August 28th, 2007

Mr. Arnie Anselm
County of Ventura
Watershed Protection District
800 S. Victoria Ave.
Ventura, CA 93009

Dear Mr. Anselm:

In accordance with the Consulting Services Contract AE No. 07-J14, Work Order No. PW07-339 dated March 20th, 2007 between the County of Ventura and Aquatic Bioassay and Consulting Laboratories, Inc., we are pleased to present the Ventura Countywide Stormwater Monitoring Program, Ventura River Watershed, 2006 Bioassessment Monitoring Report. The enclosed report includes the results for both the September 2006 survey and an historic summary of data collected from 2001 to 2006.

Yours very truly,

Scott C. Johnson
Director of Environmental Programs
Aquatic Bioassay & Consulting Laboratories
29 N. Olive St.
Ventura, CA 93001

Ventura Countywide Stormwater Monitoring Program
Ventura River Watershed
2006 Bioassessment Monitoring Report

Submitted to:

The Ventura County
Watershed Protection District
800 S. Victoria Ave.
Ventura, CA 93009

Submitted by:

Aquatic Bioassay and Consulting Laboratories
29 N Olive Street
Ventura, CA 93001

August 2007

Executive Summary

The 2006 bioassessment survey of the Ventura River Watershed was conducted by staff members from the Ventura County Watershed Protection District, the Ojai Valley Sanitation District and Aquatic Bioassay and Consulting Laboratories on September 11th, 12th and 13th. Staff members from the California Department of Fish and Game (CDFG) and/or the Sustainable Land Stewardship Institute (SLSI) have been present during the four surveys since 2001 to audit sample collection activities and to provide data analysis and reporting services (CDFG = Jim Harrington, SLSI = Monique Born).

Fifteen benthic macroinvertebrate (BMI) sampling locations were visited during the survey, with 14 sites having sufficient flow for sample collection. Physical/habitat observations flow and water quality samples were also collected at each site. The taxonomic identification of BMI organisms was conducted by Aquatic Bioassay and Consulting Laboratories in Lake Oswego, OR and data analysis and report generation was conducted in Ventura, CA. All of the QC guidelines for collection, sorting and identification of BMI organisms specified in the California Stream Bioassessment Protocol (2003) were met.

The physical habitat quality of the survey stations ranged from poor to optimal. The best habitat scores were found at Stations located on the main stem of the Ventura River just below Matilija Dam and on the North Fork of Matilija Creek. These sites were characterized by relatively high substrate complexity, were composed of high percentages of cobble and boulders, had good bank stability, had little evidence of sedimentation due to upstream erosion and had good vegetative protection. The lowest habitat scores were measured on the Ventura River just upstream of the ocean and on Canada Larga Creek just above its confluence with the Ventura River. These sites were characterized by having less instream cover and increased amounts of sedimentation and embeddedness (a measure of the amount of space surrounding cobble and gravel in the streambed). Water quality (pH, dissolved oxygen, temperature, specific conductance) was similar at all sites during the survey.

The aquatic health of the Ventura River Watershed for 2006 was assessed using the Southern California Index of Biological Integrity (So CA IBI). Based on this index, BMI communities that are ranked as poor can be considered to be impaired. The IBI rankings for the 14 stations sampled for BMIs in 2006 included good (1 station), fair (9 stations) and poor (4 stations) rankings. The four stations that were rated as poor were located at the Main St. bridge near where the Ventura River discharges into the Pacific Ocean (Station 0), at Foster Park (Station 4), on the lower Canada Larga Creek (Station 2) and Station 15 located on San Antonio Creek. Station 14 in the Matilija Creek had the highest IBI score of all sites, just above the good range, indicating that the BMI community found there is comparable to other reference site locations in southern California. IBI scores increased from the lower watershed to the upper watershed.

An invasive species, the New Zealand mudsnail, which has been found at several locations in southern California during the past three years, has not been found in the Ventura River Watershed to date. This non-indigenous gastropod snail, once introduced, can reproduce rapidly and reach abundances of over 100,000 per m^2 within a year, excluding other species. Members of the Ventura River Watershed Protection District and other associated agencies are aware of this threat and are taking every precaution to reduce the chances that this species will become established in the watershed.

Program History Results (2001 to 2006)

Physical habitat scores for each station from 2001 to 2006 were averaged to assess long term conditions in the Ventura River Watershed. The best habitat conditions during the six year period were measured at Station 12 below the Matilija Dam and the worst occurred on Canada Larga Creek above its confluence with the main stem of the Ventura River. Physical habitat scores increased as elevation in the watershed increased, becoming progressively greater on the Ventura River main stem from the ocean to below Matilija Dam and from Canada Larga Creek to the North Fork of the Matilija Creek.

During the six year period from 2001 to 2006 the average IBI scores for all sites, except Stations 0, 1 and 2, were in the fair or good range. The average scores for Stations 0, 1 (above the Main Street Bridge) and 2 (Canada Larga Creek), were slightly below the impairment threshold (39). IBI scores increased with elevation on the Ventura River, Canada Larga Creek (Stations 2 and 3) and San Antonio Creek (Stations 7, 15, 8 and 9). The greatest average IBI score during the five year period was at Station 11 on the North Fork of the Matilija.

The six years of BMI data were assessed using a multivariate clustering technique which defined seven station cluster groups and eight species cluster groups. The station cluster groups were delineated spatially by their location in either the lower or upper watershed and temporally by whether they were sampled before or after the 2005 rain events. The greatest dissimilarities between station groups occurred between lower watershed stations sampled prior to 2005 and upper and lower watershed sites sampled in 2005 and 2006. This indicates that sites in the lower watershed, which are composed of more gravel and fine sediments, are probably more susceptible to the scouring that occurs following large storm events such as those that occurred during the winter of 2005. These habitat changes are generally less favorable to BMI species. In 2005 and 2006 a transitional group of more opportunistic species colonized the lower watershed sites. The upper watershed was less susceptible to scouring since the streambeds are composed of larger percentages of cobble and boulder. As a result, the community assemblages were not as affected by the 2005 storms.

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INTRODUCTION

Ventura River Watershed

The 228 square mile Ventura River Watershed includes rugged mountains, a coastal chaparral ecosystem and valleys that lead to the Pacific Ocean. Almost half of the watershed is in the Los Padres National Forest. The Ventura River is the main watercourse within the watershed, with several major tributaries that includes Matilija Creek, San Antonio Creek and Canada Larga Creek (Figure 1). Matilija Creek drains the mountainous northern most portion of the watershed and can be divided into the main stem of the Creek above Matilija Dam and the North Fork of Matilija Creek which discharges into the main stem below the dam. San Antonio Creek drains the northeastern portion of the watershed and has two main tributaries, Lions Canyon Creek and Stewart Canyon Creek. Canada Larga Creek drains the eastern portion of the watershed.

The land use patterns within the watershed vary, but for the most part is undeveloped land and open space (89%). There are urbanized areas (1.5%) that include the cities of Ojai and Ventura (southeast side), and unincorporated communities including Oak View, Matilija Canyon, Live Oak Acres, Meiners Oaks and Casitas Springs. The approximate human population of these communities is 20,000. The land use designations in the developed areas vary widely from rural to residential to industrial. Human impacted areas include activities related to grazing and livestock, agriculture, oil production and recreation.

Bioassessment Monitoring

Biological communities act to integrate the effects of water quality conditions in a stream by responding with changes in their population abundances and species composition over time. These populations are sensitive to multiple aspects of water and habitat quality and provide the public with more familiar expressions of ecological health than the results of chemical and toxicity tests (Gibson 1996). Furthermore, biological assessments when integrated with physical and chemical assessments, better define the effects of point-source discharges of contaminates and provide a more appropriate means for evaluating discharges of non-chemical substances (e.g. nutrients and sediment).

Benthic macroinvertebrates (BMIs) are ubiquitous, relatively stationary and their large species diversity provides a spectrum of responses to environmental stresses (Rosenberg and Resh 1993). Individual species of BMIs reside in the aquatic environment for a period of months to several years and are sensitive, in varying degrees, to temperature, dissolved oxygen, sedimentation, scouring, nutrient enrichment and chemical and organic pollution (Resh and Jackson 1993). Finally, BMIs represent a significant food source for aquatic and terrestrial animals and provide a wealth of ecological and bio-geographical information (Erman 1996).

In the United States the evaluation of biotic conditions from community data uses a multi-metric technique. In multi-metric techniques, a set of biological measurements ("metrics"), each representing a different aspect of the community data, is calculated for each site. An overall site score is calculated as the sum of individual metric scores. Sites are then ranked according to their scores and classified into groups with "good", "fair" and "poor" water quality. This system of scoring and ranking sites is referred to as an Index of Biotic Integrity (IBI) and is the end point of a multi-metric analytical approach recommended by the EPA for development of biocriteria (Davis and Simon 1995). The original IBI was created for assessment of fish communities (Karr 1981) but was subsequently adapted for BMI communities (Kerans and Karr 1994). An IBI specific to the southern California region was developed by the California Department of Fish and Game between 2000 and 2003, using bioassessment data collected at nearly 300 locations from the Mexican border to the south, Monterey County to the north and to the eastern extent of the Coastal Mountain range. These data were used to create an IBI that is applicable to southern California and is applied to the data in this report (Ode 2004).

In fulfillment of the District's NPDES storm water permit requirement, the goal of this report was to assess the aquatic health of the Ventura River and its main tributaries based on the results of the water quality, physical habitat and BMI community data collected at 14 sites in September 2006. In addition, these data were compared and contrasted to the previous five years of data to look for any spatial or temporal water quality trends.

MATERIALS AND METHODS

Sampling Site Descriptions

Fifteen BMI sampling locations were visited in the Ventura River Watershed on September 11th through the 13th, 2006 (Figure 1, Table 1). Photographs of each site are displayed in Figure 2. The 15 sites can be grouped into four geographic areas: Stations 0, 4, 6 and 12 located in the main stem of the Ventura River; Stations 2 and 3 located in Canada Larga Creek; the upper watershed which includes Stations 10, 11, 13 and 14 in Matilija Creek and the North Fork of Matilija Creek; and Stations 5, 7, 8, 9 and 15 located in San Antonio Creek and its tributaries, Lions Canyon Creek and Stewart Canyon Creek. All stations in the watershed, except Station 6, were flowing during the 2006 survey as a result of the above average rainfall that occurred during the previous winter. This was in contrast to previous years when numerous sites were dry during the September sampling event.

Ventura River, Lower Watershed (Stations 0, 4, 6 and 12)

The stations located on the main stem of the Ventura River range in elevation from 19 ft. at Station 0 near the ocean to 1020 ft. at Station 12 below the Matilija Dam. The Ventura River is the main drainage for the entire watershed and receives runoff from three main tributary systems: the Matilija Creek system above the dam; the San Antonio Creek system; and the Canada Larga Creek system.

Station 0 is located upstream of the Main St. bridge just above where the Ventura River discharges into the Pacific Ocean. It is the first site in the Ventura River that is not influenced by salinity changes caused by tidal flushing. The river bed at Station 0 is heavily influenced by a large transient human population which lives there. The bank on the east side of the river is stabilized by a rock levee designed to protect the City of Ventura from flooding. The Ojai Valley Sanitation Plant is located 2.5 miles upstream of Station 0 and discharges 2.0 million gallons per day (MGD) of tertiary treated effluent, a process that includes nitrogen and phosphorus removal.

Station 4 is located at Foster Park, just upstream of a traffic bridge and has small levees stabilizing both banks. In past years sampling at this site occurred across the entire width of the river. In both 2005 and 2006, the north half of the reach was not flowing due to sediment deposition. The river bottom is composed of boulders and cobble. During the dry season filamentous algae is prevalent.

Station 6 is located upstream of the traffic bridge at Santa Ana Road. The channel at this site is concrete reinforced and covered with cobble on the sides and bottom. This site has been dry during September for the last six years.

Station 12 is located at the base of the Matilija Dam. The dam, which is fed by Matilija Creek, is filled with sediment and no longer serves as a flood control structure and is scheduled for removal in the future. The habitat at Station 12 is composed of boulders and natural vegetation.

Canada Larga Creek (Stations 2 and 3)

Stations 2 and 3 are located on Canada Larga Creek, the first major tributary to the Ventura River upstream of the ocean. The Canada Larga drains a rural area composed of ranch land and open space. Station 3 is located near its headwaters and above areas of heavy grazing. Station 2 is located just upstream of the Canada Larga’s confluence with the Ventura River and downstream of the heavily grazed portion of the watershed. Both of these sites were flowing during the September 2006 sampling event.

Matilija Creek, Upper Watershed (Stations 10, 11, 13 and 14)

Each of the stations in the upper watershed is located above the influence of the Matilija Dam, at elevations near or above 1,000 ft. The Matilija Creek system drains a small portion of the Los Padres National Forest and is composed of mostly rural and recreational lands. Each of the monitoring sites is located in relatively pristine areas and is composed of high gradient, bolder and cobble habitats. Stations 10 and 11 are located on the North Fork of Matilija Creek, above (Station 11) and below (Station 10) an active rock quarry. Station 10 is heavily used for recreational swimming. Stations 13 and 14 are located on the main stem of Matilija Creek, above (Station 14) and below (Station 13) a small residential community that uses septic tanks as its means of sanitation. In previous years excessive algal growth had been present at Station 13, leading to concerns that the community could be contributing nutrients to the Creek.

San Antonio Creek (Stations 5, 7, 8, 9 and 15)

Stations 5, 7, 8, 9 and 15 are located in the San Antonio Creek system and include sites on San Antonio Creek (Stations 5, 9 and 15), as well as its main tributaries, Lions Canyon Creek (Station 7) and Stewart Canyon Creek (Station 8). Station 5 is located upstream of the bike path on San Antonio Creek just above its confluence with the Ventura River. The streambed is predominantly cobble with dense bank vegetation. Station 7 is located in Lions Canyon Creek above its confluence with San Antonio Creek in an area with stables, heavy grazing and sedimentation. During the heavy winter storms in 2005 this site was heavily scoured and was reinforced with erosion control projects after the storms subsided. Station 15 is located in San Antonio Creek upstream of Lions Canyon Creek and is composed of boulders, cobble and sand. Station 8 is located in Stewart Canyon Creek above the confluence with the San Antonio Creek and has a streambed composed of cobble, gravel and sand. Station 9 is located in San Antonio Creek upstream of Stewart Canyon Creek and is composed of cobble, gravel and sand with heavy vegetation on both banks. Stewart Canyon at Station 8 drains the City of Ojai’s downtown and residential areas. San Antonio Creek at Station 9 drains the City of Ojai’s rural and agricultural areas.

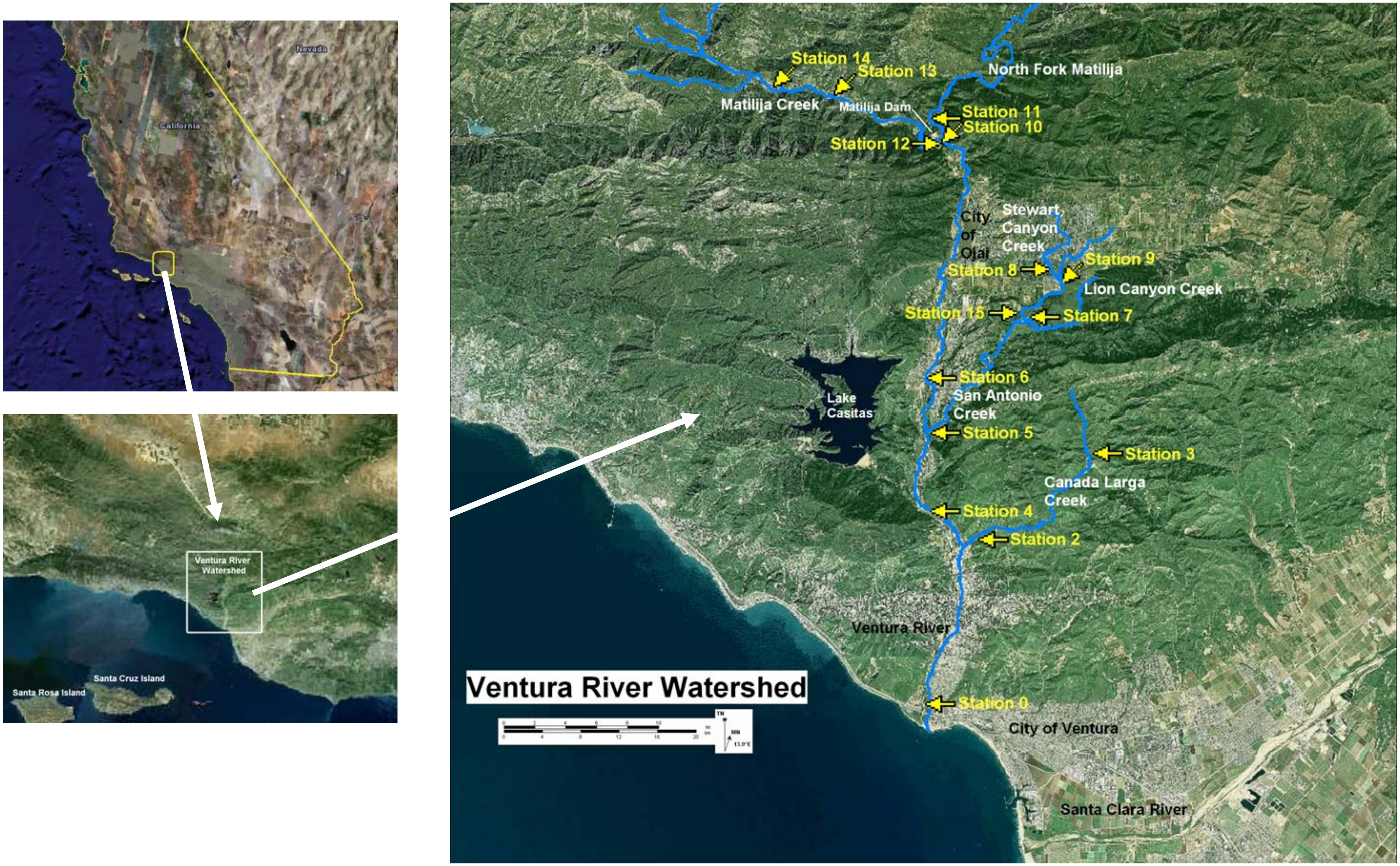


Figure 1. Fifteen BMI sampling locations in the Ventura River watershed.

