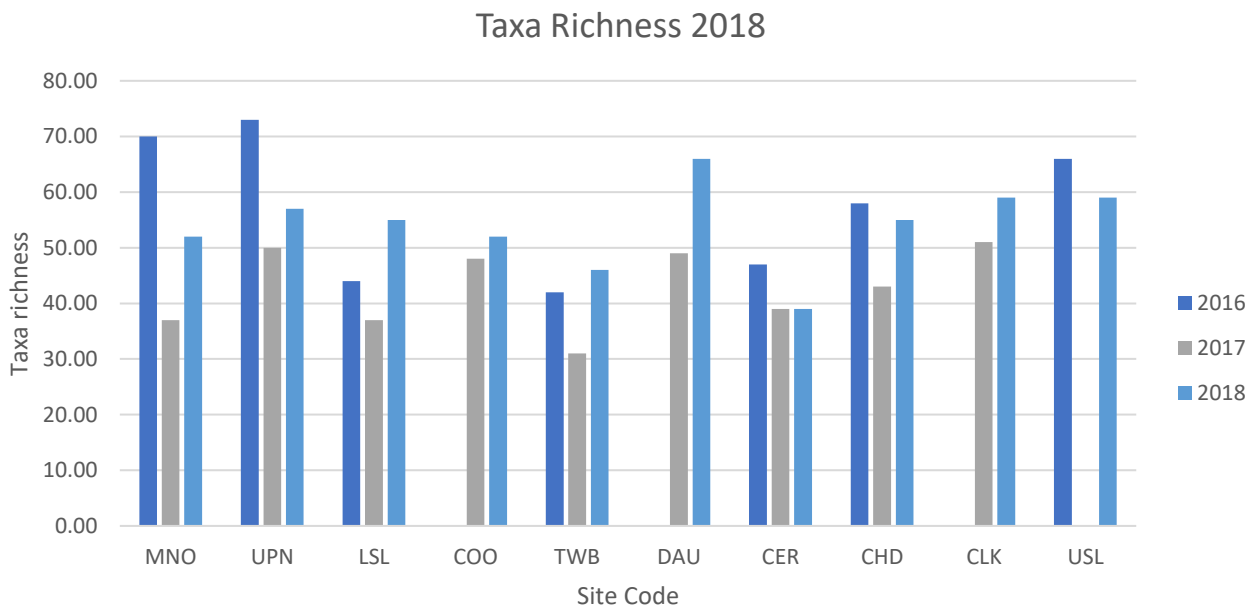

Figure 3. Taxa richness data for 2016 - 2018 bioassessment monitoring.

