Malibu Creek Watershed Monitoring Program

Bioassessment Monitoring

Spring / Fall 2005

Presented by:

AQUATIC BIOASSAY & CONSULTING LABORATORIES, INC.
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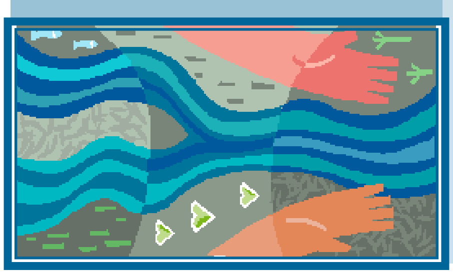
March 2005

THE MALIBU CREEK WATERSHED MONITORING PROGRAM



June 14th, 2006

Ms. Jamie Rinehart
Malibu Creek Watershed Monitoring Coordinator
City of Calabasas, Environmental Services Division
26135 Mureau Road
Calabasas, CA 91302

Dear Ms. Rinehart:

We at Aquatic Bioassay and Consulting Laboratories are pleased to present the Malibu Creek Watershed Monitoring Program, 2005 Bioassessment Monitoring Report. The report includes the summarized results for the spring and fall 2005 sampling events.

Please contact me if you have any questions regarding this submittal.

Yours very truly,

Scott C. Johnson

Scott C. Johnson
Director of Environmental Programs

Malibu Creek Watershed Monitoring Program
Malibu Watershed
2005 Bioassessment Monitoring Report

Submitted to:

The Malibu Creek Watershed Monitoring Program
City of Calabasas, Environmental Services Division
26135 Mureau Road
Calabasas, CA 91302

Submitted by:

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

June 2006

Executive Summary

The 2005 bioassessment survey of the Malibu Creek watershed was conducted by staff members of the Malibu Creek Watershed Monitoring Program and Aquatic Bioassay and Consulting Laboratories during the spring (June 1st and 2nd) and fall (September 19th and 20th), 2005. Eleven benthic macroinvertebrate (BMI) sampling locations were visited during the survey, of these, three sites (Liberty Canyon Creek, lower Lindero Creek and Potrero Creek) were not sampled during either season because they were not flowing and Hidden Valley Creek, which is located on private land, was only sampled in the spring due to access problems. The taxonomic identification of BMI organisms (Level 1), data analysis and report generation was conducted by Aquatic Bioassay and Consulting Laboratories 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 Southern California Index of Biological Integrity (IBI) score provides a measure of the aquatic health of a stream reach and is calculated using 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 that were measured at a site were converted to an IBI score then summed. These cumulative scores can then be ranked according to very good (80-56), good (41-55), fair (27-40), poor (14-26) and very poor (0-13) habitat conditions. The threshold limit for this scoring index is 26. Sites with scores below 26 are considered to have impaired conditions.

The habitat conditions in a stream reach play a key role in the development of a healthy aquatic community. 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. For example, excess sediment caused by bank erosion due to human activities can fill pools and interstitial areas of the stream substrate where fish spawn and invertebrates live, causing their populations to decline or to be altered. Also, loss of vegetative canopy cover and reduced width of the riparian zone can have similar effects on the BMI communities.

The IBI scores for the aquatic communities at each of the Malibu Creek Watershed Monitoring Program sites during the spring and fall of 2005 ranked below 26 and can be considered as "impaired". Physical/habitat conditions of each site were also assessed during both surveys. Of the eight sites visited during the 2005 surveys, only the Malibu Creek site upstream of the lagoon ranked in the optimal range during both the spring and fall. Three sites (lower Las Virgenes Creek, lower Medea Creek and Triunfo Creek) scored in the suboptimal range, three (upper Medea Creek, Lindero Canyon Creek and Hidden Valley Creek) in the marginal range, and one (upper Las Virgenes Creek) in the poor range. Water quality (pH, dissolved oxygen, temperature, specific conductance) was within normal ranges and similar at all sites during each survey.

The physical/habitat scores at the four sites which ranked in the relatively good range (optimal to suboptimal), had IBI scores that indicated that their resident aquatic communities were impaired. This indicates that stressors other than habitat conditions may have effected the composition of these communities, including nutrients, metals or organic contaminants from anthropogenic sources such as street runoff and agriculture. The IBI scores calculated for the 2005 survey were compared to IBI scores calculated by the Heal the Bay, Stream Team between 2000 and 2003. In all cases where the same stations were monitored, the IBI ranks were in the impaired range.

The collection of the New Zealand mudsnail (*Potamopyrgus antipodarum*) in the watershed is of immediate environmental concern. The snail was first collected in the upper and lower Medea Creek in the spring of 2005 and represented 85 and 15% of the populations at these sites, respectively. By the fall survey the snail's populations had increased to 91% at MED2 and 80% at MED1, and were collected in low numbers in upper Lindero Canyon Creek, Las Virgenes Creek and in Malibu Creek above the lagoon. This invasive species is thought to have been introduced to the Great Lakes by ships arriving from Europe. Since then the snails have invaded streams in Colorado, Montana, Arizona, Oregon, Utah, Wyoming and California. The North American populations of this tiny snail (up to 6 mm) are all females which reproduce without the need of a male, through an asexual process called parthenogenesis. They are capable of surviving a wide range of water quality conditions including desiccation. These factors have allowed them to quickly spread to new stream systems, since they don't rely on the transport of both a male and female to establish a reproductive population and they can survive transport to new stream systems on the equipment of anglers and water quality monitors. Once established in a stream, the New Zealand mudsnail population can reach between 100,000 to 800,000 individuals per square meter and exclude most other taxa. Methods for controlling New Zealand mudsnail populations have not yet been established. At present the only controls include methods to stop its spread to new stream systems.

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INTRODUCTION

Malibu Creek Watershed

The 109 square mile Malibu Creek watershed is located about 35 miles west of Los Angeles, California, and extends from the Santa Monica Mountains and adjacent Simi Hills to the Pacific coast at Santa Monica Bay (Figure 1). Several creeks and lakes are located in the upper portions of the watershed, and these ultimately drain into Malibu Creek at the downstream end of the watershed. Historically, there is little flow in the summer months; much of the natural flow that does occur in the summer in the upper tributaries comes from springs and seepage areas. Malibu Creek drains into Malibu Lagoon, a 13-acre tidal lagoon, which in turn drains into Santa Monica Bay when the entrance to the lagoon is open.

Bioassessment Monitoring

Major issues facing streams and rivers in California include modification of in-stream and riparian structure, contaminated water and increases in impervious surfaces, which has led to the increased frequency of flooding. There have been many studies and reports showing the deleterious effects of land-use activities to macroinvertebrate and fish communities (Jones and Clark 1987; Lenat and Crawford 1994; Weaver and Garman 1994; and Karr 1998). A major focus of freshwater scientists has been the prevention of further degradation and restoration of streams to their more pristine conditions (Karr et al. 2000).

During the past 150 years direct measurements of biological communities including plants, invertebrates, fish, and microbial life have been used as indicators of degraded water quality. In addition, biological assessments (bioassessments) can be used as a watershed management tool for surveillance and compliance of land-use best management practices. Combined with measurements of watershed characteristics, land-use practices, in-stream habitat, and water chemistry, bioassessment can be a cost-effective tool for long-term trend monitoring of watershed conditions (Davis and Simons 1995). Bioassessment monitoring has been ongoing in the Malibu Creek watershed since 2000 as part of Heal the Bays, Stream Team monitoring effort. The bioassessment data presented in this report were collected as part of the Malibu Creek Watershed Monitoring Program.

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).

Water resource monitoring using benthic macroinvertebrates (BMI) is by far the most popular method used throughout the world. 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 Environmental Protection Agency (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).

The first demonstration of a California regional IBI was applied to the Russian River watershed in 1999 (DFG 1998). As the Russian River IBI was being developed, the Department of Fish and Game (DFG) began a much larger project for the San Diego Regional Board. After a pilot project conducted on the San Diego River in 1995 and 1996, the San Diego Regional Board contracted DFG to help them incorporate bioassessment into their ambient water quality monitoring program. During 1997 through 2000, data was collected from 93 locations distributed throughout the San Diego region. Finally, between 2000 and 2003, bioassessment data were collected 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).

This report includes the results and analyses of physical habitat and bioassessment data collected at eight sites in the spring and fall of 2005 in fulfillment of the Malibu Creek Monitoring Program's, NPDES storm water permit. In addition, these data were compared and contrasted to previous BMI IBI scores generated by the Heal the Bay Stream Team.

Materials and Methods

Sampling Site Descriptions

Eleven BMI sampling locations were visited in the Malibu Creek watershed during the spring (June 1st and 2nd) and fall (September 19th and 20th) 2005 (Figure 1, Table 1). Of these, three sites Liberty Canyon Creek (LC), lower Lindero Creek (LIN2), and Potero Creek (PC) were not sampled during either season because they were not flowing and Hidden Valley Creek (HV), which is located on private land, was only sampled in the spring due to access problems. Photographs of each site are displayed in Figure 2.

Collection of Benthic Macroinvertebrates

Malibu Creek and its tributaries can be periodically dry throughout the year as is typical of most southern California river systems. Although average rainfall during the 2004 – 2005 rainy season was above normal, only eight of the eleven sites specified in the stormwater permit had flowing water during at least one of the two sampling events.

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). The sampling procedures used by Aquatic Bioassay were audited and approved by Jim Harrington of the California Department of Fish and Game in September and October of 2005.

Benthic macroinvertebrate (BMI) samples were collected in strict adherence to the CSBP in terms of both sampling methodology and QC procedures. For high gradient reaches (>2%) a 100 m length 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. For low gradient reaches (<2%), where no discrete riffles were present, a 100 m reach was measured and 3 meter-wide transects were randomly selected.

Once three transects were randomly identified, the most downstream one was occupied and, in the case of a riffle, the length was measured. A random number table was used to randomly establish three points along the upper one third of the riffle where transects were established perpendicular to stream flow. Starting with the downstream riffle, the benthos within a 2 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 along each transect that were representative of habitat diversity were sampled. This process was repeated along each of the three transects and combined into a single composite sample which was then transferred into a 1 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, pH and dissolved oxygen were measured using a hand held YSI 85 water quality meter that was 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 an inclinometer.

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. The 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

As species were identified, they were included in an Excel data sheet that, once complete, automatically calculated the bioassessment metrics used to assess the spatial and temporal BMI community changes in the watershed or necessary to calculate the southern California IBI (Ode, et al. 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 (%).

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 from a composite sample collected at each stream reach. These 500 organisms were used to compute the seven biological metrics used in the IBI computation.