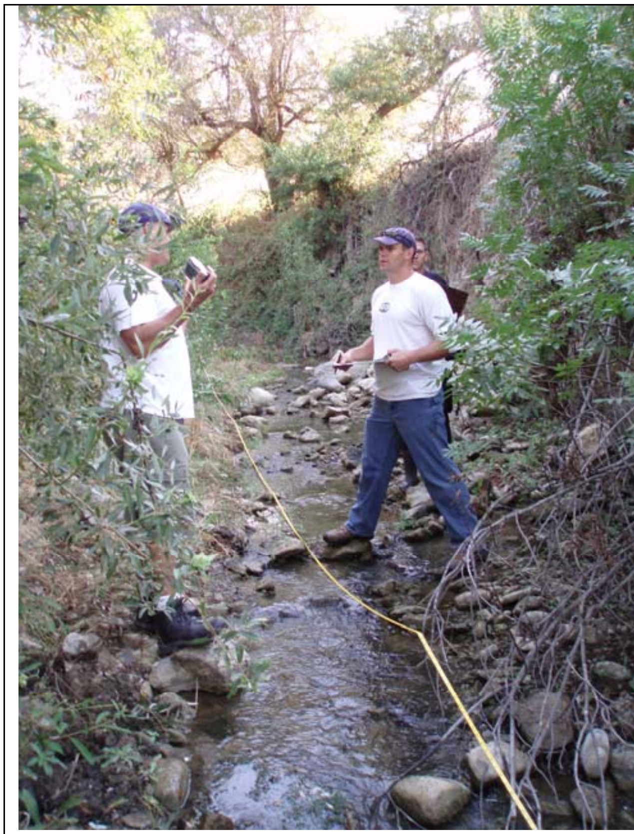
Table 1. Sampling locations descriptions for 15 locations in the Ventura River Watershed. u/s = upstream; d/s = downstream.

Sta.ID	Name	Description and Comments	Latitude	Longitude	Elev.
0	Ventura River – Main Street Bridge	Mainstem Ventura River, first site above estuary with fresh water.	34 16 54.23	119 18 24.09	19
4	Ventura River - Foster Park	Mainstem Ventura River. Closest downstream site to confluence with San Antonio Creek. Station is also mass emission station. Bioassessment d/s from Foster Park Bridge.	34 21 07.9	119 18 23.7	200
6	Ventura River -Santa Ana Rd.	Mainstem Ventura River **Dry - Not Sampled**	34 23 59.1	119 18 29.7	403
12	Ventura River - below Matilija Dam	Matilija Creek. First station below Matilija dam and first existing station above urban influence.	34 29 2.4	119 18 1.7	1020
2	Canada Larga Creek	Canada Larga Creek, d/s of grazing	34 20 31.7	119 17 08.2	293
3	Canada Larga Creek	Canada Larga Creek, above main area of grazing impact.	34 22 23.3	119 14 8.8	334
5	San Antonio Creek - near Ventura River	San Antonio Creek, first upstream site from confluence with Ventura River.	34 22 50.9	119 18 23.9	347
7	Lion Canyon Creek – u/s conf. San Antonio Creek	Lion Canyon Creek (tributary to San Antonio Creek) First u/s location from confluence. Site with heavy sediment load and influenced by nearby stables and grazing.	34 25 19.3	119 15 46.8	623
15	San Antonio Creek above Lion Creek	San Antonio Creek above Lion Creek	34 25 19.3	119 15 46.8	623
8	Stewart Canyon Creek – u/s conf. San Antonio Creek	Stewart Creek (tributary to San Antonio Creek) First u/s location from confluence. Within close proximity to the City of Ojai and less densely developed residential lots.	34 26 07.1	119 14 49.3	685
9	San Antonio Creek near Stewart Canyon Creek	San Antonio Creek. Within close proximity to the City of Ojai and less densely developed residential lots.	34 26 1.8	119 14 52.7	650
10	North Fork Matilija Creek- u/s Ventura River conf.	North Fork Matilija Creek above influence of Matilija Dam and below rock quarry.	34 29 06.0	119 17 59.4	978
11	North Fork Matilija Creek- at gauging station	North Fork Matilija Creek above influence of Matilija Dam and above rock quarry.	34 29 35.1	119 18 18.6	1,360
13	Matilija Creek - below community	Matilija Creek. Above dam and below community. Site has excessive amount of algae.	34 30 04.5	119 20 51.7	1,355
14	Matilija Creek - at gate at end of road	Matilija Creek. Above dam and above community.	34 30 16.9	119 22 26.3	1,553

Figure 2. Photos of each Ventura River Watershed site.

 Station 0 – Main Street Bridge	
 Station 4 – Foster Park	
 Station 12 – Below Matilija Dam	

Station 2 – Lower Canada Larga Creek

 Station 3 – Upper La Canada Creek	
 Station 5 – San Antonio Creek	

 Station 7 – Lion Canyon Creek	
 Station 15 – San Antonio Creek	
 Station 8 – Stewart Canyon Creek	

 Station 9 – San Antonio Creek, upstream of Stewart Canyon Creek	
Station 10 – N. Fork of Matilija Creek, below quarry	
 Station 11 – N. Fork of Matilija Creek, upstream of quarry	

 Station 13 – Matilija Creek, below community	
 Station 14 – Matilija Creek, above community	

Collection of Benthic Macroinvertebrates

September was chosen for sampling the BMI communities in the Ventura River Watershed since fall represents the time when the water quality conditions are the most stressful for biotic communities. However, the Ventura River and its tributaries can be dry during the late summer and fall months as is typical of most southern California river systems. This was not the case for the 2005-2006 rain year when precipitation was well above normal. As a result, only Station 6 was not flowing during September 2006.

Sampling and laboratory procedures for this survey followed the California Stream Bioassessment Procedure (CSBP 2003). The CSBP is a regional adaptation of the U.S. Environmental Protection Agency (EPA) Rapid Bioassessment Protocols (Barbour et al. 1999) and has been used in various parts of the world to measure biological integrity of aquatic systems (Davis et al. 1996). Sampling procedures were audited by Jim Harrington of the California Department of Fish and Game.

Benthic macroinvertebrate (BMI) samples were collected in strict adherence to the CSBP in terms of both sampling methodology and QC procedures. At each station, a 100 m reach was measured and 3 riffles were randomly selected from all the possible riffles that were present within the reach. When access to the full 100 m reach was not possible due to obstacles (i.e. heavy vegetation), riffles were chosen from the portion of the reach where access was possible. Riffles were defined as areas in the reach where the velocity of flow was greatest due to shallow water coupled with a high relief bottom. At each site the California Bioassessment Worksheet (CBW) was used to collect all of the necessary station information.

Once three riffles were randomly identified, the most downstream riffle was occupied and the length of the riffle was measured. A random number table was used to randomly establish three points along the riffle where transects were established perpendicular to stream flow. Starting with the downstream riffle, the benthos within a 1 ft^2 area was sampled upstream of a 1 ft wide, 0.5 mm mesh D-frame kick-net. Sampling of the benthos was performed manually by rubbing cobble and boulder substrates in front of the net, followed by "kicking" the upper layers of substrate to dislodge any remaining invertebrates. The duration of sampling ranged from 60-120 seconds, depending on the amount of boulder and cobble-sized substrate that required rubbing by hand; more and larger substrates required more time to process.

Three locations that were representative of habitat diversity were sampled along each of the three transects for a total of nine samples. Each of these was combined into a single composite sample. The composite sample was transferred into a 1/2 gallon wide-mouth plastic jar containing approximately 300 ml of 95% ethanol. Chain of Custody (COC) sheets were completed for samples as each station was completed.

Physical/Habitat Quality Assessment, Water Quality and Chemical Measurements

Physical habitat quality was assessed for the monitoring reaches using U.S. Environmental Protection Agency (EPA) Rapid Bioassessment Protocols (RBPs) (Barbour et al. 1999). The team collected the physical/habitat measurements at each station and recorded the information on the CBW. These measurements are summarized as follows:

1. Water temperature, specific conductance and dissolved oxygen were measured using a hand held YSI 85 and pH with a Beckman 255 water quality meters. Both were pre-calibrated in the laboratory.
2. Riffle length, width and depth in meters were recorded. Width measures were averages taken at each transect and depth measures were averages taken along each transect.
3. A hand held Marsh McBirney Flowmate 2000 velocity meter was used to measure current velocity. Three measures were collected along each transect and then averaged together. Flow was calculated using the cross sectional flow measurement method.
4. A densitometer was used to measure % canopy cover.
5. Substrate complexity, embeddedness, consolidation and categories (fines, gravel, cobble, boulder, and bedrock) were estimated using the CSBP Physical/Habitat Quality Form.

(Measurements for canopy cover and streambed substrates were not collected during the 2006 survey. As a result, the data from the 2005 survey were used instead.)

6. Stream gradient was estimated using a survey rod and hand level.
7. Nutrient samples for nitrate and nitrite nitrogen, and phosphate phosphorus were collected by the Ojai Valley Sanitation District laboratory and analyzed by Fruit Growers Laboratories in Santa Paula, CA.

8. Aquatic Bioassay and Consulting Laboratories analyzed all bacterial samples. Samples were collected in sterile 250 mL plastic containers and analyzed according to *Standard Methods for the Examination of Water and Wastewater*, APHA, 19th Edition, methods 9223.

Sample Analysis/Taxonomic Identification of Benthic Macroinvertebrates (BMIs)

Sample sorting and taxonomy were conducted by Aquatic Bioassay and Consulting Laboratories. Sorting was conducted in the Aquatic Bioassay laboratory in Ventura, CA and taxonomic identifications were conducted by Dr. Kim Kratz in Lake Oswego, OR. Identifications were made using standard taxonomic keys (Literature Cited, Taxonomic References). In most cases taxa for this study were identified to the species level. In adherence with Taxonomic Effort Level 1 specified in the CSBP, identifications were rolled up to the appropriate taxonomic level for the calculation of biological metrics and the Southern California IBI. Samples entering the lab were processed as follows:

A maximum number of 500 organisms were sub-sampled from the composite sample using a divided tray, and then sorted into major taxonomic groups. All remnants were stored for future reference. The 500 organisms were identified to the genus level for most insects and order or class for non-insects. As new species to the survey area were identified, examples of each were added to the voucher collection. The voucher collection includes at least one individual of each species collected and ensures that naming conventions can be maintained and changed as necessary into the future.

The taxonomic quality control (QC) procedures followed for this survey included:

- Sorting efficiencies were checked on all samples. The leftover material from each sample was inspected by the laboratory supervisor. Minimum required sorting efficiency was 95%, i.e. no more than 5% of the total number of organisms sorted from the grids could be left in the remnants. Sorting efficiency results were documented on each station's sample tracking sheet.
- Once identification work was completed, 10% of all samples were sent to the Department of Fish and Game (DF&G) offices in Rancho Cordova for a QC check. Samples were sorted by species into individual vials that included an internal label. Any discrepancies in counts or identification found by the DF&G taxonomists were discussed, and then resolved. All data sheets were corrected and, when necessary, bioassessment metrics were updated.

Data Development and Analysis

Multi-metric Analysis

After species were identified, they were into an Access data base that automatically calculated all of the bioassessment metrics used to assess the BMI community and to calculate the southern California IBI (Ode 2005). The following metrics were calculated and their responses to impaired conditions are listed in Table 2:

1. Richness measures: taxa richness, cumulative taxa, EPT taxa, cumulative EPT taxa, Coleopteran taxa.
2. Composition measures: EPT index, sensitive EPT index, Shannon diversity.
3. Tolerance/intolerance measures: mean tolerance value, intolerant organisms (%), tolerant organisms (%), dominant taxa (%), Chironomidae (%), non-insect taxa (%).
4. Functional feeding group: collectors (%) & filterers (%), grazers (%), predators (%), shredders (%).

Table 2. Bioassessment metrics used to describe characteristics of the BMI community.

BMI Metric	Description	Response to Impairment
Richness Measures		
Taxa Richness	Total number of individual taxa	decrease
EPT Taxa	Number of taxa in the Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) insect orders	decrease
Ephemeroptera Taxa	Number of taxa in the insect order Ephemeroptera (mayflies)	decrease
Plecoptera Taxa	Number of taxa in the insect order Plecoptera (stoneflies)	decrease
Trichoptera Taxa	Number of taxa in the insect order Trichoptera (caddisflies)	decrease
Composition Measures		
EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae	decrease
Sensitive EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae with tolerance values between 0 and 3	decrease
Shannon Diversity	General measure of sample diversity that incorporates richness and evenness (Shannon and Weaver 1963)	decrease
Tolerance / Intolerance Measures		
Tolerance Value	Value between 0 and 10 weighted for abundance of individuals designated as pollution tolerant (higher values) or intolerant (lower values)	increase
Percent Intolerant Organisms	Percent of organisms in sample that are highly intolerant to impairment as indicated by a tolerance value of 0, 1 or 2	decrease
Percent Tolerant Organisms	Percent of organisms in sample that are highly tolerant to impairment as indicated by a tolerance value of 8, 9 or 10	increase
Percent Dominant Taxa	Percent composition of the single most abundant taxon	increase
Percent Hydropsychidae	Percent of organisms in the caddisfly family Hydropsychidae	increase
Percent Baetidae	Percent of organisms in the mayfly family Baetidae	increase
Functional Feeding Groups (FFG)		
Percent Collectors	Percent of macrobenthos that collect or gather fine particulate matter	increase
Percent Filterers	Percent of macrobenthos that filter fine particulate matter	increase
Percent Grazers	Percent of macrobenthos that graze upon periphyton	variable
Percent Predators	Percent of macrobenthos that feed on other organisms	variable
Percent Shredders	Percent of macrobenthos that shreds coarse particulate matter	decrease
Estimated Abundance	Estimated number of BMIs in sample calculated by extrapolating from the proportion of organisms counted in the subsample	variable

Southern California IBI

The seven biological metric values used to compute the Southern California Index of Biological Integrity (So CA IBI) are presented in Table 3 (Ode et al. 2005). The So CA IBI is based on the calculation of biological metrics from a group of 500 organisms sub sampled from a composite sample. The sampling design for the Ventura River Watershed prior to the 2006 survey (2001 through 2005) included a total of 900 organisms per reach (three replicate samples, 300 organisms each). As a result, before historical comparisons could be made using the So CA IBI, the 2001 to 2005 taxa abundance lists were reduced to 500 individual organisms using Monte Carlo randomization. These 500 organisms were used to compute the seven biological metrics used in the IBI computation. Ode et. al. (2005) showed that this adjustment does not affect the outcome of the IBI.

Table 3. Scoring ranges for the seven metrics included in the Southern California IBI and the cumulative IBI score ranks.

Metric Scoring Ranges for the Southern California IBI

Metric Score	Coleoptera Taxa	EPT Taxa		Predator Taxa	% Collector Individuals		% Intolerant Individuals		% Non-Insect Taxa	% Tolerant Taxa
	All Sites	6	8	All Sites	6	8	6	8	All Sites	All Sites
10	>5	>17	>18	>12	0-59	0-39	25-100	42-100	0-8	0-4
9		16-17	17-18	12	60-63	40-46	23-24	37-41	9-12	5-8
8	5	15	16	11	64-67	47-52	21-22	32-36	13-17	9-12
7	4	13-14	14-15	10	68-71	53-58	19-20	27-31	18-21	13-16
6		11-12	13	9	72-75	59-64	16-18	23-26	22-25	17-19
5	3	9-10	11-12	8	76-80	65-70	13-15	19-22	26-29	20-22
4	2	7-8	10	7	81-84	71-76	10-12	14-18	30-34	23-25
3		5-6	8-9	6	85-88	77-82	7-9	10-13	35-38	26-29
2	1	4	7	5	89-92	83-88	4-6	6-9	39-42	30-33
1		2-3	5-6	4	93-96	89-94	1-3	2-5	43-46	34-37
0	0	0-1	0-4	0-3	97-100	95-100	0	0-1	47-100	38-100

Cumulative IBI Scores

Very Poor	Poor	Fair	Good	Very Good
0-19	20-39	40-59	60-79	80-100

Historical Analysis

Historical IBI Scores

The average (± 95% CI) So CA IBI was calculated for each station from 2001 through 2006 and presented graphically with stations ordered from the lower to upper watershed.

Cluster analysis was used to define groups of samples, based on species presence, abundance and year. Identified clusters were then evaluated to define the habitat and year to which they belonged. In cluster analysis, samples with the greatest similarity are grouped first. Additional samples with decreasing similarity are then progressively added to the groups. The percentage dissimilarity (Bray-Curtis) metric (Gauch, 1982; Jongman et al., 1995) was used to calculate the distances between all pairs of samples. The cluster dendrogram was formed using the un-weighted pair-groups method using arithmetic averages (UPGMA) clustering algorithm (Sneath and Sokal, 1973). All steps were completed using the Ecological Analysis Package (EAP, Smith 1982 and 1984). Only the most commonly occurring species were used in the analysis, in this case only those that occurred at more than one station and season. The abundances of all species of Chironomidae were rolled up into a single abundance value by site to correct for differences in taxonomic resolution during the six year period. Clusters that were created for station and species groups were merged into a single two-way table depicting the most frequently collected species by station.

Ordination analysis displays the sampling stations as points in a multidimensional space and was used to graphically display how stations in the watershed varied along environmental gradients. The distance between the stations (points) in the space is proportional to the dissimilarity of the communities found at the respective stations. The different dimensions of the ordination space, called axes, define independent gradients of biological change in the community data. The projections of the station points onto the various axes are called scores. The axes are ordered so that the first axis displays a maximal amount of the community change; the second axis defines a maximal amount of the remaining community change, and so on for subsequent axes. Often most of the relevant community changes are displayed in a few ordination axes.

RESULTS

Rainfall

Rainfall measured at the Stewart Creek gauging station during the 2005 to 2006 rain year (23.44 inches) was slightly above normal (21.2 inches) (Figure 3). Typical of southern California, little to no rain fell between June and September. In normal rainfall years many reaches in the Ventura River Watershed are dry during September when sampling for BMI's is conducted. As a result of the unusually large amount of rain that fell during the 2004 to 2005 rain year (43 inches), followed by the 2005 to 2006 year, all BMI sampling locations (except Station 6 on the Ventura River main stem) had flow. Station 6 is chronically dry due to sub-surface flow, as well as ground water pumping and diversion upstream of the site.

