Benthic Macroinvertebrate Bioassessment

Data Summary Memo

2021

September 2022

Morro Bay National Estuary Program
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- Our dedicated staff and volunteers who have donated their time to ensuring the success of this project.
- The many landowners who have allowed access for this monitoring.

List of Acronyms

Acronym	Definition
BMI	Benthic Macroinvertebrate
CDFW	California Department of Fish and Wildlife
CCRWQCB	Central Coast Regional Water Quality Control Board
CSCI	California Stream Condition Index
EPT	Ephemeroptera, Plecoptera, and Trichoptera
MBNEP	Morro Bay National Estuary Program (or Estuary Program)
RWB	Reach-wide benthos (biotic sampling method)
SAFIT	Southwest Association of Freshwater Invertebrate Taxonomists
SoCal B-IBI (IBI)	Southern California Coastal Index of Biotic Integrity
SWAMP	Surface Water Ambient Monitoring Program
WY	Water Year (Oct 1st to September 30th, named for the year in which it ends)

Citation

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Introduction

The Morro Bay National Estuary Program (Estuary Program) 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.

The Estuary Program conducts monitoring within the Morro Bay watershed, which is approximately 77 square miles. The watershed is largely dominated by agricultural use, with some urban land use primarily along the coast. The inland watershed drains west into the Morro Bay estuary via two primary creeks: Chorro Creek and Los Osos Creek.

Benthic macroinvertebrates, or BMIs, are bottom-dwelling organisms, composed mainly of insects in their larval stage as well as other small aquatic species. These organisms are sensitive to changes in stream chemistry and substrate conditions, and therefore have been used as a means of assessing waterbody health for decades (Barbour, 1999).

This report summarizes the results of benthic macroinvertebrate samples collected during bioassessment surveys from 1994 to 2021[1] from Chorro Creek, Los Osos Creek, and their tributaries. Bioassessment monitoring is conducted per the Surface Water Ambient Monitoring Program (SWAMP) *Standard Operating Procedures (SOP) for the Collection of Field Data for Bioassessments of California Wadeable Streams* (Ode et. al, 2016). This protocol incorporates physical, chemical, and biotic factors that can be used to measure and assess impacts to surface water ecosystems over time.

Sites

The Estuary Program conducts bioassessment surveys each spring at various locations throughout the Morro Bay watershed. Typically, 10 site locations are selected for monitoring each year. The site selection process is dictated by several factors, including site status (“core” or “rotating”), site access, creek conditions, and adequate staffing. There are six core sites that are monitored every year and a number of rotating sites that are generally monitored every other or every third year. Sites not listed as either core or rotating are historic sites which have been dropped due to access issues or unfavorable monitoring conditions. Due to the COVID-19 pandemic in 2020 and 2021, additional factors contributed to site selection, including adequate space for social distancing and sites that could be monitored with a small staff-only crew.

During the 2021 effort, 10 surveys were conducted by Estuary Program staff. Only five of the six core sites could be monitored due to issues with site access at Upper Los Osos Creek (CLK). Two new sites were monitored as po10tial reference sites in the Morro Bay watershed. These sites are located in the upper middle and upper north forks of Pennington Creek (UMP, UNP).

[1] Data prior to 2002 was collected by the Central Coast Regional Water Quality Control Board (CCRWQCB).

Table 1. *Bioassessment sites codes and locations for sites monitored in 2021.*

Site Code	Site Description	Type
TWB	Lower Chorro Creek	Core
CER	Middle Chorro Creek	Rotating
ACR	Mid/Upper Chorro Creek	Rotating
MNO	San Bernardo Creek	Core
LSL	Lower San Luisito Creek	Core
UPN	Upper Pennington Creek	Core
UMP	Upper Middle Pennington	Rotating
UNP	Upper Northern Pennington	Rotating
DAU	Upper Dairy Creek	Core
DAM	Middle Dairy Creek	Rotating

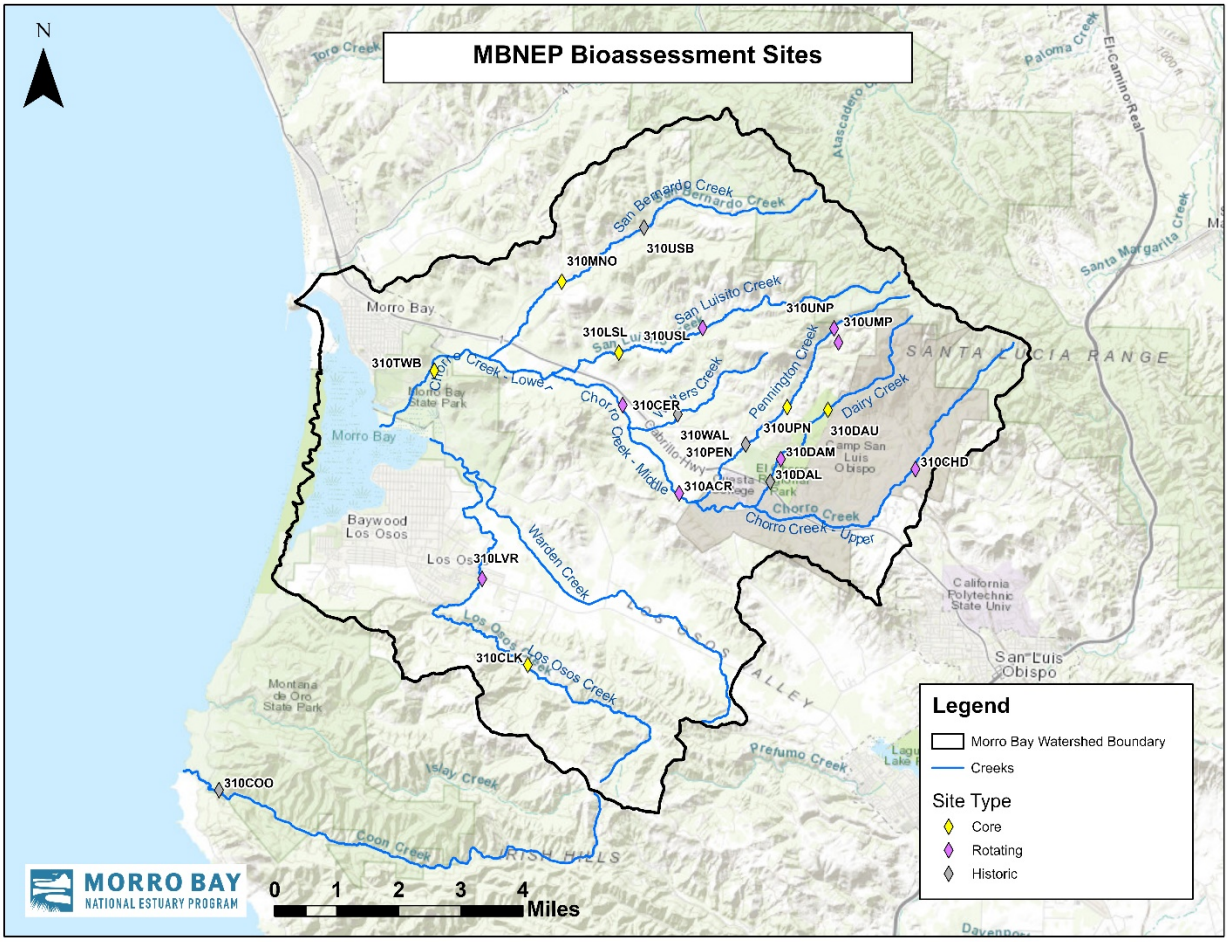

Figure 1. *Core, rotating, and historic bioassessment monitoring locations.*

Methods

The Estuary Program conducts annual spring bioassessment surveys per the SWAMP *Standard Operating Procedures* protocol (Ode et. al, 2016). Due to limited sampling resources, the Estuary Program does not conduct the algae collection module. All surveys are conducted under a current scientific collection permit (SCP), granted by the California Department of Fish and Wildlife (CDFW). The Estuary Program conducts all required notifications and reporting needed to maintain the SCP.

