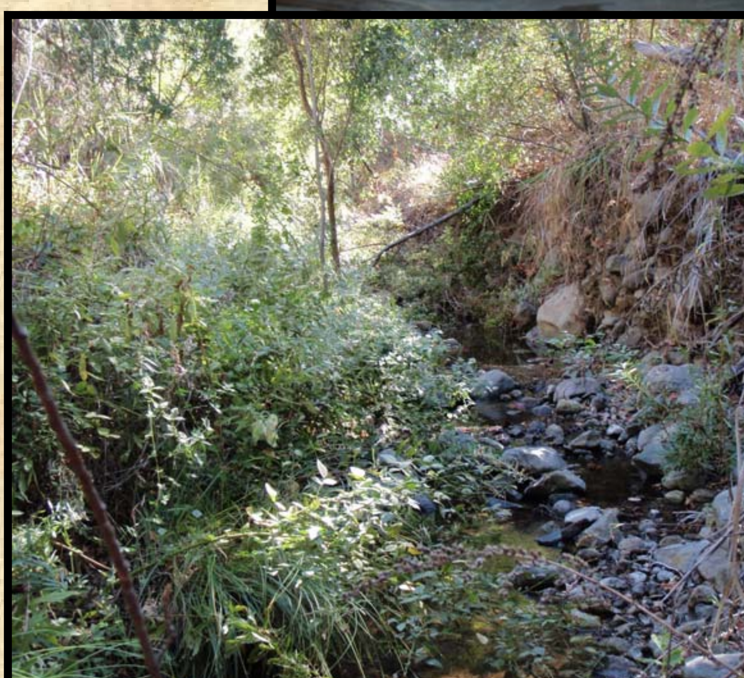
2008
BIOASSESSMENT MONITORING PROGRAM IN LOS ANGELES COUNTY

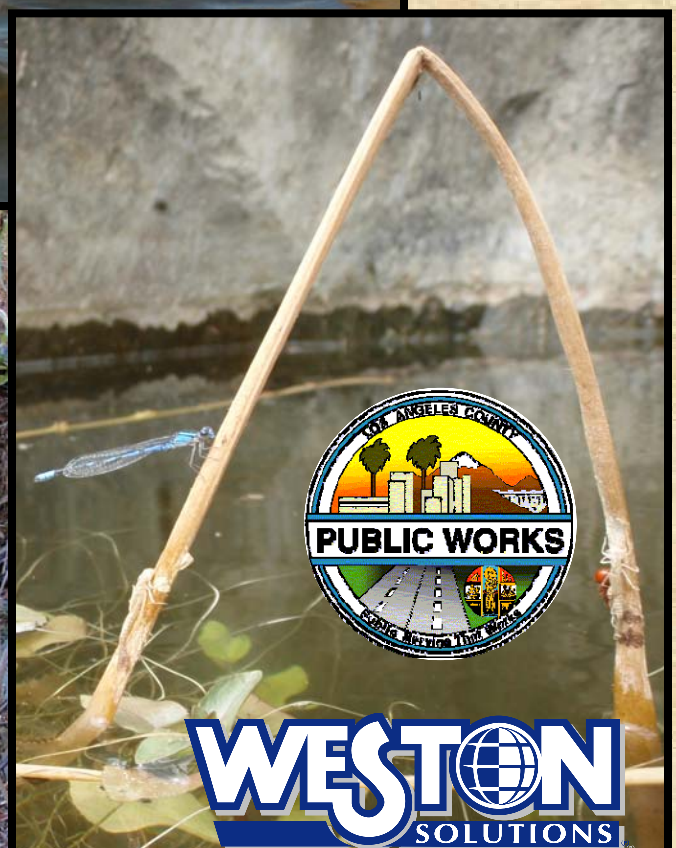
Final Report

Prepared for:

Los Angeles County Department of Public Works
Watershed Management Division
900 South Fremont Avenue
Alhambra, California 91803-1331

May 2009





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900 South Fremont Avenue
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ACRONYMS AND ABBREVIATIONS

CSBP	California Stream Bioassessment Procedure
EPT	Ephemeroptera, Plecoptera, and Trichoptera
FFG	functional feeding group
IBI	Index of Biotic Integrity
LACDPW	Los Angeles County Department of Public Works
LARWMP	Los Angeles River Watershed-Wide Monitoring Program
QA	quality assurance
QC	quality control
SWAMP	Surface Water Ambient Monitoring Program
TV	tolerance value
USEPA	United States Environmental Protection Agency
WESTON®	Weston Solutions, Inc.

EXECUTIVE SUMMARY

Background

Weston Solutions, Inc. (WESTON®) was contracted by the Los Angeles County Department of Public Works (LACDPW) to perform biological assessments of various freshwater streams in Los Angeles County. The goals of the program are to assess biological integrity and to detect biological trends and responses to pollution in receiving waters throughout the county. This program focuses on the sampling and analysis of freshwater stream benthic macroinvertebrates to achieve these goals. The program was initiated in October 2003, with monitoring surveys conducted once per year since that time, for a total of six surveys to date.

Study Area

The study area consisted of the five primary watersheds of Los Angeles County, including 18 stream monitoring sites. The watersheds included the following:

- Santa Clara River Watershed.
- Santa Monica Bay Watershed (including Malibu Creek Watershed and Ballona Creek Watershed).
- Dominguez Channel Watershed.
- Los Angeles River Watershed.
- San Gabriel River Watershed.

In 2008, 18 sites were proposed for sampling, and 17 of the proposed sites were sampled. One site, Bouquet Canyon Wash in Santa Clara River Watershed, was not sampled due to dry weather conditions. The sites were sampled in the months of June (San Gabriel River Watershed only) and November (all remaining watersheds).

Monitoring Sites

Six of the 2008 monitoring reaches were located in concrete-lined channels, including one station in San Gabriel River Watershed (SGLR00190), three stations in Los Angeles River Watershed (LALT500, LALT501, and LALT503), one station in Ballona Creek Watershed (Station 14), and one station in Dominguez Channel Watershed (Station 19). Three of the monitoring reaches (SGUT-504, Station 6 – Arroyo Seco, and Station 17 – Cold Creek) were considered reference sites with minimal upstream urban development. Two of the sites had non-optimal flow conditions in 2008: Station 16 – Las Virgenes Creek had surface flow for approximately 100 m that emanated from an underground spring, and Station 18 – Triunfo Creek was limited to standing pools of water.

Methodology

Field sampling followed the standard protocols described in the California Stream Bioassessment Procedure (CSBP) (Harrington, 2003). Sites located in the San Gabriel Watershed and in the Los Angeles River Watershed also incorporated the Surface Water Ambient Monitoring Program (SWAMP) physical habitat assessment protocol (Ode, 2007). Organisms were identified to standard taxonomic level I as specified in the *Southwest Association of Freshwater Invertebrate Taxonomists List of Freshwater Invertebrate Taxa*. Data analysis included the calculation of standard community-based metric values and a Southern California Index of Biotic Integrity (IBI) (Ode et al., 2005). Additional analyses included a comparison of concrete-lined channels with unlined channels, cluster analysis of stations and taxa identified, comparison of IBI scores with site elevations, and an analysis of IBI scores and key metrics since the beginning of the program in 2003.

Findings

Taxonomic evaluation of the 2008 samples yielded 99 different taxa from 10,353 individual organisms. The most abundant organisms collected throughout the county were midges of the family Chironomidae, which were present at every monitoring site. The majority of organisms collected from the monitoring sites were moderately or highly tolerant to stream impairments. Thirteen of the 18 sites were dominated by organisms in the collector–gatherer feeding group, all of which were located in the lower elevation urbanized areas of the watersheds.

The IBI score of a monitoring reach is considered the strongest analytical tool for rating overall benthic community quality. Sites rated Poor and Very Poor have an IBI score of 26 or lower (0–70 scale) and are considered impaired. The IBI scores for the 2008 study ranged from one to 55, out of a possible 70 points (Table ES-1), and the quality of benthic macroinvertebrate communities were rated from Very Poor to Good. The monitoring reaches located in highly modified, concrete-lined channels had IBI ratings of Very Poor. Analysis of individual metrics as well as total IBI scores showed that monitoring sites located in the lower elevation watershed areas had lower-quality benthic communities than sites located in the mid to upper reaches of the watersheds. A simple correlation analysis of elevation and IBI scores indicated a significant and positive correlation between the two. Analysis of the IBI scores for the six survey years through 2008 did not indicate any substantial trend towards degradation or improvement at any of the sites.

Table ES-1. Index of Biotic Integrity Scoring for 2008

Watershed	Monitoring Reach	Receiving Water	Total IBI Score (0–70 Point Scale)	IBI Rating
Malibu	17	Cold Creek	55	Good
Los Angeles	6	Arroyo Seco	42	Good
San Gabriel	SGUT-504	San Gabriel River	33	Fair
Santa Clara	1	Santa Clara River	24	Fair
Los Angeles	7	Arroyo Seco	18	Poor
San Gabriel	SGUT-505	San Gabriel River	18	Poor
Malibu	16	Las Virgenes Creek	16	Poor
Malibu	18	Triunfo Creek	15	Poor
Malibu	15	Medea Creek	7	Very Poor
San Gabriel	SGLR00190	San Gabriel River Unnamed Tributary	6	Very Poor
San Gabriel	5, SGLT-506	Walnut Creek	5	Very Poor
Ballona	14	Ballona Creek	4	Very Poor
Los Angeles	LALT500	Rio Hondo	3	Very Poor
Los Angeles	8, LALT502	Compton Creek	3	Very Poor
Los Angeles	LALT503	Tujunga Wash	3	Very Poor
Los Angeles	LALT501	Arroyo Seco	2	Very Poor
Dominguez	19	Dominguez Channel	1	Very Poor
Santa Clara	20*	Bouquet Canyon		

*Not sampled due to dry conditions

An analysis of the benthic community quality in concrete-lined sites versus unlined sites indicated that there was a statistically significant difference in IBI scores between sites located in the lower watershed areas based on channel type. When reference sites were added to the analysis, the difference in IBI scores between concrete-lined sites and unlined sites was of much greater significance. When considering the 2008 data only, the difference between concrete-lined sites and unlined sites was much greater than for the combined 2003 to 2008 data.

Two-way cluster analysis of taxa and stations showed evidence of clustering by taxa, and the stations appeared to cluster according to site physical conditions, location in the watershed, and IBI scores. Lower watershed sites were populated by ubiquitous taxa common to most all sites, whereas the upper watershed and reference sites had taxa unique to each site in addition to the ubiquitous taxa. Upper watershed sites with natural channels clustered together, mid to lower watershed sites with soft bottoms clustered together and fully concrete-lined sites clustered together.

Conclusion

Stream bioassessment monitoring of the watersheds of Los Angeles County has been conducted for six consecutive years beginning October 2003. Monitoring sites located in highly urbanized areas of the watersheds have had benthic macroinvertebrate communities that were considered impaired based on the Southern California IBI. Reference monitoring site macroinvertebrate communities have been rated unimpaired for the duration of the study. Sampling and analysis methodology has undergone some minor alterations, but overall results have been relatively consistent for all of the monitoring sites and none have shown any significant trend for increasing or decreasing biotic integrity.

1.0 INTRODUCTION

WESTON was contracted by the LACDPW to perform biological assessments of various freshwater streams in six Los Angeles County watersheds. The goals of the program are to assess biological integrity and to detect biological trends and responses to pollution in receiving waters throughout the county Sampling and analysis followed the protocols described in the CSBP (Harrington, 2003) and also incorporated the Southern California IBI (Ode et al., 2005). This program was initiated in October 2003, with monitoring surveys conducted once per year since that time.

The sampling protocol of the CSBP includes the collection and identification of stream benthic macroinvertebrates and also assesses the quality and condition of the in-stream physical habitat and adjacent riparian zone. Utilizing species-specific tolerance values (TVs) and community species composition, numerical biometric indices are calculated, allowing for the determination of habitat health in streams. Over time, this information is used to identify ecological trends and aid analyses of the appropriateness of water quality management programs (Yoder and Rankin, 1998). Invertebrates reside in streams for periods ranging from one month to several years and have varying sensitivities to physical, biological, and chemical disturbances in the stream. By assessing the invertebrate community structure of a stream, a realistic, long-term measure of stream habitat health and ecological response is obtained. This information may complement monitoring programs that test water quality parameters, which provide a measure of habitat conditions only at the moment sampling occurs. The addition of bioassessment to chemical, bacterial, and toxicological approaches to watershed monitoring programs gives a comprehensive indication of water quality and the effects of ecological impacts.

This report will present the results of stream bioassessment surveys of 18 monitoring reaches in the Los Angeles Basin, conducted from June 17 to 25, 2008 (San Gabriel River sites only) and from November 5 to 11, 2008. There were no significant rain events during the sampling period, although light to moderate rainfall occurred within a couple of weeks of the November sampling. A taxonomic listing of all collected benthic macroinvertebrates, biological metric and IBI calculations, and a discussion and analysis of the results are included in this report.

2.0 STUDY AREA OVERVIEW

The monitoring reaches assessed in this study were located in six major watersheds throughout Los Angeles County, including the Santa Clara River Watershed, the Santa Monica Bay Watershed (including the Ballona Creek Watershed and the Malibu Creek Watershed), the Dominguez Watershed, the Los Angeles River Watershed, and the San Gabriel River Watershed. The monitoring reaches are described in Table 1, and the rationale for monitoring each site is included. A map of the monitoring locations is shown on Figure 1.

Six of the monitoring reaches (stations LALT500, LALT501, LALT502, LALT503, 14, and 19) were located in concrete-lined channels. Three of the monitoring reaches (stations SGUT-504, 6, and 17) may be considered reference sites with minimal upstream urban development.