Physical Habitat Characteristics

Velocity and Flow

The physical characteristics of the riffles sampled in the Ventura River Watershed during September 2006 are presented in Table 4. Riffle velocities ranged from 0.51 ft/sec at Stations 3 (Canada Larga Creek) to 2.16 ft/sec at Station 12 below Matilija Dam on the Ventura River. Flow in the watershed was greatest at Stations 0 and 4 (12.4 and 12.3 cfs, respectively) on the Ventura River. Lowest flows were measured at Station 7 (0.06 cfs) in Lion Canyon Creek.

Canopy Cover and Substrates

Vegetative canopy cover ranged from 0% at Stations 4 (Foster Park), 7 (Lion Canyon Creek), 13 and 14 (Matilija Creek) to 100% at Stewart Canyon Creek (Station 8) (Table 4). Substrate complexity was relatively good at most stations in the watershed ranging from poorest (2) at Station 2 (Canada Larga Creek) to best (19) at Station 15 (Lion Canyon Creek). Other sites with low complexity scores included Station 0 (Main Street Bridge), Station 3 (Canada Larga Creek), Station 5 (San Antonio at Ventura River confluence), Station 7 (lower Lion Canyon Creek) and Station 9 on the upper San Antonio Creek. Streambed substrates in the most of the watershed were, for the most part, composed of low percentages of fines and gravel and greater percentages of cobble and boulders. The exceptions to this were Stations 0 (Main St. Bridge), 2 and 3 (Canada Larga Creek) where fines and sand predominated. All of the sites were high gradient streams (≥ 2%), except Stations 0, 2 and 5 (all <2%).

Water Quality, Nutrients & Bacteria

The range for pH measurements was narrow among all sites and ranged from 7.73 at Station 9 (Stewart Canyon Creek) to 8.74 at Station 0 (Table 4). Dissolved oxygen concentrations ranged from 5.01 mg/L at Station 8 to 12.66 mg/L at Station 0. Dissolved oxygen concentrations can vary widely at the same site throughout the day due to changes in water temperature and, based on the amount of available sunlight, the photosynthetic rate of oxygen producing algae. Water temperatures were typical of summer conditions and ranged from 15.4 °C on Canada Larga Creek to 27.4 °C on lower Canada Creek (Stations 2). Specific conductance was lowest at upper watershed sites 10, 11, 13 and 14, at Foster Park (Station 4) and below the Matilija Dam (Station 12) (range = 775 to 882 uS/cm). The greatest conductance was measured at Station 2 in Lower Canada Larga Creek (2576 uS/cm).

Nitrate nitrogen was greatest at Stations 9 (4.9 mg/L) and was lower or below detection (0.1 mg/L) at all other sites. Nitrite nitrogen and phosphate phosphorus were below detection at all sites.

Indicator bacteria concentrations were moderately high at several sites in the watershed. Total coliform bacteria concentrations were greatest at Station 8 (8,164 MPN/100 mL) and lowest at Station 14 above the community on Matilija Creek (771 MPN/100 mL). E.coli concentrations were greatest at Stations 3 (354 MPN/100 mL) and 7 (369 MPN/100mL), and were below detection (<10 MPN/100 mL) at Stations 9, 11 and 13. Enterococcus bacteria concentrations exceeded REC1 standards (104 MPN/100mL) at Stations 3, 5, 7, 8 and 9.

Physical/Habitat Scores

Assessment of the physical/habitat conditions of a stream reach is necessary for two reasons: one is to assess the overall quality of a stream reach and another is to assess the physical/habitat of the bioassessment site. In many cases organisms may not be exposed to chemical contaminants, yet their populations indicate that impairment has occurred. These population shifts can be due to degradation of the streambed and bank habitats. Excess sediment, caused by bank erosion due to human activities, is the leading pollutant in streams and rivers of the United States (Harrington and Born 2000). Sediments fill pools and interstitial areas of the stream substrate where fish spawn and invertebrates live, causing their populations to decline or to be altered. Physical/habitat characterization of the site is also important to help ensure that habitats are uniform between riffles so that population differences can be accurately assessed.

Out of a total possible score of 200, physical/habitat scores ranged from worst (39) at Station 2 on Canada Larga Creek to 177 at Station 12 below the Matilija Dam (Table 4, Figure 4). Physical habitat scores increased from downstream to upstream on the main stem of the Ventura River from Station 0 (99) to Station 12 (177) located just below the Matilija Dam. The reduction in habitat quality from Station 12 to 0 was due mostly to a reduction in streambed complexity owing to increased sediment deposition, channel alteration and decreased bank stability. Station 12 is composed mostly of boulders and cobble, and is well vegetated along its entire reach. Station 4 is located upstream of a bridge and has levees that line both banks. Station 0 is also located above a bridge and has levees on both banks, but also is impacted by a large transient population.

Conditions on Canada Larga Creek were better above the grazing zone at Station 3 (95) than near the confluence of the Ventura River at Station 2 (39). This was due mostly to better instream cover, less channel alteration, a higher frequency of riffles and a large riparian zone at Station 3.

Each of the San Antonio Creek sites scored over 100, with the best habitat found at Station 15 and Station 8. Stations 5 and 9 both lacked good instream cover and depth/velocity regimes, and were more embedded than other sites on the San Antonio. Station 7 was heavily eroded and scored low for vegetative protection, bank stability and width of the riparian zone.

The best habitat scores were measured at Stations 13 and 14 on the main stem of Matilija Creek and Stations 10 and 11 on the North Fork of Matilija Creek. These sites all were composed of a mixture of boulder, cobble and gravel, had little sediment deposition and good vegetative cover.

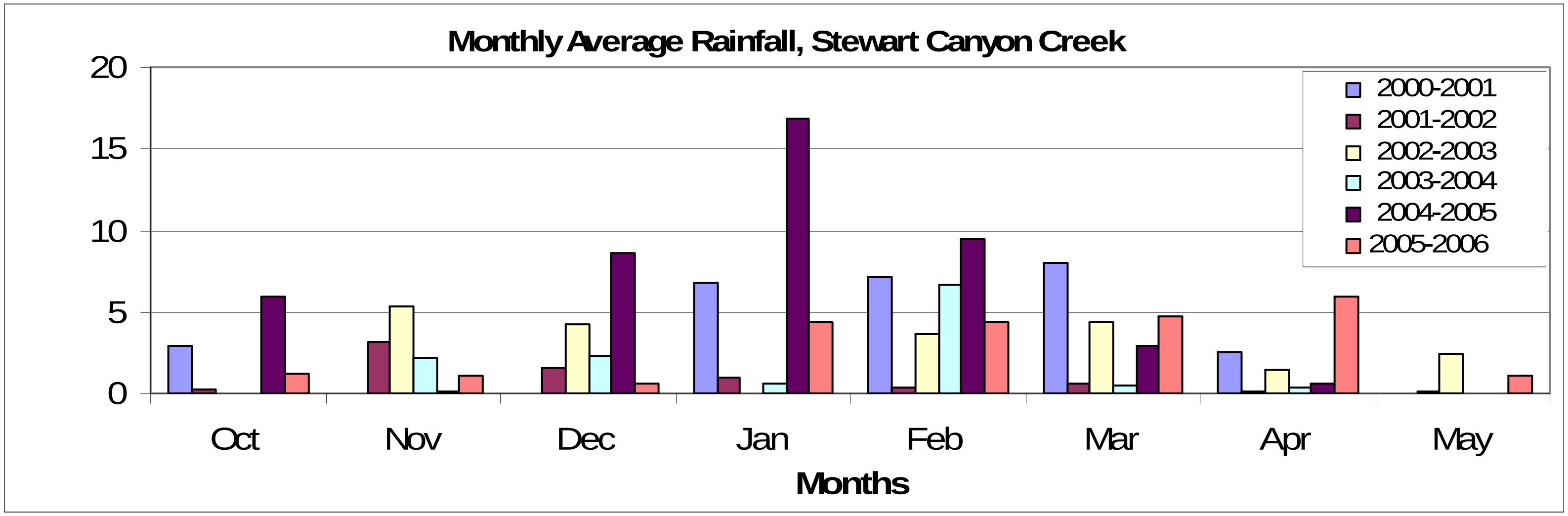


Figure 3. Monthly average rainfall (inches) at Stewart Canyon Creek for the 2000-2001 through 2005-2006 rain years (wet weather months only).

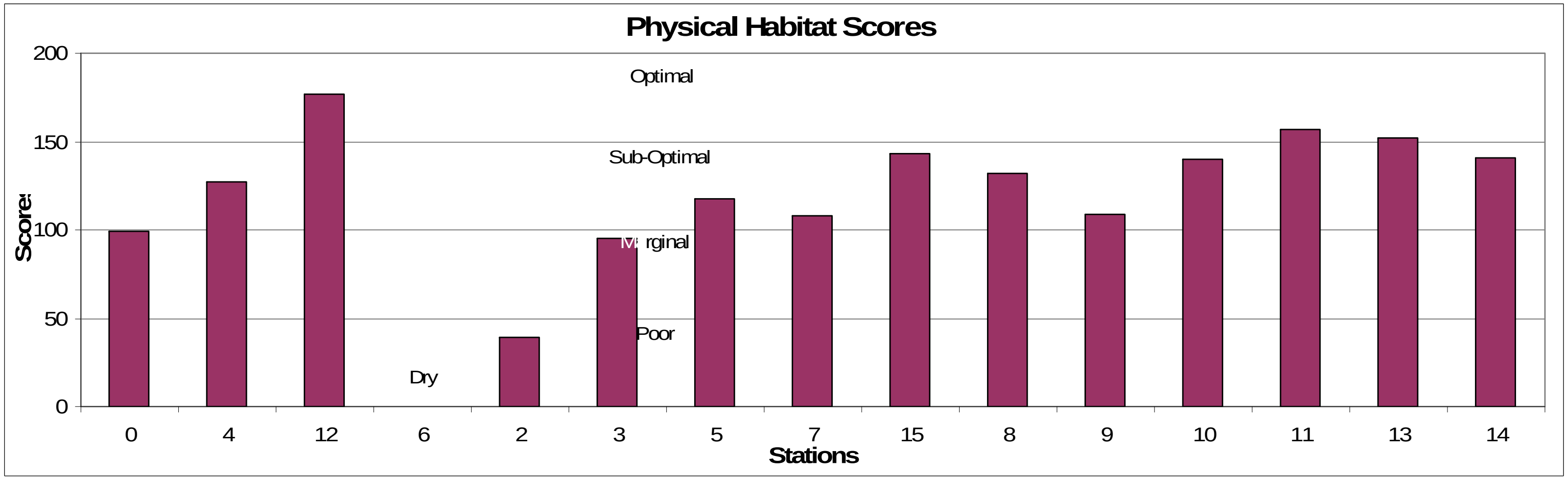


Figure 4. Physical habitat scores for reaches in the Ventura River Watershed.

Table 4. Physical habitat scores and characteristics for reaches in the Ventura River Watershed (CADFG 2003).

	Ventura River				Canada Larga		San Antonio Creek					North Fork Matilija Creek		Matilija Creek	
	Main Street Bridge	Foster Park	Below Matilija Dam	@Santa Ana Rd.	Below Grazing	Above Grazing	u/s Ventura River Confluence	Lion Canyon u/s San Antonio	u/s Lion Canyon	Stewart Canyon u/s San Antonio	u/s Stewart Canyon Creek	u/s Ventura River Confluence	At gauging station	Below community	Above Community
Station	0	4	12	6 Dry	2	3	5	7	15	8	9	10	11	13	14
Physical Habitat Parameter															
1. Instream Cover	7	12	17		2	10	9	5	19	15	7	14	16	14	12
2. Embeddedness	12	8	16		8	4	11	17	17	11	8	15	13	16	16
3. Velocity/Depth Regime	12	15	19		8	10	9	14	19	13	9	19	17	15	9
4. Sediment Deposition	7	11	16		2	5	11	16	15	17	14	12	13	17	16
5. Channel Flow	8	9	19		5	8	10	6	11	12	12	15	14	10	9
6. Channel Alteration	12	10	19		2	19	12	17	19	10	18	13	18	16	18
7. Riffle Frequency	16	19	18		2	15	16	19	19	16	9	18	18	16	19
8. Bank Stability	9	18	18		3	0	17	4	5	17	9	16	16	18	17
9. Vegetative Protection	9	7	18		2	9	10	1	10	10	9	10	18	13	8
10. Riparian Vegetative Zone Width	7	18	17		5	15	13	9	9	11	14	8	14	17	17
Reach Total	99	127	177		39	95	118	108	143	132	109	140	157	152	141
Physical Habitat Characteristics															
Average Riffle Length (ft)	150*	27	3		43	37*	12	9	7	18	26	7	17	3	3
Average Riffle Width (ft)	1.8	1.4	1.5		1.4	0.9	1.3	0.9	1.4	1.0	1.9	1.2	1.1	2.4	2.2
Average Riffle Depth (in)	7	5	26		3	2	4	2	5	3	13	5	5	9	6
Average Riffle Velocity (ft/sec)	1.34	1.99	2.16		0.75	0.51	1.63	0.75	2.09	1.03	1.64	2.01	2.00	1.96	1.38
Flow (cf/sec)	12.40	12.32	4.69		0.45	0.38	2.23	0.06	3.46	0.30	3.48	0.92	2.54	7.80	4.34
Vegetative Canopy Cover (%)	10*	0*	24*		1*	26*	53*	0*	59*	100*	39*	36*	59*	0*	0*
Average Substrate Complexity	7	12	17		2	6	9	5	19	15	7	14	16	14	12
Average Embeddedness	12	8	16		8	4	11	17	17	11	8	15	13	16	15
Substrate Composition (%)															
Fines (<0.1 in.)	25	5	5		40	32	10	5	10	8	7	5	5	5	5
Gravel ((0.1 -2 in.)	25	5	5		23	27	20	0	30	8	7	5	5	5	25
Cobble (2-10 in)	22	10	10		27	23	50	0	30	14	42	10	30	20	40
Boulder (>10 in.)	20	75	80		10	10	20	10	30	47	15	80	60	70	30
Bedrock (solid)	7	5	0		0	8	0	85	0	23	30	0	0	0	0
Substrate Consolidation	Moderate	Moderate	High		Moderate	High	Low	High	Moderate	Moderate*	Moderate	High*	Moderate	High	High
Percent Gradient (%)	1.5*	2*	3*		1*	6*	1*	2*	4*	N/A*	N/A*	N/A*	4*	4*	2.5*

*Not recorded. Values are from 2005 data set.

Table 4. (continued)

	Ventura River				Canada Larga		San Antonio Creek					North Fork Matilija Creek		Matilija Creek	
	Main Street Bridge	Foster Park	Below Matilija Dam	@Santa Ana Rd.	Below Grazing	Above Grazing	u/s Ventura River Confluence	Lion Canyon u/s San Antonio	u/s Lion Canyon	Stewart Canyon u/s San Antonio	u/s Stewart Canyon Creek	u/s Ventura River Confluence	At gauging station	Below community	Above Community
Station	0	4	12	6 Dry	2	3	5	7	15	8	9	10	11	13	14
Chemical Characteristics															
pH	8.74	8.39	8.36		8.34	7.84	8.13	8.20	8.32	7.90	7.73	8.22	8.16	8.06	7.88
D.O (mg/L)	12.66	9.97	8.37		12.20	8.90	11.63	9.80	11.88	5.01	7.34	8.48	9.25	9.36	10.22
Water Temperature (C°)	22.2	21.6	24.2		27.4	15.4	19.5	19.5	18.9	16.8	18.4	20.8	18.9	18.92	16.5
Specific Conductance (µS/cm at 25EC)	1117	882	853		2576	2278	1098	1822	1141	1579	1061	803	793	788	775
Nitrate Nitrogen (mg/L)	0.2	0.1	ND		ND	ND	0.9	ND	3.9	1.6	4.9	ND	ND	ND	ND
Nitrite Nitrogen (mg/L)	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phosphate-Phosphorus (mg/L)	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indicator Bacteria															
Total Coliforms (MPN/100 mL)	4106	1956	3448		6488	6488	2359	2202	2098	8164	6131	2613	960	1126	771
E. coli (MPN/100 mL)	31	41	10		100	354	31	369	52	20	<10	10	<10	<10	20
Enterococcus (MPN/100 mL)	10	62	10		50	298	213	211	20	209	164	20	31	30	63

ND = non-detected, nitrate & nitrite <0.1 mg/L; phosphate <0.17

BMI Community Structure

The complete taxa list including raw abundances by site and replicate are presented in Appendix A, Table A-1. The ranked abundance of the top 10 species at each site is illustrated in Table 5. The biological metrics calculated for this survey were grouped into the four categories described in Table 3 and presented in Figures 5 through 8: richness measures, composition measures, tolerance/intolerance measures and functional feeding groups. The So CA IBI scores for each station are shown in Table 7 and illustrated in Figure 9. The biological metrics are presented for each site in Appendix A (Table A-2).

Species Composition

A combined total of 7,117 BMIs, represented by 100 taxa, were identified from the 14 replicate samples collected at the 14 sampling sites during the September 2006 survey (Appendix A, Table A-1). The estimated total abundance for all sites combined is 29,923 individuals (Figure 5 and Appendix A, Table A-1). The composition of the BMI communities collected at each of the sites in the Ventura River Watershed was very similar. By far the most abundant species collected in the Ventura River Watershed was the caddisfly, Hydropsyche sp. which was either the first or second most abundant species collected at all sites except Station 0 near the ocean (Table 6). Other species that were found in the top five species at most sites included baetid mayflies (*Baetis sp.*) and *Tricorythodes sp*., midges (Chironominae), true flies (Orthocladiinae, *Caloparyphus/Euparyphus sp*.) and black flies (*Simulium sp.*). Black flies were most prevalent in the upper watershed at Stations 10, 11, 13 and 14 on Matilija Creek and the North Fork of Matilija Creek.

Stoneflies, which are generally very intolerant to stressors, but were found in relatively high abundances at Station 3 in the upper Canada Larga Creek (Appendix A, Table A-1).

Biological Metrics

The biological metrics listed in Table 3, above, were calculated for this survey and are presented by group in Figures 5 through 8 and Appendix A, Table A-2.

Richness Measures: Taxa richness is a measure of the total number of species found at a site. This relatively simple index can provide much information about the integrity of the community. Few taxa at a site indicate that some species are being excluded, while a large number of species indicate a more healthy community. EPT taxa are the simultaneous count of all of the mayflies (Ephemeroptera), caddisflies (Trichoptera), and stoneflies (Plecoptera) present at a location. These families are generally sensitive to impairment and, when present, are usually indicative of a healthy community. Both Coleopteran and Predator taxa are included since they are used to calculate the So CA IBI.

