Santa Clara Valley
Urban Runoff
Pollution Prevention Program

Watershed Monitoring and Assessment Program

Monitoring and Assessment Summary Report

Guadalupe River

September 15, 2009

EOA inc.

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EXECUTIVE SUMMARY

In Fiscal Year (FY) 2008-2009, SCVURPPP surveyed the benthic macroinvertebrate (BMI) community, algae community and physical habitat of Guadalupe River and tributaries. BMI bioassessments and physical habitat assessments were conducted at 22 locations in Guadalupe River watersheds in April 2009. Algae was collected at a subset of sites (n=4) where bioassessment and PHAB surveys were also conducted. BMIs were assessed using the preliminary Benthic Index for Biological Integrity (B-IBI) previously developed by SCVURPPP.

Total B-IBI scores for all sites in Guadalupe River watershed ranged from 2 – 49 (0-50 possible). B-IBI scores were ranked into five condition categories (optimal, good, fair, marginal and poor). Rankings of “poor” or “marginal” for B-IBI scores occurred at 77% of all sites, including all sampling sites in the Guadalupe River and lower three elevation sites for both Alamitos and Los Gatos Creeks. “Good” or “optimal” ranking scores occurred at the upper elevation sites for all three major tributaries (i.e., Alamitos, Guadalupe and Los Gatos Creeks). PHAB scores for sites in the Guadalupe River watershed ranged from 8-58 (0-60 possible), with scores generally increasing in an upstream direction. The highest physical habitat scores occurred in Alamitos and Guadalupe Creeks.

B-IBI scores were partially correlated with elevation and qualitative physical habitat (PHAB) scores, with B-IBI scores generally exhibiting a longitudinal pattern of scores increasing in an upstream direction. With the exception of Canoas and Ross Creeks, tributary sites exhibited a range of conditions, with B-IBI scores generally exhibiting a longitudinal pattern of scores increasing in an upstream direction. Sites that were directly downstream of dams were considerably lower in scores compared to sites above. In addition, sites in lower and middle reaches of Alamitos Creek had poor biotic condition, despite having good physical habitat scores and coarse substrate.

Sites that have poor biotic condition and good physical habitat condition may indicate potential water quality impacts to the biota. Mercury contamination in creeks originating from historic mine wastes may be impacting the benthic community. Water and/or sediment chemistry data and toxicity testing at selected sites may provide additional insight into potential causes of poor biotic condition.

The preliminary metric results indicate some differences in the condition of the benthic algae/diatom community for the three different waterbodies sampled. The number of samples (n=4), however, was too small to develop any conclusions on the biotic condition of algae/diatom communities for the Guadalupe River watershed.

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1.0 INTRODUCTION

The Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)[1] developed a Multi-Year Receiving Waters Monitoring Plan (Multi-Year Plan) in 2001 in compliance with requirements specified in its National Pollutant Discharge Elimination System (NPDES) permit (Permit) issued by the San Francisco Bay Regional Water Quality Control Board (Water Board). The Multi-Year Plan defines monitoring and assessment activities scheduled for completion in 2002 through 2010. Monitoring conducted under the Multi-Year Plan is designed to assess the condition of beneficial uses (i.e., aquatic life and recreational) in creeks within the Santa Clara Basin.

The SCVURPPP conducted screening-level monitoring in 11 major watersheds of the Santa Clara Basin during the first five years (FY 02-03 to FY 06-07) of the Multi-Year Plan. SCVURPPP (2007a) provides a summary of the monitoring results as well as an assessment of the condition of aquatic life and recreational uses in creeks monitored over that timeframe. In addition, the report provides preliminary conclusions and lessons learned intended to inform future monitoring efforts conducted by the SCVURPPP.

During FY 06-07 and FY 07-08, the SCVURPPP pilot tested a sediment quality triad (SQT) that entailed a weight of evidence approach using bedded sediment chemistry, sediment toxicity, benthic macroinvertebrate (BMI) community and physical habitat. The SQT approach is intended to better evaluate relationships between BMIs and stressor variables and identify potential causes of aquatic life use impacts in creeks within the Santa Clara Valley. The SCVURPPP implemented the SQT approach in the Coyote Creek watershed during both years and Lower Penitencia Creek watershed during the second year (FY 07-08). Overall evaluation of the SQT monitoring approach and results from both years are provided in SCVURPPP (2007b and 2008).

The SCVURPPP is currently planning to adapt its monitoring approach to meet new requirements expected via the Municipal Regional Permit (MRP) for stormwater, which is currently under development. One of the monitoring requirements that will likely be included in the MRP is to conduct biological assessments using protocols developed for the Surface Water Ambient Monitoring Program (SWAMP). Biological assessments include sampling BMI and algae communities and conducting quantitative physical habitat assessments. This report provides a summary of data collected during pilot testing of SWAMP biological assessments protocols in the Guadalupe River watershed during Spring 2009.

1.1 Guadalupe Watershed

1.1.1 Tributaries and Subwatersheds

The Guadalupe River watershed covers approximately 170 square miles, with its headwaters originating on the eastern Santa Cruz Mountains (elevation 3,790 feet) and then flowing in a northern direction to the South San Francisco Bay (SCBWMI 2001). Alamitos and Guadalupe Creek subwatersheds are a combined 53 square miles, which comprise nearly 31% of the total watershed area. The Guadalupe River begins at the confluence of Alamitos Creek and Guadalupe Creek, and then flows 19 miles through urbanized portions of San Jose. There are three major subwatersheds that enter the Guadalupe River, including Ross Creek ($10mi^2$), Canoas Creek ($19mi^2$) and Los Gatos Creek ($55mi^2$). The river then flows through a 5-mile tidally influenced reach through Alviso Slough and into the South San Francisco Bay. The subwatersheds of Guadalupe River watershed are shown in Figure 1.

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[1] The Santa Clara Valley Urban Runoff Pollution Prevention Program SCVURPPP is comprised of Santa Clara County, thirteen municipalities and the Santa Clara Valley Water District (i.e., Co-permittees).

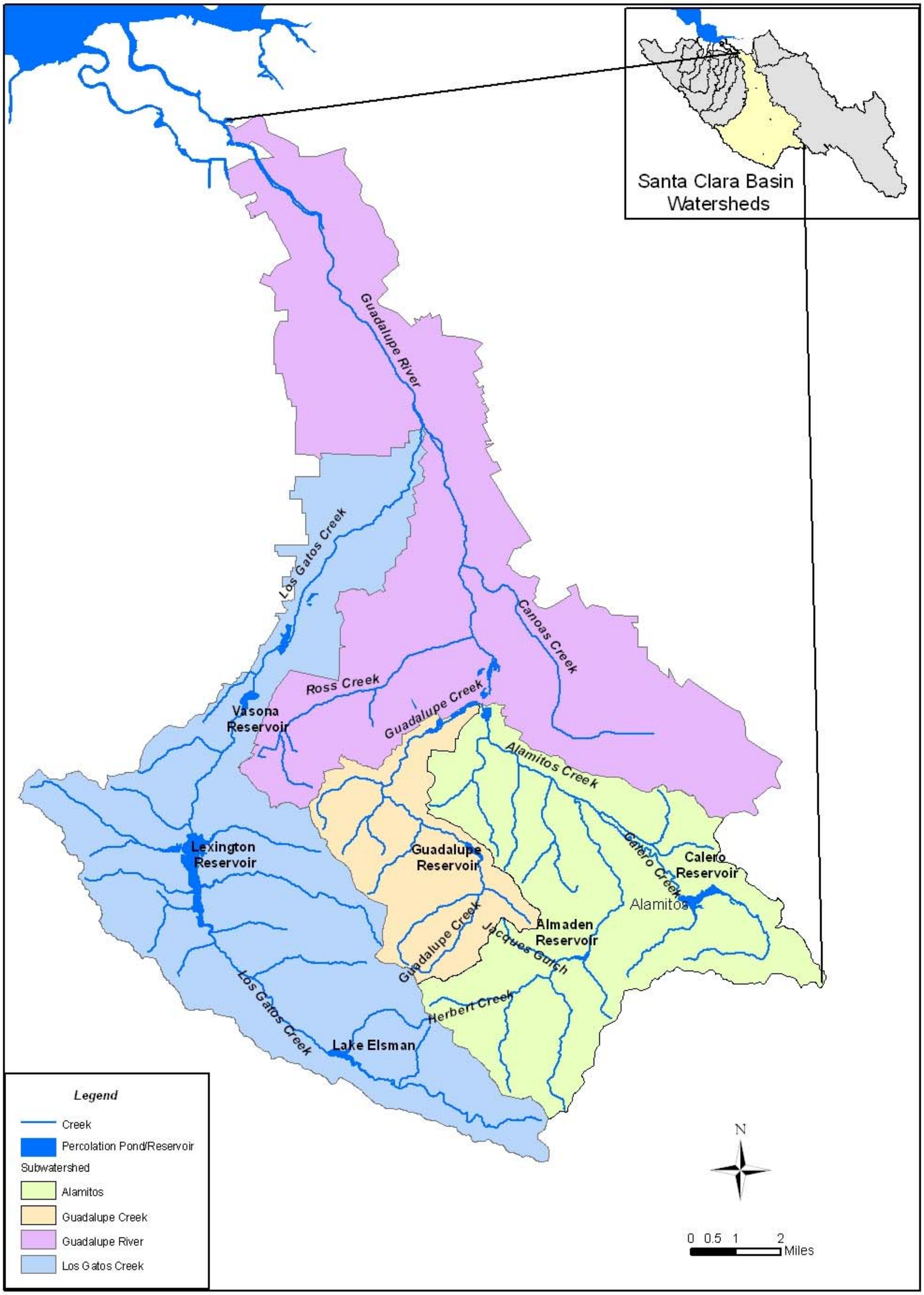

Figure 1. Tributaries and subwatersheds in the Guadalupe watershed.

1.1.2 Ecological Subregions

The United States Department of Agriculture (USDA) Forest Service developed the National Hierarchical Framework of Ecological Units as a classification and mapping system for "stratifying the landscape into progressively smaller areas of increasingly uniform ecological potentials for use in ecosystem management" (Bailey 1995). Ecological types are classified and ecological units are mapped based on associations of biotic and environmental factors that include climate, physiography, water, soils, hydrology, and potential natural communities. Ecological Subsection is the smallest ecological unit in the classification hierarchy. A total of 4 ecological subsections occur in the Guadalupe River watershed (Table 1). Leeward Hills and Santa Clara Valley comprise over 87% of the total watershed area.

Table 1. Ecological Subsection Area in the Guadalupe River watershed.

