Benthic Macroinvertebrate Assemblages of San Pedro Creek, San Mateo County

- Spring 2002 -

Prepared For:

THE SAN MATEO COUNTYWIDE STORMWATER POLLUTION PREVENTION PROGRAM

Prepared By:

BIOASSESSMENT SERVICES

Folsom, California

in association with

EOA, INC.

Oakland, California

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SUMMARY

The San Mateo Countywide Stormwater Pollution Prevention Program (STOPPP) conducted a biological assessment of San Pedro Creek in May 2002 to help evaluate the creek's biotic condition. The assessment was conducted using protocols outlined in the California Stream Bioassessment Procedure. This procedure uses the benthic macroinvertebrate assemblage as an indicator of water and habitat quality. Because of benthic macroinvertebrate abundance, taxonomic diversity and range of response to changes in their aquatic environment, they are commonly the resident biota used to monitor the quality of water resources.

A total of six sites were assessed within the San Pedro Creek system: two sites that receive flow from the middle/ south fork drainages; one site that receives flow from the north fork; and three sites in the mainstem, downstream of the middle and north fork drainages. Three replicate benthic samples were collected at each site in conjunction with a habitat assessment.

At the laboratory, the benthic samples were processed by subsampling 300 organisms from each sample and identifying the organisms to a standard taxonomic level. Biological metrics were used to describe characteristics of the benthic macroinvertebrate assemblages and cluster analysis was used to assess the degree of site similarity based on the composition of benthic macroinvertebrate assemblages.

Results of the assessment indicated that benthic macroinvertebrate assemblages sampled from the sites were highly dissimilar. While the sites were distributed along an elevational gradient, the data suggested that most of the variation in the benthic macroinvertebrate assemblages was due to factors associated with the urbanized north fork branch of San Pedro Creek and the mainstem. Benthic macroinvertebrate assemblages sampled from sites receiving flow from the less urbanized middle and south forks had consistently higher richness and diversity and were less tolerant than benthic macroinvertebrate assemblages sampled from the other sites. Streams that receive runoff from urban watersheds with impervious landscape surfaces may contain petroleum hydrocarbons, fine sediment, pesticides, fertilizers and detergents and have been characterized as having altered flow and temperature regimes. These characteristics of the urban stream have been shown to affect the composition of instream aquatic biota including benthic macroinvertebrates. However, additional data are needed before it can be concluded that urbanization is impacting macroinvertebrate assemblages in the San Pedro Creek watershed. In particular, additional local BMI bioassessment data in conjunction with water quality monitoring would help better characterize and explain variations in the benthic macroinvertebrate assemblages in San Pedro Creek.

STOPPP plans to collect a second year of BMI bioassessment data in San Pedro Creek during Spring 2003. Water quality monitoring for toxicity and selected pollutants will be performed concurrently. Goals will include better characterizing any water quality impairment problems in San Pedro Creek and, if needed, beginning to refine existing water quality management

strategies or develop new strategies. The lessons learned will be applied during STOPPP's future efforts to characterize and improve water quality in other urban watersheds in San Mateo County.

STOPPP will also participate in the Bay Area Macroinvertebrate Bioassessment Information Network (BAMBI). This new regional effort will coordinate Bay Area BMI bioassessment efforts and help develop standards for interpreting and applying the results in the context of watershed assessment and management.

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INTRODUCTION

Bioassessment Services of Folsom, California was contracted by EOA, Inc. of Oakland, California to provide laboratory services for processing 18 stream benthos samples. The samples were collected in May 2002 from six sites in San Pedro Creek, San Mateo County. This report documents the results of the stream benthos processing and provides insight into the quality of the benthic macroinvertebrate (BMI) assemblages sampled from the San Pedro Creek sampling sites.

This work was performed as part of the San Mateo Countywide Stormwater Pollution Prevention Program's (STOPPP's) efforts to assess the health of creeks in representative urban watersheds in San Mateo County. The overall goal is to help solve water quality impairment problems in creeks using a watershed-based approach.

BMIs are an essential component of the food web in aquatic habitats. They cycle nutrients in their aquatic environment by feeding on algae and organic detritus and by preying on a wide range of small organisms. They are an important food resource for fishes, amphibians, reptiles, birds and mammals. Because of BMI abundance, taxonomic diversity and range of response to changes in their aquatic environment, they are commonly the resident biota used to monitor the quality of water resources throughout the United States (Davis et al. 1996). Justifications for their use as indicators of water and habitat quality have been described by Hutchinson (1993), Karr and Chu (1999), Resh and Jackson (1993), Rosenburg and Resh (1993) and others. Additional advantages of BMI-based biological assessment include long holding times for preserved samples and the establishment of BMI voucher collections.

METHODS

Benthic sampling and habitat assessment

EOA, Inc., members of the San Pedro Creek Watershed Coalition, and local volunteers performed the benthic sampling and habitat assessment for the project using methods outlined in the California Stream Bioassessment Procedures (CSBP). Prior to conducting the bioassessment, STOPPP conducted a two-day field workshop (May 4 and 5, 2002) at San Pedro Creek to train the volunteer field crew on implementing the CSBP protocols. The Sustainable Land Stewardship International Institute (SLSII) facilitated the training workshop. The CSBP was developed by Harrington (1999) and the California Department of Fish and Game (DFG) for assessing biotic integrity in wadeable streams. The non-point source pollution BMI sampling methodology in the CSBP was applied to this assessment for documenting and describing BMI assemblages and physical habitat within the selected sites. Table 1 provides location descriptions of the sampling sites; a map of the sites is shown in Figure 1. The fieldwork was conducted on May 11 and 15, 2002.

Five riffle habitat units were identified within each site and three were randomly chosen for sampling. Riffle length was determined at each randomly selected riffle and a transect was randomly established within the upper third of the riffle. Three samples were collected along

the transect and composited. Samples were collected by rubbing cobble and boulder substrates and disturbing finer substrates within a 2 sq. ft. area upstream of a D-frame kicknet fitted with a 0.5 mm mesh net. The total area sampled per transect was 6 sq. ft. Each sample was transferred to a plastic jar, preserved with 95% ethanol and labeled, and chain-of-custody forms were completed. Three samples were collected in this manner at each of six sites for a total of 18 samples.

At each site water quality measurements were taken and physical characteristics of the riparian zone were documented using the US EPA's Rapid Bioassessment Protocols for high gradient streams (Barbour et al. 1999). Criteria for scoring the habitat parameters are shown in Appendix A. Specific conductance, pH and dissolved oxygen were measured with portable meters at one location per site after instrument calibration.

Table 1. Site location data for the San Pedro Creek biological assessment initiated in May 2002.

Stream Name	Site Code	Elevation (ft)	Coordinates		No. of Samples
			Latitude	Longitude	
Middle Fork San Pedro Creek	MF	230	N 37° 34' 30.57"	W 122° 27' 45.01"	3
San Pedro Creek	SPC-01	140	N 37° 34' 43.76"	W 122° 28' 14.60"	3
North Fork San Pedro Creek	NF	125	N 37° 34' 59.67"	W 122° 28' 31.74"	3
San Pedro Creek	SPC-02	115	N 37° 34' 55.94"	W 122° 28' 36.41"	3
San Pedro Creek	SPC-03	75	N 37° 34' 55.44"	W 122° 29' 07.87"	3
San Pedro Creek	SPC-04	40	N 37° 35' 16.33"	W 122° 29' 46.81"	3
3 creek sections	6 sites				18 samples

