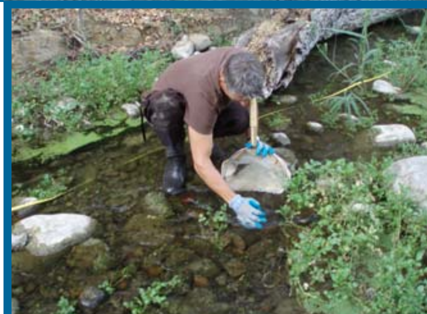
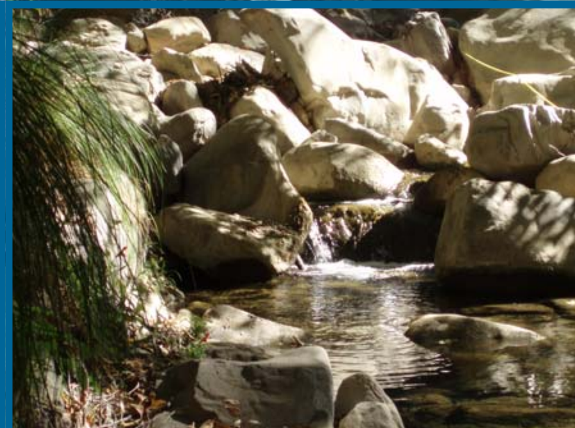
APPENDIX O

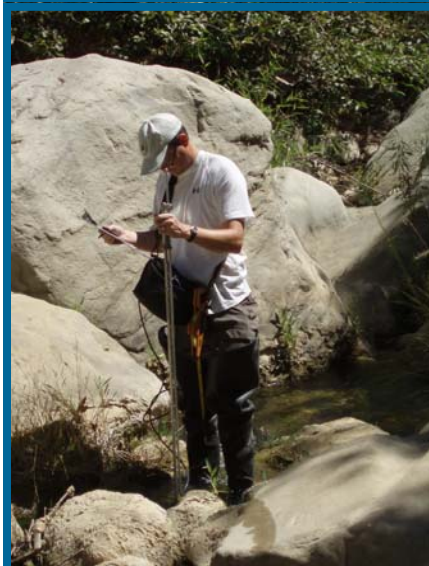
Ventura River Watershed
2007 Bioassessment Monitoring Report

Aquatic Bioassay and Consulting Laboratories

Ventura Countywide Stormwater Monitoring Program
Ventura River Watershed
2007 Bioassessment Monitoring Report







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Watershed Protection District
VENTURA COUNTY

Prepared August 2008

Ventura Countywide Stormwater Monitoring Program
Ventura River Watershed
2007 Bioassessment Monitoring Report

Submitted to:

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

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August 2008

Executive Summary

2007 Survey Results

During September 2007 teams from the Ventura County Watershed Protection District, Ojai Sanitation District and Aquatic Bioassay and Consulting Laboratories collected water quality and benthic macroinvertebrate (BMI) sampling at nine of 15 sites in the Ventura County 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. This was the last of a seven year monitoring effort at these 15 sites.

This report represents the culmination of seven years of an ongoing effort to assess the water quality conditions in the Ventura River Watershed. Starting in the spring and summer of 2009 this effort will continue, but will be based on a probabilistic regional monitoring design that will allow for the direct comparison of water quality conditions in the Ventura River Watershed, with watersheds from throughout the southern California region. This effort will include sampling at six randomly assigned stations in the watershed each year and several fixed locations that will be returned to each year to detect water quality trends. Besides the collection of benthic macroinvertebrate and physical habitat data, nutrients, water chemistry and algae data will also be collected as part of the regional effort. At the end of five years a total of 30 random sites will have been sampled in the Ventura Watershed, the minimum necessary to make statistically valid comparisons with other watersheds in the region.

The physical habitat quality of the survey stations ranged from suboptimal to optimal. The best habitat scores were found at Station 12 located on the main stem of the Ventura River below Matilija Dam and on the Matilija Creek in the upper watershed. These sites were characterized by relatively high substrate complexity, high percentages of cobble and boulders, had good bank stability, had little evidence of sedimentation due to upstream erosion and had good vegetative protection. In contrast, the lowest habitat scores were measured on the Ventura River just upstream of the ocean. The decrease in habitat quality from the upper main stem to the ocean was due mostly to a reduction in streambed complexity owing to increased sediment deposition, channel alteration and decreased bank stability. 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 2007 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 have impaired water quality conditions. Based on this criteria only one of the nine sites ranked in the impaired range during 2007. This station was located at the Main St. Bridge near where the Ventura River discharges into the Pacific Ocean (Station 0). The IBI rankings for the other 8 stations were either fair or good. This is an indication that the physical habitat and BMI community found there is comparable to other reference site locations in southern California.

An invasive species, the New Zealand mudsnail, which has been found at several locations in southern California during the past four 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 County 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 2007)

Physical habitat scores for each station from 2001 to 2007 were averaged to assess long term conditions in the Ventura River Watershed. The best habitat conditions during the seven 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 2007 the average IBI scores for all sites, except Stations 0, 1, 12 and 2, were in the fair to good range. This indicates that water quality conditions at most sites support BMI populations that are similar to those found at reference locations throughout the southern California region. The average scores for Stations 0 and 1 (each located above the Main Street Bridge), Station 2 (Canada Larga Creek) and Station 12 (below Matilija Dam) were below the impairment threshold (39). IBI scores in the impaired range for Stations 0 and 1 can be at least partly attributed to the lower physical habitat conditions found at these lower watershed sites. In contrast, Station 12 had optimal physical habitat conditions during the seven year period. The low IBI scores could be the result of decreased water quality due to some anthropogenic input (e.g. nutrients, heavy metals, etc) or possibly this sites location directly below the Matilija Dam.

Results for cluster and ordination analysis of the combined data from 2001 to 2007 showed that the BMI community in the Ventura Watershed has been relatively stable, both spatially and temporally during the seven year period between 2001 and 2007. Nine station groups were identified based on cluster analysis. The three main cluster groups were spatially delineated by their location in either the lower or upper watershed, with little separation by sampling year. The BMI communities at stations above Matilija Dam (10, 11, 13 and 14) were similar to one another, while lower watershed stations located on the main stem (1 and 4), Canada Larga Creek (2) and the San Antonio Creek system (7, 9 and 15) tended to cluster together. In addition, there was a transition group of stations that spanned sites in both the upper (11) and lower (8 and 9) watersheds.

The lack of any observable temporal trend across the seven year period is of note. Historic rainfall during the winter of 2005 dropped over 40 inches of rain in most parts of the watershed, leading to scouring, erosion and sedimentation at many of the sampling sites, especially in the lower watershed. There were observable changes in the BMI community in 2006, but these changes were not of a magnitude great enough to create an observable signal in the seven year trend analysis. This indicates that the BMI community in the watershed is relatively stable and responds to natural environmental stressors (e.g. heavy rainfall) in a predictable way.

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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 2005).

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 2007. In addition, these data were compared and contrasted to the previous six years of data to look for any spatial or temporal water quality trends.

This report represents the culmination of seven years of an ongoing effort to assess the water quality conditions in the Ventura River Watershed. Starting in the spring and summer of 2009 this effort will continue, but will be based on a probabilistic regional monitoring design that will allow for the direct comparison of water quality conditions in the Ventura River Watershed, with watersheds from throughout the southern California region. This effort will include sampling at six randomly assigned stations in the watershed each year and several fixed locations that will be returned to each year to detect water quality trends. Besides the collection of benthic macroinvertebrate and physical habitat data, nutrients, water chemistry and algae data will also be collected as part of the regional effort. At the end of five years a total of 30 random sites will have been sampled in the Ventura Watershed, the minimum necessary to make statistically valid comparisons with other watersheds in the region.

MATERIALS AND METHODS

Sampling Site Descriptions

Fifteen BMI sampling locations were visited in the Ventura River Watershed on September 9th and 10th, 2007 (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. Similar to years previous to 2006, numerous sites were dry during the September 2007 sampling event, including Stations 2, 3, 5, 6, 7 and 14.

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 dry during the September 2007 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. Station 14 was dry during the 2007 sampling event.

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. Stations 5 and 7 were dry during the 2007 sampling event.

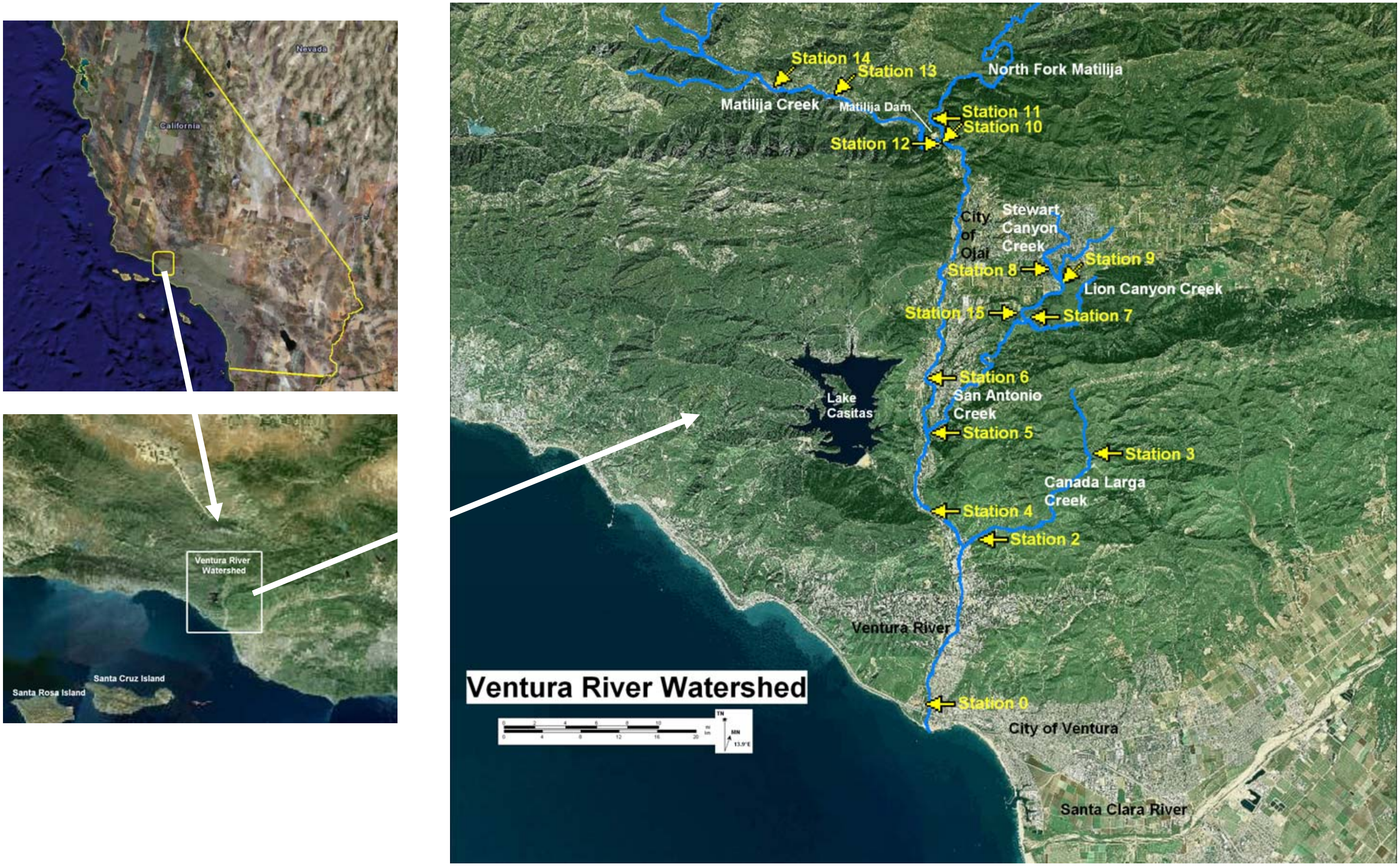


Figure 1. Fifteen BMI sampling locations in the Ventura River watershed.