Surveys are completed along a 150-meter long reach that is established at each site and returned to each sampling year. Measurements and observations are taken at 11 equidistant main transects and 10 equidistant inter-transects. These include wetted width, water depth, substrate size, canopy cover, slope, bank stability and algal observations. Macroinvertebrate samples are collected from each of the 10 main transect locations using the reach-wide benthos (RWB) procedure, rotating between the margins and center of the creek. The samples are then composited into a single sample and sent to a certified taxonomy laboratory (EcoAnalysts, Inc.) for sorting and analysis, per Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) Level 2 protocols. The samples are sorted and counted by certified taxonomists until 600 organisms are identified. A final report is then provided by EcoAnalysts Inc., which includes the taxa classifications as well as several calculated metrics and indices. These metrics and indices provide the foundation for the analysis presented in this report.

Results

The following tables, graphs, and maps summarize the results of the 2021 macroinvertebrate sampling effort and provide context for the results by comparing them to the historical data. The metrics and indices presented throughout this report typically decrease in response to disturbance, so higher values generally indicate optimal conditions and lower values indicate less ideal conditions. A dash (-) within any table indicates that no monitoring occurred that year. An absence of a bar on bar graphs indicates no monitoring occurred that year, while a small horizontal line (_) indicates a zero value.

Taxa Metrics

The calculated metrics included in this report are as 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), which are collectively known as EPT.
- **EPT percent** is the percentage of EPT individuals within the total number of individuals in a given sample.
- **Percent sensitive EPT** is the percentage of EPT individuals with associated tolerance values of 0 to 3.

Table 2. *Benthic taxa metric scores from 2019 to 2021.*

Site	Year	Taxa Richness	EPT Richness	% EPT	% Sensitive EPT
MNO (San Bernado Creek)	2019	52	17	32.17	7.50
	2020	61	14	25.90	8.75
	2021	47	11	12.20	3.08
LSL (Lower San Luisito Creek)	2019	52	19	39.74	6.53
	2020	55	15	7.73	5.25
	2021	48	16	42.43	8.62
DAM (Middle Dairy Creek)	2019	38	8	27.98	11.39
	2020	-	-	-	-
	2021	40	6	26.85	26.26
DAU (Upper Dairy Creek)	2019	55	15	42.56	8.78
	2020	-	-	-	-
	2021	27	6	32.23	25.00
UPN (Upper Pennington Creek)	2019	60	16	26.43	9.62
	2020	67	20	24.85	26.41
	2021	61	15	19.69	15.37
UNP (Upper North Pennington)	2019	-	-	-	-
	2020	-	-	-	-
	2021	64	16	17.05	15.15
UMP (Upper Middle Pennington)	2019	-	-	-	-
	2020	-	-	-	-
	2021	51	16	17.53	16.67
TWB (Lower Chorro Creek)	2019	43	10	22.81	1.26
	2020	47	9	26.72	7.01
	2021	40	6	7.37	0.95
CER (Chorro Ecological Reserve)	2019	36	6	36.64	0.41
	2020	-	-	-	-
	2021	29	4	3.88	0.00
ACR (Above Chorro Reserve)	2019	46	13	30.39	0.94
	2020	36	10	53.81	1.16
	2021	31	4	14.33	0.00