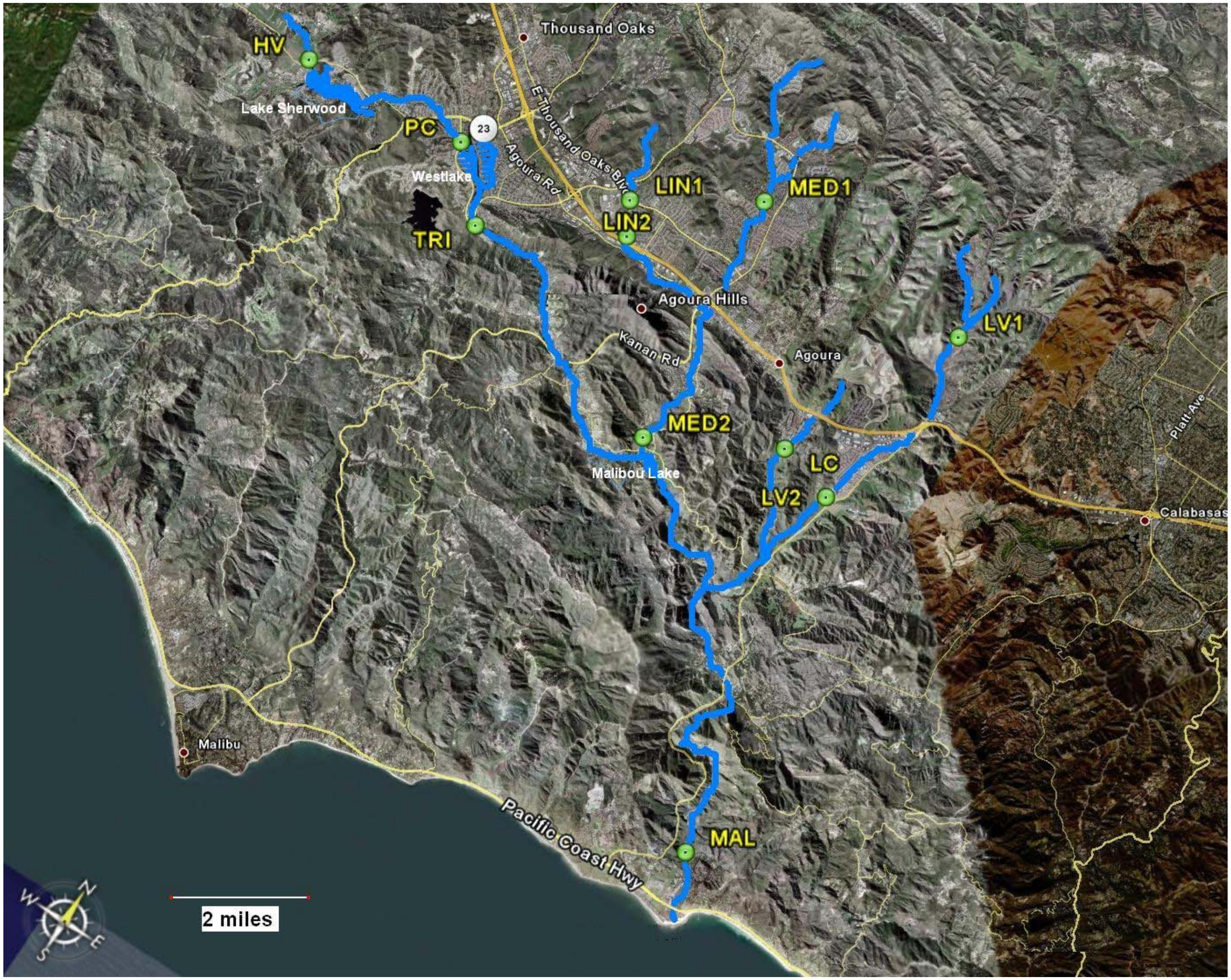

Figure 1. BMI sampling locations in the Malibu Creek watershed.

Table 1. Sampling locations descriptions for sampling locations in the Malibu Creek watershed.

Sta.ID	Stream	Latitude	Longitude	Elev. (ft)	Comments
MAL	Malibu Creek	34° 02.761' N	118° 41.270' W	27	
LV2	Las Virgenes Creek	34° 07.507' N	118° 42.494' W	611	
LV1	Las Virgenes Creek	34° 10.108' N	118° 42.155' W	856	
LC	Liberty Canyon Creek	34° 07.730' N	118° 43.429' W	740	No Flow, did not sample
MED2	Medea Creek	34° 06.865' N	118° 45.328' W	722	
MED1	Medea Creek	34° 10.180' N	118° 45.762' W	964	
LIN2	Lindero Creek	34° 08.863' N	118° 47.218' W	926	No Flow, did not sample
LIN1	Lindero Creek	34° 09.262' N	118° 47.481' W	970	
TRI	Trifuno Creek	34° 07.927' N	118° 49.237' W	840	
PC	Potrero Creek	34° 08.703' N	118° 50.121' W	889	No Flow, did not sample
HV	Hidden Valley Creek	34° 08.510' N	118° 52.738' W	958	Private propertly, no access for fall sampling

MAL – Malibu Creek	
Spring	Fall
	

LV2 – Las Virgenes Creek	
Spring	Fall
	

Figure 2. Photos of each Malibu Creek watershed BMI sampling location during the spring and fall 2005.

Las Virgenes Creek 1	
Spring	Fall
	

MED2 – Medea Creek 2	
Spring	Fall
	

Figure 2. continued

MED1 – Medea Creek 1	
Spring	Fall
	

LIN1 – Lindero Creek 1	
Spring	Fall
	

Figure 2. continued

<table>
<tr><td colspan="2">TRI – Triunfo Creek</td></tr>
<tr><td>Spring</td><td>Fall</td></tr>
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Figure 2. continued

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

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	Colepter a Taxa	EPT Taxa		Predator Taxa	% Collector Individuals		% Intolerant Individuals		% Non-Insect	% Tolerant
	All Sites	6	8	All Sites	6	8	6	8	All Sites	All Site
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**
0-13	**14-26**	**27-40**	**41-55**	**56-70**

RESULTS

Rainfall

The total rainfall measured at the Lake Sherwood gauging station during the 2004 to 2005 rain year was 52.92 inches (Figure 3). Peak months for rain were October, December, January and February. In March, less than 3 inches of rain fell, then became progressively less each month until June when no rain fell through August. BMI sampling in June followed three weeks of continuous dry weather and in September by four months of dry weather.

Physical Habitat Characteristics

Velocity

The physical characteristics of the riffles sampled in the Malibu Creek watershed during the spring and fall of 2005 are presented in Table 5. Riffle velocities during both the spring and fall were low and ranged from <0.07 ft/sec at Station LV1 (upstream) to 2.20 ft/sec at Station LV2 (downstream) both in Las Virgenes Creek during the fall.

Canopy Cover and Substrates

Vegetative canopy cover ranged from 0% at Station HV on Hidden Valley Creek to 99% at Station LN1. Substrate complexity was lowest at Stations LV1, MED1, LIN1 and HV (range = 3 to 6). Highest streambed complexity was found at Stations MAL, LV2, MED2, and TRI (range = 8 to 16).

Streambed substrates were composed of mostly fine sediments and gravel at Stations LV1, LV2, MED2 and HV during both seasons and LIN1 in the fall. Triunfo Creek (TRI) was composed mostly of bedrock. Malibu Creek (MAL) and Medea Creek (MED1) were composed of sediments more evenly distributed between fines, gravel, cobble and either boulders or bedrock. All of the sites were low gradient streams (<2%), except MAL and MED1 (3% each).

Water Quality

The range for pH measurements was narrow among all sites and ranged from 7.88 to 8.37 for both spring and fall surveys (Table 5, Figure 4). Dissolved oxygen concentrations ranged from 3.64 mg/L at LV1 in the fall to 15.50 mg/L at LIN1 in the fall. 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 late spring and summer conditions and ranged from 14.83 °C to 21.95 °C. Specific conductance ranged from 835 uS/cm at HV in the spring to 3771 uS/cm at LV1 in the fall.

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.

Of the eight sites visited during the 2005 surveys, only MAL (Malibu Creek upstream of the lagoon) ranked in the optimal range during both the spring and fall. Three sites (LV2, MED2 and TRI) scored in the suboptimal range, three (MED1, LIN1 and HV) in the marginal range, and one (LV2) in the poor range. Of note were the following findings:

The Malibu Creek site (MAL) is located above the lagoon, has residential housing set back from its southern bank and is easily accessed by the public. In spite of this, the streambed appears fairly natural and is composed of boulders, cobble and gravel. There is little deposition of fine sediments, the reach has numerous runs, riffles and pools, and the riparian corridor is relatively wide, all characteristics of relatively good BMI habitat.

The lower Las Virgenes (LV2), Medea Creek (MED2) and Triunfo Creek (TRI) sites all had good canopy cover and relatively good instream cover for BMIs, but did not have the same high level of complexity throughout their reaches as were found at the Malibu Creek reach. Lower complexity at these sites led to lower scores for velocity/depth regimes and riffle frequency. In addition, when compared to Malibu Creek, bank vegetative protection at Las Virgenes and Triunfo Creeks was sparse.

The upper Lindero Creek site (LIN1) is located in a cement drainage that leads to a retention basin. Likewise, the upper Medea Creek site (MED1) is located in a storm water channel with cement stabilized banks and streambed, although portions of the reach have a natural bottom. As a result these sites scored low for instream cover, channel alteration, vegetative protection and riparian zone. The Hidden Valley Creek site (HV) is located on horse stable property in a stormwater drainage ditch and had low scores for each category except bank stability.

The upper Las Virgenes Creek site (LV1) was the only site that ranked in the poor category. This site has been heavily impacted by bank erosion and sedimentation. The western bank is cement stabilized with a road on top and a residential community up above. There are several drainage pipes lying in the streambed and exposed in the eastern bank. Recent fires have helped to denude the banks of vegetation and the streambed in filled with reeds and cattails. As a result this reach scores low for instream cover, embeddedness, channel alteration, riffle frequency and vegetative protection.