Table 1. Los Angeles County Department of Public Works Stream Bioassessment Monitoring Stations, 2008

Station	Receiving Waterbody	Location – Date	Coordinates	Justification	Elevation (ft above sea level)
San Gabriel River Watershed					
SGUT-504	San Gabriel River Mainstem	Upper San Gabriel River near East Fork Road – 06/17	N 34º 14.228' W -117º 49.129'	Offset site for the San Gabriel River Watershed Monitoring Project	1,512
SGUT-505	San Gabriel River Mainstem	Upper San Gabriel River below Morris Reservoir – 06/17	N 34º 10.164' W -117º 53.359'	Offset site for the San Gabriel River Watershed Monitoring Project	898
SGLR00 190	San Gabriel River Unnamed Tributary Lined Channel	Lower San Gabriel River Tributary at Rose Hill Road – 06/25	N 34º 00.894' W -118º 02.871'	Offset site for the San Gabriel River Watershed Monitoring Project	220
5 SGLT-506	Walnut Creek Unlined Channel	Walnut Channel upstream of San Gabriel River – 06/17	N 34º 03.704' W -117º 59.477'	Assess impacts of upstream land uses; nursery and residential area / San Gabriel River Watershed Monitoring Project Site.	298
Los Angeles River Watershed					
6	Arroyo Seco Unlined Channel	Upstream of Arroyo Seco Spreading Grounds – 11/05	N 34º 12.189' W -118º 09.968'	Upstream reference site with minimal impact from residential land use	1,118
7	Arroyo Seco Unlined Channel	Arroyo Seco downstream from Interstate 134 – 11/05	N 34º 08.676' W -118º 09.982'	Assess impacts of residential land use	725
LALT500	Rio Hondo Lined Channel	Rio Hondo at Los Angeles River – 11/10	N 33º 56.134' W -118º 10.275'	Offset site for the Los Angeles River watershed-wide monitoring project; assess impacts of upstream land uses	82
LALT501	Arroyo Seco Lined Channel	Arroyo Seco at Los Angeles River – 10/11	N 34º 04.805' W -118º 13.451'	Offset site for the Los Angeles River watershed-wide monitoring project; assess impacts of upstream land uses	295
8 LALT502	Compton Creek Unlined Channel	Compton Creek upstream of the confluence with the Los Angeles River – 11/10	N 33º 50.788' W -118º 12.535'	Offset site for the Los Angeles River watershed-wide monitoring project; assess impacts of upstream land uses	22
LALT503	Tujunga Wash Lined Channel	Tujunga Wash at Los Angeles River – 10/11	N 34º 08.900' W -118º 23.344'	Offset site for the Los Angeles River watershed-wide monitoring project; assess impacts of upstream land uses	578
Ballona Creek Watershed					
14	Ballona Creek Lined Channel	Ballona Creek at Interstate 405 and S. Sepulveda Blvd – 11/05	N 34º 00.445' W -118º 23.761'	Original location relocated due to tidal influence	29
Malibu Creek Watershed					
15	Medea Creek Unlined Channel	Medea Creek at Kanan Road – 11/06	N 34º 09.043' W -118º 45.456'	Assess impacts of Medea Creek to Malibu Creek	862
16	Las Virgenes Creek Unlined Channel	Las Virgenes Creek near Los Angeles County line – 11/06	N 34º 10.133' W -118º 42.192'	Assess impacts from tributary to Malibu Creek	856
17	Cold Creek Unlined Channel	Cold Creek at Stunt Rd. at Cold Creek Preserve – 11/06	N 34º 05.707' W -118º 38.918'	Upstream reference site	1,242
18	Triunfo Creek Unlined Channel	Triunfo Creek downstream of Troutdale Drive and nursery – 11/06	N 34º 06.851' W -118º 46.750'	Assess impacts of nursery	761
Dominguez Channel Watershed					
19	Dominguez Channel Lined Channel	Dominguez Channel and Vermont Avenue – 11/05	N 33º 52.270' W -118º 17.909'	Original location relocated due to tidal influence	3
Santa Clara River Watershed					
1	Santa Clara River Unlined Channel	Santa Clara River at The Old Road – 11/07	N 34º 25.945' W -118º 35.689'	Location of DPW mass emission monitoring site	1,015
20	Bouquet Canyon Unlined Channel	Bouquet Canyon Wash below Vasquez Canyon Road – 11/07	N 34º 28.422' W -118º 28.023'	Assess conditions upstream of Diazinon findings; *not sampled due to dry conditions*	1,512

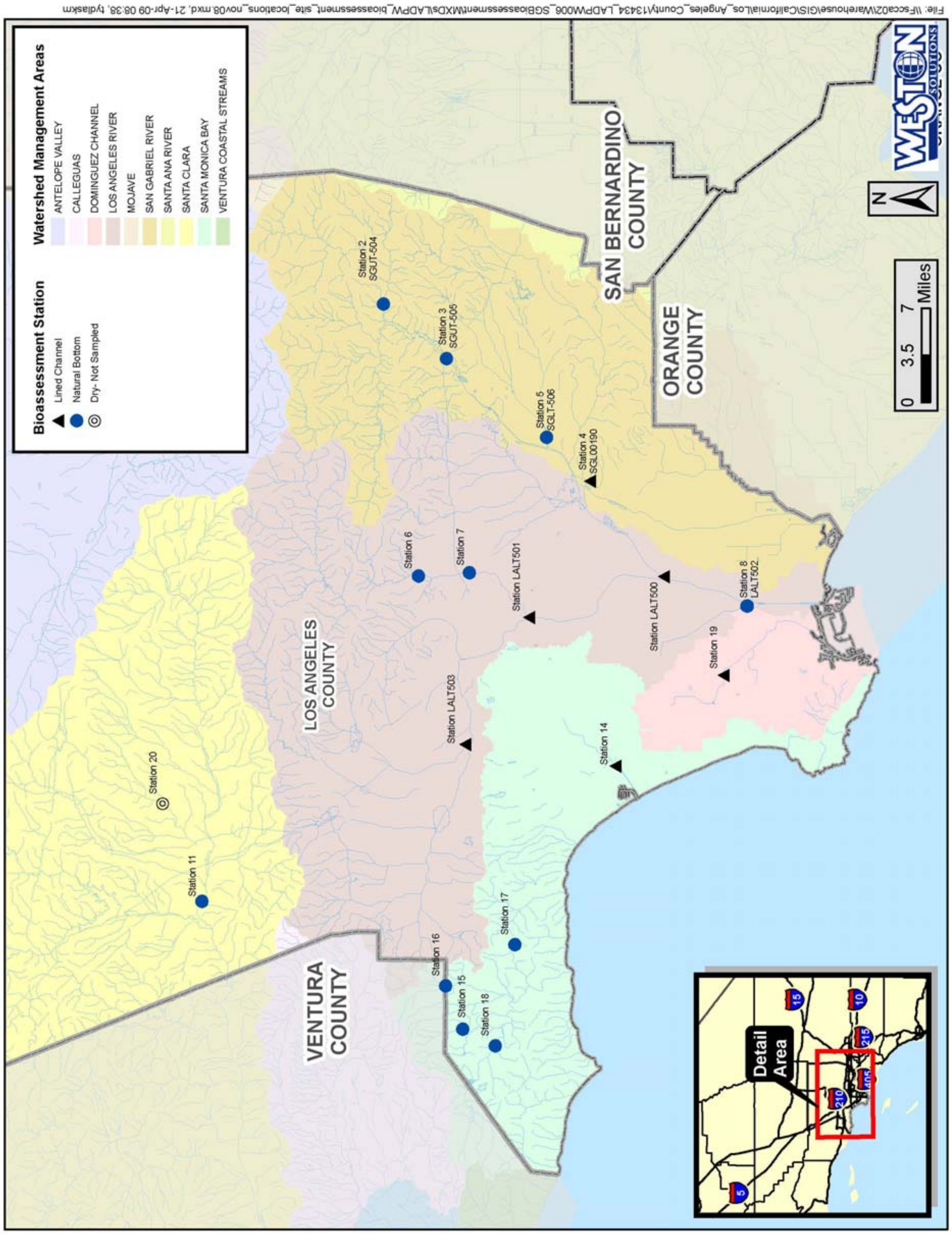

Figure 1. Stream Bioassessment Monitoring Locations, 2008

3.0 METHODS

A general description of the methods incorporated in the sampling program is presented below. WESTON personnel adhered to the protocols of the CSBP (Harrington, 2003) as closely as practicable, and this document may be referenced for more detailed procedural information (http://www.dfg.ca.gov/cabw/Field/csbpwforms.html). The sites in the Los Angeles and San Gabriel River Watersheds also incorporated the SWAMP physical habitat assessment protocol (Ode, 2007).

The sampling and analysis for the 2008 survey was performed by nearly the same protocols as the 2006 and 2007 surveys. The last three years of surveys were different from previous surveys in two respects, which reflected the difference between the 1999 CSBP version and the 2003 version. One difference was in the level of field sampling effort, where the total benthic area sampled was reduced from 18 ft^2 to 9 ft^2. The second difference was in the laboratory sample processing. Prior methods required three sample replicates to be processed separately with 300 organisms removed from each replicate (900 total organisms). In the new protocol, the three replicate samples were combined, and a total of 500 organisms were removed from the sample. It did not appear that this reduction in effort affected the overall diversity of taxa, as the 2006 and 2007 surveys had similar or greater diversity than in previous surveys (Section 4.6). One additional change was made in 2008 at the recommendation of SWAMP, and the 500 organism count was increased to 600 organisms.

3.1 Sampling Site Selection

A field reconnaissance of the monitoring reaches by LACDPW staff occurred prior to program initiation in 2003 to determine the suitability of the twenty proposed sites. Since the program inception, variability in rainfall amounts has resulted in some inconsistency in flow regimes at the monitoring sites. Station 20 – Bouquet Canyon was dry in 2008 and could not be sampled. Originally established stations 11, 12, and 13 in the Los Angeles River Watershed were offset in 2008 with stations LALT500, LALT501, and LALT503 as a contribution to the Los Angeles River Watershed-Wide Monitoring Program (LARWMP) for the Los Angeles / San Gabriel River Watershed Council. Station LALT502 in Compton Creek was sampled in the same location as historical Station 8. The remaining ten sites were sampled in the same locations as in previous years. The four San Gabriel River Watershed sites (three fixed and one random) were sampled in June 2008 by Aquatic Bioassay and Consulting Laboratories, and those data are also presented in this report.

3.2 Monitoring Reach Delineation

The sampling points specified in the CSBP target a stream feature known as a riffle. An ideal riffle is an area of variable flow regimes with some surface disturbance and a relatively complex and stable substrate. These areas provide increased colonization potential for benthic invertebrates. Riffles typically support the greatest diversity of invertebrates in a stream, and by selecting the richest habitats available at each stream, comparability among streams is possible. For some of the monitoring reaches in this study, optimal riffle habitat was not always available; therefore, best available habitat was sampled. Best available habitat was selected based on complexity of substrates in the stream bed.

Under optimal conditions, five riffles constituted a monitoring reach, and three of these were randomly selected for sampling using a random number table. Given sufficient riffle width and length, a sampling transect perpendicular to stream flow was selected randomly in the upper 1/3 of the riffle. In situations where the only available riffles were very short and/or narrow, the samples were taken to best represent available substrate types. For monitoring reaches in uniform concrete channels, a 150-m reach of the stream was selected, and three separate 1-m wide transects were randomly selected. Every monitoring reach was sampled from downstream to upstream. Photographs were taken of every monitoring reach, and most of the individual riffles were sampled. Representative photos of the monitoring reaches are presented in Appendix A.

3.3 Sample Collection

Once a sampling transect was established, benthic invertebrates were collected using a 1-ft wide, 0.5-mm mesh D-frame kick-net. A 1-ft^2 area upstream of the net was sampled by disrupting the substrate and scrubbing the cobble and boulders so that the organisms were dislodged and swept into the net by the current or by hand sweeping. In areas with little or no current, the substrate was disturbed, and the net was swept back and forth to capture the organisms. The duration of the sampling generally ranged from one to three minutes, depending on substrate complexity. Three 1-ft^2 areas were sampled along each transect and were combined into one composite sample. The three sample points on the transect were usually taken near the right and left margins and in the middle of the stream, or the three sample points were selected to best represent the diversity of habitat types present. This procedure was repeated for the next two riffles until a total of nine replicate 1-ft^2 samples were collected. Samples were transferred to 1-qt jars, preserved with 95% ethanol, and returned to WESTON's benthic laboratory for processing.

3.4 Physical Habitat Quality Assessment

For each monitoring reach sampled, the physical habitat of the stream and its adjacent banks were assessed using United States Environmental Protection Agency (USEPA) Rapid Bioassessment Protocols (Barbour et al., 1999). Habitat quality parameters were assessed to provide a record of the overall condition of the reach. Parameters, such as channel alteration, frequency of riffles, width of riparian zones, and vegetative cover, help to provide a more comprehensive understanding of the condition of the stream. Additionally, specific characteristics of the sampled riffles were recorded, including riffle length, depth, gradient, velocity, substrate complexity, and substrate composition.

Water quality measurements were taken at each of the monitoring sites. Measurements included water temperature, specific conductance, pH, dissolved oxygen, turbidity, and hardness.