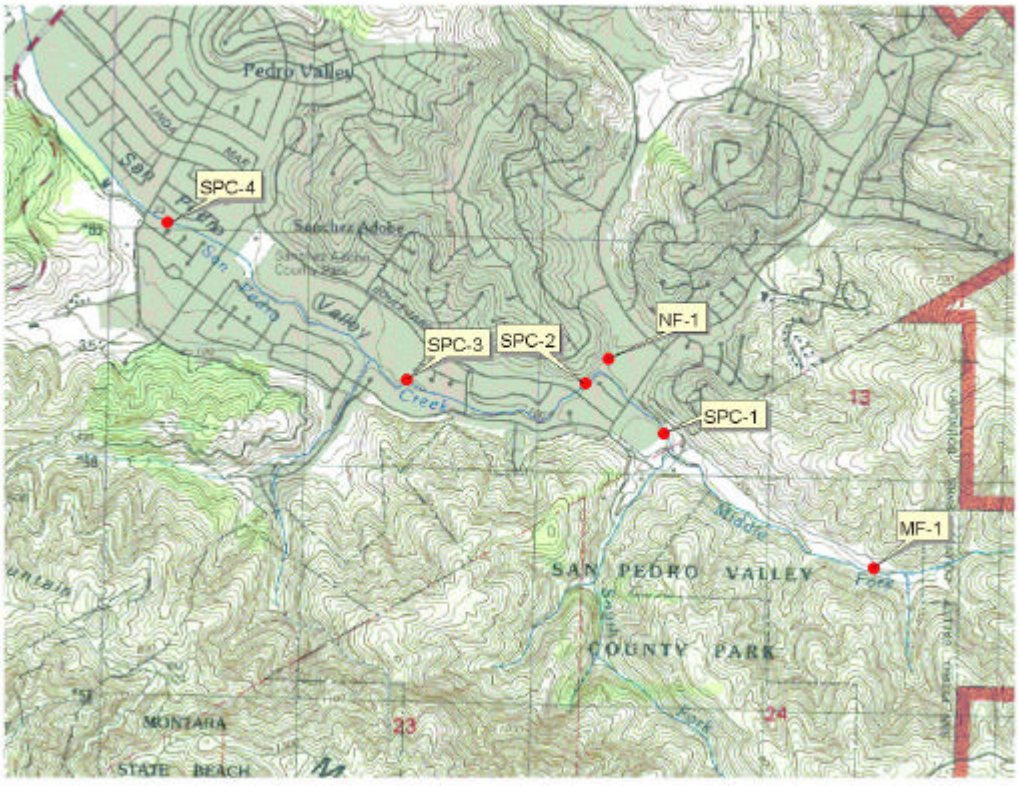

Figure 1. Site locations where benthic samples were collected in May 2002.

Sample processing

At the laboratory, each sample was rinsed in a standard no. 35 sieve (0.5 mm) and transferred to a tray with twenty, 4 sq. in. (25 sq. cm) grids for subsampling. Benthic material in the subsampling tray was transferred from randomly selected grids (or half grids if BMI densities were high) to petri dishes where the BMIs were removed systematically with the aid of a stereomicroscope and placed in vials containing 70% ethanol and 2% glycerol. At least 300 BMIs were subsampled from a minimum of three grids. If there were more BMIs remaining in the last grid after 300 were archived, then the remaining BMIs were tallied and archived in a separate vial. This was done to assure a reasonably accurate estimate of BMI abundance based on the portion of benthos in the tray that was subsampled. These "extra" BMIs were not included in the taxonomic lists and metric calculations. A flotation technique was used to concentrate the BMIs for one sample that contained a large volume of sand with low BMI density.

Subsampled BMIs were identified using taxonomic keys (Merritt and Cummins 1996; Stewart and Stark 1993; Thorp and Covich 1991 and Wiggins 1996) and unpublished references. A standard level of taxonomic effort was used as specified in the draft California Aquatic Macroinvertebrate Laboratory Network short list of taxonomic effort. Exceptions were made for some early instar taxonomic groups. The subsampled BMIs identified from each sample were archived in labeled vials with a mixture of 70% ethanol and 2% glycerol.

Data processing and analysis

The identified taxa and the numbers of BMIs comprising each taxonomic group were entered into a Microsoft Access® database. A taxonomic list and a table of the five most numerically abundant (dominant) taxa for each site were generated using Microsoft Excel®. Cumulative site totals were determined by pooling the BMIs from the three replicate samples collected at each site.

Cluster analysis is a multivariate procedure for detecting natural groupings in data. PC-ORD® (version 4) software was used for performing cluster analysis on samples and cumulative site totals. The cluster distance measure used was Euclidean (Pythagorean) and Ward's method was used for group linking (Davis 1986). Dendrograms are scaled by the percentage of information remaining, which is based on information loss as agglomeration (linking of groups) proceeds during the analysis.

Biological metrics (numerical attributes of biotic assemblages) suggested by the DFG were generated using Excel® and are described in Appendix B. Tolerance values and functional feeding group designations were obtained from the DFG (http://www.dfg.ca.gov/cabw/ABLTaxa.PDF). Biological metric values were tabulated by sample and summarized by site using mean, standard error and cumulative site totals.

Each of the samples (transects) was given a relative ranking score based on a set of BMI assemblage metric values. The metrics used for the scores were Taxonomic Richness, Ephemeroptera Taxa, Plecoptera Taxa, Trichoptera Taxa, Shannon Diversity, Tolerance Value, Percent Intolerant Organisms, Percent Tolerant Organisms, Percent Dominant Taxon and Percent

Predators. The ranking score was an integrative index of these 10 metrics. Nine of the 10 metrics used for the ranking score were found to be reliable responders to disturbance by Karr and Chu (1999). Shannon Diversity, although not identified by Karr and Chu, was incorporated into the suite of metrics because it integrates richness and evenness (Shannon and Weaver 1963; Magurran 1988).

Sites that score high in this integrative index have better than average scores for most or all of the metrics, while sites that score low have poorer scores for most or all of the component metrics. Average ranking sites either have average scores for the component metrics or have a combination of high and low scores. This ranking method was developed by the DFG Aquatic Bioassessment Laboratory.

The formula for computing the ranking scores is as follows:

$$\text{Ranking Score} = \pm(\mathbf{x}_i - x_i)/\text{sem}_i$$

where: $\mathbf{x}_i$ = sample value for the i-th metric; x_i = overall mean for the i-th metric; sem_i = standard error of the mean for the i-th metric; ±: a plus sign denotes a metric that decreases with response to impairment (e.g. Taxonomic Richness) while a minus sign denotes a metric that increases with response to impairment (e.g. Tolerance Value).

RESULTS

Benthic macroinvertebrate taxa

Out of the 18 samples collected, 77 distinct taxa were identified; a total of 5,360 BMIs was processed. Table 2 shows the five numerically abundant (dominant) taxa at each site. Figure 2 is a cluster dendrogram that shows the relative similarity of samples based on the composition of BMIs while Figure 3 shows relative site similarity based on the cumulative composition of BMIs in the samples collected from the sites. A complete taxonomic list including tolerance value (TV) and functional feeding group (FFG) designations is presented in Appendix C.

Table 2, Figure 2 (grouping 1) and Figure 3 indicate high similarity of BMI composition for sites SPC3 and SPC4. At the highest level of grouping (2), as shown in Figure 2, samples collected from sites MF and SPC1 were highly dissimilar from samples from the other sites. This pattern is also evident in Table 2 and Figure 3. Midges (Orthocladiinae and Tanytarsini) were the only numerically dominant insects at site NF (Table 2). Representative genera within the EPT taxonomic orders were numerically dominant at sites MF and SPC1 while only one Ephemeroptera taxon (*Baetis*) was dominant at the other sites excluding site NF, where no ephemeropterans were dominant. Oligochaetes (Naididae and/or Tubificidae) comprised at least 50 percent of the BMIs sampled from sites NF and SPC2.

Table 2. Numerically dominant benthic macroinvertebrate taxa and their percent contribution by site from samples collected from San Pedro Creek in May 2002.