Taxa richness ranged from 22 (Station 13, Matilija Creek) to 41 (Stations 7, Lion Canyon Creek) (Figure 5). EPT taxa were lowest at Station 12 and greatest at Stations 9 on Stewart Canyon Creek. The average numbers of Coleoptera taxa ranged from zero (Stewart Canyon Creek) to 5 (Station 14, Matilija Creek), while the average numbers of predator taxa ranged from 4 (Station 13) to 13 (Station 2). Average estimated abundances ranged from 8,308 at Station 4 at Foster Park to 634 at Station 8 on Stewart Canyon Creek.

Composition Measures: The percent EPT taxa, sensitive EPT, percent non-insects and the Shannon Diversity index are all measures of community composition. Species diversity indices are similar to numbers of species; however they contain an evenness component as well. For example, two samples may have the same numbers of species and the same numbers of individuals. However, one station may have most of its numbers concentrated into only a few species while a second station may have its numbers evenly distributed among its species. The diversity index would be higher for the latter station. Percent EPT taxa are the proportion of the abundance at a site that is comprised of mayflies, stoneflies and caddisflies. Percent Sensitive EPT taxa is similar except it includes only those EPT taxa whose tolerance values range from 0 to 3. These taxa are very sensitive to impairment and, when present, can be indicative of more natural conditions. Percent non-insect taxa are used in the calculation of the So CA IBI.

The average percentage of EPT ranged from 21% at Station 12 to 69% at Station 3 on Canada Larga Creek (Figure 6). The average percentage of Sensitive EPT taxa was lowest at sites in the lower watershed and were greatest at Stations 8 in Stewart Canyon Creek (10%) and 11 in Matilija Creek (12%). Shannon Diversity just exceeded 2.0 at all sites, except at Stations 12 and 13 (1.6 each). The average percentage of non-insect species was lowest in the upper watershed, ranging from 0.8% at Station 10 on the N. Fork of Matilija Creek to 28% at Stations 0 near the Main Street Bridge.

Tolerance Measures**:** The Southern California IBI uses both the percent intolerant and tolerant organisms to evaluate the overall sensitivity of organisms to pollution and habitat impairment. Each species is assigned a tolerance value from 0 (highly intolerant) to 10 (highly tolerant). The percent Intolerance Value for a site is calculated by multiplying the tolerance value of each species with a tolerance value ranging from 0 to 2, by its abundance, then dividing by the total abundance for the site. The percent Tolerant Value is similar except that only species with tolerance values ranging from 8 to 10 are included. A site with many tolerant organisms present is considered to be less pristine or more impacted by human disturbance than one that has few tolerant species. The tolerance values for each species were developed in different parts of the United States and can therefore be region specific. Also, different organisms can be tolerant to one type of disturbance, but highly sensitive to another. For example, an organism that is highly sensitive to sediment deposition may be very insensitive to organic pollution. With these drawbacks in mind, the Tolerance measures generally depict disturbances in a stream that, when coupled with other metrics, can provide good information regarding a stream reach.

Percent dominance reflects the proportion of the total abundance at a site represented by the most abundant species. For example, if 100 organisms are collected at a site and species A is the most abundant with 30 individuals, the percent dominance index score for the site is 30%. The benthic environment tends to be healthier when the dominance index is low, which indicates that more than just a few taxa make up the majority of the community.

The percent Hydropsychidae (caddisflies) and Baetidae (mayflies) present in a stream reach can indicate stressed habitat conditions when they are found in high abundance. They will not be present in highly polluted streams, but can be found in moderately polluted streams, especially when nutrients are high or there is a large amount of sedimentation.

Mean Tolerance Values were similar across sites and ranged from 4.8 at Station 3 to 6.4 at Station 2 (Figure 7). There were low percentages of intolerant organisms present at all sites, with the greatest percentage found at Station 11 (9.6%). The greatest percentage of tolerant organisms were found at Station 2 (45%). Percent Dominance was greatest at Stations 12 and 13 (>50% respectively) and least at Station 9 (26%). Hydropsychid caddisflies were abundant, exceeding 40% of the population at Stations 3, 5, 15 and 10. Baetid mayflies accounted for less than 10% of the population at all sites except Stations 9, 13 and 14.

Functional Feeding Groups**:** These indices provide information regarding the balance of feeding strategies represented in an aquatic assemblage. The combined feeding strategies of the organisms in a reach provide information regarding the form and transfer of energy in the habitat. When the feeding strategy of a stream system is out of balance it can be inferred that the habitat is stressed. For the purposes of this study, species were grouped by feeding strategy as percent collector-gatherers, collector-filterers, grazers, predators and shredders. The Southern California IBI uses the numbers of predators and percent collectors (gatherers + filterers) at a site to calculate the index.

Collecting and filtering were the predominant feeding strategies used by organisms in the watershed (Figure 8). Collectors were greatest at lower watershed Stations 0, 4, 2 and 9, and least at Stations 12 and 5. The percentage of filterers was lowest in the lower watershed and ranged from 4% at Station 0 to 73% at Station 12. Predators ranged from 1% at Station 13 to 21% at Station 8. Grazers and shredders accounted for less than 10% of the population at most sites in the watershed.

IBI Scores

The IBI is a multi-metric technique that employs seven biological metrics that were each found to respond to a habitat and/or water quality impairment. Each of the seven biological metrics measured at a site are converted to an IBI score then summed. These cumulative scores can then be ranked according to very good (80-100), good (60-79), fair (40-59), poor (20-39) and very poor (0-19) habitat conditions. The threshold limit for this scoring index is 39. Despite the fact that rankings can be identified as "fair", sites with scores above 39 are within two standard deviations of the mean reference site conditions in southern California and are not considered to be impaired. Sites with scores below 39 are considered to have impaired conditions. The metric scoring ranges established for the Southern California IBI survey are listed in Table 3 and were used to classify the Ventura River Watershed sites for the 2006 survey.

Nine Ventura River Watershed sites had IBI scores in the "fair" range (40-59) for the 2006 survey (Table 7, Figure 9). Stations 0 (Main Street Bridge), 4 (Ventura River at Foster Park), 2 (Canada Larga) and 15 (Lion Canyon Creek) scored below 39, which is in the "poor" or impaired range. Station 14, located above the community on Matilija Creek was the only site to score in the "good" range. Scores tended to increase from the lower to the upper portion of each system. IBI scores on the Ventura River increased from lowest at Stations 0 and 4 to greatest at Station 12. On Canada Larga Creek the IBI score increased from downstream Station 2 to upstream Station 3. San Antonio Creek (Stations 7, 15, 8 and 9) IBI scores were similar across sites and lowest at Station 15 which is located downstream of stables. IBI scores downstream of the community on Matilija Creek (Station 13) and the rock quarry on the N. Fork of the Matilija Creek (Station 10) were slightly lower than the upstream station (Stations 14 and 11, respectively). This may indicate that the community and quarry are influencing the BMI communities on these reaches.

Historical Results (2001 to 2006)

Physical habitat and IBI scores for the first six years of the Ventura River Watershed BMI monitoring program were combined and are presented graphically by site in Figures 10 and 11.

6 Year Physical Habitat Scores

The best habitat conditions during the five year period were measured at Station 12 below the Matilija Dam and worst occurred on Canada Larga Creek above its confluence with the main stem of the Ventura River (Figure 10). Physical habitat scores increased as elevation in the watershed increased, becoming progressively greater on the Ventura River main stem from Station 0 near the ocean to Station 12 below Matilija Dam and from Canada Larga Creek (Stations 2 and 3) to the North Fork of the Matilija Creek (Stations 10 to 14). The greatest variation in physical/habitat scores during the five year period were found at Stations 0 and 2. Station 0 is located just above the confluence of the Ventura River with the ocean and Station 2 is located just above the confluence of Canada Larga Creek with the Ventura River in the lower watershed. The habitats at each of these sites are strongly influenced by the severity of the storm season preceding sampling. During large storms the stream beds are scoured of vegetation and up stream sediments are deposited which decreases the amount of instream cover present for BMI's. During relatively mild storm seasons the vegetative and instream cover at these sites remains unchanged. In contrast, the upper watershed (Station 12, 10, 11, 12 and 13) are characterized as much more stable owing to a streambed composed mostly of boulder, cobble and gravel, with banks that are, for the most part, covered with dense stands of vegetation.

6 Year IBI Scores

During the six year period from 2001 to 2006 the average IBI scores for all sites, except Stations 0, 1 and 2 were in the fair or good range (Figure 11). The average scores for Stations 0, 1 (above the Main Street Bridge) and 2 (Canada Larga Creek), were slightly below the impairment threshold (39). IBI scores increased with elevation on the Ventura River, Canada Larga Creek (Stations 2 and 3) and San Antonio Creek (Stations 7, 15, 8 and 9). The greatest average IBI score during the five year period was at Station 11 on North Fork of the Matilija.

6 Year Cluster and Ordination Analysis

Spatial and temporal patterns in the BMI community data from 2001 to 2006 were investigated using cluster and ordination analyses. Both of these are based on the Bray-Curtis dissimilarities for pairs of stations. The results of the cluster and ordination analyses are summarized in Figures 12 to 13. Station and species dendrograms are presented in Appendix B, Figures B-1 and B-2. The two-way coincidence table (Figure 12) presents a summary of species abundances in each station and species cluster group. Symbols in the table represent transformed, standardized abundance values. Community analyses used a trimmed species list. Rare species and generic taxa containing multiple species were eliminated from analysis. Remaining taxa were trimmed to those which occur at a minimum of four stations. A total of 88, representing 99% of the species were used in the ordination and cluster analyses.

Cluster Analysis

Seven station cluster groups and eight species cluster groups were identified based on Bray-Curtis dissimilarities and ordination space distances (Figure 12). The station cluster groups were delineated spatially by their location in either the lower or upper watershed and temporally by whether they were sampled before or after the 2005 rain events. The greatest dissimilarities between station groups occurred between station groups 1 thru 4 and groups 5 thru 7 (Appendix B, Figure B-1). For the most part, station groups 1 through 4 were represented by samples taken prior to 2005 in the lower watershed, except for Station 11 located on the North Fork of Matilija Creek. Station group 5 in the lower watershed and 7 in the upper watershed was represented by sites sampled in 2005 and 2006. Station group 6 was represented by sites sampled prior to 2005, but included only sites in the upper watershed and Station 12 below Matilija Dam.

Species groups A, B, C and D were composed of species that were relatively abundant from 2001 to 2004 at sites in the lower watershed (except for Station 11). Many of these species have tolerance values ranging from 5 to 8 (e.g. the seed shrimp Cyprididae, the crustacean *Hyalella sp.*, the gastropods *Pisidium sp.* and *Fossaria sp.*) indicating the ability to survive in stressful conditions. Others, including *Heliopsyche sp* and *Psephenus falli* which were relatively abundant at Station 11 in the upper watershed, are mainly found when water quality and habitat conditions are good.

Species group E was represented by a ubiquitous assemblage of species that were relatively abundant in both the upper and lower watershed regardless of year indicating that these species were not heavily affected by the storms of 2005. The species in this group had a wide range of tolerance values. Species group F was represented a group of organisms that became relatively abundant following the winter storms of 2005. Several of these were opportunistic species that are tolerant of disturbed conditions. The stonefly, *Malenka sp*., was the only species in group G. The only occurrences of this sensitive species were at Station 3 in the Upper Canada Larga Creek during the six year period. Species group H was represented by species that are very intolerant of disturbed conditions. This group was relatively abundant at the upper watershed sites during all years.

Ordination Analysis

Ordination analysis further distinguishes community patterns into three or more dimensions or axes. Each axis represents an environmental gradient that describes a portion of the variation that is driving the distribution of infauna in the survey area. Each station represents a point in the ordination space, and the previously discussed cluster groups are circled to illuminate the patterns (Figures 13 and 14).

Axis 1 explained 14% of the variation in community structure and seemed to separate stations by geographical location in the watershed (Figure 13). Station 1, located near the ocean (moved to current location at Station 0 in 2002) was composed of the most different assemblage during the six year period. Each of the other station groups aligned along axis 1 lower to upper watershed. Axis 2 explained 10% of the environmental variation and separated Station group 2 from the other groups probably due to the high relative abundance of the stonefly, Malkena sp., which was only found in very low numbers at upper watershed sites.

Discussion

During September 2006 teams from the Ventura River Watershed Protection District, Ojai Sanitation District and Aquatic Bioassay and Consulting Laboratories collected water quality and benthic macroinvertebrate (BMI) sampling at 15 sites in the Ventura River Watershed in fulfillment of the District's NPDES stormwater permit. All sampling was conducted following the California Stream Bioassessment protocols (CSBP 2003). All samples were successfully collected and analyzed, and results fell within acceptable QC guidelines for each parameter.

Rainfall during the 2005 to 2006 rain year (23.4 inches) was slightly above the annual average (21.2 inches). This was far less than the previous year (2004 to 2005) when 44.5 inches of rain fell, causing widespread flooding, erosion and sedimentation throughout the watershed. Rainfall amounts and intensity determine the extent of scouring, erosion and sedimentation in the watershed. These processes in turn play a key role in determining the habitat available for the BMI communities. This was especially true in the lower reaches of the watershed where the streambeds are composed more of fine sediments, gravel and cobble. This is in comparison to sites in the upper watershed where the streambeds are stabilized more by boulders. In normal rainfall years many reaches in the Ventura River Watershed are dry during September when sampling for BMI's is conducted. As a result of the unusually large amount of rain during the 2004 to 2005 rain year and normal amounts during the 2005 to 2006 rain year, all BMI sampling locations (except Station 6 on the Ventura River main stem) had significant flow during the 2006 survey.

Ventura River

The aquatic health of the Ventura River Watershed ranged from poor to good in 2006, based on the results of the southern California IBI. Stations 0 and 4 each scored in the poor range, indicating that the BMI communities found there were impaired. Station 0 is located just upstream of where the Ventura River discharges into the Pacific Ocean. During the previous six years the average IBI score at this site was also poor. The physical habitat score at this site was either suboptimal or optimal during the previous five years (2001 to 2004) as a result of the good instream cover, vegetative protection, bank stability, and low amounts sedimentation. The streambed and bank scouring, and the elimination much of the instream and vegetative cover caused by the heavy storms during the winter of 2005 had mostly recovered by the 2006 sampling event. The explanation for the low IBI scores are related to several factors including poor water quality, the a reinforced levee present on the east bank which protects the City of Ventura from flooding, the large transient human population that use the streambed for shelter and possibly the sites location 2.5 miles downstream of the Ojai Valley Sanitation Plant. This site supported no sensitive BMI species, but 27% of the population was dominated by the mayfly, *Tricorythodes sp*., which has a moderate tolerance value of 4 and oligochaete worms (16%) which are tolerant of disturbed conditions.

Stations located above the Main Street Bridge on the main stem of the Ventura River had physical habitat that improved with elevation in the watershed. Compared to Station 0, Station 4 at Foster Park had better instream cover, velocity depth regimes, bank stability and riparian zone width. Station 12 (below Matilija Dam) had the best physical habitat score of all sites in the watershed as a result of little sedimentation, stable banks, good instream habitat and flow. If physical habitat alone were driving the composition of the BMI communities at these sites, the IBI score should have increased accordingly. While there was an increase in IBI score from Station 0 to 12, the BMI communities at these sites were still in the impaired range. This indicates that some water quality stressor other than physical habitat conditions was affecting the BMI communities at these sites.

Canada Larga Creek

The Canada Larga Creek drainage is impacted by grazing in its lower reaches. As a result, the physical habitat scores are much lower at Station 2 located downstream of the grazing area when compared to Station 3, which is located above them. Station 3 had better instream habitat cover, riffle frequency, vegetation protection and riparian zone width, and less channel alteration compared to Station 2. The IBI scores reflected the habitat conditions found at each of these sites, with Station 2 scoring in the poor range and Station 3 scoring in the fair range. Station 3 was the only site where the stonefly, *Malenka sp*. (a species that is highly sensitive to disturbances), appeared as one of the top 10 most abundant species. In addition, a large school of the native Arroyo chub *(Gila orcuttii*), was observed at Station 3 indicating that relatively good fish habitat was present there.

San Antonio Creek

The three stations located on the main stem of San Antonio Creek (5, 15 and 9), and on its tributaries at Lion Canyon and Stewart Canyon Creeks (7 and 8, respectively), all scored in the sub-optimal range for physical habitat conditions. Each of these sites ranked in the fair range for the IBI score, except for Station 15 which scored in the poor range. Since Station 15 had the best physical habitat score due to the presence of good instream cover, low sediment deposition, embeddedness and channel alteration, the low IBI score indicates that some other disturbance was occurring. This could be due to the fact that this site has stables and grazing land in its vicinity.

The poorest physical habitat conditions were found at Station 7 on Lion Canyon Creek and San Antonio Creek (Station 9) upstream of Stewart Canyon Creek (Station 8). Station 7 on Lion Canyon Creek had extremely low flow during the survey and offered little instream cover, vegetative protection or bank stability. Similar to Station 15, this site is located near stables and grazed land. Conversely, Station 8 located on Stewart Canyon Creek and drains the streets and agricultural land surrounding downtown Ojai. Surprisingly, this site had a relatively high IBI score (fair range). However, the physical habitat conditions at this site were reasonably good and included decent instream cover, little sediment deposition and good bank stability.

Station 5 was characterized by poor instream cover, velocity/depth regimes, channel flow and vegetative protection, along with high sediment deposition and embeddedness. Station 9, located upstream of the confluence with Stewart Canyon Creek, had poor instream cover, vegetative cover and bank stability. In fact, the heavy erosion of the eastern bank caused by the winter storms of 2005 was still present so that it was a vertical 20 foot cliff, completely denuded of vegetation.

Matilija Creek

Four stations were located in the upper watershed: Stations 10 and 11 on the North Fork of Matilija Creek and Stations 13 and 14 located on Matilija Creek above Matilija Dam. Each of these sties had some of the best physical habitat conditions found in the watershed, with the exception of Stations 12. In general, these sites were composed of boulders and coble, had good instream cover, little sediment deposition and good vegetative and riparian cover. All of these sites are used by the public as recreational swimming areas, especially Stations 10 and 11. Station 10 is located below Station 11 and an active rock quarry. Station 13 is located downstream of a small residential community and Station 14 is located upstream. Stations 11 and 14 are located at the highest elevations in the watershed (over 1,300 ft) and had the best IBI scores (54 and 61, respectively) in the watershed, which were at the upper threshold of the fair range and good range, respectively. Both Stations 10 and 13 had slightly lower IBI scores (47 and 43, respectively) which might be due to the influence of the rock quarry and residential communities located upstream.