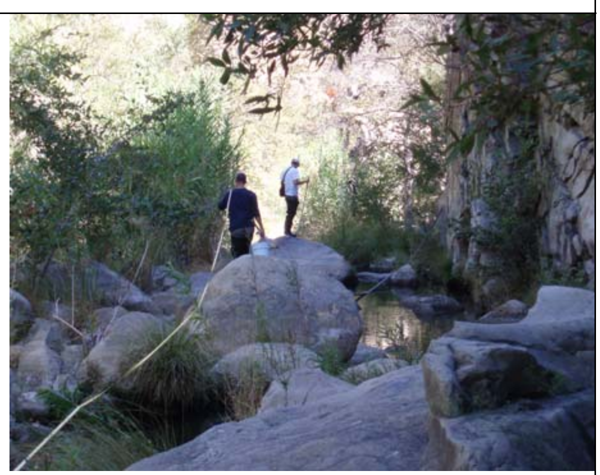
Table 1. Sampling locations descriptions for 15 locations in the Ventura River Watershed. u/s = upstream; d/s = downstream.

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 **Dry - Not Sampled**	34 20 31.7	119 17 08.2	293
3	Canada Larga Creek	Canada Larga Creek, above main area of grazing impact. **Dry - Not Sampled**	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. **Dry - Not Sampled**	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. **Dry - Not Sampled**	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. **Dry - Not Sampled**	34 30 16.9	119 22 26.3	1,553

Figure 2. Photos of each Ventura River Watershed site.

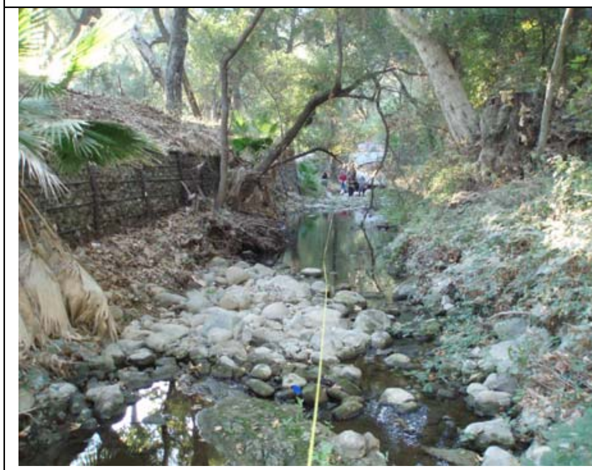

Station 0 – Main Street Bridge

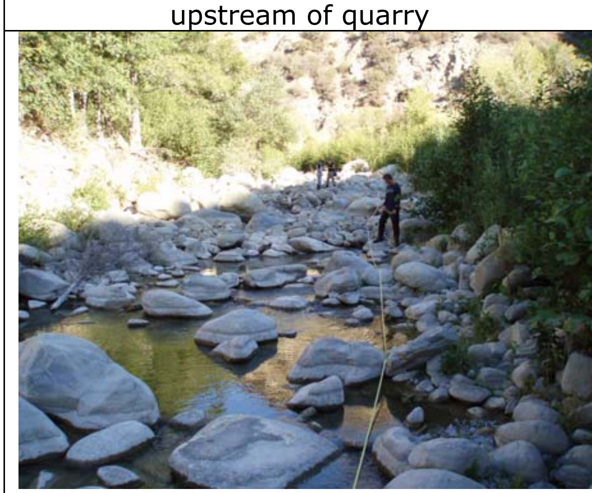

Station 4 – Foster Park

Station 12 – Below Matilija Dam

DRY
Station 2 – Lower Canada Larga Creek

DRY Station 3 – Upper La Canada Creek	
DRY Station 5 – San Antonio Creek	
DRY Station 7 – Lion Canyon Creek	
DRY 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	
Dry 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 the case for the 2006-2007 rain years when precipitation was below normal. As a result, Stations 2, 3, 5, 6, 7 and 14 were 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). Starting in 2009 this protocol will be replaced by the recently completed Surface Water Ambient Monitoring Program protocol (SWAMP 2007).

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.
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 and taxonomic identifications were conducted in the Aquatic Bioassay laboratory in Ventura; CA. 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 Professional Taxonomic Effort Level 3 specified by the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT), 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 2007 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. Simple agglomerative, hierarchical clustering using the Bray-Curtis dissimilarity metric (Bray and Curtis 1957; Lance and Williams 1967) 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 Primer v6 (Clarke and Gorley 2006). 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.

Non-metric multidimensional scaling (MDS) was used to ordinate the similarity scores derived from clustering (Shepard 1962 and Kruskal 1964). 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 define independent stress gradients of biological change in the community data.

RESULTS

Rainfall

Rainfall measured at the Stewart Creek gauging station during the 2006 to 2007 rain year (6.4 inches) was far below 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. In 2007, six of 15 stations were dry due to the exceptionally low rainfall conditions. This was in stark contrast to the previous two years when all stations had flow (except Station 6) as a result of extremely high rainfall, especially during the 2004 to 2005 rain year (43 inches). 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 2007 are presented in Table 4. Riffle velocities ranged from 0.20 ft/sec at Stations 8 (Stewart Canyon Creek) to 1.01 ft/sec at Station 0 on the Ventura River near its discharge point to the ocean. Flow in the watershed was greatest at Station 13 (8.48 cfs) on Matilija Creek and lowest at Station 8 (0.08 cfs).

Canopy Cover and Substrates

Vegetative canopy cover ranged from 3% at Station 4 (Foster Park) to 100% at Stewart Canyon Creek (Station 8) and on the North Fork of Matilija Creek (Station 11) (Table 4). Substrate complexity was relatively good at most stations in the watershed ranging from poorest (7) at Station 0 (Ventura River near the ocean) to best (17) at Station 15 (Lion Canyon Creek). Streambed substrates in the most of the watershed were, for the most part, composed of mixtures of fines, gravel, cobble and boulders. Stations 0 and 4 on the Ventura River and 15 and 9 on San Antonio Creek had the greatest percentage of fines. Upper watershed sites on Matilija Creek (10, 11 and 13) were composed mostly of gravel, cobble and boulders, as was Station 12 below the Matilija Dam. All of the sites were high gradient streams (≥ 2%), except Station 8 (<2%).

Water Quality, Nutrients & Bacteria

The range for pH measurements was narrow among all sites and ranged from 7.7 at Station 11 (N. Fork Matilija Creek) to 8.1 at Stations 4 (Foster Park) and 10 (N. Fork Matilija Creek) (Table 4). Dissolved oxygen concentrations ranged from 5.57 mg/L at Station 8 to 12.02 mg/L at Station 4. 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 percentage of canopy cover, ranging from 16.2 °C at Station 8 where there was nearly 100% canopy to 24.5 °C in the lower watershed at Station 4 where there was only 4% canopy. 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 = 739 to 910 uS/cm). The greatest conductance was measured at Station 8 in Stewart Canyon Creek (1675 uS/cm).

Nitrate nitrogen was greatest at Station 9 (4.6 mg/L) and was much lower or below detection (0.1 mg/L) at all other sites. Nitrite nitrogen and phosphate phosphorus were below detection at all sites, except phosphate which was just above detection at Station 0.

Indicator bacteria concentrations were elevated at several sites in the watershed. Total coliform bacteria concentrations exceeded the single sample REC1 standard (>10,000 MPN/100 mL) at Stations 0, 12 and 15. E. coli concentrations exceeded the REC1 standard

(400 MPN/100 mL) at Stations 0 and 10. Enterococcus bacteria concentrations exceeded REC1 standards (104 MPN/100mL) at Stations 0, 4 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 (101) at Station 0 on the Ventura River near its ocean discharge point to 171 at Station 12 located below Matilija Dam (Table 4, Figure 4). Physical habitat scores increased from downstream (Station 0) to upstream (Station 12). The decrease in habitat quality from the upper main stem to the ocean 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 at Foster Park, upstream of a bridge, with levees that line both banks and a streambed dominated by cobble and boulders. Station 0 is located above the Main Street Bridge and has levees on both banks, but also is impacted by a large transient population.

Each of the San Antonio Creek system sites scored over 100, with the best habitat found at Station 15 as a result of good instream cover, low embeddedness, and bank stability. Station 8, on Stewart Canyon Creek, had good canopy cover, low sediment deposition and good bank stability as a result of historical shoring with metal mesh. Station 9 lacked good instream cover and depth/velocity regimes, and was more embedded than other sites on the San Antonio. In addition, the north bank at this site was completely eroded as a result of large storm flows in 2005.

Stations 10, 11 and 13 on the main stem and N. Fork of Matilija Creek had physical habitat scores just below optimal. These sites all had good instream cover, were composed of a mixture of boulder, cobble and gravel, had little sediment deposition and good vegetative cover.