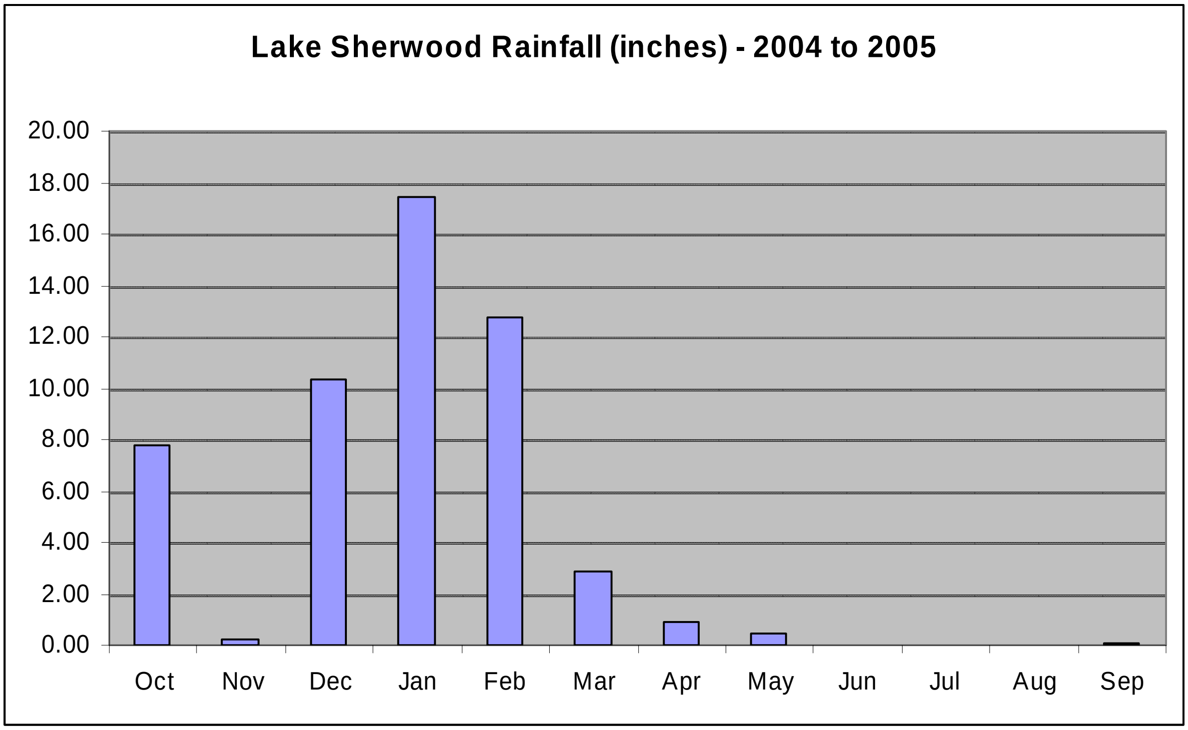

Figure 3. Monthly average rainfall (inches) at Lake Sherwood for the 2004-2005 rain year.

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

Parameter	MAL		LV2		LV1		MED2		MED1		LIN1		TRI		HV	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Physical Habitat Parameter																
1. Instream Cover	16	15	11	15	2	3	14	11	5	4	3	6	16	11	3	
2. Embeddedness	16	15	14	9	4	4	15	9	16	8	12	5	18	1	1	
3. Velocity / Depth Regime	15	19	10	10	9	2	10	15	14	10	9	5	10	8	10	
4. Sediment Deposition	17	16	14	13	4	13	15	6	19	14	9	10	19	14	2	
5. Channel Flow	17	10	10	8	5	3	6	6	9	15	11	12	6	14	10	
6. Channel Alteration	16	19	17	11	2	2	10	10	1	1	2	6	9	6	3	
7. Riffle Frequency	17	19	5	10	3	1	9	8	10	13	1	2	9	11	1	
8. Bank Stability	20	18	16	14	2	2	18	16	20	20	18	14	18	20	16	
9. Vegetative Protection	18	18	10	12	5	3	16	14	2	3	6	8	9	10	8	
10. Riparian Vegetative Zone	17	18	14	11	8	4	4	14	1	3	2	9	5	6	2	
Reach Total	**169**	**167**	**121**	**113**	**44**	**37**	**117**	**109**	**97**	**91**	**73**	**77**	**119**	**101**	**56**	
Condition Category	**Optimal**	**Optimal**	**Subopti**	**Subopti**	**Poor**	**Poor**	**Subopti**	**Subopti**	**Marginal**	**Marginal**	**Marginal**	**Marginal**	**Subopti**	**Subopti**	**Marginal**	
Physical Habitat Characteristics																
Average Riffle Length (ft)	20	33	6	6	6	9	39	30	33	34	44	40	68	43	6	
Average Riffle Width (ft)	20	21	3	4	5	2	18	16	10	7.3	5	10	14	18	7	
Average Riffle Depth (ft)	1.4	1.0	0.7	0.9	0.4	0.1	0.5	0.4	0.3	0.4	0.4	0.5	0.4	0.3	0.2	
Average Riffle Velocity (ft/sec)	1.7	2.0	1.0	2.2	0.9	<0.07	0.9	1.3	1.4	1.0	1.8	1.0	1.4	0.4	1.0	
Vegetative Canopy Cover (%)	18	24	76	84	65	65	42	55	7	5	27	99	92	89	0	
Average Substrate Complexity	16	15	11	12	4	3	13	8	6	4	3	6	16	11	3	
Average Embeddedness	16	15	13	7	2	4	16	5	17	15	10	5	18	1	1	
Substrate Composition (%)																
Fines (<0.1 in.)	10	5	61	57	90	90	18	50	4	10	33	85	7	0	80	
Gravel ((0.1 -2 in.)	20	13	33	25	5	5	72	40	20	10	27	15	13	0	20	
Cobble (2-10 in)	60	48	5	18	5	5	10	9	6	47	7	0	8	4	0	
Boulder (>10 in.)	10	33	0	0	0	0	0	1	1	0	0	0	12	2	0	
Bedrock (solid)	0	0	0	0	0	0	0	0	50	33	33	0	60	94	0	
Substrate Consolidation	High	High	Low	Low	Low	Low	Low	Low	High	Mod	Mod	Low	High	High	Low	
Percent Gradient (%)	3	3	1	1	1	1	2	2	3	3	1	1	2	2	1	
Chemical Characteristics																
pH	8.15	8.37	8.00	8.15	7.93	7.88	7.88	8.07	8.23	8.05	8.32	7.98	7.91	7.93	7.88	
D.O (mg/L)	7.81	12.20	7.66	9.70	8.50	3.64	6.71	6.60	13.56	8.94	15.50	5.78	4.49	5.41	8.97	
Water Temperature (C°)	18.94	20.80	18.32	17.06	16.70	14.83	18.15	17.56	20.37	17.45	19.40	17.33	21.95	20.10	18.77	
Specific Conductance (uS/cm at 25EC)	1763.0	2267.0	3213.0	3029.0	2950.0	3771.0	2716.0	2732.0	3630.0	3428.0	2998.0	2742.0	1218.0	1502.0	835.0	

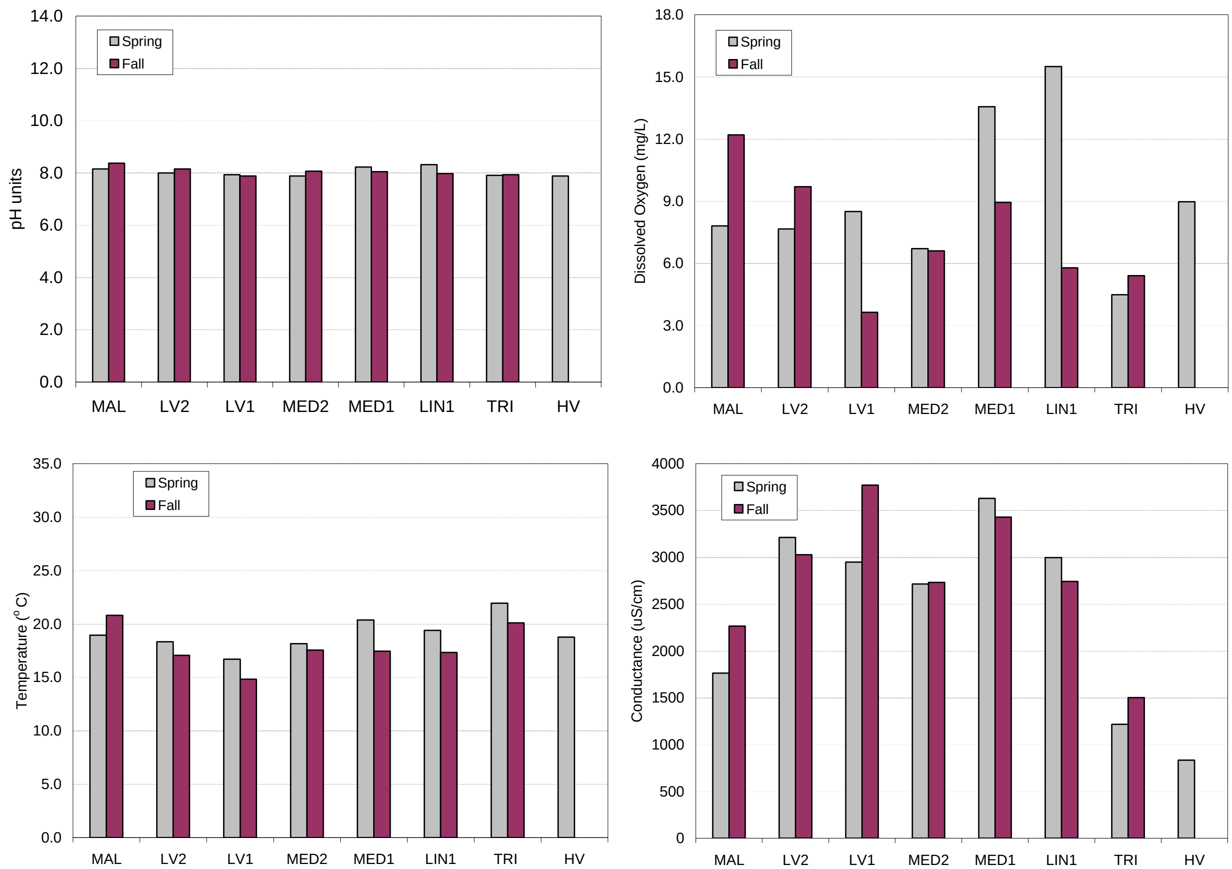

Figure 4. Water quality measurements collected in the spring and fall 2005 at eight sites in the Malibu Creek watershed.

