Benthic Macroinvertebrate Bioassessment

Data Summary Memo

2023

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

August 2024

Table of Contents

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
Estuary Program	Morro Bay National Estuary Program
RWB	Reach-wide benthos (biotic sampling method)
MLML	Moss Landing Marine Laboratory
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 1 to September 30; named for the year in which it ends)

Suggested Citation

Morro Bay National Estuary Program. (2024). *Benthic Macroinvertebrate Bioassessment Data Summary Memo 2023*. https://library.mbnep.org/

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 have made this project possible:

- The Harold J. Miossi Charitable Trust for their generous grant, which has funded this monitoring effort since 2013.
- Our dedicated volunteers who have donated their time to help ensure the success of the project.
- The many landowners who have allowed access for this monitoring.

Introduction

The Morro Bay National Estuary Program (Estuary Program) is a nonprofit organization that brings together the community, 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) 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.

This report summarizes the results of benthic macroinvertebrate sampling from 1994 to 2023[1] from Chorro Creek, Los Osos Creek, and their tributaries. Benthic macroinvertebrates (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 provide a means of assessing waterbody health over time (Barbour, 1999).

Macroinvertebrate samples are collected during annual spring bioassessment surveys. Surveys are 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. EcoAnalysts, Inc. conducts taxonomic analysis of the biotic samples, and the Moss Landing Marine Laboratory (MLML) calculates biotic index scores.

Sites

The Estuary Program conducts bioassessment surveys each spring at various locations throughout the Morro Bay watershed[2]. Typically, ten 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

[1] Prior to 2002, data was collected by the Central Coast Regional Water Quality Control Board (CCRWQCB).
[2] For a map of all monitoring sites, refer to Appendix A.

number of rotating sites that are generally monitored every other or every third year. The Estuary Program is also working to establish a reference site, which would represent a benchmark of biological conditions in a minimally disturbed environment. Sites not listed as either core, rotating, or reference are historic sites that are no longer monitored due to access issues or unfavorable monitoring conditions.

During the 2023 effort, Estuary Program staff and volunteers conducted 11 surveys due to staffing capacity and funding. Monitoring locations included the six core sites, four rotating sites, and one potential reference site (Table 1).

Table 1. *Bioassessment sites codes and locations monitored in 2023.*

Site Code	Location	Type
310TWB	Lower Chorro Creek	Core
310CER	Middle Chorro Creek above Ecological Reserve	Rotating
310ACR	Middle Chorro Creek below wastewater treatment plant	Rotating
310UCD	Upper Chorro Creek above Chorro Reservoir	Potential reference
310MNO	San Bernardo Creek	Core
310LSL	Lower San Luisito Creek	Core
310UPN	Pennington Creek	Core
310DAM	Middle Dairy Creek	Rotating
310DAU	Upper Dairy Creek	Core
310LVR	Lower Los Osos Creek	Rotating
310CLK	Upper Los Osos Creek	Core

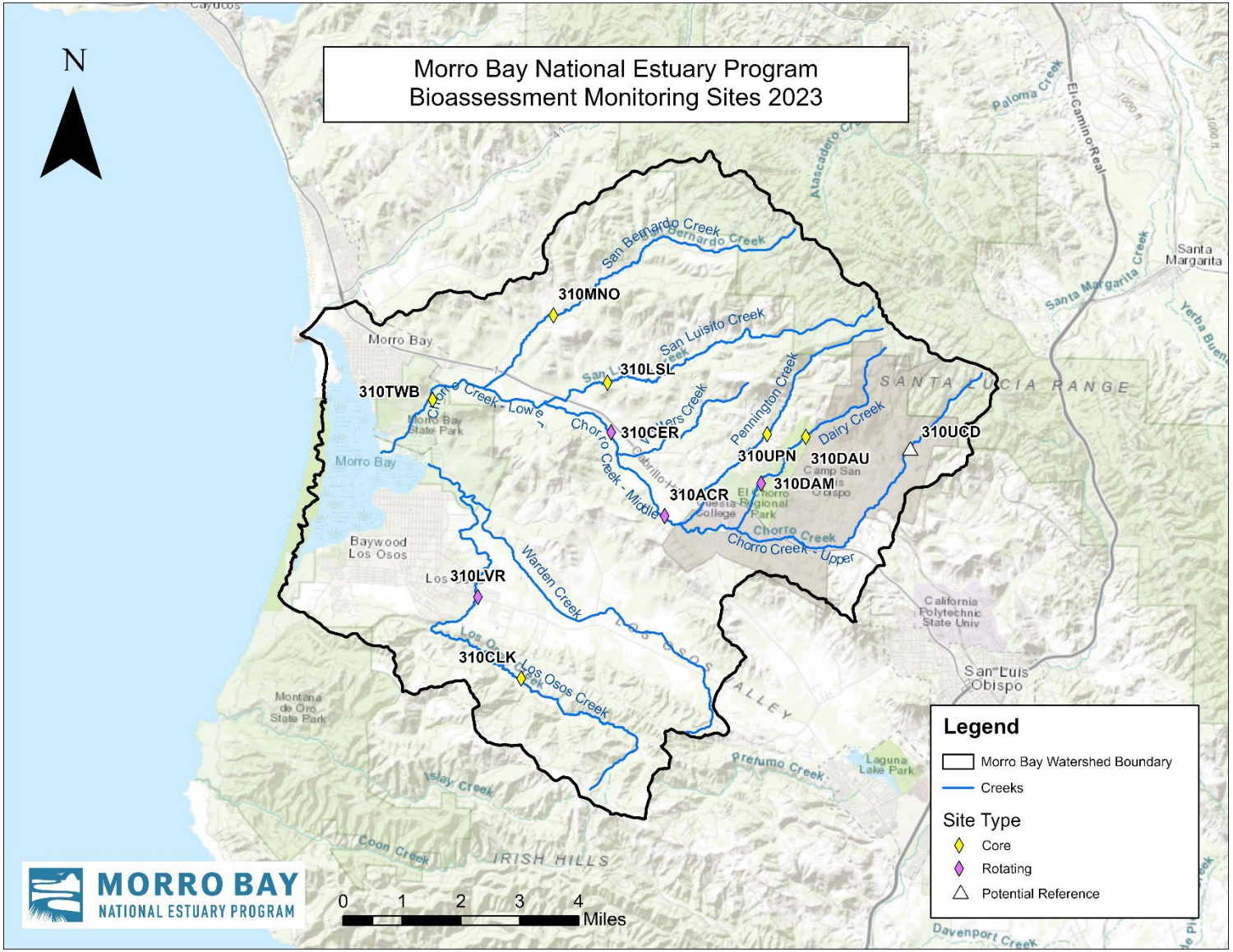

Figure 1. *Bioassessment sites monitored in 2023. Core sites are monitored each year, and rotating sites are monitored approximately every other year. Potential reference sites are located in the upper watershed and denoted with a white triangle.*

Methods

The Estuary Program conducts 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 scientific collection permit (SCP) from the California Department of Fish and Wildlife (CDFW). Sites within California State Parks property boundaries are also collected under a State Parks SCP. The Estuary Program conducts all required notifications and reporting to maintain the SCPs.