Site	Dominant Taxa				
	1	**2**	**3**	**4**	**5**
MF	Orthocladiinae 18%	*Baetis* 15%	*Diphetor* 8%	*Malenka* 6%	*Parthina* 6%
SPC1	Orthocladiinae 32%	Tanytarsini 18%	*Baetis* 9%	*Malenka* 5%	*Rhyacophila* 3%
NF	Naididae 42%	Orthocladiinae 25%	Tubificidae 8%	Tanytarsini 6%	Planariidae 5%
SPC2	Naididae 51%	Orthocladiinae 17%	*Baetis* 13%	Tanypodinae 4%	*Simulium* 3%
SPC3	*Baetis* 30%	Naididae 22%	Orthocladiinae 17%	*Antocha* 6%	Tanypodinae 6%
SPC4	*Baetis* 34%	Naididae 28%	Orthocladiinae 12%	*Simulium* 10%	*Antocha* 9%

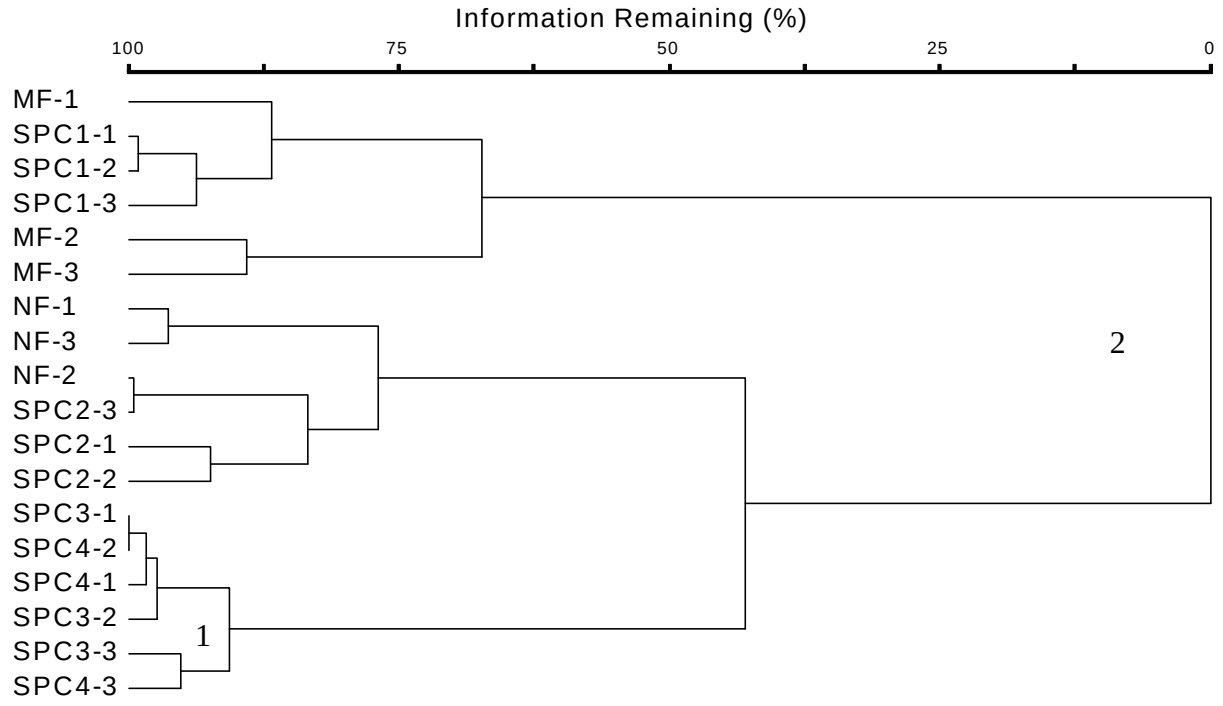

Figure 2. Dendrogram showing degree of sample similarity based on the composition of benthic macroinvertebrate assemblages sampled from San Pedro Creek in May 2002. Site dissimilarity increases as links are made from left to right.

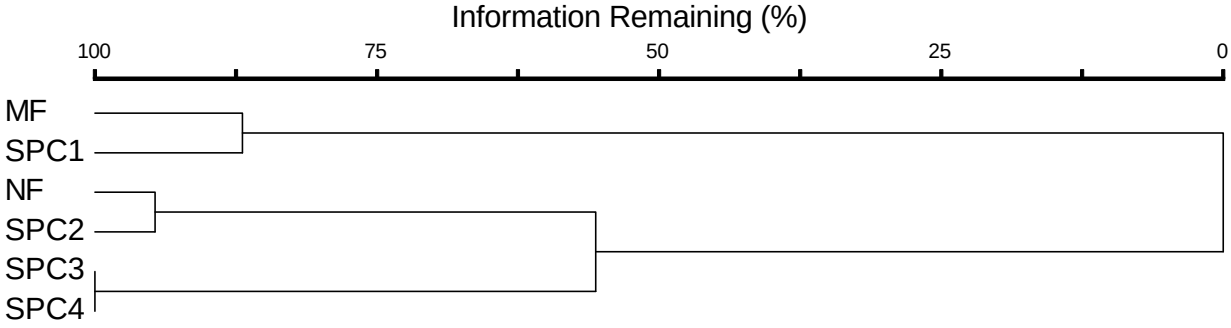

Figure 3. Dendrogram showing degree of site similarity based on the composition of benthic macroinvertebrate assemblages sampled from San Pedro Creek in May 2002. Site dissimilarity increases as links are made from left to right.

BMI metrics and site ranking

BMI metric values are summarized in Table 3 and tabulated by transect in Appendix D. Functional feeding groups and site ranking scores are presented in Figures 4 and 5, respectively.

Richness and Composition Metrics - Mean Taxonomic Richness values ranged from 12 at SPC4 to 35 at MF. Mean EPT Taxa values for sites MF and SPC1 were over three times higher than the other sites and similar patterns were evident for the mean EPT Index and Shannon Diversity values.

Tolerance Metrics – Mean Tolerance values ranged from 3.9 at site MF to 6.9 at site NF. Oligochaete dominance was a primary factor contributing to sites with high tolerance values. Mean Percent Intolerant Organism metric values ranged from 0 at site NF to 30 at site MF. BMI taxa contributing to sites with higher intolerance included the mayfly genus *Drunella*, the stonefly genera *Malenka*, *Suwallia* and *Calineuria,* and the caddisfly genera *Rhyacophila* and *Parthina*.

Functional Feeding Groups (FFG) and Abundance – Figure 4 indicates that sites MF and SPC1 have a more even distribution of FFGs than the other sites. Shredders comprised one percent or less of the FFGs at sites NF, SPC2, SPC3 and SPC4 while collectors comprised over 80 percent of the FFGs at these sites. Mean abundance values ranged from 890 at site MF to 4,100 at site SPC4.

Ranking Scores – The mean metric values for the sites suggest a trend that is supported by the site Ranking Scores (Figure 5) that show sites MF and SPC1 to rank consistently higher than the other sites. The higher ranking of these sites is due to their relatively higher richness and diversity, lower tolerance and higher proportion of intolerant and EPT taxa when compared to the other sites.

Table 3. Site mean, standard error (SE) and cumulative site total (CST) metric values for benthic macroinvertebrate assemblages sampled from San Pedro Creek in May 2002. Metrics identified with an asterisk were used for site ranking scores.