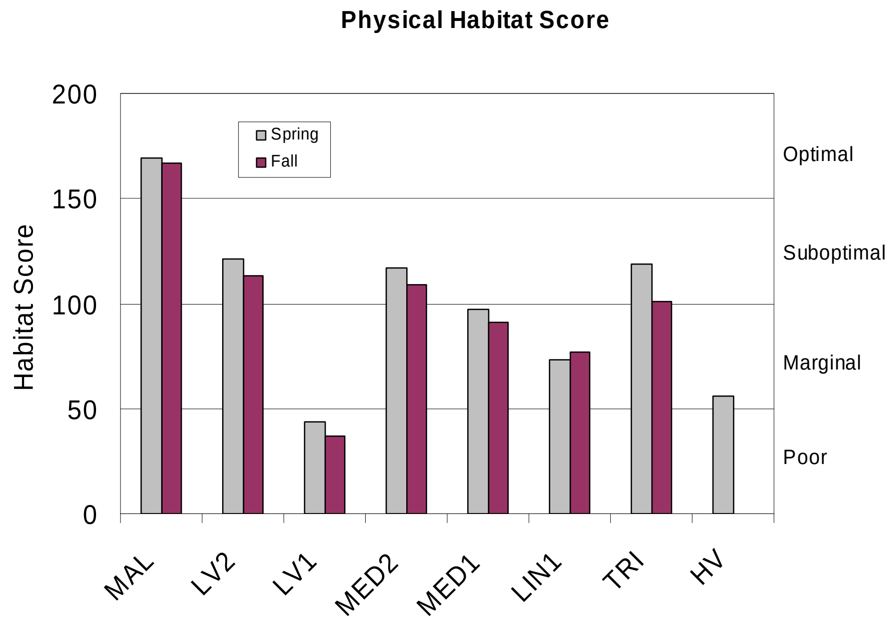

Figure 5. Physical habitat scores for reaches in the Malibu Creek watershed.

BMI Community Structure

The complete taxa list including raw abundances by site are presented in Appendix A, Table A-1. The ranked abundance of each species by site is illustrated in Tables 6a and 6b. The biological metrics calculated for this survey were grouped into the four categories described in Table 3 and presented in Figures 6 through 9 and Appendix A (Table A-2): richness measures, composition measures, tolerance/intolerance measures and functional feeding groups. The So CA IBI scores for each station and season are shown in Table 7 and illustrated in Figure 10.

Species Composition

A combined total of 7,686 BMIs, represented by 46 taxa, were identified from the 15 samples collected at the eight sampling sites during the spring and fall of 2005 (Appendix A, Tables A-1 and A-2). The estimated total abundance for all sites and seasons combined would be 109,737 individuals (Appendix A, Table A-3).

During the spring the most abundant species at most sites included Baetid mayflies (*Baetis sp*.), flies (Orthocladiinae, Chironominae, *Simulium sp*.), ostracods and amphipods (Cyprididae and *Hyalella sp*.) (Table 6a). At each of the sites, the combined abundances of three to five species accounted for over 75% of the total abundance, except at Medea Creek Station MED2, where the New Zealand mudsnail (*Potamopyrgus antipodarum*) accounted for 85% of the population. This species was also collected at MED1, accounting for 15% of the population. This was the first positive identification of this invasive species in the watershed.

By fall the New Zealand mudsnail had become more abundant at both Medea Creek sites (MED1 and MED2), accounting for 80 and 91% of these populations, respectively (Table 6b). This species had also spread to lower Malibu Creek (n = 3), upper Las Virgenes Creek (n = 1), and Lindero Canyon Creek (n = 1). Ostracods were the most abundant species collected at MAL, TRI and LV1. The stonefly, *Malenka sp*., is sensitive to disturbances and was only found in the fall at the upper Las Virgenes Creek site (LV1).

Biological Metrics

The biological metrics listed in Table 3, above, were calculated for this survey and are presented by group in Figures 6 through 9 and Appendix A, Table A-3.

***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 is 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 lowest (n = 10) at LV2 and MED2 in the fall, and MED2 in the spring, to greatest (n = 24) in the fall at LV1 (Figure 6, Appendix A Table A-3). EPT taxa were ≤3 at all sites except MAL during both surveys (6 and 5). Few Coleoptera taxa were collected at any of the sites, except LV1 during both the spring and fall (4 and 3, respectively). The greatest numbers of predator taxa were collected at MAL, LV2 and TRI in the spring and LV1 in the spring. The fewest predators were collected at LV2 in the fall and MED2 and MED1 during both seasons. Estimated abundances were greatest at MED1 during both seasons and least LV2, LIN1 and TRI.

Composition Measures: The 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. EPT taxa are the numbers of taxa at a site that are mayflies, stoneflies and caddisflies. Percent Sensitive EPT taxa is the proportion of 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 greatest numbers of EPT taxa were collected at MAL and the fewest were found at MED1 and HV in the fall (Figure 7). No Sensitive EPT taxa were collected at any of the sites. The greatest percentages of non-insects were collected in the fall at LV2, MED2 and MED1 (>90%). The lowest percentages of non-insects were found in the spring at MAL and LV1. Shannon Diversity ranged from lowest at MED2 in the spring and fall and MED1 in the fall to greatest at LV1 in the fall. Diversity was similar to or greater at each site in the spring compared to the fall, except at LV1 and LIN1 where diversity was slightly greater in the fall.

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, ranging from 5.2 to 7.8 and were slightly greater in the fall (Figure 8). Dominance was greatest at MED 2 (spring and fall) and MED1 (fall) and least at MED1 in the spring. The greatest percentage of tolerant organisms was collected at LV2 (fall), MED2 (spring and fall) and MED1 (fall), and the least were collected in the spring at MAL and LIN1. No intolerant species were collected at any site except at LV1 in the fall (Malenka sp., <0.01%). Few Hydropsychidae (caddisflies) were collected, except at MAL in the spring (17%). The greatest number of Baetidae (mayflies) were collected at MAL in the spring (34%).

***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 was the predominant feeding strategy used by organisms in the watershed, especially in the spring (Figure 9). This was not the case at LV2 (fall), MED2 (spring and fall), and MED1 (fall) where grazing was the preferred strategy. Predation was greatest MAL, LV1 and LIN1 in the spring and TRI in the fall.

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 (80-56), good (41-55), fair (27-40), poor (14-26) and very poor (0-13) habitat conditions. The threshold limit for this scoring index is 26. Despite the fact that rankings can be identified as "fair", sites with scores above 26 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 26 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 Malibu Watershed sites for the 2005 surveys.

The IBI scores for each of the sites in the Malibu Watershed were impaired and ranked as "poor or very poor", except for MAL in the spring, which ranked in the "fair" range (Table 6, Figure 10). Therefore, the IBI rank scores for all sites were in the impaired range.

Discussion

The IBI results for the 2005 benthic macroinvertebrate survey indicated that the aquatic health of sites visited for the Malibu Creek Watershed Monitoring Program were impaired, with all stations ranking in the "very poor to poor" range. Multiple factors have most likely contributed to the impaired BMI communities found at these sites, including the degradation of stream habitat and anthropogenic inputs.

Malibu Creek (MAL)

The results of the physical/habitat assessment indicated that the best habitat conditions occurred at the Malibu Creek site located just above the lagoon (MAL). Although located next to a residential area, this site had relatively good instream cover and complexity, low sedimentation, high bank stability and good vegetative protection. The IBI scores at this site ranked in the "fair" range (33) in the spring and "poor" (17) in the fall. This indicated that the BMI populations at this site were possibly responding to a water quality stressor(s) in combination with any physical habitat impairments. In seven BMI samples collected at a site located 0.3 miles downstream of MAL during the spring and fall from 2000 to 2003, the Heal the Bay Stream Team found similar IBI scores (range = 16 to 39; average = 25). In addition, during the spring sample collection large mats of algae were present along the entire reach. Luce (2003) showed that these algal mats were significantly related to the discharge of nitrate and orthophosphate from the Tapia Water Reclamation Facility.

Upper Las Virgenes Creek (LV1)

The upper Las Virgenes Creek site, located just below the Ahmanson Ranch property had the lowest physical/habitat score of all sites. There was little instream cover, heavy sedimentation, extensive bank erosion, little to no riparian vegetation and the west bank was cement stabilized with a road on top. Reductions in riparian habitat have resulted from recent fires which have denuded the banks of vegetation. The IBI scores were in the "poor" range during both the spring and fall (25 and 23, respectively) surveys but were slightly better than all other sites. Considering the poor habitat conditions, we would expect that the IBI scores would be correspondingly lower than all other sites. This indicates that the water quality emanating upstream of this site may be good enough to overcome some of the local, degraded, habitat conditions found there.

Lower Las Virgenes Creek (LV2), lower Medea Creek (MED2) and Triunfo Creek (TRI)

Three sites scored in the suboptimal physical/habitat range including the middle Las Virgenes Creek site (LV2), the Medea Creek site at Paramount Ranch (MED2) and Triunfo Creek (TRI). The IBI scores at each of these sites ranked in the "very poor" range. LV2 is located downstream of a mostly residential community in, what appears to be, relatively good stream bed habitat. There is moderately good instream and vegetative cover, and the riparian zone is fairly wide. The banks are shored with walking paths down to the creek and there is evidence of heavy human usage. MED2 is located in a dredged channel with a walking bridge and abutments located just upstream. There is good vegetative cover and undercut banks, but the riparian zone is narrow and ends on the south bank with a parking lot and the north bank with a grass recreation area. The site receives heavy recreational use and has walking paths along both banks. The streambed is mostly fine grain sand and cobble with few boulders. This site had high abundances of the New Zealand mudsnail (*Potamopyrgus antipodarum*) during both the spring and fall (see discussion below). The Triunfo Creek site is located downstream of Lakes Sherwood and Westlake. Most of the bottom and southern bank has been shored with cement and there is a bridge upstream of the site. Heal the Bay's Stream Team found similar IBI scores at this site from four samples collected from 2000 to 2003 (range = 4 to 20; average = 15).

Upper Medea Creek (MED1), upper Lindero Creek (LIN1) and Hidden Valley Creek (HV)

Three sites scored in the marginal physical/habitat range including the upper Medea Creek site (MED1), upper Lindero Creek (LIN1) and Hidden Valley Creek (HV). Correspondingly, the IBI for each of these sites ranked as "very poor". MED1 is located in a mostly cement lined channel, below a bridge. The complexity of the streambed has been improved with boulders embedded in the cement and the streambed is unlined in the lower portion of the reach. During the spring, dense algal mats were present and the New Zealand mudsnail had become established at this site by the fall survey. IBI scores found by Heal the Bay ranked as "very poor to fair" (range = 9 to 34; average = 20) between 2000 and 2003. LIN1 is located downstream of a golf course in a cement lined drainage channel containing irrigation runoff. This channel empties into a relatively large pool which empties into an unlined channel that is densely packed with reeds. HV is located in a dirt lined drainage channel surrounded by horse property. There is little instream cover, no riparian zone and a road running along one bank.