At each monitoring site, staff and trained volunteers conduct assessments along a pre-determined 150-meter reach. Measurements and observations are taken at 11 equidistant main transects and ten equidistant inter-transects. These include wetted width, water depth, bankfull measurements, substrate size, canopy cover, slope, sinuosity, bank stability, algal observations, and anthropogenic modifications. Macroinvertebrate samples are collected from each of the 11 main transect locations using the reach-wide benthos (RWB) method, rotating between the margins and center of the creek. The samples are then composited into a single sample and preserved before shipping to a certified laboratory for analysis.

In 2023, the Estuary Program sent macroinvertebrate samples to a certified taxonomy laboratory, EcoAnalysts Inc., for analysis per Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) Level 2 protocols. The samples were sorted, counted, and identified by certified taxonomists until 600 organisms were identified. EcoAnalysts Inc. provided a spreadsheet containing the taxa classifications and several calculated metrics and indices. The Estuary Program contracted with Moss Landing Marine Labs (MLML) to calculate index scores using the California Stream Condition Index (CSCI) analysis method. The data obtained from EcoAnalysts and MLML provide the foundation for the analysis presented in this report.

The Estuary Program also collected environmental DNA (eDNA) samples for metabarcoding analysis as part of the SWAMP eDNA Metabarcoding Monitoring and Analysis Project (SeMMAP). Single replicate samples were collected at each of the 11 sites monitored, and duplicates were collected at the six core sites using Jonah Ventures Next Generation Sequencing (NGS) sampling kits. Depending on water clarity conditions, between 300 mL to 1000 mL of water was filtered per sample.

Shipment Issues

Macroinvertebrate samples are preserved in 91% isopropyl alcohol after field collection, then refrigerated until the field season is complete. Samples are then drained of the preservative before they are overnight shipped to a laboratory for analysis. Samples typically arrive at the laboratory no more than one to two days after shipment.

While this process was followed closely in 2023, the shipper misplaced the samples at their sorting facility for nine days before they arrived at the taxonomy laboratory. Despite a much longer than normal transit time, the laboratory determined that the organisms were intact enough for accurate identification. The lab confirmed that there had been adequate preservation over the nine-day period, likely due to the residual alcohol that remained within the organic matter of the samples. It is impossible

to quantify the impact of this shipping error on the samples and subsequent taxonomic analysis, and this should be kept in mind when analyzing results from the 2023 bioassessment effort.

Results

The following tables, graphs, and maps summarize the results of the 2023 macroinvertebrate sampling effort and provide context for the results by comparing them to 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 dashed line within any table indicates that no monitoring occurred that year. On bar graphs, an absence of a bar indicates no monitoring occurred that year.

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 2020 to 2023.*

Site	Year	Taxa Richness	EPT Richness	% EPT	% Sensitive EPT
ACR (Chorro Creek below WWTP)	2020	36	10	53.81	1.16
	2021	31	4	14.33	0.00
	2022	----	----	----	----
	2023	40	11	50.00	1.62
CER (Middle Chorro Creek)	2020	----	----	----	----
	2021	29	4	3.88	0.00
	2022	----	----	----	----
	2023	34	6	32.69	0.37
TWB (Lower Chorro Creek)	2020	47	9	26.72	7.01
	2021	40	6	7.37	0.95
	2022	44	8	13.38	2.40
	2023	40	6	10.76	1.05
UCD (Above Chorro Reservoir)	2020	----	----	----	----
	2021	----	----	----	----
	2022	81	22	21.86	20.70

Site	Year	Taxa Richness	EPT Richness	% EPT	% Sensitive EPT
	2023	40	10	31.00	31.81
CLK (Upper Los Osos Creek)	2020	59	15	51.75	12.16
	2021	----	----	----	----
	2022	----	----	----	----
	2023	39	5	4.91	1.29
LVR (Lower Los Osos Creek)	2020	----	----	----	----
	2021	----	----	----	----
	2022	----	----	----	----
	2023	31	5	4.40	0.65
MNO (San Bernado Creek)	2020	61	14	25.90	8.75
	2021	47	11	12.20	3.08
	2022	66	15	21.44	7.96
	2023	33	4	43.01	0.93
LSL (Lower San Luisito Creek)	2020	55	15	7.73	5.25
	2021	48	16	42.43	8.62
	2022	58	17	40.78	13.77
	2023	27	9	67.35	3.93
UPN (Upper Pennington Creek)	2020	67	20	24.85	26.41
	2021	61	15	19.69	15.37
	2022	60	17	20.70	11.68
	2023	45	9	31.81	7.36
DAM (Middle Dairy Creek)	2020	----	----	----	----
	2021	40	6	26.85	26.29
	2022	----	----	----	----
	2023	38	4	62.50	4.92
DAU (Upper Dairy Creek)	2020	----	----	----	----
	2021	27	6	32.23	25.00
	2022	66	16	21.17	22.25
	2023	32	7	58.16	3.80

