Benthic Macroinvertebrate Bioassessment

Data Summary Memo

2017

September 19, 2018

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- EcoAnalysts. Inc. for analyzing the samples.
- The landowners who granted access for the monitoring.

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List of Acronyms

Acronym	Definition
BMI	Benthic Macroinvertebrate
CCRWQCB	Central Coast Regional Water Quality Control Board
CDFW	California Department of Fish and Wildlife
EPT	Ephemeroptera, Plecoptera, and Trichoptera
MBNEP	Morro Bay National Estuary Program
SoCal IBI	Southern California Coastal Index of Biotic Integrity
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 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 2017 water year (WY2017). 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 twelve locations throughout the Morro Bay watershed during WY2017. Table 1 highlights these twelve 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 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 2005 to 2017.

Table 1. MBNEP Bioassessment Sites, with WY2017 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

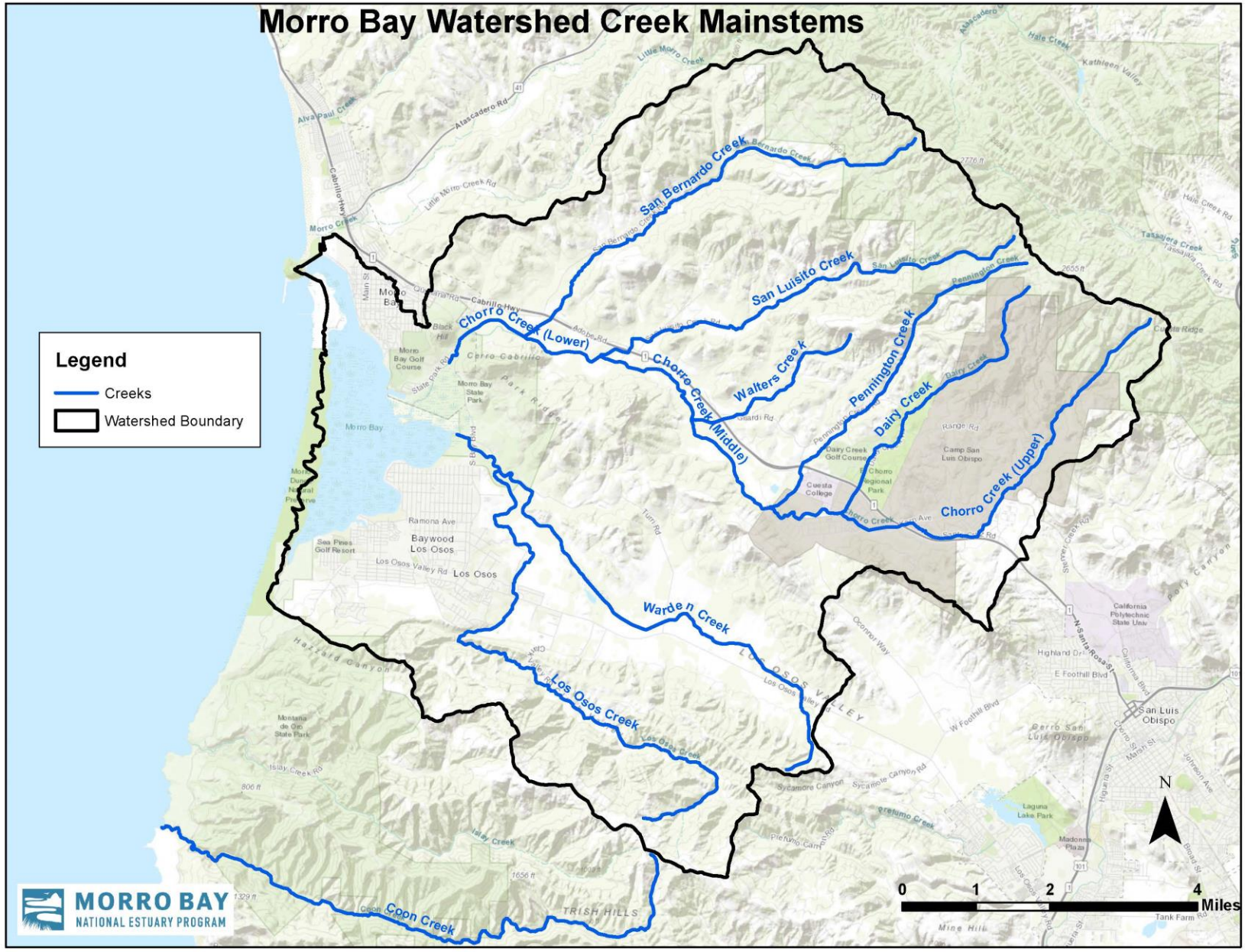

Figure 1. Morro Bay Watershed boundary and the main stem creek segments.

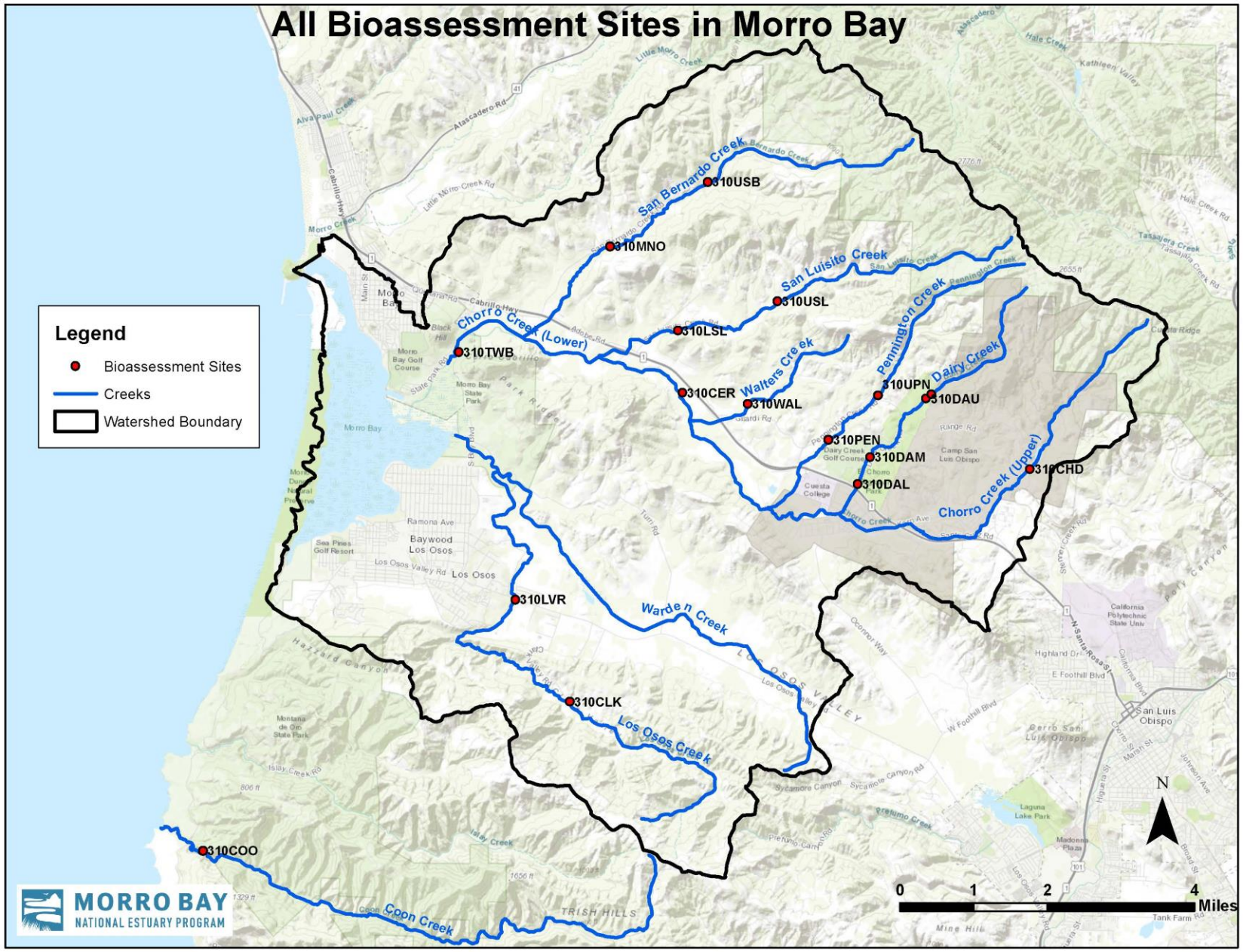

Figure 2. Bioassessment Sites in the Morro Bay Watershed surveyed between 2005 - 2017.