Ecological Subsection	Extent	Area (Sq. mi.)	Percent
Leeward Hills	The interior, or northeast, side of the Santa Cruz Mountains that is between the San Andreas fault and the alluvial plain in the Santa Clara Valley.	76.4	44.5
Santa Clara Valley	The alluvial plain in the Santa Clara Valley that extends from Hollister to San Francisco Bay.	74.0	43.1
Santa Cruz Mtns	The western and southwestern parts of the Santa Cruz Mountains, between the San Andreas fault and the Pacific Ocean	17.1	10.0
Bay Flats	The section of the alluvial plain at the south end of San Francisco Bay that is less than 10 feet above mean tide level.	4.2	2.4

1.1.3 Climate and Hydrology

The Santa Clara Valley has a Mediterranean-type climate that is characterized by wet winters and dry summers. The mean annual precipitation ranges from 14 to 48 inches, with majority of rain occurring between November and April. There are nine stream gauges that are on the SCVWD ALERT system and two stream gauges operated by the USGS in the Guadalupe River watershed (http://alert.valleywater.org). The average daily flow at the old USGS gauging station at St John's Street on Guadalupe River between 1960 and 2002 was 54.3 cubic feet per second (cfs) (Tetra Tech 2004). Daily mean flow recorded at the new USGS gauge site near San Jose Airport during FY 08-09 is shown in Figure 2. During this period, the minimum and maximum daily flow was 17 and 1100 cfs, respectively, with an average flow rate of 48 cfs. The last storm event during the wet season occurred on March 22, 2009.

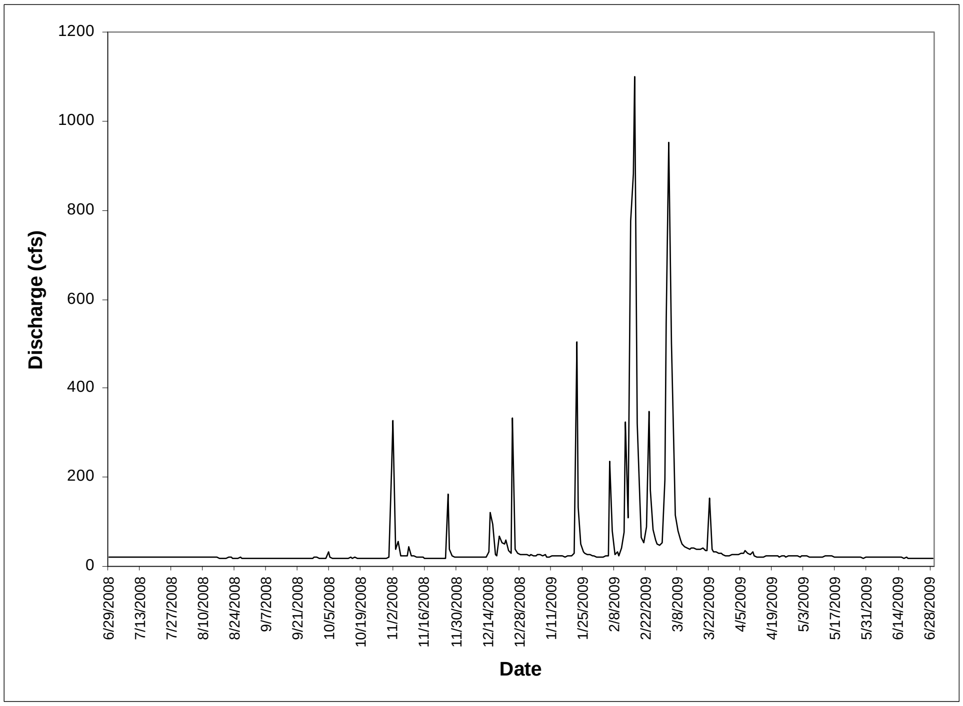

Figure 2. Daily stream flow recorded in Guadalupe River at Highway 101 during FY08-09.

Guadalupe River has six major reservoirs, including Calero Reservoir on Calero Creek, Guadalupe Reservoir on Guadalupe Creek, Alamaden Resevoir on Alamitos Creek, and Vasona, Lexington, and Lake Elsman Reservoirs on Los Gatos Creek (Figure 1). Lexington Reservoir is located on Los Gatos Creek about 11 miles upstream of its confluence with Guadalupe River and Lake Elsman is located about 4 miles further upstream. Reservoir capacity and upstream drainage area for all six reservoirs is shown in Table 2 (Tetra Tech 2004).

Table 2. Reservoir capacity and drainage areas of reservoirs in Guadalupe watershed.

Reservoir (Creek)	Area Draining to Reservoir (mi^2)	Capacity (acre-ft)
Almaden (Alamitos)	12	1,586
Guadalupe (Guadalupe)	6	3,228
Calero (Calero)	7	10.050
Lake Elsman (Los Gatos)	9.9	6,280
Lexington (Los Gatos)	37.5	19,834
Vasona (Los Gatos)	44	400

The SCVWD also operates in-stream and off-stream percolation ponds as groundwater recharge facilities in the Guadalupe River watershed. Percolation ponds are located along Los Gatos Creek downstream of Lexington and Vasona reservoirs; and along Alamitos Creek, Guadalupe Creek and the Guadalupe River downstream of Almaden, Calero and Guadalupe reservoirs. The SCVWD typically releases water from its reservoirs during the summer months allowing it to flow downstream and percolate into permeable stream beds and/or ponds for groundwater recharge (SCBWMI 2001).

1.1.4 Geology and Mining History

The Guadalupe watershed is composed of three distinct geological regions: 1) upland area with bedrock outcrops; 2) alluvial plain; and 3) baylands (Tetra Tech 2004). The upland region is primarily composed of sedimentary and metamorphic formations belonging to the Franciscan Formation. The alluvial plain includes a deep basin filled with Plio-Pleisocene and Quaternary unconsolidated alluvial materials. These deposits include fine sands and silts mixed with some gravels, and coarse gravels deposits in some reaches of Guadalupe River. The stream channel downstream of Highway 237 is composed of mud and fine-grained silts and clays.

Mercury deposits in the South San Francisco Bay are mostly associated with serpentine intrusions in the Franciscan Formation, where the serpentine has been converted to silica carbonate (Tetra Tech 2004). The naturally occurring mercury is mostly in the form of cinnabar, or mercury sulfide, within the silica carbonate. Soils derived from rocks in the Franciscan Formation are typically alkaline due to the presence of limestone and carbonates. The serpentine beds associated with the Franciscan Formation underlie the New Almaden Mining District, which is now the present location of the Almaden Quicksilver County Park. About 75% of the total park area drains into upper tributary areas of the Guadalupe watershed (SCBWMI 2001).

Approximately 38.4 million kilograms of mercury was produced from the New Almaden Mining District. Of that, about 80% was extracted prior to 1935 (Tetra Tech 2004). Prior to construction of Guadalupe and Almaden Reservoirs, mine wastes called calcines were dumped near mining process areas or disposed of in or near creeks to be transported downstream. These wastes are still present along stream banks of both creeks. Remediation efforts in 1990s focused on removal of mining waste piles (both on land and creek areas), covering and re-vegetating contaminated soil areas, and implementing run-off protection measures to protect sites from erosion.

1.2 Water Quality Standards and Impacts

1.2.1 Beneficial Uses

Beneficial Uses in Santa Clara Valley creeks are designated by the Water Board and are defined as water resources that are protected by State law. Table 3 lists Beneficial Uses designated by the San Francisco Bay Regional Water Board (1995) for water bodies monitored by the SCVURPPP during FY 08-09.

Table 3. Beneficial uses designated in the Water Quality Control Plan for the San Francisco Bay Basin for Santa Clara Valley creeks monitored by SCVURPPP during FY 08-09 (Water Board 2007).

WATER BODY	AGR	MUN	FRSH	GWR	COLD	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2
Los Gatos Creek					E	P		P	E	E	P	E
Guadalupe River		E	E	E	E	P		P	E	E		P

E = Existing; P = Potential

1.2.2 Guadalupe River Mercury TMDL

On October 8, 2008, the California Regional Water Quality Control Board (Water Board) adopted a Basin Plan amendment to amend mercury water quality objectives and incorporate TMDLs for mercury in the Guadalupe River watershed. In September 2008, the Water Board developed the Guadalupe River Watershed Mercury TMDL Staff Report as supporting documentation for the proposed Basin Plan amendment, total maximum daily loads (TMDLs), and an implementation plan for mercury in the portion of the Guadalupe River watershed downstream of mercury mines and in waters that receive urban runoff. The waters addressed by the TMDL include Guadalupe Reservoir, Almaden Reservoir, Calero Reservoir, Lake Almaden, Guadalupe Creek, Alamitos Creek, and Guadalupe River.

The problem statement in the TMDL Report states that “fish downstream of the mining district have extremely high mercury concentrations and are unsafe to eat” and those “fish from Guadalupe Reservoir contain the highest recorded fish tissue mercury concentrations in California” (SFRWQCB 2008). Human consumption of fish (REC1) and wildlife consumption of fish (RARE and WILD) are the two designated Beneficial Uses in Guadalupe River that are impaired by mercury.

Existing studies have identified four major sources of mercury in the Guadalupe River watershed: mining waste, urban stormwater runoff, naturally occurring mercury in the soil, and atmospheric deposition (SFRWQCB 2008). Loading studies of total mercury conducted during the 2003-2004 wet season indicate that mining waste is by far the largest source. Key findings from previous studies showed that large amounts of methylmercury was produced in Guadalupe and Almaden reservoirs in the 2004 dry season (SFRWQCB 2008). There was an equal amount of methylmercury that was retained in Guadalupe Reservoir as was discharged to Guadalupe Creek, whereas more than twice as much methylmercury was discharged to Alamitos Creek as retained in Almaden Reservoir. In addition, total mercury is transported in stormwater during the wet season, whereas methylation and bioaccumulation largely occur in the dry season when and where the critical condition of low oxygen (anoxic conditions) occurs.

The TMDL report includes a summary of the fate and transport processes of mercury in Guadalupe River. The wet season is largely a time of transport of inorganic particulate mercury, whereas methylation and bioaccumulation largely occur in the dry season when and where the critical condition of low oxygen (anoxic conditions) occurs (SFRWQCB 2008). One implication of the linkage is that both dissolved and total mercury loads must be reduced; mining waste erosion controls will keep mercury on the landscape and out of the aquatic system where it may dissolve.

The linkage between sources and the numeric targets (i.e., fish tissue methylmercury concentrations) is not direct; however, sources and the numeric targets are linked by the sites where methylmercury is produced. Methylation of mercury principally occurs in the oxygen-depleted depths of impoundments (i.e., dams, drop structures, and former quarries). The total contribution of creeks site to methylmercury production is much smaller than the exports from the reservoirs and Lake Almaden during the dry season. This suggests that that reducing methylmercury production to attain TMDL targets in reservoirs downstream of mercury mines and Lake Almaden will likely also attain targets in downstream waters (SFRWQCB 2008).