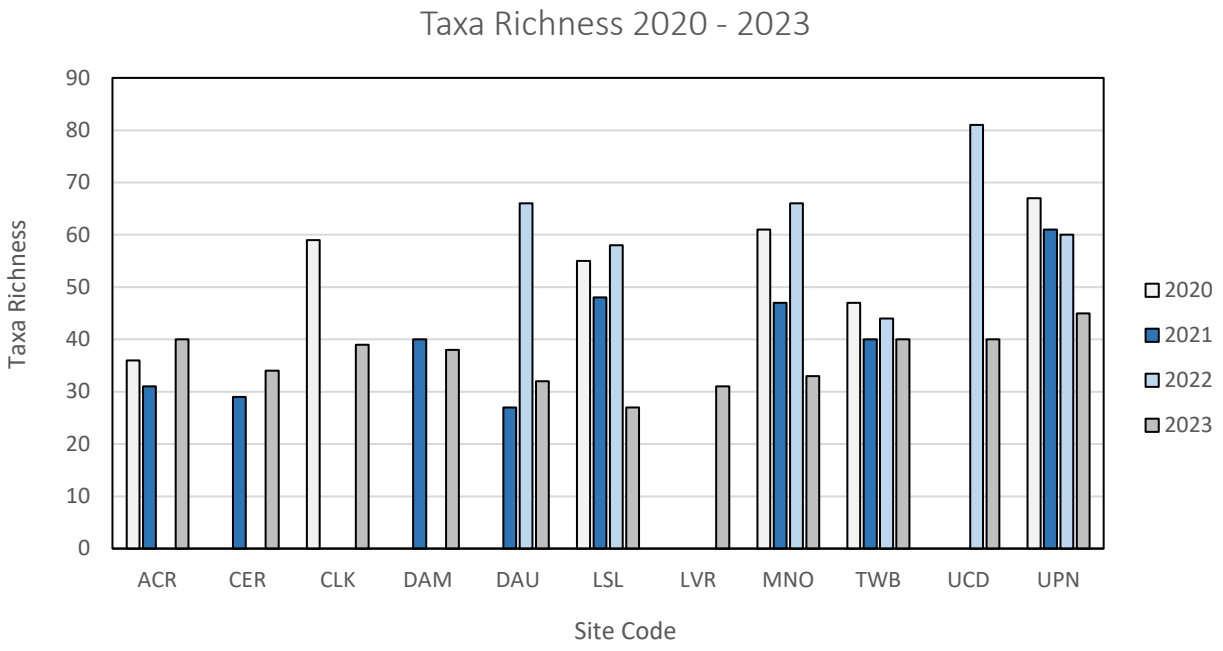

***Figure 2**. Taxa richness data for 2020 to 2023 macroinvertebrate sampling.*

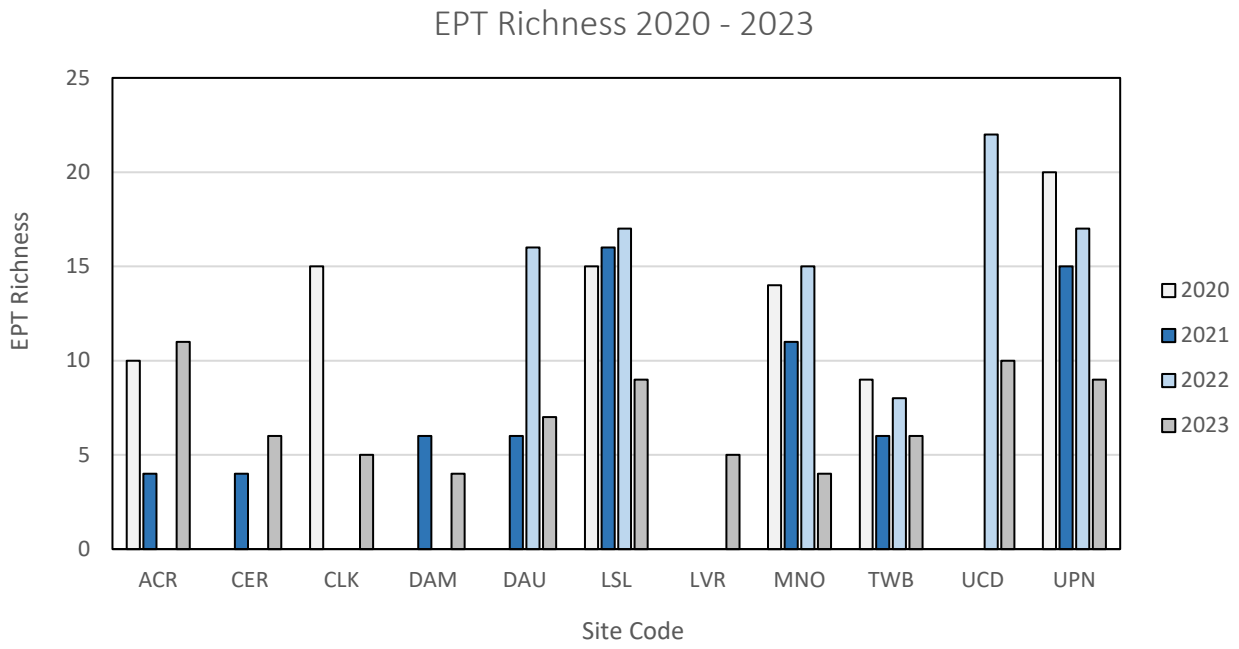

Figure 3. *EPT richness data for 2020 to 2023 macroinvertebrate sampling.*

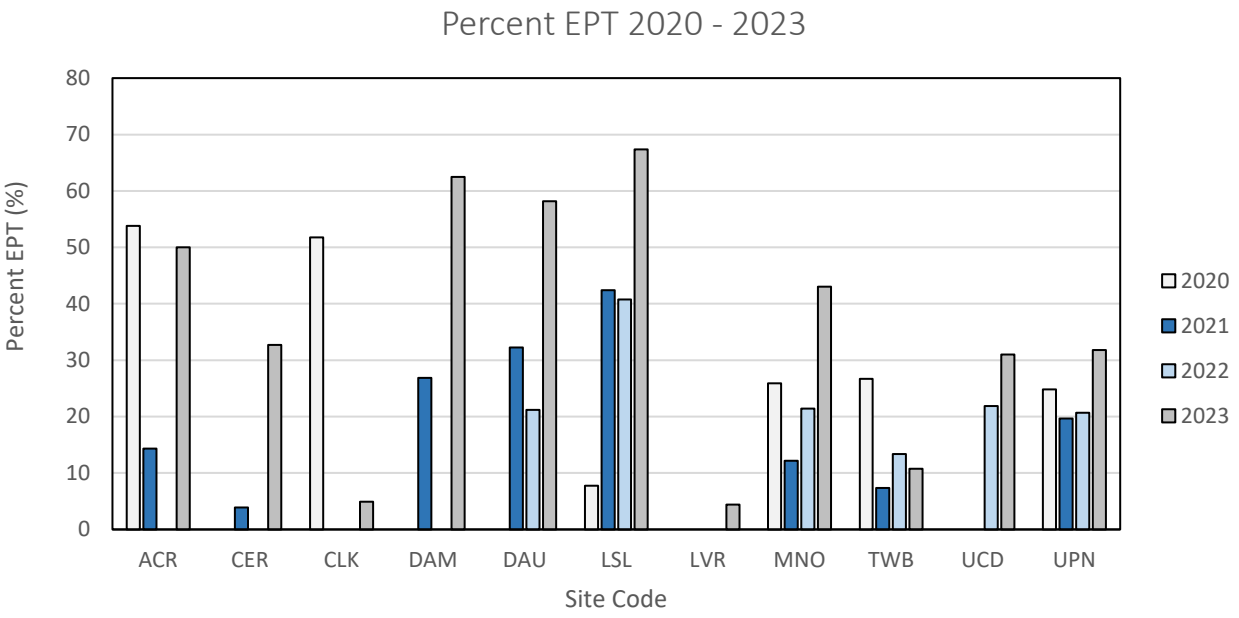

Figure 4. *Percent EPT data for 2020 to 2023 macroinvertebrate sampling.*

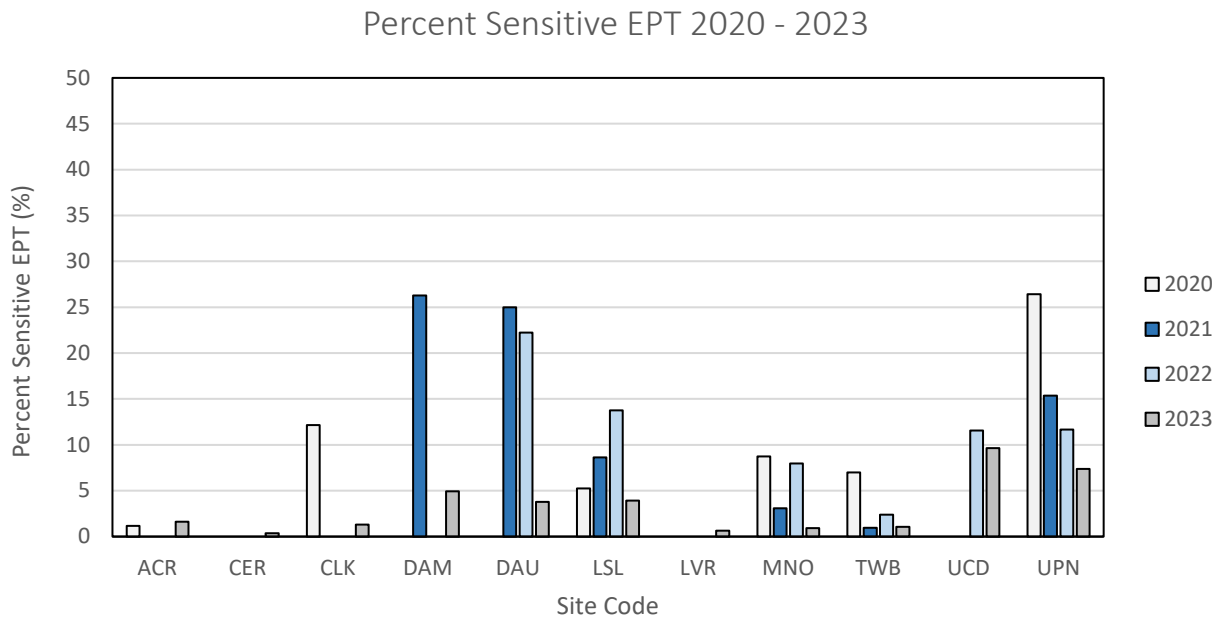

Figure 5. *Percent sensitive EPT data for 2020 to 2023 macroinvertebrate sampling.*

Biotic Indices

The Estuary Program uses a statewide biological scoring tool to assess overall stream health called the California Stream Condition Index (CSCI). The CSCI uses biotic and environmental data to measure how well a site's observed condition matches its expected condition using a numeric scoring system to interpret stream degradation, as shown in Table 3 (Rehn et al., 2015).

Historically, the Estuary Program used the Southern California Coastal Index of Biotic Integrity (SoCal B-IBI, or IBI) as a primary index for classifying stream health. But as the metric was designed for the coastal region from Monterey to San Diego[3], the method doesn't allow for direct comparison with data from outside of this geographic area. The Estuary Program recently adopted the use of the CSCI, which is not tied to a specific region in California. 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.

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

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

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