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 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 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.

This monitoring effort is conducted under a CDFW Scientific Collection Permit. 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 WY2017 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 (2015–2017) are displayed below in Table 2. These are specific to the twelve sites monitored in 2017. An "x" indicates that a site was not monitored. 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 2015 – 2017.

Site	Year	Taxa Richness	EPT Richness	% EPT	SoCal B-IBI
WAL (Walters Creek)	2015	X	X	X	X
	2016	X	X	X	X
	2017	49.00	7.00	31.58	54.29
LVR (Los Osos Creek)	2015	X	X	X	X
	2016	X	X	X	X
	2017	34.00	7.00	50.15	28.57
DAM (Middle Dairy Creek)	2015	X	X	X	X
	2016	X	X	X	X
	2017	52.00	10.00	48.50	50.00
MNO (San Bernardo Creek)	2015	57.00	5.00	4.30	48.6
	2016	70.00	16.00	23.59	71.4
	2017	44.00	17.00	52.70	40.00
UPN (Upper Pennington Creek)	2015	53.00	10.00	16.07	61.4
	2016	73.00	14.00	15.95	72.9
	2017	58.00	20.00	58.44	77.14
LSL (Lower San Luisito Creek)	2015	54.00	14.00	17.83	67.1
	2016	44.00	15.00	31.99	65.7
	2017	45.00	18.00	28.80	50.00
COO (Coon Creek)	2015	X	X	X	X
	2016	X	X	X	X
	2017	62.00	24.00	56.91	71.43
TWB (Lower Chorro Creek)	2015	31.00	0.00	0.00	24.3
	2016	42.00	2.00	2.92	30.0
	2017	37.00	10.00	34.07	48.57
DAU (Upper Dairy Creek)	2015	X	X	X	X
	2016	X	X	X	X
	2017	59.00	14.00	44.79	80.00
CER (Middle Chorro Creek)	2015	42.00	9.00	11.90	32.9
	2016	47.00	5.00	12.94	18.6
	2017	46.00	13.00	34.10	31.43
CHD (Upper Chorro Creek)	2015	63.00	14.00	13.04	50.0
	2016	58.00	15.00	24.66	50.0
	2017	53.00	18.00	37.07	44.29
CLK (upper Los Osos Creek)	2015	X	X	X	X
	2016	X	X	X	X
	2017	59.00	8.00	4.95	51.43

The following figures contain the taxa richness data. For Figures 3 to 6, the absence of a bar indicates that monitoring was not conducted. A score of zero is indicated by a green arrow.