New Zealand mudsnail

The collection of the New Zealand mudsnail (*Potamopyrgus antipodarum*) in the watershed is of immediate environmental concern. The snail was first collected in the upper and lower Medea Creek in the spring of 2005 representing 85 and 15% of the populations at these sites respectively. By the fall survey the snails populations had increased to 91% at MED2 and 80% at MED1, and was collected in low numbers in upper Lindero Canyon Creek, Las Virgenes Creek and in Malibu Creek above the lagoon. This invasive species is thought to have been introduced to the Great Lakes by ships arriving from Europe. Since then the snails have invaded streams in Colorado, Montana, Arizona, Oregon, Utah, Wyoming and California. The North American populations of this tiny snail (up to 6 mm) are all females which reproduce without the need of a male, through an asexual process called parthenogenesis. They are capable of surviving a wide range of water quality conditions including desiccation. These factors have allowed them to quickly spread to new stream systems, since they don't rely on the transport of both a male and female to establish a reproductive population and they can survive transport to new stream systems on the equipment of anglers and water quality monitors. Once established in a stream, the New Zealand mudsnail population can reach between 100,000 to 800,000 individuals per square meter and exclude most other taxa. Methods for controlling New Zealand mudsnail populations have not yet been established. At present the only controls include methods to stop its spread to new stream systems.

The results of the 2005 BMI survey conducted by Aquatic Bioassay and Consulting Laboratories for the Malibu Creek Watershed Monitoring Program indicated that the aquatic health of the selected sites were impaired. The combined effects of both habitat and water quality degradation in the watershed have most likely caused these conditions.

Table 5a. Ranked % abundance for species at each site in the Malibu Creek Watershed during spring 2005.

MAL

Species	% of Total Abund	Cumulative % Abund
Baetis sp.	33.4	33.4
Orthocladiinae	20.6	54.0
Hydropsyche sp.	17.6	71.6
Chironominae	10.4	82.0
Sperchon sp.	5.8	87.8
Oligochaeta	2.6	90.4
Planariidae	2.4	92.8
Physa/Physella sp.	1.8	94.6
Torrenticola sp.	1.2	95.8
Tricorythodes sp.	1.0	96.8
Tanypodinae	0.8	97.6
Hydra sp.	0.6	98.2
Fallceon quilleri	0.4	98.6
Cheumatopsyche sp.	0.4	99.0
Lebertia sp.	0.2	99.2
Atractides sp.	0.2	99.4
Cloeodes excogitatus	0.2	99.6
Microcylloepus sp.	0.2	99.8
Simulium sp. (P)	0.2	100.0
TOTAL	**100**	

MED1

Species	% of Total Abund	Cumulative % Abund
Cyprididae	21.8	21.8
Simulium sp. (P)	18.2	40.0
Potamopyrgus antipodarum	15.4	55.4
Orthocladiinae	13.0	68.4
Baetis sp.	11.4	79.8
Oligochaeta	7.4	87.2
Hyalella sp.	4.8	92.0
Planariidae	2.0	94.0
Tanypodinae	2.0	96.0
Physa/Physella sp.	1.8	97.8
Chironominae	1.6	99.4
Sperchon sp.	0.2	99.6
Hydroptila sp.	0.2	99.8
Caloparyphus/Euparyphus sp.	0.2	100.0
	100	

MED2

Species	% of Total Abund	Cumulative % Abund
Potamopyrgus antipodarum	85.0	85.0
Hyalella sp.	5.6	90.6
Baetis sp.	3.8	94.4
Simulium sp. (P)	2.6	97.0
Cyprididae	0.8	97.8
Tanypodinae	0.8	98.6
Oligochaeta	0.6	99.2
Planariidae	0.4	99.6
Hydroptila sp.	0.2	99.8
Hydraena sp.	0.2	100.0
	100	

TRI

Species	% of Total Abund	Cumulative % Abund
Hyalella sp.	41.8	41.8
Cyprididae	17.6	59.4
Planariidae	10.4	69.8
Argia sp.	8.2	78.0
Simulium sp. (P)	7.6	85.6
Baetis sp.	3.6	89.2
Hydroptila sp.	3.2	92.4
Hydra sp.	2.2	94.6
Ferrissia sp.	1.2	95.8
Sperchon sp.	1.0	96.8
Orthocladiinae	1.0	97.8
Physa/Physella sp.	0.6	98.4
Chironominae	0.6	99.0
Oligochaeta	0.4	99.4
Prostoma sp.	0.2	99.6
Torrenticola sp.	0.2	99.8
Coenagrion/Enallagma sp.	0.2	100.0
	100	

HV

Species	% of Total Abund	Cumulative % Abund
Cyprididae	55.2	55.2
Simulium sp. (P)	17.0	72.2
Baetis sp.	12.8	85.0
Chironominae	4.2	89.2
Oligochaeta	3.8	93.0
Fallceon quilleri	2.4	95.4
Physa/Physella sp.	1.2	96.6
Dasyhelea sp.	0.8	97.4
Cloeodes excogitatus	0.6	98.0
Coenagrion/Enallagma sp.	0.4	98.4
Orthocladiinae	0.4	98.8
Tanypodinae	0.4	99.2
Corixidae (imm)	0.2	99.4
Agabus sp.	0.2	99.6
Pericoma/Telmatoscopus sp. (L)	0.2	99.8
	100	

LV1

Species	% of Total Abund	Cumulative % Abund
Chironominae	42.4	42.4
Cyprididae	19.0	61.4
Orthocladiinae	18.8	80.2
Simulium sp. (P)	9.6	89.8
Oligochaeta	3.2	93.0
Baetis sp.	2.2	95.2
Bezzia/Palpomyia sp.	0.6	95.8
Limnophora sp. (L)	0.6	96.4
Physa/Physella sp.	0.4	96.8
Lebertia sp.	0.4	97.2
Hydropsyche sp.	0.4	97.6
Peltodytes sp. (L)	0.4	98.0
Tanypodinae	0.4	98.4
Tipula sp. (L)	0.4	98.8
Hyalella sp.	0.2	99.0
Hydroptila sp.	0.2	99.2
Agabus sp.	0.2	99.4
Stictotarsus (A)	0.2	99.6
Atrichopogon sp.	0.2	99.8
	100	

LV2

Species	% of Total Abund	Cumulative % Abund
Cyprididae	30.6	30.6
Orthocladiinae	17.4	48.0
Chironominae	11.8	59.8
Baetis sp.	10.0	69.8
Tanypodinae	8.6	78.4
Hydra sp.	5.0	83.4
Oligochaeta	5.0	88.4
Physa/Physella sp.	4.8	93.2
Simulium sp. (P)	3.6	96.8
Hydroptila sp.	1.6	98.4
Bezzia/Palpomyia sp.	0.4	98.8
Tipula sp. (L)	0.4	99.2
Sperchon sp.	0.2	99.4
Corixidae (imm)	0.2	99.6
Atrichopogon sp.	0.2	99.8
Dolichopodidae (L)	0.2	100.0
	100	

LIN1

Species	% of Total Abund	Cumulative % Abund
Oligochaeta	48.0	48.0
Chironominae	18.0	66.0
Orthocladiinae	13.8	79.8
Simulium sp. (P)	6.8	86.6
Cyprididae	5.2	91.8
Planariidae	2.2	94.0
Physa/Physella sp.	2.0	96.0
Hyalella sp.	1.6	97.6
Tanypodinae	0.6	98.2
Prostoma sp.	0.4	98.6
Baetis sp.	0.4	99.0
Pericoma/Telmatoscopus sp. (L)	0.4	99.4
Procambarus clarkii	0.2	99.6
Hydra sp.	0.2	99.8
Nematoda	0.2	100.0
	100	

Table 5b. Ranked % abundance for species at each site in the Malibu Creek Watershed during fall 2005.

MAL

Species	% of Total Abund	Cumulative % Abund
Cyprididae	29.8	29.8
Planariidae	26.0	55.8
Caloparyphus/Euparyphus sp.	15.0	70.8
Physa/Physella sp.	5.5	76.3
Hydropsyche sp.	4.1	80.3
Euparyphus sp.	3.2	83.6
Sperchon sp.	2.8	86.4
Fallceon quilleri	2.6	89.0
Hydroptila sp.	2.6	91.7
Prostoma sp.	2.4	94.1
Coenagrion/Enallagma sp.	1.6	95.7
Oligochaeta	1.2	97.0
Potamopyrgus antipodarum	0.6	97.6
Baetis sp.	0.6	98.2
Orthocladiinae	0.6	98.8
Helisoma sp.	0.2	99.0
Tricorythodes sp.	0.2	99.2
Microcylloepus sp.	0.2	99.4
Atrichopogon sp.	0.2	99.6
Tanypodinae	0.2	99.8
Tipula sp.	0.2	100.0
TOTAL	**100**	

MED1

Species	% of Total Abund	Cumulative % Abund
Potamopyrgus antipodarum	80.4	80.4
Hyalella sp.	6.9	87.2
Planariidae	5.9	93.1
Prostoma sp.	1.7	94.9
Cyprididae	1.7	96.6
Physa/Physella sp.	1.1	97.7
Caloparyphus/Euparyphus sp.	1.1	98.9
Oligochaeta	0.6	99.4
Orthocladiinae	0.4	99.8
Tanypodinae	0.2	100.0
	100	

MED2

Species	% of Total Abund	Cumulative % Abund
Potamopyrgus antipodarum	91.1	91.1
Planariidae	1.9	92.9
Baetis sp.	1.5	94.4
Simulium sp.	1.3	95.7
Coenagrion/Enallagma sp.	1.1	96.8
Orthocladiinae	0.9	97.8
Prostoma sp.	0.6	98.3
Hyalella sp.	0.6	98.9
Oligochaeta	0.4	99.3
Cyprididae	0.4	99.6
Hydroptila sp.	0.4	100.0
	100	

TRI

Species	% of Total Abund	Cumulative % Abund
Hyalella sp.	74.8	74.8
Tricorythodes sp.	7.3	82.1
Tanypodinae	6.5	88.7
Cyprididae	5.2	93.8
Argia sp.	1.9	95.8
Oligochaeta	1.5	97.3
Chironominae	1.3	98.7
Ferrissia sp.	0.4	99.0
Simulium sp.	0.4	99.4
Procambarus clarkii	0.2	99.6
Sperchon sp.	0.2	99.8
Coenagrion/Enallagma sp.	0.2	100.0
	100	

HV

Species	% of Total Abund	Cumulative % Abund
No Sample due to access problems		
TOTAL		

