SWAMP
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REPORT
WADEABLE STREAMS BIOASSESSMENT
REGION 8
Sites Sampled – May - June 2007

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REPORT
WADEABLE STREAMS BIOASSESSMENT
REGION 8
Sites Sampled – May - June 2007

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California State University Long Beach
Stream Ecology and Assessment Laboratory

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Executive Summary

The Santa Ana Regional Water Quality Control Board contracted California State University Long Beach Stream Ecology and Assessment Laboratory, through the Institute for Integrated Research in Materials Environments and Society, to conduct a five-year study of the waterways within the Santa Ana River watershed. This study is designed to address the federal Environmental Protection Agencies mandated requirement (305(b)) for an assessment of the integrity of surface waters in the Santa Ana River watershed by sampling the biological (benthic macroinvertebrates), physical (in-stream habitat, surrounding riparian habitats), and chemical (water quality measurements and water samples for further laboratory analysis) attributes at each sampling location. At the conclusion of the five-year period, the data collected will be used to estimate the number of stream kilometers that are in one of five categories of health (very good, good, fair, poor, and very poor). Annual reports during these five years will provide information on the quality of the individual sites sampled.

During the spring 2007 bioassessment sampling events, benthic macroinvertebrate taxa were identified from 29 sampled locations. Taxa were identified to standard taxonomic levels based on the California Aquatic Macroinvertebrate Laboratory Network's list of Californian Macroinvertebrate Taxa and Standard Taxonomic Effort. Using the Southern California Coastal Index of Biotic Integrity (Ode et al. 2005) as a measure of biotic condition, stream sites were classified into one of five categories (very poor, poor, fair, good, and very good). The Southern California Coastal Index of Biotic Integrity adjusted scores for the 2007 bioassessment sampling events ranged from 19 (poor) to 73 (good) and were positively correlated with elevation. On the contrary, Southern California Coastal Index of Biotic Integrity scores were not correlated with dissolved oxygen, nitrate, phosphate, turbidity, or total suspended solids. The physical habitat condition of the sampled sites ranged from poor to optimal (0 to 15 "poor," 16 to 30 "marginal," 31 to 45 "suboptimal," and 46 to 60 "optimal;" Predominantly natural high-elevation channels had the highest values (averaging 44.5 and ranged from 21 to 60), followed by mid-elevation channels (averaging 27.3 and ranged from 14 to 46), and finally the low-elevation channels had the lowest values (averaging 25.7 and ranged from 15 to 41). The water quality characteristics were relatively consistent among sites with near neutral or slightly alkaline mean pH field values (5.22 to 8.24), more than adequate levels of mean dissolved oxygen (5.9 to 11.88), and relatively low conductivity values (0.001 to 0.001 mS/cm).

The data collected during the 2007 bioassessment sampling events are only a small subset of the data to be collected within the region over the next four years; the results obtained during the 2007 sampling events will provide baseline information to assess the health of the waters within the region.

INTRODUCTION

Freshwater is an important natural resource. Understanding the health of rivers, streams, and other water resources is essential for the development of management plans that protect the

nation's vital water resources. One approach that has been advocated for determining water quality is the "Aquatic Life Use Assessment" (ALUA). ALUA is one of the Environmental Protection Indicators for California (EPIC) adopted by the California Environmental Protection Agency (Cal/EPA) for determining water quality. These bioassessment tools utilize direct measurements of biological assemblages occupying various trophic levels and can include plants, macroinvertebrates, vertebrates (fish) and periphyton (diatoms and algae), as direct methods for assessing the biological health of a waterway's ecosystem. Direct measurements of biological communities, when used in conjunction to other relevant measurements of watershed health (e.g. watershed characteristics, land-use practices, in-stream habitat and water chemistry), are effective ways to monitor long-term trends of a watershed's condition (Davis and Simon 1995). Biological assessments, which integrate the effects of water quality over time, are sensitive to many aspects of both habitat and water chemistry and provide a more familiar representation of ecological health to those who are unfamiliar with interpreting the results of chemical or toxicity tests (Gibson 1996). When integrated with physical habitat assessments and chemical test results, biological assessments can better describe the health of a waterway and provide an *in vivo* means of evaluating the anthropogenic effects (e.g. sediments, temperature and habitat alteration) on a waterway. As defined by the 2006 EPA Wadeable Streams Assessment (WSA) document, *"biological integrity represents the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity and functional organization comparable to that of the natural habitat of the region."* Bioassessment is a proxy for determining stream water quality and habitat quality based on the types and numbers of organisms living there.

The monitoring of water quality using BMIs is the most utilized bioassessment method when compared with similar assessments that use vertebrates or periphyton. BMIs are not only ubiquitous, but are relatively stationary and highly diverse. These traits can provide a variety of predictable responses to a number of environmental stresses (Rosenberg and Resh 1993). Depending on the length of time an individual BMI taxon resides in an aquatic environment (a few months to several years), the sensitivity to physical and chemical alterations to its environment will vary. BMIs are an excellent indicator group in assessing the health of a waterway (Resh and Jackson 1993) and function as a significant food resource for both aquatic and terrestrial organisms. In addition, herbivorous BMIs aid in the control of periphyton populations and many BMI taxa contribute to the breakdown of detritus. Furthermore, the diversity of BMI taxa also plays an important role in the overall ecology and biogeography of a region (Erman 1996).

Biological assessments are often based on multimetric techniques. These techniques use a number of biologic measurements (metrics), each representing a particular aspect of the biological community, to assign a water quality value to the location under study. Locations can then be ranked by these values and classified into qualitative categories of "very good," "good," "fair," "poor," and "very poor." This system of ranking and categorizing biological conditions is referred to as an Index of Biotic Integrity (IBI), and is currently the recommended method for the development of biocriteria by the United States Environmental Protection Agency (USEPA; Davis and Simon 1995). This method may also be used in the development of Tiered Aquatic Life Uses (TALU). The current IBI used for southern California is the Southern Coastal

California Index of Biological Integrity (SCC-IBI; Ode et al. 2005), developed by the California Department of Fish and Game's Aquatic Bioassessment Laboratory (Cal/DFG-ABL).

Water quality information for the streams in the Santa Ana River watershed (Region 8) is currently based mostly on discharger data from NPDES permits, and volunteer monitoring efforts of selected streams. This information focuses on problem areas within the region or areas where permits have been issued. Consequently, there are a large number of streams in the region that lack water quality information. Due to lack of available funding to implement a fully comprehensive "multiple biological assemblage model" to assess the biotic integrity, a decision was made by the Santa Ana Regional Water Quality Control Board (SARWQCB) to initially focus on using a macroinvertebrate bioassessment tool to assess the biotic integrity of the wadeable streams in Region 8 of California.

The SARWQCB contracted California State University Long Beach (CSULB) Stream Ecology and Assessment Laboratory (SEAL), through the Institute for Integrated Research in Materials Environments and Society (IIRMES), to conduct a five-year study within Region 8 of California waterways utilizing a probabilistic sampling design. IIRMES, a multifaceted organization was designed to promote and enhance educational and research opportunities for faculty, graduate and undergraduate students, and the greater community at large by embracing and integrating all scientists who study historical and temporally changing phenomena from the solid earth to organisms, landscapes, and societies. By collaborating with interdisciplinary faculty, scientists within the organization are able to bring common research perspectives, techniques, and instrumentation to bear their research.

Project Objective

The overall objective of the five-year bioassessment project described within this report is to address the federal Environmentla Protection Agency (EPA) mandated requirement (EPA requirement 305(b)) for an assessment of the integrity of surface waters in Region 8 of California. Specifically, this project aims to meet this objective by collecting and subsequently analyzing macroinvertebrate data collected from random sites using the SCC-IBI. This method yields a single score of the biological integrity of a site. The SCC-IBI model provides a score based on the combination of seven biological metrics. This score can then be ranked, and compared to sites that are independently designated as high-quality "reference" sites.

The data collected using this analysis may be used to identify streams that may require improvement of water quality. They also may be used to refine and compare several methods of analysis and interpretation of bioassessment data. Although not comprehensive by nature, the design of the ongoing project will also provide a basis to estimate the percentage of stream kilometers in the region that meet the aquatic life beneficial use. The region's Basin Plan related to beneficial use is as follows: *"Inland surface water communities and populations including vertebrate, invertebrate and plant species shall not be degraded as a result of the discharge of waste. Degradation is damage to an aquatic community or population with the result that a balanced community no longer exists. A balanced community is one that is diverse, has the ability to sustain itself through cyclic seasonal changes, includes necessary food chain species, and is not dominated by pollution tolerant species, unless that domination is caused by physical habitat limitations. A balanced community also may include historically introduced non-native*

species but does not include species present because best available technology has not been implemented or because site-specific objectives have been adopted or because of thermal discharges." (SARWQCB 1995)

METHODS

In order to comply with standard sampling protocols, initially established by the Cal/DFG-ABL during the development of the SCC-IBI, benthic macroinvertebrate samples were collected between an index period between May and July.

Sampling Site Selection

The SARWQCB worked with statistician Tony Olsen from EPA at Corvallis to design a cost effective, randomized sampling design based upon the Environmental Monitoring and Assessment Program (EMAP; USEPA 2006) criteria that could be used to representatively sub-sample the various streams in the region. Dr. Olsen provided a list of coordinates for 750 potential locations to select for sampling. Under the original sampling design, 50 sites would be randomly selected from these locations annually for a period of five years to provide a total of 250 sites that would be considered statistically representative of the 1302 linear stream kilometers covering the Santa Ana regional stream network. This sampling density provided a level of statistical precision of +/- 12% with at a spatial coverage resolution of approximately 1.6 linear kilometers. The original sampling study also did not include any stratification elements, and was designed for perennial and non-perennial streams that were 3rd and higher Strahler order. Given the nature of the terrain and the xeric conditions in southern California, not all sites were found to be viable for the study. Consequently prior to collecting any environmental measurements or infauna samples, the sites from within the list were prescreened by first undertaking reconnaissance of each of the sampling locations to determine accessibility and suitability for benthic macroinvertebrate sampling. Elements that were deemed essential for an accessible site to be considered suitable for sampling were based upon criteria that led to the development of the SCC-IBI

Subsequently, two approved modifications were made to the design in the sampling study outlined above:

First, due to the constraints in the available funds for the project, the number of sampling sites was reduced from 50 to 30 for the 2007 sampling year. Statistical analyses show that this reduction in sampling effort increased the level of imprecision regarding the representation of the sub samples by 4% (Tony Olsen, personal communication). While not desirable, this difference was not considered to unduly compromise the objectives of the study. Furthermore it was concluded that additional sampling or an extension to the duration of the study could ultimately be undertaken to restore the original level of precision in the sampling design.