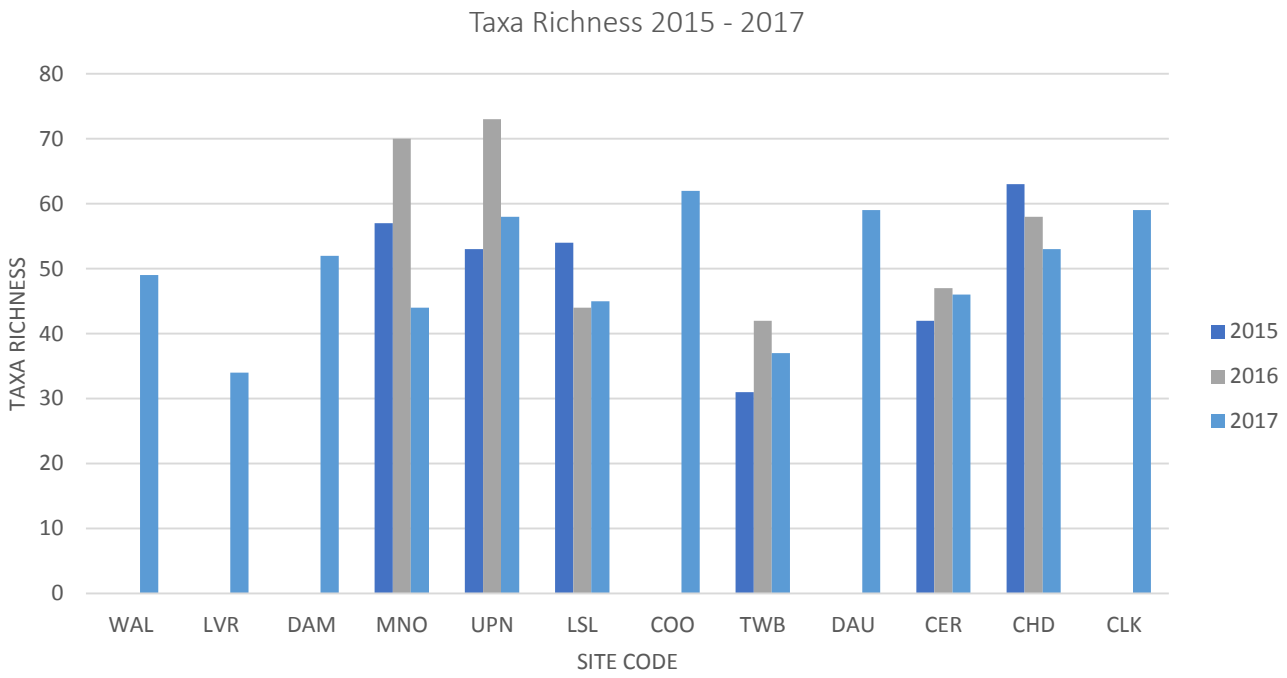

Figure 3. Taxa richness data for 2015 – 2017 bioassessment monitoring.

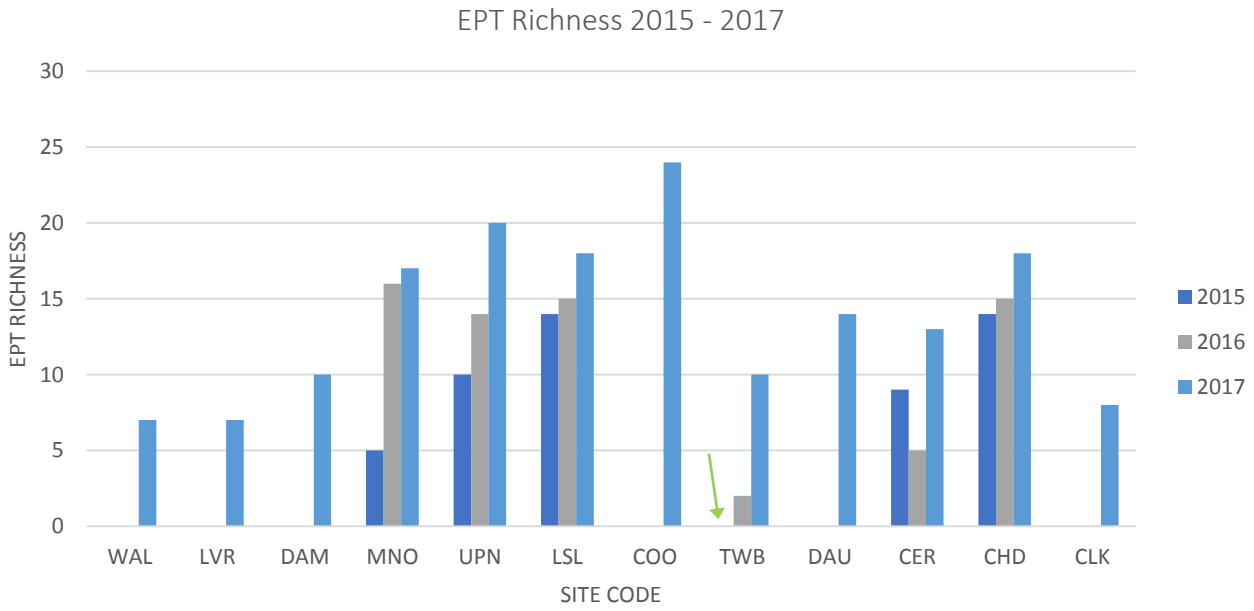

Figure 4. EPT richness data for 2015 – 2017 bioassessment monitoring.