3.5 Laboratory Processing and Analysis

At the laboratory, samples were relinquished to the laboratory sample custodian. Prior to sample processing, technicians signed out each sample in a sample tracking log book. The sample was poured over a No. 35 standard testing sieve (0.5-mm stainless-steel mesh), and the ethanol was retained for re-use. The sample was gently rinsed with freshwater, and large debris such as wood, leaves, or rocks were removed. The sample was transferred to a tray marked with grids approximately 25 cm^2 in size and was spread homogenously to a thickness of approximately

0.25 inch. One grid was randomly selected, and the sample material contained within the grid was removed and processed. In cases where the animals appeared extremely abundant, a fraction of the grid may have been removed. The material from the grid was examined under a stereomicroscope, and the invertebrates were removed, sorted into major taxonomic groups, and placed in vials containing 70% ethanol. This process was repeated until 600 organisms were removed from the sample. Organisms from a grid in excess of the 600 were placed in a separate vial labeled "extra animals," so that a total abundance for the sample could be estimated. All sample processing information was entered onto a Stream Bioassessment Sorting Sheet (Appendix C). Processed material from the sample was placed in a separate jar and was labeled "sorted," and the unprocessed material was returned to the original sample container, checked in to the sample tracking log book, and archived. Sorted material was retained for quality assurance (QA) purposes.

All organisms were identified to standard taxonomic level I as specified in the Southwest Association of Freshwater Invertebrate Taxonomists List of Freshwater Invertebrate Taxa (SAFIT, 2006), genus level for most insects, and order or class for non-insects. The taxonomic levels are fixed under this document to prevent inconsistencies in taxonomic effort between laboratories. The level of taxonomic effort has not changed since the inception of the LACDPW bioassessment monitoring program in 2003, although a few minor adjustments in taxa determinations have been made. With the exception of some beetles, nearly all of the insects identified in the program were in the larval and pupal stages of development, which metamorphose into an aerial adult form. Nearly all of the non-insect taxa are aquatic for their entire life history.

Quality Assurance / Quality Control—After sample processing is complete, at least 10% of the sample lot, or two samples processed per each technician, are checked to ensure a 90% or better organism removal efficiency. Results of the sorting QA/ quality control (QC) were entered onto the Stream Bioassessment Sorting Sheet. To ensure accuracy of the taxonomic identifications, 10% of the samples were sent to the California Department of Fish and Game (CDFG) Aquatic Bioassessment Laboratory (ABL) for verification. Any discrepancies between ABL identifications and the original identifications were reconciled in the taxonomic database. Results of the sorting and taxonomic QA/QC analyses are presented in Appendix C.

3.6 Data Analysis

Taxonomic data were entered into an electronic file using Microsoft Word and were converted into a SAS® database for QA/QC and data reduction. Benthic macroinvertebrate community-based metric values were calculated from the database. A list of the standard CSBP metrics and a brief description of what they signify is presented in Table 2. A taxonomic list of the macroinvertebrates present in each sample was created in Microsoft Excel, including the designated TV and functional feeding group (FFG) of each taxon. Macrophyte herbivores (mh), piercer herbivores (ph), omnivores (om), parasites (pa) and xylophages/wood eaters (xy) were combined into a group designated "other." Also note that for some organisms identified at the Family level or above, a single TV or FFG was not assigned. This is because the taxa within the group have a broad range of tolerances or feeding strategies, and a single designation is not representative.

Table 2. Bioassessment Metrics Used to Characterize Benthic Invertebrate Communities

BMI[1] Metric	Description	Response to Impairment
Richness Measures		
Taxa Richness	Total number of individual taxa	Decrease
Coleopteran Taxa*	Number of taxa in the insect order Coleoptera (beetles)	Decrease
EPT[2] Taxa*	Number of taxa in the Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) insect orders	Decrease
Dipteran Taxa	Number of taxa in the insect order Diptera (true flies)	Increase
Non-Insect Taxa	Number of non-insect taxa	Increase
Predator Taxa*	Number of taxa in the predator feeding group	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 TVs between 0 and 3	Decrease
Shannon Diversity Index	General measure of sample diversity that incorporates richness and evenness (Shannon and Weaver, 1963)	Decrease
Margalef Diversity	Measure of sample diversity weighted for richness	Decrease
Tolerance/Intolerance Measures		
TV	Value between 0 and 10 of individuals designated as pollution tolerant (higher values) or intolerant (lower values)	Increase
Dominant Taxon	Percent composition of the single most abundant taxon	Increase
Percent Chironomidae	Percent composition of the tolerant dipteran family Chironomidae	Increase
Percent Intolerant Organisms*	Percent of organisms in sample that are highly intolerant to impairment as indicated by a TV of 0, 1, or 2	Decrease
Percent Tolerant Organisms	Percent of organisms in sample that are highly tolerant to impairment as indicated by a TV of 8, 9, or 10	Increase
Percent Tolerant Taxa*	Percent of taxa in sample that are highly tolerant to impairment as indicated by a TV of 8, 9, or 10	Increase
Percent Non-insect Organisms	Percent of organisms in sample that are not in the Class Insecta	Increase
Percent Non-insect Taxa*	Percent of taxa in sample that are not in the Class Insecta	Increase
FFGs		
Percent Collector–Gatherers*	Percent of macrobenthos that collect or gather fine particulate matter	Increase
Percent Collector–Filterers*	Percent of macrobenthos that filter fine particulate matter	Increase
Percent Scrapers	Percent of macrobenthos that graze upon periphyton	Increase
Percent Predators	Percent of macrobenthos that feed on other organisms	Variable
Percent Shredders	Percent of macrobenthos that shreds coarse particulate matter	Decrease
Percent Other	Percent of macrobenthos that are parasites, macrophyte herbivores, piercer herbivores, omnivores, and xylophages	Variable
Abundance		
Estimated Abundance	Estimated number of organisms in entire sample	Variable

*indicates metrics used to calculate the IBI
[1]BMI = benthic macroinvertebrate
[2]EPT = Ephemeroptera, Plecoptera, and Trichoptera
Source: modified from SDRWQCB, 1999

In addition to the individual metric values, a multi-metric IBI was calculated for each monitoring reach (Ode et al., 2005). The IBI is a quantitative scoring system for assessing the quality of benthic macroinvertebrate assemblages and is currently the most useful tool in reducing a complex macroinvertebrate data set to a qualitative rating for each monitoring reach. The IBI score is derived from the cumulative value of seven biological metrics (Table 2, asterisked metrics). The total scores were categorized into ratings of the benthic community, ranging from Very Poor to Very Good. It has been noted that the Southern California IBI was developed with very few sites located at low elevations in Los Angeles County, and future development of a refined IBI has been suggested.

4.0 RESULTS

A discussion of the results of the survey is presented below. A complete listing of the benthic invertebrates identified at all stations and replicates are presented systematically in Appendix B.1. Ranked total abundance for each species at all sampling sites combined are presented in Appendix B.2, and the calculated metric values for each monitoring reach are presented in Appendix B.3.

The reader may notice seeming discrepancies between the number of unique taxa listed in the metrics tables and the apparent number of taxa in the taxa list. This is due to the presence of immature or damaged specimens that were identified at a higher systematic level than the standard effort, but were not thought to be unique taxa.

4.1 Benthic Invertebrate Community – Study Area Summary

Combining all stations in the Los Angeles County study area, a total of 99 unique taxa were identified from 9,754 individual organisms (Appendix B.1 and Appendix B.2). The five most abundant taxa in descending order were chironomid midges (2,413 individuals), Oligochaetes (earthworms – 1,110 individuals), the mayfly (*Baetis*) (1,096 individuals), the black fly (*Simulium*) (972 individuals), and the Amphipod crustacean (*Hyalella*) (860 individuals) (Appendix B.2). All of these taxa are moderately to highly tolerant to habitat impairment, and four of the five are in the collector–gatherer feeding group. Collector–gatherers feed on organic detritus, algae, and various micro-organisms (Pennak, 2001; Usinger, 1956), and high abundances of these organisms are often associated with high levels of urban runoff (Lenat and Crawford, 1994).


Midge, Chironomidae


Earthworm, Oligochaeta


Mayfly, *Baetis*


Black Fly, *Simulium*


Amphipod, *Hyalella*

The order Diptera (true flies) had the greatest number of unique taxa identified (18 taxa), followed by Trichoptera (caddisflies) and Coleoptera (beetles) with 12 and 11 taxa, respectively

(Appendix B.1). Chironomid midges were present at all of the monitoring sites and were the dominant organism at six of the 17 sites.

4.2 Benthic Invertebrate Community Metrics

Benthic invertebrate community metric values for each monitoring reach are presented in Appendix B.3. A listing of the five most dominant (i.e., abundant) taxa for each monitoring reach is presented in Appendix B.4.

Taxa Richness—Taxa richness is the total number of unique taxa in a sample. This number does not account for damaged or immature specimens that were identified at a higher taxonomic level than specified in the SAFIT list (also referred to as indiscriminate taxa). Taxa richness per sample ranged from six taxa at Station 16 – La Virgenes Creek to 38 taxa at Station 6 – Arroyo Seco (Appendix B.3). Station 18 – Triunfo Creek had the greatest taxa richness for the urban influenced sites.

Diversity and Dominance—Two diversity indices were calculated for each site: Shannon diversity, which weights for evenness of the distribution of the different taxa, and Margalef diversity, which weights for total number of different taxa. Shannon diversity values per station ranged from 0.2 at Station 16 – Las Virgenes Creek to 2.6 at Station 6 – Arroyo Seco (Appendix B.3). Margalef Diversity values per station ranged from 0.8 at Station 16 – Las Virgenes Creek to 5.8 at Station 6 – Arroyo Seco (Appendix B.3). Dominance by a single taxon ranged from 25.2% *Hyalella* at Station 15 – Medea Creek to 97.2% *Simulium* at Station 16 – Las Virgenes Creek (Appendix B.4).

Ephemeroptera, Plecoptera, and Trichoptera Taxa—This metric represents the number of taxa in the orders of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (EPT) that are collected at each station. These orders contain many taxa that are sensitive to impairment. Several of these taxa, including mayflies in the family Baetidae and the caddisflies, *Cheumatopsyche*, *Hydropsyche*, and *Hydroptila*, however, are tolerant to urban runoff that does not contain high levels of chemical pollutants. This means that percent sensitive EPT is a much stronger metric than total percent EPT for assessing ecological health at a site. All of the stonefly taxa are quite sensitive to urban runoff.

The greatest number of EPT taxa (13) were collected at Station 2 (SGUT-504) – San Gabriel River (Appendix B.3). There were no EPT taxa collected at three of the monitoring sites, including Station LALT500 – Rio Hondo, Station 16 – Las Virgenes Creek, and Station 19 – Dominguez Channel. EPT individuals were most abundant at Station 3 (SGUT-505) – San Gabriel River where they comprised 78.6% of the benthic community (Appendix B.3). The most abundant of the EPT taxa across the survey region included the baetid mayflies, *Baetis* and *Fallceon quilleri* (Appendix B.2). Sensitive EPT taxa (TV 0–3) were collected at five of the sites but were collected in substantial numbers only at Station 17 – Cold Creek, where they comprised 41.4% of the benthic community. The other sites with sensitive EPT taxa included Station 2 (SGUT-504) – San Gabriel River, Station 3 (SGUT-505) – San Gabriel River, Station 6 – Arroyo Seco, and Station 18 – Triunfo Creek. Stoneflies (Plecoptera), all of which are highly sensitive, were collected at stations 2, 17, and 18.

Tolerance Values—For most stream macroinvertebrates, a TV has been determined for each taxon through prior research on the animals' life history (Hilsenhoff, 1987). TVs range from 0, for organisms highly sensitive to impairments, to 10, for organisms that are highly tolerant to impairments. Low to moderate abundance of impairment tolerant organisms does not necessarily imply impairment (SDRWQCB, 2001), but more importantly, the presence of sensitive organisms is unlikely when a stream is impaired. The presence of highly intolerant organisms (TV 0–2) is likely the strongest indicator of good water quality.

Average community TVs for all sites ranged from 3.9 at Station 17 – Cold Creek to 7.3 at Station 15 – Medea Creek (Appendix B.3). Highly tolerant organisms (TV 8–10) were most abundant at Station 15 – Medea Creek, where high numbers of the amphipod, *Hyalella*, and Ostracods contributed to a total of 76.7% tolerant organisms. Highly tolerant organisms were least abundant at Station 16 – Las Virgenes Creek, where they comprised 0.2% of the community. Highly intolerant organisms were collected from five sites: Station 2 (SGUT-504) – San Gabriel River, Station 3 (SGUT-505) – San Gabriel River, Station 6 – Arroyo Seco, Station 17 – Cold Creek, and Station 18 – Triunfo Creek. Highly intolerant organisms were much more abundant at Station 17 – Cold Creek than at any of the other sites.

Functional Feeding Groups—As with TVs, FFG designations have been determined through prior life-history research or observations of each taxon. The percent composition of the FFGs provides useful information regarding benthic community function, and some feeding groups contain greater numbers of intolerant organisms (Table 2). In general, a more even distribution of the feeding groups indicates a higher quality benthic community. The information from feeding group composition may be particularly useful in detecting physical habitat degradation and impacts from urbanization.

Twelve of the seventeen monitoring reaches were dominated by taxa in the collector–gatherer feeding group (Appendix B.1 and Appendix B.3). Four of the top five dominant taxa in the study region (i.e., chironomid midges, *Baetis*, *Hyalella*, and Oligochaetes) were in the collector–gatherer feeding group and generally increase in abundance in response to urban runoff in a watershed. Station 2 (SGUT-504)-San Gabriel River and Station 16-Las Virgenes Creek were dominated by collector–filterers. Station 1 – Triunfo Creek was dominated by scrapers (snails), Station 6 – Arroyo Seco was dominated by predators, and Station 17 – Cold Creek was dominated by shredders. Stations 6 and 17 also had the greatest evenness of distribution of the various feeding strategies, indicating a more dynamically functioning benthic community than the other sites. Station LALT503 – Tujunga Wash had the greatest dominance by a single feeding group, where collector–gatherers comprised 99.2% of the community.