Second, the initial experimental design involved dividing Region 8 into three hydrological units (Santa Ana, San Gabriel, and the San Jacinto units). Because the portion of the San Gabriel hydrological unit included in Region 8 contained only seven sites, those sites were combined

with those in the Santa Ana hydrological unit. The two hydrologic units (Santa Ana and San Jacinto, with the former including the San Gabriel) were subsequently divided into three elevation strata: 0 meters to 350 meters, 350 meters to 700 meters, and 700 meters and up. Randomly generated GPS coordinates were used to determine the location of sites (evenly distributed throughout defined categories). The purpose of dividing the region into three elevation categories was to ensure that sampling occurred throughout the entire region each year. It was determined that not dividing the region into these biologically relevant strata might have resulted in analytical bias due to intensive sampling in a small subset of the region one year and no sampling in this subset the following year.

Sampling took place between May and June in 2007, and the samples were transported to the laboratory within three days of collection for water chemistry analyses, storage and subsequent processing. Table 1 provides site-specific information.

Sampling Reach Determination

The sampling procedures used during the 2007 bioassessment survey followed the BASIC level of the *Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California* (Ode 2007); a modification of the California Stream Bioassessment Procedures (CSBP; DFG 2003) and Environmental Monitoring and Assessment Program (EMAP) procedures. At each sample location, a 150-meter reach was surveyed to locate all riffles. A riffle is defined as a shallow area with fast flowing water that supports a complex substrate and the greatest diversity of BMIs and are therefore targeted as the ideal location for BMI collection. Sample locations that were classified as a continuous riffle or lacked riffles completely followed the reach-wide benthos procedure (RWB) or multi-habitat approach. Each reach was broken into 11 equidistant transects, spaced every 15 meters, with each transect designated with a number representing its location along the reach (0 meters through 150 meters, downstream to upstream).

Table 1. Sites sampled during the 2007 index period (April – July 2007)

Site Code	Stream name	County	Latitude	Longitude	Elevation (m)	Collection date
361	Santa Ana River	Riverside	33.96825	117.44789	210	10 June 2007
151	Santa Ana River	Riverside	33.98873	117.39614	232	10 June 2007
121	City Creek	San Bernardino	34.12372	117.19213	400	09 June 2007
398	City Creek	San Bernardino	34.13646	117.18965	441	15 June 2007
208	San Timoteo	Riverside	34.00230	117.16428	476	17 June 2007
159	San Jacinto River	Riverside	33.73904	116.83089	598	20 April 2007
453	San Jacinto River	Riverside	33.73882	116.82834	606	20 April 2007
587	San Jacinto River	Riverside	33.72206	116.80423	677	18 May 2007
446	City Creek	San Bernardino	34.18543	117.18567	723	09 June 2007
247	City Creek	San Bernardino	34.18771	117.18359	751	09 June 2007
271	Lytle Creek	San Bernardino	34.22931	117.47362	799	02 June 2007
346	Lytle Creek (South Fork)	San Bernardino	34.23613	117.49604	880	02 June 2007
105	Lytle Creek (North Fork)	San Bernardino	34.25265	117.49250	967	02 June 2007
370	Mill Creek	San Bernardino	34.10015	117.02393	983	17 June 2007
069	Lytle Creek	San Bernardino	34.24810	117.51276	1007	01 June 2007
025	Deer Creek	San Bernardino	34.17390	116.98390	1365	16 June 2007
203	Hamilton Creek	San Bernardino	34.18658	116.91801	1600	29 May 2007
163	San Jacinto River	Riverside	33.79478	116.74829	1635	19 May 2007
419	Strawberry Creek	Riverside	33.74266	116.71364	1640	19 April 2007
635	Indian Creek	Riverside	33.80349	116.78271	1645	20 May 2007
147	San Jacinto River	Riverside	33.79427	116.74714	1655	19 May 2007
530	Barton Creek	San Bernardino	34.17834	116.90881	1706	29 May 2007
375	Strawberry Creek	Riverside	33.75.657	116.70164	1755	19 April 2007
543	San Jacinto River	Riverside	33.80281	116.73208	1774	19 May 2007
168	Santa Ana River	San Bernardino	34.17865	116.84726	1846	16 June 2007
686	Halfway Creek	San Bernardino	34.16918	116.89195	1932	30 May 2007
093	Frog Creek	San Bernardino	34.16891	116.88367	1942	20 May 2007
087	Santa Ana River	San Bernardino	34.16287	116.80945	1990	30 May 2007
106	Barton Creek	San Bernardino	34.15508	116.88528	2109	16 June 2007
100	Metcalf Creek	San Bernardino	34.22644	116.93895	2241	28 May 2007

Sample Collection

BMI samples were collected starting with the downstream transect and then proceeding upstream. This technique was used in order to avoid habitat disruption to downstream transects during sample collection. Samples were collected at either 25% instream of the right bank (R), 50% instream of the right bank (C) or 75% instream of the right bank (L) at each transect following a R, C, L pattern starting with the right bank. This alternating pattern was followed along each 150-meter sampling reach until a single sample was collected from each reach (0 meters to 150 meters).

The BMIs were collected using a one foot wide, 0.5-milimeter mesh D-frame kick-net. A one-foot by one-foot sampling plot, directly in front of the net, was sampled by first checking for heavy organisms such as clams and/or snails. These organisms were removed from the substrate by hand and placed into the net. Stones larger than a golf ball were carefully picked-up and rubbed in front of the net to collect all attached animals. The remaining underlying substrate was

sampled by digging through the material to a depth of four inches (10-centimeters) and thoroughly manipulating the substrate in each quadrat with a consistent sampling effort (approximately one to three minutes). This procedure was repeated at each of the 11 transects.

The resulting 11 samples from a site were composited into one 1-liter jar and preserved in the field using 95% ethanol. Larger samples (e.g. samples that contained more than 50% sediment or 66% organic material) were split into additional jars as needed. A label containing the project, sample date, site designation, longitude and latitude, sampler's initials, and jar number was placed in each jar. A chain of custody form was completed for each sample location. As soon as the samples were returned to the lab, the ethanol, having been diluted with variable amounts of water from the samples, was replaced with fresh 75% ethanol.

Physical Habitat Quality Assessment and Water Quality Measurements

The physical habitat quality was surveyed along the entire reach of each sampling location following a modified version of the standardized BASIC California Stream Bioassessment Protocol (CSBP) sampling procedures (Ode 2007), approved by the Surface Water Ambient Monitoring Program (SWAMP), SARWQCB, and Cal/DFG-ABL. At every 30-meter interval along the 150-meter reach, starting at transect 0 meters, physical habitat quality was determined by observing substrate complexity, consolidation, embeddedness, sediment depth, identifying human influences, determining canopy cover, and identifying indications of trophic complexity. In addition, at each transect, a depth profile was obtained at five equidistant points starting at banks edge and ending on the opposite banks edge. Each sampling reach was scored using the General Habitat Characterization Form. Stream velocity was measured using a 60% stream depth method at each transect using a Flowatch flow-meter that measures velocities directly.

Various water quality parameters were collected on site at each sample location using a HORIBA environmental monitoring unit. Water quality parameters included pH, dissolved oxygen (mg/l), conductivity (mS/cm), water temperature (°C), and turbidity (NTU). A LaMotte alkalinity kit was used to determine total alkalinity. In addition to these on site measurements, a 1000 ml water sample was collected at each site for laboratory analysis to test for other parameters used to describe the general chemical status of the streams. These measurements were performed by CRG Marine Laboratories, Inc. and include the quantification of ammonia nitrogen, dissolved orthophosphate, nitrate-nitrogen, nitrite-nitrogen, and total suspended solids. Although this form of sampling only provides a snapshot of the potential water chemistry at the time of BMI collection, the water chemistry collected during BMI sampling can provide valuable insight as to potential exposure values at each site.

Taxonomic Identification of BMIs

The BMI samples were transported to and processed by CSULB-SEAL. At the laboratory, each sample was rinsed through a No. 35 standard testing sieve (0.5 mm brass mesh) and transferred into a tray marked with twenty, 25 cm^2 grids. All sample material was removed from one randomly selected grid at a time and placed into a Petri dish for inspection under a stereomicroscope. All invertebrates from the grid were separated from the surrounding detritus and transferred to vials containing 75% ethanol. This process was continued until 500 organisms were removed from each sample. The material left from the processed grids was transferred into a jar with 75% ethanol and labeled as "remnant" material. Any remaining unprocessed sample from the tray was transferred back to the original sample container with 75% ethanol and archived. BMIs were then identified to standard taxonomic levels established by CAMLnet using standard taxonomic keys, typically genus level for insects and order or class for non-insects (Brown 1972, Edmunds et al. 1976, Kathman and Brinkhurst 1998, Klemm 1985, Merritt and Cummins 1995, Pennak 1989, Stewart and Stark 1993, Surdick 1985, Thorp and Covich 1991, Usinger 1963, Wiederholm 1983, 1986, Wiggins 1996, Wold 1974).

Data Analysis

A taxonomic list of all aquatic macroinvertebrates identified from the samples was entered into a Microsoft Excel® spreadsheet program. Excel® was used to generate a stand alone taxonomic list, and to calculate and summarize the benthic macroinvertebrate community-based metric values.