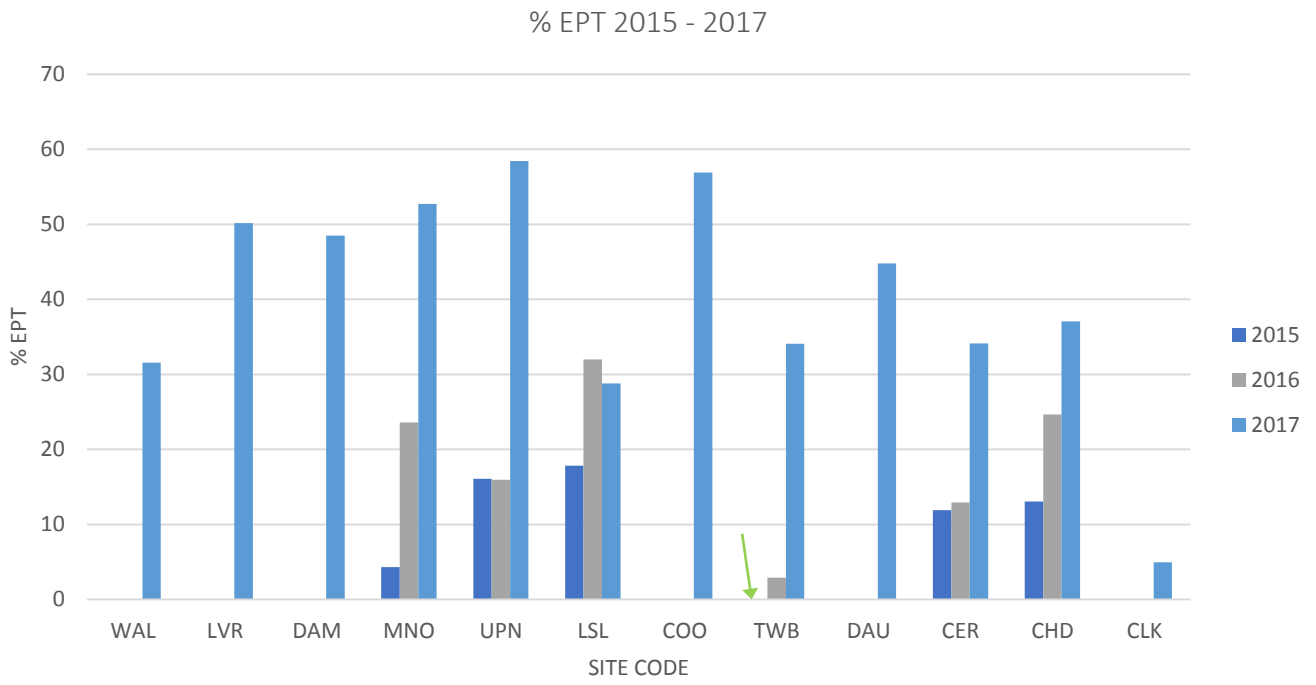

Figure 5. Percent EPT data for 2015 – 2017 bioassessment monitoring.