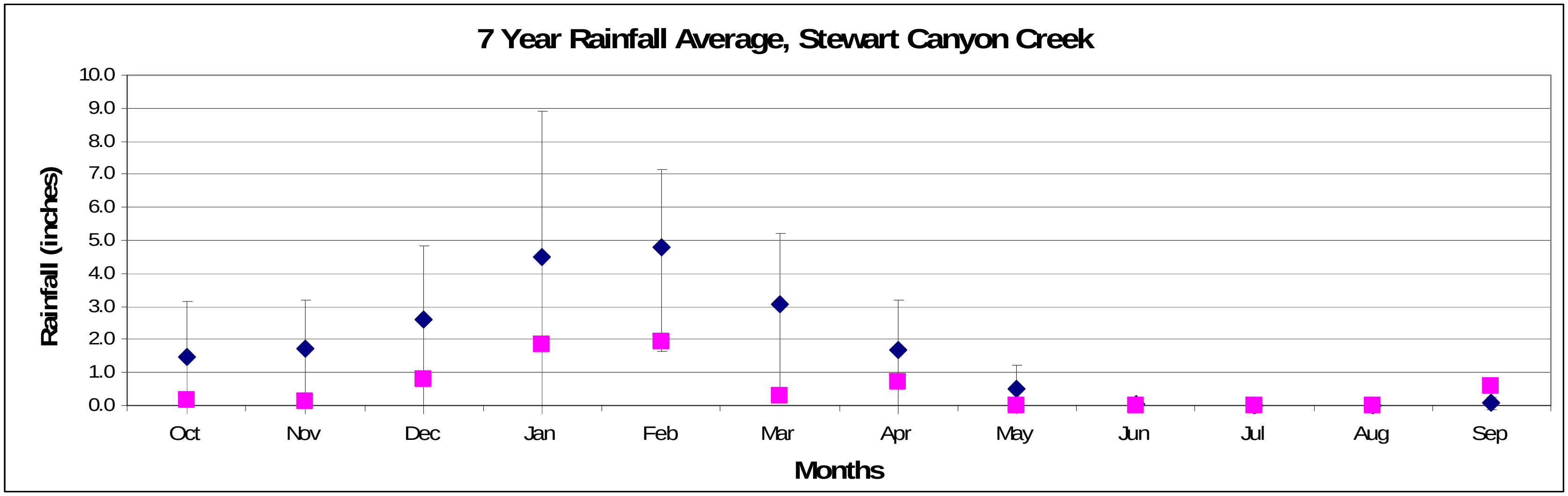


Figure 3. Average of monthly rainfall (blue symbols, ± 95% CI) at Stewart Canyon Creek from October 2000 to September 2007. Average monthly rainfall (pink symbols) for the 2006 to 2007 rain year only.

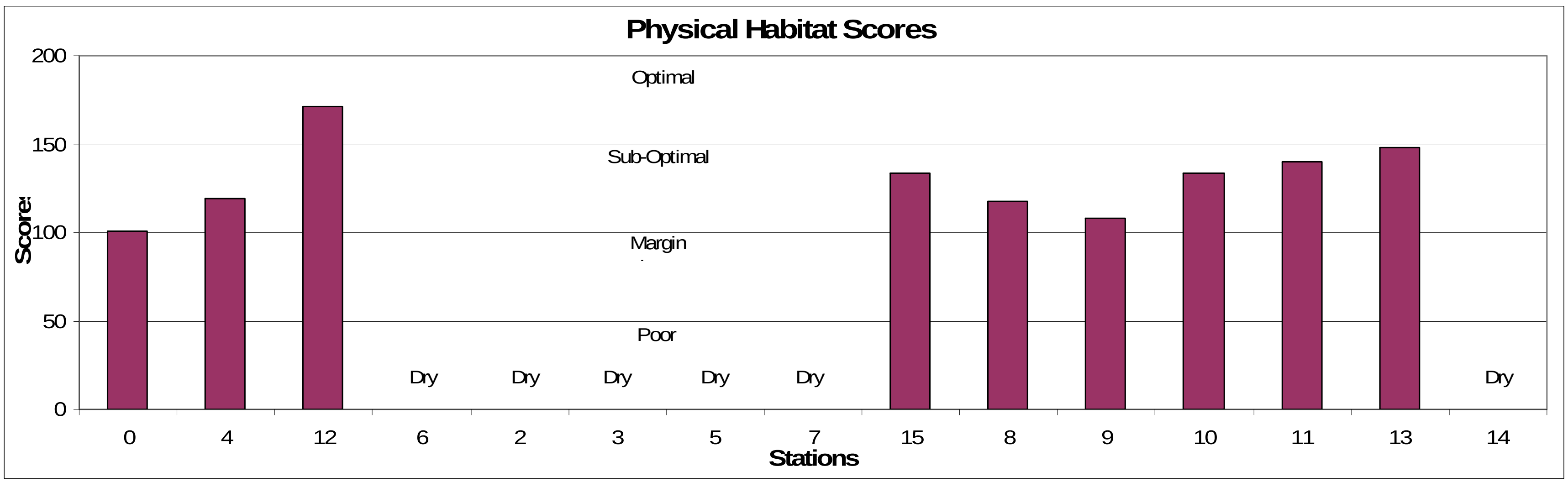


Figure 4. Physical habitat scores for reaches in the Ventura River Watershed.

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 Dry	3 Dry	5 Dry	7 Dry	15	8	9	10	11	13	14 Dry
Physical Habitat Parameter															
1. Instream Cover	7	12	18						18	13	8	16	16	14	
2. Embeddedness	11	10	16						14	12	8	15	13	16	
3. Velocity/Depth Regime	14	10	18						15	13	8	18	11	15	
4. Sediment Deposition	7	11	17						15	17	12	12	15	16	
5. Channel Flow	8	7	17						9	8	10	14	10	8	
6. Channel Alteration	12	11	17						19	10	18	13	15	18	
7. Riffle Frequency	16	16	18						15	10	9	14	17	11	
8. Bank Stability	9	17	18						6	14	8	15	16	17	
9. Vegetative Protection	10	7	15						12	10	9	9	17	15	
10. Riparian Vegetative Zone Width	7	18	17						11	11	18	8	10	18	
Reach Total	101	119	171						134	118	108	134	140	148	
Physical Habitat Characteristics															
Average Riffle Length (ft)	28	23	61						27	21	27	48	7	18	
Average Riffle Width (ft)	2.0	2.0	1.0						4.4	1.0	1.5	1.0	1.0	12.2	
Average Riffle Depth (in)	6	3	5						4	2	3	5	3	6	
Average Riffle Velocity (ft/sec)	1.01	0.46	0.75						1.04	0.20	0.21	0.88	0.53	0.95	
Flow (cf/sec)	5.08	2.88	0.97						4.44	0.08	0.66	0.80	0.27	8.48	
Vegetative Canopy Cover (%)	12.7	2.9	25.5						66.7	99	68.6	62.3	99.5	23.5	
Average Substrate Complexity	7	12	16						17	13	8	15	16	14	
Average Embeddedness	11	10	18						14	12	7	16	16	15	
Substrate Composition (%)															
Fines (<0.1 in.)	20	13	5						23	5	20	7	10	5	
Gravel ((0.1 -2 in.)	35	22	8						17	5	35	22	15	10	
Cobble (2-10 in)	43	61	32						48	85	42	28	38	50	
Boulder (>10 in.)	2	3	52						12	5	3	58	37	35	
Bedrock (solid)	0	0	3						0	0	0	0	0	0	
Substrate Consolidation	High	Mod	High						Mod	High	High	High	High	High	
Percent Gradient (%)	2	2	2						2	1	3	3	3	2	

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 Dry	3 Dry	5 Dry	7 Dry	15	8	9	10	11	13	14 Dry
Chemical Characteristics															
pH	7.85	8.10	7.90						8.00	7.80	7.80	8.10	7.70	7.80	
D.O (mg/L)	9.14	12.02	7.50						7.58	5.57	7.40	8.85	6.38	7.65	
Water Temperature (C°)	19.8	24.5	20						17.7	16.2	17.4	21	17.4	17.6	
Specific Conductance (µS/cm at 25EC)	1332	910	831						758	1675	1054	844	834	739	
Nitrate Nitrogen (mg/L)	ND	0.2	ND						ND	0.4	4.6	ND	ND	ND	
Nitrite Nitrogen (mg/L)	ND	ND	ND						ND	ND	ND	ND	ND	ND	
Phosphate-Phosphorus (mg/L)	0.2	ND	ND						ND	ND	ND	ND	ND	ND	
Indicator Bacteria															
Total Coliforms (MPN/100 mL)	17329	4352	10462						19890	461	6131	2987	1211	135	
E. coli (MPN/100 mL)	1126	31	10						<10	63	121	404	10	<10	
Enterococcus (MPN/100 mL)	278	388	62						31	94	211	41	10	10	

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 4,745 BMIs, represented by 74 taxa, were identified from the nine samples collected at the nine sampling sites during the September 2007 survey (Appendix A, Table A-1). The overall composition of the BMI communities collected at each of the sites in the Ventura River Watershed was very similar (Table 5). However, eight of the nine stations had different species that ranked as most abundant. The most abundant species at the Ventura River Stations (0, 4 and 12) included flatworms (Turbellaria), seed shrimp (Ostracoda) and black flies (*Simulium sp*). A mayfly (*Tricorythodes sp*) was most abundant at Stations 15 and 9 on San Antonio Creek, while a gastropod (*Physa sp*) was most abundant at Stewart Canyon Creek. A beetle (*Microcylloepus sp*) and midge flies (Chrionomidae) were most abundant at Matilija Creek Stations 11 and 13, respectively.

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 20 (Station 0, Ventura River) to 39 (Stations 8 and 9, Stewart Canyon Creek) (Figure 5). EPT taxa were lowest at Station 0 and greatest at Stations 16 on Stewart Canyon Creek. The average numbers of Coleoptera taxa ranged from one (Station 0) to 5 (Station 11, Matilija Creek), while the average numbers of predator taxa ranged from 4 (Station 4) to 12 (Station 8).

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 are 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 11% at Stations 0 and 4 to 74% at Station 9 (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 (13%) and 11 in Matilija Creek (17%). Shannon Diversity was least at Station 0 (1.88) and greatest at Station 8 (3.12). The average percentage of non-insect individuals was lowest in the upper watershed, ranging from 0.8% at Station 13 on Matilija Creek to 67.8% at Station 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 4.4 at Station 9 to 6.7 at Station 4 (Figure 7). There were low percentages of intolerant organisms present at all sites, with the greatest percentage found at Station 11 (17%). The greatest percentage of tolerant organisms was found at Station 4 (58%). Percent Dominance was greatest at Station 0 and least at Station 8 (11%).