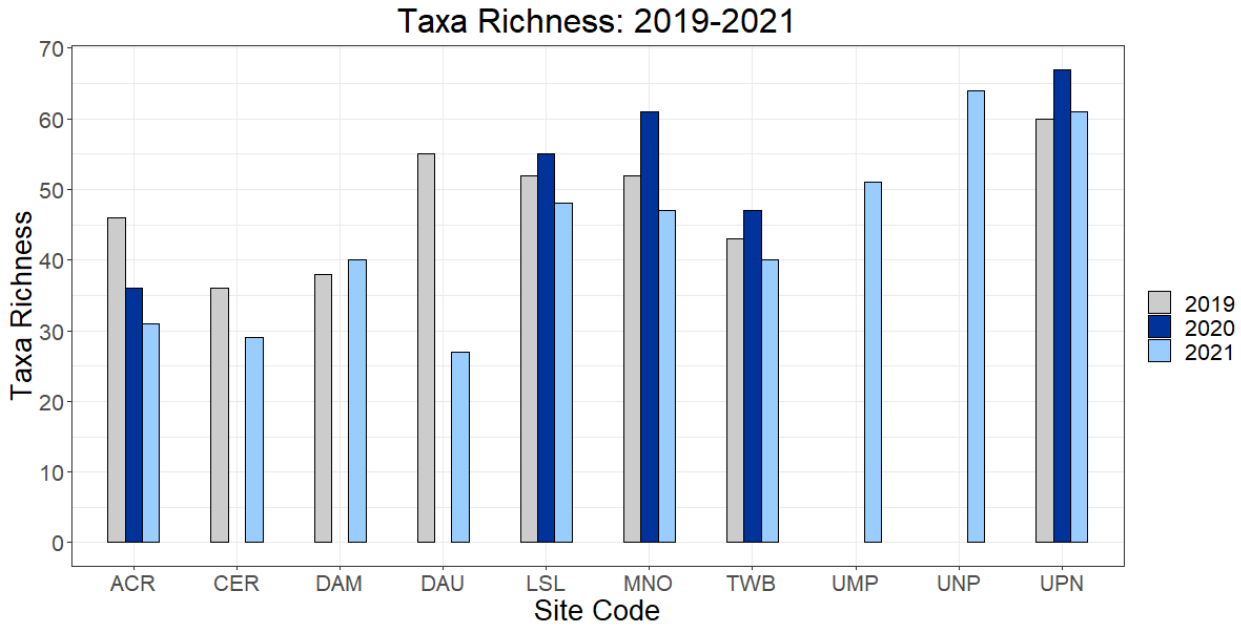

Figure 1. *Taxa richness data for 2019 to 2021 macroinvertebrate sampling.*

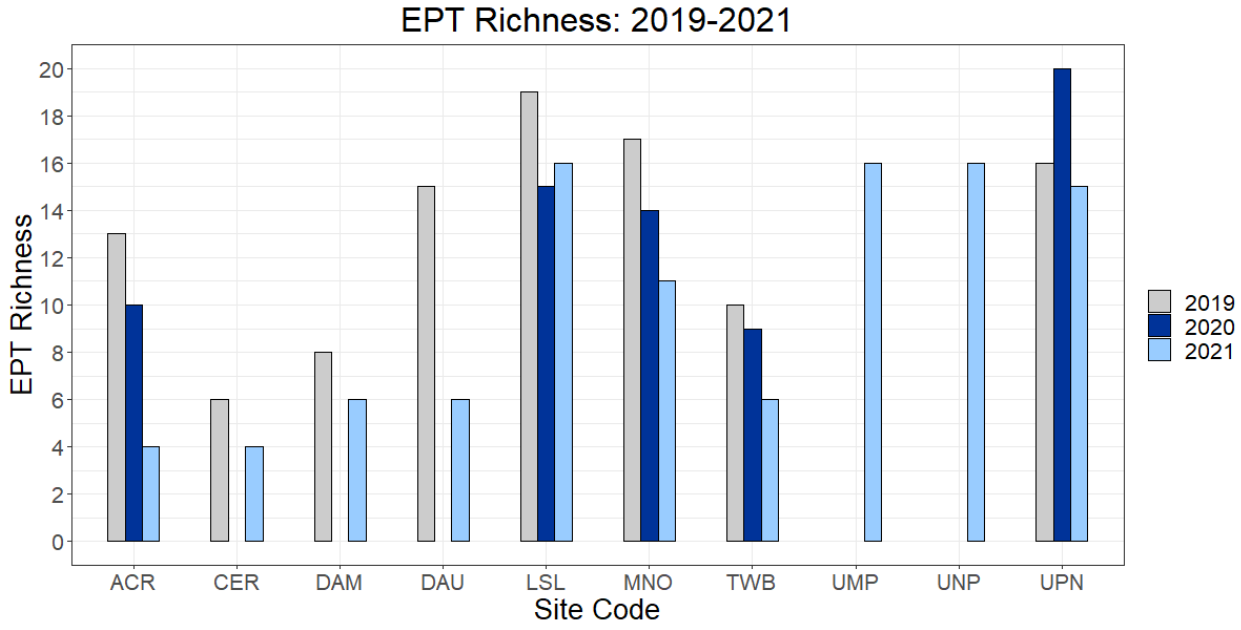

Figure 2. *EPT richness data for 2019 to 2021 macroinvertebrate sampling.*

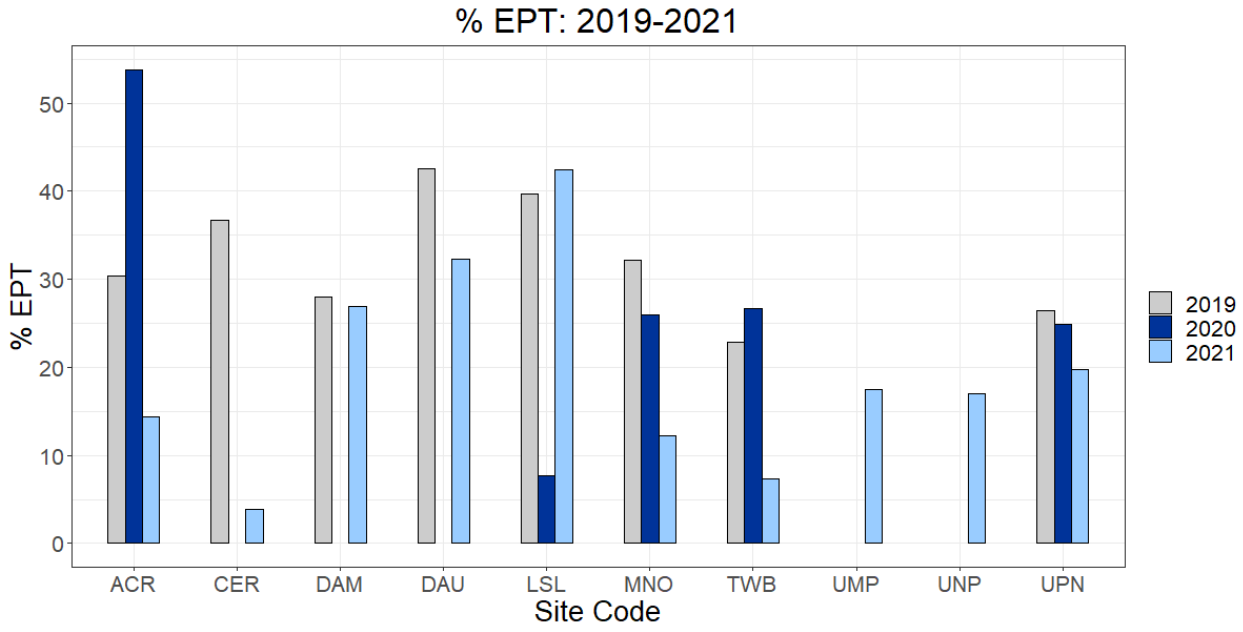

Figure 3. *Percent EPT data for 2019 to 2021 macroinvertebrate sampling.*

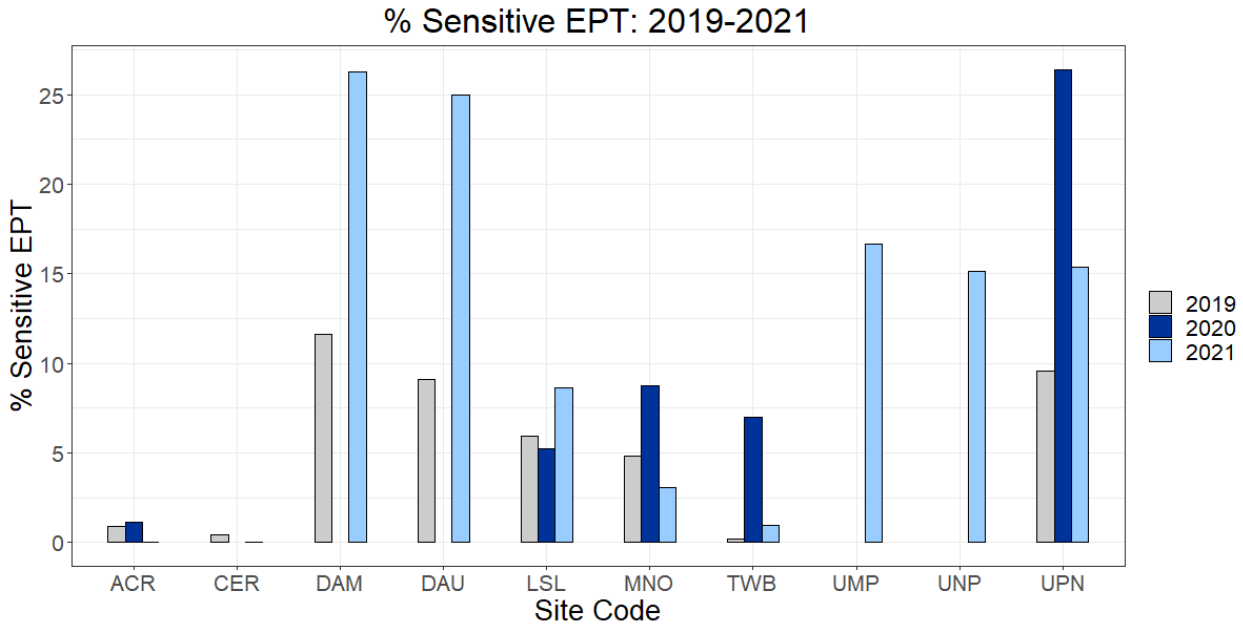

Figure 4. *Percent sensitive EPT data for 2019 to 2021 macroinvertebrate sampling.*

Biotic Indices

The Estuary Program has historically used the Southern California Coastal Index of Biotic Integrity (SoCal B-IBI, or IBI) as a primary index for classifying stream health, but due to its limited range[2] has recently adopted the use of the California Stream Condition Index (CSCI). This was driven in part by a shift by the State Water Resources Control Board to utilize CSCI for its own analysis of waterbody impairment.

The indices used to analyze the 2021 taxa metrics are as follows:

- The **Index of Biotic Integrity (IBI)**, or SoCal B-IBI, was developed by the Aquatic Bioassessment Laboratory in 2005. The IBI uses seven uncorrelated biotic measurements to calculate a single value for each site. These measurements include collector-gatherer and collector-filterer individuals, percent non-insect taxa, percent tolerant taxa, Coleoptera richness, predator richness, percent intolerant individuals, and EPT richness (Ode et al., 2005).
- The **California Stream Condition Index (CSCI)** is a relatively new biological scoring tool, which uses both biotic and environmental data to measure how well a site's observed condition matches its expected condition (Rehn et al., 2015). Unlike the IBI, the CSCI is a statewide index that utilizes environmental variables that affect BMI composition like geology, climate and watershed size to produce a score.

The scoring system for the IBI and CSCI are similar in that they divide scores into five index categories. The IBI uses the classification of "Very Good", "Good", "Fair", "Poor", and "Very Poor", while the CSCI uses a slightly different classification based on stream alteration (Table 3).