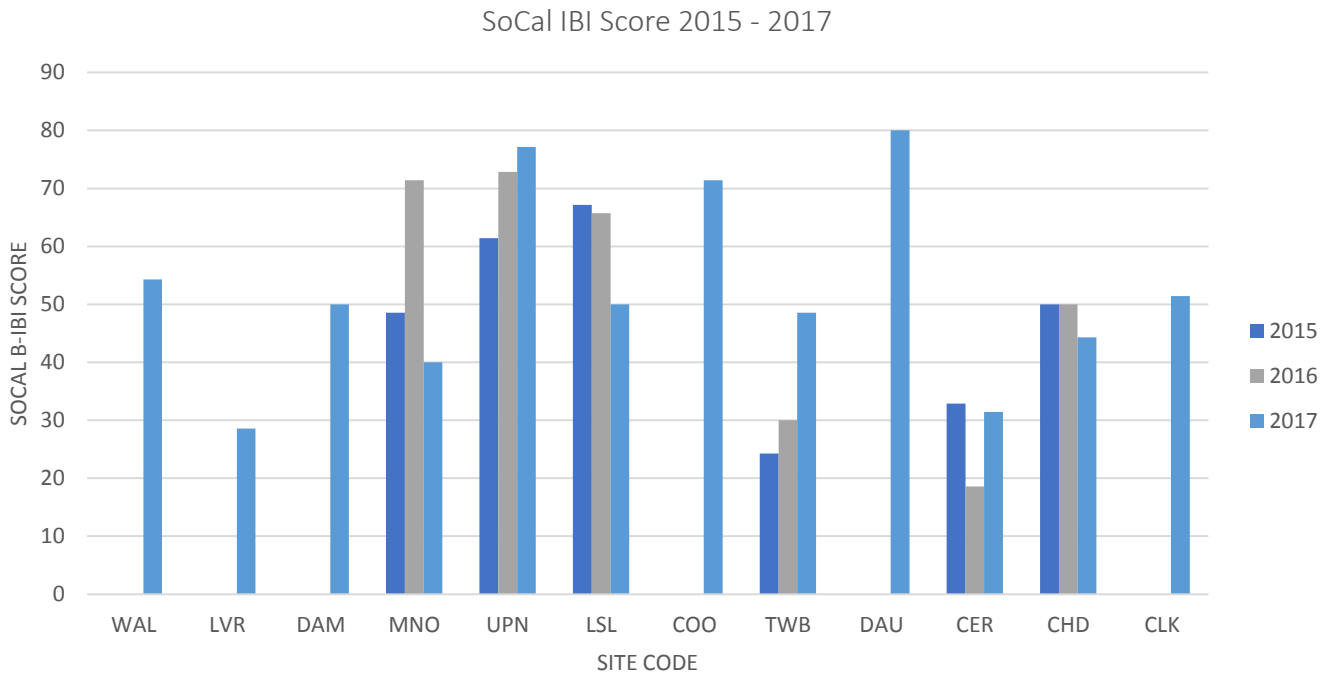

Figure 6. SoCal IBI scores for 2015 – 2017 bioassessment monitoring.

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 measurable sites 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 – 2017.

	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
Average IBI	41.7	33.3	44.0	61.8	77.2	70.7	61.9	40.5	77.3	63.4	76.3	58.6	55.1	67.5	48.3	78.8

Table 4. General Ecological Health Designations for SoCal 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 WY2017 IBI scores as well as historical averages including WY2017, two maps were created, shown in Figures 7 and 8. Figure 7 shows main stem stream segments and their ecological health designations based on 2017 IBI scores. Figure 8 shows the same designations based on 1994 to 2017 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

In WY2017, the Morro Bay Watershed received 36.57" of rain (150.4% of normal). Given the available resources and adequate stream conditions, twelve sites were monitored by the MBNEP during WY2017, including a number of sites that had not been monitored for several years due to lack of adequate flow. Of the twelve sites monitored in WY 2017, only six had comparable values from WY2015 and WY2016. The other six sites did not have adequate flow or were dry during the prolonged drought and thus, have not been monitored since 2011 or 2012. The 2017 IBI scores from these six sites varied in relation to the last two years, but overall were similar to historic averages for those sites. An increase from the historical average was observed at Lower Chorro Creek (TWB) and Middle Chorro Creek (CER), whereas Upper Chorro Creek (CHD), San Bernardo (MNO), Lower San Luisito (LSL), and Upper Pennington (UPN) were all slightly lower than average. The greatest deviation was observed at MNO, which was 35% lower than its historical average, and 44% lower than its WY2016 IBI score.

Since 2011, IBI scores tended to be lower than average, which is thought to be due to the persistent drought conditions that California experienced from 2011 to 2017. Though 2017 was a high rainfall year, scores still followed this trend, and this is thought to be due to the lasting effects of the drought and the time necessary to recover from drought impacts.