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 exceeding 50% of the population at each site, except at Station 0 which was 39.7% (Figure 8). The percentage of filterers was lowest at Stations 0, 4 and 15 in the lower watershed, ranging from 2.6% to 9.6%. Filterers were greatest at Station 12 (42%)

below Matilija Dam. Predators ranged from 1.5% at Station 10 to 50.3% at Station 0. The large abundance of predators at Station 0 was due to the presence of flatworms (Turbellaria). Grazers accounted for 22.9% of the population at Station 8, but were <10% at all other sites.

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 2007 survey.

Eight of the nine stations sampled in 2007 had IBI scores indicating that water quality conditions were unimpaired. Station 0 (Main Street Bridge) was the only site in the watershed to score in the "poor" range (20-39) during the 2007 survey (Table 6, Figure 9). This score indicates that water quality conditions at the site were impaired. Six sites had IBI scores in the "fair" range (40-59), and two sites scored in the "good" range (60-79). 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. San Antonio Creek (Stations 15, 8 and 9) IBI scores increased upstream from lowest at Station 15 which is located downstream of stables to greatest at Station 9 located upstream of the confluence with Stewart Canyon Creek. IBI scores downstream of the rock quarry on the N. Fork of the Matilija Creek (Station 10) were slightly lower than the upstream Station 11. This may indicate that the quarry is influencing the BMI communities on this reach. Station 13, located downstream of a small community on Matilija Creek, had the lowest IBI score of all upper watershed sites, but could not be compared to upstream Station 14 since it was dry.

Historical Results (2001 to 2007)

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.

7 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 seven 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.

7 Year IBI Scores

During the seven year period from 2001 to 2007 the average IBI scores for all sites, except Stations 0, 1, 12 and 2 were in the fair or good range (Figure 11). The average scores for Stations 0, 1 (above the Main Street Bridge), 2 (Canada Larga Creek) and 12 (below Matilija Dam) 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.

7 Year Cluster and Ordination Analysis

Spatial and temporal patterns in the BMI community data from 2001 to 2007 were investigated using cluster and ordination analyses. Both of these are based on the Bray-Curtis similarities for pairs of stations. The results of the cluster and ordination analyses are summarized in Figures 12 to 13.

Nine station cluster groups were identified based on Bray-Curtis dissimilarities and ordination space distances (Figures 12 and 13). The species composition and abundances of each of the three station groups was, for the most part, very similar to one another during the seven year period. This is depicted in the ordination space by the extensive overlap between station groups, especially groups 7, 8 and 9. The station cluster groups were delineated spatially by their location in either the lower or upper watershed and were not clearly separated by survey year.

Station groups 1 thru 6 were represented by one to three miscellaneous stations that were most dissimilar to the other three main station groups (7, 8 and 9). These three cluster groups were represented by stations located in the lower watershed (9), upper watershed (8) and a mixture of both upper and lower watershed sites in (7). Group 8 included upper watershed sites located on Matilija Creek, the North Fork of Matilija Creek and Station 12 below Matilija Dam. Station 12 is technically in the lower watershed, but had the best physical habitat conditions of any site during the seven year period. Group 9 included mostly sites located on the Ventura River main stem and on the San Antonio Creek system. Group 7 included upper watershed sites located on Matilija Creek and also lower watershed sites on Stewart Canyon Creek and Upper Canada Larga Creek.

Discussion

During September 2007 teams from the Ventura County Watershed Protection District, Ojai Sanitation District and Aquatic Bioassay and Consulting Laboratories collected water quality and benthic macroinvertebrate (BMI) sampling at 9 of 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. This was the last of a seven year monitoring effort at these 15 sites.

This report represents the culmination of seven years of an ongoing effort to assess the water quality conditions in the Ventura River Watershed. Starting in the spring and summer of 2009 this effort will continue, but will be based on a probabilistic regional monitoring design that will allow for the direct comparison of water quality conditions in the Ventura River Watershed, with watersheds from throughout the southern California region. This effort will include sampling at six randomly assigned stations in the watershed each year and several fixed locations that will be returned to each year to detect water quality trends. Besides the collection of benthic macroinvertebrate and physical habitat data, nutrients, water chemistry and algae data will also be collected as part of the regional effort. At the end of five years a total of 30 random sites will have been sampled in the Ventura Watershed, the minimum necessary to make statistically valid comparisons with other watersheds in the region.

Rainfall

Rainfall at Stewart Canyon Creek during the 2006 to 2007 rain year (6.4 inches) was far below the annual average (21.2 inches). This was less than the previous year (2005 to 2006) when 23.4 inches fell and far less than in 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 is 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. Following drought conditions in 2007, only nine of the 15 stations had enough flowing water for samples to be taken.

Ventura River

The aquatic health of the Ventura River Watershed ranged from poor to fair in 2007, based on the results of the southern California IBI. Station 0 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 recovered by the 2007 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 and 67% of the population was dominated by flatworms (Turbellaria), midge flies (Chironomidae) and seed shrimp (Ostracoda).

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 increase accordingly. This was the case as the IBI scores increased into the "fair" or unimpaired range at these sites.

Canada Larga Creek

The Canada Larga Creek drainage was dry during the 2007 survey.

San Antonio Creek

Of the five stations located on the San Antonio Creek system (5, 7, 8, 9 and 15), only Stations 15, 8 and 9 were flowing during the 2007 survey. Each of these scored in the sub-optimal range for physical habitat conditions and had unimpaired IBI scores. Station 15 had the best physical habitat score due to the presence of good instream cover, low sediment deposition, embeddedness and channel alteration and has stables and grazing land in its vicinity. Station 8 is 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 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. During 2007 Station 14 was dry. Each of these sites had 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. Station 11 is located at the highest elevation in the watershed (over 1,300 ft) and had the best IBI score (67) in the watershed, scoring in the good range. Both Stations 10 and 13 had slightly lower IBI scores (47 and 41, 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 the 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 2007 the average IBI scores for all sites, except Stations 0, 1, 12 and 2, were in the fair to good range. The average scores for Stations 0 and 1 (each located above the Main Street Bridge), Station 2 (Canada Larga Creek) and Station 12 (below Matilija Dam) were below the impairment threshold (39). IBI scores in the impaired range for Stations 0 and 1 can be at least partly attributed to the lower physical habitat conditions found at these lower watershed sites. In contrast, Station 12 had optimal physical habitat conditions during the seven year period. The low IBI scores could be the result of decreased water quality due to some anthropogenic input (e.g. nutrients, heavy metals, etc) or possibly this sites location directly below the Matilija Dam. Ward and Stanford (1983) showed that dams disturb biological communities by creating disruptions in the river continuum. This is due to a lack of upstream recruitment and alterations in water quality (e.g. temperature, pH, dissolved oxygen, etc). They tested this hypothesis using datasets from nine rivers from around the world (Stanford and Ward, 2001). The biological communities tend to recover with distance downstream of the dam so long as other anthropogenic disturbances are not present.

7 Year Cluster and Ordination Scores

Results for cluster and ordination analysis of the combined BMI data from 2001 to 2007 showed that the BMI community in the Ventura Watershed has been relatively stable, both spatially and temporally during the seven year period between 2001 and 2007. Nine station groups were identified based on cluster analysis. The three main cluster groups were spatially delineated by their location in either the lower or upper watershed, with little separation by sampling year. Stations above Matilija Dam (10, 11, 13 and 14) clustered together while lower watershed stations located on the main stem (1 and 4), Canada Larga Creek (2) and the San Antonio Creek system (7, 9 and 15) tended to cluster together. In addition, there was a transition cluster group that spanned sites in both the upper (11) and lower (8 and 9) watersheds.

The lack of any observable temporal trend across the seven year period is of note. Historic rainfall during the winter of 2005 dropped over 40 inches of rain in most parts of the watershed, leading to scouring, erosion and sedimentation at many of the sampling sites, especially in the lower watershed. There were observable changes in the BMI community in 2006, but these changes were not of a magnitude great enough to create an observable signal in the seven year trend analysis. This indicates that the BMI community in the watershed is relatively stable and responds to natural environmental stressors (heavy rainfall) in a predictable way.

Table 5. The top 10 species at each station in the Ventura River Watershed, ranked by % abundance, 2007.

0			4			12			15			8		
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
Turbellaria	46.7	46.7	Ostracoda	22.2	22.2	Simulium sp	37.8	37.8	Tricorythodes sp	19.4	19.4	Physa sp	11.9	11.9
Chironomidae	11.9	58.6	Calopary/Eupary sp	21.0	43.2	Baetis sp	13.4	51.2	Microcylloepus sp	14.6	34.0	Simulium sp	9.3	21.2
Ostracoda	8.8	67.4	Chironomidae	15.7	58.9	Microcylloepus sp	12.5	63.7	Calopary/Eupary sp	11.4	45.4	Chironomidae	8.9	30.1
Fallceon quilleri	8.0	75.4	Sperchon sp	11.0	69.9	Argia sp	6.6	70.3	Chironomidae	11.4	56.8	Hydropsyche sp	8.5	38.6
Physa sp	7.6	83.0	Turbellaria	8.4	78.3	Turbellaria	5.1	75.4	Turbellaria	7.4	64.2	Sperchon sp	8.2	46.8
Microcylloepus sp	5.6	88.6	Simulium sp	3.7	82.0	Chironomidae	3.7	82.8	Fallceon quilleri	5.8	70.0	Tinodes sp	6.8	53.6
Menetus sp	2.0	90.6	Ochrotrichia sp	3.1	85.1	Hydropsyche sp	3.7	79.1	Culicoides sp	4.6	74.6	Wormaldia sp	4.4	58.0
Baetis sp	1.9	94.4	Hydropsyche sp	2.2	89.5	Petrophila sp	3.4	86.2	Simulium sp	4.6	79.2	Baetis sp	3.6	68.8
Nematoda	1.9	92.5	Hydroptilidae	2.2	87.3	Culicoides sp	2.7	88.9	Hydropsyche sp	2.0	83.2	Hydropsychidae	3.6	61.6
Simulium sp	1.7	96.1	Euparyphus sp	1.8	91.3	Ochrotrichia sp	2.0	90.9	Hydropsychidae	2.0	81.2	Ochrotrichia sp	3.6	65.2