Table 3. *SoCal IBI and CSCI score ranges and associated categories. CSCI categories adapted from Rehn et al, 2015.*

IBI Score Range	IBI Score Category
≥ 80 up to 100	Very Good
≥ 60 up to 79.9	Good
≥ 40 up to 59.9	Fair
≥ 20 up to 39.9	Poor
0 up to 19.9	Very Poor
CSCI Score Range	**CSCI Score Category**
> 1.00	Better ecological and biological stream conditions than expected
≥ 0.92 up to 1.00	Likely intact stream conditions
≥ 0.79 up to 0.92	Possibly altered stream conditions
0.63 to 0.79	Likely altered stream conditions
≤ 0.62	Very likely altered stream conditions

[2] The SoCal IBI score is only applicable in a range from San Diego to Monterey. This region tracks closely with the jurisdictions of Regional Water Quality Control Boards 3, 4, 8, and 9.

The following table shows a comparison of recent IBI scores and CSCI scores, using the classifications outlined in Table 3. A table of all CSCI scores are available in Appendix A. A table of all IBI scores are available in Appendix B.

Table 4. *SoCal B-IBI and CSCI scores from 2019 to 2021.*

Site	Year	IBI Score	CSCI Score
MNO (San Bernado Creek)	2019	67.1 (Good)	1.11 (Better than expected)
	2020	71.4 (Good)	0.97 (Likely intact)
	2021	41.4 (Fair)	0.82 (Possibly altered)
LSL (Lower San Luisito Creek)	2019	68.6 (Good)	1.05 (Better than expected)
	2020	61.4 (Good)	0.88 (Possibly altered)
	2021	68.6 (Good)	0.98 (Likely intact)
DAM (Middle Dairy Creek)	2019	48.6 (Fair)	0.82 (Possibly altered)
	2020	-	-
	2021	62.9 (Good)	0.82 (Possibly altered)
DAU (Upper Dairy Creek)	2019	65.7 (Good)	0.92
	2020	-	-
	2021	57.1 (Fair)	0.80 (Possibly altered)
UPN (Upper Pennington Creek)	2019	82.9 (Very Good)	0.98 (Likely intact)
	2020	77.1 (Good)	0.98 (Likely intact)
	2021	75.7 (Good)	0.97 (Likely intact)
UNP (Upper North Pennington)	2019	-	-
	2020	-	-
	2021	84.3 (Very Good)	0.79 (Possibly altered)
UMP (Upper Middle Pennington)	2019	-	-
	2020	-	-
	2021	74.3 (Good)	0.96 (Likely intact)
TWB (Lower Chorro Creek)	2019	31.4 (Poor)	0.91 (Possibly altered)
	2020	52.9 (Fair)	0.97 (Likely intact)
	2021	21.4 (Poor)	0.79 (Possibly altered)
CER (Chorro Ecological Reserve)	2019	18.6 (Very Poor)	0.76 (Likely altered)
	2020	-	-
	2021	8.6 (Very Poor)	0.58 (Very likely altered)
ACR (Above Chorro Reserve)	2019	32.86 (Poor)	0.86 (Possibly altered)
	2020	48.57 (Fair)	0.83 (Possibly altered)
	2021	17.14 (Very Poor)	0.68 (Likely altered)

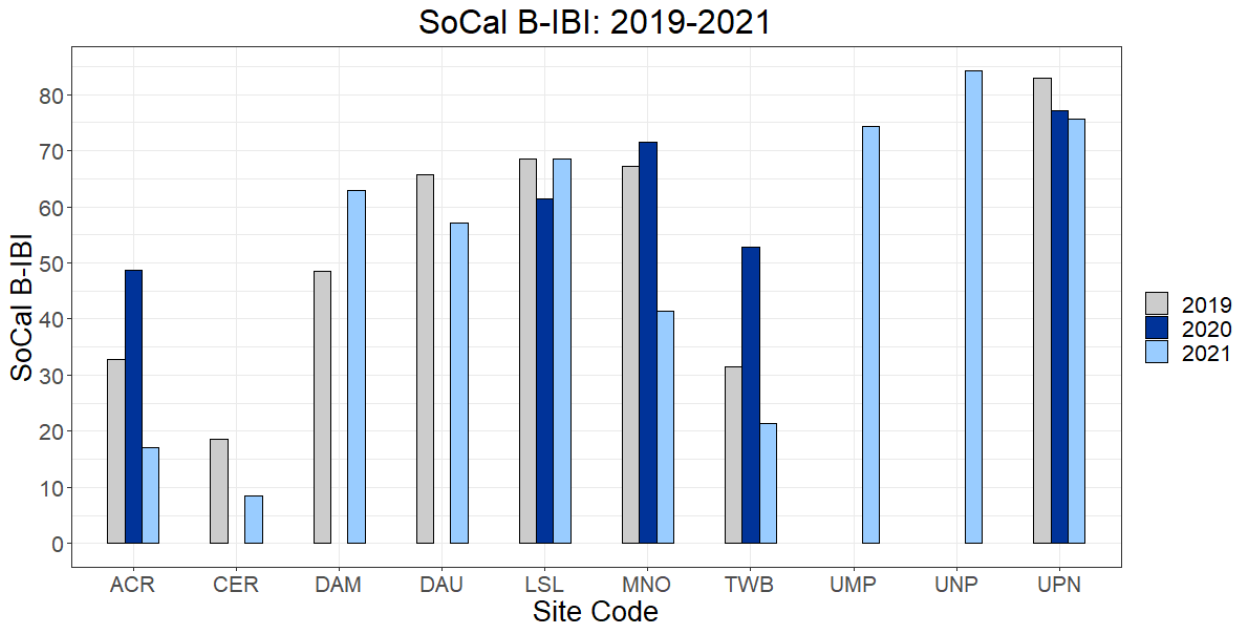

Figure 5. *SoCal IBI scores for 2019 – 2020 bioassessment monitoring.*

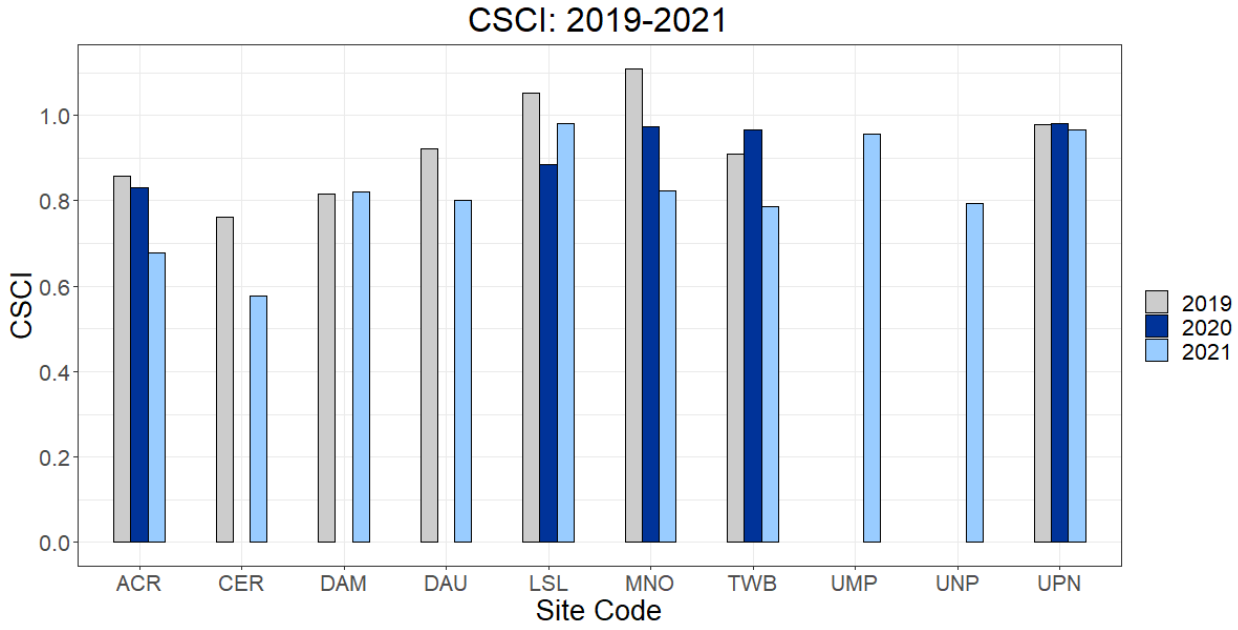

Figure 6. *CSCI scores for 2019 – 2020 bioassessment monitoring.*

The following figures illustrate the spatial distribution of CSCI scores in the watershed. Figure 8 shows the distribution of CSCI scores along mainstem creek segments during 2021. Figure 9 shows the distribution of historic CSCI scores along mainstem creek segments using averaged data from 1994 to 2021.