Little to no flow in streams can result in inadequate habitat conditions for many aquatic organisms, including BMI. Many of the sites that were monitored in WY2017 had previous sampling events factored into the historic average that took place during the drought. Though the drought can have negative effects on stream conditions, bioassessment data collected during these years can be very informative, especially when compared to years of normal to high rainfall.

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.

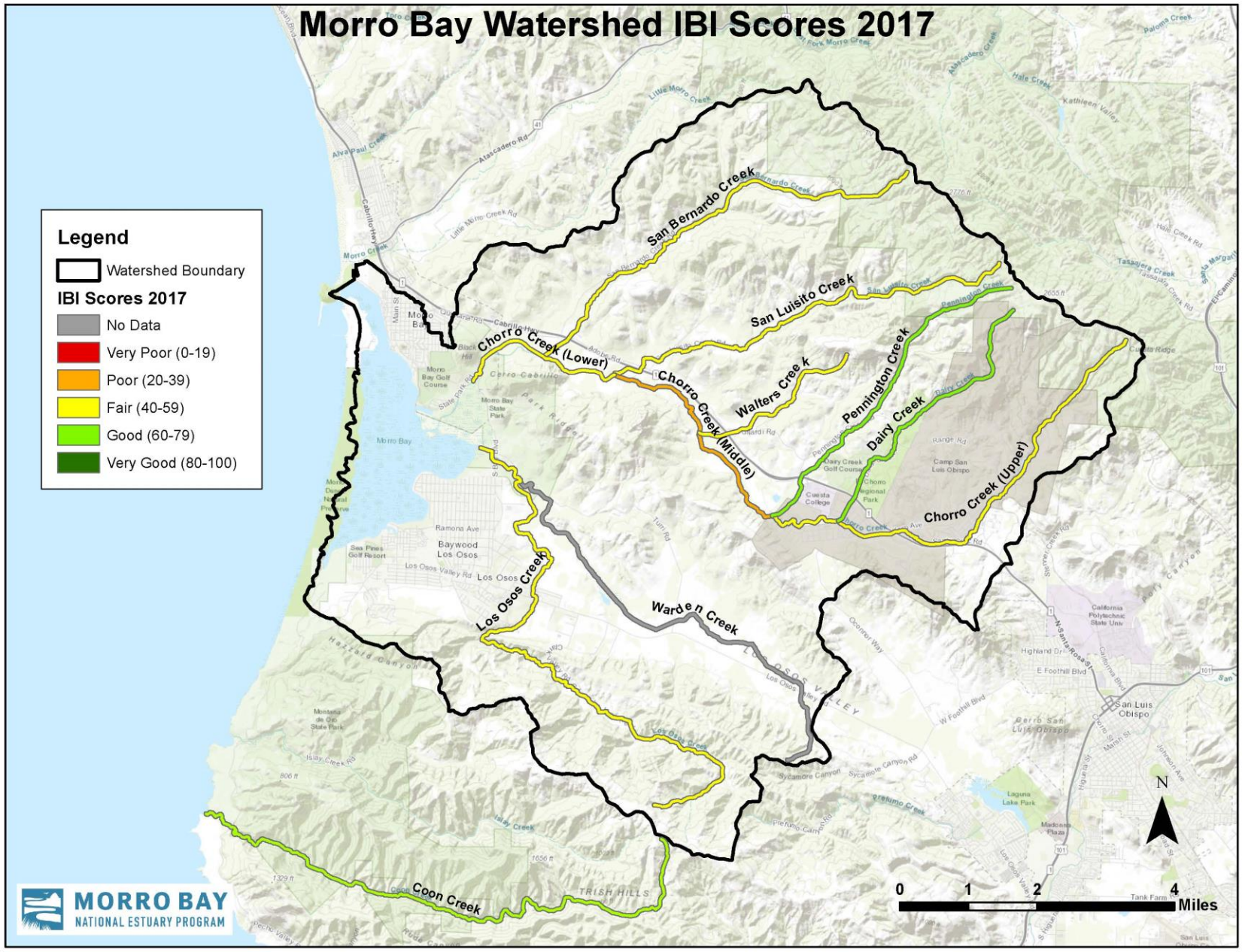

Figure 7. Main stem stream segments and their ecological health designations based on 2017 IBI scores.