	San Pedro Creek																	
	Middle Fork			SPC-01			North Fork			SPC-02			SPC-03			SPC-04		
Metrics	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST
Taxonomic Richness *	35	3.0	53	33	0.6	45	15	1.9	23	18	1.5	30	19	1.5	30	12	1.2	18
EPT Taxa	13	0.3	18	15	0.6	18	1	0.0	1	4	0.9	8	4	0.3	7	3	0.3	3
Ephemeroptera Taxa *	5	0.0	7	6	0.3	6	1	0.0	1	2	0.6	4	2	0.0	2	2	0.0	2
Plecoptera Taxa *	4	0.3	6	4	0.7	5	0	0.0	0	1	0.7	2	0	0.3	1	0	0.0	0
Trichoptera Taxa *	4	0.6	5	6	0.9	7	0	0.0	0	1	0.6	2	1	0.3	4	1	0.3	1
EPT Index	53	9.6	53	33	3.8	33	3	0.9	3	15	4.4	15	34	2.9	34	35	3.5	35
Sensitive EPT Index (<4)	29	8.4	29	18	1.2	18	0	0.0	0	1	0.6	1	4	1.3	4	0	0.1	0
Shannon Diversity *	2.71	0.3	3.03	2.47	0.1	2.56	1.70	0.1	1.81	1.62	0.1	1.71	2.00	0.1	2.07	1.71	0.0	1.75
Tolerance Value *	3.9	0.4	3.9	4.4	0.1	4.4	6.9	0.2	6.9	6.5	0.3	6.6	5.5	0.1	5.5	5.8	0.1	5.8
Percent Intolerant Organisms *	31	9.4	31	19	1.4	19	0	0.1	0	4	1.9	4	10	1.2	10	9	1.4	9
Percent Tolerant Organisms *	5	2.4	5	2	0.2	2	57	4.8	58	52	6.8	52	23	3.4	23	28	2.4	28
Percent Dominant Taxon *	22	8.0	18	32	4.6	32	42	8.3	42	51	7.0	51	30	3.7	30	35	2.3	34
Percent Collectors	57	5.6	57	51	3.3	51	85	1.2	86	87	1.8	87	82	2.0	82	83	3.4	83
Percent Filterers	5	2.3	5	21	3.7	21	7	1.2	7	6	1.7	6	7	1.9	7	13	3.4	13
Percent Grazers	3	1.7	3	8	1.2	8	0.0	0.0	0.0	1	0.5	1	4	1.2	4	1	0.1	1
Percent Predators *	20	3.5	20	13	1.2	13	7	1.0	7	6	0.5	6	7	1.1	7	2	0.9	2
Percent Shredders	16	4.3	16	6	0.7	6	0.4	0.2	0.3	1	0.1	1	0.2	0.1	0.2	0.0	0.0	0
Abundance (x1000)	0.89	0.6	2.7	1.2	0.2	3.5	1.3	0.1	3.9	2.1	0.2	6.2	1.5	0.3	4.6	4.1	1.2	12

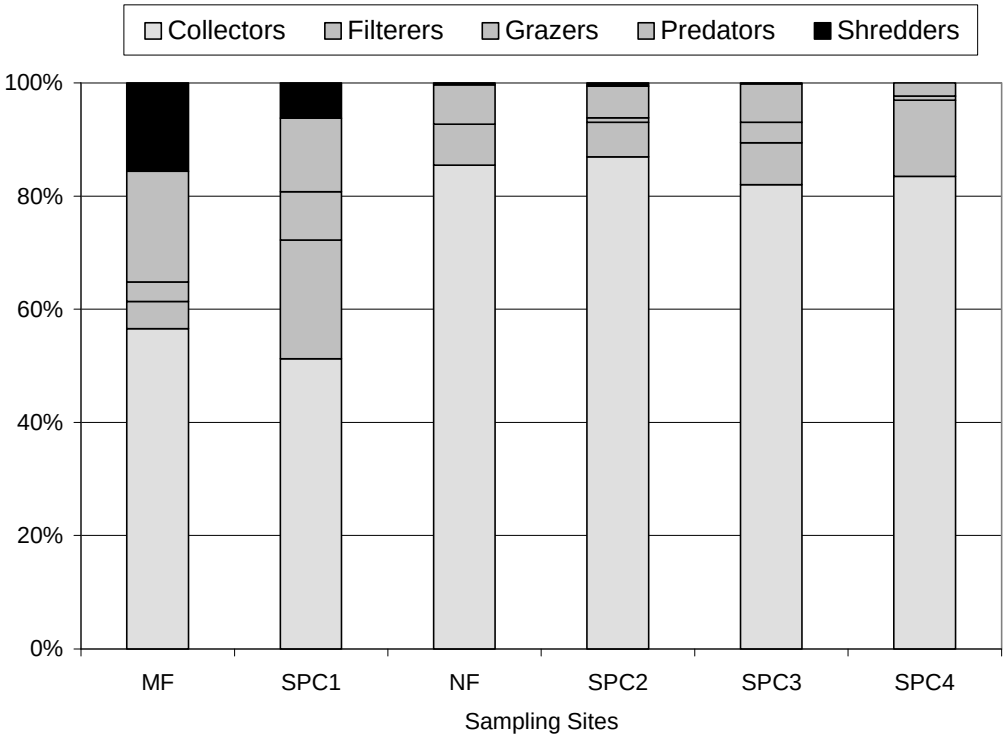

Figure 4. **Percentages of benthic macroinvertebrate functional feeding groups sampled from San Pedro Creek in May 2002.**

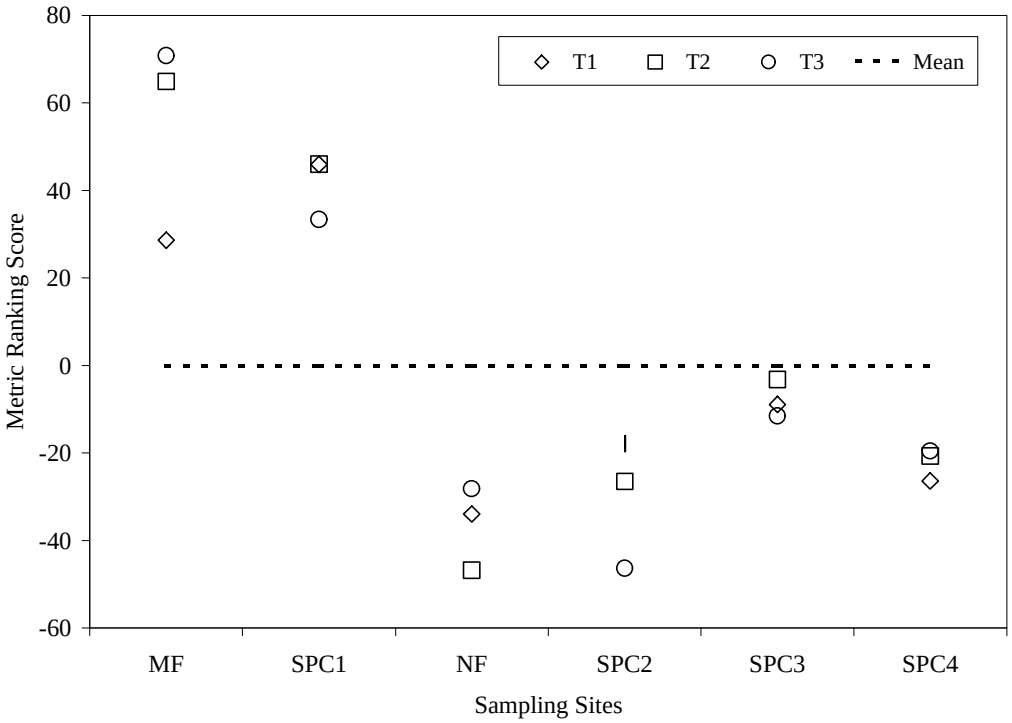

Figure 5. **Relative site ranking scores based on integrated metric values for samples (T1, T2 and T3) collected from San Pedro Creek in May 2002.**

Habitat assessment

Site scale habitat assessment results are presented in Table 4. Habitat scores ranged from 106 at SPC4 to 146 at site MF. According to Barbour et al. (1999) these scores would imply suboptimal habitat. For reference, scores less than 50 would imply poor habitat, scores between 50 and 100 would imply marginal habitat and scores greater than 150 would imply optimal habitat.

Table 4. Site scale habitat scores and water quality constituents measured for San Pedro Creek in May 2002 (determined by EOA, Inc.)