Table 4 shows a comparison of recent CSCI scores (2020 to 2023) using the classifications outlined in Table 3. A dashed line indicates that no monitoring occurred during that year. A table of all CSCI scores is available in Appendix B.

Table 4. CSCI scores from 2020 to 2023.

Site	Year	CSCI	CSCI Status
ACR (Chorro Creek below WWTP)	2020	0.83	Possibly Altered
	2021	0.68	Likely Altered
	2022	----	----
	2023	0.82	Possibly Altered
CER (Middle Chorro Creek)	2020	----	----
	2021	0.58	Very Likely Altered
	2022	----	----
	2023	0.78	Likely Altered
TWB (Lower Chorro Creek)	2020	0.97	Likely Intact
	2021	0.79	Likely Altered
	2022	0.85	Possibly Altered
	2023	0.90	Possibly Altered
UCD (Above Chorro Reservoir)	2020	----	----
	2021	----	----
	2022	1.04	Better than expected
	2023	0.91	Possibly Altered
CLK (Upper Los Osos Creek)	2020	0.97	Likely Intact
	2021	----	----
	2022	----	----
	2023	0.72	Likely Altered
LVR (Lower Los Osos Creek)	2020	----	----
	2021	----	----
	2022	----	----
	2023	0.67	Likely Altered

Site	Year	CSCI	CSCI Status
MNO (San Bernardo Creek)	2020	0.97	Likely Intact
	2021	0.82	Possibly Altered
	2022	0.94	Likely Intact
	2023	0.68	Likely Altered
LSL (Lower San Luisito Creek)	2020	0.88	Possibly Altered
	2021	0.98	Likely Intact
	2022	1.02	Likely Intact
	2023	0.83	Possibly Altered
UPN (Upper Pennington Creek)	2020	0.98	Likely Intact
	2021	0.97	Likely Intact
	2022	1.13	Better than expected
	2023	0.77	Likely Altered
DAM (Middle Dairy Creek)	2020	----	----
	2021	0.82	Possibly Altered
	2022	----	----
	2023	0.69	Likely Altered
DAU (Upper Dairy Creek)	2020	----	----
	2021	0.8	Possibly Altered
	2022	0.94	Likely Intact
	2023	0.69	Likely Altered