All biological metric scores reported in this document are based on 500 organisms (less than 500 organisms were used only if the total number of organisms in a sample was less than 500). For those sites where more than 500 organisms were identified, the total number of organisms were used. Seven biological metrics (Table 2) were determined from the following groups:

Richness Measures – These metrics reflect the diversity of the aquatic assemblage where increasing diversity correlates with increasing health of the assemblage and suggests that niche space, habitat, and food sources are adequate to support survival and propagation of a variety of species.

Tolerance/Intolerance Measures – These metrics reflect the relative sensitivity of the community to aquatic perturbations. The taxa used are usually pollution tolerant or intolerant, but are generally nonspecific to the type of stressors. The metric values usually increase as the effects of pollution in the form of organics and sedimentation increase.

Functional Feeding Groups – These metrics provide information on the balance of feeding strategies in the aquatic assemblage. The functional feeding group composition is a surrogate for complex processes of trophic interactions, production, and food source availability. An imbalance of the functional feeding groups reflects unstable food dynamics and indicates a stressed condition.

Index of Biotic Integrity

An Index of Biotic Integrity (IBI) uses biological metrics to describe the biological condition of a watershed or ecoregion. These metrics vary by biogeographical area and are based on reference sites. These reference sites are locations within the biogeographical area thought to be relatively pristine and minimally impacted by anthropogenic activities. Many different metrics are measured, but only those that show responsiveness to watershed-scale and reach-scale disturbance variables and lack correlation with other responsive metrics are used (Ode et al. 2005). The IBI used to evaluate the 29 sampled sites was developed from 2000 to 2003 and is based on data from the Southern California Coastal region (Ode et al. 2005; Table 3). It should be noted that the reference sites assessed during the development of the SCC-IBI did not include sites with physical alterations (i.e., concrete-lined or modified channels), and low gradient reference sites were largely underrepresented.

Quality Assurance and Quality Control (QA/QC)

All QA/QC requirements were followed by sampling personnel (Appendix B) during the 2007 sampling events. An auditor from SLSII accompanied sampling personnel during the 2007 bioassessment to ensure that all sampling activities were completed using the approved methods. Only CSULB-SEAL personnel trained in the approved sampling methods participated in the collection of BMIs during the 2007 sampling events. All internal QA/QC procedures were followed and none of the limits described in the document were violated, with the exception of hold-times for some water quality samples collected for nutrient analyses (due to some sample locations, the 48 hour hold-time could not be met; those samples were maintained on ice at less than 4 degrees Celsius). Picking error also occurred in certain samples during sample processing leading to greater than 500 BMIs being picked, when this occurred 500 BMIs were randomly subsampled from the overall data set from that specific location. Four sites (87, 147, 361, 446) had fewer then 450 BMIs found in the benthic sample. Although SCC-IBI scores were generated for these sites, scores generated using fewer than 450 BMIs have not been validated. All QA/QC documentation, including the chain of custody forms for each site, is on file with the appropriate contract laboratory and CSULB-SEAL.

Table 2: Bioassessment metrics used to describe characteristics of the benthic macroinvertebrate (BMI) communities at assessed sites.

BMI Metric	Description	Response to Impairment
Richness Measures		
EPT Taxa	Number of taxa in the Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) insect orders	Decrease
Number of Coleoptera Taxa	Number of taxa from the insect order Coleoptera (beetles)	Decrease
Number of Predator Taxa	Number of taxa from the predator functional feeding group	Decrease
Tolerance/Intolerance Measures		
Percent Tolerant Taxa	Percent of taxa in sample that are highly tolerant to impairment as indicated by a tolerance value 8, 9, 10	Increase
Percent Non-insect Taxa	Percent of organisms in sample that are not in the Class Insecta	Increase
Functional Feeding Groups (FFG)		
Percent Collector-Gatherers (CG)	Percent of macrobenthos that collect or gather fine particulate matter	Increase
Percent Collector-Filterers (CF)	Percent of macrobenthos that filter fine particulate matter	Increase
Percent Collector Gathererers + Collector Filterers (CF)	Percent of macrobenthos that collect or gather fine particulate matter and/or percent of macrobenthos that filter fine particulate matter	Increase

Table 3: Southern Coastal California Benthic Macroinvertebrate Index of Biotic Integrity parameters and scoring ranges (to adjust IBI score, multiply total IBI score by 7/10; from Ode et al. 2005).

	Metric Scoring Ranges for the Southern Coastal California B-IBI						
Metric Score	**# EPT Taxa**	**% Intolerant Individuals**	**# Predator Taxa**	**% Tolerant Taxa**	**% Non-Insect Taxa**	**% CF + CG**	**# Coleoptera Taxa**
10	> 17	25-100	> 12	0-4	0-8	0-59	> 5
9	16-17	23-24	12	5-8	9-12	60-63	
8	15	21-22	11	9-12	13-17	64-67	5
7	13-14	19-20	10	13-16	18-21	68-71	4
6	11-12	16-18	9	17-19	22-25	72-75	
5	9-10	13-15	8	20-22	26-29	76-80	3
4	7-8	10-12	7	23-25	30-34	81-84	2
3	5-6	7-9	6	26-29	35-38	85-88	
2	4	4-6	5	30-33	39-42	89-92	1
1	2-3	1-3	4	34-37	43-46	93-96	
0	0-1	0	0-3	38-100	47-100	97-100	0

Total IBI Scoring Range Adjusted Scale (0 - 100)	0-20 Very Poor	21-40 Poor	41-60 Fair	61-80 Good	81-100 Very Good

RESULTS

BMI Community Structure

During the spring 2007 bioassessment sampling events, BMI taxa were identified from the 29 sampled locations (Appendix D). Low elevation sites were dominated by aquatic fly larvae from the family Chironomidae, fly larvae *Simulium* sp., aquatic crustaceans from the order Ostracoda, as well as crustaceans from the order *Hyalella* sp. Mid elevation sites were not only dominated by the aforementioned organisms, but also were dominated by baetid mayfly larvae *Baetis* sp. and *Paracloedes* sp. High elevation sites (700 meters and up) were dominated by larvae from the fly families Chironomidae and Simuliidae and aquatic crustaceans from the order Ostracoda, baetid mayfly larvae *Baetis* sp., heptageniid mayfly larvae *Epeorus* sp, hydroptilid caddisfly larvae *Hyalella* sp., and aquatic worms from the order Oligochaeta.

Index of Biological Integrity – SCC-IBI scores are adjusted from a scale of 0 to 70 (seven summed metrics ranging from 0 to 10), to a scale of 0 to 100 for ease of interpretation. Adjusted SCC-IBI scores were obtained by multiplying the summed SCC-IBI score by 10 and dividing that score by 7. The adjusted SCC-IBI scores for the 2007 bioassessment sampling events ranged from 19 to 73 (Table 4). SCC-IBI scores and elevation were positively correlated (Figure 2). However SCC-IBI scores were not correlated with dissolved oxygen (Figure 3), nitrate (Figure 4), phosphate (Figure 5), turbidity (Figure 6), or total suspended solids (Figure 7). A qualitative analysis of the seven metrics that comprise the SCC-IBI scores for the sites sampled in 2007 (Figure 8) suggests that low elevation sites are comparable to higher elevation sites with respect to the metrics percent non-insect taxa and percent tolerant taxa, but are deficient in numbers of EPT and Coleoptera taxa.

Water Chemistry – Refer to Appendix C for water chemistry values.

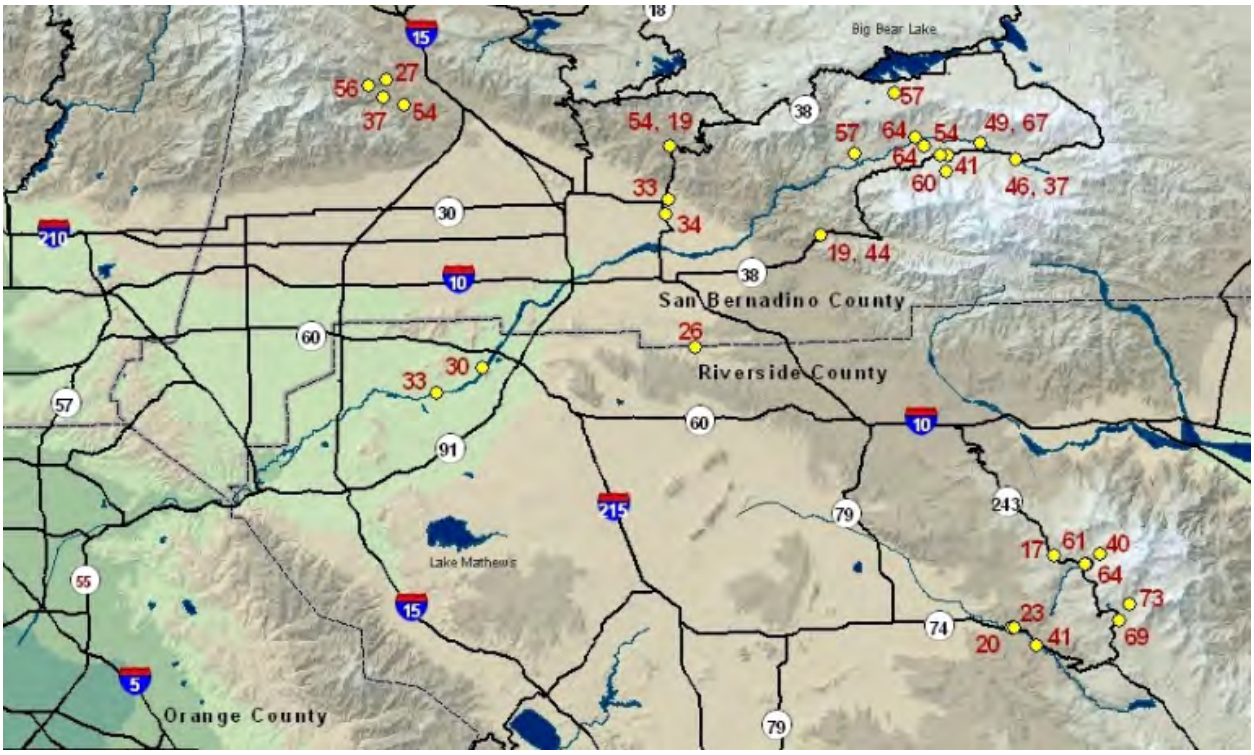

Figure 1. SCC-IBI scores for sites sampled during 2007.