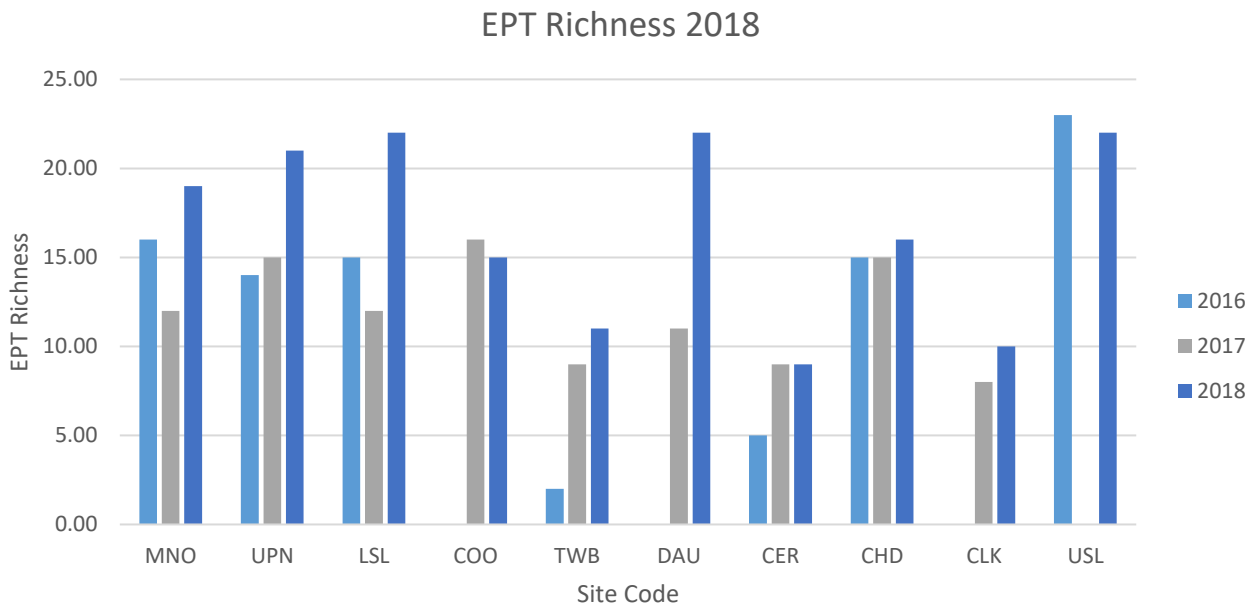

Figure 4. EPT richness data for 2016 - 2018 bioassessment monitoring.

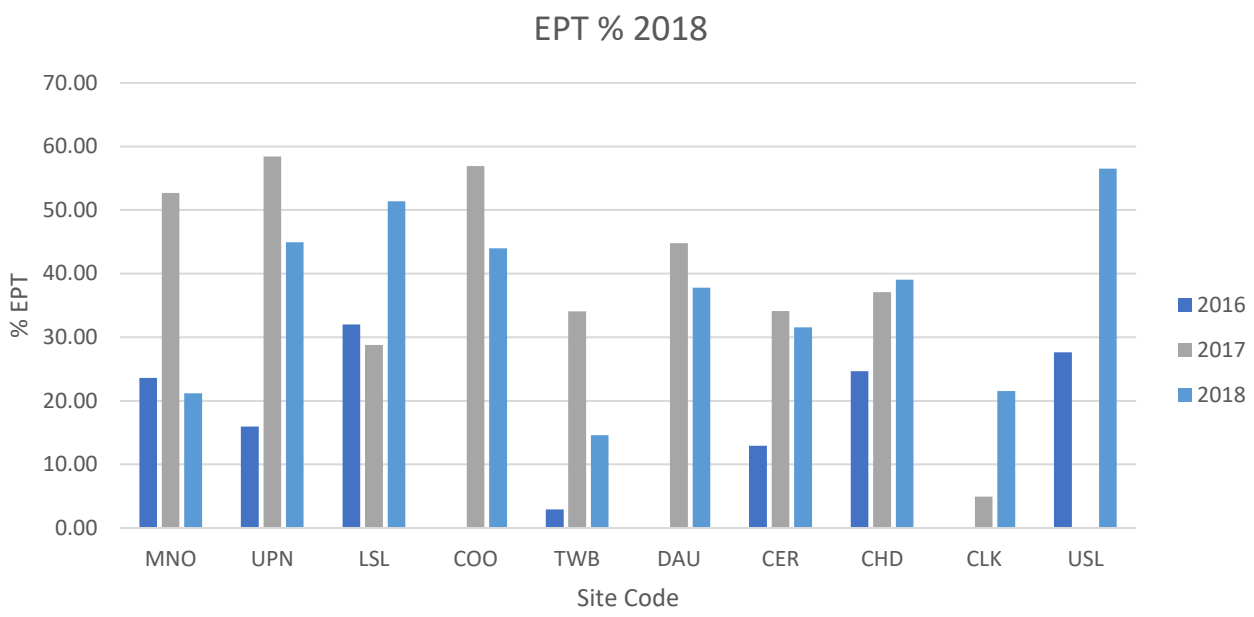

Figure 5. Percent EPT data for 2016 - 2018 bioassessment monitoring.