Habitat Parameter	MF	SPC1	NF	SPC2	SPC3	SPC4
Epifaunal Substrate/ Available Cover	13	9	9	12	17	8
Embeddedness	18	18	7	12	12	14
Velocity/Depth Regime	11	14	15	14	18	10
Sediment Deposition	15	9	6	10	6	6
Channel Flow Status	18	18	18	18	18	18
Channel Alteration	18	13	16	12	13	8
Frequency of Riffles	13	16	19	19	19	18
Bank Stability	9	7	10	14	10	13
Vegetative Protection	17	6	11	12	11	7
Riparian Vegetative Zone Width	14	7	6	6	8	4
Total Score	146	117	117	129	132	106
Water Quality						
Water Temperature (°C)	9.2	11	15	14	12	14
Specific Conductance (ì mho/cm @ 25ºC)	271	192	580	334	313	328
PH	7.9	7.9	7.8	7.9	8.2	8.3

DISCUSSION

Evaluating influences on benthic fauna

Since reference conditions have not been established in California, it is difficult to know what range of biotic metric values would be considered typical for a given region. Until reference conditions are established on a regional basis, investigators must use best professional judgment and empirical methods on a project-by-project basis to evaluate effects of habitat and/or water quality impairment on benthic fauna. A limitation of the metric ranking scores used for this assessment is that some of the metrics measure related attributes of the BMI assemblage and therefore amplify a response. While this is helpful for use as a screening tool for assessing differences in sites or samples, it is not an absolute measure of biotic integrity.

Site MF is located in the less urbanized Middle Fork San Pedro Creek drainage. In addition to receiving flow from the middle fork, site SPC1 receives flow from the South Fork San Pedro Creek, which, like the middle fork, is less urbanized than the north fork. Both sites MF and SPC1 had similar metric scores but the MF site had the highest habitat quality ranking. While the cluster dendrogram does not infer a qualitative measure of biotic integrity, it does support the metric ranking scores by showing that the BMI assemblages of sites NF and SPC2 through SPC4 were highly dissimilar from the BMI assemblages of sites MF and SPC1.

Several factors, working in various combinations, could be contributing to the dissimilarity of BMI assemblages inhabiting the sites. Factors associated with elevation such as gradient, canopy cover, stream width, substrate composition, allocthonous input, depth and temperature regime have been described by Vannotte et al. (1980) in the River Continuum Concept to influence the composition of benthic fauna along elevational gradients. Other investigators (e.g., Allan 1995 and Merritt and Cummins 1996) have shown these factors, individually and in various combinations, to be important influences on benthic fauna.

While metric scores and elevation were correlated (R^2=0.53; Figure 6), other factors associated with the sites such as degree of urbanization could be contributing to the variation. For this stream system, it appears that the magnitude of urbanization increases with decreasing elevation (Figure 1) and may be the primary factor contributing to the correlation. Other factors associated with elevation appear less important because the elevation difference between site SPC1 and NF is only 15 feet yet the differences in the metric values were high (e.g., one EPT taxon at site NF compared with an average of 15 EPT taxa for site SPC1). Although additional data are needed to better characterize the stressors affecting BMI communities in San Pedro Creek, this difference suggests that factors associated with the urbanized north fork drainage were influencing the composition of BMIs at the sites receiving north fork flow.

It is unlikely that a lack of coarse substrate contributed to the differences of BMI assemblages between the sites because gravel and cobble were well represented at all sites (Appendix E).

While coarse substrate was present at all the sites, other transect scale benthic habitat parameters (embeddedness and consolidation) were variable (Appendix E). Embeddedness was highest (lower ranking scores) at site NF and lowest at sites MF and SPC1 and intermediate at the other sites. Site scale embeddedness scores (Table 4) followed a similar trend with sites MF and SPC1 ranking high, site NF ranking low and the other sites ranking within an intermediate range. Site scale sedimentation scores for site MF ranked considerably higher (less fine sediment) than the other sites (Table 4). Site MF, however, had a moderately consolidated substrate and high percentage of canopy cover (Appendix E), factors which may have contributed to its lower BMI abundance.

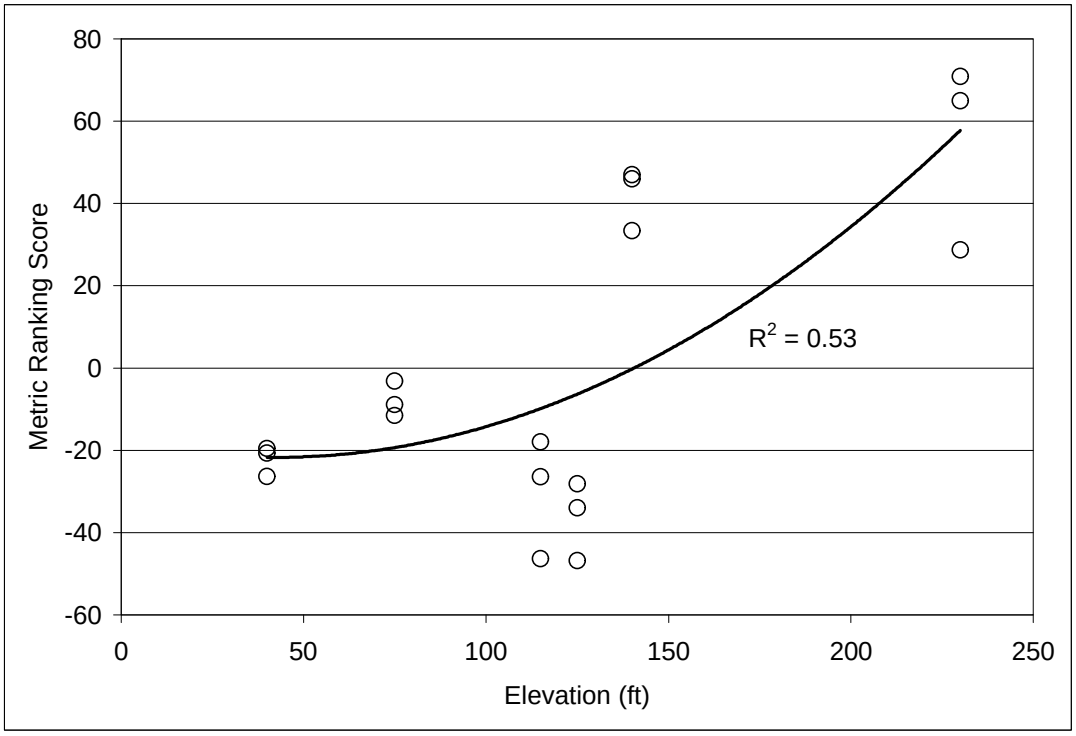

Figure 6. Relationship of factors associated with site elevation and metric ranking scores.

Effects of urbanization

Factors contributing to streams with productive and diverse benthic fauna include mixtures of loosely consolidated coarse substrate, a natural hydrograph, allochthonous inputs and good water quality. These conditions become altered in urban areas where upstream impervious landscape surfaces alter the natural hydrograph and interfere with the production and transport of allocthonous material (Williams and Feltmate 1992, Schueler 1995, and Karr and Chu 1999). While bank sloughing is a natural phenomenon of stream systems, urban streams are characterized as having higher peak discharges, which contribute to increases in bank instability, increasing channel cross-sectional area and sediment discharge (Trimble 1997). Excessive sediment input occludes interstitial space and thereby decreases the variation of area within the substrate for insect colonization (Allan 1995). Often, a shift in benthic fauna occurs with increases in sedimentation resulting in increases in burrowing forms such as oligochaetes, as was seen at sites NF and SPC2 through SPC4. Furthermore, altered hydrographs may affect benthic fauna such as uni/ semi-voltine taxa that are dependent on cyclic thermal cues for their development (Ward and Stanford 1979). Benthic fauna of urban streams may also be affected by constituents that may be found in storm water runoff such as petroleum hydrocarbons, fine sediment, pesticides, fertilizers and detergents (Schueler 1987).