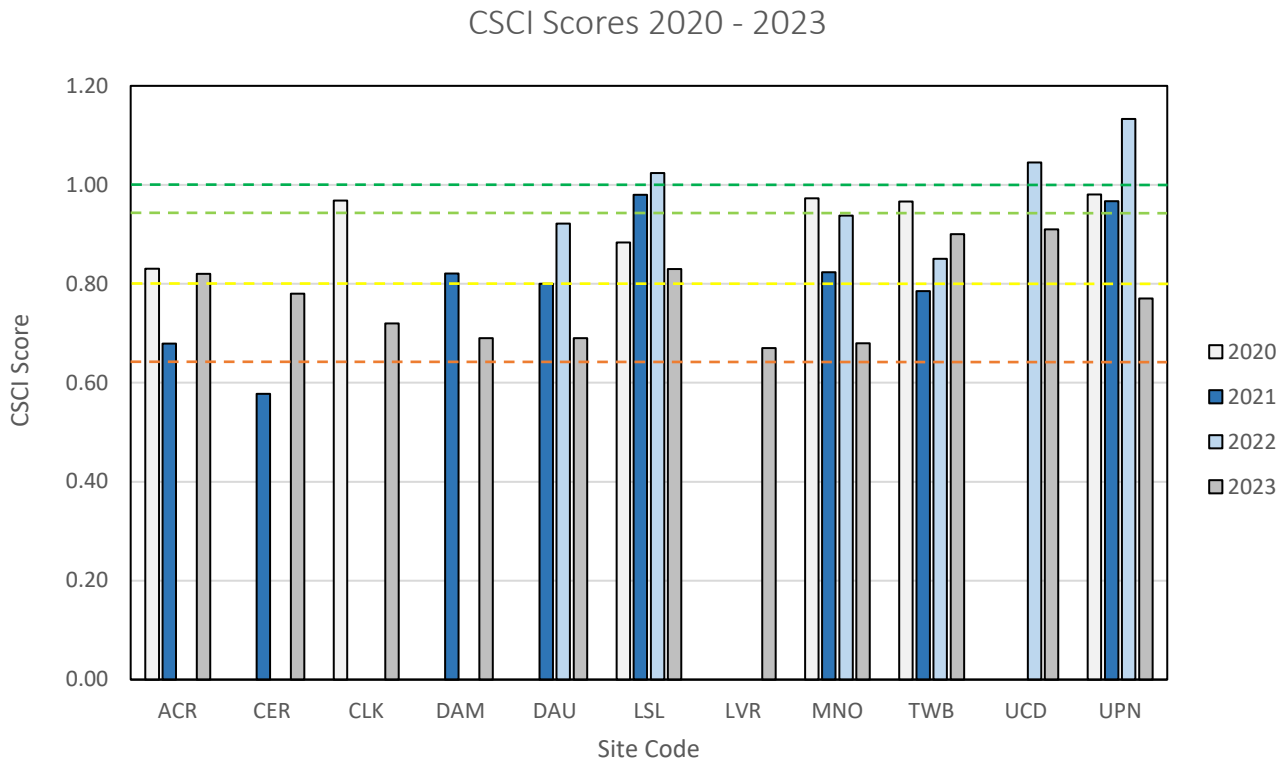

Figure 6. *CSCI scores for 2020 to 2023 bioassessment monitoring.*

Figures 7 and 8 show the spatial distribution of CSCI scores along creek mainstems. Figure 7 shows the 2023 scores averaged by creek segment, and Figure 8 shows the average CSCI scores by creek segment from 1994 to 2023. For CSCI score criteria, refer to Table 3.

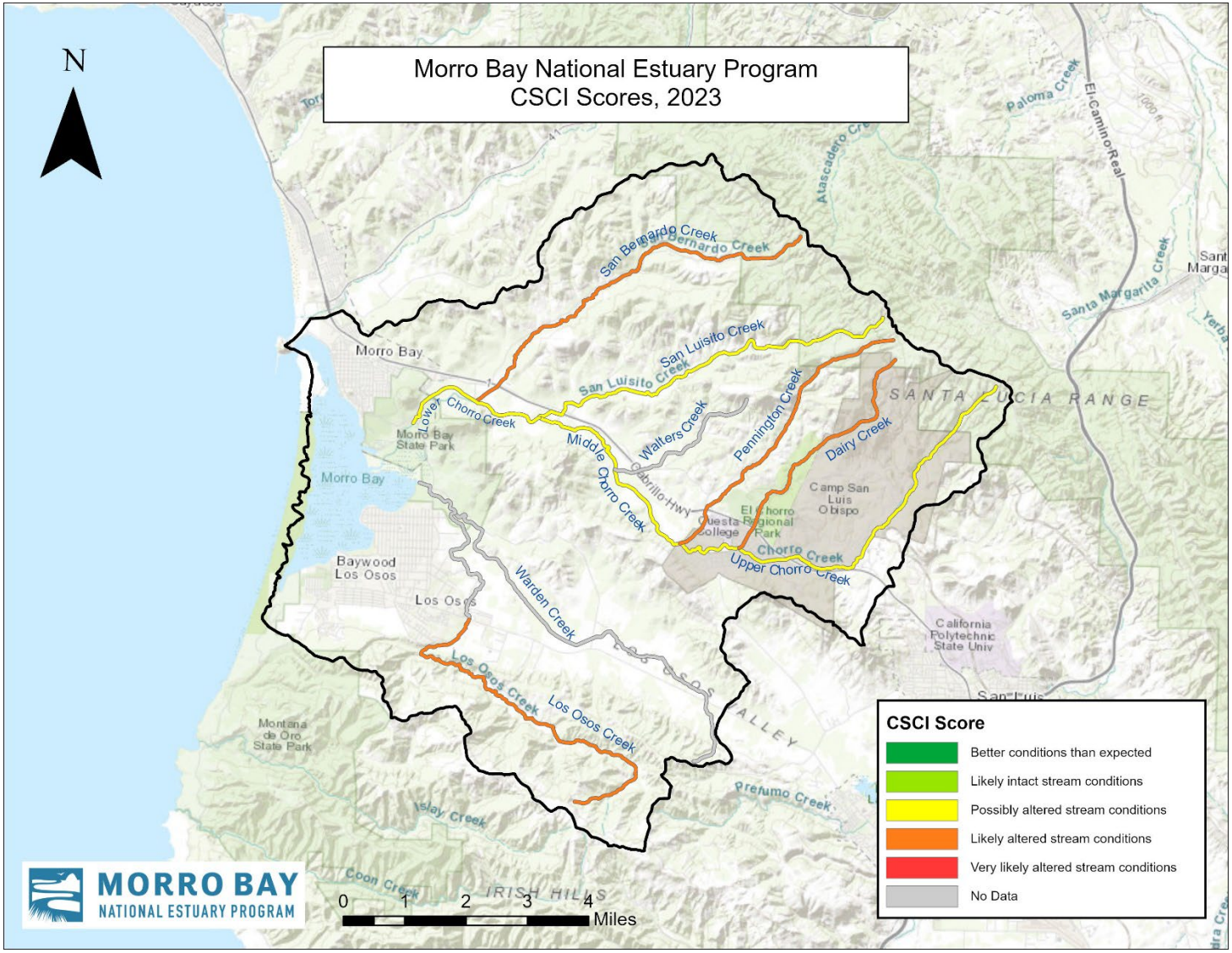

Figure 7. *Mainstem stream segments and their ecological health designations based on 2023 CSCI scores averaged by creek segment.*