9			10			11			13		
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	25.1	25.1	Baetis sp	34.3	34.3	Microcylloepus sp	20.2	20.2	Chironomidae	28	28
Hydropsyche sp	14.7	39.8	Simulium sp	14.8	49.1	Chironomidae	14.1	34.3	Culicoides sp	10.3	38.3
Hydropsychidae	8.8	48.6	Microcylloepus sp	13.9	63.0	Micrasema sp	13.0	47.3	Ochrotrichia sp	9.4	47.7
Chironomidae	6.1	54.7	Hydropsyche sp	13.7	76.7	Hydropsyche sp	12.1	59.4	Microcylloepus sp	8.8	56.5
Simulium sp	5.9	60.6	Chironomidae	4.0	80.7	Baetis sp	7.9	67.3	Simulium sp	8.4	64.9
Ochrotrichia sp	5.3	65.9	Petrophila sp	3.4	84.1	Simulium sp	4.9	72.2	Baetis sp	6.3	71.2
Fallceon quilleri	4.4	70.3	Ochrotrichia sp	2.7	86.8	Elmidae	3.2	75.4	Hydroptilidae	5.2	76.4
Hydroptilidae	3.5	73.8	Fossaria sp	2.5	89.3	Calopary/Eupary sp	3.0	78.4	Calopary/Eupary sp	5	81.4
Micrasema sp	3.1	76.9	Tinodes sp	1.7	91.0	Culicoides sp	3.0	81.4	Ceratopogonidae	4.4	85.8
Sperchon sp	2.9	79.8	Fallceon quilleri	1.5	92.5	Tinodes sp	2.6	84.0	Tricorythodes sp	3.3	89.1

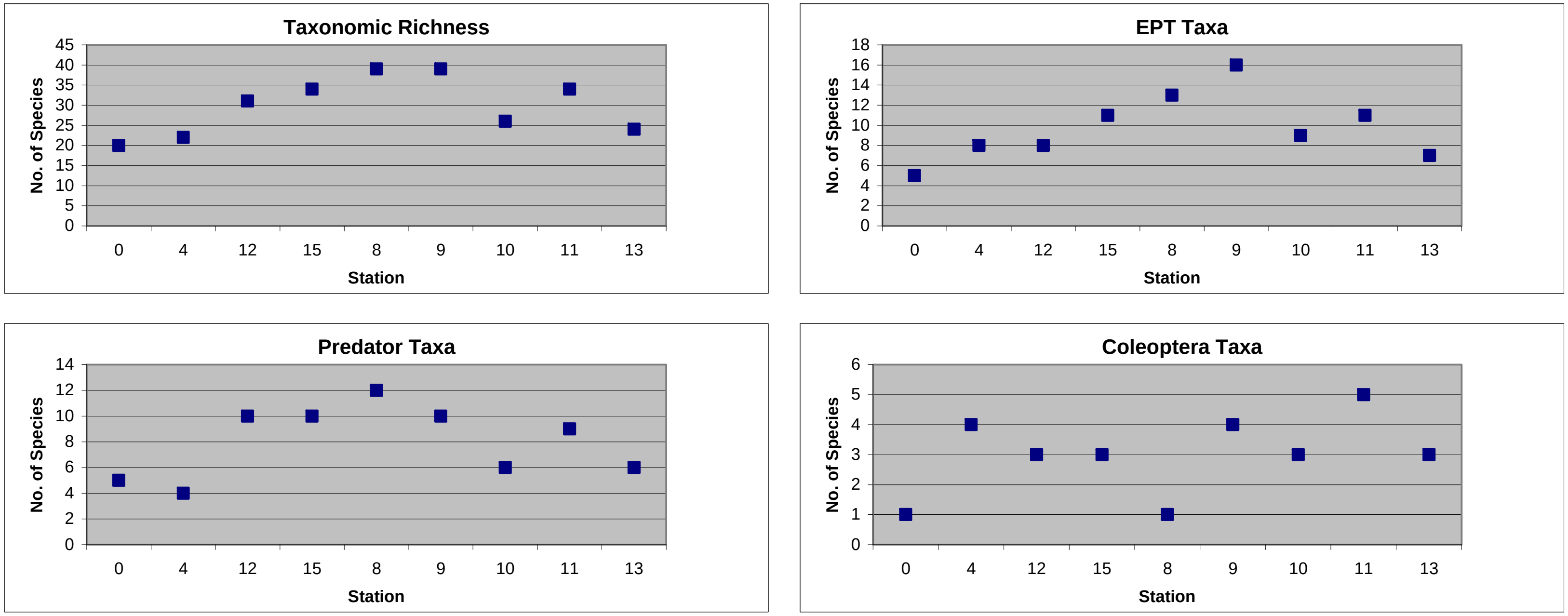


Figure 5. Richness measures: average (n=3) for each biological metric (± 95% CI) by site in the Ventura River Watershed, 2007.

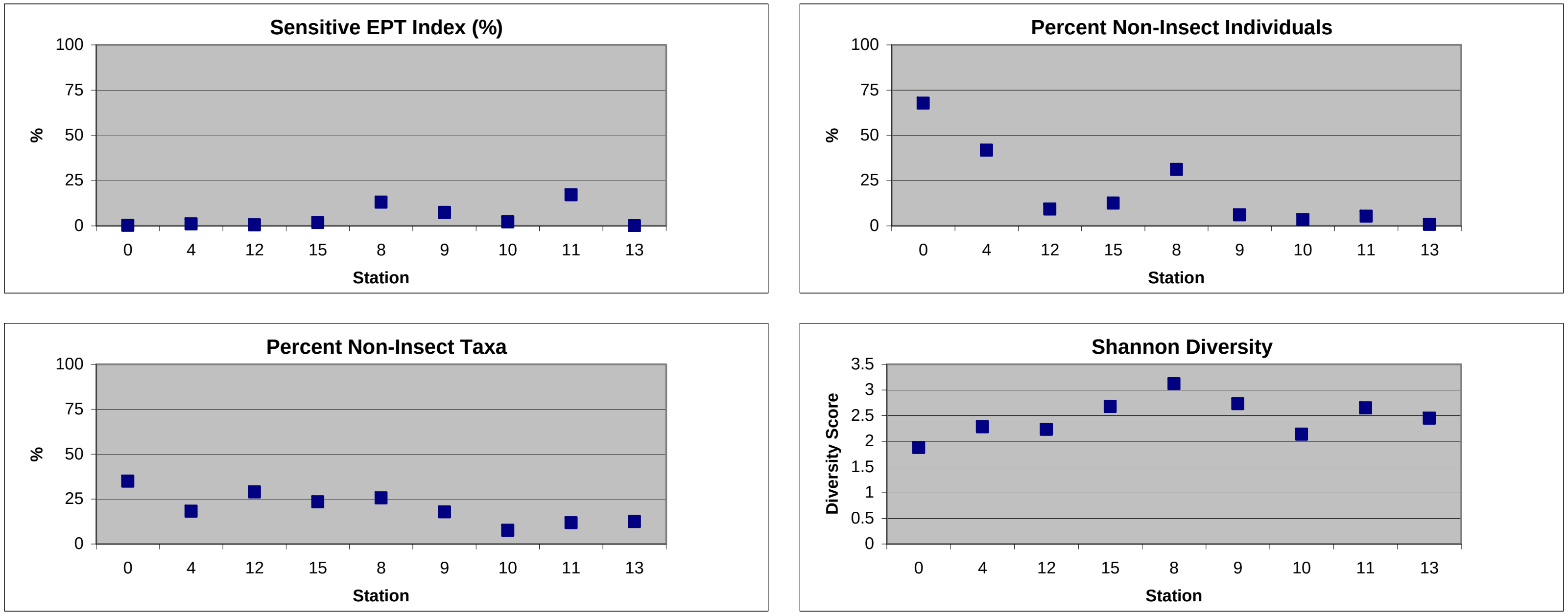


Figure 6. Composition measures: average (n=3) for each biological metric (± 95% CI) by site in the Ventura River Watershed, 2007.

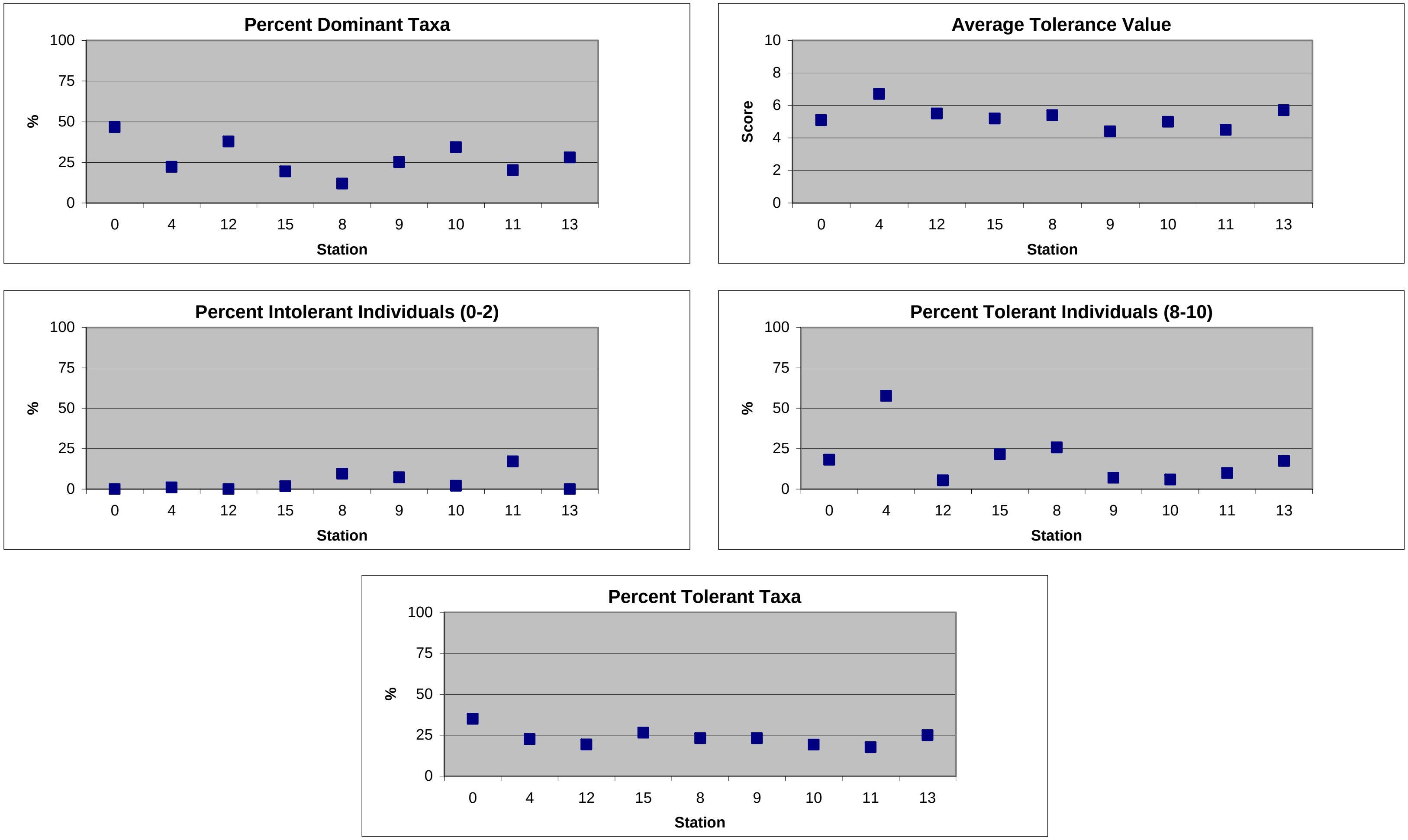


Figure 7. Tolerance/Intolerance measures: average (n=3) for each biological metric (± 95% CI) by site in the Ventura River Watershed, 2007.