LV1

Species	% of Total Abund	Cumulative % Abund
Hyalella sp.	27.3	27.3
Tanypodinae	15.4	42.7
Physa/Physella sp.	11.4	54.1
Orthocladiinae	10.6	64.7
Ephydra sp.	10.2	74.9
Coenagrion/Enallagma sp.	7.0	81.9
Argia sp.	4.9	86.8
Cyprididae	4.5	91.3
Malenka sp.	2.3	93.6
Hydropsyche sp.	1.5	95.1
Planariidae	0.8	96.0
Stictotarsus sp.	0.7	96.6
Oligochaeta	0.5	97.2
Caloparyphus/Euparyphus sp.	0.5	97.7
Prostoma sp.	0.3	98.0
Sperchon sp.	0.3	98.3
Peltodytes sp.	0.3	98.7
Pericoma/Telmatoscopus sp.	0.3	99.0
Potamopyrgus antipodarum	0.2	99.2
Abedus sp.	0.2	99.3
Tropisternus sp.	0.2	99.5
Bezzia/Palpomyia sp.	0.2	99.7
Chironominae	0.2	99.8
Simulium sp.	0.2	100.0
	100	

LV2

Species	% of Total Abund	Cumulative % Abund
Physa/Physella sp.	68.5	68.5
Cyprididae	22.6	91.1
Simulium sp.	2.5	93.6
Prostoma sp.	1.9	95.6
Hydroptila sp.	1.7	97.3
Oligochaeta	1.4	98.6
Planariidae	0.6	99.2
Baetis sp.	0.4	99.6
Hydra sp.	0.2	99.8
Orthocladiinae	0.2	100.0
	100	

LIN1

Species	% of Total Abund	Cumulative % Abund
Oligochaeta	30.4	30.4
Simulium sp.	19.9	50.3
Prostoma sp.	12.5	62.8
Planariidae	11.3	74.0
Baetis sp.	7.8	81.9
Physa/Physella sp.	6.2	88.1
Orthocladiinae	5.4	93.6
Coenagrion/Enallagma sp.	1.6	95.2
Argia sp.	1.6	96.8
Cloeodes excogitatus	0.8	97.6
Chironominae	0.8	98.4
Cyprididae	0.6	99.0
Caloparyphus/Euparyphus sp.	0.4	99.4
Procambarus clarkii	0.2	99.6
Potamopyrgus antipodarum	0.2	99.8
Fallceon quilleri	0.2	100.0
	100	

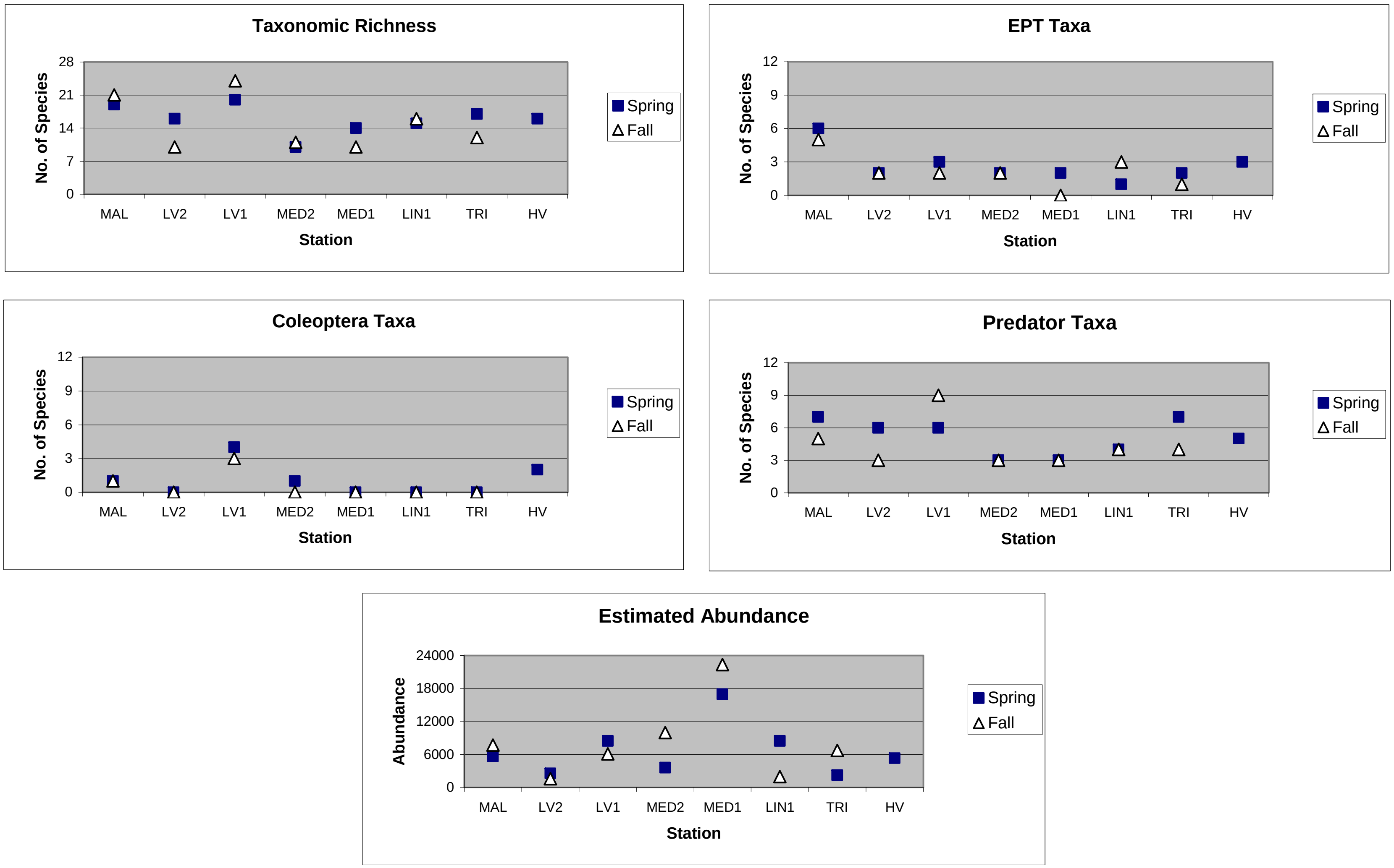

Figure 6. Spring and fall richness measures for each biological metric by site in the Malibu Creek Watershed, 2005.

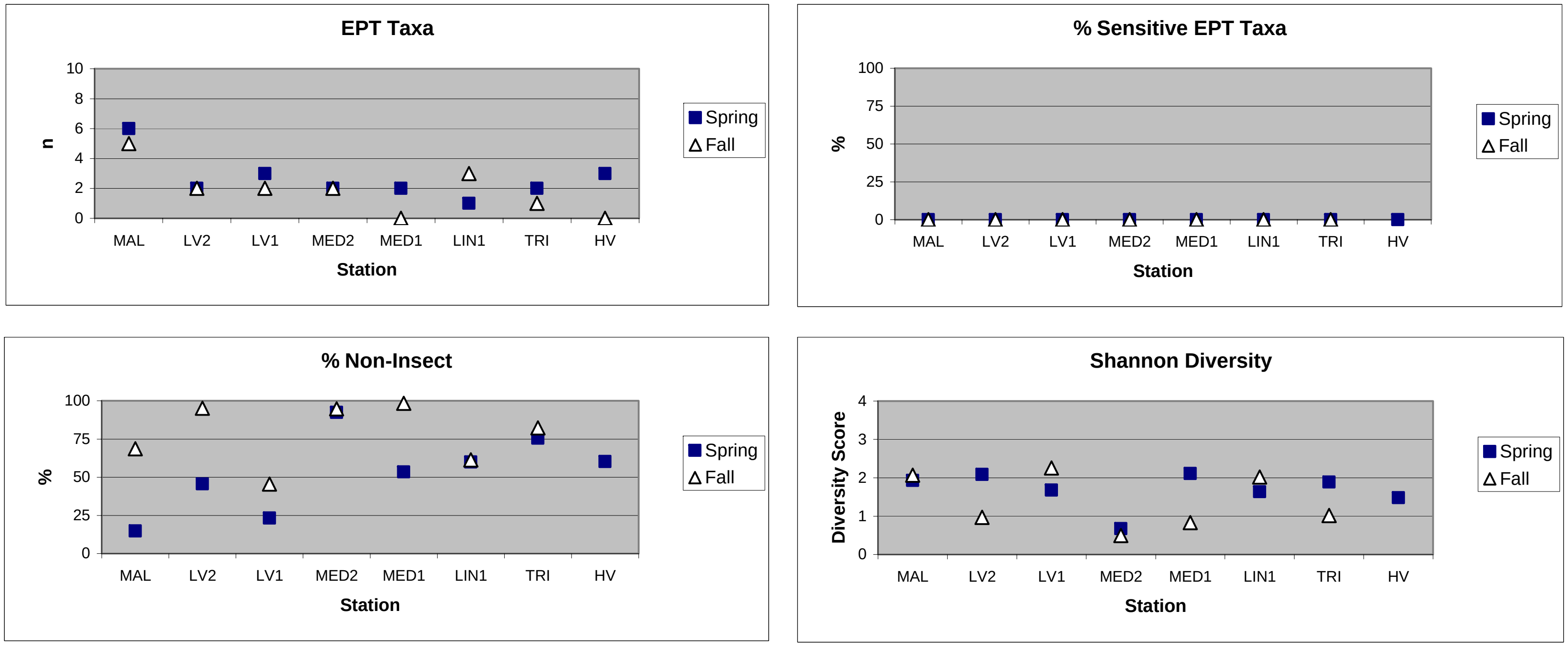

Figure 7. Spring and fall composition measures for each biological metric by site in the Malibu Creek Watershed, 2005.