Table 4: SCC-IBI metrics and overall rating for each location sampled during the 2007 bioassessment survey.

Elevation Strata (meters)	Site	EPT Taxa	% Intolerant Individuals	# Predator Taxa	% Tolerant Taxa	% Non-Insect Taxa	% CF + CG	# Coleoptera Taxa	Total IBI Score (Adjusted on a scale of 0 to 100)	IBI Rating
0 - 350	361	0	0	0	10	10	1	2	33	Poor
0 - 350	151	1	0	0	8	9	3	0	30	Poor
350 -700	121	3	0	0	9	10	2	0	34	Poor
350 -700	398	4	1	2	4	5	5	2	33	Poor
350 -700	208	1	0	0	7	8	2	0	26	Poor
350 -700	159	0	1	1	7	3	2	0	20	Poor
350 -700	453	0	1	2	8	3	2	0	23	Poor
350 -700	587	4	3	2	7	8	3	2	41	Fair
700 +	446	5	4	3	8	8	5	5	54	Fair
700 +	446D	1	0	0	2	7	3	0	19	Very Poor
700 +	271	3	8	0	9	7	7	4	54	Fair
700 +	346	3	6	1	7	3	4	2	37	Poor
700 +	105	3	1	4	5	5	1	0	27	Poor
700 +	370	1	1	0	4	6	1	0	19	Very Poor
700 +	370D	5	2	2	8	10	2	2	44	Fair
700 +	069	8	5	1	10	8	7	0	56	Fair
700 +	025	8	7	7	6	7	5	0	57	Fair
700 +	203	9	10	5	10	9	2	0	64	Good
700 +	163	6	10	1	7	8	9	2	61	Good
700 +	419	10	10	6	8	8	4	2	69	Good
700 +	635	1	1	0	6	2	2	0	17	Very Poor
700 +	147	4	10	4	8	8	7	4	64	Good
700 +	530	10	8	9	7	6	5	0	64	Good
700 +	375	10	10	7	8	8	4	4	73	Good
700 +	543	3	4	2	6	6	3	4	40	Poor
700 +	168	5	7	2	10	8	2	0	49	Fair
700 +	168D	9	8	7	8	7	4	4	67	Good
700 +	686	5	3	0	9	9	3	0	41	Fair
700 +	093	8	7	3	7	6	5	2	54	Fair
700 +	087	5	4	0	10	10	1	2	46	Fair
700 +	087D	3	4	5	6	6	2	0	37	Poor
700 +	106	9	6	8	7	4	8	0	60	Fair
700 +	100	7	8	6	7	4	8	0	57	Fair

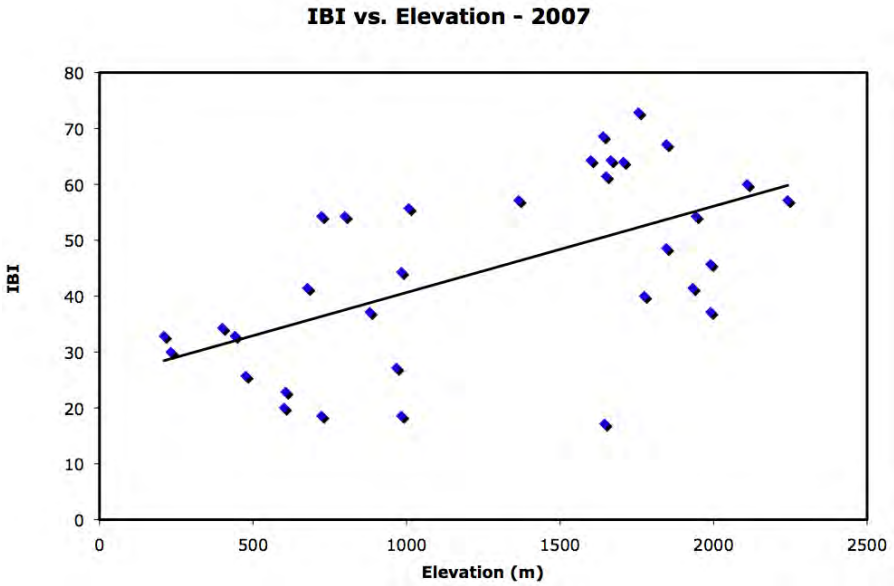

Figure 2. IBI scores as a function of elevation.

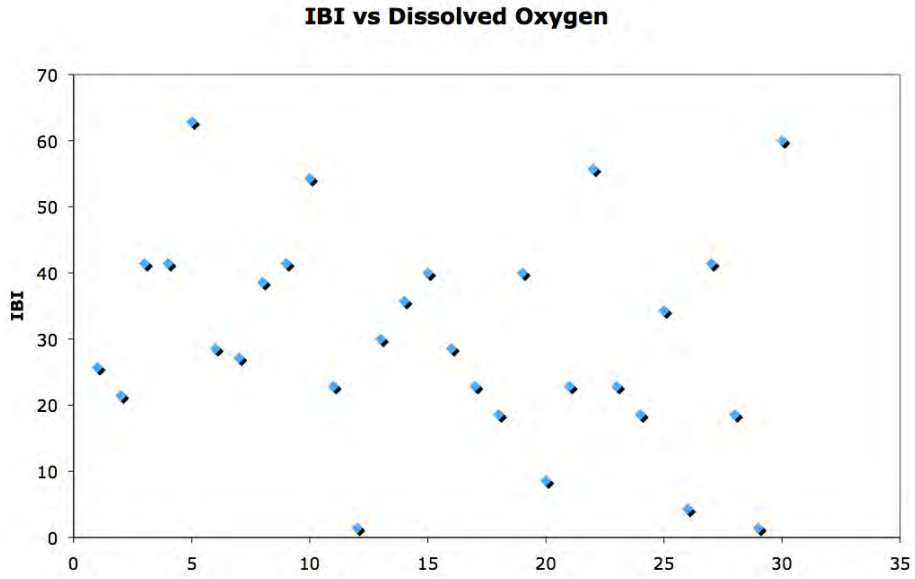

Figure 3. IBI scores as a function of dissolved oxygen.

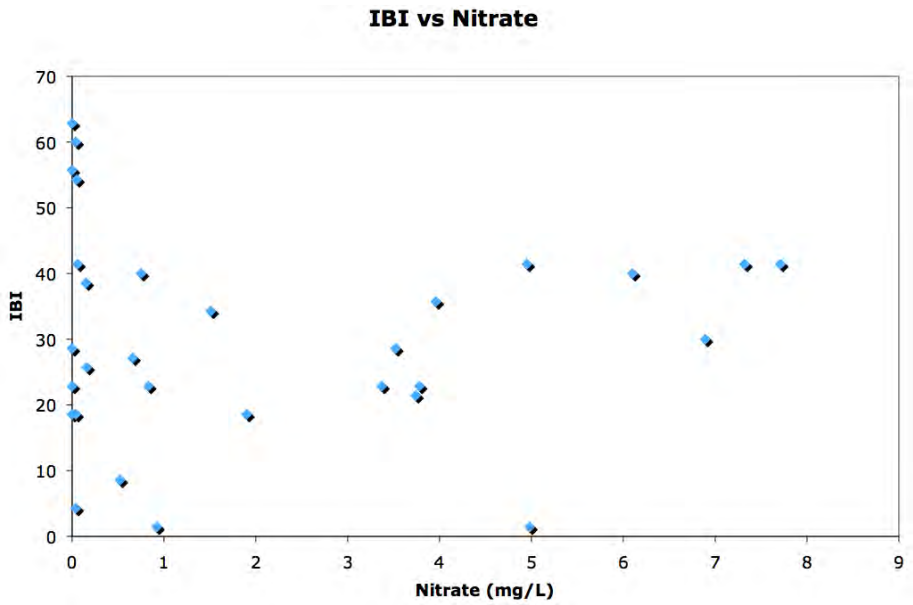

Figure 4. IBI scores as a function of nitrate.

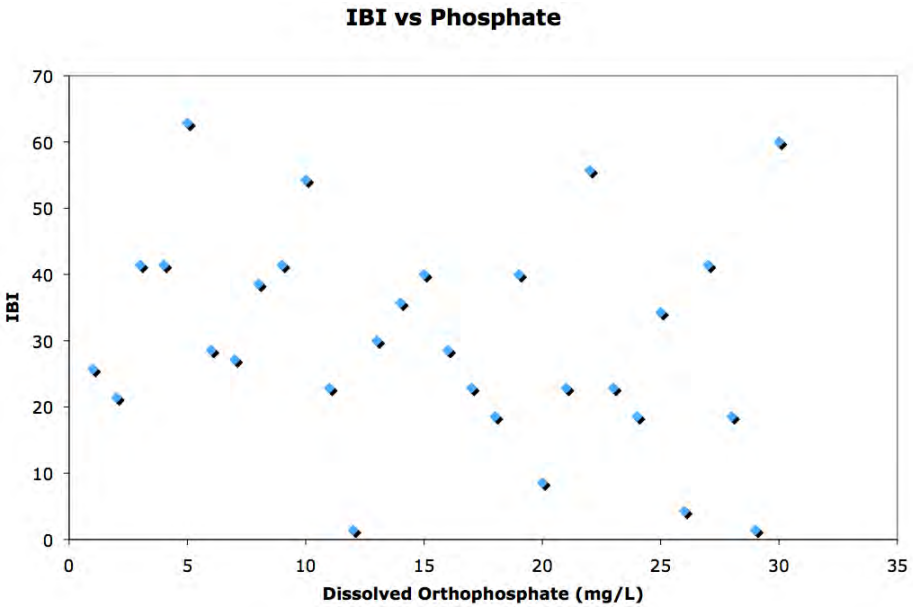

Figure 5. IBI scores as a function of phosphate.