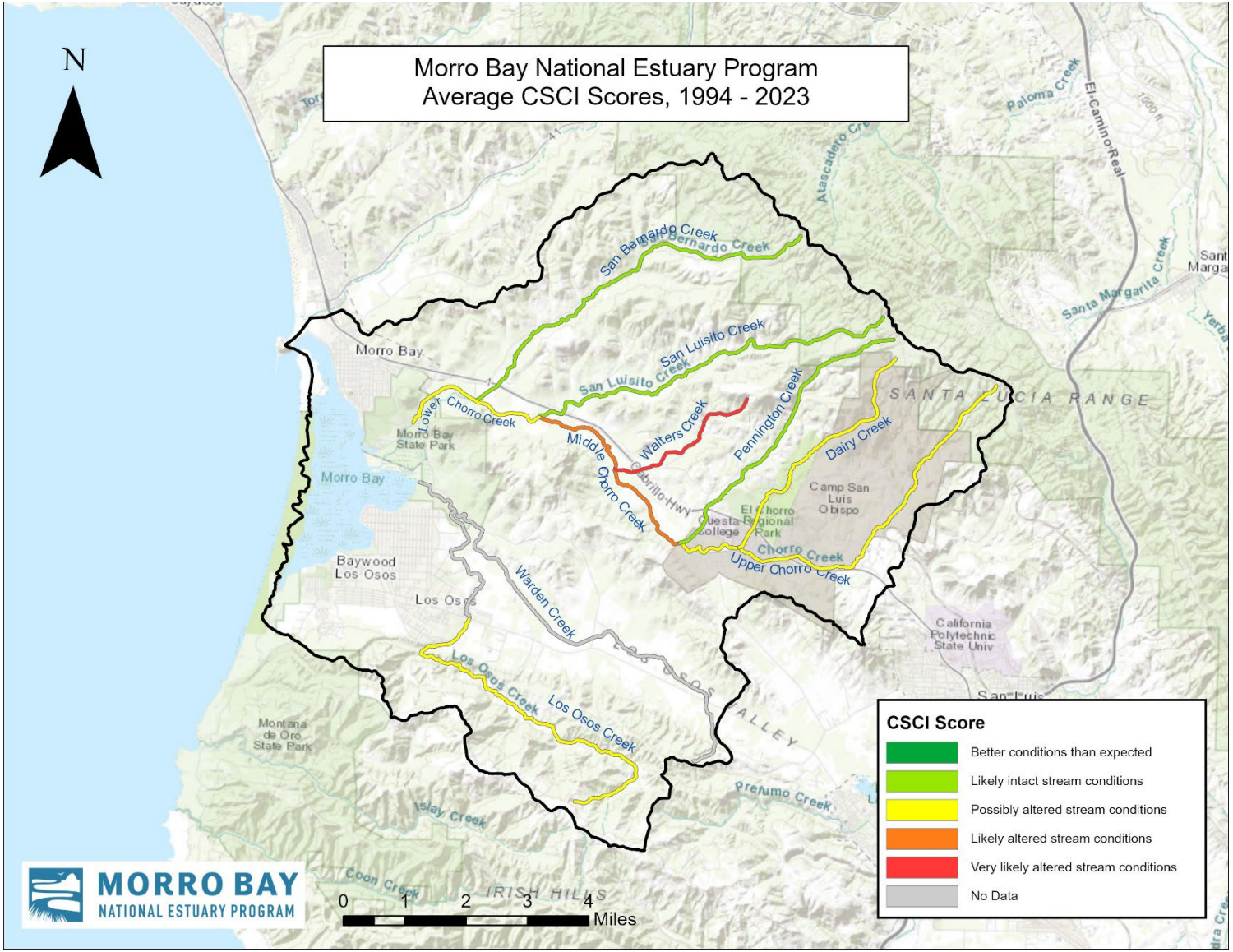

Figure 8. *Mainstem stream segments and their ecological health designations based on average CSCI scores from 1994 to 2023. Refer to Appendix B for more detailed information regarding individual site scores and number of data points.*

eDNA

The Estuary Program sent eDNA samples to Jonah Ventures for metabarcoding analysis to assess macroinvertebrate presence and biodiversity. Results were compared with macroinvertebrate taxonomy data to determine similarity between the two approaches and to identify potential data gaps. Because the lists of genera and species differed with each method, the respective datasets were grouped into broader taxonomic categories like Phylum and Order so they could be more directly compared. Species outside of these categories were excluded from this analysis.

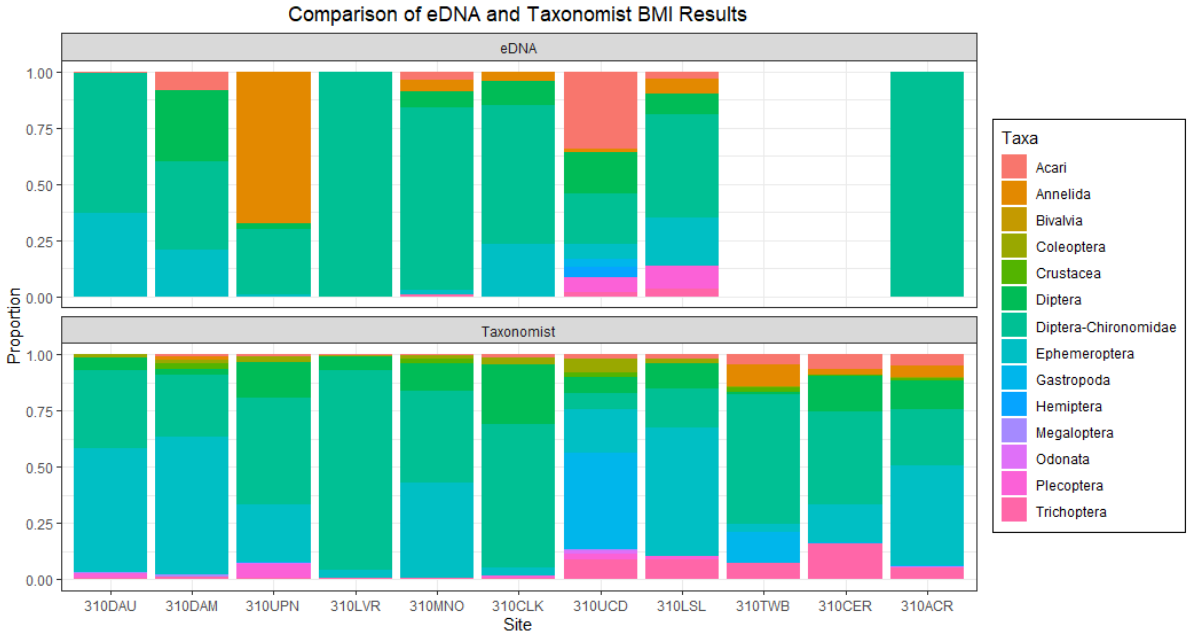

Figure 9. *Proportional bar plots describing the composition of the biota based on eDNA samples (top) compared to the taxonomist assessment (bottom) for each bioassessment site. Invertebrates were grouped into the broadest taxonomic category as identified by the taxonomists. Absence of a bar indicates that no taxa were detected.*

Presence-absence analysis of broad taxonomic categories showed only 52% similarity between the two methods. Most dissimilarities were attributed to false negatives for eDNA, where taxonomists had positively identified taxa in the macroinvertebrates sample that were not detected by eDNA. Two sites from Chorro Creek, TWB and CER, did not have any positive identifications of macroinvertebrate taxa. Furthermore, there were no eDNA detections of Coleoptera despite being present in taxonomist analysis for all samples. This lack of Coleoptera species may be due to limitations in the reference database used to assign identifications, or potentially a lack of genetic material in the water due to physiological differences between beetles and other taxa.

Because eDNA metabarcoding is still a relatively new method, it will likely improve with further refinement and the development of more robust reference libraries. The Estuary Program will be partnering with SeMMAP for a second year of sampling and comparative analysis in 2024 and will be tracking further improvements in this methodology.

Conclusions

Water year (WY) 2023[4] was one of the wettest years on record following a series of consecutively dry years. The County of San Luis Obispo's gauge at Canet Road (Station 753) recorded 31.9 inches of annual rainfall during WY2023, which is nearly 46% higher than the area's average of 21.8 inches per year (Cal Poly, 2017). The area also experienced several notably large storms between December 2022 and March 2023 that led to flooding and streambed mobilization throughout the watershed. The Station 753 stream gauge recorded six unique flooding events in WY2023, where flows from Chorro Creek had overtopped the Canet Road bridge[5]. Four of the six flooding events occurred within a two-week period from December 31, 2022, to January 14, 2023, and the following two flood events occurred on March 10 and March 14, 2023. The occurrence of six bridge-topping events within a three-month period is extremely uncommon for this gauge.