NEXT STEPS

Additional local BMI bioassessment data in conjunction with water quality monitoring would help better characterize and explain variations in the benthic macroinvertebrate assemblages in San Pedro Creek. STOPPP plans to collect a second year of BMI bioassessment data during Spring 2003 using similar methodologies described in this report for the first year of work. Water quality monitoring for toxicity and selected pollutants will be performed concurrently. Goals will include better characterizing any water quality impairment problems in San Pedro Creek and, if needed, beginning to refine existing water quality management strategies or develop new strategies. The lessons learned will be applied during STOPPP's future efforts to characterize and improve water quality in other urban watersheds in San Mateo County.

STOPPP will also participate in the Bay Area Macroinvertebrate Bioassessment Information Network (BAMBI). This new regional effort will coordinate Bay area BMI bioassessment efforts and help develop standards for interpreting and applying the results in the context of watershed assessment and management. Priority issues that BAMBI will address include the following:

- Standardizing field and lab protocols for BMI data collection in the Bay area.
- Standardizing data management, reporting and sharing in the Bay area.
- Identifying reference conditions in urbanized Bay area streams.
- Improving the consistency and usefulness of physical habitat assessments associated with bioassessments.

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APPENDIX A

Habitat ranking criteria used for the San Pedro Creek biological assessment in May 2002

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

APPENDIX B

Metrics used to describe characteristics of benthic macroinvertebrate assemblages as described in the California Stream Bioassessment Procedures

BMI Metric	Description	Response to Impairment
Richness Measures		
1. Taxonomic Richness	Total number of individual taxa.	decrease
2. EPT Taxa	Number of taxa in the orders Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly)	decrease
3. Ephemeroptera Taxa	Number of mayfly taxa	decrease
4. Plecoptera Taxa	Number of stonefly taxa	decrease
5. Trichoptera Taxa	Number of caddisfly taxa	decrease
Composition Measures		
6. EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae	decrease
7. Sensitive EPT Index*	Percent composition of mayfly, stonefly and caddisfly larvae with Tolerance Values less than 4.	decrease
8. Shannon Diversity Index	General measure of sample diversity that incorporates richness and evenness (Shannon and Weaver 1963).	decrease
Tolerance/Intolerance Measures		
9. Tolerance Value (TV)	TVs between 0 and 10 weighted for abundance of individuals designated as pollution tolerant (higher values) and intolerant (lower values).	increase
10. Percent Intolerant Organisms*	Percentage of organisms that are highly intolerant to water and/ or habitat quality impairment as indicated by TVs of 0, 1 or 2.	decrease
11. Percent Tolerant Organisms	Percentage of organisms that are highly tolerant to water and/ or habitat quality impairment as indicated by TVs of 8, 9 or 10.	increase
12. Percent Dominant Taxon	The highest percentage of organisms represented by one taxon.	increase
Functional Feeding Groups (FFG)		
13. % Collectors	Percent of macroinvertebrates that collect or gather material	increase
14. % Filterers	Percent of macroinvertebrates that filter suspended material from the water column	increase
15. % Grazers	Percent of macroinvertebrates that graze upon periphyton	variable
16. % Predators	Percent of macroinvertebrates that prey on living organisms	decrease
17. % Shredders	Percent of macroinvertebrates that shred leaf litter	decrease
Other		
18. Abundance	Estimate of the number of BMIs in a sample based on the proportion of BMIs subsampled.	variable

APPENDIX C

Taxonomic list of benthic macroinvertebrates sampled from San Pedro Creek in May 2002

Phylum	*Stream:*		San Pedro Creek																	
Class	*Site:*		Middle Fork			SPC-01			North Fork			SPC-02			SPC-03			SPC-04		
Order	*Transect:*		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Family	*BAS#:*		1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224
Final ID	TV	FFG																		
Arthropoda																				
Insecta																				
Coleoptera																				
Dytiscidae																				
Ametor	5	p	1																	
Elmidae																				
Cleptelmis	4	c	3	1	1	1	1	1						1						
Narpus	4	c	1	18	7		6	2							5	25	9		1	
Narpus (adult)	4	c																		1
Optioservus	4	g	2	11	1	7	10	11				1	1		1	2				
Optioservus (adult)	4	g	1	2																
Zaitzevia	4	c		26		13	3	3				2	1							
Zaitzevia (adult)	4	c	1	12	2	2	8	3				1								
Diptera																				
Ceratopogonidae																				
Bezzia/ Palpomyia	6	p		5		2	4	1				1			1	1	1			
Chironomidae																				
Chironomini	6	c				1		2	4			3	2	4	1	2	3	2	2	3
Orthocladiinae	5	c	111	26	24	86	79	124	65	61	87	73	30	46	55	38	57	45	40	21
Podonominae	6	c			3								1							
Tanypodinae	6	p	16	7	5	7	3	18	1		1	8	19	9	21	9	20	2	6	10
Tanytarsini	6	f	18	8	3	51	71	45	20	17	14	4	12	7	1	17	8	13	8	12
Dixidae																				
Dixa	1	c		1	7															
Meringodixa	2	c	1		1															
Empididae																				
Chelifera	6	p			1		1	1	1	1	2						1			
Clinocera	6	p				1														
Hemerodromia	6	p							1			1								
Trichoclinocera	6	p																		1
Pelecorhynchidae																				
Glutops	3	p		2	2	1		1												
Psychodidae	4	c								1							1			
Pericoma	4	c	2					1	1											
Simuliidae																				
Prosimulium	3	f					1													1
Simulium	6	f	9	1	2	5	7	2		1	3	4	15	12	12	13	13	40	12	36

Phylum	*Stream:*		San Pedro Creek																	
Class	*Site:*		Middle Fork			SPC-01			North Fork			SPC-02			SPC-03			SPC-04		
Order	*Transect:*		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Family	*BAS#:*		1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224
Final ID	TV	FFG																		
Tipulidae																				
Antocha	3	c							1	2	1	15	9	1	21	19	18	18	34	26
Dicranota	3	p	1	1	1		3													
Limonia	6	s	3								2									
Rhabdomastix	3	p		1																
Tipula	4	s							1			2								
Ephemeroptera																				
Baetidae																				
Baetis	5	c	68	22	43	36	23	19	7	7	14	48	55	16	90	73	112	82	106	121
Diphetor	5	c	7	23	39	13	7	3					2							
Ephemerellidae																				
Drunella	0	g		2		8	10	4				4			5	16	7	2	1	1
Serratella	2	c	1																	
Heptageniidae																				
Cinygmula	4	g			1	3	1													
Ironodes	4	g	2	3	1	6	1	1					1							
Leptophlebiidae																				
Paraleptophlebia	4	c	1	3	4	2	6	7												
Plecoptera																				
Chloroperlidae	1	p			8															
Suwallia	1	p	11	11	13	10	3	3				2			1					
Nemouridae																				
Malenka	2	s	14	4	37	12	14	18												
Zapada	2	s	1		15															
Perlidae																				
Calineuria californica	1	p	2	19	18	3	6	11				1								
Hesperoperla	2	p				1														
Perlodidae	2	p		1		1														
Trichoptera																				
Brachycentridae																				
Brachycentrus	1	f				1	1	1								1				
Glossosomatidae																				
Agapetus	0	g				8	3	1												
Glossosoma	0	g	1	1																
Hydropsychidae																				
Hydropsyche	4	f					2	1												
Hydroptilidae																				
Hydroptila	6	g													1				1	1