Historical Analysis

6 Year Physical Habitat and So CA IBI Scores

The best habitat conditions during the five year period were measured at Station 12 below the Matilija Dam and worst occurred on Canada Larga Creek (Station 2) above its confluence with the main stem of the Ventura River (Figure 10). Physical habitat scores increased as elevation in the watershed increased, becoming progressively greater on the Ventura River main stem from Station 0 near the ocean to Station 12 below Matilija Dam and from Canada Larga Creek (Stations 2 and 3) to the North Fork of the Matilija Creek (Stations 10 to 14). The greatest variation in physical/habitat scores during the five year period were found at Stations 0, 2 and 9. Station 0 is located just above the confluence of the Ventura River with the ocean and Station 2 is located just above the confluence of Canada Larga Creek with the Ventura River in the lower watershed. Station 9 is located on San Antonio Creek. The habitats at each of these sites were strongly influenced by the severity of the storm seasons preceding sampling. During the large storms of 2005 the stream beds and banks were scoured of vegetation and up stream sediments were deposited, decreasing the amount of instream cover that was present for BMI's. During relatively mild storm seasons the vegetative and instream cover at these sites remains unchanged. In contrast, the upper watershed (Station 12, 10, 11, 12 and 13) are characterized as much more stable owing to a streambed composed mostly of boulder, cobble and gravel, with banks that are, for the most part, covered with dense stands of vegetation.

During the six year period from 2001 to 2006 the average IBI scores for all sites, except Stations 0, 1 and 2 were in the fair to good range. The average scores for Stations 0 and 1 (each located above the Main Street Bridge) and Station 2 (Canada Larga Creek) were below the impairment threshold (39). IBI scores increased with elevation on the Ventura River, Canada Larga Creek (Stations 2 and 3) and San Antonio Creek (Stations 5, 7, 15, 8 and 9). The greatest average IBI score during the five year period was at Station 11 on North Fork of Matilija Creek.

6 Year Cluster and Ordination Scores

Seven station cluster groups and eight species cluster groups were identified based on cluster analysis. The station cluster groups were delineated spatially by their location in either the lower or upper watershed and temporally by whether they were sampled before or after the 2005 rain events. The greatest dissimilarities between station groups occurred between lower watershed stations sampled prior to 2005 and upper and lower watershed sites sampled in 2005 and 2006. This indicates that sites in the lower watershed, which are composed of more gravel and fine sediments, are probably more susceptible to the scouring that occurs following large storm events such as those that occurred during the winter of 2005. These habitat changes are generally less favorable to BMI species. In 2005 and 2006 a transitional group of more opportunistic species colonized the lower watershed sites. The upper watershed was less susceptible to scouring since the streambeds are composed of larger percentages of cobble and boulder. As a result, the community assemblages were not as affected by the 2005 storms.

Table 5. The top 10 species at each station in the Ventura River Watershed, ranked by % abundance, 2006.

0			4			12			2			3			5			7		
Species	% of Total Abund	Cumulative % Abund	Species	% of Total Abund	Cumulative % Abund	Species	% of Total Abund	Cumulative % Abund	Species	% of Total Abund	Cumulative % Abund	Species	% of Total Abund	Cumulative % Abund	Species	% of Total Abund	Cumulative % Abund	Species	% of Total Abund	Cumulative % Abund
Tricorythodes sp	27	27	Caloparyph/Euparyph	27	27	Simulium sp	59	59	Caloparyph/Euparyph	38	38	Hydropsyche sp	46	46	Hydropsyche sp	41	41	Hydropsyche sp	27	27
Ostracoda	16	43	Hydropsyche sp	10	37	Hydropsyche sp	11	70	Hydropsyche sp	14	52	Baetis sp	8	54	Sperchon sp	9	50	Caloparyph/Euparyph	16	43
Polypedilum sp	8	51	Tricorythodes sp	7	44	Baetis sp	9	79	Tanytarsus sp	7	59	Tricorythodes sp	7	61	Caloparyph/Euparyph	8	58	Thienemanniella sp	8	50
Fallceon quilleri	6	63	Thienemannimyia sp	7	50	Microcylloepus sp	5	84	Pseudochironomus sp	6	65	Sperchon sp	5	66	Simulium sp	6	64	Sperchon sp	7	57
Microcylloepus sp	6	57	Eukiefferiella sp	6	56	Eukiefferiella sp	3	87	Thienemannimyia sp	5	69	Caloparyph/Euparyph	4	70	Rheocricotopus sp	4	69	Eukiefferiella sp	6	63
Planariidae	6	69	Fallceon quilleri	6	67	Rheotanytarsus sp	3	90	Tricorythodes sp	5	74	Rheotanytarsus sp	4	73	Cheumatopsyche sp	4	72	Baetis sp	5	68
Sperchon sp	4	73	Rheocricotopus sp	6	61	Petrophila sp	2	92	Baetis sp	4	78	Oligochaeta	3	77	Planariidae	3	75	Cheumatopsyche sp	5	73
Hydropsyche sp	4	77	Ostracoda	5	72	Sperchon sp	1	93	Euparyphus sp	3	81	Eukiefferiella sp	3	80	Eukiefferiella sp	3	78	Cricotopus sp	4	76
Ochrotrichia sp	4	81	Planariidae	5	77	Cardiocladius sp	1	96	Ostracoda	3	84	Malenka sp	3	83	Microcylloepus sp	2	80	Tinodes sp	4	80
Baetis sp	3	84	Baetis sp	3	83	Ochrotrichia sp	1	95	Cheumatopsyche sp	2	87	Cheumatopsyche sp	2	85	Thienemannimyia sp	2	83	Tricorythodes sp	3	83

15			8			9			10			11			13			14		
Species	% of Total Abund	Cumulative % Abund	Species	% of Total Abund	Cumulative % Abund	Species	% of Total Abund	Cumulative % Abund	Species	% of Total Abund	Cumulative % Abund	Species	% of Total Abund	Cumulative % Abund	Species	% of Total Abund	Cumulative % Abund	Species	% of Total Abund	Cumulative % Abund
Hydropsyche sp	36	36	Hydropsyche sp	32	32	Tricorythodes sp	26	26	Hydropsyche sp	40	40	Hydropsyche sp	26	26	Simulium sp	51	51	Simulium sp	33	33
Caloparyph/Euparyph	19	54	Planariidae	8	40	Hydropsyche sp	20	46	Caloparyph/Euparyph	15	55	Simulium sp	24	50	Hydropsyche sp	18	69	Hydropsyche sp	31	63
Eukiefferiella sp	8	62	Sperchon sp	8	48	Caloparyph/Euparyph	11	57	Simulium sp	15	70	Baetis sp	8	58	Baetis sp	11	80	Baetis sp	9	72
Cheumatopsyche sp	5	67	Wormaldia sp	7	55	Fallceon quilleri	10	67	Microcylloepus sp	9	80	Micrasema sp	6	63	Microcylloepus sp	7	87	Eukiefferiella sp	5	77
Microcylloepus sp	5	77	Caloparyph/Euparyph	5	60	Rheocricotopus sp	5	72	Petrophila sp	5	85	Eukiefferiella sp	5	68	Eukiefferiella sp	4	92	Rheotanytarsus sp	4	81
Rheocricotopus sp	5	72	Simulium sp	5	65	Thienemannimyia sp	4	75	Baetis sp	5	89	Rheotanytarsus sp	5	73	Caloparyph/Euparyph	2	93	Epeorus sp	4	84
Planariidae	4	80	Ochrotrichia sp	4	69	Simulium sp	3	78	Eukiefferiella sp	2	91	Caloparyph/Euparyph	4	76	Oligochaeta	1	94	Caloparyph/Euparyph	1	87
Fallceon quilleri	4	84	Oligochaeta	4	73	Thienemanniella sp	2	81	Cricotopus sp	1	92	Hydroptila sp	3	79	Dasyhelea sp	1	95	Torrenticola sp	1	86
Ostracoda	3	87	Tinodes sp	3	76	Baetis sp	2	83	Euparyphus sp	1	93	Wormaldia sp	3	83	Epeorus sp	1	96	Euparyphus sp	1	89
Tricorythodes sp	2	89	Stenochironomus sp	3	80	Sperchon sp	2	85	Rheotanytarsus sp	1	94	Microcylloepus sp	3	85	Euparyphus sp	1	97	Fallceon quilleri	1	88

= Caloparyphus/Euparyphus sp

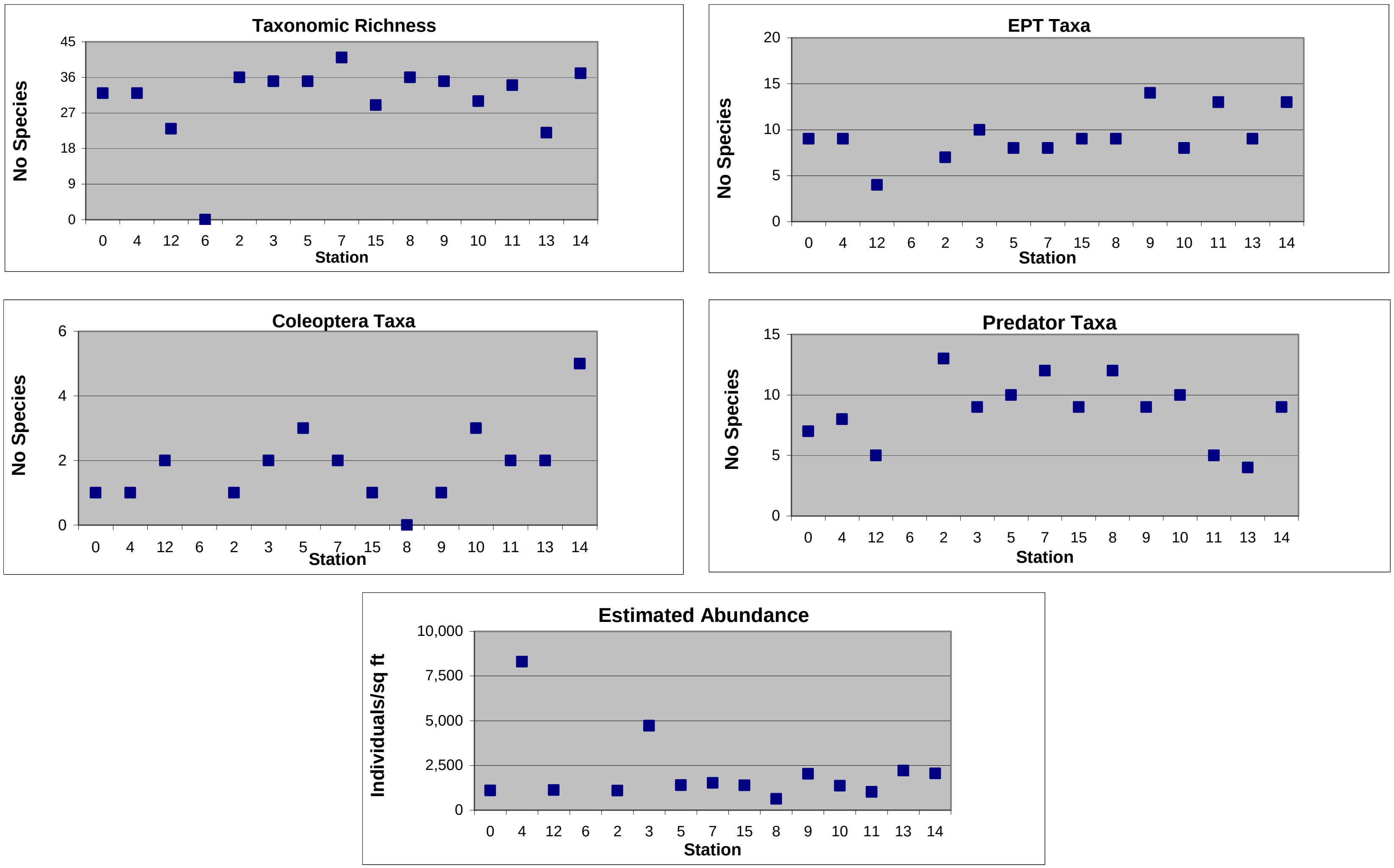


Figure 5. Richness measures: average (n=3) for each biological metric (± 95% CI) by site in the Ventura River Watershed, 2006.

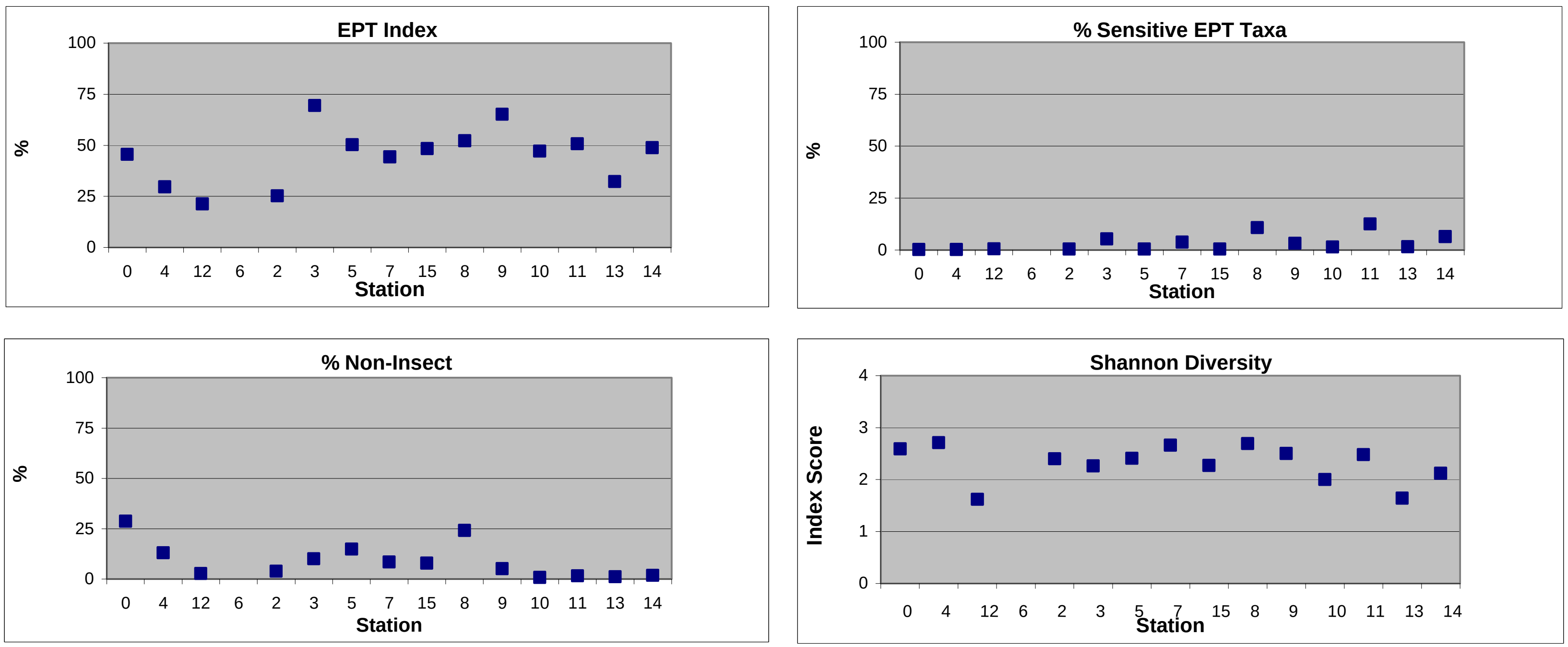


Figure 6. Composition measures: average (n=3) for each biological metric (± 95% CI) by site in the Ventura River Watershed, 2006.

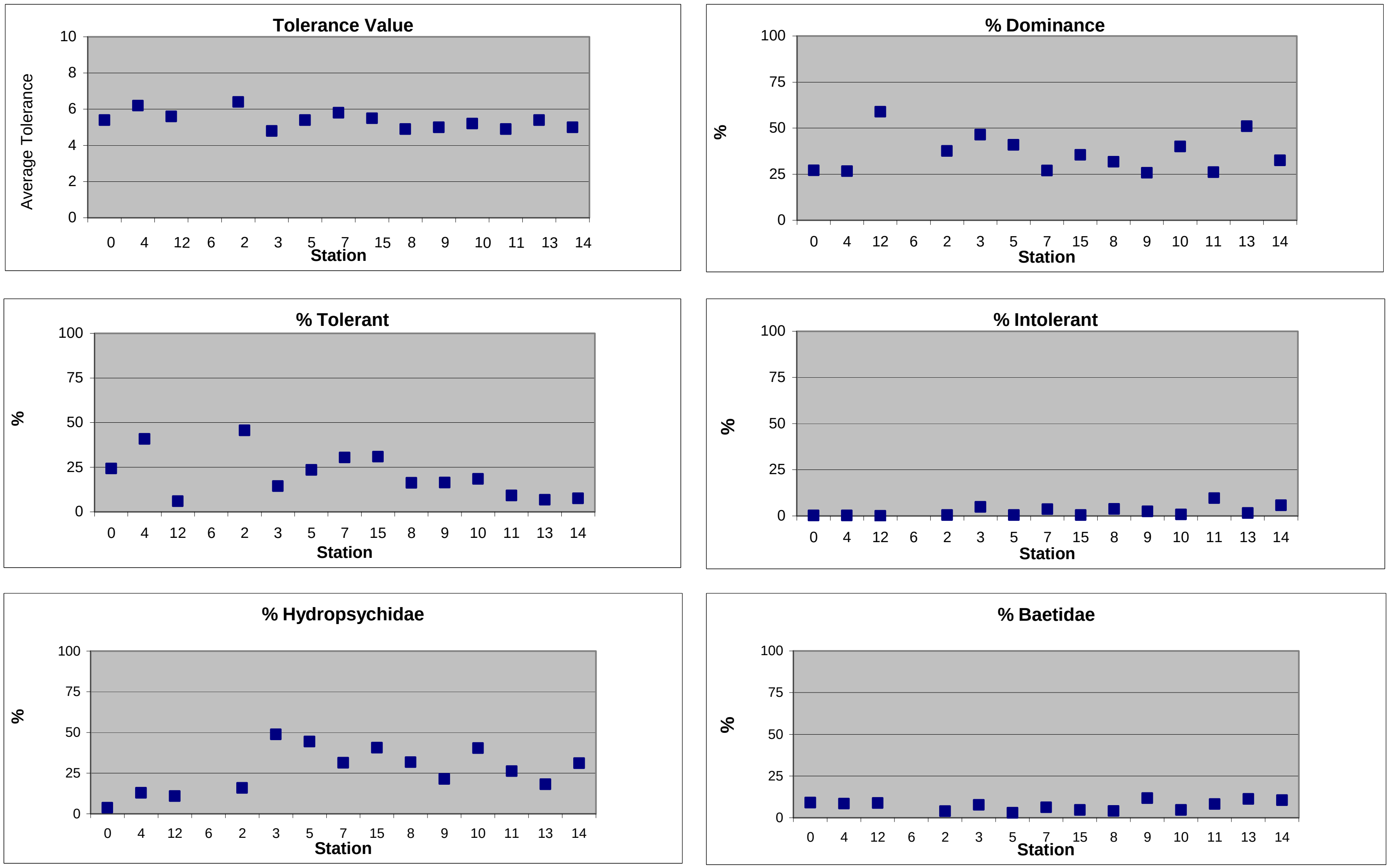


Figure 7. Tolerance/Intolerance measures: average (n=3) for each biological metric (± 95% CI) by site in the Ventura River Watershed, 2006.