Existing studies suggest that methylmercury bioconcentrates as it moves up the food chain from algae to zooplankton to prey fish and to predator fish. The largest single jump in concentration occurs from the water to algae.

1.3 Management Questions and Sampling Design

Data collection efforts conducted in FY 08-09 in the Guadalupe watershed were intended to assist SCVURPPP in answering the following core management questions:

1. *What is the condition of aquatic life uses in the Guadalupe River and tributaries?*
2. *What are the stressors causing impacts to aquatic life uses in the Guadalupe River and tributaries?*

Benthic macroinvertebrate (BMI) bioassessments and physical habitat (PHAB) assessments were conducted during April 2009 at 22 sites to assist in answering these questions. Algae assessments were also synoptically conducted at 4 of the 22 sites. Conventional water quality parameters of temperature, pH, conductivity and dissolved oxygen were measured during all bioassessment sample events. EOA, Inc. conducted all bioassessments and physical habitat assessments. BMI taxonomy was performed by Bioassessment Services, Inc. and algae taxonomy was preformed by EcoAnalysts, Inc.

BMI bioassessments and physical habitat assessments were conducted at 22 targeted locations and algae assessments at a subset of those locations (four sites). Sampling locations within Guadalupe watershed is shown in Figure 3. Information on site location, date of sampling and parameter measured is shown in Table 4.

Table 4. Sampling site locations and monitoring parameters for 22 sites in Guadalupe watershed monitored by SCVURPPP during FY 08-09.

SWAMP ID	Waterbody	Description	Date	Latitude	Longitude	Elevation	BMI/ PHAB	Algae
205GUA015	Guadalupe River	Upstream of Trimble Road	4/17/2009	37.37888	121.93712	30	X	
205GUA025	Guadalupe River	Downstream of Hedding Street	4/17/2009	37.35223	121.91086	60	X	
205GUA040	Guadalupe River	Downstream of Julian Street bridge	4/15/2009	37.33732	121.90134	75	X	
205GUA110	Guadalupe River	Downstream of W. Virginia Street	4/15/2009	37.32156	121.88969	115	X	
205GUA130	Guadalupe River	Downstream of Malone Road	4/20/2009	37.30058	121.8804	180	X	
205GUA180	Guadalupe River	Upstream of Branham Road	4/20/2009	37.25969	121.86955	260	X	X
205GUA050	Los Gatos Creek	Near intersection of Conus and Sunol Streets	4/22/2009	37.31617	121.90273	360	X	X
205GUA060	Los Gatos Creek	Access at Campisi, SCVWD gate near parking lot	4/22/2009	37.29092	121.93495	800	X	
205GUA070	Los Gatos Creek	Downstream of footbridge near Lark Avenue	4/21/2009	37.25306	121.96336	95	X	
205GUA080	Los Gatos Creek	Upstream of east Main street, along LGC trail	4/21/2009	37.22079	121.98212	125	X	X
205GUA090	Los Gatos Creek	End of Aldercroft Heights Rd -- San Jose Water Co.	4/3/2009	37.15099	121.96042	160	X	
205GUA140	Canoas Creek	Upstream Blossom Hill Rd	4/10/2009	37.24985	121.84186	180	X	
205GUA160	Ross Creek	Downstream of Meridian Avenue	4/10/2009	37.26033	121.89892	160	X	
205GUA200	Guadalupe Creek	Perc. Ponds - Sentinel and Coleman	4/13/2009	37.23474	121.89215	230	X	
205GUA210	Guadalupe Creek	Shannon and Hicks, upstream of gage station	4/13/2009	37.21743	121.9107	320	X	
205GUA220	Guadalupe Creek	Downstream from reservoir, near stream gage	4/23/2009	37.20101	121.88298	480	X	X
205GUA230	Guadalupe Creek	Within Sierra Azul, upstream Hicks Road	4/23/2009	37.18076	121.87386	680	X	
205GUA260	Alamitos Creek	Graystone upstream of stream gage	4/6/2009	37.22229	121.85049	240	X	
205GUA270	Alamitos Creek	Downstream of Almaden Expressway	4/6/2009	37.20252	121.8297	320	X	
205GUA280	Alamitos Creek	Alamitos Road south of Old Mine road	4/7/2009	37.1734	121.82478	520	X	
205GUA300	Jaques Gulch	Hicks Road upstream of reservoir	4/7/2009	37.16189	121.84434	640	X	
205GUA330	Calero Creek	Downstream from Harry Road	4/8/2009	37.21072	121.82637	310	X	

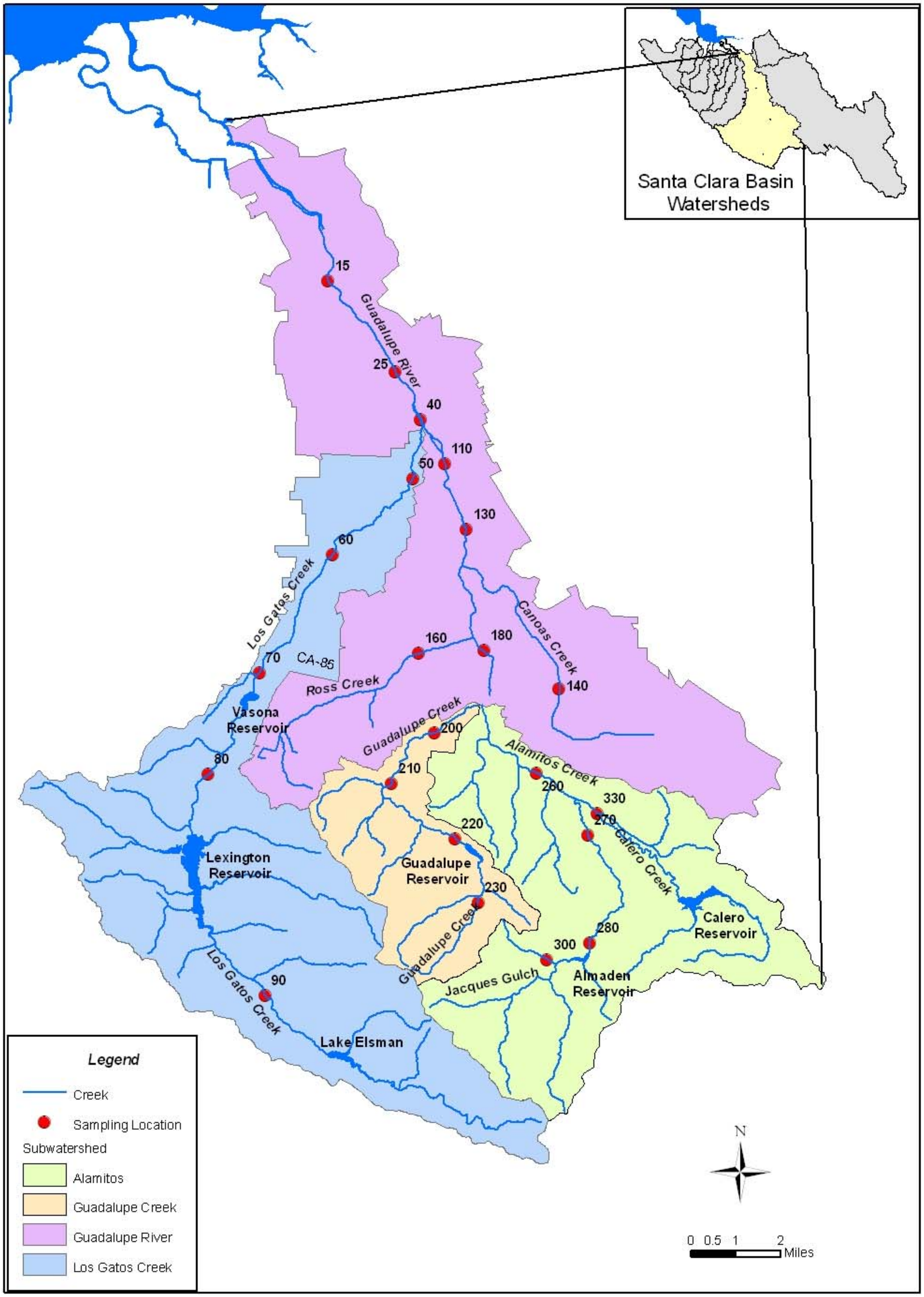

Figure 3. Sampling site locations in Guadalupe watershed monitored by SCVURPPP during FY 08-09.

2.0 Methods

2.1 Benthic Macroinvertebrate Bioassessments

Benthic macroinvertebrate (BMI) communities were sampled at 22 sites using the Reach-wide Benthos (RWB) method described in Ode (2007), which was developed for the California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP). Each bioassessment sampling site consisted of approximately 300 foot reach[2] of the channel that was divided into 11 equidistant transects that are placed perpendicular to the direction of flow. Ten additional transects ('inter-transects") are located between main transects for total of 21 transects within the reach. Inter-transects are used for physical habitat component of the procedure (see below). BMIs are collected using 500-u mesh D-frame net at each of the 11 main transects. The sampling position within each transect is alternated between 25%, 50% and 75% distance of the wetted width of the stream as you move upstream from transect to transect. One position along transect was established, BMIs were collected approximately 1 meter downstream of transect.

The benthos from a 1 ft^2 area at each transect were disturbed by manually rubbing coarse substrate followed by disturbing the upper layers of substrate to dislodge any remaining invertebrates into a D-frame kick net. Slack water habitat procedures were used at transects with deep and/or slow moving water (Ode 2007). Material collected from all eleven 1 ft^2 areas was then transferred into 1-2 500-ml wide-mouth jar(s) and preserved in the field with 95% ethanol.

Bioassessment Services, Inc. laboratory was contracted for processing all BMI samples collected. Based on CDFG (1999, 2003) each sample was rinsed in a standard no. 35 sieve (0.02 in; 0.5 mm) and transferred to a tray with twenty, 4 $in.^2$ (26 cm^2) 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 solution. For samples exceeding 500 organisms, a total of 500 (± 5%) BMIs were subsampled from a minimum of three grids. If there were more BMIs remaining in the last grid after 500 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.

Subsampled BMIs were identified using taxonomic keys (Kathman and Brinkhurst 1998, Merritt and Cummins 1996, Stewart and Stark 1993, Thorp and Covich 2001, Wiggins 1996) and unpublished references. A standard level of taxonomic effort was used as specified in the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) master taxa list (http://www.waterboards.ca.gov/ swamp/docs/safit/ste_list.pdf). California tolerance values and functional feeding group designations were obtained from the California Aquatic Macroinvertebrate Laboratory Network (CAMLnet) list of taxonomic effort (27 January, 2003 revision). One exception to the level 1 standard taxonomic effort included identifying chironomids (midges) to subfamily/tribe instead of family (Chironomidae). Minor exceptions included lower resolution identification of some immature organisms and pupae. The subsampled BMIs identified from each sample were archived in labeled vials with a mixture of 70% ethanol solution.