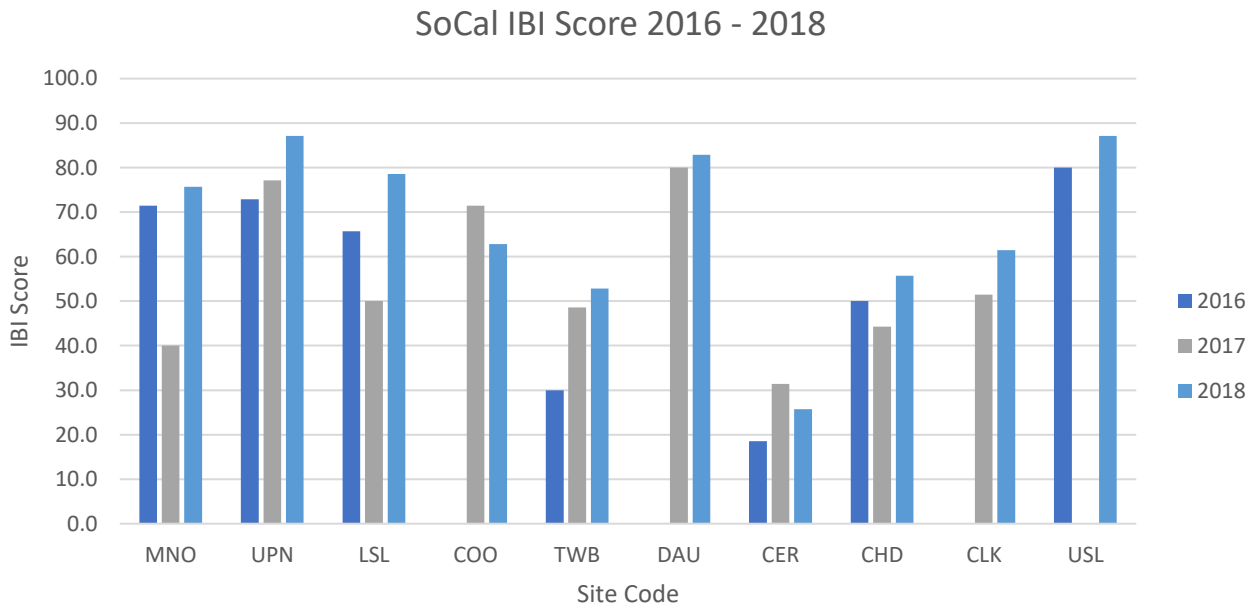

Figure 6. SoCal IBI scores for 2016 - 2018 bioassessment monitoring.

Table 3 shows IBI scores for all Morro Bay watershed creek sites, as well as the average IBI scores. 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). Every year, the number of sites monitored was 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 highlighted based on the ecological health designations in Table 4.

Table 3. All IBI scores for all Morro Bay watershed creek sites from 1994 – 2018.