Similar maps were generated to compare distributions of IBI scores. These maps are available in Appendix C and D. Score criteria for each index is available in Table 3.

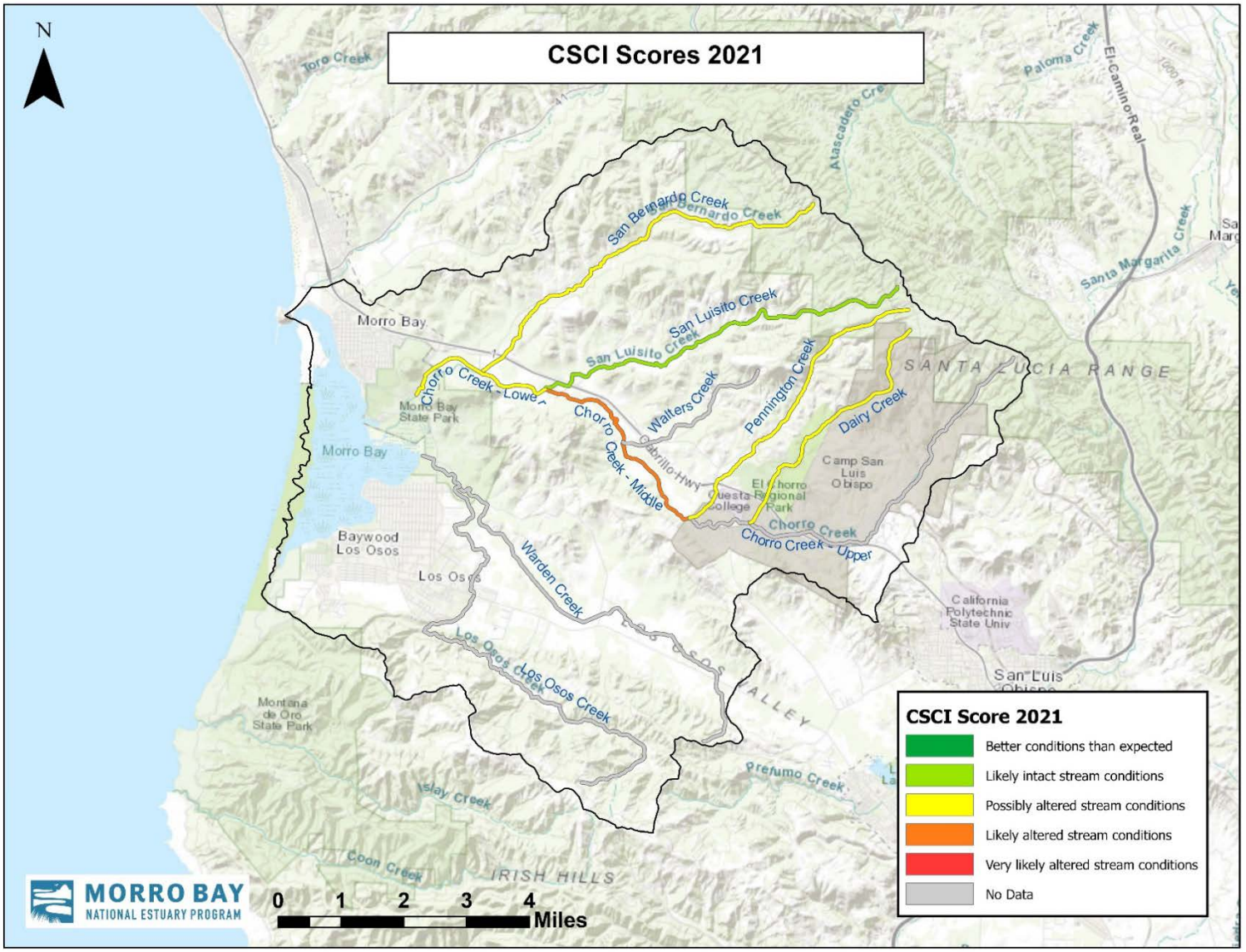

Figure 7. *Mainstem stream segments and their ecological health designations based on 2021 CSCI scores.*