Estimated Abundance—The estimated total abundance is the total number of animals predicted to be in the sample if the entire sample had been processed. This value was used to calculate the estimated number of animals living in 1 ft^2 of benthic habitat. Response to moderate habitat impairment is often indicated by an increase in total abundance by highly tolerant organisms, with a corresponding decrease in taxa richness and diversity; however, severe impairment can result in a catastrophic decrease in total abundance.

Estimated abundance ranged from 58 organisms per square foot of substrate at Station 19 – Dominguez Channel to 5,221 organisms per square foot at Station 5 (SGLT-506) – Walnut Creek (Appendix B.3). Abundance at the reference sites ranged from 197 to 397 organisms per square foot.

4.3 Physical Habitat Quality Assessment

Ten parameters of the physical habitat of the monitoring reaches were scored on a 0 to 20 scale, thus 200 is the highest possible score. Table 3 lists the parameters and gives a brief description of the conditions that are most beneficial to macroinvertebrate communities. The parameters for assessment and their scoring ranges were established by the USEPA and were adapted for use in California for the CSBP. Most of the physical habitat quality parameters are scored in a qualitative manner, and they provide a good comparative tool for sites within a sampling program. Physical habitat quality scores for each monitoring reach are presented in Appendix B.5, and water quality data are presented in Appendix B.6. The San Gabriel River sites were assessed according to SWAMP protocols in which only three of the ten parameters are assessed.

Table 3. Parameters Used to Characterize the Physical Habitat of a Stream Reach

Parameter	Conditions Assessed	Optimal Conditions
Instream Cover	The percentage of substrate favorable for epifaunal colonization. Most favorable is a mix of snags, submerged logs, undercut banks, cobble and other stable habitats.	Complex mix of stable substrates occupying a high percentage of the stream bottom.
Embeddedness	The percentage of fine sediment surrounding gravel, cobble, and boulder particles.	Very little embeddedness, with layered substrate.
Velocity/Depth Regimes	The four velocity/depth regimes are: slow-deep, slow-shallow, fast-deep, and fast-shallow.	A mix of all four regimes, dominated by fast-shallow.
Sediment Deposition	The percentage of bottom affected by the deposition of new gravel, sand, or fine sediment.	Little or no new deposition, less than 5% of the bottom affected.
Channel Flow	The percentage of the stream channel filled by flowing water and the amount of substrate covered.	Water reaches base of both lower banks and minimal amount of substrate is exposed.
Channel Alteration	The amount of channelization, dredging, embankments, or shoring structures present.	Channelization or dredging absent or minimal; stream with normal pattern.
Riffle Frequency	The frequency of occurrence of riffle habitat.	Occurrence of riffles frequent, with variety of habitat.
Bank Stability	Evidence of erosion or bank failure.	Evidence of erosion and bank failure absent or minimal.
Vegetative Protection	The percent cover by undisturbed, native vegetation on the streambank surfaces and immediate riparian zones.	More than 90% of the streambank surfaces covered by native vegetation.
Riparian Vegetative Zone Width	The width of native riparian vegetation along both streambanks.	Width of riparian zone more than 18 m; human activities have not impacted zone.
Source: CSBP, 1999		

Total physical habitat quality scores ranged from 66 at Station LALT500 to 170 at Station 17 – Cold Creek. Other sites with high quality physical habitats included Station 2 (SGUT-504) – San Gabriel River, Station 3 (SGUT-505) – San Gabriel River, and Station 6 – Arroyo Seco. Under the current scoring protocol, concrete-lined channels are somewhat over-scored due to high ratings in categories, such as Embeddedness, Sediment Deposition, and Bank Stability. The scores are effective at ranking the sites in the proper order based on overall quality. Below are photographic examples of sites with good physical habitat quality (top row) and poor physical habitat quality (bottom row).

Site 6 – Arroyo Seco

Site 7 – Arroyo Seco

Site 17 – Cold Creek

LALT500 – Rio Hondo

SGLR00190

Site 8 – LALT502 Compton Creek

Water quality measurements at most of the monitoring sites did not indicate severe impairment. Values for pH at most of the sites were between 7.2 and 8.8, although Station LALT500 – Rio Hondo was quite high with a value of 10.2. Specific conductance, a general indicator of dissolved solids, was moderate to low at all sites except Station 15 – Medea Creek and Station 16 – Las Virgenes Creek, which had values of 3.070 mg/L and 2.413 mg/L, respectively. Hardness measures ranged from 100 mg/L $CaCO_3$ at Station 16 – Las Virgenes Creek to 1600 mg/L $CaCO_3$ at Station 15 – Medea Creek. These two sites, similar to past surveys, were outliers and the remaining sites had hardness values from 182–852 mg/L. Excessive salts, metallic cations (e.g., calcium, magnesium, and ferrous iron), and limestone formations can naturally elevate water hardness (Sawyer and McCarty, 1978). Dissolved oxygen levels ranged from 3.01 mg/L at Station 18 – Triunfo Creek to 18.35 mg/L at Station LALT500 – Rio Hondo. Station 8 – Compton Creek also had a low dissolved oxygen value of 4.24 mg/L. Water temperatures were quite variable throughout the county ranging from 13.9°C (57.2 °F) at Station 17 – Cold Creek to 34.8 degrees C (94.6°F) at Station 5 (SGLT-506) – Walnut Channel. Turbidity, a measure of water clarity (clear waters have low nephelometric turbidity unit (ntu) values), was relatively low at most sites, and the most turbid water was at Station 16 – Las Virgenes Creek, with a value of 93.9 ntu.

Additional water chemistry testing was performed for the four Los Angeles River tributary sites for the LARWMP, and results are presented in Appendix B.7. Analyses included nutrients and other general chemical constituents, organophosphorus pesticides, dissolved metals, and total metals. Most of the general chemical constituents were highest at Station 8 (LALT502)-Compton Creek with the exception of nitrate and nitrite, which were highest at Station LALT501-Arroyo Seco. Organophosphorus pesticides were generally below the test detection limits at all of the stations. The single exception was Malathion, which was present at Station 8 (LALT502)-Compton Creek at a level of 66.8 ng/L. Compton Creek also tended to have higher levels of dissolved and total metals than the other sites, with a few notable exceptions. Station LALT500-Rio Hondo had the highest levels of dissolved selenium, total lead, and total zinc while Station LALT503-Tujunga Wash had the highest level of total copper. Many of the dissolved and total metals were below the detection limits at all of the sites.

4.4 Index of Biotic Integrity

In 2004, a Southern California IBI was developed to cover the region extending from southern Monterey County to the Mexican border (Ode et al., 2005). The IBI gives a single quantified score to a site based on a multi-metric evaluation technique, and the scores may be compared across seasons and years of a monitoring program to give an indication of trends over time. The CDFG developed the IBI based on a multi-year comprehensive assessment of reference and non-reference conditions in Southern California to establish an expected range of benthic invertebrate community structure in the region. It is possible that this IBI may be refined in the future, as it has been noted that it may lack strength when assessing low gradient or low elevation sites (due to the rarity of reference streams in Southern California with these characteristics).

Table 4. Index of Biotic Integrity Scoring Ranges

Metric Score	Number Coleoptera Taxa	Number EPT Taxa	Number Predator Taxa	Percent CF and CG Individuals	Percent Intolerant Individuals	Percent Non-Insect Taxa	Percent Tolerant Taxa
10	>5	>17	>12	0–59	25–100	0–8	0–4
9		16–17	12	60–63	23–24	9–12	5–8
8	5	15	11	64–67	21–22	13–17	9–12
7	4	13–14	10	68–71	19–20	18–21	13–16
6		11–12	9	72–75	16–18	22–25	17–19
5	3	9–10	8	76–80	13–15	26–29	20–22
4	2	7–8	7	81–84	10–12	30–34	23–25
3		5–6	6	85–88	7–9	35–38	26–29
2	1	4	5	89–92	4–6	39–42	30–33
1		2–3	4	93–96	1–3	43–46	34–37
0	0	0–1	0–3	97–100	0	47–100	38–100
Cumulative Ratings: Very Poor: 0–13 Poor: 14–26 Fair: 27–40 Good: 41–55 Very Good: 56–70							

Source: Ode et al., 2005

Ode et al. (2005) selected seven metrics that showed a strong and predictable response to ecological impacts and stressors to calculate the IBI (Table 4). The seven metrics include Number Coleoptera Taxa, Number EPT Taxa, Number Predator Taxa, Percent Collector–Filterers plus Collector–Gatherers, Percent Intolerant Individuals, Percent Non-Insect Taxa, and Percent Tolerant Taxa. Each metric value was given a score from 0 to 10, and the scores were added to give a final IBI score; the highest possible total score was 70 (this score was often normalized to a 0–100 scale; the raw IBI scores are presented in this report). Each final score was then classified into rating categories ranging from Very Poor to Very Good. Table 4 shows the metric scoring ranges and rating categories for the Southern California IBI.

The IBI is quite effective for broadly identifying impairment, and the boundary between Fair and Poor (IBI score of 26) is considered to be the threshold for impairment. It must be noted that small differences in IBI scores are not significant and may be due to natural biological variability within a stream reach. Ode et al. determined that the minimum detectable difference between IBI scores is approximately 9 points (on the 0–70 point scale), thus two site scores must be at least 9 points apart from one another to determine one is of significantly higher quality than the other.

The total IBI scores for each monitoring reach are shown on Figure 2 and Figure 3. A complete list of the mean metric values, individual IBI scores, and the total IBI scores are presented in Appendix B.8.

The 17 monitoring reaches in Los Angeles County had IBI ratings ranging from Good to Very Poor. Three of the sites were rated above the level of impairment (Fair and above), including SGUT-504 – San Gabriel River, Station 6 – Arroyo Seco, and Station 17 – Cold Creek. Station 1 – Santa Clara River was very close to the impairment threshold and was the highest rated urban-influenced site. The remaining sites had IBI scores of 18 or lower, and Station 19 – Dominguez Channel was the lowest rated site with an IBI score of 1.

Comparison of Concrete-Lined Channels and Unlined Channels

In the 2008 survey, six sites were located in concrete-lined channels, including stations 14, 19, LALT500, LALT501, LALT503, and SGLR00190. A concrete substrate is considered inferior for macroinvertebrate colonization compared to a more complex natural substrate (e.g., substrates of layered cobblestone, plant stems, and wood). The concrete-lined channels generally had minimal coarse organic food sources and riparian canopy and had uniform water flow characteristics consisting of flat runs rather than true riffles. Concrete-lined channel sites typically had a relatively thick periphyton layer containing detritus and micro-organisms which provide the primary food resources for macroinvertebrates. Physical habitat scores for these sites are somewhat elevated due to very stable bank conditions, and they typically have ample flow volume due to persistent urban runoff (Appendix D, Physical Habitat Quality Data Sheets).

In 2008, the concrete-lined channel sites had IBI scores of 6 or less and benthic quality ratings of Very Poor (Figure 4). It is reasonable to infer that the poorer quality physical habitats of the concrete-lined channel sites had a deleterious effect on benthic community quality and the IBI scores in the lower watershed stream reaches, but since these sites were dominated by urban runoff, water quality may have had an additional impact.

The Mann-Whitney test was used to determine if the IBI scores for unlined sites were statistically different from IBI scores at concrete-lined sites. This test is a non-parametric alternative to the two-sample t-test. Instead of using the actual values of the data set, ranks of the data are used. More detailed methods may be found in *Biostatistical Analysis* (Zar, 1999). There was no differentiation between the number of samples collected at each site. All results for the two groups were pooled together, and the two groups were compared.

The hypothesis was tested at an alpha of 0.05:

$$H_0: \text{Unlined} = \text{Lined}$$
$$H_a: \text{Unlined} \neq \text{Lined}$$

The test was run using two scenarios, both with and without the reference sites, and no exclusions were made based on location (i.e., upper or lower) in the watershed.

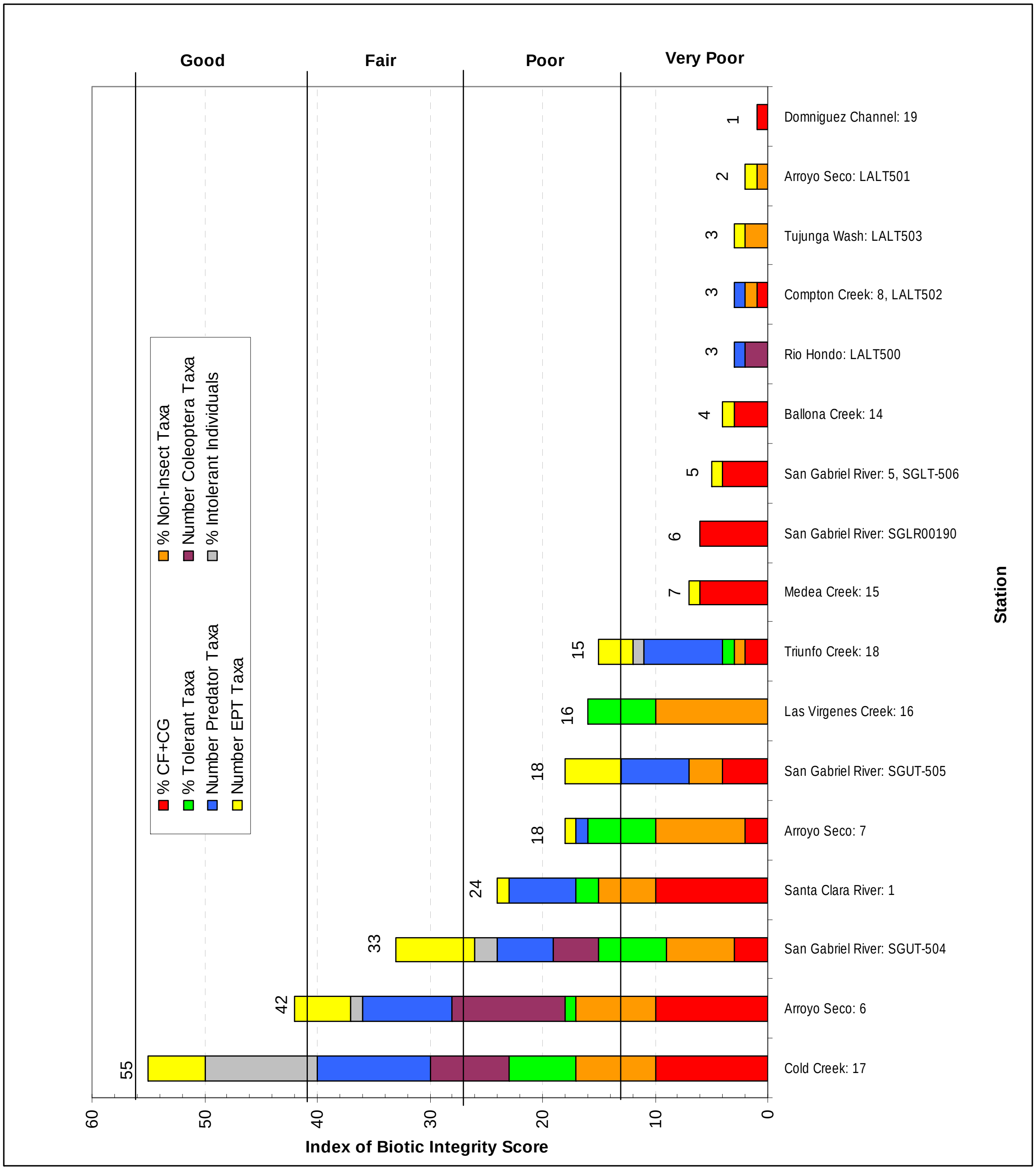

Figure 2. Index Biotic Integrity Scores for Los Angeles Department of Public Works Bioassessment Sites, 2008 (0–70 scale)