2.2 Benthic Algae Bioassessments

Filamentous algae and diatoms were collected at four sites using the Reach-wide Benthos (RWB) method described in Draft SWAMP Algae Standard Operating Procedures Version 4 (dated April 2009) (SWRCB 2009). The sampling position within each transect was the same used for BMI

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[2] Ode (2007) identifies minimum reach length as 150 meters in length, except when site conditions require shorter reach lengths. SCVURPPP monitoring locations typically had features (e.g., road crossings, deep water habitat) that precluded standard reach lengths. As a result, shorter reach length was applied across all sites for consistency.

sampling, except samples were collected 6 inches upstream of the BMI sampling position. The algae were collected using a range of methods and equipment, depending on the particular substrate occurring at the site (i.e., erosional, depositional, large and/or immobile, etc). Sampling devices include a rubber delimiter, PVC delimiter, syringe scrubber and spatula (Table 5). Erosional substrates includes any material (substrate or organics) that was small enough to be removed from stream bed, but large enough in size to isolate an area equal in size to the rubber delimiter (12.6 cm^2 in area).

Table 5. Sample devices and methods for sampling filamentous algae and diatoms.

Device	Description	Application	Method Summary
Rubber delimiter	Rubber tubing attached to metal washer (diameter is 12.6 cm^2 in area)	Erosional substrate types (i.e., cobble substrate; organic debris).	Clean area within delimiter using toothbrush; wash material directly into bucket
PVC delimiter	PVC Tube 4-inches in length (diameter is 12.6 cm^2 in area)	Depositional substrate type (e.g., Silt/sand, gravels)	Insert PVC into substrate 1 cm deep; use spatula to trap and transport sediment/water to bucket
Syringe scrubber	Plastic syringe with scrubber attached to end (diameter is 5.3 cm^2 in area)	Boulders, bedrock or concrete	Place syringe on material and rotate 3X; pull plunger upward and use spatula to trap and transport water to bucket

When sample location along transect was too deep to sample, a more suitable location was selected, either on same transect or subsequent transect further upstream. Algae samples were collected at each transect prior to moving on to next transect. Sample material (substrate and water) from all eleven transects is combined into sample bucket as a composite sample for entire reach, similar to BMI sampling procedure.

The bucket containing sample material was agitated and suspended algae sample was then poured off into a 500-ml cylinder, making up a composite sample for the site. The composited sample was then poured into two sample 50 mL sample tubes to 45mL mark and a 5 mL volume of glutaraldehyde was added to each tube. Each tube was labeled and identified for taxonomic identification of algae and diatoms. Laboratory processing includes identification and enumeration of 300 natural units of soft algae and 600 diatom valves to the lowest practical taxonomic level. Biomass samples (i.e., Chlorophyll a or ash-free dry mass), two additional indicators recommended in SWAMP protocols, were not prepared for laboratory analyses during this project.

2.3 Physical Habitat Assessments and Water Quality Measurements

Physical habitat (PHAB) assessments were conducted at each BMI bioassessment sampling event using protocols described in Ode (2007). Physical habitat data were collected at each main transect and inter-transect location following the “Basic” level of effort, with the following additional measurements/assessments: water depth and pebble counts, cobble embeddedness, flow habitat delineation, and instream habitat complexity. At algae sampling locations, additional assessment of presence of micro- and macroalgae was conducted during the pebble counts. In addition, bankfull width and heights were measured at 3 transect locations (where possible) and water velocities were measured at one transect (where possible) using protocols described in Ode (2007). PHAB quality was assessed using three physical habitat sub-categories (epifaunal substrate/cover, sediment deposition, and channel alteration). Combined PHAB scores range from 0 – 60 (20 possible points per sub-category), with higher scores reflecting higher quality habitat.

Conventional water quality parameters of temperature, pH, conductivity, and dissolved oxygen (D.O.) were also measured at each site with portable field instruments. Water quality was measured during the BMI bioassessments using a multi-parameter probe YSI model 556MPS. Stream velocity was measured at each sample riffle using a Global Water FP201 flow meter.

2.4 Data Quality Assessment

Quality Assurance/Quality Control (QA/QC) activities associated with the field data collection and laboratory analyses are described in more detail in the SCVURPPP Draft Quality Assurance Project Plan (QAPP). The major goal for these QA/QC procedures is to have representative, comparable, accurate and precise data, to the extent possible under the given limitations. QA/QC activities associated with water quality field sampling included the following:

- Adherence to documented procedures, USEPA methods and written SOPs;
- Calibration of analytical instruments;
- Use of quality control samples (i.e., duplicates and validation datasets)
- Complete documentation of sample tracking and analysis.

Duplicate samples were collected at 10% of sites (2 sites) sampled to evaluate precision of BMI field sampling methods. Duplicate samples for algae were not taken during the study due to the limited number of sites sampled and the pilot nature of the assessments. In addition to duplicate samples, 10% of the total number of BMI samples collected was submitted to CDFG's Aquatic Bioassessment Laboratory for independent assessment of taxonomic accuracy, enumeration of organisms and conformance to standard taxonomic level. For benthic algae samples, one of four samples was re-identified by an independent taxonomist. A Data Quality Assurance report was developed for the taxonomy re-identification (Made available upon request).

2.5 Data Analysis and Interpretation

2.5.1 Preliminary Benthic Index Biological Integrity

A series of BMI metrics representing taxonomic richness, composition, tolerance and functional feeding groups were generated for each site. The biological condition of each site was assessed by calculating a Benthic Index of Biotic Integrity (B-IBI) score, using a preliminary draft B-IBI[3] scoring system recently developed by SCVURPPP (2007a) for Santa Clara Basin creeks. The following five metrics were selected for the B-IBI based on their ability to discriminate between reference and test sites:

1. EPT Richness
2. Diptera Richness
3. Predator Richness
4. Percent Collector Individuals
5. Percent Non-insect Taxa

Metric scoring ranges were defined using techniques described in Hughes *et al*. (1998) and McCormick *et al*. (2001). Table 6 present the scoring ranges for the five metrics included in the preliminary B-IBI for Santa Clara Valley Creeks. In addition to B-IBI scores, physical habitat assessment scores were also used to evaluate the physical habitat condition of each monitoring site in the Guadalupe watershed. Table 7 presents the B-IBI and PHAB condition categories.

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[3] Program staff is currently developing a B-IBI for creeks in the San Francisco Bay area. The B-IBI is intended to replace the preliminary B-IBI developed for Santa Clara Valley creeks.

The State Water Resources Control Board is currently developing biological metrics for benthic algae communities in selected regions in California. However at this time, no IBI is available to evaluate benthic algae community composition in San Francisco Bay area watersheds.

Table 6. Scoring Ranges for the Five Metrics Included in the Preliminary Draft Santa Clara County B-IBI (SCVURPPP 2007a).

IBI Score	# EPT Taxa	% Non-Insect Taxa	# Diptera Taxa	# Predator Taxa	% Collectors
10	≥21	0 - 11	>10	≥12	0 - 48
9	19-20	12 - 19	10	11	49 - 54
8	17-18	20 - 26	9	10	55 - 60
7	15-16	27 - 32	8	9	61 - 66
6	13-14	33 - 39	7	8	67 - 72
5	11-12	40 - 46	6	7	73 - 78
4	9-10	47 - 53	5	6	79 - 84
3	7-8	54 - 60	4	5	85 - 90
2	5-6	61 - 67	3	4	91 - 96
1	3-4	68 - 74	2	3	97 - 99
0	≤2	75 -100	<2	≤2	100

Table 7. Benthic Macroinvertebrate Index of Biotic Integrity (B-IBI) and Physical Habitat Assessment (PHAB) condition categories.

Condition Category	BMI Bioassessment (B-IBI)	Physical Habitat Quality (PHAB)
Optimal	60-46	60-49
Good	45-40	48-37
Fair	39-26	36-25
Marginal	25-13	24-13
Poor	12-0	12-0

2.5.2 Nonmetric Multidimensional Scaling (NMS) Ordination

Nonmetric multidimensional scaling (NMS) ordination was used to evaluate relative similarity of samples based on BMI taxonomic composition. NMS ordination is based on ranking distances of taxonomic dissimilarity, which make it suitable for ecological data that are often not normally distributed nor measured on continuous scales (McCune and Grace 2002). The output of NMS is a graph, which shows sites (sample units) oriented in relative space where the distance between the sites increases with increasing taxonomic dissimilarity. In addition, quantitative environmental variables can be included as an overlay of lines (joint plot) radiating from the center of the graph, with each line indicating both the direction and strength of correlation with the graph axes.

In addition to examining distributions of BMI taxonomic composition, categorical and quantitative variables were incorporated in NMS to explore factors that could influence taxonomic composition. Categorical environmental variables included:

- Three ecological subregions: Santa Clara Valley, Leeward Hills, and Santa Cruz Mountains (see Section 1.1.2 for ecoregion descriptions);
- Seven waterbodies: Guadalupe River/Creek, Los Gatos Creek, Canoas Creek, Ross Creek, Alamitos Creek, Jacques Gulch, and Calero Creek; and,
- Three hydrological and land use categories: flow regulated/ urban, flow regulated/ open space, and flow unregulated/ open space. Sites downstream of dams were classified as “flow regulated” and sites upstream of dams were defined as “unregulated”. Predominant land use adjacent to monitoring location was used for land use classification. “Urban” was defined for developed land use types (e.g., residential, commercial, transportation) and “open space” was defined for undeveloped land use types (e.g., forest, rangeland).

Quantitative environmental variables included elevation, substrate size, physical habitat assessment score, weighted mean habitat type, and canopy cover.

PC-ORD version 5 software (McCune and Mefford 2006) was used to perform NMS in “autopilot mode”, utilizing the “medium” setting (200 iterations) and the Sorensen (Bray-Curtis) distance measure. Plots of stress versus iteration (scree plots) were evaluated to assure that improvement in fit was achieved with added dimensions and exceeded a cumulative coefficient of determination of 0.6.

3.0 RESULTS

3.1 BMI Bioassessments

From the 24 composite samples (including the 2 duplicates) collected during spring 2009 from 22 sites in the Guadalupe watershed, 12,041 BMIs were processed comprising 115 taxa (SAFIT Level 1 STE). Metric values are shown in Appendix A and B-IBI scores are shown in Appendix B.

3.1.1 Biological Metrics

Richness

The highest values for Taxa Richness and EPT Taxa metrics occurred at site GUA230 (51 and 23) and site GUA090 (49 and 23), respectively. In contrast, the lowest values for Taxa Richness (8) and EPT Taxa metrics occurred at sites GUA140 and GUA160, score 0 and 2 respectively. Coleoptera Taxa ranged from 0 to 6, with the highest value occurring at GUA230.