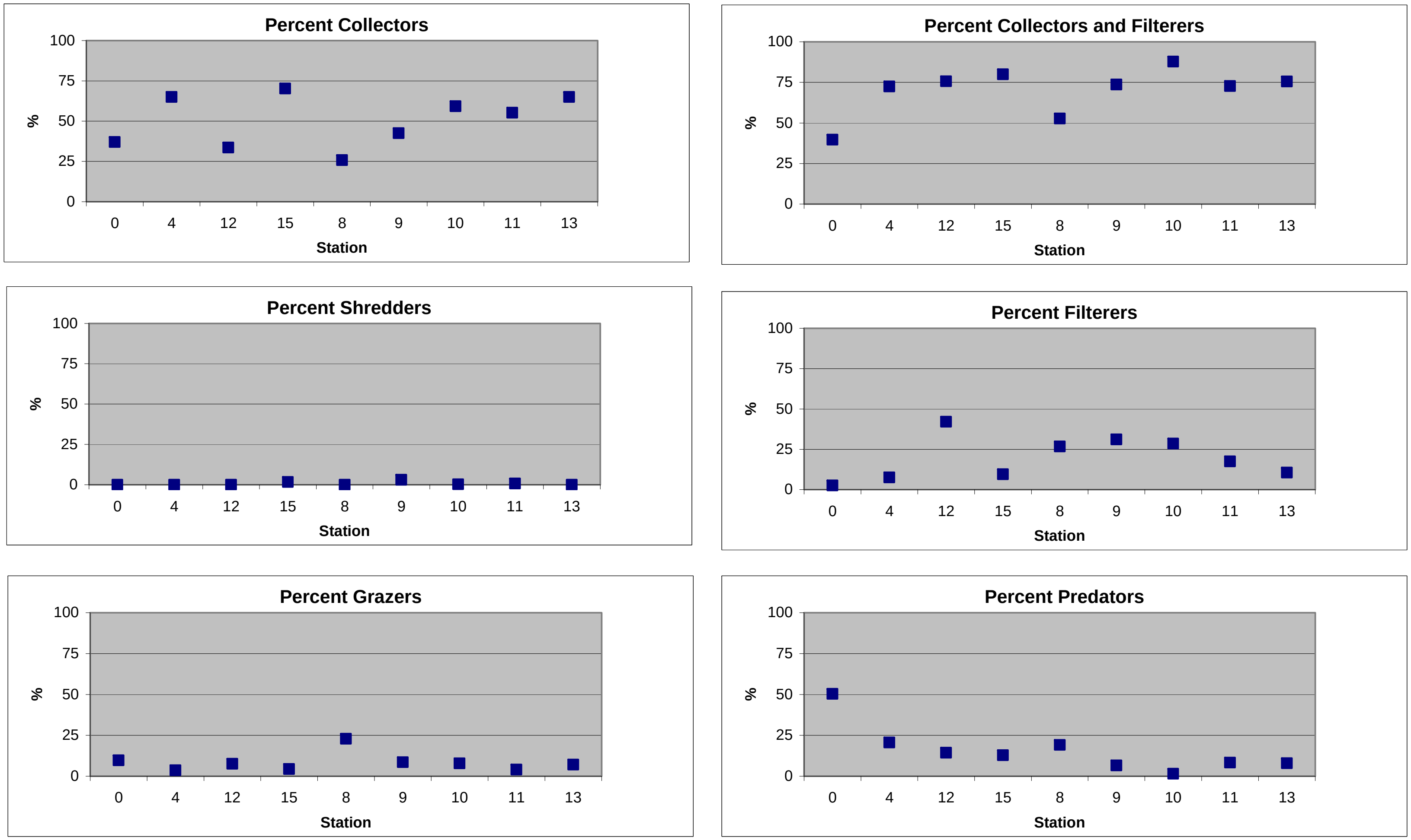


Figure 8. Functional Feeding Group measures: average (n=3) for each biological metric (± 95% CI) by site in the Ventura River Watershed, 2007.

Table 6. Southern California IBI scores and ratings for sites sampled in the Ventura River Watershed, 2007.

	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	3	4	4						6	7	9	5	6	4	
Predator Taxa	2	1	7						7	9	7	3	6	3	
Coleoptera Taxa	2	7	5						5	2	7	5	8	5	
% Non-Insect	3	7	5						6	5	7	10	9	8	
% Intolerant Individuals	0	1	0						1	4	3	1	6	0	
% Tolerant	1	4	6						3	4	4	6	6	4	
% Collector Individuals	10	6	5						5	10	6	3	6	5	
Total	21	30	32						33	41	43	33	47	29	
Adjusted to 100 Scale	30	43	46						47	59	61	47	67	41	
	Poor	Fair	Fair						Fair	Fair	Good	Fair	Good	Fair	

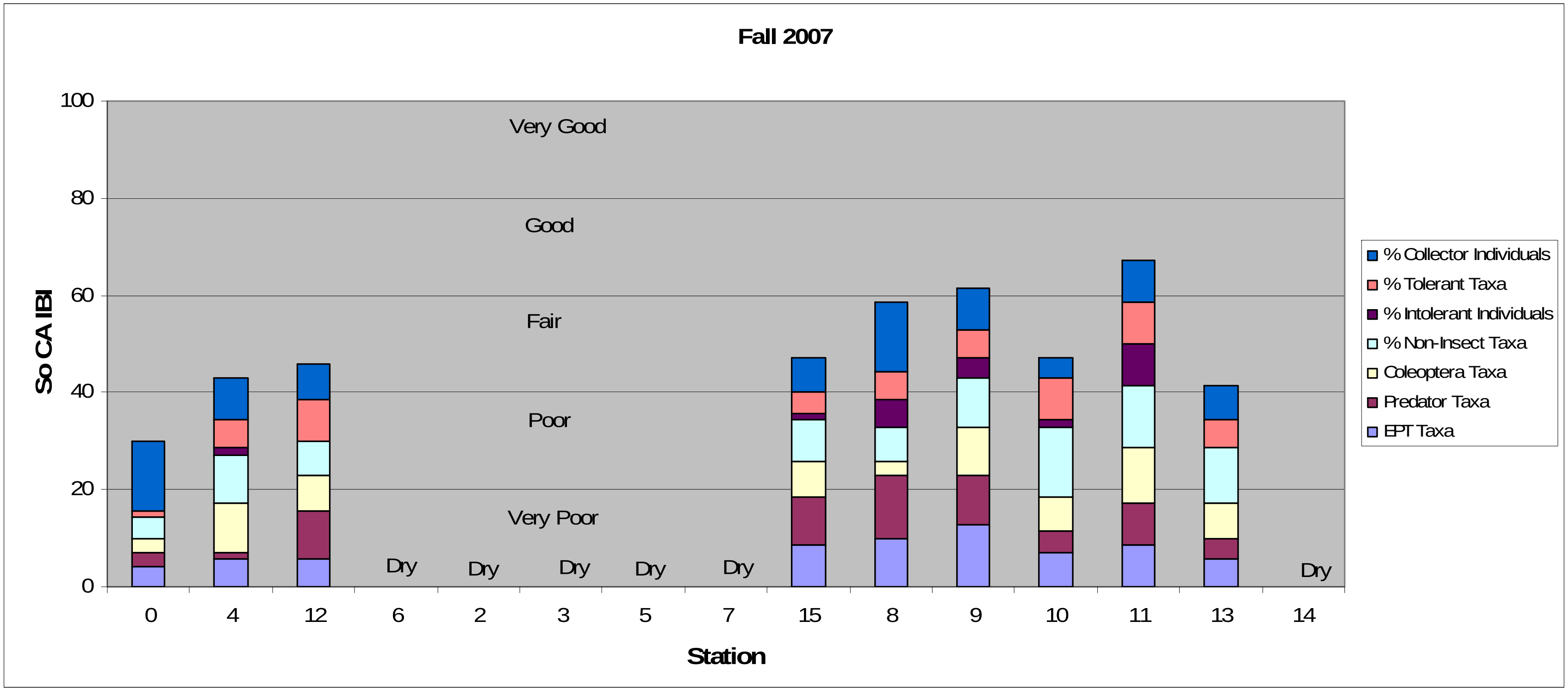


Figure 9. Southern California IBI Scores for sites in the Ventura River Watershed, 2007. Histogram bars are divided by the proportion that each biological metric contributed to the total score.