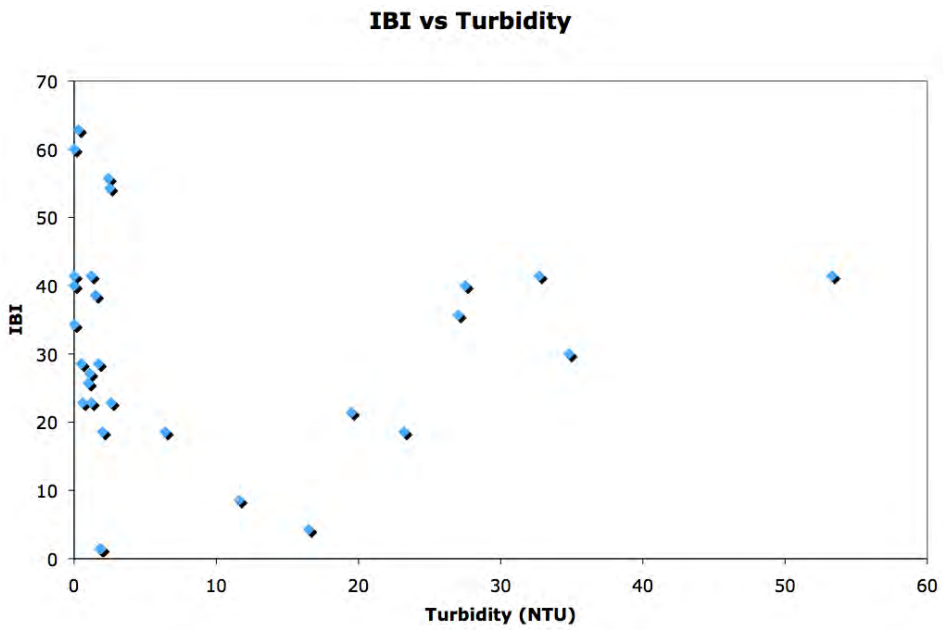

Figure 6. IBI scores as a function of turbidity.

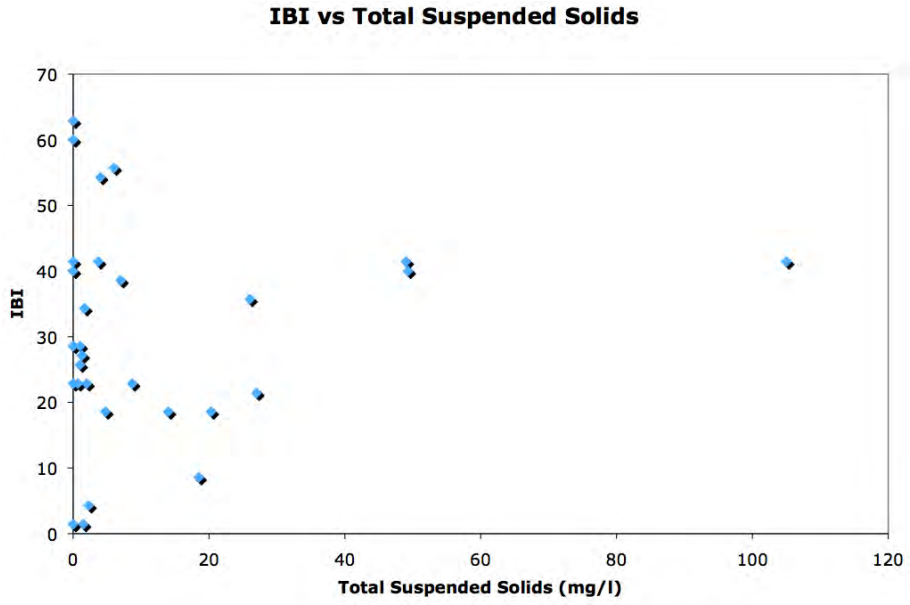

Figure 7. IBI scores as a function of total suspended solids.

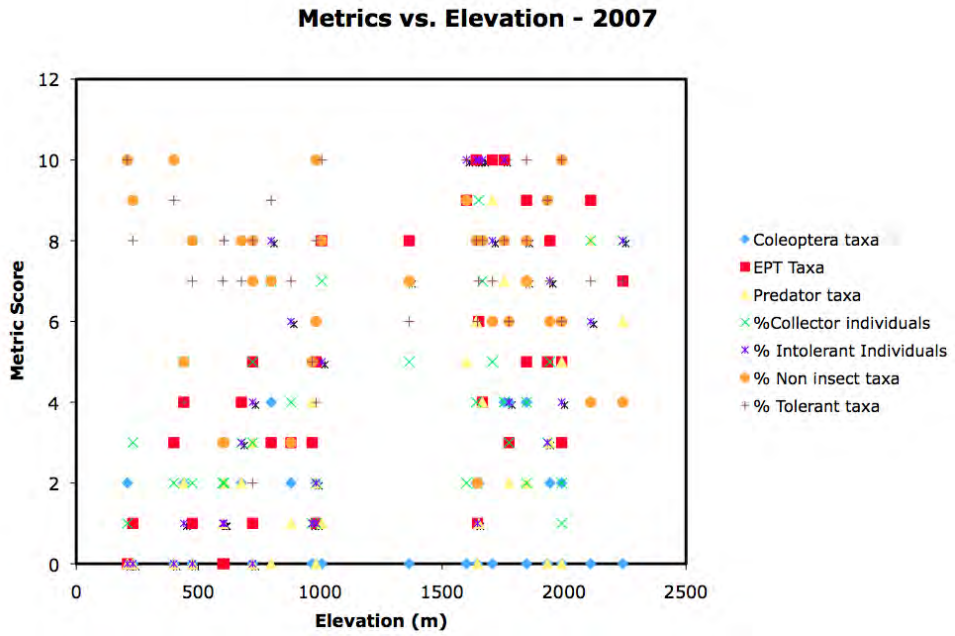

Figure 8. IBI metrics as a function of elevation.

Conclusion

This report gives the results from the second year of an ongoing five-year monitoring project to assess the quality of the waterways within Region 8.

BMI Community Structure - The low and mid elevation sites were dominated by the facultative and tolerant insects and non-insects. These included midge larvae Chironomidae, crustaceans *Hyalella* sp. and Ostracoda, as well as mayflies *Baetis* sp. High-elevations sites were not only dominated by the aforementioned organisms of the low and mid elevations, but were also dominated by intolerant mayflies *Epeorus* sp.

Chironomidae larvae are highly tolerant of impaired conditions and are a documented signature of urbanization (Wang and Lyons 2002). Although Chironomidae larvae were present at all but one site, their presence was not entire determined by urbanization. Sites that were isolated from the influence of urbanization still exhibited similar levels of Chironomidae larvae when compared to sites surrounded by urbanization. Most Baetidae mayfly genera are moderately tolerant members of the EPT group of BMIs and have a preference for sediment-dominated streambeds, having no need for complex habitat with high volume of interstitial areas. They are, however, sensitive to contamination and low dissolved oxygen levels. The presence of *Epeorus* sp. within high-elevation sites indicates relatively pristine habitat conditions for these sensitive organisms.

Physical/Habitat Quality and Chemical Characteristics – The physical habitat condition of the sampled sites ranged from poor to optimal (0 to 15 "poor," 16 to 30 "marginal," 31 to 45

"suboptimal," and 46 to 60 "optimal;" Figure 3). Predominantly natural high-elevation channels had the highest values (averaging 44.5 and ranged from 21 to 60), followed by mid-elevation channels (averaging 27.3 and ranged from 14 to 46), and finally the low-elevation channels had the lowest values (averaging 25.7 and ranged from 15 to 41).

The water quality characteristics were relatively consistent among sites with near neutral or slightly alkaline mean pH field values (5.22 to 8.24; Appendix C), more than adequate levels of mean dissolved oxygen (5.9 to 11.88; Appendix C), and relatively low conductivity values (0.0001 to 0.001 mS/cm; Appendix C). Natural inland waters usually contain small amounts of dissolved mineral salts; low levels of dissolved salts can be harmful to living organisms not able to osmoregulate causing the uptake of water into the organism's cells which can be lethal. Surveys of inland fresh waters indicate that a good mix of fish fauna is found where conductivity values range between 150 and 500 mS/cm and that the upper tolerance limit for freshwater organisms is 2000 mS/cm (McKee and Wolf 1971).

SCC-IBI and Region 8 – While an IBI is an informative tool for assessing waterway condition, this multimetric technique is not without its limitations. When an IBI is developed, the individual metrics that make up an IBI are generated for a specific region based on reference condition sites for that area. While Region 8 falls within the boundaries of the SCC-IBI, there are few sites from this area reflected in the developed SCC-IBI. Therefore, sites within Region 8 may not be within the model's experience, and the resultant IBI scores may not adequately reflect waterway condition or health. Many sites included in the developed SCC-IBI were located at high elevations and were also characterized as high gradient streams. However, the sites in Region 8 are primarily low elevation, and are characterized as low gradient with many site reaches located in a channelized environment. Currently there is no developed IBI for low gradient, low elevation streams in this region, nor are channelized waterways included in the developed SCC-IBI.

It is also important to note that the relationships on which the SCC-IBI was generated were characterized by considerable variation with apparent thresholds. BMI communities and their respective IBI scores may change considerably once the thresholds have been exceeded.

Another important notation is that the SWAMP mandated sampling protocols include both a targeted riffle and multihabitat approach. The targeted riffle approach is used for high gradient streams, while the multihabitat approach is used at for low gradient streams. The multihabitat protocol may not be the best approach for these stream types, as many BMIs in this setting live on or near the bank margins. A 'margin-center-margin' protocol may better depict waterway condition for these site types.