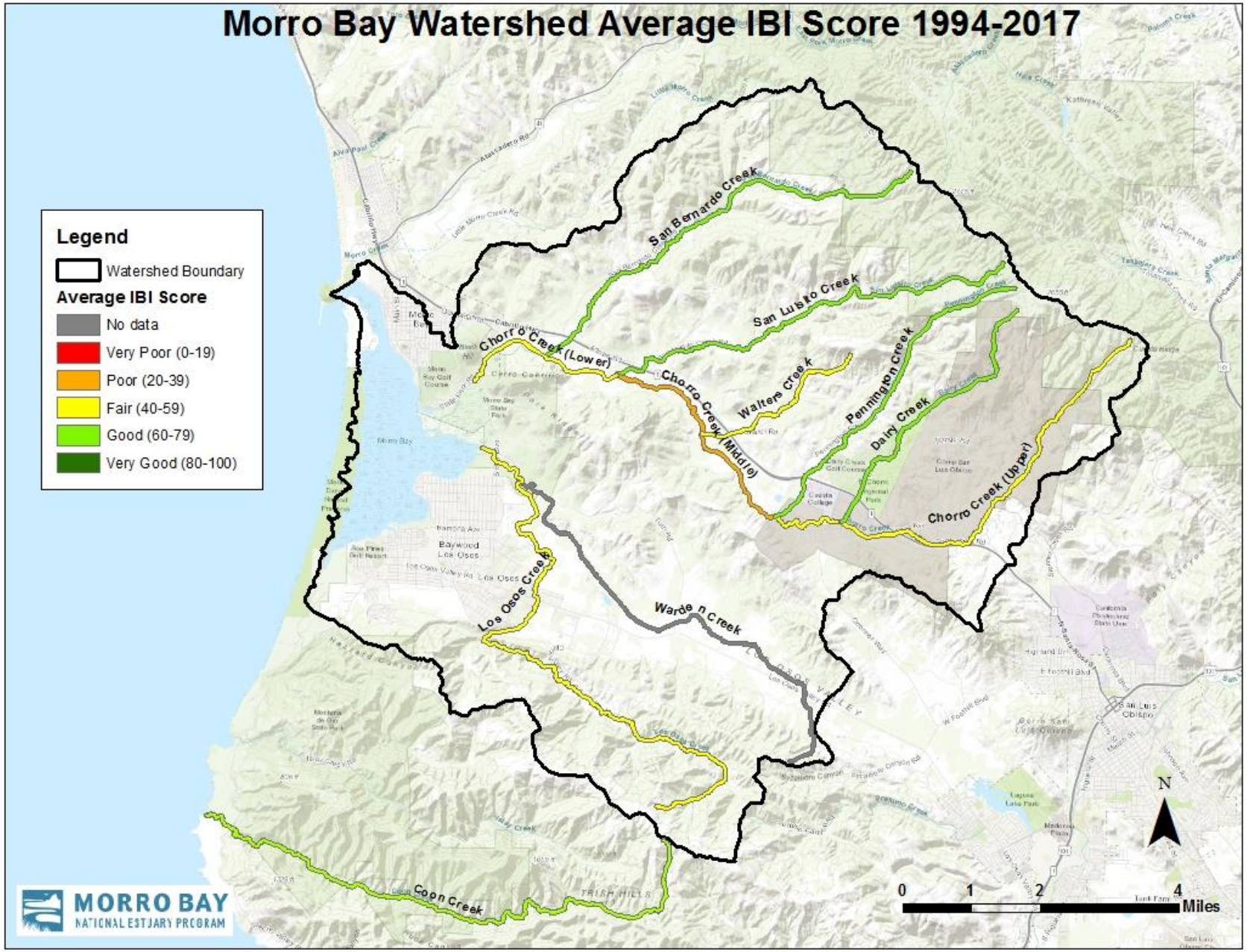

Figure 8. Main stem stream segments and their ecological health designations based on average IBI scores from 1994 to 2017.

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