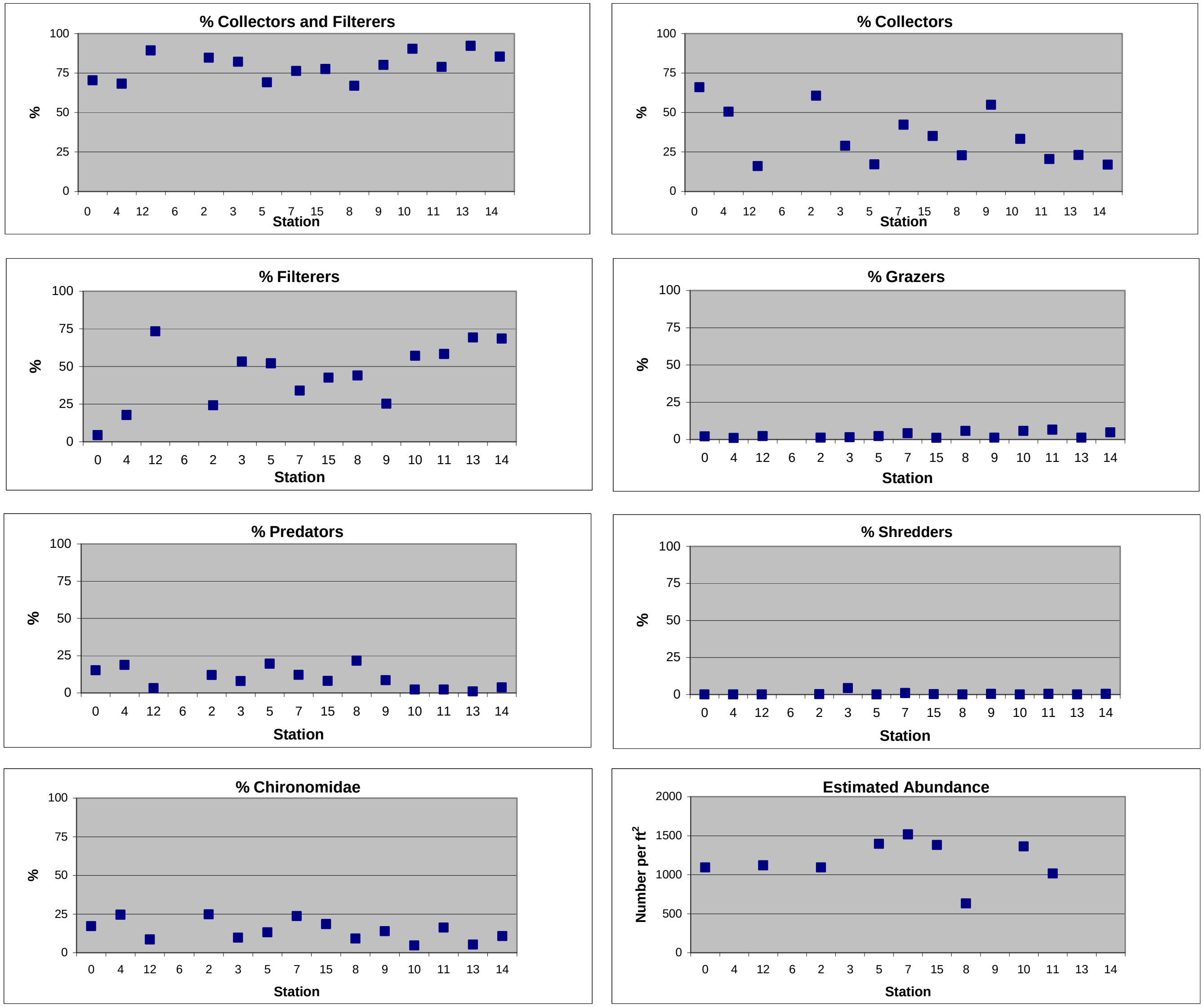


Figure 8. Functional Feeding Group measures: average (n=3) for each biological metric (± 95% CI) by site in the Ventura River Watershed, 2006.

Table 6. Southern California IBI scores and ratings for sites sampled in the Ventura River Watershed, 2006.

	Ventura River				Canada Larga		San Antonio Creek					North Fork Matilija Creek		Matilija Creek	
	Main Street Bridge	Foster Park	Below Matilija Dam	At Santa Ana Raod	Below Grazing	Above Grazing	u/s Ventura River Confluence	Lion Canyon u/s San Antonio	u/s Lion Canyon	Stewart Canyon u/s San Antonio	u/s Stewart Canyon Creek	u/s Ventura River Confluence	At gauging station	Below Community	Above Community
Metric	**0**	**4**	**12**	**6**	**2**	**3**	**5**	**7**	**15**	**8**	**9**	**10**	**11**	**13**	**14**
EPT Taxa	5	5	2	Dry	4	5	4	4	5	5	7	4	7	5	7
Predator Taxa	2	2	1		7	3	5	8	3	6	3	5	0	0	4
Coleoptera Taxa	2	2	4		2	4	5	4	2	0	2	5	4	4	8
% Non-Insect	5	8	10		10	9	8	10	10	6	10	10	10	10	10
% Intolerant Taxa	0	0	0		0	2	0	2	0	2	1	1	4	1	2
% Tolerant	4	1	10		0	8	5	4	4	7	7	6	10	10	10
% Collector Taxa	4	2	1		1	3	5	3	1	7	2	2	3	0	2
Total	**22**	**20**	**28**	**-**	**24**	**34**	**32**	**35**	**25**	**33**	**32**	**33**	**38**	**30**	**43**
Adjusted Total (1.43)	**31.46 Poor**	**28.6 Poor**	**40.04 Fair**	**-**	**34.32 Poor**	**48.62 Fair**	**45.76 Fair**	**50.05 Fair**	**35.75 Poor**	**47.19 Fair**	**45.76 Fair**	**47.19 Fair**	**54.34 Fair**	**42.9 Fair**	**61.49 Good**

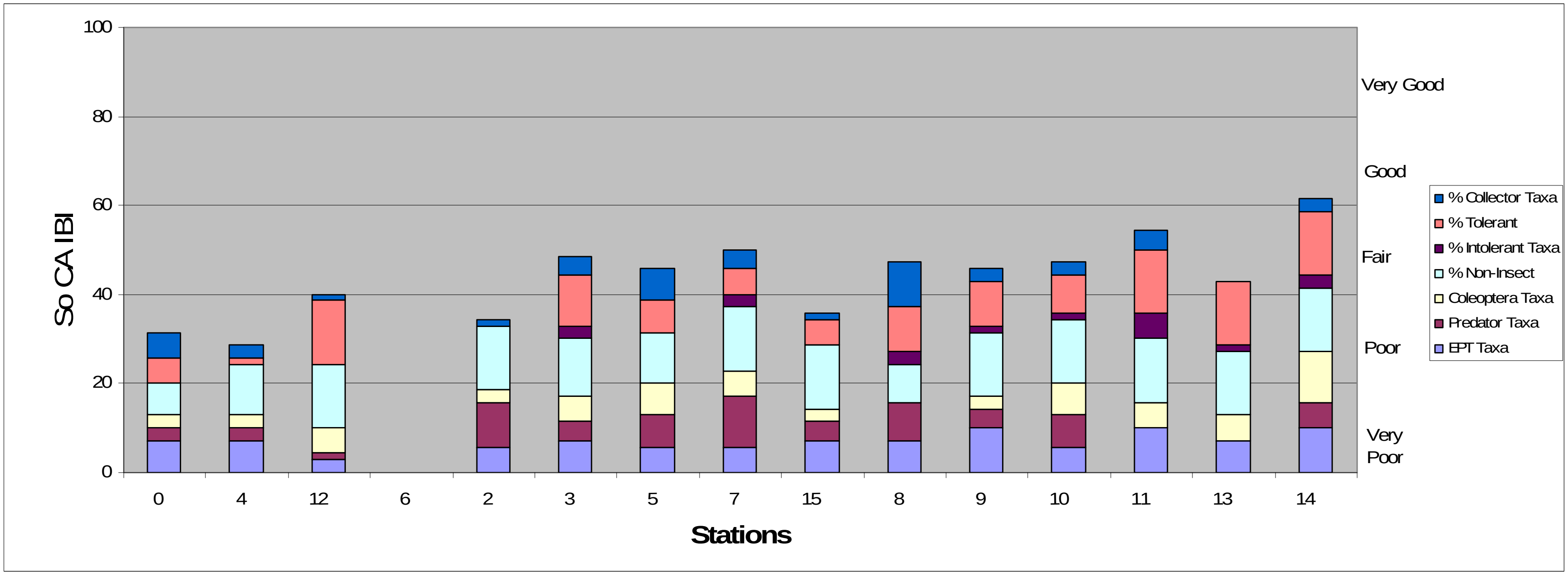


Figure 9. Southern California IBI Scores for sites in the Ventura River Watershed, 2006. Histogram bars are divided by the proportion that each biological metric contributed to the total score.

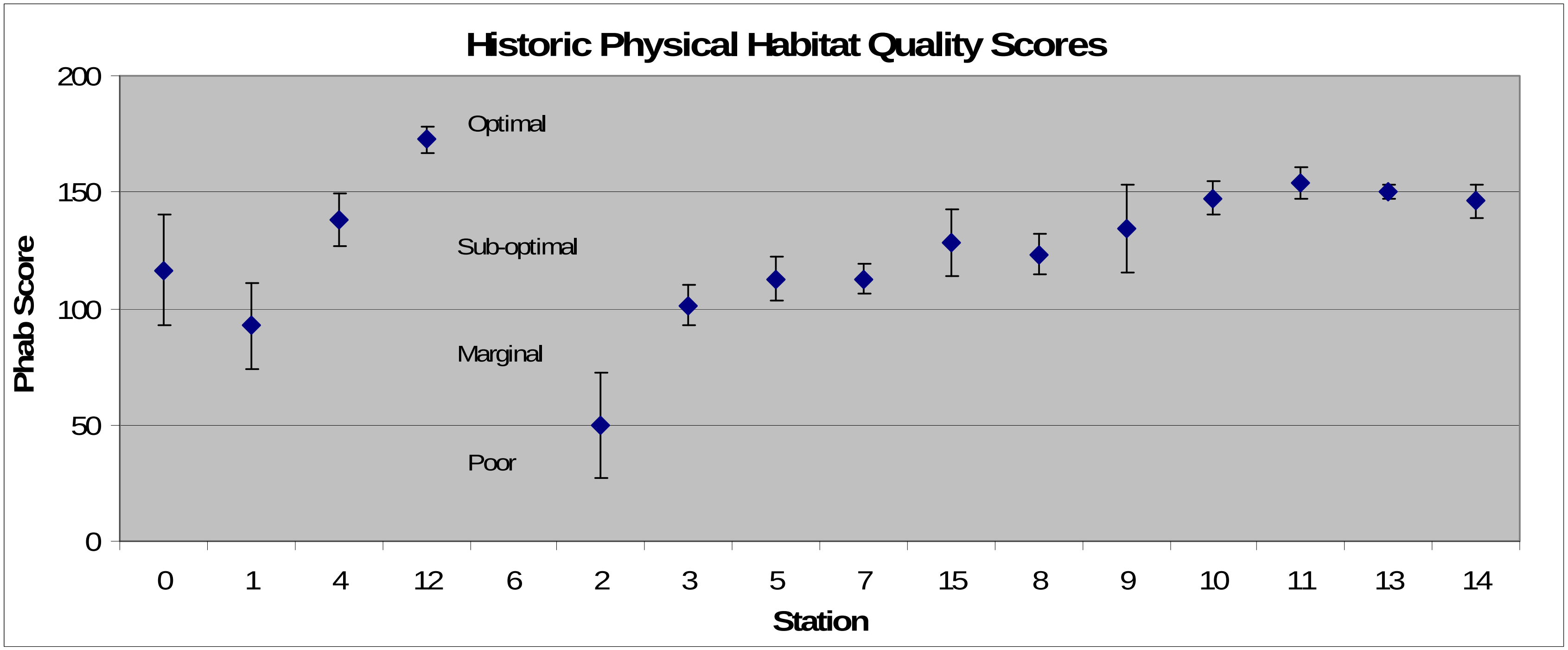


Figure 10. Average physical habitat scores (± 95% CI) for sites in the Ventura River Watershed, 2001 to 2006.

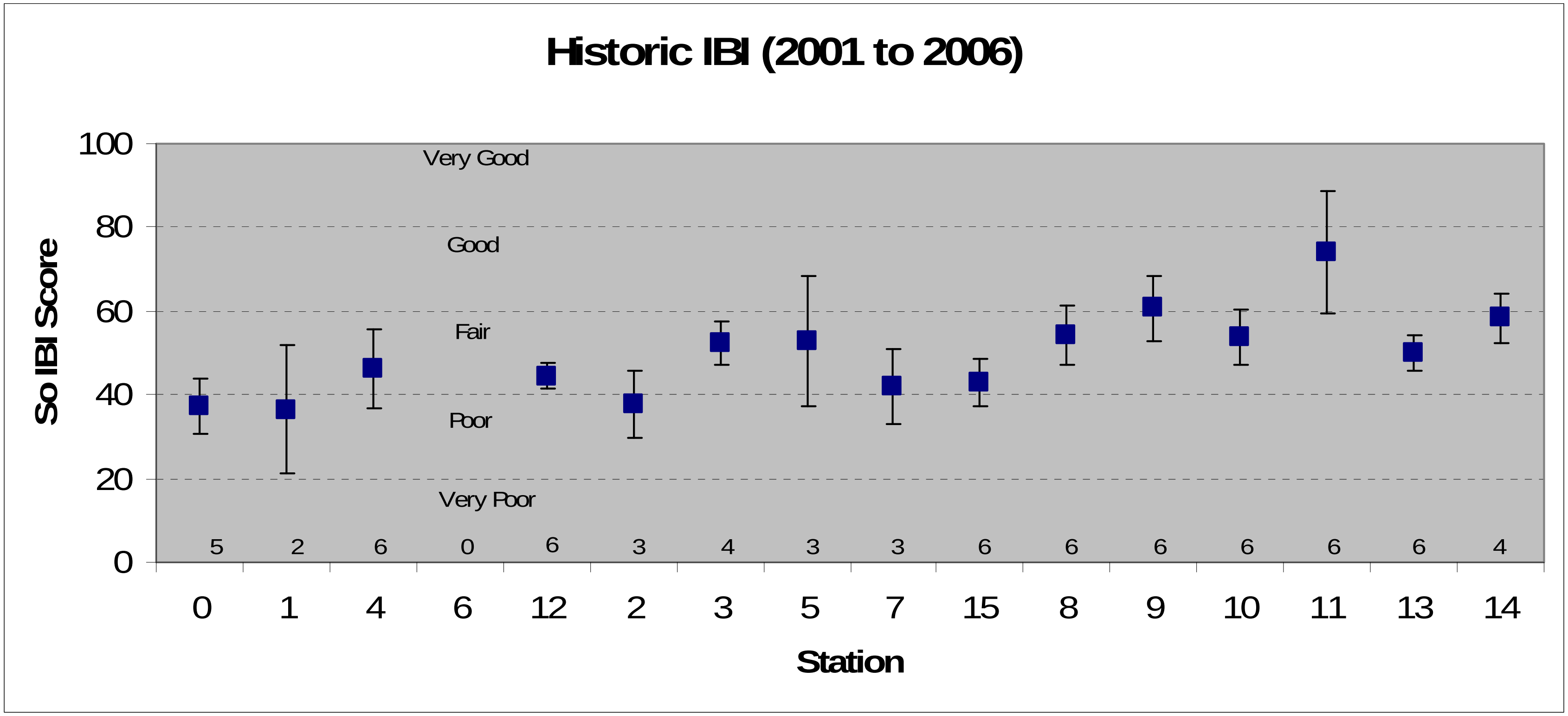


Figure 11. Average (± 95% CI) So CA IBI scores for sites in the Ventura River Watershed, 2001 to 2006. Number of years included in average (n) appears above station label.