While flooding and disturbance play a critical role in regulating macroinvertebrate species diversity and structure, research has shown that flooding events that alter streambed materials, remove vegetation, or change food availability may lower benthic macroinvertebrate biomass, disproportionately impacting sensitive taxa (Supp & Ernest, 2014). Severe scouring events may also have long-term effects on habitat that persist for years or even decades (Lake, 2000; Death, 2003; Holomuzki & Biggs, 2000).

The results from 2023 indicate impairment for several of the analysis metrics, which may be attributed to ecosystem disturbances associated with scouring events earlier in the water year. These effects were more pronounced in Pennington Creek, Dairy Creek, San Luisito Creek, and San Bernardo Creek (UPN, DAU, LSL, MNO) which are all smaller tributaries in the watershed, as well as in the upper section of Chorro Creek (UCD). These monitoring sites represent relatively small, low-flow channels that are generally not well-suited for large volumes of water. Sites on the mainstem of Chorro Creek (ACR, CER, TWB), however, may be better equipped for high flow disturbance due to their wider cross-sectional areas which allow for impacts to be spread out, thus reducing the severity of localized damage. Larger channels may also allow for more effective sediment transport and deposition, which has a direct impact on biotic communities. While macroinvertebrate sampling took place nearly four months after any severe storms, it may take several more years before the ecosystem fully recovers from the impact of WY2023.

Uncertainty regarding the potential degradation of samples during transit adds a layer of complexity to the WY2023 results, since compromised samples can affect taxonomists' ability to accurately identify taxa. While taxonomists at the lab indicated that the samples were in adequate condition for identification, the possibility of some degradation due to the extended transit time cannot be ruled out.

Monitoring Partnerships

In 2021, the Harold J. Miossi Charitable Trust approached the Estuary Program about a partnership to expand bioassessment monitoring into the neighboring San Luis Obispo watershed. While the Estuary Program typically limits work to within the Morro Bay watershed, a goal of the program is to share

[4] Water year 2023 is defined as October 1, 2022 to September 30, 2023.

[5] The Canet Road bridge overtops at stage heights greater than 13.2 feet. For stage heights of 12.1 to 13.2 feet, the culverts are assumed to be full, but the bridge has not overtopped.

expertise and resources that build capacity. Since then, the Estuary Program has worked with Cal Poly and the City of San Luis Obispo to develop a bioassessment monitoring framework for the San Luis Obispo watershed.

The second year of monitoring was completed in 2023 along five stream segments in the San Luis Obispo watershed. Results were compiled into a final report which is available for download through the Cal Poly Digital Commons website at: https://digitalcommons.calpoly.edu/nres_rpt/50/

Future Efforts

While more conventional methods of water quality monitoring may capture instantaneous conditions, they cannot measure 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.

References

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. (1999). *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish* (Second Edition. EPA 841-B-99-002). U.S. Environmental Protection Agency, Office of Water.

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/.

Death, R. G. (2003). Spatial patterns in lotic invertebrate assemblages: Is substrate disturbance actually important? *Canadian Journal of Fisheries and Aquatic Sciences, 60*(6), 603-611. https://doi.org/10.1139/f03-048

Herbst, D., S. Cooper, B. Medhurst, S. Wiseman, and C. Hunsaker. (2019). Drought ecohydrology alters the structure and function of benthic invertebrate communities in mountain streams. *Freshwater Biology 64* (5), 886-902.

Holomuzki, J. R., & Biggs, B. J. F. (2000). Taxon-specific responses to high-flow disturbance in streams: Implications for population persistence. *Journal of the North American Benthological Society, 19*(4), 670-679. https://doi.org/10.2307/1468127

Lake, P. S. (2000). Disturbance, patchiness, and diversity in streams. *Journal of the North American Benthological Society, 19*(4), 573-592. https://doi.org/10.2307/1468118

National Oceanic and Atmospheric Administration (NOAA). (2023). *Annual Drought Report for 2022*. National Centers for Environmental Information (NCEI). https://www.ncei.noaa.gov/access/monitoring/monthly-report/drought/202213.

Ode P.R., A.C. Rehn, & J.T. May. (2005). A quantitative tool for assessing the integrity of Southern California coastal streams. *Environmental Management, 35 (*4), 493-504.

Ode, P.R., A.E. Fetscher, 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* (Bioassessment SOP 004). California State Water Resources Control Board, Surface Water Ambient Monitoring Program (SWAMP).

Rehn, A.C., R.D. Mazor & P.R. Ode. (2015). *The California Stream Condition Index (CSCI): A New Statewide Biological Scoring Tool for Assessing the Health of Freshwater Streams*. SWAMP Technical Memorandum SWAMP-TM-2015-0002.

Supp, S. R., & Ernest, S. K. M. (2014). Species-level and community-level responses to disturbance: A cross-community analysis. *Ecology, 95*(7), 1717-1723. https://doi.org/10.1890/13-2250.1

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

This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement CE-98T25101 to the Bay Foundation of Morro Bay. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does the EPA endorse trade names or recommend the use of commercial products mentioned in this document.