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Appendix A:

Location Photos

Site: 025 Transect: 0

Site: 069 Transect:0

Site: 087 Transect: 0

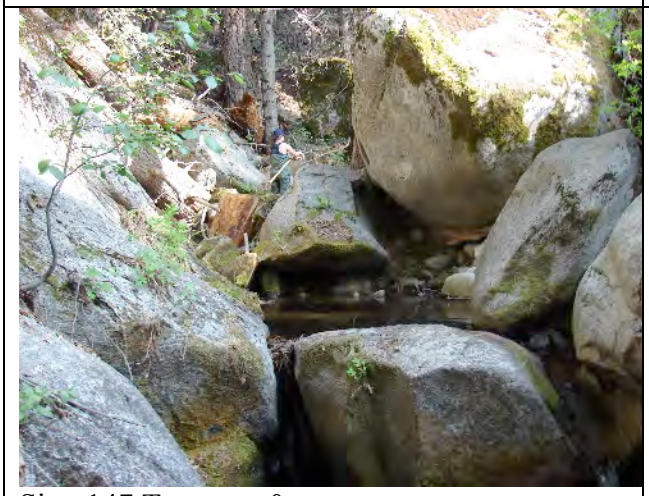
Site: 092 Transect: 0

Site: 100 Transect: 0

Site: 105 Transect: 0

Site: 106 Transect: 0

Site: 121 Transect:0



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Site: 151 Transect: 0

Site: 159 Transect: 0

Site: 163 Transect: 0

Site: 168 Transect: 0

Site: 203 Transect:0

Site: 208 Transect: 0

Site: 247 Transect: 0

Site: 271 Transect: 0

Site: 346 Transect: 0

Site: 361 Transect: 0

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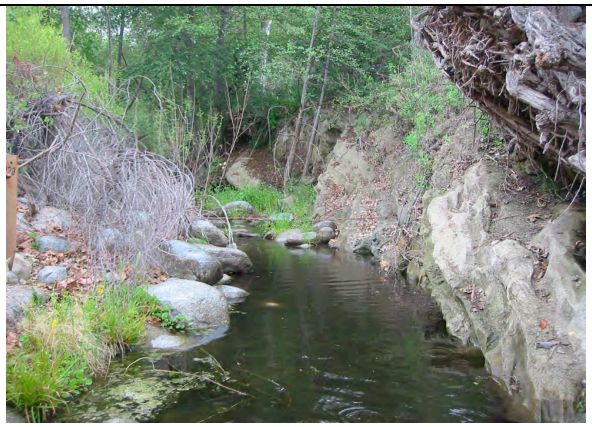
Site: 375 Transect: 0

Site: 398 Transect: 0

Site: 419 Transect: 0



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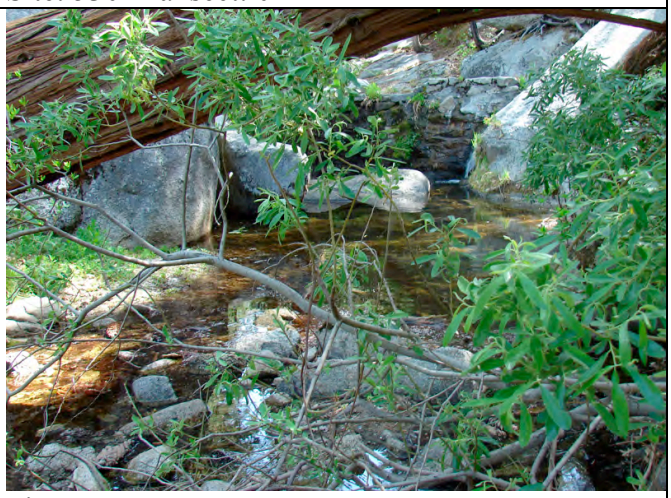
Site: 446 Transect: 0

Site: 530 Transect: 0

Site: 543 Transect: 0



Site: 587 Transect: 0

Site: 635 Transect: 0

Site: 686 Transect: 0

Appendix B:

Quality Compliance and Standard Operating Procedures

California State University, Long Beach
Stream Ecology and Assessment Laboratory (CSULB-SEAL)

QUALITY ASSURANCE PROJECT PLAN

for

Aquatic invertebrate bioassessment monitoring for the Santa Ana Regional Water Quality Control Board (Region 8)

Version 3.4

A01. TITLE AND APPROVAL SHEET

Prepared by:
Drs. Dessie Underwood and Bruno Pernet
Department of Biological Sciences
California State University, Long Beach
1250 Bellflower Blvd
Long Beach, CA 90840
email: dlunderw@csulb.edu, bpernet@csulb.edu

APPROVALS

CSULB-SEAL Project Manager (Zed Mason)	Date
CSULB-SEAL Quality Assurance Officer (Bruno Pernet)	Date
Water Board Contract Manager (Pavlova Vitale)	Date
Water Board Quality Assurance Officer	Date

A02. TABLE OF CONTENTS

LIST OF TABLES

A03. DISTRIBUTION LIST

Pavlova Vitale, Santa Ana Regional Water Quality Control Board
Dr. Zed Mason, California State University, Long Beach
Rich Gossett, CRG Marine Laboratories

Dr. Dessie Underwood, California State University, Long Beach
Dr. Bruno Pernet, California State University, Long Beach

A04. PROJECT/TASK ORGANIZATION

Project Manager: Dr. Zed Mason, CSULB. Oversight of the project, generation of reports
Quality Assurance Officer: Dr. Bruno Pernet, CSULB.; Quality control – will NOT be involved with generating data
Maintenance of the QAPP: Dr. Dessie Underwood, CSULB
Field/Lab Supervisor: Dr. Dessie Underwood, CSULB; Training and oversight of technicians and students involved in data collection
Field Biologists/Taxonomists: Mark Canfield, Coventry Dougherty, Kacy Jones, Craig Pernot
Chemical Analyst: Rich Gossett, CRG Marine Laboratories

Table 1. Personnel responsibilities

Name	Organizational Affiliation	Title	Contact Information
Dr. Zed Mason	CSULB	Project Manager	Tel: (562)-985-5266 Fax: (562)-985-8878 zedmason@csulb.edu
Dr. Bruno Pernet	CSULB	Quality Assurance Officer	Tel: (562)-985-5378 Fax: (562)-985-8878 bpernet@csulb.edu
Dr. Dessie Underwood	CSULB	Field/Lab Supervisor	Tel: (562)-985-7475 Fax: (562)-985-8878 dlunderw@csulb.edu
Rich Gossett	CRG Marine Laboratories	Chemical Analyst	Tel: (310) 533-5190 Fax: (310) 533-5003 crglabs@sbcglobal.net

A05. PROBLEM DEFINITION/BACKGROUND

Bioassessment is a tool for measuring stream water quality and habitat quality based on the types and numbers of organisms living there. It is a direct method for assessing the biological health or integrity of stream ecosystems. The objectives of the bioassessment program described here are to meet the federal EPA-mandated requirement (EPA requirement 305(b)) for an assessment of the integrity of surface waters in Region 8 (Santa Ana Region) of California. In addition, the data collected in this program will be used to identify streams that may require improvement of water quality. It will also be used to refine and compare several methods of analysis and interpretation of bioassessment data.

The Santa Ana region encompasses over 8000 stream-km distributed among three hydrologic units (Santa Ana, San Jacinto, and San Gabriel). These streams range from sea-level, low-gradient streams to high-gradient streams found well above 700 meters in elevation in the San Bernadino and San Jacinto Mountains. A great variety of land uses may affect water quality in this region, including urbanization, agriculture, manufacturing, livestock grazing, erosion, and channelization. This program will represent the first comprehensive bioassessment of streams in this region.

A06. PROJECT/TASK DESCRIPTION

Work to be performed under this QAPP focuses on selecting sites for bioassessment sampling in 2006; field surveys of the physical habitat and water chemistry parameters, and benthic macroinvertebrates in 30 stream sites distributed throughout the area of interest; laboratory analyses of water chemistry and taxonomy and enumeration of benthic invertebrates; and analysis and summary of the data for presentation as technical reports. A specific timetable is shown below:

Table 2. Project schedule timeline

Activity	**Start and expected completion dates**
Site selection, reconnaissance, and obtaining permission from landowners for sampling	Aug 06 - Jan 07
Field surveys	Jan – May 07
Laboratory analysis: water chemistry and benthic macroinvertebrate taxonomy and enumeration	May 07-Jan 08
Reporting	June 08

We will summarize our findings by calculating IBI scores using the Southern California – IBI developed by Ode et al. 2005. For each site sampled, we will provide the quantitative IBI score as well as the category of impairment that this score generates. Additionally, we will also analyze the benthic macroinvertebrate assemblages using Hawkins' RIVPACS model for Southern California (Utah State University, BugLab). This model will provide a comparison of which benthic macroinvertebrates should be present (expected) to what is actually captured (observed). As we are not a regulatory agency, we will not recommend specific water quality improvement activities; this will be left up to the appropriate personnel within the Region 8 administration.

A07. QUALITY OBJECTIVES AND CRITERIA

A. Data quality objectives for this project will consist of the following:

Field Measurements – Accuracy, Precision, Completeness
Laboratory Measurements - Accuracy, Precision, Completeness

Accuracy will be determined by measuring each parameter from performance test samples or standard solutions from sources other than those used for calibration.

Precision measurements will be determined on both field and laboratory replicates. The number of replicates for field measurements will be three.

Completeness is the number of analyses generating useable data for each analysis divided by the number of samples collected for that analysis.

Project specific action limits are not applicable for this study.

Previously collected information must meet the minimum criteria for newly collected information as outlined in this document to be considered acceptable in this study.