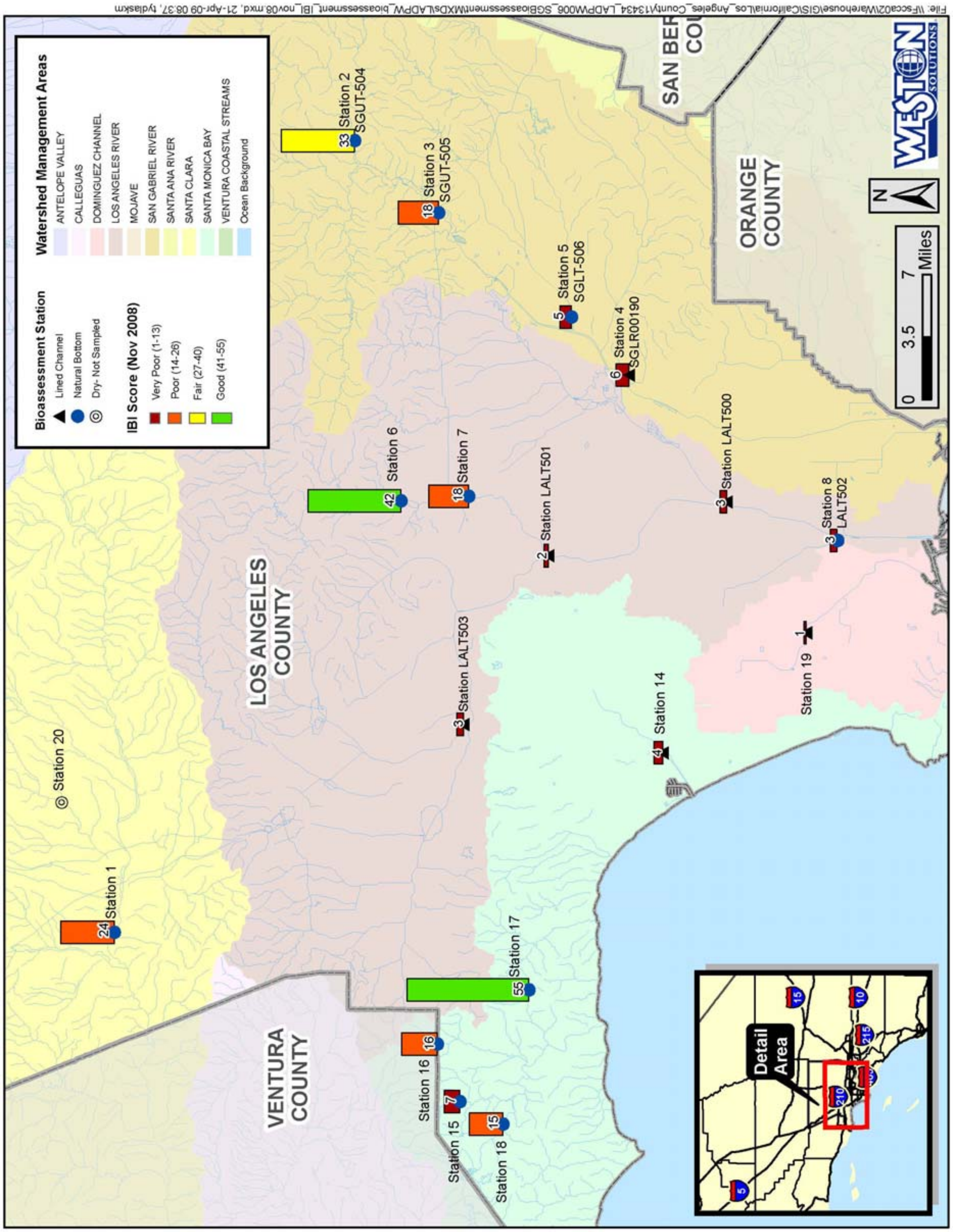

Figure 3. Stream Bioassessment Monitoring Locations with Index of Biotic Integrity Scores, 2008

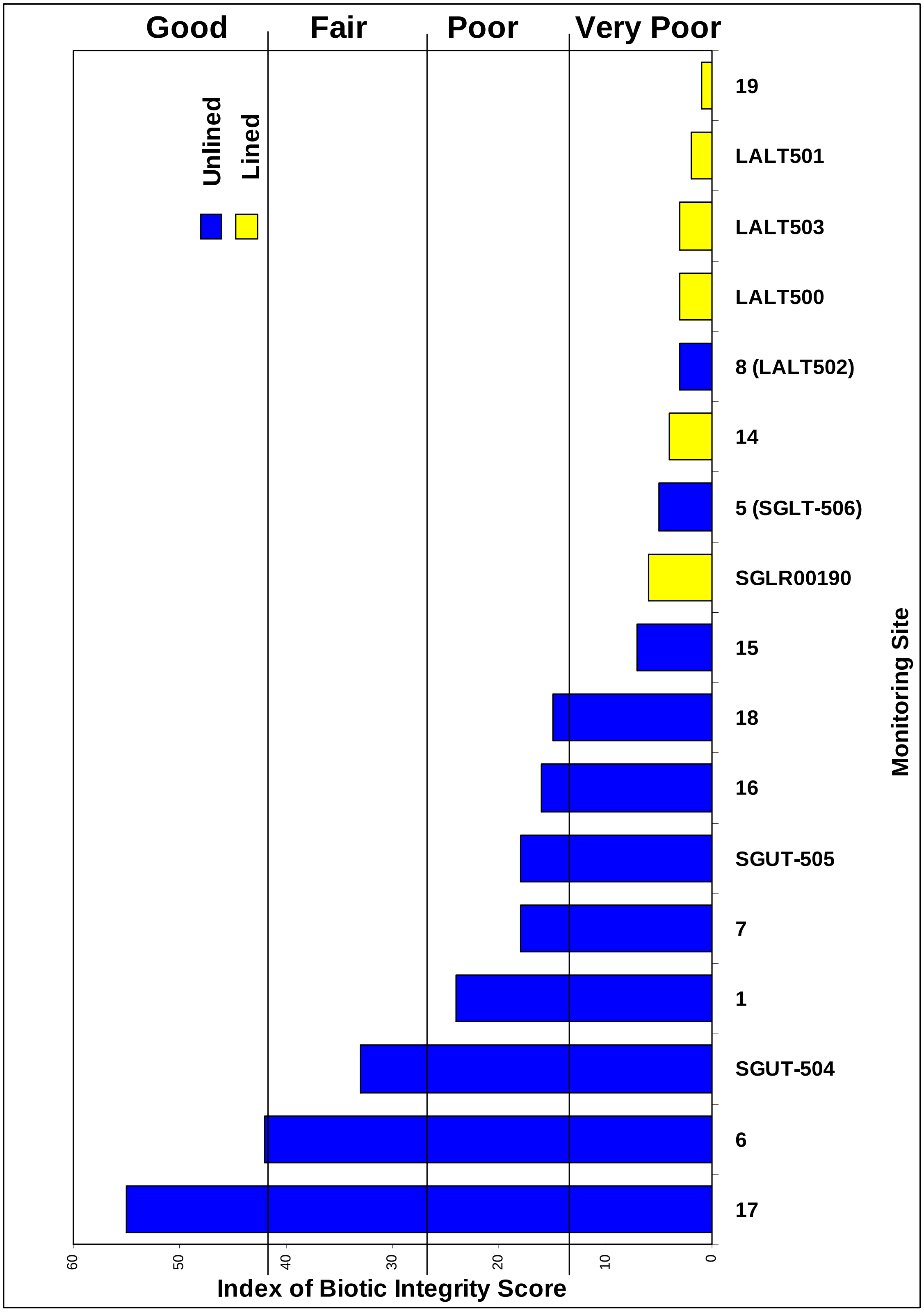

Figure 4. Index Biotic Integrity Scores for Concrete-Lined Versus Unlined Channels, 2008

The results of the analysis indicated that in both scenarios the null hypothesis was rejected, and the alternate was accepted. This means that the IBI scores at unlined sites were statistically different, overall, than the IBI scores at concrete-lined sites ($p=<0.001$, without reference sites; $p=<0.001$, with reference sites). On Figure 5, a visual comparison of the two groups is presented. One version does not include reference sites in the unlined group, whereas the other includes reference sites in the unlined group. Without considering reference sites, the mean IBI scores of the unlined sites are higher than the 75th percentile (top of the shaded box) of the concrete-lined sites. When reference sites are considered, this difference is increased, and the unlined sites are clearly statistically superior to the concrete-lined sites.

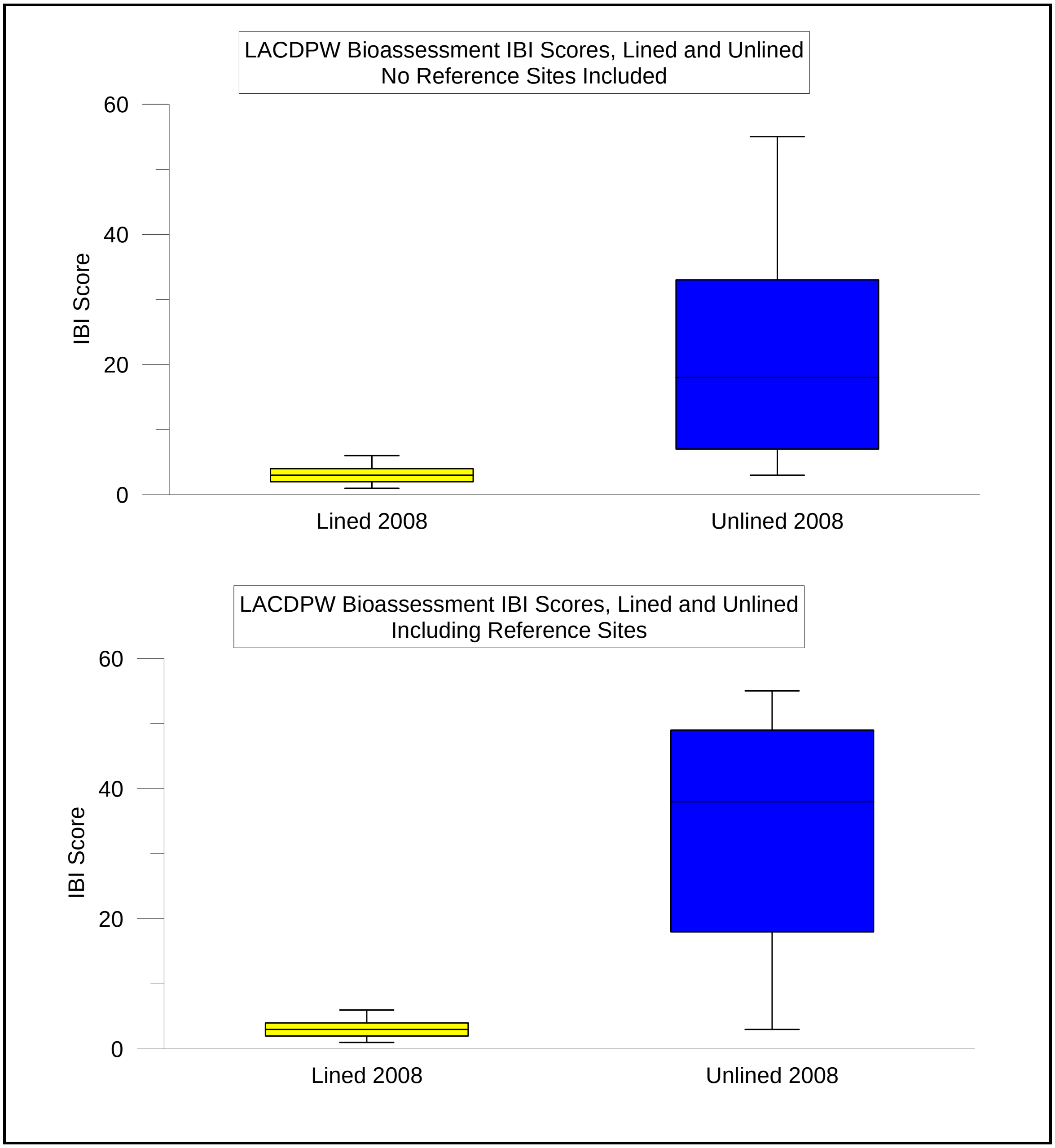

Figure 5. Comparison of Lined and Unlined Channel Sites, 2008

Comparison of Index of Biotic Integrity Scores and Elevation

To examine the relationship of IBI scores and elevation, a Spearman rank correlation was conducted for IBI score versus elevation. The correlation coefficient for 2008 IBI versus elevation was 0.789. The correlation was significant based on an alpha of 0.05 and 18 samples. These results indicate that site IBI scores are significantly correlated to elevation.