Appendix A. Bioassessment Monitoring Locations

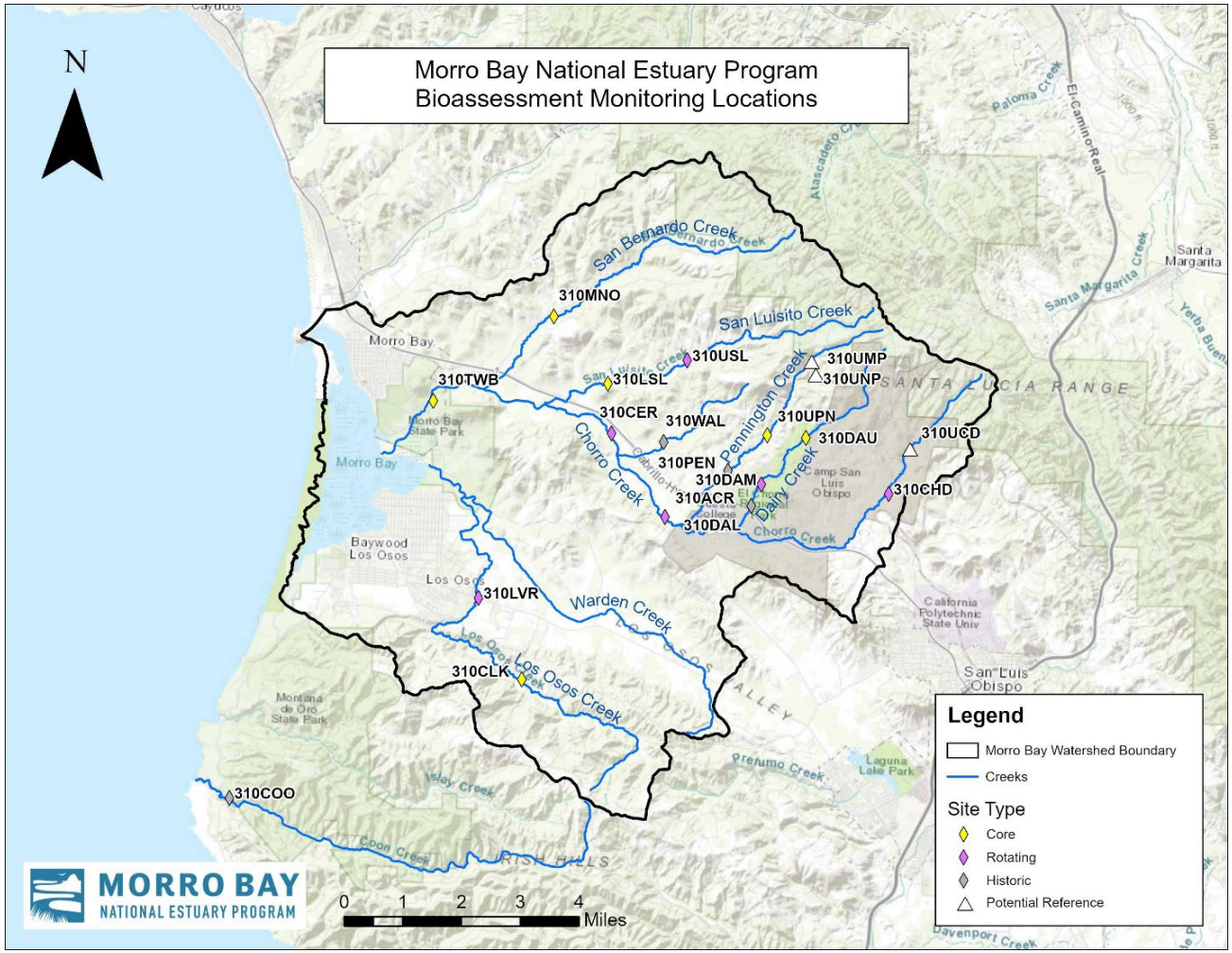

Figure 10. *Core, rotating, and historic bioassessment monitoring locations. Potential reference sites are located in the upper watershed and denoted with a white triangle.*

Appendix B: CSCI Scores 1994 – 2023

Year	Chorro Creek					Dairy Creek			Pennington Creek				Walters Creek	San Luisito Creek		San Bernardo Creek	Los Osos Creek		Coon Creek
Site Code	UCD	CHD	ACR	CER	TWB	DAU	DAM	DAL	PEN	UMP	UNP	UPN	WAL	LSL	USL	MNO	CLK	LVR	COO
1994	*	0.70	*	*	*	0.94	0.62	*	0.94	*	*	*	*	*	*	*	*	*	*
1995	*	0.57	*	*	*	0.61	0.71	*	0.85	*	*	*	*	*	*	*	*	*	*
1996	*	0.76	*	*	*		1.09	*	1.17	*	*	*	0.48	*	*	*	1.02	1.05	*
1997	*	0.84	*	*	0.73	1.12	1.09	1.13	1.13	*	*	*	0.49	*	*	*	1.02	*	1.13
1998	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1999	*	*	*	*	*	0.40	0.87	0.88	1.04	*	*	*	*	*	*	*	1.06	*	*
2000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
2001	*	0.76	*	*	*	1.07	*	1.18	0.98	*	*	*	0.75	*	*	*	*	*	*
2002	*	*	*	*	0.73	*	*	*	*	*	*	*	*	*	*	*	0.93	*	0.97
2003	*	*	*	0.82	0.74	*	*	0.87	*	*	*	*	*	*	*	*	0.96	*	0.98
2004	*	0.85	*	0.67	*	*	*	0.77	0.85	*	*	*	*	*	*	*	0.94	*	*
2005	*		*	0.67	*	*	*	0.75	*	*	*	*	*	*	*	*	0.74	*	*
2006	*	0.71	*	*	0.90	*	*	0.83	0.82	*	*	0.97	*	*	*	*	0.88	*	1.05
2007	*	0.82	*	0.75	0.82	*	*	*	*	*	*	1.09	*	*	*	*	*	*	1.26
2008	*	0.81	*	0.77	1.03	1.02	0.82	0.85	*	*	*	1.17	0.44	0.98	*	1.03	0.76	*	1.13
2009	*	*	*	0.70	*	1.03	0.96	*	*	*	*	*	*	0.98	*	*	*	*	*
2010	*	*	*	*	*	1.08	0.70	0.74	*	*	*	*	0.56	1.03	1.15	1.01	0.95	0.57	*
2011	*	0.92	*	0.84	*	1.03	1.14	*	*	*	*	1.13	*	1.00	1.09	0.99	1.06	0.91	*
2012	*	*	*	0.87	0.79	*	*	*	*	*	*	1.04	*	1.06	*	1.01	0.85	*	*
2013	*	*	*	0.59	0.91	*	*	*	*	*	*	1.13	*	0.68	0.92	1.02	*	*	*
2014	*	*	*	0.66	0.78	*	*	*	*	*	*	1.04	*	0.86	0.89	0.61	*	*	*
2015	*	0.77	*	0.79	0.61	*	*	*	*	*	*	0.88	*	0.97	1.03	0.72	*	*	*
2016	*	0.82	*	0.81	0.71	*	*	*	0.83	*	*	1.04	*	1.00	1.09	0.86	*	*	*
2017	*	0.78	*	0.82	0.98	0.98	0.81	*	*	*	*	1.10	*	1.04	*	0.98	0.76	0.64	1.07
2018	*	0.92	*	0.79	0.96	1.20	*	*	*	*	*	1.06	*	1.10	1.17	1.06	0.75	*	0.97
2019	*	*	0.86	0.76	0.91	0.92	0.82	*	*	*	*	0.98	*	1.05	*	1.11	0.90	0.65	*
2020	*	*	0.83	*	0.97	*	*	*	*	*	*	0.98	*	0.88	0.97	0.97	0.97	*	*
2021	*	*	0.68	0.58	0.79	0.80	0.82	*	*	0.96	0.79	0.97	*	0.98	*	0.82	*	*	*
2022	1.04	0.88	*	*	0.85	0.92	*	*	*	0.89	0.84	1.13	*	1.02	1.02	0.94	*	*	*
2023	0.91	*	0.82	0.78	0.90	0.69	0.69	*	*	*	*	0.77	*	0.83	*	0.68	0.72	0.67	*
Average CSCI	**0.98**	**0.79**	**0.80**	**0.74**	**0.84**	**0.92**	**0.86**	**0.89**	**0.96**	**0.92**	**0.82**	**1.03**	**0.54**	**0.97**	**1.04**	**0.92**	**0.90**	**0.75**	**1.07**

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