Composition Measures

Shannon Diversity Index values are affected by taxonomic richness and the distribution of individuals among the taxa. The Shannon Diversity values may range from 0 to 3.3 (natural log), with the higher diversity values being indicative of greater stream health. Shannon Diversity values were highest (3.0) at sites GUA090 and GUA230 and lowest (0.4) at site GUA160.

Another measure of composition characteristics is Percent Dominant Taxon. Unlike the previous metrics, a higher Percent Dominant Taxon value often indicates a more disturbed environment. Percent Dominant Taxon values ranged from 18% to 91% with the highest percentage occurring at site GUA160 and the lowest occurring at site GUA230.

Tolerance Measures

Intolerant Organism values ranged from 0.0% to 19%, with the highest value occurring at site GUA090 and the lowest value occurring at 15 sites, including all sites in Alamitos Creek and Gualalupe River. Weighted Mean Tolerance values ranged from 4.0 to 6.1 (on a scale from 0 to 10), with the lowest value occurring at sites GUA090 and GUA230 and the highest value occurring at site GUA060. While tolerance values generally increase with increasing disturbance to aquatic environments, natural gradients of tolerance may occur with changes in elevation and stream order.

Functional Feeding Groups

Collector-gatherer and collector-filterer relative abundances varied substantially throughout the Guadalupe watershed, ranging from 29 to 98% and 0 to 47%, respectively (Figure 4). Non-biting midges, *Baetis* mayflies, and segmented worms were the dominant collector-gatherers at most of the sites but ostracods (seed shrimp) were the dominant collector-gatherers at site GUA140. Black flies, hydropsychid caddisflies, amphipods (*Americorophium*), and clams were the dominant collector-filterers. Sites with higher proportions of pool and glide habitat favored non-insect collector-filterers.

Scraper and predator relative abundances across the Guadalupe watershed were 0 to 47% and 0.2 to 14%, respectively (Figure 4). Snails were the primary scrapers at sites within the Santa Clara Valley ecological subregion while heptageniid mayflies, riffle beetles, moth flies, and individuals from several caddisfly genera were dominant scrapers at less urbanized upper elevation sites. Scrapers were absent or sparse at sites immediately downstream of the major reservoirs including Guadalupe, Lexington and Almaden. Predators consisted of generally low numbers of individuals among many taxonomic groups including tanypod midges, water mites, damselflies, dragonflies, biting midges, and empidids (dance flies). Stonefly and caddisfly predators were sparse throughout the watershed and were more restricted to sites upstream of the major reservoirs.

Shredders and “other” FFGs were absent or sparse, ranging from 0 to 5% and 0 to 3%, respectively (Figure 4). Shredders were nearly absent from sites in the Santa Clara Valley ecological subregion. Where present in the upper ecological subregions, shredders consisted of low numbers of individuals in many taxonomic groups including tipulid, *Cryptolabis*, nemourid stoneflies, *Malenka*, and several caddisfly genera (*Lepidostoma*, *Gumaga*, and *Parthina*). The “other” FFGs were primarily piercer herbivores (hydroptilids) and macrophyte hervbivores (*Micrasema*).

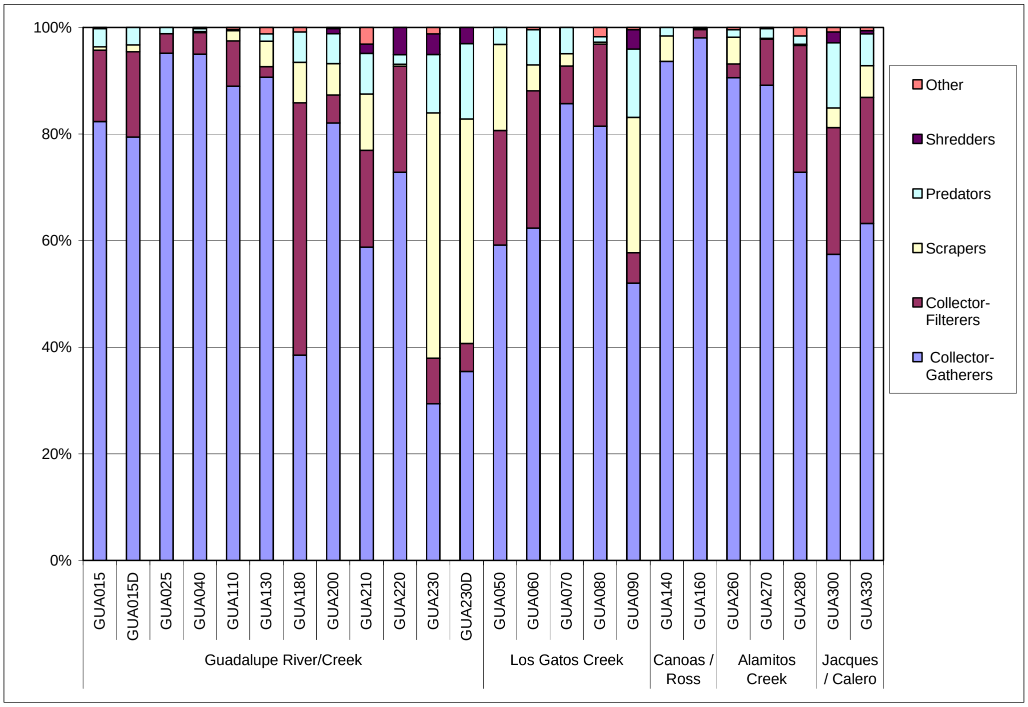

Figure 4. Percentages of benthic macroinvertebrate functional feeding groups sampled from the Guadalupe watershed in April 2009.

3.1.2 Benthic Index Biological Integrity

Total B-IBI scores (0-50 possible) ranged from 4 to 13 for Guadalupe River mainstem sites, 9 to 46 for Los Gatos Creek sites, 21 to 49 for Guadalupe Creek sites, 8 to 41 for sites within Alamitos Creek subwatershed, and 2 to 8 for sites on Canoas and Ross Creeks (Figure 5). Elevation and approximate dam locations in relation to I-IBI score is also shown for each monitoring location. Individual metric scores for all sites are provided in Appendix B.

In the context of the overall B-IBI for the Santa Clara Valley creeks, all of the Guadalupe River mainstem sites ranked in the ‘poor’ category. With the exception of Canoas and Ross Creeks, tributary sites exhibited a range of conditions, with B-IBI scores generally exhibiting a longitudinal pattern of scores increasing in an upstream direction. Sites that were directly downstream of dams were considerably lower in B-IBI scores compared to sites above the dams. Upper elevation sites in Guadalupe, Los Gatos, and Alamitos Creeks had the three highest scores among all sites sampled during FY 08-09 (ranging 41 to 49) and were the only three sites that ranked as ‘good’ or ‘optimal’. Canoas and Ross creeks, and the three lowest elevation sites on Los Gatos and Alamitos creeks all exhibited low scores (2 to 13) in the ‘poor’ category.

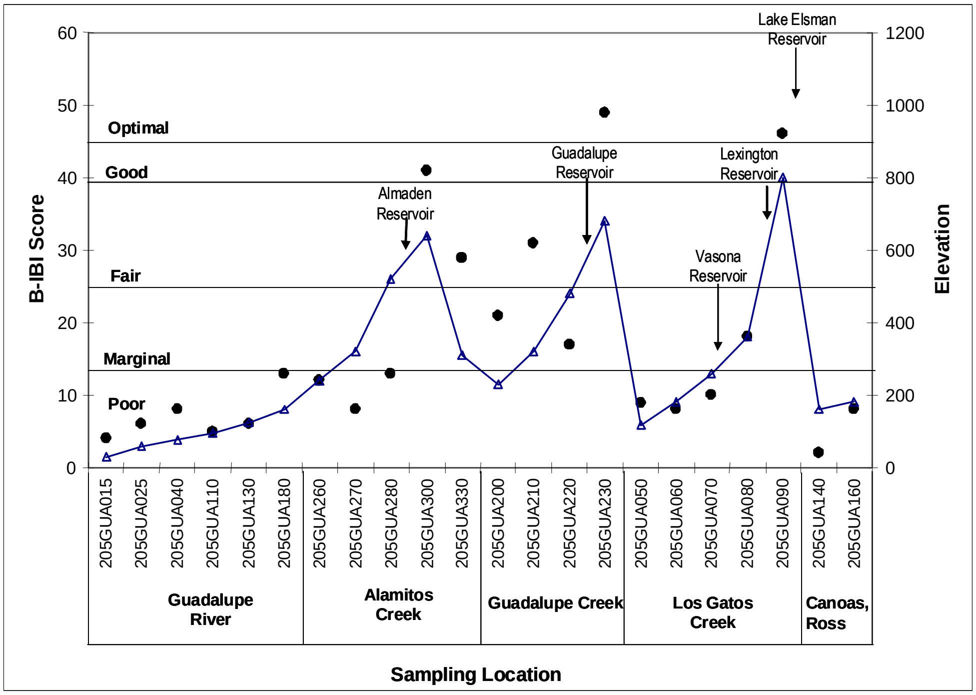

Figure 5. Benthic Index of Biotic Integrity (B-IBI) scores for sites in Guadalupe subwatersheds. Site elevations and relative position of dams are also shown.

3.1.3 NMS Ordination

Results of NMS ordination indicate that two axes explain most of the variation (cumulative r^2= 0.86) in taxonomic composition with most variation explained by axis 1 (r^2=0.74). Ordination results were summarized using three categorical variables with quantitative variables screened for coefficients of determination exceeding 0.3. There were distinct groupings of sites along axis 1 into ecological subregions, particularly the lower elevation Santa Clara Valley subregion and upper elevation Leeward Hills (Figure 6). Increasing variation in taxonomic composition corresponds to increasing distance in ordination space between sites.

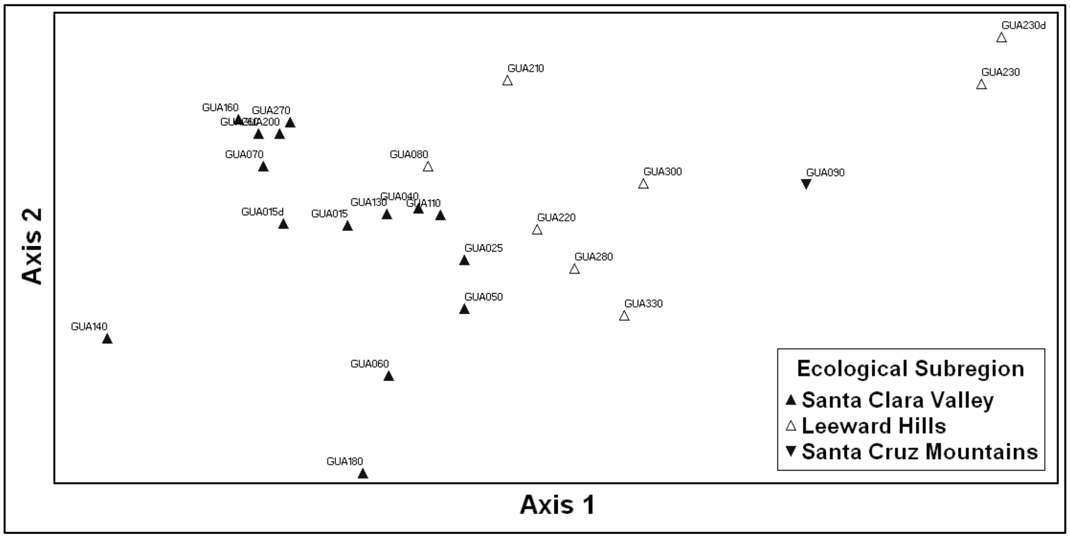

Figure 6. NMS ordination of relative site similarity as a function of BMI taxonomic composition showing sites grouped by ecological subregion.