Objectives for the precision, accuracy, and measurement ranges of selected physical and chemical parameters:

Table 3. Data quality objectives for field measurements

Parameter	Accuracy	Precision	Target Reporting Limits	Completeness
Conductivity	± 1%	± 1%	2.5	90%
Dissolved O_2	± 0.2 mg/L	± 0.4 mg/L	0.2 mg/L	90%
Turbidity	± 2%	± 1%	0.5 ntu	90%
pH	± 0.01	± 0.10		90%

Table 4. Data quality objectives for laboratory measurements

Parameter	Accuracy	Precision	Target Reporting Limits	Completeness
Ammonia - N	75-125%	0-25%	0.05 mg/L	90%
Dissolved Orthophosphate	75-125%	0-25%	0.01 mg/L	90%
Nitrate-N	75-125%	0-25%	0.05 mg/L	90%
Nitrite-N	75-125%	0-25%	0.05 mg/L	90%
Total Suspended Solids	75-125%	0-25%	0.5 mg/L	90%

B. Data representativeness: Previous studies suggest that physical and chemical parameters are typically within 10% of actual values. Measures of diversity (total and component) are likely to be underestimates but by no more than 30% of true richness and this due entirely to rare taxa or those not present in riffle habitat zones. Density is also underestimated, likely by about 10-20% due to incomplete capture of some organisms.

C. Data comparability: The field sampling and laboratory methods described here are based on evolving standard methods in the state of California, and as such should be fully comparable with other data collected by similar means. These data will be able to be used with preexisting IBI measures and RIVPACS models.

D. Data completeness (for each study reach unit): The completeness of data is a relationship of what percentage of the data are available for use compared to the total potential data before any conclusion is reached. Ideally, 100% of the data should be available. However, the possibility of data becoming unavailable due to laboratory error, insufficient sample volume, or samples broken in shipping must be expected. Also, unexpected situations may arise where

field conditions do not allow for 100% data completeness. Therefore, 90% data completeness is required by SWAMP for data usage in most cases.

A high level of completeness is essential in all phases of this study due to the limited number of samples and sampling effort. The overall goal is to obtain completeness of 100 percent; however, the data quality objective is established at 90% to ensure an adequate level of data return.

E. Precision and Accuracy: The precision and accuracy of data are determined by particular actions of the analytical laboratory and field staff. The precision of data is a measure of the reproducibility of the measurement when an analysis is repeated. It is reported in Relative Percent Difference (RPD) or Relative Standard Deviation (RSD). The accuracy of an analysis is a measure of how much of the constituent actually present is determined. It is measured, where applicable, by adding a known amount of the constituent to a portion of the sample and determining how much of this spike is then measured. It is reported as Percent Recovery. The acceptable percent deviations and the acceptable percent recoveries are dependent on many factors including: analytical method used, laboratory used, media of sample, and constituent being measured. It is the responsibility of the program manager to verify that the data are representative while the analytical data's precision, accuracy, and comparability are mainly the responsibility of the laboratory supervisor. The program manager also has prime responsibility for determining that the 90% data completeness criteria (85% for tissue analyses as outlined previously) are met or for justifying acceptance of a lesser percentage. Laboratories performing the analysis of samples for this project have developed precision and accuracy limits for acceptability of data. For parameters and matrices, which have USEPA established criteria, the limits are either equal to, or more stringent than, the established limit. For matrices without USEPA established criteria, the laboratories have developed control limits following the procedures published in the USEPA Handbook for Analytical Quality Control in Water and Wastewater Laboratories. These DQO's are used to evaluate the acceptability of each set of results. If the objectives are not passed for a particular analysis, the lab will immediately determine the cause of the discrepancy and resolve the problem.

A08. SPECIAL TRAINING/CERTIFICATIONS

Field and laboratory technicians will be provided with this QAPP and with detailed standard operating procedures (SOPs) for all protocols used in the field and in the laboratory. Prior to each field season the project QA officer will involve all personnel in a training session on each protocol used in physical habitat, chemical, and biological sampling, including practice in each of the above protocols. Field quality control (QC) involves regular review of sample collection, preservation, and labeling. Laboratory training involves QC checking of all samples sorted during an initial training period. When a technician has met initial QC standards for removal of specimens from sample debris (<5% organisms missed), then 20% (1 of 5) samples are subsequently checked for completeness of removal. Log sheets and sample processing sheets are used to track who processed samples, time spent on each sample, number of organisms recovered, who did QC checks, and the number of organisms missed (in QC-checked samples). These data are used for feedback and improvement of sorting rate and effectiveness. Each

technician will maintain a notebook with copies of taxonomic keys, notes, and illustrations. All identified sample replicates are reviewed with a supervisor during QC checks (each taxon verified, changed, or deleted). During initial training 100% of identified sample replicates are QC checked, but later only 20% of samples are so checked. Regular work performance evaluations are performed to certify compliance with the QC goals of quality in completing field and laboratory tasks (see section 20). The QA officer is responsible for assuring that the training and QC requirements are satisfied.

Training documentation will be stored in Peterson Hall 2, Room 03.

A09. DOCUMENTATION AND RECORDS

Records of field surveys will be maintained on standard forms (Appendix 1) for each site studied, using water-resistant paper. All field data are entered on these forms at the time data are gathered. All laboratory records are also maintained on standard forms (Appendix 1). These data will be transferred to a database system for summary and analysis. The database system that we will use is a Microsoft ACCESS database in a format compatible with the evolving SWAMP database. Backups of electronic record will be made as described below (section 19). All biological samples, including remnant samples, will be archived for five years. Voucher specimens for each invertebrate taxon encountered will be maintained in a separate laboratory collection.

Data will be submitted to the SWAMP database and a final report will be generated that outlines the site-specific IBI scores and RIVPACS O/E values. Both submission of data to the SWAMP database and the generation of a final report constitute the final work product.

Data will be stored indefinitely on computers in Peterson Hall 2, Room 3, with electronic back ups kept on the CSULB server.

Dr. Underwood will be responsible for distributing the most recent copy of the QAPP.

B01. SAMPLING PROCESS DESIGN

Sites will be selected according to specific research questions and to address the primary objective (quantifying the integrity of streams in the entire region). Briefly, we will classify stream sites by hydrologic unit (HU) and elevation. Because the portion of the San Gabriel HU included in Region 8 is so small, we will pool those sites with those in the Santa Ana HU. The two hydrologic units (Santa Ana and San Jacinto, with the former including the San Gabriel) will be divided into three elevation strata – 0-350 meters, 350-700 m, and 700+ m. Because there are no sites in the San Jacinto HU in the 0-350 m stratum, the combination of HU and elevation yields five sampling units. The target 30 sites sampled per year will be evenly distributed among these five sampling units. Sampling will take place between May and July 2006, and samples will be transported to the laboratory within three days of collection for water chemistry analyses, storage and subsequent processing.

Potential sources of variability and bias are as follows:

Variability: During the index period variation in weather may increase inter-site variability due to periodic rainfall, changes in air and water temperature, etc. There should be little variation due to sampling as the field crew membership will be stable and training was extensive during the fall months of 2005. Additional training will occur prior to sampling.

Bias: Sampling may be constrained by access and will be limited to sites that do not pose a safety hazard to the field crew. Some bias may be introduced as higher elevation sites may also be characterized by increased slope and inaccessibility. Higher elevation sites may also be correlated with decreased human impacts and, as such, might be expected to exhibit IBI scores above regional averages. We will avoid these biases whenever possible by selecting alternative sites that are as similar as possible to the inaccessible sites with respect to elevation and potential human influences both upstream and immediately surrounding each site.

B02. SAMPLING METHODS

For details of methods of field sample collection, please see the Field Sampling SOP (Appendix 2 – SOP 2.1 [2/20/06]). How water samples will be collected, preservation methods, sampling containers, equipment, etc. are discussed in SOP 2.1 (2/20/06).

All work will be carried out according to these detailed instructions. Briefly, field work will include measurement of physical habitat parameters, measurement of some water chemistry parameters and collection of water samples for later laboratory assessment of others, and collection of benthic macroinvertebrates for bioassessment. For all three categories of field work we will follow California's evolving standard protocols for sampling. For example, current recommendations from the State Water Resources Control Board are to use the EMAP multihabitat sampling methods for low-gradient, sandy bottom streams; for high-gradient streams, the targeted riffle approach used by the US Forest Service is recommended. We will use these methods.

Water samples will be transported on ice from the field to the lab. They will not be preserved beyond the time required for lab analysis.

Sampling equipment and samplers will be cleaned after each use. As we are only sampling water and macroinvertebrates, thorough rinsing in fresh water will suffice for decontamination and no by-products will be produced (and hence, no need to state how these by-products will be disposed of).

All equipment needed is clearly stated in the SOPs. Support facilities including laboratory and office space are provided by CSULB.

B03. SAMPLE HANDLING AND CUSTODY

Samples collected in the field and returned to the laboratory from each site include one composited benthic invertebrate sample (labeled with stream, site name, and date) preserved in ethanol, and water samples for chemical analyses. Upon return to the laboratory, which will occur immediately after the completion of each field survey trip (so within one week of collection), all biological samples will be logged into a Sample Tracking Log, and will subsequently be stored in cabinets; water samples will be analyzed immediately on return to the laboratory. Biological samples will be sorted and identified within nine months of collection. All samples will be in the custody of the CSULB research team or contractors at all times, from the time of collection to completion of processing, identification, and analysis. Log sheets (Appendix 1) are used to track benthic macroinvertebrate samples in the laboratory through sorting, subsampling, identification, and quality control. Chain-of-custody forms (Appendix 1) are used for transferring samples to external laboratories for identification verification checks.

Because the research laboratory is a new one, all biological samples taken during the first year of the study will be archived for five years.

The maximum holding time for all water samples is 48 hours.

B04. ANALYTICAL METHODS AND FIELD REQUIREMENTS

Please refer to SOPs (Appendix 2 – SOP 01 [2/20/06], SOP 02 [2/20/06], SOP 03 [2/20/06]) for methods used in field surveys and laboratory analysis. Some water chemistry parameters will be measured by CRG Marine Laboratories, Inc, Torrance, CA.

No *in situ* or continuous monitoring will be done.

Specific method performance criteria are not applicable for this project.