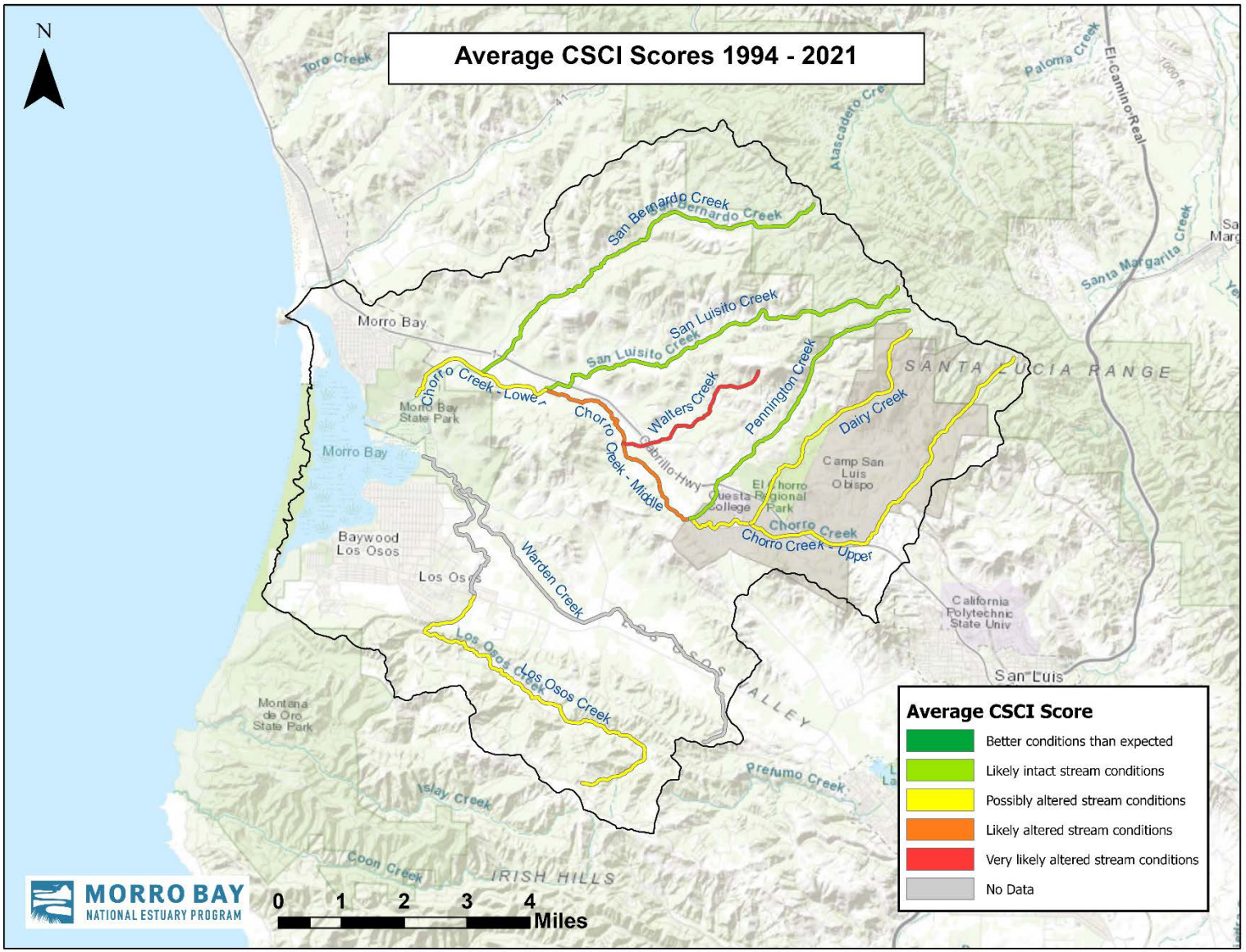

Figure 8. *Mainstem stream segments and their ecological health designations based on average CSCI scores. These data are averaged from 1994 to 2021.*

Conclusions

Ten sites were monitored during the 2021 bioassessment survey effort, including three sites on Chorro Creek (ACR, CER and TWB), two sites on Dairy Creek (DAM and DAU), one site on San Luisito Creek (LSL), one site on San Bernardo Creek (MNO), and three sites on Pennington Creek (UPN, UNP and UMP). The metrics and indices compiled have shown widespread variation amongst the sites monitored. Generally, index and metric scores either decreased or remained stable during 2021, although certain sites did see moderate improvement among specific metrics.

Each of the sites on the mainstem of Chorro Creek (ACR, CER and TWB) saw a decline in metrics and index scores. The biggest declines between the 2020 and 2021 survey seasons occurred at Chorro Creek at ACR, located just below the wastewater treatment plant and at Chorro Creek at TWB, located near the mouth of Chorro Creek. Both ACR and TWB saw substantial declines of more than 70% in percent EPT and declines of more than 80% in percent sensitive EPT. Chorro Creek at CER and Chorro Creek at ACR also received a score of 0.00 for percent sensitive EPT, meaning that no sensitive EPT individuals were collected at either site location.

Unlike most sites monitored during 2021, San Luisito Creek at LSL showed some improvement in EPT metrics. This site received low scores during 2020, leading to a substantial increase in percent EPT (+449%) and percent sensitive EPT (+64%). There were no significant changes between 2020 and 2021 for EPT richness, taxa richness, CSCI, or IBI.

While the two new sites on upper Pennington Creek (UMP and UNP) have insufficient data for analysis, preliminary CSCI results from UNP indicate “possibly altered conditions.” Further analysis will be conducted after the 2022 survey effort to establish a long-term reference monitoring site.

The 2021 field effort was the earliest and most expedited survey effort for the Estuary Program to date. Surveys were conducted slightly earlier in season than in past years due to warmer than normal conditions and lack of annual rainfall. Despite the earlier schedule, both sites on Dairy Creek were at or approaching intermittent flow conditions.

Prolonged periods of drought and low or intermittent flow conditions can have adverse implications for benthic invertebrate communities, leading to changes in community structure (Herbst et al., 2019). According to independent analyses by National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA), 2021 was tied with 2018 for the sixth warmest year on record (NASA, 2022). Additionally, San Luis Obispo County received less than half of the average amount of annual rainfall during WY2021. Rainfall gauges at the nearby California Polytechnic State University, San Luis Obispo (Cal Poly) reported that the area surrounding San Luis Obispo averages 21.8 inches of rain per year[3] (Cal Poly San Luis Obispo, 2017).

[3] This gauge is located approximately nine miles from the center of the Morro Bay watershed.

Future Efforts

While more conventional methods of water quality monitoring may capture instantaneous conditions, they cannot capture the overall aquatic health of a water body. Biotic data collected during bioassessment allows for a more complete picture of creek health. This data is of value to the Estuary Program, its partners, and to the CCRWQCB who utilizes this data to assess impairment in Central Coast waterbodies. Due to the value of this data to the program and its partners, the Estuary Program plans to continue annual bioassessment monitoring for the foreseeable future.

In 2022, the Estuary Program will also partner with the Harold J. Miossi Charitable Trust, Cal Poly, and the City of San Luis Obispo to pilot bioassessment surveys in the San Luis Obispo watershed.

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Appendix A: CSCI Scores, 1994 - 2021

	ACR	CER	CHD	CLK	COO	DAL	DAM	DAU	LSL	LVR	MNO	PEN	TUR	TWB	UMP	UNP	UPN	USL	WAL	WLM
1994	*	*	0.70	*	*	*	0.62	0.94	*	*	*	0.94	*	*	*	*	*	*	*	*
1995	*	*	0.57	*	*	*	0.71	0.61	*	*	*	0.85	*	*	*	*	*	*	*	*
1996	*	*	0.76	1.02	*	*	1.09		*	1.05	*	1.17	0.76	*	*	*	*	*	0.48	*
1997	*	*	0.84	1.02	1.13	1.13	1.09	1.12	*	*	*	1.13	0.75	0.73	*	*	*	*	0.49	*
1998	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1999	*	*	*	1.06	*	0.88	0.87	0.40	*	*	*	1.04	0.63	*	*	*	*	*	*	*
2000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
2001	*	*	0.76	*	*	1.18	*	1.07	*	*	*	0.98		*	*	*	*	*	0.75	*
2002	*	*	*	0.93	0.97	*	*	*	*	*	*	*	*	0.73	*	*	*	*	*	*
2003	*	0.82	*	0.96	0.98	0.87	*	*	*	*	*	*	*	0.74	*	*	*	*	*	*
2004	*	0.67	0.85	0.94	*	0.77	*	*	*	*	*	0.85	*	*	*	*	*	*	*	*
2005	*	0.67		0.74	*	0.75	*	*	*	*	*	*	*	*	*	*	*	*	*	*
2006	*	*	0.71	0.88	1.05	0.83	*	*	*	*	*	0.82	*	0.90	*	*	0.97	*	*	*
2007	*	0.75	0.82	*	1.26	*	*	*	*	*	*	*	*	0.82	*	*	1.09	*	*	*
2008	*	0.77	0.81	0.76	1.13	0.85	0.82	1.02	0.98	*	1.03	*	*	1.03	*	*	1.17	*	0.44	*
2009	*	0.70	*	*	*	*	0.96	1.03	0.98	*	*	*	*	*	*	*	*	*	*	*
2010	*	*	*	0.95	*	0.74	0.70	1.08	1.03	0.57	1.01	*	*	*	*	*	*	1.15	0.56	*
2011	*	0.84	0.92	1.06	*	*	1.14	1.03	1.00	0.91	0.99	*	*	*	*	*	1.13	1.09	*	*
2012	*	0.87	*	0.85	*	*	*	*	1.06	*	1.01	*	*	0.79	*	*	1.04	*	*	*
2013	*	0.59	*	*	*	*	*	*	0.68	*	1.02	*	*	0.91	*	*	1.13	0.92	*	*
2014	*	0.66	*	*	*	*	*	*	0.86	*	0.61	*	*	0.78	*	*	1.04	0.89	*	*
2015	*	0.79	0.77	*	*	*	*	*	0.97	*	0.72	*	*	0.61	*	*	0.88	1.03	*	*
2016	*	0.81	0.82	*	*	*	*	*	1.00	*	0.86	0.83	*	0.71	*	*	1.04	1.09	*	*
2017	*	0.82	0.78	0.76	1.07	*	0.81	0.98	1.04	0.64	0.98	*	*	0.98	*	*	1.10	*	*	0.64
2018	*	0.79	0.92	0.75	0.97	*	*	1.20	1.10	*	1.06	*	*	0.96	*	*	1.06	1.17	*	*
2019	0.86	0.76	*	0.90	*	*	0.82	0.92	1.05	0.65	1.11	*	*	0.91	*	*	0.98	*	*	*
2020	0.83	*	*	0.97	*	*	*	*	0.88	*	0.97	*	*	0.97	*	*	0.98	0.97	*	*
2021	0.68	0.58	*	*	*	*	0.82	0.80	0.98	*	0.82	*	*	0.79	0.96	0.79	0.97	*	*	*
Average CSCI	**0.79**	**0.74**	**0.79**	**0.91**	**1.07**	**0.89**	**0.87**	**0.94**	**0.97**	**0.77**	**0.94**	**0.96**	**0.72**	**0.83**	*	*	**1.04**	**1.04**	**0.54**	*