There were also groupings of sites based on flow regime and land use categories (Figure 7) (see Section 2.5.2 for definition of categories). All of the sites within the Santa Clara Valley ecological subregion are within urban areas downstream of reservoirs while majority of sites within the Leeward Hills ecological subregion are in areas of open space where two sites are upstream of reservoirs (GUA230 and GUA300).

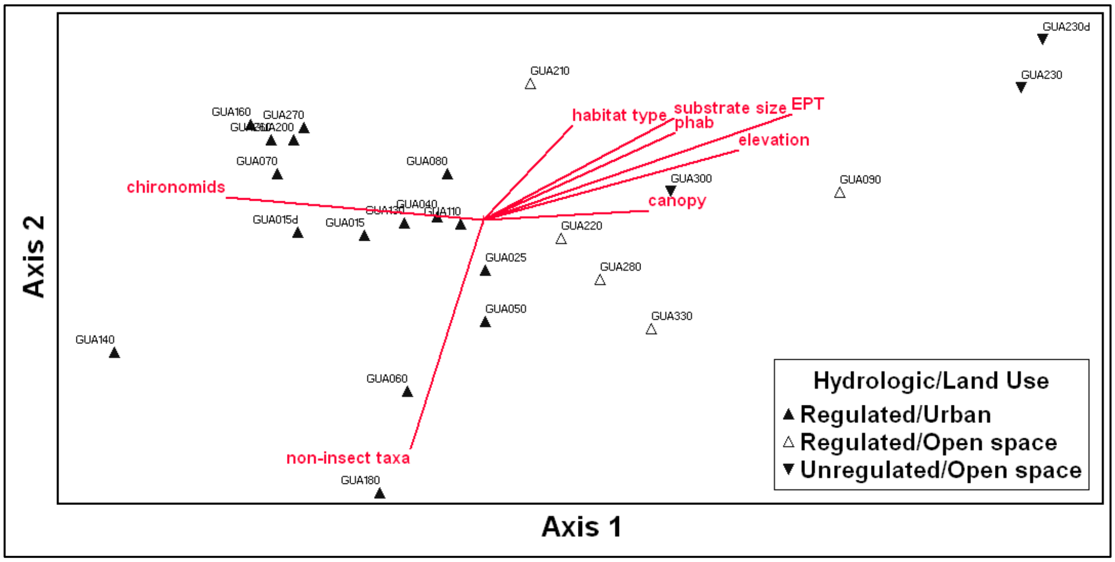

Figure 7. NMS ordination of relative site similarity as a function of BMI taxonomic composition showing sites grouped by flow regime (regulated/unregulated) and land use (urban/open space) conditions.

Figure 8 shows the longitudinal variation in taxonomic composition of sites for the major stream systems. Sites along Guadalupe Creek sites exhibited the greatest amount of variation along axis 1. Los Gatos Creek sites showed variation along both axes 1 and 2. Sites within both of these subwatersheds show high variation in taxonomic composition corresponding with changes in elevation, substrate size, physical habitat quality, canopy, and habitat type. The direction and strength of the relationships (minimum r^2=0.3) are indicated by the direction and length of lines of the joint plot. Conversely, as the aforementioned environmental variables decreased in value, there were corresponding increases in relative abundances of chironomids (axis 1) and non-insect taxa (axis 2).

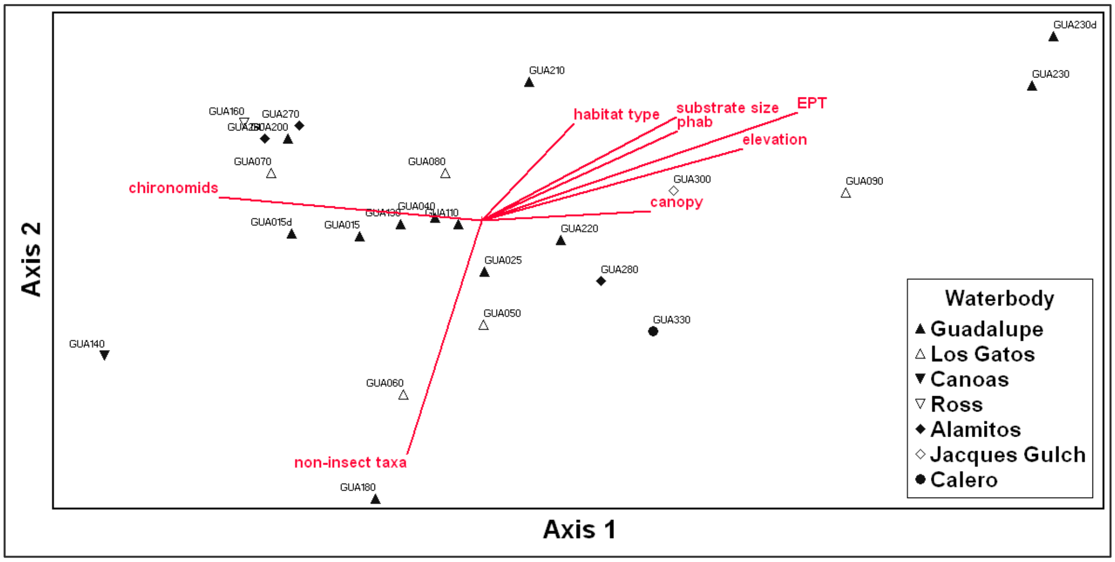

Figure 8. NMS ordination of relative site similarity as a function of BMI taxonomic composition showing sites grouped by waterbody.

3.2 Algae Bioassessments

Species richness for soft algae ranged from 20 to 30 across all 4 sites, with the highest richness occurring in Los Gatos Creek (site GUA050) and lowest in Guadalupe Creek (site GUA220). Similar pattern in richness was observed for diatoms with highest values at site GUA080 in Los Gatos Creek (65) and lowest at site GUA220 in Guadalupe Creek (32). Additional metric index results for soft bodied algae and diatoms are presented in Appendix C.

3.3 Physical Habitat Quality

Physical habitat scores can range from 0 to 60 (score of 60 = most optimal habitat conditions). PHAB scores for Guadalupe River ranged from 9-30, with the highest score occurring at site GUA025. Scores for Guadalupe River tributaries ranged from 8 to 58, the highest score occurring in Guadalupe Creek (site GUA230) and lowest score in Canoas Creek (site GUA160).

Average substrate sizes in Guadalupe River main stem sites ranged from 12.9 mm (coarse gravel) to 119.6 mm (cobble) (Table 8). Average substrate sizes in tributaries ranged from 0.3 mm (sand) to 175.8 mm (cobble). Percentage of riffle and/or run habitat for sites in Guadalupe River and Los Gatos Creek ranged between 39 and 82, with and average of 52 (note pools and glides were the remaining habitat types). Riffle and run habitat types were more frequent in sites located in Guadalupe and Alamitos Creek, ranging 55 to 100, with an average of 80 percent. Average stream widths for sites in Guadalupe River and Los Gatos Creek were 21 feet and average widths for sites in Guadalupe Creek and Alamitos Creek were 15 feet. Refer to Table 8 for habitat data collected at each site.

Table 8. Physical habitat measurements and assessment scores for BMI assessment sites.

Site	Elev. (ft)	Ave Particle Size (mm)	Ave Wetted Width (ft)	Habitat Type (%)				PHAB			
				Riffle	Run	Glide	Pool	Epi Sub	Sed Dep	Chan Alter	Total Score
Guadalupe River											
205GUA015	30	12.9	20.1	0	82	10	4	4	3	2	9
205GUA025	60	56.6	28.8	21	21	26	32	8	7	15	30
205GUA040	75	38.3	31.5	26	20	30	25	9	8	5	22
205GUA110	95	119.6	19.3	15	25	41	19	5	10	8	23
205GUA130	125	88.6	15.9	7	44	49	0	6	5	7	18
205GUA180	160	21.8	18.3	13	53	20	15	9	8	12	29
Los Gatos Creek											
205GUA050	115	26.5	21.3	20	24	57	0	9	5	13	27
205GUA060	180	64.4	24.4	8	25	65	0	5	3	11	19
205GUA070	260	53.2	19.1	12	65	13	0	10	2	15	27
205GUA080	360	46.9	25.6	47	12	40	0	7	3	14	24
205GUA090	800	39.9	16.4	34	5	46	15	9	7	20	36
Canoas/Ross Creeks											
205GUA140	160	0.3	10.3	0	0	100	0	1	6	1	8
205GUA160	180	27.6	8.6	21	3	77	0	3	8	4	15
Guadalupe Creek											
205GUA200	230	54.2	14.5	18	37	0	45	14	14	13	41
205GUA210	320	44.6	21.1	57	32	11	0	12	14	17	43
205GUA220	480	77.5	15.7	25	35	13	27	15	11	19	45
205GUA230	680	175.8	7.0	43	51	0	7	20	18	20	58
Alamitos Creek											
205GUA260	240	38.5	21.7	20	70	0	10	15	12	16	43
205GUA270	320	58.3	18.1	55	23	23	0	15	14	17	46
205GUA280	520	40.2	12.0	12	88	0	0	17	15	19	51
205GUA300	640	45.5	9.3	50	39	0	9	13	15	19	47
205GUA330	310	23.9	15.5	12	55	0	33	9	8	17	34

3.4 Water Quality

Water temperature measurements ranged from minimum of 9.6 °C (site GUA090) to maximum of 21.6 °C (site GUA130) across all sites. Water temperatures at the three lowest elevation sites in Los Gatos Creek, all downstream of Vasona Reservoir, ranged 19.6 to 21.4 °C. Measurements of pH were within range of 6.5 to 8.5 for all sites, with the exception of site GUA140 (pH = 6.36). Dissolved oxygen concentrations were all above 7.0 mg/L for all sites, with the exception of site GUA180 (6.04 mg/L). Conductivity measurements ranged 116 to 687 across all sites.