	TWB	CER	CHD	MNO	USB	USL	LSL	WAL	UPN	PEN	DAU	DAM	DAL	CLK	LVR	COO
1994	*	*	44.0	*	*	*	*	*	*	*	*	*	*	*	*	*
1995	*	*	23.0	*	*	*	*	*	*	*	*	*	*	*	*	*
1996	*	*	33.0	*	*	*	*	*	*	*	*	*	*	73.0	77.0	*
1997	39.0	*	44.0	*	*	*	*	*	*	*	*	*	*	90.0	*	*
1998	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1999	*	*	*	*	*	*	*	*	*	*	*	*	*	70.0	*	*
2000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
2001	54.0	*	27.0	*	*	*	*	*	*	*	*	*	*	*	*	*
2002	36.0	*	*	*	*	*	*	*	*	*	*	*	*	70.0	*	66.0
2003	34.0	51.0	*	*	*	*	*	*	*	*	*	*	*	81.0	*	80.0
2004	32.0	41.0	50.0	*	*	*	*	*	*	66.0	*	*	*	79.0	*	*
2005	36.0	31.0	*	*	*	*	*	*	*	*	*	*	*	60.0	46.0	83.0
2006	46.0	*	46.0	*	*	*	*	*	84.0	70.0	*	*	*	51.0	*	87.0
2007	49.0	30.0	49.0	*	*	*	*	*	70.0	*	*	*	*	*	*	83.0
2008	55.8	30.0	44.3	75.8	*	*	67.2	38.6	78.7	*	80.1	50.1	50.1	58.6	*	81.5
2009	*	*	57.2	*	*	*	70.1	*	*	*	91.5	74.4	*	*	*	*
2010	*	*	*	67.2	77.2	91.5	75.8	28.6	*	*	71.5	52.9	60.1	65.8	41.5	*
2011	*	34.3	54.3	62.9	*	58.6	54.3	*	85.7	*	58.6	65.7	*	57.1	48.6	*
2012	45.7	47.1	*	74.3	*	*	72.9	*	84.3	*	*	*	*	70.0	*	*
2013	54.3	22.9	*	71.4	*	60.0	40.0	*	80.0	*	*	*	*	*	*	*
2014	41.4	30.0	*	44.3	*	65.7	55.7	*	78.6	*	*	*	*	*	*	*
2015	24.3	32.9	50.0	48.6	*	68.6	67.1	*	61.4	*	*	*	*	*	*	*
2016	30.0	18.6	50.0	71.4	*	80.0	65.7	*	72.9	54.3	*	*	*	*	*	*
2017	48.6	31.4	44.3	40.0	*	*	50.0	54.3	77.1	*	80.0	50.0	*	51.4	28.6	71.4
2018	52.9	25.7	55.7	75.7	*	87.1	78.6	*	87.1	*	82.9	*	*	61.4	*	62.9
Average IBI	42.4	32.8	44.8	63.2	77.2	73.1	63.4	40.5	78.2	63.4	77.4	58.6	55.1	67.0	48.3	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 WY2018 IBI scores as well as historical averages including WY2018, two maps were created, shown in Figures 7 and 8. Figure 7 shows mainstem stream segments and their ecological health designations based on 2018 IBI scores. Figure 8 shows the same designations based on 1994 – 2018 averages. To protect landowner privacy, 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 7 and Figure 8. Coon Creek (site code COO), while not directly draining to Morro Bay, is used as a nearby reference site to demonstrate the potential conditions in the Morro Bay watershed without human disturbance.

Conclusion

Based on available resources and stream conditions, ten sites were monitored by the MBNEP in WY2018. A majority of these sites have been regularly monitored by the MBNEP, with the exception of three sites: Coon Creek (COO), Upper Dairy Creek (DAU), and Upper Los Osos Creek (CLK). These had not been monitored recently due to inadequate flow or dry conditions during the prolonged drought. The WY2018 scores have comparable values to WY2016 and WY2017. In comparing WY2017 and to WY2018, eight of the 10 sites monitored had increases in IBI scores. San Bernardo Creek (MNO) displayed the greatest change with an increase of 89% from WY2017. Small decreases were observed at only two sites, Coon Creek (COO) and Middle Chorro Creek (CER). Middle Chorro (CER) had the biggest drop in IBI score with a decrease of about 18%. The WY2018 score from Coon Creek (COO) was 12% lower than the WY2017 score. Both of these sites also had IBI scores lower than the average of their past scores.

The IBI scores for WY2018 were on par with historic averages. An upward trend was observed for a majority of the sites monitored. There was an increase from the historical average at Lower Chorro (TWB), San Bernardo (MNO), Upper Pennington (UPN), Lower San Luisito (LSL), Upper Dairy (DAU), Upper Chorro (CHD), and Upper San Luisito (USL). At three sites, Coon Creek (COO), Middle Chorro (CER), and Upper Los Osos (CLK), the WY2018 scores were slightly lower than the average for the site. The greatest deviation was observed at TWB which was 25% higher than its historical average, though only 9% higher than WY2017 IBI scores. Lower San Luisito also showed significant increases with IBI scores 24% higher than average, and 57% higher than WY2017.

Due to drought conditions experienced in California from 2011 to 2017, IBI scores have tended to be lower than average. WY2018 appears to be one of the first years to show an upward trend in scores, despite the lasting effects of the drought.

Future Efforts

More conventional methods of water quality monitoring capture instantaneous conditions but don't always allow an assessment of the overall aquatic health of a water body. Biotic data such as bioassessment allow 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.