Phylum	*Stream:*		San Pedro Creek																	
Class	*Site:*		Middle Fork			SPC-01			North Fork			SPC-02			SPC-03			SPC-04		
Order	*Transect:*		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Family	*BAS#:*		1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224
Final ID	TV	FFG																		
Lepidostomatidae																				
Lepidostoma	1	s		6	3												1			
Odontoceridae																				
Parthina	0	s	4	40	11	3	8	2					1	2		1				
Philopotamidae																				
Wormaldia	3	f					2													
Rhyacophilidae																				
Rhyacophila	0	p	3	5	20	13	10	6					1							
Uenoidae																				
Neophylax	3	g	1	1			1	2												
Megaloptera																				
Sialidae																				
Sialis	4	p			1															
Odonata																				
Coenagrionidae																				
Argia	7	p														2				
Cordulegastridae																				
Cordulegaster dorsalis	0	p			1															
Arachnoidea																				
Acari																				
Lebertiidae	5	p	4	4	2	2								2	1					
Sperchontidae	5	p				1		1								1				1
Torrenticolidae	5	p		1	2		1									1				
Malacostraca																				
Amphipoda																				
Crangonyctidae																				
Stygobromus	4	c			1															
Gammaridae																				
Gammarus	4	c			1															
Isopoda																				
Isopoda	8	c				1														
Ostracoda																				
Ostracoda																				
Cyprididae	8	c		4	3	1		5	1	1				2	1	1				
Annelida																				
Hirudinea																				
Pharyngobdellida																				
Erpobdellidae	8	p							1											

Phylum	*Stream:*		San Pedro Creek																	
Class	*Site:*		Middle Fork			SPC-01			North Fork			SPC-02			SPC-03			SPC-04		
Order	*Transect:*		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Family	*BAS#:*		1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224
Final ID	TV	FFG																		
Oligochaeta																				
Haplotaxida																				
Haplotaxidae	8	p		3																
Lumbriculida																				
Lumbriculidae	8	c		6	5		1		9	5	30	2	1	1		2	3			
Tubificida																				
Enchytraeidae	8	c								6	3	4	1	2	1		3		2	
Naididae	8	c	1	10	5				108	173	85	114	150	188	83	71	45	94	85	72
Tubificidae	10	c		2	2	2	2	1	49	4	17					2				
Coelenterata																				
Hydrozoa																				
Hydroida																				
Hydridae	5	f														1				
Molluska																				
Gastropoda																				
Prosobranchia																				
Hydrobiidae	7	g													1					
Pulmonata																				
Lymnaeidae																				
Fossaria	6	g																	1	
Bivalvia																				
Pelecypoda																				
Corbiculacea	9	f			1		1		8			1								
Platyhelminthes																				
Turbellaria																				
Tricladida																				
Planariidae	4	p		1		1			12	12	22	1		4						
Nematoda																				
Nematoda	5	p		1			1	1	1	5				1	1			1		
Nemertea																				
Enopa																				
Tertastemmatidae																				
Prostoma	?	c							1											
Total BMIs processed:			291	295	297	305	301	302	292	296	281	292	302	298	303	298	302	299	299	307

APPENDIX D

Transect scale biological metrics for benthic macroinvertebrates sampled from San Pedro Creek in May 2002

	San Pedro Creek																	
Site:	Middle Fork			SPC-01			North Fork			SPC-02			SPC-03			SPC-04		
Transect:	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Taxonomic Richness	29	38	38	33	34	32	19	14	13	21	17	16	19	21	16	10	13	14
EPT Taxa	13	14	13	15	16	14	1	1	1	4	5	2	4	4	3	2	3	3
Ephemeroptera Taxa	5	5	5	6	6	5	1	1	1	2	3	1	2	2	2	2	2	2
Plecoptera Taxa	4	4	5	5	3	3	0	0	0	2	0	0	1	0	0	0	0	0
Trichoptera Taxa	4	5	3	4	7	6	0	0	0	0	2	1	1	2	1	0	1	1
EPT Index	40	48	72	39	33	26	2	2	5	19	20	6	32	31	40	28	36	40
Sensitive EPT Index (<4)	13	31	42	20	19	16	0	0	0	2	1	1	2	6	3	1	0	0
Shannon Diversity	2.14	3.07	2.93	2.57	2.57	2.27	1.87	1.41	1.84	1.82	1.66	1.39	1.87	2.20	1.95	1.70	1.69	1.75
Tolerance Value	4.6	3.7	3.4	4.3	4.4	4.6	7.2	6.9	6.6	6.1	6.6	7.0	5.7	5.4	5.4	6.0	5.7	5.7
Percent Intolerant Organisms	14	32	46	20	21	16	0	1	0	8	4	1	9	12	9	7	12	9
Percent Tolerant Organisms	0	8	5	1	1	2	60	64	48	41	50	65	28	26	17	31	29	23
Percent Dominant Taxon	38	14	14	28	26	41	37	58	31	39	50	63	30	24	37	31	35	39
Percent Collectors	68	52	50	52	45	57	84	88	84	90	83	88	85	78	83	81	90	79
Percent Filterers	9	3	2	19	28	16	10	6	6	3	9	6	4	11	7	18	7	16
Percent Grazers	2	7	1	10	9	6	0	0	0	2	1	0	3	6	2	1	1	1
Percent Predators	13	21	25	14	11	14	6	6	9	5	7	5	8	5	7	1	2	4
Percent Shredders	8	17	22	5	7	7	0	0	1	1	0	1	0	0	0	0	0	0
Abundance (x1000)	2.0	0.31	0.37	0.76	1.3	1.4	1.3	1.5	1.1	1.8	2.0	2.4	2.2	1.2	1.2	2.6	6.4	3.3

APPENDIX E

Transect scale habitat data collected during benthic sampling of San Pedro Creek in May 2002

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/ STREAM: San Pedro Creek
DATE/ TIME: 5/11/02 11:50 am
COMPANY/ AGENCY: SPCWC
SAMPLE ID #: SPC-1
SITE DESCRIPTION: Downstream SF/MF confluence

SAMPLING CREW

SITE INFORMATION

GPS Coordinates
Latitude:
Longitude:
Elevation:
Ecoregion:
COMMENTS:

CHEMICAL CHARACTERISTICS

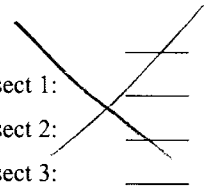
Water Temperature:	11.4 C
~~Specific~~ Conductivity	192
pH:	7.9
Dissolved Oxygen:	N/A

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO:
DFG/ WPCL
2005 Nimbus Road
Rancho Cordova, CA 95670
(916) 358-2858
website: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/ REACH CHARACTERISTICS

Point Source Sampling Design



(record Physical/ Habitat Characteristcs in Riffle 1 column)

Non-Point Source Sampling Design

Reach Length: NR
Physical Habitat Quality Score: 117

Physical/ Habitat Characteristics

	Riffle 1	Riffle 2	Riffle 3	
Riffle Length:	16'	18'	21'	
Transect Location:	(upper third)			
Avg. Riffle Width:	7'	6	7	
Avg. Riffle Depth:	2.5	3.5	3	
Riffle Velocity:	2	1.9	1.4	f/s
% Canopy Cover:	60	75	80	
Substrate Complexity:	4	7	7	(1-10)
Embeddedness:	9	9	8	(1-10)
Substrate Composition:				
Fines (<0.1"):	10	15	20	
Gravel (0.1-2"):	60	50	30	
Cobble (2-10"):	30	35	50	
Boulder (>10"):	0	0	0	
Bedrock (solid):	0	0	0	
Substrate Consolidation:	loose	med.	med loose	
Percent Gradient:	N/A	N/A	N/A	

29 cfs flowing.

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/ STREAM: San Pedro Cr
DATE/ TIME: 5/11/07 14:30
COMPANY/ AGENCY: SPCWC
SAMPLE ID #: SPC-02
SITE DESCRIPTION: Downstream NF Confl.