4.0 DISCUSSION

4.1 Potential Factors Explaining Biological Integrity

BMI community condition can be affected by a variety of natural (e.g., elevation, hydrology (perennial/intermittent), instream and riparian habitat quality) and anthropogenic (e.g., urbanization, impoundments and water quality) factors. The effects of reach-scale physical habitat quality and urbanization were evaluated using available data.

4.1.1 Reach-Scale Physical Habitat

Reach-scale physical habitat quality appears to partially explain the condition of the benthic community in Guadalupe River watershed. Specifically, regression analyses suggest that B-IBI scores are partially correlated with elevation (r^2=.73, $p<0.05$) and qualitative physical habitat (PHAB) scores (r^2=.43, $p<0.05$) (Figure 9). Additional regression analyses showed that B-IBI scores were poorly correlated with mean substrate size (r^2=.11 $p<0.05$), percent riffle/run habitat (r^2=.17 $p<0.05$) and average wetted width (r^2=.16 $p<0.05$).

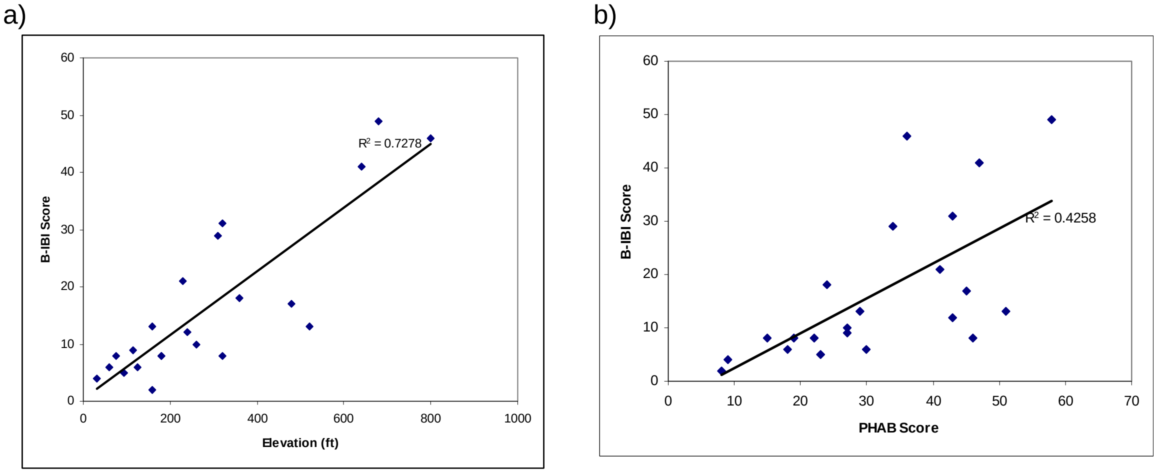

Figure 9. Comparisons of elevation (ft) (a) and Qualitative Physical Habitat Scores (b) to Benthic Macroinvertebrate Index of Biological Integrity (B-IBI) for sampling sites in Guadalupe River watershed (2009).

4.1.2 Anthropogenic Effects

Dams/Reservoirs

Effects of dam/reservoir systems on downstream aquatic biota have been well documented but effects vary depending on reservoir characteristics including operations, depth of release point, capacity, and primary production (Rehn et al. 2007, Brunke et al. 2001, Stanford and Ward 2001, and Camargo and Voelz 1998). Reservoir characteristics, including effects on fluvial processes, could influence downstream BMI composition by affecting flow and temperature regimes, food resources and substrate composition.

Reservoir effects contributing to serial discontinuity of taxonomic composition are indicated for Guadalupe and Los Gatos Creeks. The Guadalupe Reservoir is located between Guadalupe Creek sites GUA230 and GUA220 and Lexington Reservoir is located between Los Gatos Creek sites GUA090 and GUA080. The relative distances in ordination space between the two site groups is similar and relatively large (Figure 6) but the site groups are relatively close together in geographic space. Almaden Reservoir may also contribute to serial discontinuity as suggested by dissimilarities in taxonomic composition at sites upstream (site GUA300) and downstream (site GUA280) of the reservoir but the variation in taxonomic composition is less than that described for Guadalupe and Los Gatos site pairs positioned upstream and downstream of reservoirs. Nevertheless, there was an over three-fold decrease in EPT taxa at sites immediately downstream of Guadalupe, Lexington and Almaden Reservoirs when compared to EPT taxa at sites immediately upstream of the reservoirs (Appendix B).

Urbanization

Factors contributing to streams with productive and diverse benthic fauna include mixtures of loosely consolidated coarse substrate, a natural hydrograph, allochthonous inputs with retention, and good water quality (Allan and Castillo 2008, Petts 1984). These conditions become altered in urban areas where upstream impervious landscape surfaces alter the natural hydrograph and interfere with the production, transport and retention of allochthonous 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 colonization of benthic fauna (Allan and Castillo 2008, Waters 1995). Often, a shift in benthic fauna occurs with increases in sedimentation resulting in increases in burrowing forms such as oligochaetes and clams. Furthermore, altered hydrographs may affect benthic fauna 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 from stormwater runoff such as petroleum hydrocarbons, fine sediment, pesticides, fertilizers and detergents (Schueler 1987).

Changes in BMI taxonomic composition in the Guadalupe watershed suggested effects of urbanization but other factors confound the identification of cause and effect relationships. The primary confounding factor is the natural change in BMI assemblages that occur along elevation gradients described by many investigators and summarized by Allan and Castillo (2008). Ordination produced nearly identical clusters of sites based on both land use and ecological subregion (Figures 6 and 7), and ordination indicated correspondence between natural gradients and changes in taxonomic composition. The identification of minimally impaired sites in the Santa Clara Valley ecological subregion would help separate natural and anthropogenic influences on BMI assemblage quality.

Water Quality

Another factor potentially affecting taxonomic composition is sediment mercury levels within Alamitos Creek and Guadalupe River as described by Haas and Ichikawa 2000 and 2004, and Woodward-Clyde 1992. The existing monitoring study was not designed to identify specific effects of sediment mercury on BMI assemblages; however, these data may supplement existing and future efforts toward establishing links between sediment mercury levels and condition of BMI assemblages. For example, two Alamitos Creek sites (GUA260 and GUA270) were characterized as having minimally altered channels with a stable mix of coarse substrate yet chironomid relative abundance exceeded 85 percent.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The following preliminary conclusions and recommendations were based on the results and interpretation of physical and biological indicator data collected during FY 08-09 by SCVURPPP.

Conclusions

- The Preliminary Benthic Index of Biotic Integrity (B-IBI) for Santa Clara Creeks indicates that conditions of benthic macroinvertebrate (BMI) communities in sites within Guadalupe River mainstem are poor. With the exception of Canoas and Ross Creeks, tributary sites exhibited a range of conditions, with B-IBI scores generally exhibiting a longitudinal pattern of scores increasing in an upstream direction. Sites that were directly downstream of dams were considerably lower in scores compared to sites above. In addition, sites in lower and middle reaches of Alamitos Creek had poor biotic condition, despite having good physical habitat scores and coarse substrate.

- Sites that have poor biotic condition and good physical habitat condition may indicate potential water quality impacts to the biota. Mercury contamination in creeks and reservoirs originating from historic mine wastes may be impacting the benthic community. Water and/or sediment chemistry data and toxicity testing at selected sites may provide additional insight into potential causes of poor biotic condition.

- The preliminary metric results indicate some differences in the condition of the benthic algae/diatom community for the three different waterbodies sampled. The number of samples (n=4), however, was too small to develop any conclusions on the biotic condition of algae/diatom communities for the Guadalupe River watershed.

Recommendations

- Conduct BMI bioassessments an additional year in the Guadalupe watershed to better understand the inter-annual variability in BMI community composition.

- As resources are available, conduct analyses for pollutants of concern (i.e., metals, pyrethroid pesticides) and toxicity in bedded sediments to determine potetnial water quality impacts.

- Conduct benthic algae bioassessments synoptically with BMI bioassessments to provide additional information on the condition of aquatic life uses in the Guadalupe watershed.

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APPENDICES

Appendix A: BMI Metric Scores

Appendix B: B-IBI Scores

Appendix C: Algae/Diatom Metric Scores

Appendix A: Biological metrics for stream sites sampled in April 2009, Santa Clara County.

Metric	Guadalupe River							Los Gatos Creek				
	205GUA015	205GUA015D	205GUA025	205GUA040	205GUA110	205GUA130	205GUA180	205GUA050	205GUA060	205GUA070	205GUA080	205GUA090
Richness:												
Taxonomic	16	16	10	11	13	20	26	18	20	18	19	49
EPT	4	2	2	4	3	4	3	2	3	3	5	23
Ephemeroptera	2	1	1	2	1	2	1	1	1	2	3	8
Plecoptera	0	0	0	0	0	0	0	0	0	0	0	5
Trichoptera	2	1	1	2	2	2	2	1	2	1	2	10
Coleoptera	0	0	0	0	0	0	1	0	0	0	1	4
Predator	2	4	2	1	1	3	6	4	3	6	5	15
Diptera	1	2	2	2	2	2	3	2	2	2	6	11
Composition:												
EPT Index (%)	14	5.8	53	37	34	23	23	24	17	2.9	28	57
Sensitive EPT Index (%)	0.0	0.0	0.0	0.2	0.4	1.0	0.8	0.0	0.4	0.0	0.4	29
Shannon Diversity	1.5	1.4	1.1	1.1	1.4	1.6	2.3	2.1	2.1	1.0	1.3	3.0
Dominant Taxon (%)	56	66	52	53	45	54	29	34	32	78	54	20
Non-insect Taxa (%)	69	75	50	45	62	70	65	61	65	67	32	20
Tolerance:												
Tolerance Value	5.6	5.9	5.4	5.5	5.6	5.9	5.8	6.0	6.1	6.0	5.8	4.0
Intolerant Organisms (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	19
Tolerant Organisms (%)	4.7	8.4	1.4	0.8	4.1	14	20	17	22	4.9	2.1	5.1
Tolerant Taxa (%)	38	44	10.0	18	38	35	38	22	30	39	26	16
Functional Feeding Groups:												
Collector-Gatherers (%)	82	79	95	95	89	91	39	59	63	86	81	52
Collector-Filterers (%)	13	16	3.7	4.1	8.5	2.0	47	22	26	7.0	15	5.7
Collectors (%)	96	95	99	99	97	93	86	81	89	93	97	58
Scrapers (%)	0.6	1.3	0.0	0.2	1.9	4.8	7.6	16	4.8	2.3	0.4	25
Predators (%)	3.4	3.2	1.0	0.6	0.2	1.2	5.5	3.0	6.2	4.7	1.0	12
Shredders (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7
Other (%)	0.2	0.0	0.0	0.2	0.4	1.2	0.8	0.0	0.4	0.0	1.8	0.4
Estimated Abundance:												
Composite Sample (11 ft^2)	1670	462	1190	1690	1330	3760	2910	1160	1140	6960	2940	660
#/ft^2	152	42	108	154	121	342	265	105	104	633	267	60
#/m^2	1621	449	1155	1641	1291	3650	2825	1126	1107	6757	2854	641

Appendix A (cont): Biological metrics for stream sites sampled in April 2009, Santa Clara County.