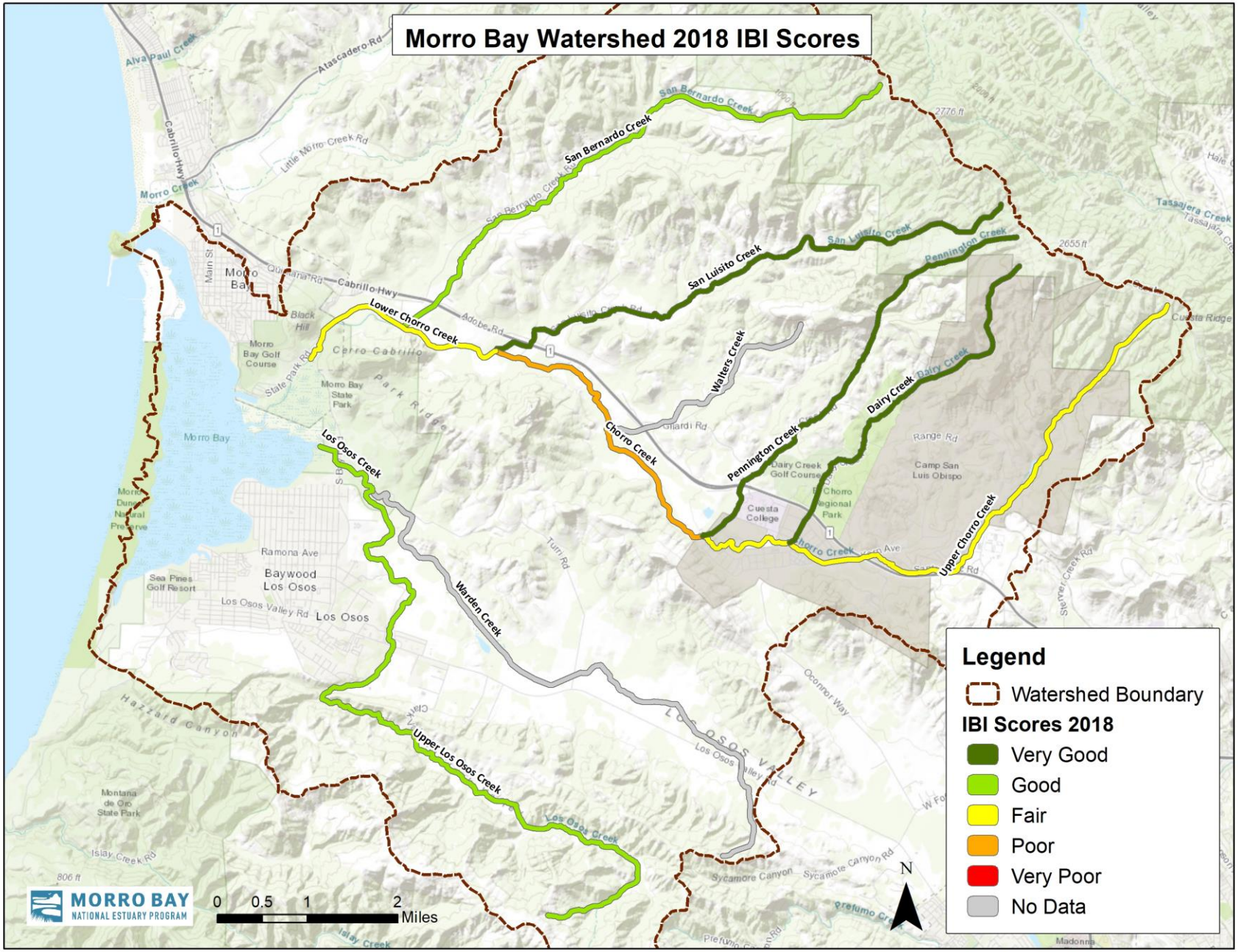

Figure 7. Mainstem stream segments and their ecological health designations based on 2018 IBI scores.