Cluster Analysis

To determine if the concrete-lined channel sites supported unique benthic communities, a cluster analysis was performed to look for similarities between site location and community structure (Figure 6). The analysis is based on a two-way Bray-Curtis similarity index calculated on relative abundances of taxa by station. Stations with similar communities of taxa will cluster together; likewise taxa that occur at the same stations will cluster together. The results are portrayed in a two-way table that shows the relative abundance of each taxon by station.

Results of the cluster analysis show four major species clusters and three station clusters, labeled one through four and A through C, respectively and highlighted by bold red lines (Figure 6). The 2008 species clusters were more discreet than in some of the previous surveys.

Overall station clustering showed that clusters A and B (i.e., urbanized sites) had the greatest degree of separation from cluster C (i.e., reference sites). Station cluster A contained the mid elevation urban sites and was substantially separated from cluster B, which contained the low elevation urban sites. The fully concrete-lined channels were mostly clustered together in station cluster B. The clusters seemed more strongly correlated with stream physical characteristics, elevation, and IBI ratings, and to a lesser degree by the individual taxa present. The strongest station pairings as a result of taxa commonality were stations 17 and 6 and stations SGUT-504 and SGUT-505.

Species clusters fell into two primary groups (clusters 1 and 2 and clusters 3 and 4) that appeared to be characterized by ubiquity and TV. Clusters 1 and 2 contained nine of the ten most abundant organisms as well as many other highly tolerant taxa that were ubiquitous throughout the study region. Species clusters 3 and 4 contained all of the highly sensitive taxa found at Station 18 and the reference sites of station cluster C.

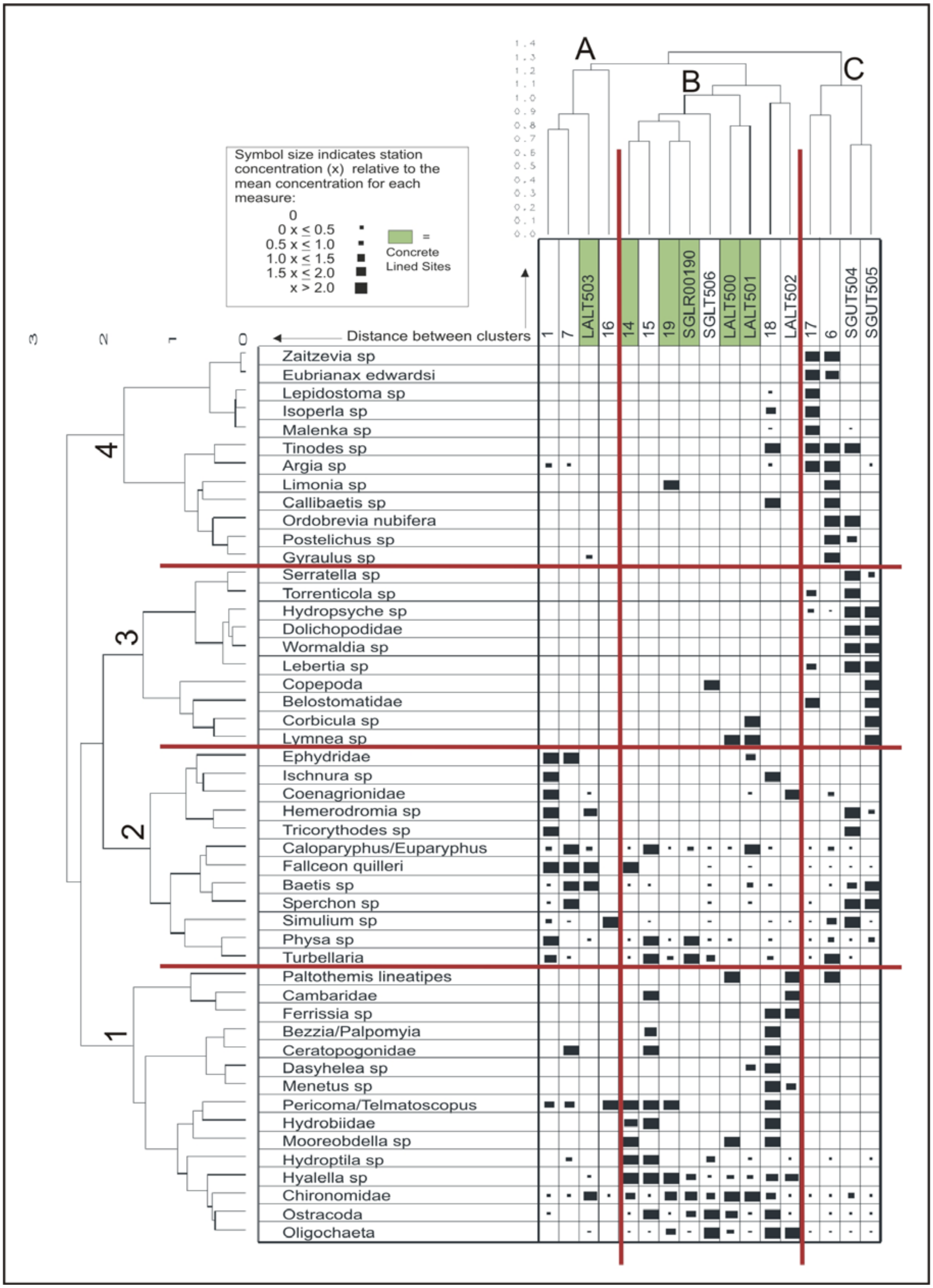

Figure 6. Cluster Analysis of Stations and Taxa for Los Angeles County Department of Public Works Bioassessment Monitoring Sites, 2008 (concrete-lined sites highlighted in green)

4.5 Comparison of 2003 through 2008 Survey Results

Information from the 2003–2007 studies (BonTerra, 2004; WESTON, 2005; WESTON, 2006; WESTON, 2007; WESTON, 2008) was compared to the 2008 data to assess the year-to-year variance and trends in biotic integrity of the streams. Monitoring reaches were relocated in very close proximity to previous years' surveys and were sampled at the same time of year (mid fall), except for the four San Gabriel River Watershed sites, which were sampled in June. One other site, Station 19 – Dominguez Channel, was moved approximately 0.5 mile upstream starting in 2006 due to high salinity (tidal influence) detected at the original site. The laboratory and data reduction procedures remained unchanged for the first three survey years. The 2006 and 2007 surveys differed in the level of laboratory processing of benthic samples, with a total of 500 organisms processed versus 900 for previous surveys. This likely did not affect the IBI scores, as the 900 count samples of the old method were randomly reduced to 500 organisms for IBI calculation. This number was then increased to 600 organisms in 2008. Note that the 2006 to 2008 surveys with the reduced level of organisms processed had greater cumulative diversity of taxa across the county than previous surveys.

Station 1 – Santa Clara River
November 2004

Station 1 – Santa Clara River
November 2005

Station 1 – Santa Clara River
October 2006

Regional macroinvertebrate community structure was relatively similar in all six survey years, and the ten most abundant taxa remained fairly consistent. Additionally, sites with unique, high quality communities (e.g., Station 6 – Arroyo Seco and Station 17 – Cold Creek) also showed taxonomic consistency. The 2008 survey collected the greatest number of unique taxa study-wide: 99, compared to 94 in 2007, 96 in 2006, 81 in 2005, 73 in 2004, and 88 in 2003.

Mean Metric Analysis, 2003–2008

Table 5 shows the mean biological metric values of four individual metrics that are considered strong indicators of ecological health. Concrete-lined channel sites are shaded in gray, and the top three metric values are highlighted in green. Note that a low value for percent collector–filterers plus collector–gatherers is an indication of good ecological conditions.

Table 5. Selected Metric Values – Mean of 2003–2008 Surveys (concrete-lined channels are shaded in gray, top three metric values are highlighted in green)

Monitoring Reach / Station Number		Taxa Richness	EPT Taxa	Percent Intolerant Taxa	Percent Collector Filterers plus Collector Gatherers
Santa Clara River	1	20.0	4.0	0%	69.4%
Coyote Creek**	2	11.5	1.5	0%	89.5%
Coyote Creek*	2A	10.0	4.0	0%	99.0%
San Jose Creek**	3	10.5	2.0	0%	84.0%
San Gabriel River**	4	24.0	12.0	3.1%	85.0%
Walnut Channel (SGLT-506)	5	14.5	2.0	0%	86.7%
Arroyo Seco****	6	34.3	10.6	1.7	51.0%
Arroyo Seco	7	15.5	2.8	0%	84.5%
Compton Creek (LALT502)	8	12.2	1.5	0%	92.2%
Zone 1 Ditch*	9	21.0	5.0	0%	74.0%
Eaton Wash	10	–	–	–	–
LALT500*		11	0	0%	97.9%
LALT501*		16	3	0%	98.9%
LALT503*		10	1	0%	99.2%
Los Angeles River	11	10.0	1.0	0%	98.2%
Los Angeles River	12	9.6	2.2	0%	90.3%
Los Angeles River	13	11.4	2.0	0%	94.7%
Ballona Creek	14	10.5	1.8	0%	94.8%
Medea Creek	15	11.7	1.0	0%	82.4%
Las Virgenes***	16	16.8	1.9	1.3%	89.8%
Cold Creek	17	29.8	11.0	34.5%	22.3%
Triunfo Creek*****	18	26.8	2.8	0.4%	64.4%
Dominguez Channel	19	9.3	0	0%	94.7%
Bouquet Canyon	20	–	–	–	–
SGUT-504***	2	26.0	12.3	8.8%	83.0%
SGUT-505***	3	25.3	9.4	2.0	77.0%
SGLR00190		7.0	0.0	0%	73.5%
SGLR-043*		13.0	0.0	0%	74.0%
SGLR-047*		11.0	0.0	0%	90.0%
SGLR-051*		15.0	3.0	0%	72.0%
SGLR-063*		14.0	3.0	0%	79.4%
SGM-110*		4.0	1.0	0%	100.0%
*Sampled one year **Sampled two years ***Sampled three years ****Sampled four years *****Sampled five years					

Overall, most of the concrete-lined channels had lower taxa richness and lower EPT taxa diversity, had no intolerant taxa present, and had higher percentages of collector–filterers plus collector–gatherers than the unlined sites.

Mean taxa richness ranged from 34.3 taxa at Station 6 – Arroyo Seco to 4.0 taxa at SGM-110 – San Gabriel River (Table 5). Most of the lower watershed sites had mean taxa richness values in the range of nine to 15 taxa per survey. The mid-watershed to upper watershed sites had mean taxa richness in the range of approximately 17–34 taxa, with the exception of Station 15 – Medea Creek, which had a mean of 11.7 taxa per survey. The number of EPT taxa was quite variable, and five sites had considerably greater EPT diversity than the other sites. Station 4 – San Gabriel River, Station 2 (SGUT-504) – San Gabriel River, Station 3 (SGUT-505) – San Gabriel River, Station 6 – Arroyo Seco, and Station 17 – Cold Creek had mean EPT taxa richness ranging from 9.4 to 12.3, whereas the other sites averaged 5.0 or less EPT taxa. The lower watershed sites typically had three or fewer EPT taxa, most frequently consisting of the mayflies, *Baetis* and *Fallceon quilleri*, and the caddisfly, *Hydroptila* (Appendix B.1).

The metric percent intolerant taxa is perhaps the strongest indicator of good water quality conditions, but the metric lacks gradation for moderately to highly impaired waterbodies as these intolerant taxa are typically absent. Station 17 – Cold Creek had an average of 34.5% intolerant taxa per survey, and the next highest site, Station SGUT-504, had 8.8%.Twenty-three of the 30 sites sampled had no intolerant taxa collected over the six years of surveys, and all but one (Station 15 – Medea Creek) of these were located in the lower reaches of the watersheds.

Mean percent collector–filterers plus collector–gatherers (CF and CG) ranged from 22.3% at Station 17 – Cold Creek to 100.0% at SGM-110 – San Gabriel River. Most of the lower watershed sites had greater than 80% of the benthic community using these two feeding strategies. This metric must be interpreted with care, for in some situations, a high abundance of impairment-tolerant organisms can occur that are not in these two feeding groups, thus reducing the percent CF and CG. A notable example of this occurred in 2006 at Station 18 – Triunfo Creek where, although a high abundance of snails (scrapers) were present, this site also had one of the highest percent tolerant taxa in the county Conversely, a high number of organisms in the CF and CG feeding group may be present, while the overall community may have many organisms with low tolerance values.

Index of Biotic Integrity Scores, 2003–2008

Table 6 presents the IBI scores of all stations for all surveys as well as the mean IBI scores, and Figure 7 shows the mean IBI scores graphically. Station 17 – Cold Creek was the highest rated site in all six surveys. Station 6 – Arroyo Seco was the second highest rated site for every survey in which it was sampled. The highest rated non-reference sites per survey year were Station 1 – Santa Clara River (2004, 2006, 2007, and 2008), Station 16 – Las Virgenes Creek (2005), and Station 18 – Triunfo Creek (2003). The mean IBI scores for these three sites were also the highest for non-reference sites.