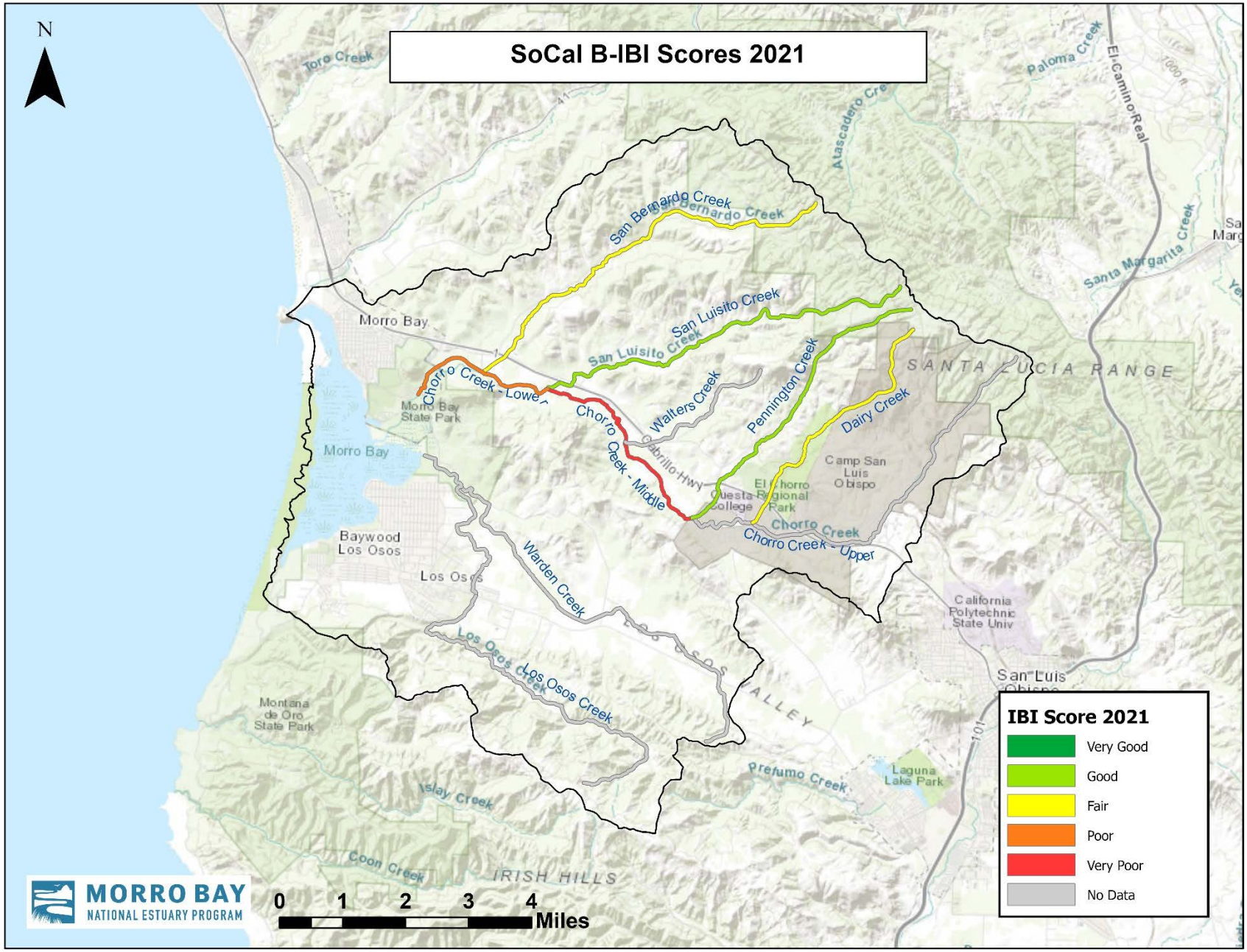
CSCI Score	CSCI Score Category
> 1.00	Better ecological and biological stream conditions than expected
≥ 0.92 up to 1.00	Likely intact stream conditions
≥ 0.79 up to 0.92	Possibly altered stream conditions
0.63 to 0.79	Likely altered stream conditions
≤ 0.62	Very likely altered stream conditions