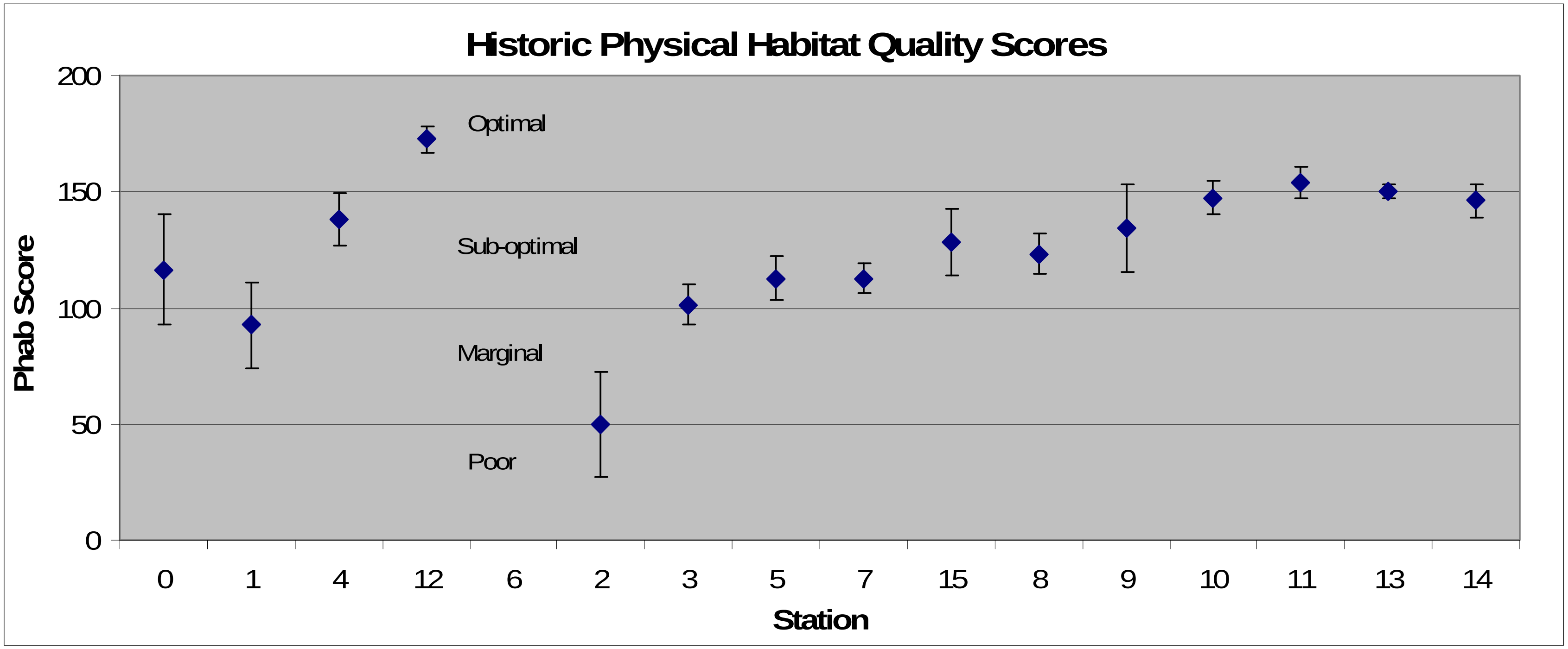


Figure 10. Average physical habitat scores (± 95% CI) for sites in the Ventura River Watershed, 2001 to 2007.

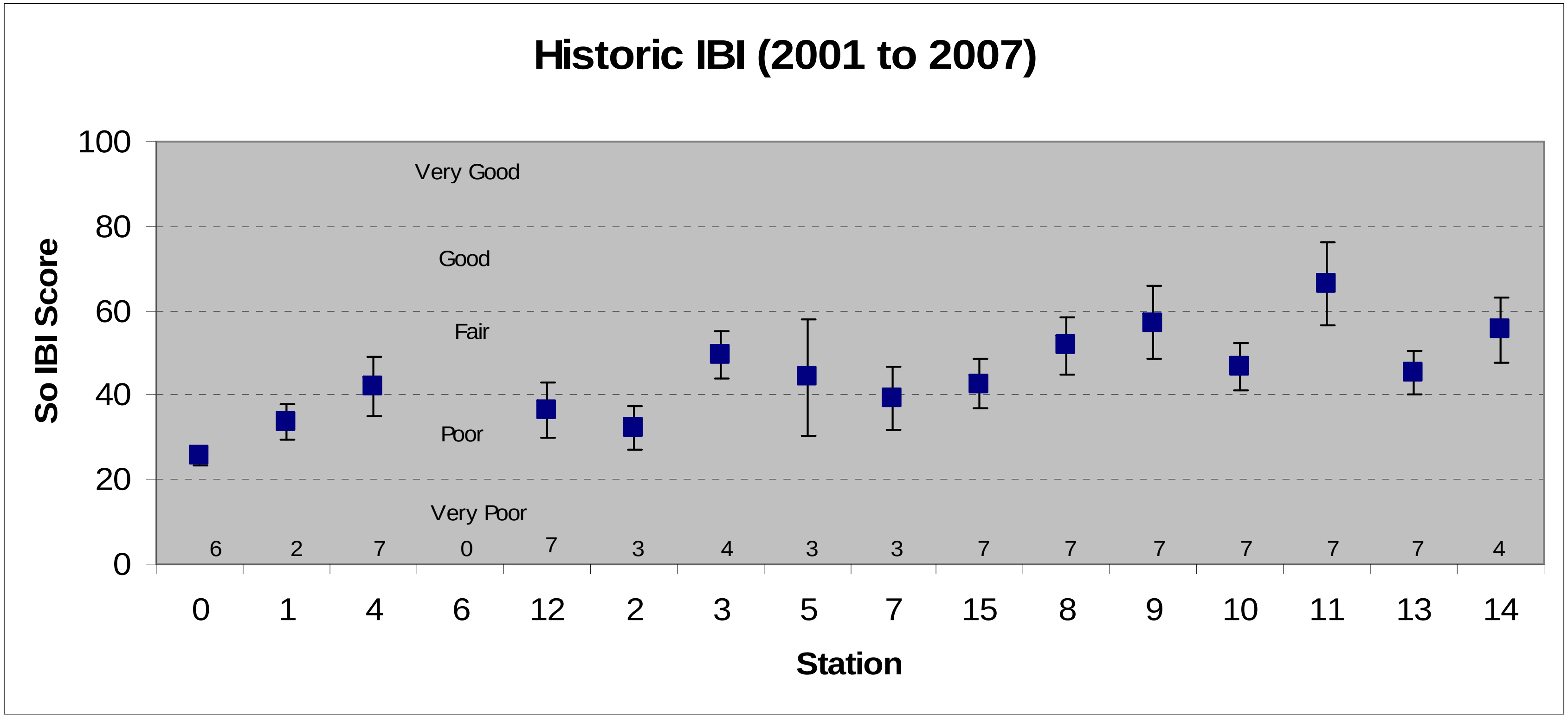


Figure 11. Average (± 95% CI) So CA IBI scores for sites in the Ventura River Watershed, 2001 to 2007. Number of years included in average (n) appears above station label.

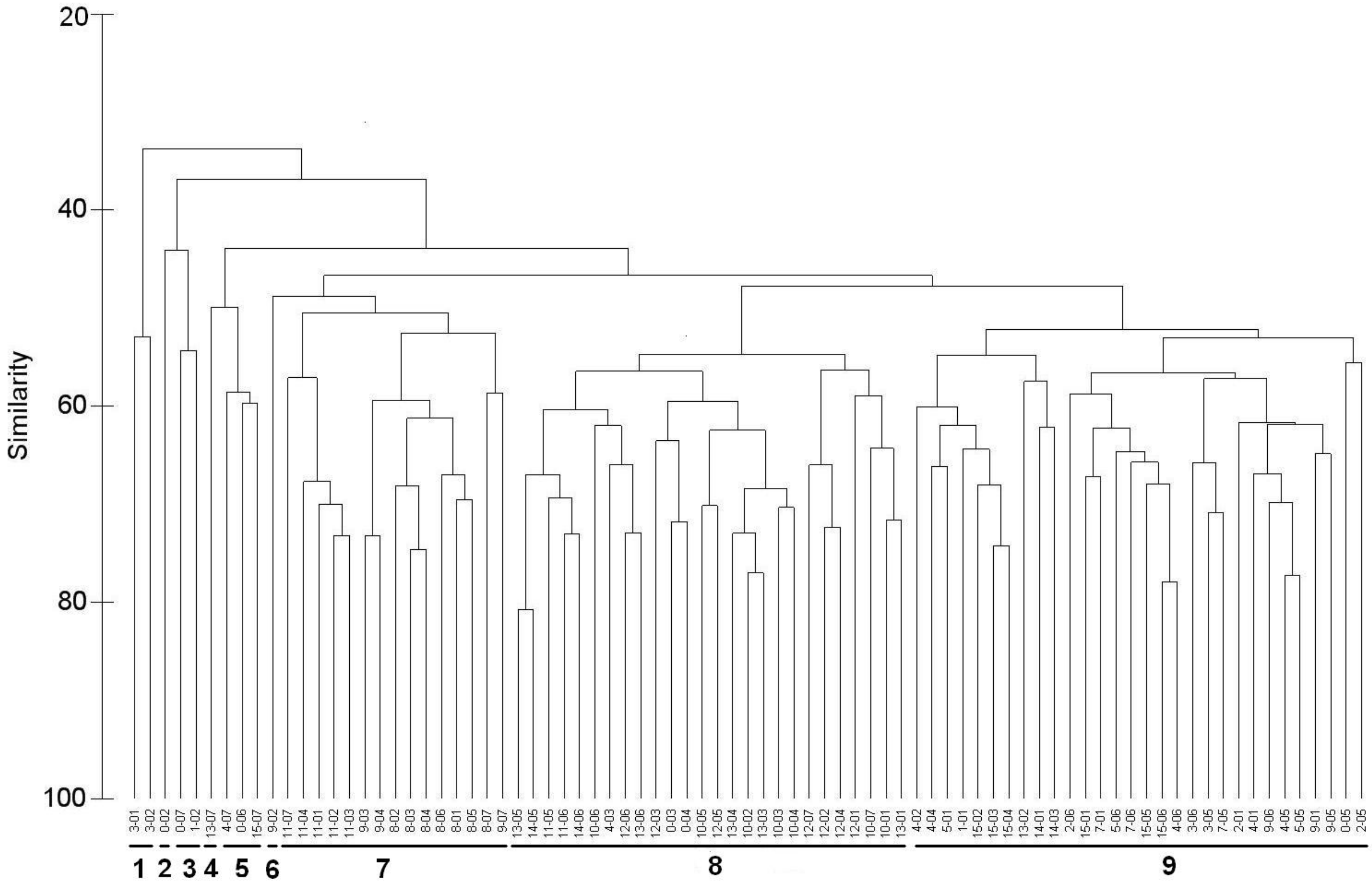


Figure 12. Station groups created by cluster analysis using the Bray-Curtis similarity index.