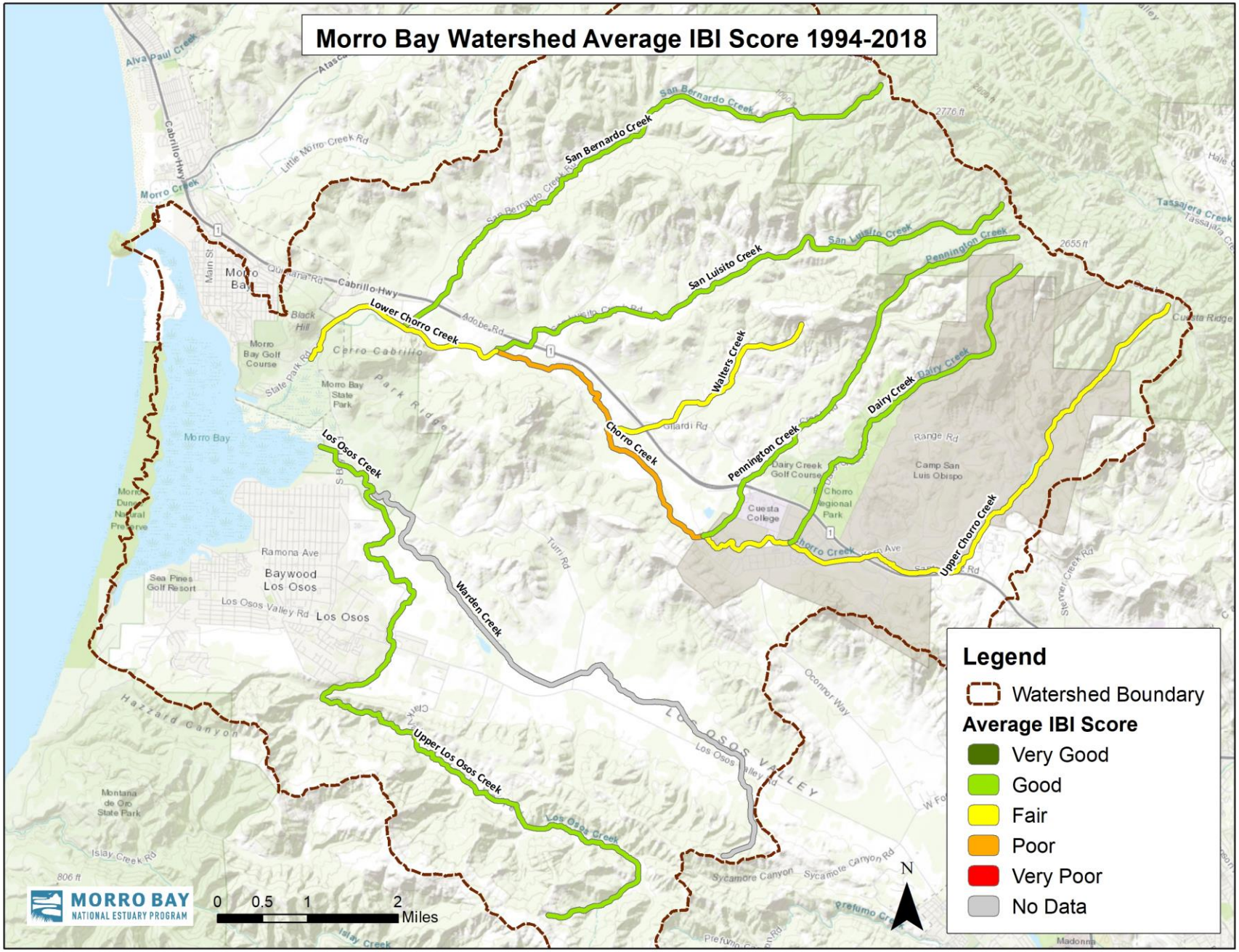

Figure 8. Mainstem stream segments and their ecological health designations based on average IBI scores from 1994 to 2018.

References

Cal Poly San Luis Obispo. 2017. *Irrigation Training & Research Center*. Official Cal Poly Precipitation Data. California Polytechnic State University, ITRC. www.itrc.org/databases/precip/ Accessed 4 October 2017.

Ode, P.R., A.E., Fetscher, and L.B. Busse. 2016. *Standard Operating Procedures for the Collection of Field Data for Bioassessments of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habitat.* California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Bioassessment SOP 004

Surface Water Ambient Monitoring Program (SWAMP). *Bioassessment.* State Water Resources Control Board, 18 July 2017, www.waterboards.ca.gov/water_issues/programs/swamp/bioassessment/. Accessed 27 November 2017.