When assessing trends of IBI scores, the minimum detectable difference of nine points must be considered. It is not apparent that any of the sites have trended upward or downward greater than this range for more than one or two surveys (Table 6). Most sites have shown a seeming random up-and-down pattern in IBI scores that could be due to natural biological variability or physical factors such as seasonal rainfall amounts. IBI scores at most of the sites in the study were relatively consistent from 2003 thru 2008. Most of the concrete-lined channel sites have varied by approximately 5 to 9 IBI points over the six surveys, whereas the natural bottom sites typically varied by eight to 13 points. Only one of the sites (Station 1 – Santa Clara River) varied across more than two quality rating categories (i.e., rated Very Poor in one survey and rated Fair in another). This site had the greatest variability in IBI scores, with a 17-point range between the high and low score. This result was likely due to the sandy substrate at the site which was severely eroded by the heavy storm flows during the Winter of 2004/2005, and the site had an IBI score of 10 for that year (see photos above). The apparent impact of the scouring flows included a substantial increase in collector individuals and a decrease in predator taxa diversity. For the 2006 to 2008, surveys of the Santa Clara River Site had recovered significantly, and in 2007, the IBI score rated the site unimpaired.

Table 6. Comparison of Index of Biotic Integrity Scores 2003–2008

Monitoring Reach / Station Number		IBI Score 2003	IBI Score 2004	IBI Score 2005	IBI Score 2006	IBI Score 2007	IBI Score 2008	Mean IBI Score
Cold Creek	17	**42**	**52**	**49**	**53**	**52**	**55**	**50.5**
Arroyo Seco	6	Dry	Dry	**38**	**50**	**40**	**42**	**42.5**
San Gabriel River (SGUT-504)	2	Not Sampled	Not Sampled	Not Sampled	**42**	**34**	**33**	**36.3**
San Gabriel River	4	**30**	**38**	Not Sampled	Not Sampled	Not Sampled	Not Sampled	**34.0**
San Gabriel River (SGUT-505)	3	Not Sampled	Not Sampled	Not Sampled	**20**	**25**	**18**	**21.0**
Santa Clara River	1	**21**	**19**	**10**	**24**	**27**	**24**	**20.8**
Las Virgenes	16	Dry	Dry	**27**	**17**	**20**	**16**	**20.0**
Triunfo Creek	18	**22**	**Dry**	**20**	**18**	**19**	**15**	**18.8**
Arroyo Seco	7	**11**	**9**	**12**	**17**	**11**	**18**	**13.0**
Los Angeles River	12	**11**	**9**	**9**	**7**	**17**	Not Sampled	**10.6**
San Jose Creek	3	**8**	**10**	Not Sampled	Not Sampled	Not Sampled	Not Sampled	**9.0**
San Gabriel River (SGLT-506)	5	**7**	**7**	**8**	**9**	**17**	**5**	**8.8**
Ballona Creek	14	**6**	**10**	**7**	**5**	**10**	**4**	**7.0**
Coyote Creek	2A	**3**	**9**	Not Sampled	Not Sampled	Not Sampled	Not Sampled	**6.0**
Medea Creek	15	**3**	**5**	**7**	**4**	**2**	**7**	**4.7**
Los Angeles River	13	**2**	**7**	**6**	**1**	**4**	Not Sampled	**4.0**
Compton Creek	8	**1**	**3**	**4**	**6**	**6**	**3**	**3.8**
Coyote Creek	2	**3**	**2**	Not Sampled	Not Sampled	Not Sampled	Not Sampled	**2.5**
Los Angeles River	11	**1**	**3**	**7**	**0**	**0**	Not Sampled	**2.2**
Dominguez Channel	19	**3**	**6**	**0**	**1**	**0**	**1**	**1.8**
Sites Sampled Once or Not Sampled								
Los Angeles River – Rio Hondo LALT500		Not Sampled	Not Sampled	Not Sampled	Not Sampled	Not Sampled	**3**	**3.0**
Los Angeles River – Arroyo Seco LALT501		Not Sampled	Not Sampled	Not Sampled	Not Sampled	Not Sampled	**3**	**3.0**
Los Angeles River – Tujunga Wash LALT503		Not Sampled	Not Sampled	Not Sampled	Not Sampled	Not Sampled	**2**	**2.0**
San Gabriel River (SGLR00190)		Not Sampled	Not Sampled	Not Sampled	Not Sampled	Not Sampled		
San Gabriel River (SGM-110)		Not Sampled	Not Sampled	Not Sampled	Not Sampled	**19**	Not Sampled	**19.0**
San Gabriel River (SGLR-063)		Not Sampled	Not Sampled	Not Sampled	**17**	Not Sampled	Not Sampled	**17.0**
Carbon Creek (SGLR-051)		Not Sampled	Not Sampled	**10**	Not Sampled	Not Sampled	Not Sampled	**10.0**
San Gabriel River (SGLR-047)		Not Sampled	Not Sampled	**14**	Not Sampled	Not Sampled	Not Sampled	**14.0**
San Gabriel River (SGLR-043)		Not Sampled	Not Sampled	**21**	Not Sampled	Not Sampled	Not Sampled	**21.0**
Zone 1 Ditch	9	**20.0**	Dry	Dry	Dry	Dry	Dry	**20.0**
Eaton Wash	10	Dry	Dry	Dry	Dry	Dry	Dry	**na**
Bouquet Canyon	20	Dry	Dry	Dry	Dry	Dry	Dry	**na**

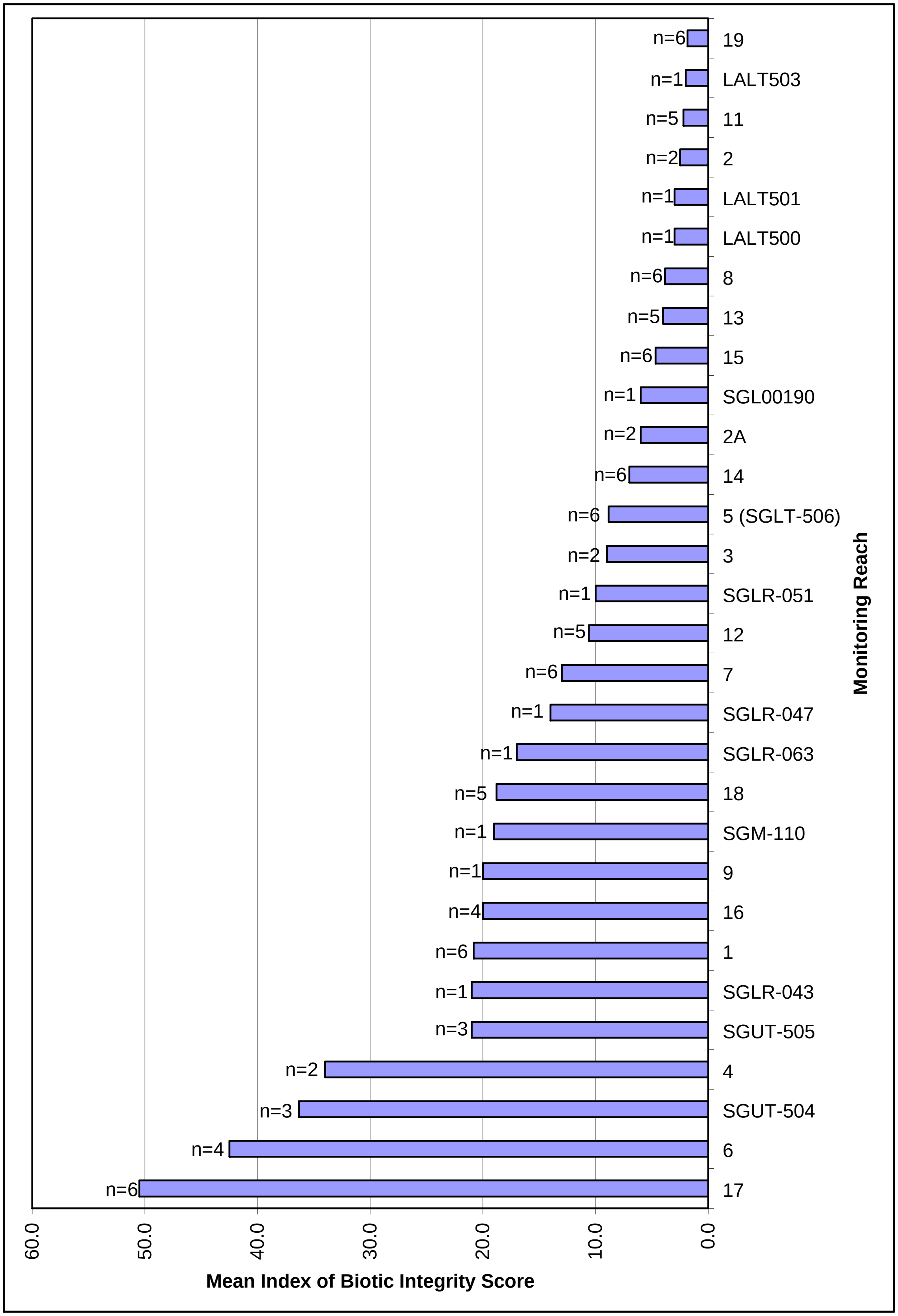

Figure 7. Mean Index of Biotic Integrity Scores, 2003-2008 (n refers to the number of surveys performed at each station)

Comparison of Concrete-Lined Channels and Unlined Channels, 2003–2008

Since the beginning of the bioassessment monitoring program in 2003, 14 of the monitoring reaches have been sampled in concrete-lined channels (stations LALT500, LALT501, LALT503, SGLR00190, SGLR-043, SGLR-047, SGLR-051, SGLR-063, SGM-110, 2/2A, 12, 13, 14, and 19), and one (Station 11) was partially lined with concrete.

All of the concrete-lined channel sites had mean IBI scores that were rated Poor and Very Poor (Figure 8). The concrete-lined sites in the lower San Gabriel River (stations SGLR-043, SGLR-047, SGLR-063, and SGM-110) received ratings of Poor, except for Station 2 which was rated Very Poor. The concrete-lined sites in Los Angeles River, Ballona Creek, and Dominguez Channel (stations LALT500, LALT501, LALT503, 12, 13, 14, and 19) had IBI scores in the Very Poor range. Through 2007, the IBI scores of the concrete-lined channel sites were evenly distributed among the other lower-watershed urban sites (excluding stations 4, 6, 17, SGUT-504, and SGUT-505, which are upper watershed sites). In 2008, the addition of four new concrete-lined sites, all of which had very low IBI scores, increased the concentration of concrete-lined sites at the low end of the IBI scale. As noted in Section 4.4, above, the poorer quality physical habitats of the concrete-lined channel sites likely had a deleterious effect on IBI scores in the lower watershed stream reaches, but also, since these sites were dominated by urban runoff, water quality may have had an additional impact.

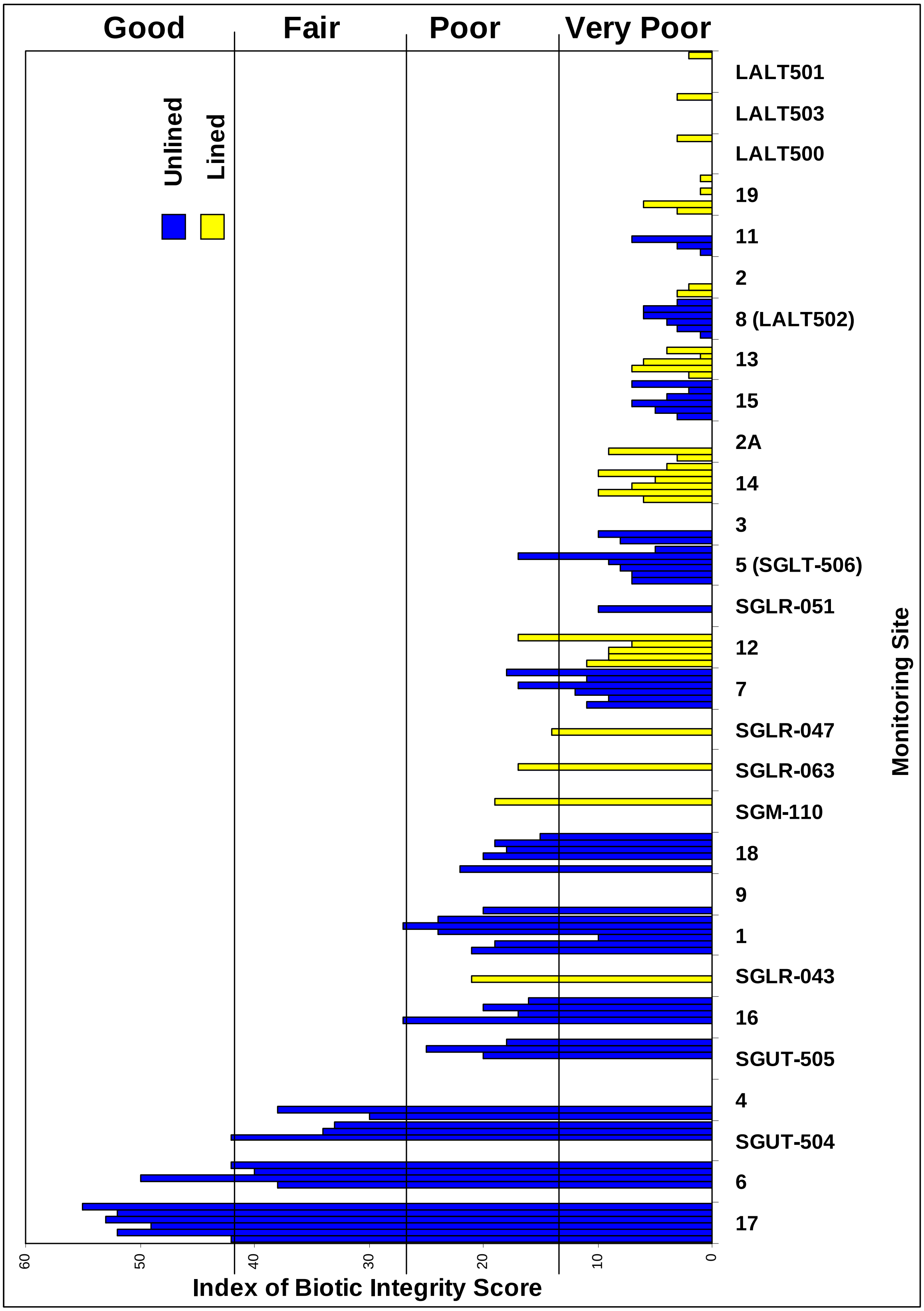

Figure 8. Comparison of Index of Biotic Integrity Scores of Concrete-Lined and Unlined Channels (0–70 scale) (each bar represents one survey year per station, beginning with 2003 at left)

The Mann-Whitney test was again used to determine if the IBI scores for unlined sites were statistically different from IBI scores at concrete-lined sites for all surveys, both with and without the reference sites.