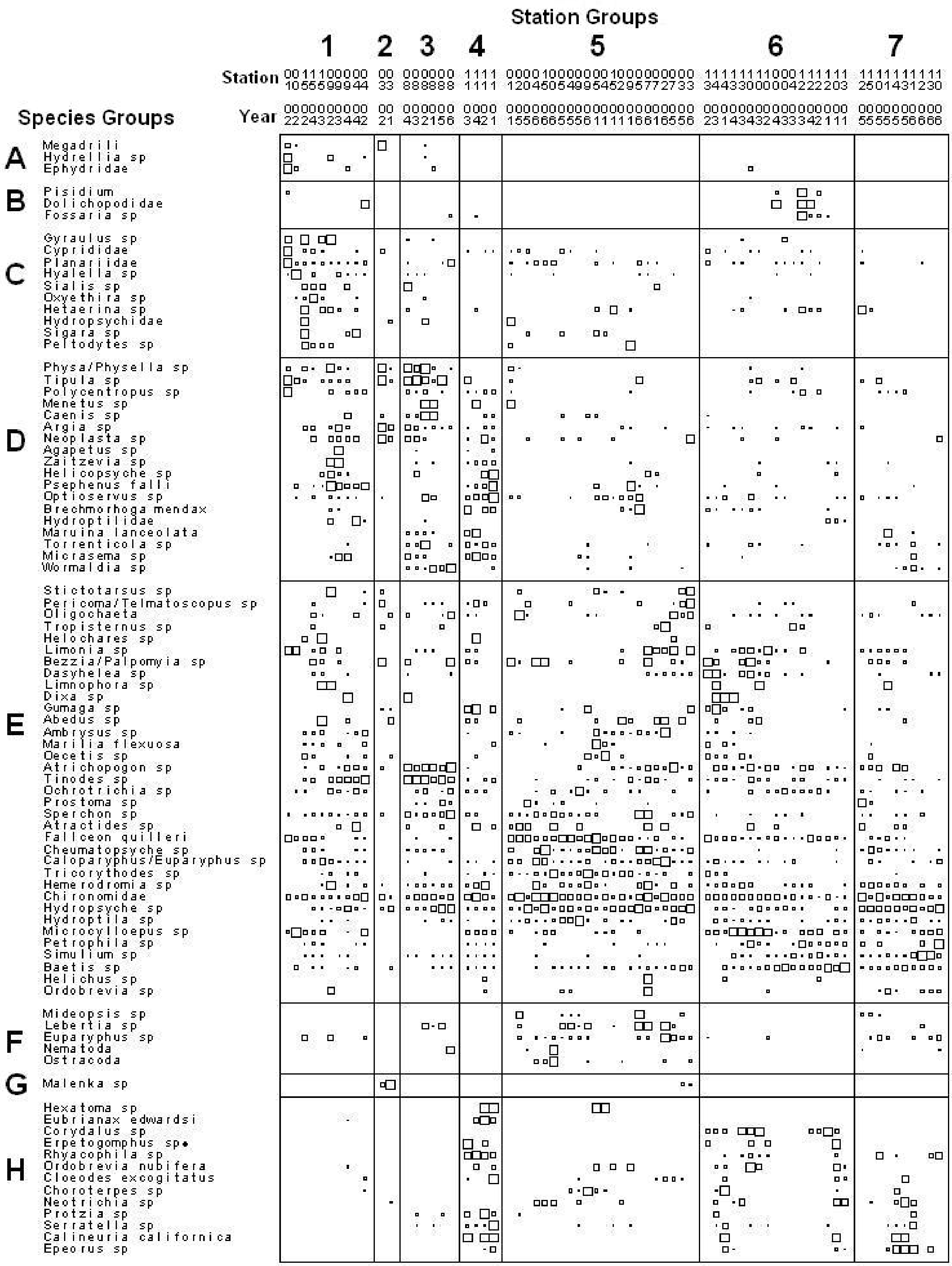


Figure 12. Two-way coincidence table of species vs. station groups created by cluster analysis using the Bray-Curtis dissimilarity index. Symbols associated with each cell represent average relative species abundances for each station.

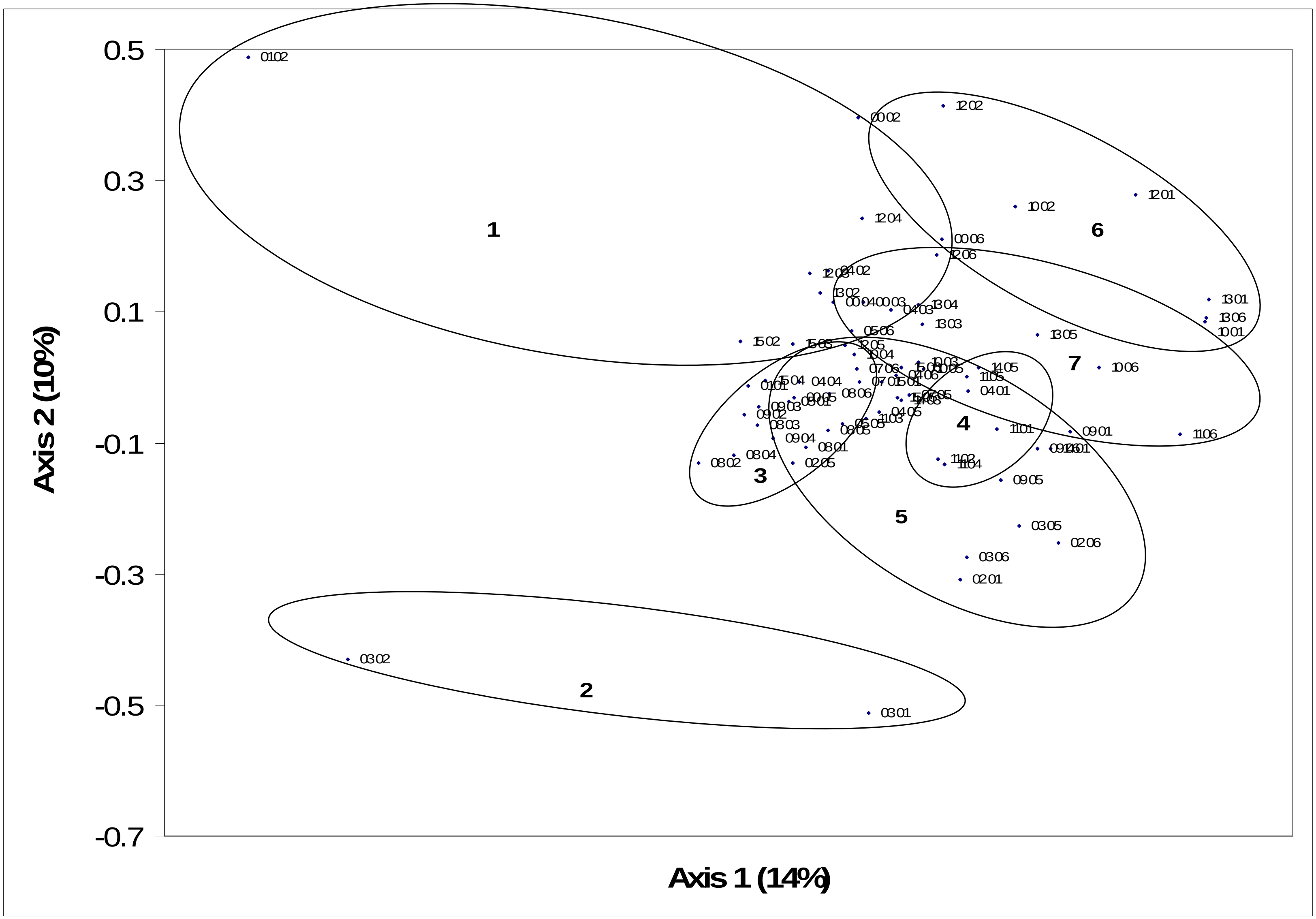


Figure 13. Ordination space plots for axis 1 vs axis 2, with cluster groups circled and stations identified.

LITERATURE CITED

Barbour, M.T., J. Gerritsen, B.D. Snyder and J.B. Stribling. 1999. Revision to rapid bioassessment protocols for use in stream and rivers: periphyton, BMIs and fish. EPA 841-D-97-002. U.S. Environmental Protection Agency. Washington DC.

CSBP, Harrington, J.M. 2003. California stream bioassessment procedures. California Department of Fish and Game, Water Pollution Control Laboratory. Rancho Cordova, CA.

DFG, Department of Fish and Game. 1998. An Index of Biological Integrity for Russian River First to Third Order Tributary Streams, A Water Quality Inventory Report. Water Pollution Control Laboratory, Rancho Cordova, CA.

Davis, W. S. and T.P. Simons, eds. 1995. Biological Assessment and Criteria: Tools for Resource Planning and Decision Making. Lewis Publishers. Boca Raton, FL.

Davis, W.S., B.D. Syder, J.B. Stribling and C. Stoughton. 1996. Summary of state biological assessment program for streams and wadeable rivers. EPA 230-R-96-007. U.S. Environmental Protection Agency; Office of Policy, Planning and Evaluation: Washington, DC.

Erman, N.A. 1996. Status of Aquatic Invertebrates. in: Sierra Nevada Ecosystem Project: Final Report to Congress, Vol II, Assessments and Scientific Basis for Management Options. University of California Davis, Centers for Water and Wildland Resources.

Gauch, H.G., Jr. 1982. Multivariate analysis in community ecology. Cambridge University Press, Cambridge, U.K.

Gibson, G.R. 1996. Biological Criteria: Technical guidance for streams and small rivers. EPA 822-B-96-001. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

Harrington, J.M. and M. Born. 2000. Measuring the health of California streams and rivers. Sustainable Land Stewardship International Institute, Sacramento, CA.

Jones, R.C. and Clark, C.C. 1987. Impact of watershed urbanization on stream insects communities. Water Resources Bulletin 23:1047-1055.

Jongman, R.H.G., C.J.F. ter Braak, and O.F.R. van Tongeren. 1995. Data analysis in community and landscape ecology. Cambridge University Press, Cambridge, UK. 299 pp.

Karr, J.R. 1981. Assessment of biotic integrity using fish communities. Fisheries 6:21-27.

Karr, J.R. 1998. Rivers as sentinels: using the biology of rivers to guide landscape management. In: Naiman, R.J. and Bilby, R.E. (eds.) River Ecology and Management:Lessons from the Pacific Coastal Ecoregion. Springer, New York, 502-528.

Karr, J.R., J.D. Allan and A.C. Benke. 2000. River conservation in the United States and Canada. In: Boon, P.J., B.R. Davies, and G.E. Petts (eds) Global Perspectives on River Conservation: Science, Policy and Practice. John Wiley and Sons Ltd, West Sussex, England, 3-39.

Kerans, B.L. and J.R. Karr. 1994. A benthic index of biotic integrity (B-IBI) for rivers of the Tennessee Valley. Ecological Applications 4: 768-785.

Lenat, D.R. and Crawford, J.K. 1994. Effects of land use on water quality and aquatic biota of three North Carolina Piedmont streams. Hydrobiologia 294:185-199.

Merritt, R.W. and K.W. Cummins. 1995. An introduction to the aquatic insects of North America. Second Edition. Kendall/Hunt Publishing Co., Dubuque, IA.

Ode, P.R., A. Rehn and J.M. Harrington. 2002. Results of May 2001 Reference Site Study and Preliminary IBI for the San Diego Regional Water Quality Control Board. California Department of Fish and Game, Aquatic Bioassessment Laboratory. Rancho Cordova, CA.

Ode, R.E., A.C. Rehn, J.T. May. 2005. A Quantitative Tool for Assessing the Integrity of Southern Coastal California Streams. Env. Man., Vol. 35, No. 4, pp. 493-504.

Pennak, R.W. 1989. Freshwater invertebrates of the United States, 3rd Ed. John Wiley and Sons, Inc., New York, NY.

Resh, V.H. and J.K. Jackson. 1993. Rapid assessment approaches to biomonitoring using benthic macroinvertebrates. In: D.M. Rosenberg and V.H. Resh, eds., Chapman and Hall, New York.

Rosenberg, D.M. and V.H. Resh (eds). 1993. Freshwater biomonitoring and benthic macroinvertebrates. Chapman and Hall. New York. NY.

Smith, R.W. 1982. Analysis of ecological survey data with SAS and EAP. Proc. 7th Annual SAS Users' Group International (SUGI). SAS Institute Inc. P.O. Box 8000, Cary NC 27511: 610-615.

Smith, R.W. 1984. The re-estimation of ecological distance values using the step-across procedure. EAP Technical Report No. 2. EcoAnalysis Inc., 221 E. Matilija St. Suite A, Ojai, CA 93023.

Stewart, K.W. and B.P.Stark. 1993. Nymphs of North American Stonefly Genera (Plecoptera). University of North Texas Press, Denton, TX.

Vannote, R.L., G.W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences 37:130-137.

VCWPD. Ventura County Watershed Protection District, Water Quality Division (Sustainable Land Stewardship Institute). 2001 & 2002. Ventura river watershed biological and physical/habitat assessment, Ventura County, CA.

Weaver, L.A. and Garman, G.C. 1994. Urbanization of a watershed and historical changes in a stream fish assemblage. Transactions of the American Fisheries Society 123:162-172.

TAXONOMIC REFERENCES

Brown, H. P. 1976. Aquatic Dryopoid Beetles (Coleoptera) of the United States. U. S. EPA. Cincinnati, Ohio. 82 Pages.

Burch, J. B. 1973. Biota of Freshwater Ecosystems Identification Manual No. 11, Freshwater Unionacean Clams (Mollusca: Pelecypoda) of North America. U. S. Environmental Protection Agency, Project # 18050, Contract # 14-12-894. 176 Pages.

Burch, J. B. 1973. Freshwater Unionacean Clams (Mollusca:gastropoda) of North America. U. S. Environmental Protection Agency, EPA-600\3-82-023. Contract # 68-03-1290. 193 Pages.

Edmunds, G. F., Jr., S. L. Jensen and L. Berner. 1976. The Mayflies of North and Central America. North Central Publishing Co., St. Paul, Minnesota. 330 Pages.

John H. Epler, 2001. Identification manual for the larval chironomidae (Diptera) of North and South Carolina.

Johannsen, O. A. 1977. Aquatic Diptera: Eggs, Larvae, and Pupae of Aquatic Flies. Published by the University, Ithaca, New York. 210 Pages.

Klemm, D. J. 1972. Biota of Freshwater Ecosystems Identification Manual No. 8, Freshwater Leeches (Annelida: Hirundinea) of North America. U.S. Environmental Protection Agency. Project # 18050, Contract # 14-12-894. 53 Pages.

Klemm, D. J. 1985. A Guide to the Freshwater Annelida (Polychaeta, Naidid and Tubificid Oligochaeta and Hirudinea) of North America. Kendall/Hunt Publishing Co., Dubuque, Iowa. 198p.

McCafferty, W. P. 1981. Aquatic Entomology. Jones and Bartlett Publishers, Inc., Boston. 448 Pages.

Merritt, R. W. and K. W. Cummins (Editors). 1996. An Introduction to the Aquatic Insects of North America, Third Edition. Kendall/Hunt Publishing Co., Dubuque, Iowa. 862 Pages.

Pennak, R. W. 1989. Freshwater Invertebrates of the United States, Third Edition, John Wiley and Sons, Inc, New York, 628 Pages.

Stewart, K. W. and B. P. Stark. 1988. Nymphs of North American Stonefly Genera (Plecoptera). University of North Texas Press, Denton Texas. 460 Pages.

Thorp J. H. and A. P. Covich (Editors). 1991. Ecology and Classification of Freshwater Invertebrates. Academic Press, Inc., San Diego, California. 911 Pages.

Wiederholm, T. (Editor) 1983. Chironomidae of the Holarctic Region. Entomologica Scandinavica. 457 Pages.

Wiggins, G. B. 1996. Larvae of North American Caddisfly Genera (Tricoptera). Second Edition, University of Toronto Press. Toronto. 457 Pages.

APPENDIX A – BMI TAXA LISTS & METRIC TABLES

Table A-1. September 2006 BMI raw taxa list for all sites in the Ventura River Watershed.

Identified Taxa	Tol Val (TV)	Func Feed Grp	0	4	12	6	2	3	5	7	15	8	9	10	11	13	14
Insecta Taxa																	
Ephemeroptera																	
Baetis sp	5	cg	15	15	46	Dry	18	38	10	26	6	12	11	24	40	56	47
Caenis sp	7	cg											2				
Choroterpes sp	2	cg											3				
Cloeodes excogitatus	4	cg					1										1
Epeorus sp	0	sc													11	4	18
Fallceon quilleri	4	cg	31	28					4	6	19	9	47		2	1	6
Serratella sp	2	cg													5		6
Tricorythodes sp	4	cg	137	34			22	35	5	13	12	6	127	1	1	1	2
Odonata																	
Argia sp	7	p					3	1			1	6					
Brechmorhoga mendax	9	p							4								
Coenagrion/Enallagma sp	9	p								1							
Coenagrionidae		p								1							
Hetaerina americana	6	p							3		1						
Libellula sp	9	p					1										
Libellulidae	9	p					1										
Progomphus borealis	4	p					1										
Plecoptera																	
Calineuria californica	2	p															1
Malenka sp	2	sh						15							2		
Hemiptera																	
Abedus sp	8	p					1										1
Ambrysus sp	5	p					7		2	1							
Trichoptera																	
Cheumatopsyche sp	5	cf	1	13			9	12	17	23	28		5	2	1		2
Gumaga sp	3	sh						2					2				
Helicopsyche sp	3	sc								1							
Hydropsyche sp	4	cf	18	52	57		69	229	201	136	192	166	101	204	133	92	158
Hydroptila sp	6	sc	8	3			3	1	1	1	2	2	5	2	17	2	
Marilia flexuosa	0	sh									1						
Micrasema sp	1	mh						3			1	1	8		28	3	3
Neotrichia sp	4	sc	1	1							1				1		
Ochrotrichia sp	4	ph	18	2	6			2	7			22	7			3	1
Oecetis sp	8	p											1				
Polycentropus sp	6	p															1
Rhyacophila sp	0	p												2		1	
Tinodes sp	2	sc	1	1			2	6	2	18		18	1	2	2		
Wormaldia sp	3	cf			3							37	2	3	16		5
Coleoptera																	
Helichus sp	5	sh								1							2
Microcylloepus sp	4	cg	31	10	28				11		26		2	47	15	36	1
Ochthebius sp	5	p						2						1			
Optioservus sp	4	sc							7								
Ordobrevia sp	4	cg			1					4				1		1	1
Psephenus falli	4	sc							1						1		1
Stictotarsus sp	5	p						2									
Tropisternus sp	5	p					1										
Zaitzevia sp	4	sc															2
Diptera																	
Apedilum sp	6	cg	1				4	1									
Atrichopogon sp	6	cg					1	2	1	4		8					5
Bezzia/Palpomyia sp	6	p		2						2	2	2					
Caloparyphus/Euparyphus sp	8	cg	10	134	4		185	20	41	79	100	27	54	78	18	8	7
Cardiocladius sp	5	p			6										1	2	
Chironomidae	6	cg	3				2	3	1	2		2			5		
Corynoneura sp	7	cg		1						1	1				2		
Cricotopus bicinctus	7	cg	7		1												
Cricotopus sp	7	cg	5		1					19		5	1	6	6	1	3
Cricotopus trifascia	7	cg	2	2										1	8		
Dasyhelea sp	6	cg		1			6	10		12	1	5		4		4	
Dicrotendipes sp	8	cg					1										
Ephydra sp	6	sh						1		1							
Eukiefferiella sp	8	om	3	28	17		1	15	14	31	43	4	5	9	24	22	23
Euparyphus sp	8	cg	3	2			16	2	3	3	1		2	6	2	3	6
Hemerodromia sp	6	p		4	1			1	2	5	1	1	3	1			2
Labrundinia sp	6	p										1					
Limonia sp	6	sh					1	3		3							
Maruina lanceolata	2	sc													1		1
Micropsectra sp	7	cg															2
Microtendipes pedellus	6	cf	2	3						1					2		

Table A-1. Continued.