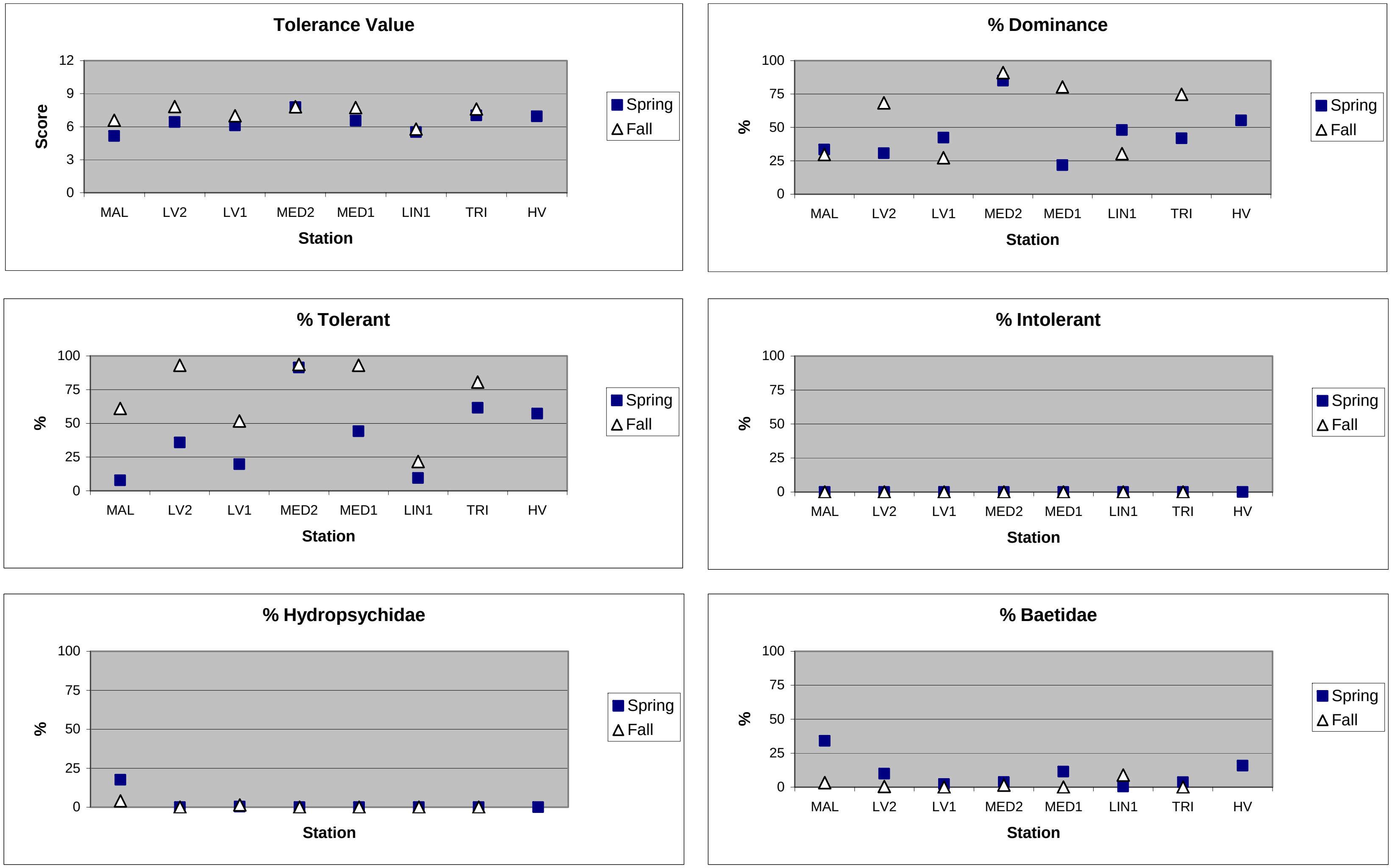

Figure 8. Tolerance/Intolerance metrics by site in the Malibu Creek Watershed, 2005.

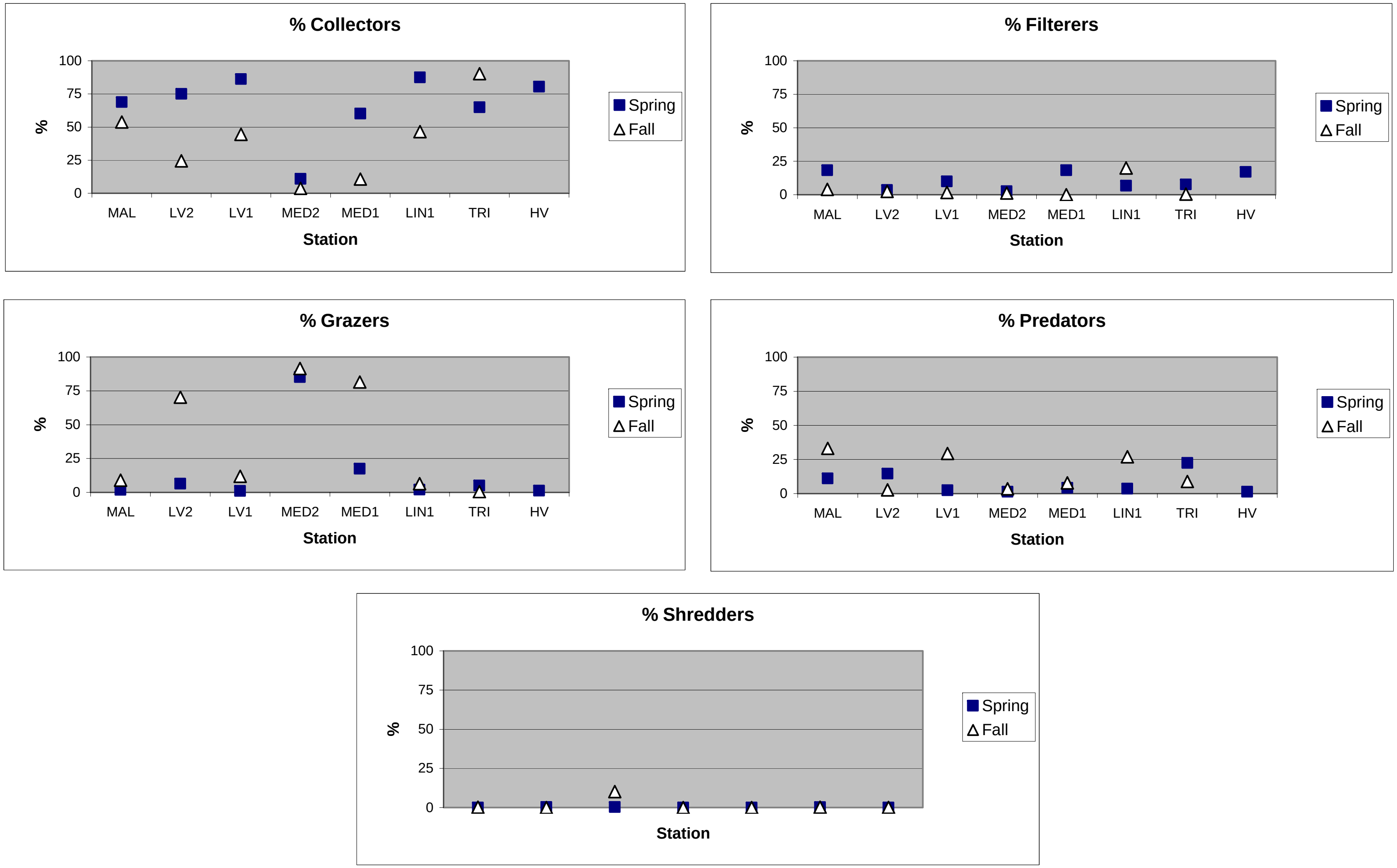

Figure 9. Functional Feeding Group metrics by site in the Malibu Creek watershed, 2005.

Table 6. Southern California IBI scores and ratings for sites sampled in the Malibu Creek Watershed.

Station / Metric	MAL	LV2	LV1	MED2	MED1	LIN1	TRI	HV
	Spring							
Coleoptera Taxa	2	0	7	2	0	0	0	4
EPT Taxa	3	1	1	1	1	0	1	1
Predator Taxa	4	3	3	0	0	1	4	2
% Collector Taxa	7	6	3	10	9	3	8	5
% Intolerant Taxa	0	0	0	0	0	0	0	0
% Non-Insect	8	1	6	0	0	0	0	0
% Tolerant	9	1	5	0	0	8	0	0
Total	**33**	**12**	**25**	**13**	**10**	**12**	**13**	**12**
So. Cal. IBI Rating	**Fair**	**Very Poor**	**Poor**	**Very Poor**	**Very Poor**	**Very Poor**	**Very Poor**	**Very Poor**
Station / Metric	**MAL**	**LV2**	**LV1**	**MED2**	**MED1**	**LIN1**	**TRI**	**HV**
	Fall							
Coleoptera Taxa	2	0	5	0	0	0	0	NS
EPT Taxa	3	1	1	1	0	1	0	
Predator Taxa	2	0	6	0	0	1	1	
% Collector Taxa	10	10	10	10	10	10	2	
% Intolerant Taxa	0	0	0	0	0	0	0	
% Non-Insect	0	0	1	0	0	0	0	
% Tolerant	0	0	0	0	0	5	0	
Total	**17**	**11**	**23**	**11**	**10**	**17**	**3**	
So. Cal. IBI Rating	**Poor**	**Very Poor**	**Poor**	**Very Poor**	**Very Poor**	**Poor**	**Very Poor**	

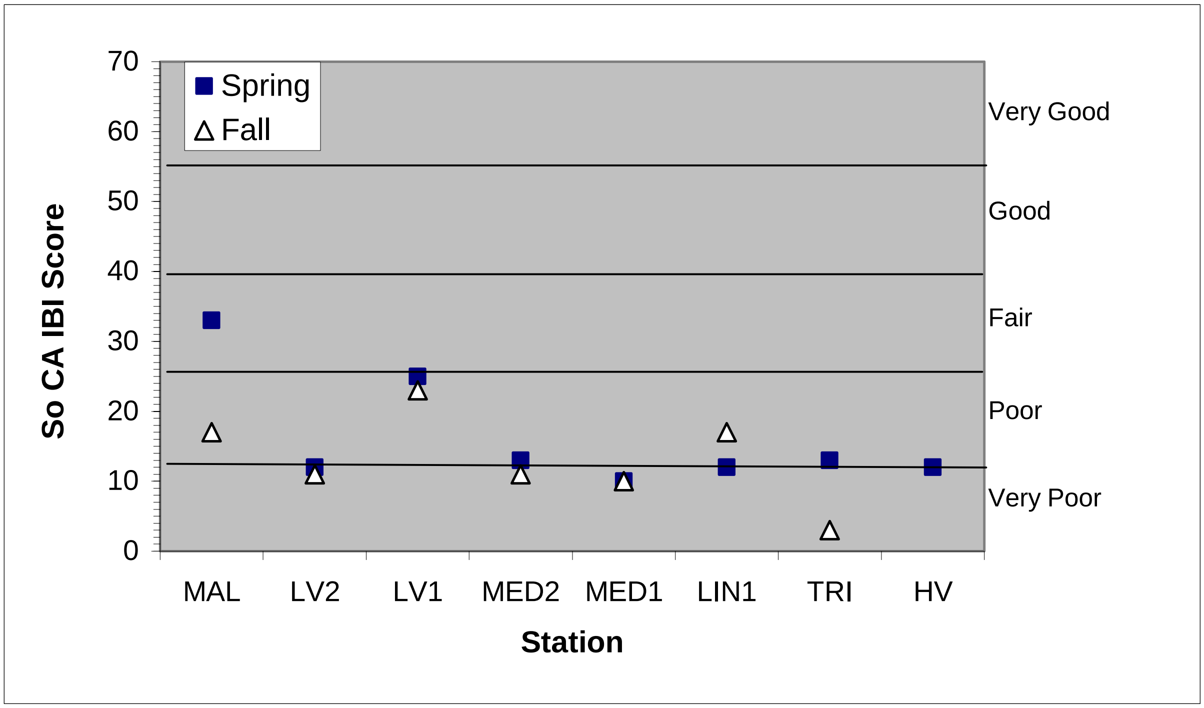

Figure 10. Southern California IBI Scores for sites in the Malibu Creek Watershed, 2005.