Ventura Watershed - 2001 to 2007

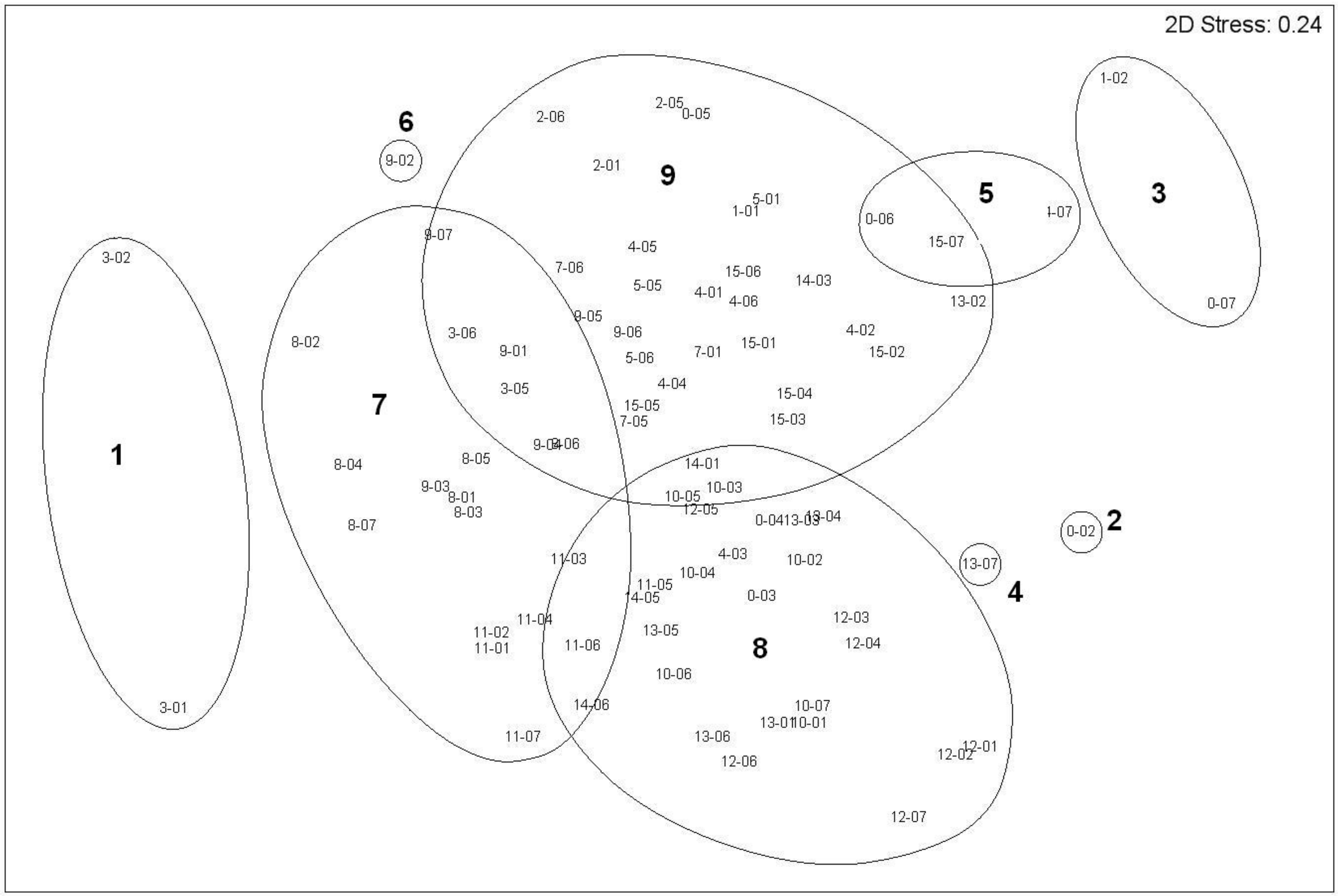


Figure 13. Ordination space plot by MDS, with station-year labels and cluster groups identified (1 thru 8).

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APPENDIX A – BMI TAXA LISTS & METRIC TABLES

Table A-1. September 2007 BMI raw taxa list for all sites in the Ventura River Watershed.

Identified Taxa	Tol Val (TV)	Func Feed Grp	0	4	12	15	8	9	10	11	13
Insecta Taxa											
Ephemeroptera											
Baetis sp	5	cg	10	1	79	2	18	13	181	42	33
Choroterpes sp	2	cg						2			
Fallceon quilleri	4	cg	43	3	3	29	4	24	8		13
Tricorythodes sp	4	cg				97	12	137	5		17
Odonata											
Argia sp	7	p			39	8	8	3	1	3	
Coenagrionidae	9	p				1		1			
Hetaerina sp	5	p			1	4					
Libellulidae	9	p	1							3	8
Plecoptera											
Malenka sp	2	sh							1	3	
Hemiptera											
Abedus sp	8	p							1		
Ambrysus sp	5	p				3					
Belostomatidae	8	p				1					
Corixidae	8	p						1			
Trichoptera											
Cheumatopsyche sp	5	cf		2		5	5	7			
Helicopsyche sp	3	sc						1			
Hydropsyche sp	4	cf	2	11	22	10	43	80	72	64	11
Hydropsychidae	4	cf		6		10	18	48		1	
Hydroptila sp	6	sc			9				1		6
Hydroptilidae	4	sc		11	2	7	4	19		1	27
Marilia sp	0	sh				8		12			
Micrasema sp	1	mh					8	17		69	
Neotrichia sp	4	sc				2					
Ochrotrichia sp	4	ph	1	15	12	4	18	29	14	6	49
Oecetis sp	8	p						2			
Oxyethira sp	3	ph	1		2						
Polycentropus sp	6	p					4	3		3	
Rhyacophila sp	0	p		5			2		1	3	
Tinodes sp	2	sc				1	34	7	9	14	
Wormaldia sp	3	cf			1		22	1		2	
Coleoptera											
Elmidae	4	cg		1	1			1		17	1
Helichus sp	5	sh						4		1	
Heterlimnius sp	4	cg				1		1	1		
Microcylloepus sp	4	cg	30	8	74	73	2		73	107	46
Optioservus sp	4	sc								2	
Peltodytes sp	5	mh		1		2					
Postelichus sp	5								1		2
Psephenus sp	4	sc		2	1			14		4	
Diptera											
Antocha sp	3	cg	1			1		1		2	
Bezzia/Palpomyia sp	6	p			1				1	7	
Caloparyphus/Euparyphus sp	8	cg	1	103		57	5	8	7	16	26
Ceratopogonidae	6	p			1		8		1	4	23
Chironomidae	6	cg	64	77	22	57	45	33	21	75	146
Culicoides sp	8	cg		8	16	23	6		5	16	54
Ephydridae	6							4			
Euparyphus sp	8	cg	3	9		5	2	2	5	4	1
Forcipomyia sp	6	p	7		4	2	9	2	3		3
Hemerodromia sp	6	p			2		1	1		3	4
Hexatoma sp	2	p						2			
Maruina sp	2	sc					4				

Table A-1. Continued.

Identified Taxa	Tol Val (TV)	Func Feed Grp	0	4	12	15	8	9	10	11	13
Meringodixa chalonensis	2	cg								2	
Muscidae	6	p					1				
Pericoma/Telmatoscopus sp	4	cg					12			2	
Probezzia sp	6	p					2				1
Psychodidae	10	cg					1				
Simulium sp	6	cf	9	18	223	23	47	32	78	26	44
Tipula sp	4	om					1			1	
Tipulidae	3				1				1		
Lepidoptera											
Petrophila sp	5	sc		5	20				18		3
Non-Insecta Taxa											
Copepoda	8	cg						1			
Nematoda	5	p	10	1	4	1					
Oligochaeta	5	cg			3		16	2	5	1	
Ostracoda	8	cg	47	109		5	7	5		9	1
Turbellaria	4	p	251	41	30	37	12	4			
Amphipoda											
Hyalella sp	8	cg				1					
Basommatophora											
Ferrissia sp	6	sc					3				
Fossaria sp	8	sc			4		5		13		1
Menetus sp	6	sc	11			2	5	3			
Physa sp	8	sc	41		3	10	60	2			
Hypsogastropoda											
Hydrobiidae	8	sc			6						
Trombidiformes											
Lebertia sp	8	p					3				
Sperchon sp	8	p	1	54	1	5	41	16		5	
Torrenticola sp	5	p			1	2	5			13	2
Veneroida											
Corbicula sp	10	cf			2						
Sphaeriidae	8	cf	3								
TOTAL			**537**	**491**	**590**	**499**	**503**	**545**	**527**	**531**	**522**

Table A-2. September 2007 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	20	22	31	Dry	Dry	Dry	Dry	Dry	34	39	39	26	34	24	Dry
EPT Taxa	5	8	8						11	13	16	9	11	7	
Predator Taxa	5	4	10						10	12	10	6	9	6	
Coleoptera Taxa	1	4	3						3	1	4	3	5	3	
Community Composition Measures															
EPT Index (%)	10.6	11	22						35.1	38.2	73.8	55.4	39.2	29.9	
Sensitive EPT Index (%)	0.2	1	0.5						1.8	13.1	7.3	2.1	17.1	0	
Percent Non-Insect Individuals	67.8	41.8	9.2						12.6	31.2	6.1	3.4	5.3	0.8	
Percent Non-Insect Taxa	35	22.7	19.4						26.5	23.1	23.1	19.2	17.6	25	
Shannon Diversity	1.88	2.28	2.23						2.68	3.12	2.73	2.14	2.65	2.45	
Community Tolerance Measures															
Percent Dominant Taxa	46.7	22.2	37.8						19.4	11.9	25.1	34.3	20.2	28	
Average Tolerance Value	5.1	6.7	5.5						5.2	5.4	4.4	5	4.5	5.7	
Percent Intolerant Individuals (0-2)	0	1	0						1.8	9.5	7.3	2.1	17.1	0	
Percent Tolerant Individuals (8-10)	18.1	57.6	5.4						21.6	25.8	7	5.9	10	17.4	
Percent Tolerant Taxa (8-10)	35	22.7	19.4						26.5	23.1	23.1	19.2	17.6	25	
Community Feeding Group Measures															
Percent Chironomidae	11.9	15.7	3.7						11.4	8.9	6.1	4	14.1	28	
Percent Collectors and Filterers	39.7	72.5	75.7						80	52.7	73.6	87.8	72.7	75.6	
Percent Collectors	37.1	65	33.6						70.3	25.8	42.5	59.2	55.2	65	
Percent Filterers	2.6	7.5	42.1						9.6	26.8	31.1	28.6	17.5	10.6	
Percent Grazers	9.7	3.7	7.6						4.4	22.9	8.5	7.8	4	7.1	
Percent Predators	50.3	20.6	14.3						12.8	19.1	6.5	1.5	8.3	7.9	
Percent Shredders	0	0	0						1.6	0	3	0.2	0.8	0	
Percent Macrophyte Herbivore	0	0.2	0						0.4	1.6	3.1	0	13	0	
Percent Omnivore	0	0	0						0	0.2	0	0	0.2	0	
Percent Parasites	0	0	0						0	0	0	0	0	0	
Percent Piercer Herbivore	0.4	3.1	2.4						0.8	3.6	5.4	2.7	1.1	9.4	
Percent Xylophage	0	0	0						0	0	0	0	0	0	
Percent Hydropsychidae	0.4	2.6	3.7						3	9.5	16.1	13.7	12.1	2.1	
Percent Baetidae	9.9	0.8	13.9						6.2	4.4	6.8	36	7.9	8.8	