Identified Taxa	Tol Val (TV)	Func Feed Grp	0	4	12	6	2	3	5	7	15	8	9	10	11	13	14
Diptera (continued)																	
Muscidae	6	p												1			
Neoplasta sp	6	p						2						1			
Parametriocnemus sp	5	cg		3								7		1			
Pentaneura sp	6	p	10	4			6	4	7		1		3			1	
Pericoma/Telmatoscopus sp	4	cg						4	1						1		
Polypedilum sp	6	om	41	2			8	1	1	2			2		6		1
Pseudochironomus sp	5	cg	6		1		28			3							
Rheocricotopus sp	6	om	1	28	4				21		26	3	25		3		2
Rheotanytarsus sp	6	cf		6	15		4	18	9	4	10	1		5	23		20
Simulium sp	6	cf		12	309		1	3	29	1		26	16	77	123	258	167
Stenochironomus sp	5	cg										17					
Tabanus sp	5	p					1										
Tanypodinae	7	p		11			9	1			6	1	2	1			1
Tanytarsus sp	6	cf	1	3			36	1		7			1				
Thienemanniella sp	6	cg							1	40	7	3	12				
Thienemannimyia sp	6	p	5	33			23	4	11	10	6	4	18	1	3	1	3
Tipula sp	4	om							1								
Tipulidae	3												1				
Lepidoptera																	
Petrophila sp	5	sc			11		1			1	3			25			2
Megaloptera																	
Corydalus sp	0	p															1
Neohermes sp	0	p										1					
Non-Insecta Taxa																	
Nematoda	5	p	8			Dry						6		1			
Oligochaeta	5	cg			2			16				19	3	1		5	
Ostracoda	8	cg	80	25			14	12	1		17		7			1	
Amphipoda																	
Hyalella sp	8	cg	3						5	2							
Basommatophora																	
Fossaria sp	8	sc										6					
Physa/Physella sp	8	sc			1							4					
Hoplonemertea																	
Prostoma sp	8	p	1	2						1		3					
Tricladida																	
Planariidae	4	p	30	24	2				16	2	20	43	1				
Trombidformes																	
Atractides sp	8	p	1				1			1							
Lebertia sp	8	p			1		4		3	3			2				
Mideopsis sp	5	p							4								
Protzia sp	8	p													1		
Sperchon sp	8	p	22	15	7			22	44	33	6	41	10	1	2		2
Torrenticola sp	5	p								1		4	2	1	5		7
Veneroida																	
Sphaeriidae	8	cf			1												
TOTAL			**506**	**504**	**525**		**492**	**494**	**491**	**506**	**541**	**523**	**494**	**510**	**511**	**506**	**514**

Table A-2. September 2006 BMI metrics for each of the sample locations in the Ventura River Watershed.

	Ventura River				Canada Larga		San Antonio Creek					North Fork Matilija Creek		Matilija Creek	
	Main Street Bridge	Foster Park	Below Matilija Dam	At Santa Ana Road	Below Grazing	Above Grazing	u/s Ventura River Confluence	Lion Canyon u/s San Antonio	u/s Lion Canyon	Stewart Canyon u/s San Antonio	u/s Stewart Canyon Creek	u/s Ventura River Confluence	At gauging station	Below Community	Above Community
Biological Metric	**0**	**4**	**12**	**6**	**2**	**3**	**5**	**7**	**15**	**8**	**9**	**10**	**11**	**13**	**14**
Community Richness Measures															
Taxonomic Richness	32	32	23	Dry	36	35	35	41	29	36	35	30	34	22	37
EPT Taxa	9	9	4		7	10	8	8	9	9	14	8	13	9	13
Predator Taxa	7	8	5		13	9	10	12	9	12	9	10	5	4	9
Coleoptera Taxa	1	1	2		1	2	3	2	1	0	1	3	2	2	5
Community Composition Measures															
EPT Index (%)	45.5	29.6	21.3		25.2	69.4	50.3	44.3	48.4	52.2	65.2	47.1	50.7	32.2	48.8
Sensitive EPT Index (%)	0.2	0.2	0.6		0.4	5.3	0.4	3.8	0.4	10.7	3.2	1.4	12.5	1.6	6.4
Percent Non-Insect	28.7	13.1	2.7		3.9	10.1	14.9	8.5	7.9	24.1	5.1	0.8	1.6	1.2	1.8
Shannon Diversity	2.59	2.71	1.62		2.4	2.26	2.41	2.66	2.27	2.69	2.5	2	2.48	1.64	2.12
Community Tolerance Measures															
% Dominant Taxa	27.1	26.6	58.9		37.6	46.4	40.9	26.9	35.5	31.7	25.7	40	26	51	32.5
Tolerance Value	5.4	6.2	5.6		6.4	4.8	5.4	5.8	5.5	4.9	5	5.2	4.9	5.4	5
Percent Intolerance Value (0-2)	0.2	0.2	0		0.4	4.9	0.4	3.6	0.4	3.8	2.4	0.8	9.6	1.6	5.8
Percent Tolerance Value (8-10)	24.3	40.9	5.9		45.7	14.4	23.4	30.4	30.9	16.3	16.4	18.4	9.2	6.7	7.6
Percent Hydropsychidae	3.8	12.9	10.9		15.9	48.8	44.4	31.4	40.7	31.7	21.5	40.4	26.2	18.2	31.1
Percent Baetidae	9.1	8.5	8.8		3.9	7.7	2.9	6.3	4.6	4	11.7	4.7	8.2	11.3	10.5
Community Feeding Group Measures															
Percent Collectors and Filterers	70.4	68.3	89.3		84.8	82.2	69.2	76.3	77.6	66.9	80.2	90.4	78.9	92.3	85.4
Percent Collectors	66	50.6	16		60.6	28.9	17.1	42.3	35.1	22.9	54.9	33.3	20.5	23.1	16.9
Percent Filterers	4.3	17.7	73.3		24.2	53.2	52.1	34	42.5	44	25.3	57.1	58.3	69.2	68.5
Percent Grazers	2	1	2.3		1.2	1.4	2.2	4.2	1.1	5.7	1.2	5.7	6.5	1.2	4.7
Percent Predators	15.2	18.8	3.2		12	7.9	19.6	12.1	8.1	21.6	8.5	2.2	2.3	1	3.7
Percent Shredders	0	0	0		0.2	4.3	0	1	0.2	0	0.4	0	0.4	0	0.4
Percent Chironomidae	17.2	24.6	8.6		24.8	9.7	13.2	23.7	18.5	9.2	14	4.7	16.2	5.3	10.7
Estimated Abundance (per ft^2)	1,094	8,308	1,121		1,093	4,720	1,397	1,518	1,381	634	2,024	1,362	1,017	2,209	2,045

APPENDIX B – 6 YEAR STATION AND SPECIES CLUSTER GROUPS

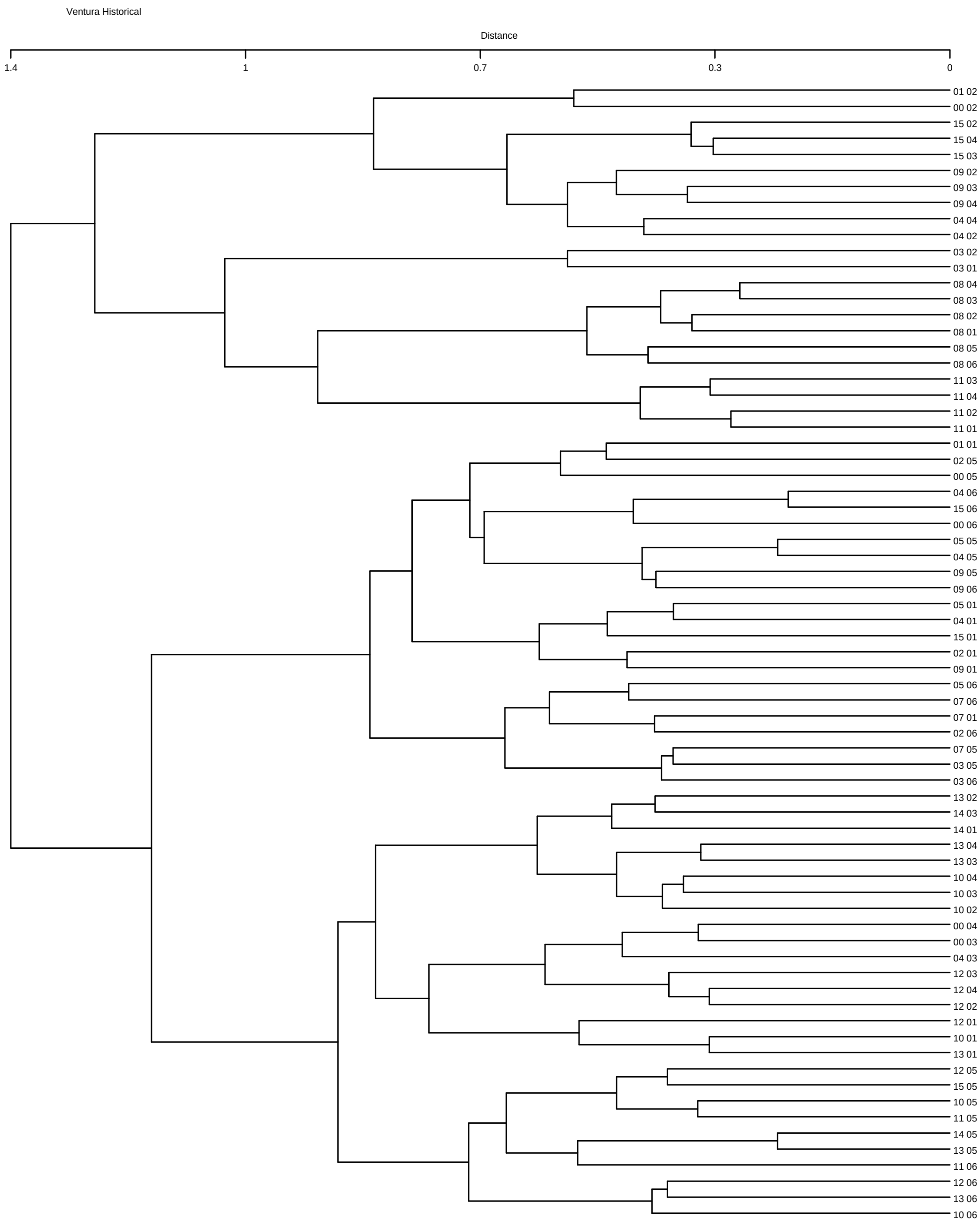


Figure B-1. Station dendrogram for BMI population collected from 2001 to 2006. Distances calculated using Bray-Curtis dissimilarity index.

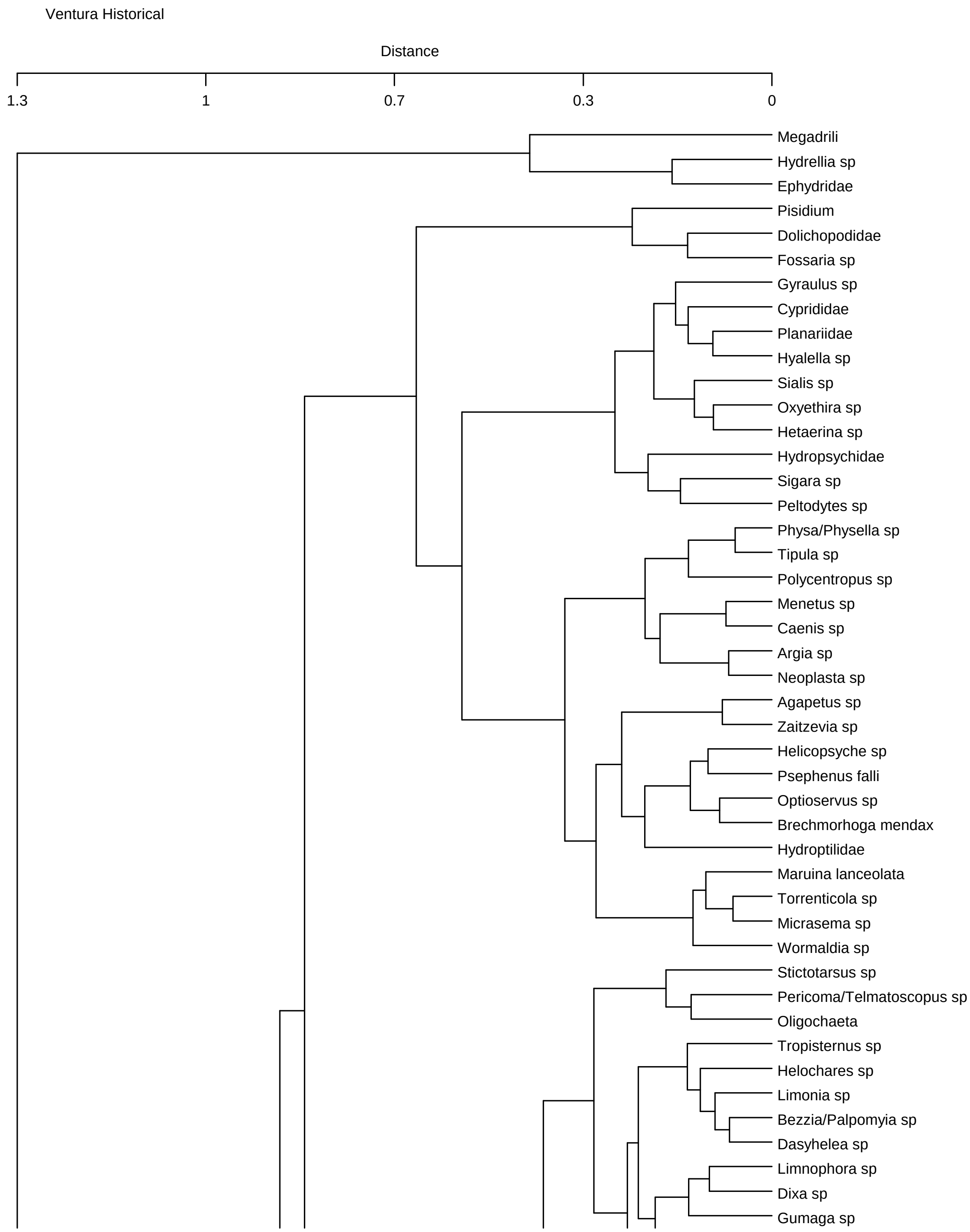


Figure B-2. Species dendrogram for BMI population collected from 2001 to 2006. Distances calculated using Bray-Curtis dissimilarity index.

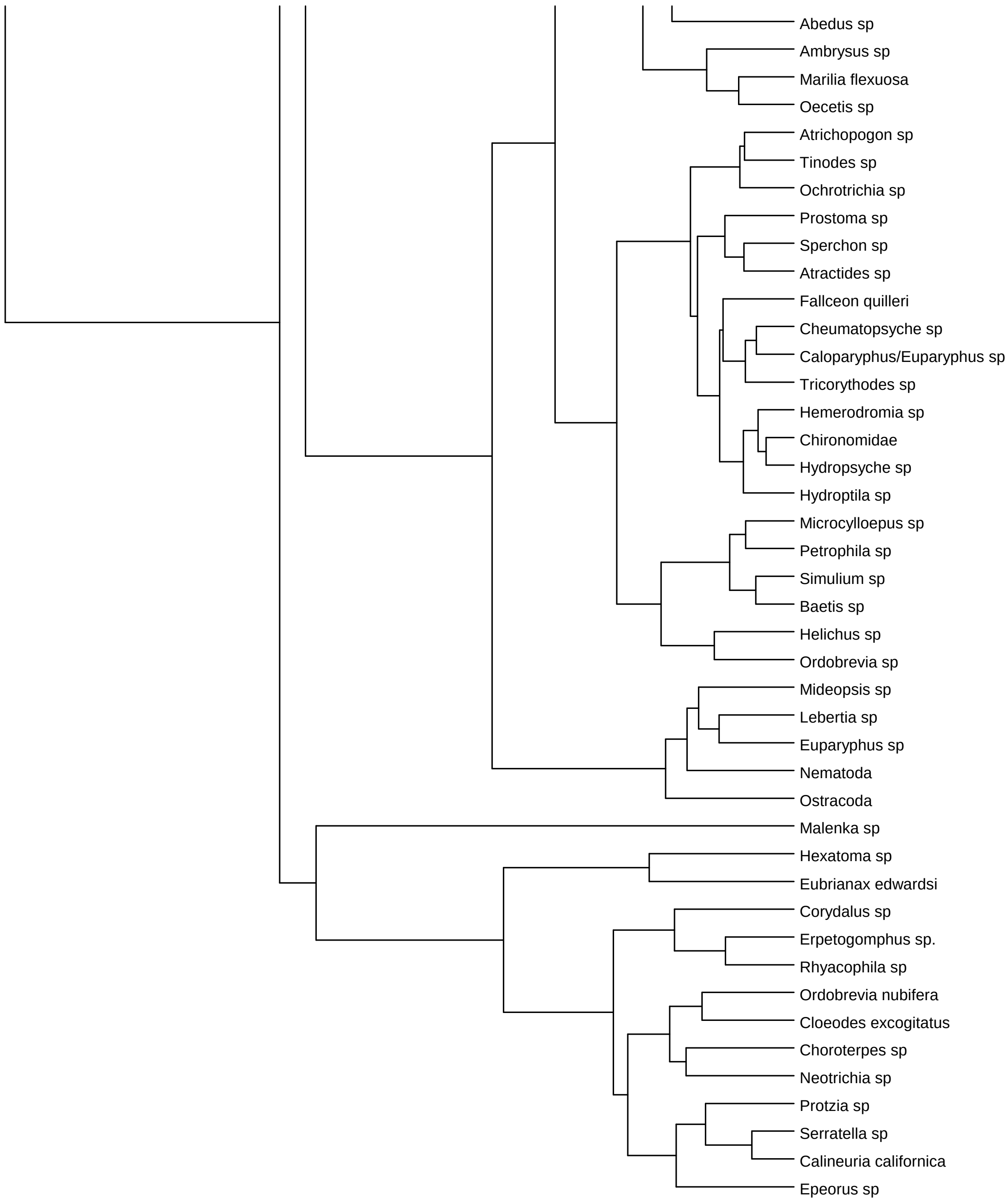


Figure B-2. (continued)