Appendix B: SoCal B-IBI Scores, 1994 - 2021

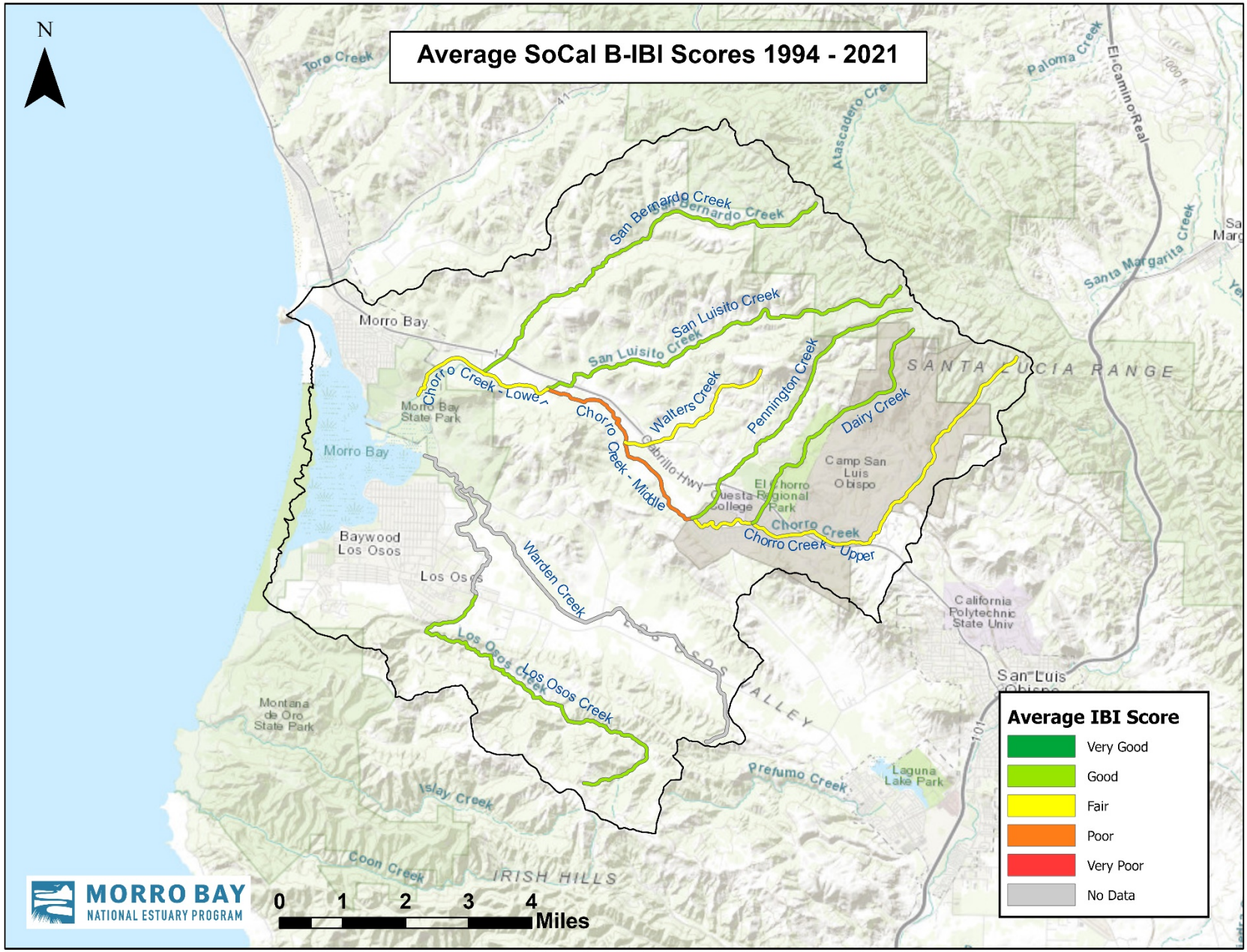
	ACR	CER	CHD	CLK	COO	DAL	DAM	DAU	LSL	LVR	MNO	PEN	TWB	UMP	UNP	UPN	USB	USL	WAL	WLM
1994	*	*	44.00	*	*	*	63.00	80.00	*	*	*	82.00	*	*	*	*	*	*	*	*
1995	*	*	23.00	*	*	*	43.00	46.00	*	*	*	*	*	*	*	*	*	*	*	*
1996	*	*	33.00	73.00	*	*	73.00	*	*	77.00	*	89.00	*	*	*	*	*	*	*	*
1997	*	*	44.00	90.00	*	74.00	59.00	76.00	*	*	*	84.00	39.00	*	*	*	*	*	*	*
1998	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1999	*	*	*	70.00	*	62.00	60.00	9.00	*	*	*	79.00	*	*	*	*	*	*	*	*
2000	*	*	*	*	*	*	*	69.00	*	*	*	*	*	*	*	*	*	*	*	*
2001	*	*	27.00	*	*	72.00	*	*	*	*	*	62.00	54.00	*	*	*	*	*	*	*
2002	*	*	*	70.00	65.71	*	*	*	*	*	*	*	28.57	*	*	*	*	*	*	*
2003	*	51.43	*	81.43	74.29	70.00	*	*	*	*	*	*	25.71	*	*	*	*	*	*	*
2004	*	41.43	50.00	78.57	*	65.71	*	*	*	*	*	66.00	32.00	*	*	*	*	*	*	*
2005	*	31.43	*	60.00	82.86	27.14	*	*	*	45.71	*	*	36.00	*	*	*	*	*	*	*
2006	*	*	46.00	51.43	87.14	50.00	*	*	*	*	*	70.00	45.71	*	*	84.00	*	*	*	*
2007	*	30.00	48.57	*	82.86	*	*	*	*	*	*	*	48.57	*	*	70.00	*	*	*	*
2008	*	30.00	44.30	58.60	81.50	50.10	50.10	80.10	67.20	*	75.80	*	55.80	*	*	78.70	*	*	38.60	*
2009	*	*	57.20	*	*	*	74.36	91.52	70.07	*	*	*	*	*	*	*	*	*	*	*
2010	*	*	*	65.78	*	60.06	52.91	71.50	75.79	41.47	67.21	*	*	*	*	*	77.22	91.52	28.60	*
2011	*	34.29	54.29	52.86	*	*	65.71	58.57	54.29	48.57	62.86	*	*	*	*	85.71	*	58.57	*	*
2012	*	47.14	*	70.00	*	*	*	*	72.86	*	74.29	*	45.71	*	*	84.29	*	*	*	*
2013	*	22.86	*	*	*	*	*	*	40.00	*	71.43	*	54.29	*	*	80.00	*	60.00	*	*
2014	*	30.00	*	*	*	*	*	*	55.71	*	44.29	*	41.43	*	*	78.57	*	65.71	*	*
2015	*	32.86	50.00	*	*	*	*	*	67.14	*	48.57	*	24.29	*	*	61.43	*		*	*
2016	*	18.57	50.00	*	*	*	*	*	65.71	*	71.43	54.29	30.00	*	*	72.86	*	80.00	*	*
2017	*	31.43	44.29	51.43	71.43	*	50.00	80.00	50.00	28.57	40.00	*	48.57	*	*	77.14	*	*	*	54.29
2018	*	25.71	55.71	61.43	62.86	*	*	82.86	78.57	*	75.71	*	52.86	*	*	87.14	*	87.14	*	*
2019	32.86	18.57	*	52.86	*	*	48.57	65.71	68.57	35.71	67.14	*	31.43	*	*	82.86	*	*	*	*
2020	48.57	*	*	74.29	*	*	*	*	61.43	*	71.43	*	52.86	*	*	77.14	*	68.57	*	*
2021	17.14	8.57	*	*	*	*	62.86	57.14	68.57	*	41.43	*	21.43	74.29	84.29	75.71	*	*	*	*
Average IBI	32.86	30.29	44.76	66.36	76.08	59.00	58.54	66.72	63.99	46.17	62.43	73.29	40.43	*	*	78.25	*	73.07	33.60	54.29

IBI Score	IBI Score Category
≥ 80 up to 100	Very Good
≥ 60 up to 79.9	Good
≥ 40 up to 59.9	Fair
≥ 20 up to 39.9	Poor
0 up to 19.9	Very Poor

Appendix C:


SoCal B-IBI Scores 2021
N
Toro Creek
Paloma Creek
El Camino Real
Atascadero Cre
San Bernardo Creek
San Bernardo Creek
Santa Margarita Creek
Morro Bay
San Luisito Creek
San Luisito Creek
Chorro Creek - Lower
Morro Bay State Park
Chorro Creek - Middle
Walters Creek
Pennington Creek
Dairy Creek
SANTA LUCIA RANGE
Morro Bay
Gabrillo Hwy
Camp San Luis Obispo
El Chorro Regional Park
Cuesta College
Chorro Creek
Chorro Creek - Upper
Baywood Los Osos
Los Osos
Warden Creek
California Polytechnic State Univ
Los Osos Creek
Los Osos Creek
LOS OSOS VALLEY
San Luis Obispo
Montana de Oro State Park
Prefumo Creek
Laguna Lake Park
Islay Creek
Coon Creek
IRISH HILLS
101
IBI Score 2021
Very Good
Good
Fair
Poor
Very Poor
No Data
MORRO BAY
NATIONAL ESTUARY PROGRAM
0 1 2 3 4
Miles

Appendix D:


Average SoCal B-IBI Scores 1994 - 2021
N
Toro Creek
Paloma Creek
El Camino Real
Atascadero Cre
San Bernardo Creek
San Luisito Creek
Santa Margarita Creek
Morro Bay
Chorro Creek - Lower
Morro Bay State Park
Morro Bay
Walters Creek
Pennington Creek
Dairy Creek
SANTA LUCIA RANGE
Camp San Luis Obispo
El Chorro Regional Park
Cuesta College
Chorro Creek - Middle
Chorro Creek
Chorro Creek - Upper
Baywood Los Osos
Los Osos
Warden Creek
Los Osos Creek
LOS OSOS VALLEY
California Polytechnic State Univ
San Luis Obispo
Montana de Oro State Park
Prefumo Creek
Laguna Lake Park
Islay Creek
Coon Creek
IRISH HILLS
101
Average IBI Score
Very Good
Good
Fair
Poor
Very Poor
No Data
MORRO BAY
NATIONAL ESTUARY PROGRAM
0 1 2 3 4
Miles