The results of the analysis indicated that in both scenarios the null hypothesis was rejected, and the alternate was accepted. This means that the IBI scores at unlined sites were statistically different, overall, than the IBI scores at concrete-lined sites (p=<0.001, without reference sites; p=<0.001, with reference sites). On Figure 9, the mean IBI scores of the unlined sites are slightly higher than the 75th percentile (top of the shaded box) of the concrete-lined sites. When reference sites are considered, this difference is increased, and the unlined sites are clearly statistically superior to the concrete-lined sites. This difference is much less than when using the 2008 survey data only (Section 4.4).

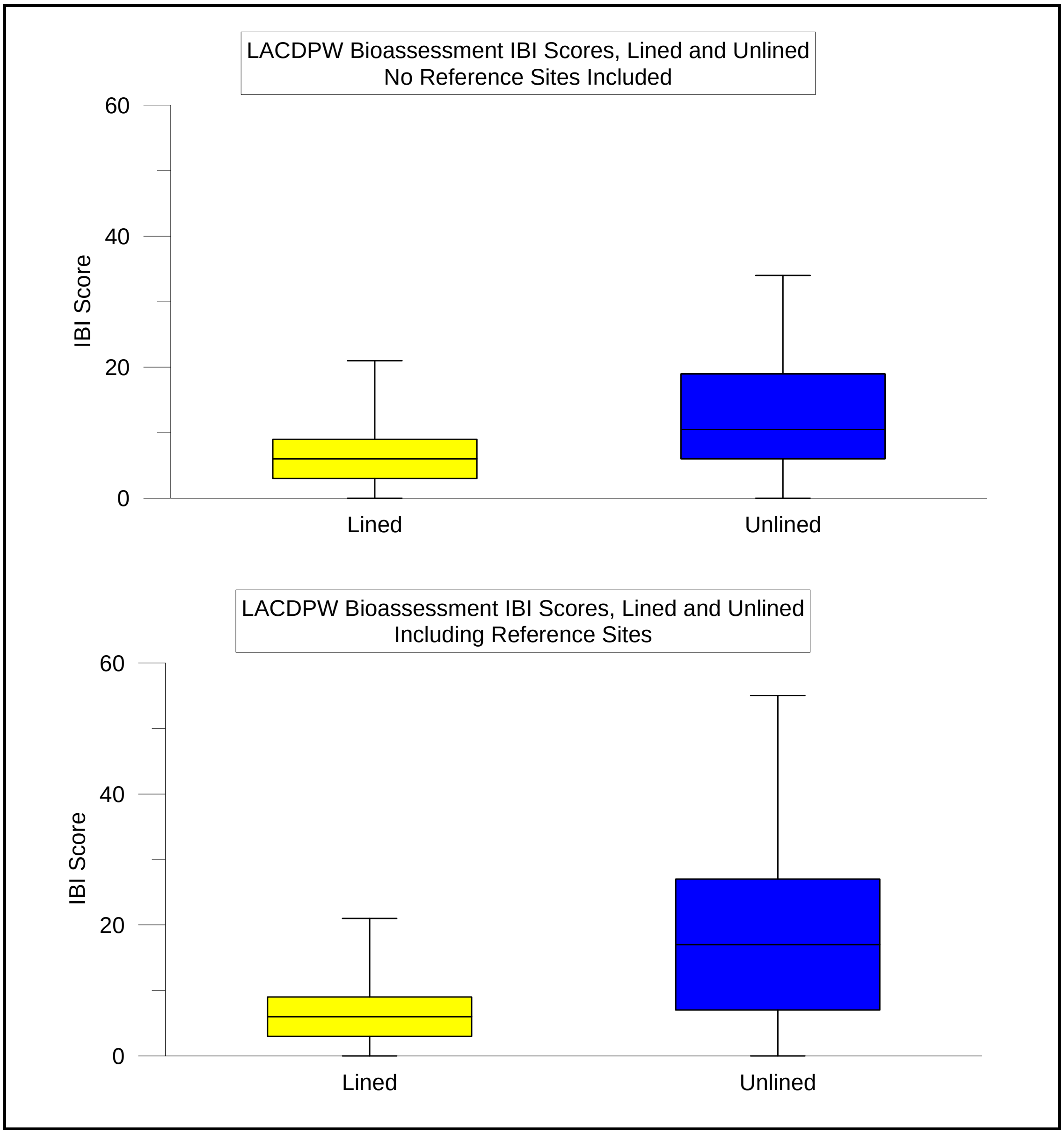

Figure 9. Comparison of Concrete-Lined and Unlined Channel Sites, 2003–2008 (0–70 scale)

Comparison of Index of Biotic Integrity Scores and Elevation, 2003–2008

To examine the relationship of IBI scores and elevation for all surveys, a Spearman rank correlation was conducted for the mean of all IBI scores versus elevation. The correlation coefficient for mean IBI versus elevation was 0.685. These results indicate that site IBI scores were significantly correlated to elevation, although the correlation was somewhat weaker than the correlation made using 2008 data only, when the coefficient of correlation was 0.789 (Section 4.4).

Cluster Analysis, 2003–2008

A two-way Bray-Curtis similarity index was calculated on relative abundances of all taxa by station for all surveys (Figure 10). There were five major species clusters and four major station clusters. Species cluster 1 contained most of the ubiquitous taxa that were highly abundant and/or collected at most stations. Species clusters 2 and 3 were characterized by taxa that are relatively rare but with moderate to high TVs (e.g., beetles, damselflies, and dragonflies). Species clusters 4 and 5 were characterized by EPT taxa with low TVs collected primarily at the reference sites.

Station clustering for all survey years was somewhat vague beyond a primary separation of the higher elevation reference sites (station cluster D) from all of the urban influenced sites. The mid-elevation natural channel sites formed subclusters at the lower cluster-distance levels, but the major clusters combined concrete-lined and unlined sites as well as mid-elevation and low-elevation sites.

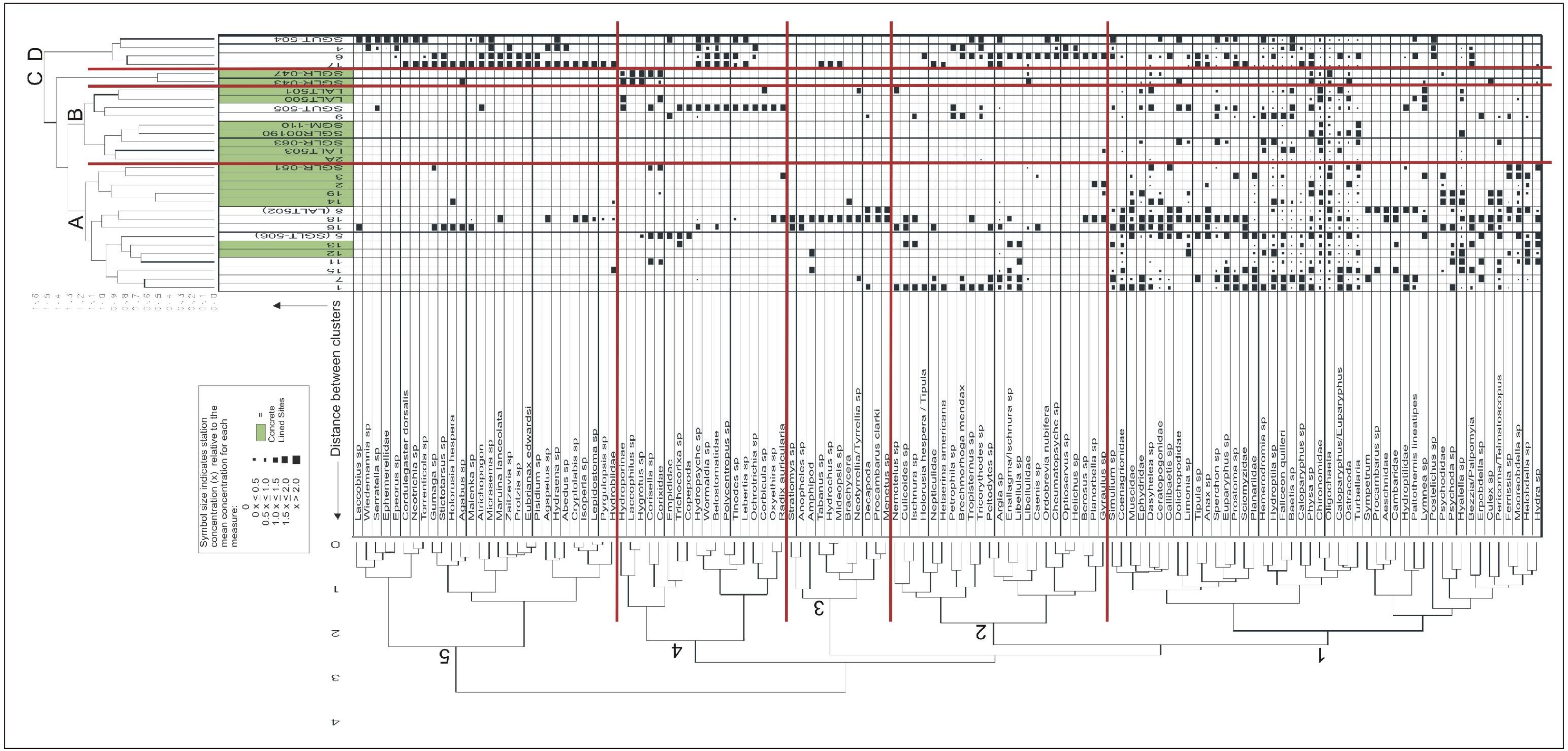

Figure 10. Cluster Analysis of Stations and Taxa for Los Angeles County Department of Public Works Bioassessment Monitoring Sites, 2003–2008 (concrete-lined sites highlighted in green)

5.0 SUMMARY

Seventeen receiving water monitoring reaches representing six watersheds in Los Angeles County were sampled for benthic macroinvertebrates and were assessed for physical habitat quality in November 2008. The monitoring reaches were located to provide an assessment of possible impacts associated with urban runoff and to evaluate the biological conditions for trend analysis of the benthic macroinvertebrate communities of the county. Since program inception in 2003, a total of 30 different sites have been sampled.

Taxonomic evaluation of the 2008 samples yielded 99 different taxa from 10,353 individual organisms by SAFIT level I taxonomic effort. The most abundant organisms collected throughout the county were midges of the family Chironomidae, which were present at every monitoring site. The majority of organisms collected from the urban monitoring reaches were moderately or highly tolerant to stream impairments, and most of the sites were dominated by organisms in the collector–gatherer feeding guild.

The IBI scores of the monitoring reaches ranged from 1 to 55 out of a possible 70 points, and the benthic macroinvertebrate communities were rated from Very Poor to Good. Station 17 – Cold Creek was the highest rated site, and Station 6 – Arroyo Seco was the second highest rated site, with IBI scores of 55 and 42, respectively. Six of the monitoring reaches were located in highly modified, concrete-lined urban water courses, and these sites had IBI ratings of Very Poor. Analysis of individual metrics as well as total IBI scores showed that monitoring sites located in the lower watershed areas had lower quality benthic communities than sites located in the mid to upper reaches of the watersheds.

Comparison of the IBI scores for the six survey years through 2008 did not indicate any substantial trend towards degradation or improvement at any of the sites. Two of the sites had the highest IBI scores since 2003 in 2008, including Station 7 – Arroyo Seco and Station 17 – Cold Creek. Six sites had their lowest IBI scores in 2008, although none varied from each site's mean score (mean of up to five previous surveys) significantly.

An analysis of the difference between concrete-lined sites and unlined sites indicated that there was a statistically significant difference in IBI scores at sites located in the lower watershed areas. When reference sites were added to the analysis, the difference in IBI scores between concrete-lined sites and unlined sites was of greater significance. The difference was greater for the 2008 data than for all data from 2003 to 2008. An additional analysis comparing IBI scores to site elevation indicated that there was a statistically significant and positive correlation between IBI score and elevation.

Two-way cluster analysis of 2008 taxa and stations indicated some clustering by taxa, wheras the stations appeared to cluster according to site physical conditions and total IBI score, with few taxa contributing to the station associations. Upper watershed sites with natural channels had the strongest clustering, lower watershed channelized sites with soft bottoms clustered together, and fully concrete-lined sites clustered together. The lower watershed sites were populated primarily with abundant, ubiquitous, and opportunistic organisms that were common to most sites, whereas the upper watershed sites had fairly distinctive benthic communities with a number of unique taxa present at each site. Cluster analysis of all 2003 to 2008 data had similar results to the 2008 data, with station physical characteristics appearing to drive the clustering among the urban influenced sites.

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