Metrics	Canoas Creek	Ross Creek	Guadalupe Creek					Alamitos Creek			Jacques Gulch	Calera Creek
	205GUA140	205GUA160	205GUA200	205GUA210	205GUA220	205GUA230	205GUA230D	205GUA260	205GUA270	205GUA280	205GUA300	205GUA330
Richness:												
Taxonomic	8	8	28	31	18	51	47	19	14	14	40	32
EPT	0	2	10	16	7	25	23	3	4	5	21	11
Ephemeroptera	0	2	6	6	2	9	9	1	1	2	9	3
Plecoptera	0	0	0	1	2	6	5	0	0	0	5	0
Trichoptera	0	0	4	9	3	10	9	2	3	3	7	8
Coleoptera	0	0	2	4	0	5	6	1	1	0	4	2
Predator	2	0	6	8	4	15	15	4	3	3	12	9
Diptera	1	3	5	5	5	13	10	4	2	5	7	8
Composition:												
EPT Index (%)	0.0	3.5	7.0	30	31	46	46	2.6	5.8	46	39	49
Sensitive EPT Index (%)	0.0	0.0	1.8	20	5.7	24	22	0.0	0.0	0.0	9.7	5.0
Shannon Diversity	1.0	0.4	1.2	2.4	1.8	2.9	3.0	0.8	0.7	1.4	2.3	2.4
Dominant Taxon (%)	55	91	77	36	30	20	18	84	83	43	27	32
Non-insect Taxa (%)	75	38	36	16	33	14	17	53	50	29	10.0	28
Tolerance:												
Tolerance Value	7.2	6.0	5.8	4.7	5.4	4.0	4.0	6.0	5.9	5.5	4.5	5.1
Intolerant Organisms (%)	0.0	0.0	1.6	12	5.5	14	18	0.0	0.0	0.0	9.7	3.8
Tolerant Organisms (%)	59	1.6	4.1	2.1	2.8	2.6	4.2	4.4	1.4	0.6	2.1	2.4
Tolerant Taxa (%)	50	38	18	9.7	28	14	17	42	29	14	13	13
Functional Feeding Groups:												
Collector-Gatherers (%)	94	98	85	60	73	30	35	91	89	73	60	63
Collector-Filterers (%)	0.0	1.6	5.3	18	20	8.5	5.2	2.6	8.6	24	24	24
Collectors (%)	94	100	90	78	93	39	41	93	98	97	84	87
Scrapers (%)	4.8	0.2	5.8	11	0.4	46	42	5.0	0.2	0.2	3.7	6.0
Predators (%)	1.6	0.0	2.9	6.6	1.8	10	14	1.4	1.8	1.4	10	5.8
Shredders (%)	0.0	0.0	1.0	1.8	5.1	3.9	3.0	0.0	0.0	0.0	2.1	0.6
Other (%)	0.0	0.0	0.2	3.1	0.0	1.2	0.0	0.4	0.2	1.6	0.8	0.6
Estimated Abundance:												
Composite Sample (11 ft^2)	7560	12920	3070	2700	4210	1450	1470	4120	3220	2110	1330	1550
#/ft^2	687	1175	279	245	383	132	134	375	293	192	121	141
#/m^2	7340	12544	2981	2621	4087	1408	1427	4000	3126	2049	1291	1505

Appendix B. Preliminary Benthic Index of Biotic Integrity (B-IBI) Calculation Tables for Guadalupe Watershed Sites.

Site	EPT Taxa	IBI Score	Number Diptera Taxa	IBI Score	Number Predator Taxa	IBI Score	% Collectors	IBI Score	% Non-Insecta Taxa	IBI Score	Total IBI Score	Rank
205GUA015	4	1	1	0	2	0	96	2	69	1	4	Poor
205GUA025	2	0	2	1	2	0	99	1	50	4	6	Poor
205GUA040	4	1	2	1	1	0	99	1	45	5	8	Poor
205GUA050	2	0	2	1	4	2	81	4	61	2	9	Poor
205GUA060	3	1	2	1	3	1	89	3	65	2	8	Poor
205GUA070	3	1	2	1	6	4	93	2	67	2	10	Poor
205GUA080	5	2	6	5	5	3	97	1	32	7	18	Marginal
205GUA090	23	10	11	10	15	10	58	8	20	8	46	Optimal
205GUA110	3	1	2	1	1	0	97	1	62	2	5	Poor
205GUA130	4	1	2	1	3	1	93	2	70	1	6	Poor
205GUA140	0	0	1	0	2	0	94	2	75	0	2	Poor
205GUA160	2	0	3	2	0	0	100	0	38	6	8	Poor
205GUA180	3	1	3	2	6	4	83	4	65	2	13	Marginal
205GUA200	10	4	5	4	6	4	90	3	36	6	21	Marginal
205GUA210	16	7	5	4	8	6	78	5	16	9	31	Fair
205GUA220	7	3	5	4	4	2	93	2	33	6	17	Marginal
205GUA230	25	10	13	10	16	10	39	10	14	9	49	Optimal
205GUA260	3	1	4	3	4	2	93	2	53	4	12	Poor
205GUA270	4	1	2	1	3	1	98	1	50	4	8	Poor
205GUA280	5	2	4	3	2	0	97	1	29	7	13	Marginal
205GUA300	21	10	8	7	13	10	84	4	10.0	10	41	Good
205GUA330	11	5	8	7	9	7	87	3	28	7	29	Fair

Appendix C. Metric Scores for soft bodies algae collected at 4 sites in Guadalupe River watershed in April 2009.

Metric	205GUA050	205GUA080	205GUA180	205GUA220
Abundance Measures				
Species Richness	30.00	28.00	29.00	20.00
Dominance Measures				
Dominant Taxon	Rhoicosphenia sp.	Achnanthes sp.	Fragilaria sp.	Diatoma sp.
Dominant Taxon Abundance	72.00	51.00	160.00	76.00
2nd Dominant Taxon	Achnanthes sp.	Cocconeis sp.	Navicula sp.	Navicula sp.
2nd Dominant Taxon Abundance	40.00	33.00	37.00	57.00
3rd Dominant Taxon	Melosira sp.	Navicula sp.	Achnanthes sp.	Melosira sp.
3rd Dominant Taxon Abundance	36.00	33.00	22.00	43.00
4th Dominant Taxon	Pyrenomonas sp.	Nitzschia sp.	Amphora sp.	LGBs
4th Dominant Taxon Abundance	22.00	27.00	22.00	42.00
5th Dominant Taxon	Cocconeis sp.	Pyrenomonas sp.	Cocconeis sp.	Achnanthes sp.
5th Dominant Taxon Abundance	21.00	21.00	11.00	27.00
% Dominant Taxon	22.29	15.79	46.92	23.31
% 2nd Dominant Taxon	12.38	10.22	10.85	17.48
% 3rd Dominant Taxon	11.15	10.22	6.45	13.19
% 4th Dominant Taxon	6.81	8.36	6.45	12.88
% 5th Dominant Taxon	6.50	6.50	3.23	8.28
Diversity/Evenness Measures				
Shannon-Weaver H' (log e)	2.79	2.89	2.19	2.34
Shannon-Weaver H' (log 10)	1.21	1.26	0.95	1.02
Shannon-Weaver H' (log 2)	4.02	4.17	3.16	3.38
Margalef's Richness	5.02	4.67	4.80	3.28
Other Measures				
% Rhopalodiales	0.00	0.00	0.00	0.00
% Achnanthes minutissima (Disturbance Index)	0.00	0.00	0.00	0.00
% Siltation Index	4.64	20.43	12.61	18.71
Siltation Richness	2.00	3.00	2.00	2.00
% Aerophiles	0.00	0.00	0.00	0.00
% Centrics	13.00	4.02	5.28	14.42
% Stability Index	7.12	5.26	48.09	26.38
% Heavy Metals Index	0.00	0.00	0.00	0.00

Appendix C (cont). Metric Scores for diatoms collected at 4 sites in Guadalupe River watershed in April 2009.

Site	205GUA050	205GUA080	205GUA180	205GUA220
Abundance Measures				
Species Richness	61.00	65.00	52.00	32.00
Number of Valves Counted	770.00	602.00	685.00	621.00
Total Cells Counted	385.00	301.00	342.50	310.50
Dominance Measures				
Dominant Taxon	Amphora pediculus	Navicula gregaria	Cyclotella atomus	Diatoma moniliformis
Dominant Taxon Abundance	167.00	78.00	268.00	305.00
2nd Dominant Taxon	Achnanthes laterostrata	Amphora pediculus	Cyclotella girdle sp.	Amphora pediculus
2nd Dominant Taxon Abundance	68.00	75.00	117.00	32.00
3rd Dominant Taxon	Nitzschia inconspicua	Nitzschia girdle sp.	Amphora pediculus	Asterionella formosa
3rd Dominant Taxon Abundance	57.00	47.00	30.00	30.00
4th Dominant Taxon	Rhoicosphenia curvata	Cocconeis placentula var. euglypta	Achnanthes minutissima	Navicula radiosa var. tenella
4th Dominant Taxon Abundance	40.00	44.00	25.00	30.00
5th Dominant Taxon	Bacillaria paradoxa	Cyclotella comensis	Nitzschia frustulum var. perminuta	Achnanthes sp.
5th Dominant Taxon Abundance	39.00	29.00	18.00	27.00
% Dominant Taxon	21.69	12.96	39.12	49.11
% 2nd Dominant Taxon	8.83	12.46	17.08	5.15
% 3rd Dominant Taxon	7.40	7.81	4.38	4.83
% 4th Dominant Taxon	5.19	7.31	3.65	4.83
% 5th Dominant Taxon	5.06	4.82	2.63	4.35
Diversity/Evenness Measures				
Shannon-Weaver H' (log e)	3.21	3.38	2.57	2.28
Shannon-Weaver H' (log 10)	1.39	1.47	1.12	0.99
Shannon-Weaver H' (log 2)	4.63	4.87	3.71	3.28
Margalef's Richness	9.03	10.00	7.81	4.82
Other Measures				
% Rhopalodiales	0.00	0.00	0.00	0.00
% Achnanthes minutissima (Disturbance Index)	2.60	1.00	3.65	2.42
% Siltation Index	23.51	37.87	12.99	14.01
Siltation Richness	20.00	34.00	19.00	10.00
% Aerophiles	47.14	53.32	23.94	23.19
% Centrics	2.47	16.94	62.63	3.54
% Stability Index	11.43	3.32	7.15	56.20
% Heavy Metals Index	0.00	0.00	0.00	0.00