SAMPLING CREW

SITE INFORMATION

GPS Coordinates
Latitude:
Longitude:
Elevation:
Ecoregion:
COMMENTS:

CHEMICAL CHARACTERISTICS

Water Temperature:	13.6
~~Specific~~ Conductance:	334.1
pH:	7.9
Dissolved Oxygen:	NA

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO:
DFG/ WPCL
2005 Nimbus Road
Rancho Cordova, CA 95670
(916) 358-2858
website: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/ REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:

(record Physical/ Habitat Characteristcs in Riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 220
Physical Habitat Quality Score: 129

Physical/ Habitat Characteristics

	Riffle 1	Riffle 2	Riffle 3
Riffle Length:	11'	22'	21'
Transect Location:			
Avg. Riffle Width:	5'	10'	14'
Avg. Riffle Depth:	3.5	3	2.5
Riffle Velocity:	1.8	1.4	1.6
% Canopy Cover:	70	40	50
Substrate Complexity:	5	8	7
Embeddedness:	6	6	6
Substrate Composition:			
Fines (<0.1"):	20	15	18
Gravel (0.1-2"):	50	30	30
Cobble (2-10"):	30	50	50
Boulder (>10"):	0	5	2
Bedrock (solid):	0	0	0
Substrate Consolidation:	ML	M	ML
Percent Gradient:			

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/ STREAM: San Pedro Creek DATE/ TIME: 5/15/02 8:00

COMPANY/ AGENCY: SPCWC SAMPLE ID #: SPC-03

SITE DESCRIPTION: Behind Sanchez Art Center
upstream Sanchez Cr

SAMPLING CREW

SITE INFORMATION

GPS Coordinates
Latitude:
Longitude:
Elevation:
Ecoregion:
COMMENTS:

CHEMICAL CHARACTERISTICS

Water Temperature:	12.2
~~Specific~~ Conductance:	313
pH:	8.21
Dissolved Oxygen:	N/A

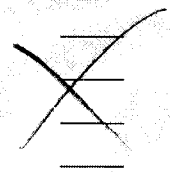
Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO:
DFG/ WPCL
2005 Nimbus Road
Rancho Cordova, CA 95670
(916) 358-2858
website: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/ REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:



(record Physical/ Habitat Characteristcs in Riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 320
Physical Habitat Quality Score: 132

Physical/ Habitat Characteristics

	Riffle 1	Riffle 2	Riffle 3
Riffle Length:	25	9	21
Transect Location:	upper 3rd		
Avg. Riffle Width:	13	8	15
Avg. Riffle Depth:	3.5	2.8	6.3
Riffle Velocity:	2	1.7	1.8
% Canopy Cover:	35	70	70
Substrate Complexity:	7	8	9
Embeddedness:	5	4	5
Substrate Composition:			
Fines (<0.1"):	15	20	5
Gravel (0.1-2"):	50	50	35
Cobble (2-10"):	30	15	35
Boulder (>10"):	5	15	25
Bedrock (solid):	0	0	0
Substrate Consolidation:	mod	mod	mod
Percent Gradient:			

26 cfs flow rate

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/ STREAM: San Pedro creek
DATE/ TIME: 5/15/07 10:30
COMPANY/ AGENCY: SPCWC
SAMPLE ID #: SPC-04
SITE DESCRIPTION: upstream Peralta bridge and Shamrock Court

SAMPLING CREW

SITE INFORMATION

GPS Coordinates UTM
Latitude: 10S 0544780
Longitude: 416 0247
Elevation:
Ecoregion:
COMMENTS:
Only 3 riffles in reach
Access Behind Marilyn's house
landscape work

CHEMICAL CHARACTERISTICS

Water Temperature: 13.6
Specific Conductance: 328
pH: 8.29
Dissolved Oxygen:

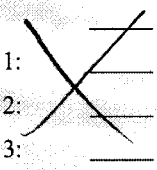
Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO:
DFG/ WPCL
2005 Nimbus Road
Rancho Cordova, CA 95670
(916) 358-2858
website: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/ REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:



(record Physical/ Habitat Characteristcs in Riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 224'
Physical Habitat Quality Score: 106

Physical/ Habitat Characteristics

	Riffle 1	Riffle 2	Riffle 3
Riffle Length:	22	26	34
Transect Location:			
Avg. Riffle Width:	13	10	9
Avg. Riffle Depth:	3	3.5	3
Riffle Velocity:	2-1	1.5	2.0
% Canopy Cover:	0	15	10
Substrate Complexity:	7	7	7
Embeddedness:	7	6	7
Substrate Composition:			
Fines (<0.1"):	5	10	5
Gravel (0.1-2"):	40	40	40
Cobble (2-10"):	50	45	50
Boulder (>10"):	5	5	5
Bedrock (solid):	0	0	0
Substrate Consolidation:	mod	firm	mod
Percent Gradient:			

5 cfs . flow rate

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/ STREAM: Middle Fork
DATE/ TIME: 5/11/02 9:30
COMPANY/ AGENCY: SPCWC
SAMPLE ID #: MF-1
SITE DESCRIPTION: Upstream Eastbridge in County Park

SAMPLING CREW

SITE INFORMATION

GPS Coordinates
Latitude:
Longitude:
Elevation:
Ecoregion:
COMMENTS:

CHEMICAL CHARACTERISTICS

Water Temperature: 9.2
Specific Conductance: 271.3
pH: 7.93
Dissolved Oxygen: N/A

Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO:
DFG/ WPCL
2005 Nimbus Road
Rancho Cordova, CA 95670
(916) 358-2858
website: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/ REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:

(record Physical/ Habitat Characteristcs in Riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 143'
Physical Habitat Quality Score: 146

Physical/ Habitat Characteristics

	Riffle 1	Riffle 2	Riffle 3
Riffle Length:	10'	17'	21
Transect Location:			
Avg. Riffle Width:	5	5.5	5
Avg. Riffle Depth:	2	2	2
Riffle Velocity:	9 1/6 s	5 1/6 s	5 1/6 s
% Canopy Cover:	50	90	80
Substrate Complexity:	8	7	5
Embeddedness:	9	9	9
Substrate Composition:			
Fines (<0.1"):	10	15	20
Gravel (0.1-2"):	20	30	40
Cobble (2-10"):	70	55	40
Boulder (>10"):	0	0	0
Bedrock (solid):	0	0	0
Substrate Consolidation:	mod	mod	mod
Percent Gradient:			

13 cfs

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/ STREAM: North Fork
DATE/ TIME: 5/11/02 15:45
COMPANY/ AGENCY: SPCWC
SAMPLE ID #: NF 1
SITE DESCRIPTION: Upstream San Pedro Cr

SAMPLING CREW

SITE INFORMATION

GPS Coordinates
Latitude:
Longitude:
Elevation:
Ecoregion:
COMMENTS:

CHEMICAL CHARACTERISTICS

Water Temperature: 14.7
~~Specific~~ Conductance: 580
pH: 7.8
Dissolved Oxygen:

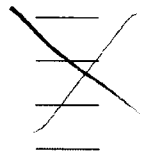
Bioassessment Laboratory Information:

SEND A COPY OF THIS FORM TO:
DFG/ WPCL
2005 Nimbus Road
Rancho Cordova, CA 95670
(916) 358-2858
website: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/ REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length:
Transect 1:
Transect 2:
Transect 3:



(record Physical/ Habitat Characteristcs in Riffle 1 column)

Non-Point Source Sampling Design

Reach Length: 78
Physical Habitat Quality Score: 117

Physical/ Habitat Characteristics

	Riffle 1	Riffle 2	Riffle 3
Riffle Length:	10	10	30
Transect Location:			
Avg. Riffle Width:	6	6	4
Avg. Riffle Depth:	4.5	4	3.5
Riffle Velocity:	.75	1.0	1.0
% Canopy Cover:	40	20	50
Substrate Complexity:	7	7	7
Embeddedness:	4	4	4
Substrate Composition:			
Fines (<0.1"):	10	10	10
Gravel (0.1-2"):	15	15	15
Cobble (2-10"):	50	45	45
Boulder (>10"):	25	30	30
Bedrock (solid):	0	0	0
Substrate Consolidation:	firm	firm	firm
Percent Gradient:			

15 cfs flow