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Appendix A – BMI Taxa Lists & Metric Tables

Table A-1. Spring 2005 BMI raw taxa list for all sites in the Malibu Creek Watershed.

Identified Taxa	Tolerance Value (TV)	Functional Feeding Group (FFG)	MAL	LV2	LV1	MED2	MED1	LIN1	TRI	HV
Insecta Taxa										
Ephemeroptera										
Baetis sp.	5	cg	167	50	11	19	57	2	18	64
Fallceon quilleri	5	cg	2	0	0	0	0	0	0	12
Cloeodes excogitatus	4	cg	1	0	0	0	0	0	0	3
Tricorythodes sp.	5	cg	5	0	0	0	0	0	0	0
Odonata										
Coenagrion/Enallagma sp.	9	p	0	0	0	0	0	0	1	2
Argia sp.	7	p	0	0	0	0	0	0	41	0
Hemiptera										
Corixidae	8	p	0	1	0	0	0	0	0	1
Trichoptera										
Cheumatopsyche sp.	5	cf	2	0	0	0	0	0	0	0
Hydropsyche sp.	4	cf	88	0	2	0	0	0	0	0
Hydroptila sp.	6	sc	0	8	1	1	1	0	16	0
Coleoptera										
Hydroporus sp.	5	p	0	0	1	0	0	0	0	0
Agabus sp.	8	p	0	0	1	0	0	0	0	1
Hygrotus sp.	5	p	0	0	0	0	0	0	0	1
Hydraena sp.	5	p	0	0	0	1	0	0	0	0
Microcylloepus sp.	4	cg	1	0	0	0	0	0	0	0
Peltodytes sp.	5	sc	0	0	2	0	0	0	0	0
Stictotarsus	5	cg	0	0	1	0	0	0	0	0
Diptera										
Bezzia/Palpomyia sp.	6	p	0	2	3	0	0	0	0	0
Dasyhelea sp.	6	cg	0	0	0	0	0	0	0	4
Atrichopogon sp.	6	cg	0	1	1	0	0	0	0	0
Chironominae	6	cg	52	59	212	0	8	90	3	21
Orthocladiinae	5	cg	103	87	94	0	65	69	5	2
Tanypodinae	7	p	4	43	2	4	10	3	0	2
Dolichopodidae	4	p	0	1	0	0	0	0	0	0
Limnophora sp.	6	p	0	0	3	0	0	0	0	0
Pericoma/Telmatoscopus sp.	4	cg	0	0	0	0	0	2	0	1
Simulium sp.	6	cf	1	18	48	13	91	34	38	85
Caloparyphus/Euparyphus sp.	8	cg	0	0	0	0	1	0	0	0
Tipula sp.	4	sh	0	2	2	0	0	0	0	0
Non-Insecta Taxa										
Arachnoidea										
Lebertia sp.	5	p	1	0	2	0	0	0	0	0
Atractides sp.	8	p	1	0	0	0	0	0	0	0
Sperchon sp.	8	p	29	1	0	0	1	0	5	0
Torrenticola sp.	5	p	6	0	0	0	0	0	1	0
Ostracoda										
Cyprididae	8	cg	0	153	95	4	109	26	88	276
Malacostraca										
Hyalella sp.	8	cg	0	0	1	28	24	8	209	0
Procambarus clarkii	8	sh	0	0	0	0	0	1	0	0
Hydrozoa										
Hydra sp.	5	p	3	25	0	0	0	1	11	0
Gastropoda										
Ferrissia sp.	6	sc	0	0	0	0	0	0	6	0
Potamopyrgus antipodarum	8	sc	0	0	0	425	77	0	0	0
Physa/Physella sp.	8	sc	9	24	2	0	9	10	3	6
Helisoma sp.	6	sc								
Nematoda	5	p	0	0	0	0	0	1	0	0
Turbellaria										
Planariidae	4	p	12	0	0	2	10	11	52	0
Oligochaeta	5	cg	13	25	16	3	37	240	2	19
Enopla										
Prostoma sp.	8	p	0	0	0	0	0	2	1	0
TOTAL			**500**	**500**	**500**	**500**	**500**	**500**	**500**	**500**

Table A-2. Fall 2005 BMI raw taxa list for all sites in the Malibu Creek Watershed.

Identified Taxa	Tolerance Value (TV)	Functional Feeding Group (FFG)	MAL	LV2	LV1	MED2	MED1	LIN1	TRI
Insecta Taxa									
Ephemeroptera									
Baetis sp.	5	cg	3	2	0	8	0	39	0
Fallceon quilleri	5	cg	13	0	0	0	0	1	0
Cloeodes excogitatus	4	cg	0	0	0	0	0	4	0
Tricorythodes sp.	5	cg	1	0	0	0	0	0	38
Odonata									
Coenagrion/Enallagma sp.	9	p	8	0	42	6	0	8	1
Argia sp.	7	p	0	0	29	0	0	8	10
Plecoptera									
Malenka sp.	2	sh	0	0	14	0	0	0	0
Hemiptera									
Abedus sp.	8	p	0	0	1	0	0	0	0
Trichoptera									
Cheumatopsyche sp.	5	cf							
Hydropsyche sp.	4	cf	20	0	9	0	0	0	0
Hydroptila sp.	6	sc	13	9	0	2	0	0	0
Coleoptera									
Microcylloepus sp.	4	cg	1	0	0	0	0	0	0
Peltodytes sp.	5	sc	0	0	2	0	0	0	0
Stictotarsus sp.	5	cg	0	0	4	0	0	0	0
Tropisternus sp.	5	p	0	0	1	0	0	0	0
Diptera									
Bezzia/Palpomyia sp.	6	p	0	0	1	0	0	0	0
Atrichopogon sp.	6	cg	1	0	0	0	0	0	0
Chironominae	6	cg	0	0	1	0	0	4	7
Orthocladiinae	5	cg	3	1	63	5	2	27	0
Tanypodinae	7	p	1	0	92	0	1	0	34
Ephydra sp.	6	sh	0	0	61	0	0	0	0
Pericoma/Telmatoscopus sp. (L)	4	cg	0	0	2	0	0	0	0
Simulium sp. (L)	6	cf	0	13	1	7	0	99	2
Euparyphus sp. (L)	8	cg	16	0	0	0	0	0	0
Caloparyphus/Euparyphus sp.	8	cg	74	0	3	0	6	2	0
Tipula sp. (L)	4	sh	1	0	0	0	0	0	0
Non-Insecta Taxa									
Arachnoidea									
Sperchon sp.	8	p	14	0	2	0	0	0	1
Ostracoda									
Cyprididae	8	cg	147	117	27	2	9	3	27
Malacostraca									
Hyalella sp.	8	cg	0	0	163	3	36	0	389
Procambarus clarkii	8	sh	0	0	0	0	0	1	1
Hydrozoa									
Hydra sp.	5	p	0	1	0	0	0	0	0
Gastropoda									
Ferrissia sp.	6	sc	0	0	0	0	0	0	2
Potamopyrgus antipodarum	8	sc	3	0	1	489	422	1	0
Physa/Physella sp.	8	sc	27	354	68	0	6	31	0
Helisoma sp.	6	sc	1	0	0	0	0	0	0
Turbellaria									
Planariidae	4	p	128	3	5	10	31	56	0
Oligochaeta	5	cg	6	7	3	2	3	151	8
Enopla									
Prostoma sp.	8	p	12	10	2	3	9	62	0
TOTAL			**493**	**517**	**597**	**537**	**525**	**497**	**520**

Table A-3. Spring and fall 2005 BMI metrics for each sample location in the Malibu Creek Watershed.

Metric	MAL		LV2		LV1		MED2		MED1		LIN1		TRI		HV	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Taxonomic richness	19	21	16	10	20	24	10	11	14	10	15	16	17	12	16	
% dominant taxa	33.4	29.8	30.6	68.5	42.4	27.3	85.0	91.1	21.8	80.4	48.0	30.4	41.8	74.8	55.2	
EPT taxa	6	5	2	2	3	2	2	2	2	0	1	3	2	1	3	
EPT Index (%)	53.0	10.1	11.6	2.1	2.8	1.7	4.0	1.9	11.6	0.0	0.4	8.9	6.8	7.3	15.8	
Sensitive EPT Index (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Predator Taxa	7	5	6	3	6	9	3	3	3	3	4	4	7	4	5	
Coleoptera Taxa	1	1	0	0	4	3	1	0	0	0	0	0	0	0	2	
Percent Chironomidae	31.8	0.8	37.8	0.2	61.6	26.1	0.8	0.9	16.6	0.6	32.4	6.2	1.6	7.9	5.0	
Percent Non-Insect	14.8	68.6	45.6	95.2	23.2	45.4	92.4	94.8	53.4	98.3	60.0	61.4	75.6	82.3	60.2	
Shannon Diversity	1.93	2.07	2.09	0.97	1.68	2.25	0.67	0.49	2.11	0.83	1.63	2.02	1.89	1.02	1.48	
Tolerance Value	5.2	6.6	6.4	7.8	6.1	7.0	7.8	7.8	6.5	7.7	5.5	5.8	7.0	7.6	6.9	
Percent Intolerance Value (0-2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Percent Tolerance Value (8-10)	7.8	61.1	35.8	93.0	19.8	51.8	91.4	93.7	44.2	93.0	9.4	21.7	61.4	80.6	57.2	
Percent Collectors	68.8	53.8	75.0	24.6	86.2	44.6	10.8	3.7	60.2	10.7	87.4	46.5	65.0	90.2	80.4	
Percent Filterers	18.2	4.1	3.6	2.5	10.0	1.7	2.6	1.3	18.2	0.0	6.8	19.9	7.6	0.4	17.0	
Percent Grazers	1.8	8.9	6.4	70.2	1.0	11.9	85.2	91.4	17.4	81.5	2.0	6.4	5.0	0.4	1.2	
Percent Predators	11.2	33.1	14.6	2.7	2.4	29.3	1.4	3.5	4.2	7.8	3.6	27.0	22.4	8.8	1.4	
Percent Shredders	0.0	0.2	0.4	0.0	0.4	10.2	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.2	0.0	
Percent Hydropsychidae	17.6	4.1	0.0	0.0	0.4	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Percent Baetidae	34.0	3.2	10.0	0.4	2.2	0.0	3.8	1.5	11.4	0.0	0.4	8.9	3.6	0.0	15.8	
Estimated Abundance	5650	7710	2575	1587	8475	6100	3600	9982	16968	22368	8445	1965	2236	6756	5320	