If problems are encountered in the field (e.g. access problems, safety issues, inadequate supplies), the field team leader will be responsible for corrective actions. If problems are encountered in the lab, the lab supervisor will be responsible for corrective actions.

Samples will be disposed of following the policy and regulations of the California State University Long Beach.

Lab turn around times can only be estimated as this is a new research laboratory, but it is anticipated to be in the range of six to nine months.

PBMS method validation and documentation are not applicable to this study.

Equipment needed for laboratory analyses is listed in SOPs 02 and 03.

When failures occur, the laboratory supervisor is responsible for initiating corrective action. All corrective action is documented by entry into the Corrective Action File (CAF).

B05. QUALITY CONTROL

Field and laboratory quality control measures include extensive training sessions in habitat surveys and sampling prior to each field season, cross-checks between observers in paired teams to ensure uniformity in how measures are taken and recorded, supervisor oversight of all technicians, use of standardized data forms for all records, and the availability of detailed SOPs for all procedures. Cross-checks of field-data forms are made at the end of each survey. During initial training of laboratory technicians, 100% checks are made during sorting (reduced to 20% when <5% error is achieved), and 100% re-identification checks with laboratory supervisors are routine. QC results are entered on the Sample Processing Lab Sheet and the Sample Tracking Log. If control limits are exceeded, 100% checks will be made during sorting and again reduced to 20% when <5% error is achieved.

Twenty percent of identified specimens will be randomly selected and sent to an external laboratory for verification. If there are errors in identification, all samples that included those taxa will be reevaluated and corrections made.

The calculation of relative percent difference or error is as follows. Each measured value is compared against the known value of the standard, and accuracy is expressed as the relative percent difference.

$$RPD = \frac{[V_m - V_k]}{V_k} \times 100\%$$

Where: RPD = the relative percent difference

Vm = the measured value,
Vk = the known value.

Duplicate field samples will be collected for all parameters at an annual rate of 5% of total samples to be collected within a given year's Work Plan. The duplicate sample will be collected in the same manner and as close in time as possible to the original sample. This effort is to attempt to examine field homogeneity as well as sample handling, within the limits and constraints of the situation.

All biological samples, including remnant samples, will be archived for five years sampling.

B06. INSTRUMENT/EQUIPMENT TESTING, INSPECTION AND MAINTENANCE

The primary types of equipment for use in the field are GPS units, a rangefinder, a flowmeter, and a dissolved oxygen/pH meter. This equipment will be examined for proper function, part replacement, battery life, and re-filling of solutions before each field survey. Spare batteries, parts and supplies are carried in the field so as to be able to deal with simple malfunctions on site. Equipment will be stored in conditions recommended by the manufacturers. Biological sampling equipment will be visually inspected before each field survey so as to detect and repair any damage.

This equipment does not have "spare parts" beyond the routine maintenance, e.g. batteries, probes, etc. In the event of malfunction, a new piece of equipment will be purchased.

Testing, inspection, and maintenance of equipment are the responsibility of the lab supervisor. The lab supervisor will also be responsible for employing any corrective actions and documenting these actions in the equipment log. The effectiveness of the corrective action will be determined by re-calibration and testing of the equipment.

B07. INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Regular calibration of field and laboratory instruments described above (section 15) will be conducted prior to each field survey, or prior to each use in the laboratory. Calibration will be carried out according to the manufacturer's instructions, and will be recorded in calibration logbooks. Deficiencies will be resolved by repair or replacement of equipment. All equipment will be recalibrated and tested following repair or replacement. Corrective action will be logged in the Corrective Action File.

B08. INSPECTION/ACCEPTANCE FOR SUPPLIES AND CONSUMABLES

All shipments received are checked to verify that the packing slip is complete and matches the materials ordered. Standard supplies are stored in designated areas. Most supplies and equipment are ordered from: Fisher Scientific, Forestry Suppliers, and BioQuip.

The lab supervisor is responsible for supplies and consumables.

B09. NON-DIRECT MEASUREMENTS

This project will not require non-direct measurements to generate the final report.

B10. DATA MANAGEMENT

Data will be recorded on standardized forms for all procedures (Appendix 1). After QC checks, habitat, chemistry, and taxonomy data will be recorded in an ACCESS database described above (section 9) for summary and analysis. After data entry, entries on field or laboratory data sheets will be checked against those in the database. Where there is disagreement, corrections will be made as necessary. Original field and laboratory datasheets will be stored in a secure location. Database records will be stored on a computer hard drive, and copies on storage media (CD or DVD) will be stored in separate locations.

The lab supervisor is responsible for data management.

C01. ASSESSMENTS AND RESPONSE ACTIONS

Field and laboratory personnel will be evaluated at 6-month intervals. These evaluations will focus on performance in terms of accuracy in carrying out procedures and in taxonomic identifications. Audits of equipment and analysis will occur during QC checks, data management, and comparisons of data quality objectives with actual data products. Corrective actions for assessment not meeting objectives are described above (sections 14 & 19).

The QA officer is responsible for conducting assessments. The assessment information is reported to the lab supervisor in the form of a report that includes all the pertinent information: date, type of assessment, control limits, and results.

C02. REPORTS TO MANAGEMENT

Reports will be produced as required and specified by contracts for this project. Each report will first be produced as a draft for review by the funding source and any individuals or organizations specified by the source. After review, revisions will be made and the final report will be generated for distribution to the funding source and other specified recipients. Progress reports are made quarterly to the project manager and the Regional Water Resources Control Board Project Official. Reports will generally follow the structure of a scientific paper, and will include extensive presentation of data in graphical or tabular format so that these may be inspected relatively directly.

The QA officer is responsible for writing project QA status reports. These reports will be distributed to project manager and the lab supervisor.

D01. DATA REVIEW, VERIFICATION, AND VALIDATION

Responsibility for data review and verification is in the hands of the program leader and program manager. This process involves use of the QAPP for defining acceptance or rejection of the data results and conclusions produced.

D02. VERIFICATION AND VALIDATION METHODS

Please refer to sections 7, 8, 12, 14, 19, and 20 above, as well as the SOPs (Appendix 2).

The QA officer is responsible for data verification and validation. Laboratory technicians will confirm accurate data entry. The lab supervisor will re-check all data entered. We require 100% accuracy in data entry. QA officer will perform a check of 10% of the reports.

Issues will be resolved as soon as possible after they become apparent. The resolution process will involve investigating all potential sources resulting in the issue, discussion among project leaders as to necessary corrective actions, then implementation of these corrective actions.

The project manager is responsible for reporting to data users the nature of any issues, corrective actions taken, and if there are any implications for data use.

D03. RECONCILIATION WITH USER REQUIREMENTS

Correspondence of the data produced with the measurement quality objectives specified in this QAPP (section 7) will be reviewed during analysis. Corrective actions as specified in the QAPP will be taken to address any problems detected. If revisions of this QAPP are necessary (due to changing standards for data collection or analysis, or problems detected), this document will be revised and submitted to the appropriate agency QC officers for approval.

The objective of this project is to provide the first bioassessment completed within Region 8. As such, it is not hypothesis driven, but strictly descriptive in nature. We will use the recently published Southern California B-IBI (Ode et al. 2005) and the RIVPACS model developed for California by Dr. Hawkins at Utah State University to assess degree of impairment for all sites sampled. These two models combined will provide two independent estimates to the ecological integrity of the streams in Region 8

Appendix C:

Water Chemistry Data

Table C: Water quality results for measurements recorded both within the field prior to BMI collection, as well as samples sent for analysis. The table also includes the three overall reach assessment categories for assessing overall stream viability. "R2" represents random 10% QA of the lab samples processed.

Site	pH	Water Temp. (°C)	Conductivity (mS/cm)	Turbidity (NTU)	Dissolved O2 (mg/l)	Alkalinity	Ammonia-N (mg/L)	Dissolved Orthophosphate (mg/L)	Nitrate-N (mg/L)	Nitrite-N (mg/L)
25	6.92	15.0	0.0001	4.8	7.4	90	<0.03	<0.0075	0.03	<0.01
69	6.8	16.0	0.001	2.8	10.83	118	<0.03	<0.0075	0.13	<0.01
87	6.45	10.2	0.001	2.4	N/A	210	<0.03	<0.0075	<0.01	<0.01
93	5.9	12.7	0.001	5.3	N/A	62	0.01	<0.0075	<0.01	<0.01
100-R1	5.69	13.0	0.001	1.4	N/A	74	<0.03	<0.0075	<0.01	<0.01
100-R2			0.001	1.4		76	<0.03	<0.0075	<0.01	<0.01
105	6.67	17.4	0.001	2.2	8.41	174	<0.03	<0.0075	0.04	<0.01
106	6.36	10.7	0.001	2.4	5.4	28	<0.03	<0.0075	<0.01	<0.01
121	6.95	25.0	0.001	2.8	7.8	130	0.01	<0.0075	0.04	<0.01
147	6.75	14.8	0.001	<1.0	8.4	N/A	<0.03	<0.0075	<0.01	<0.01
151	6.7	27.0	0.001	2.0	9.4	192	0.02	1.4537	1.45	0.078
159	7.33	13.5	0.001	<1.0	9.25	155	0.02	<0.0075	<0.01	<0.01
163	6.81	14.5	0.001	<1.0	9.4	N/A	<0.03	<0.0075	<0.01	<0.01
168	7.67	12.6	0.001	1.6	6.4	68	0.02	<0.0075	<0.01	<0.01
203	6.02	10.0	0.001	2.2	N/A	96	<0.03	12.4984	<0.01	<0.01
208-R1	7.89	27.0	0.001	3.6	6.7	126	0.04	3.5666	10.46	0.07
208-W-R1			0.001	1.0		194	0.01	<0.0075	<0.01	<0.01
247-R1	6.73	21.9	0.001	<1.0	6.0	112	<0.03	<0.0075	<0.01	<0.01
247-R2			0.001	<1.0		114	<0.03	<0.0075	<0.01	<0.01
271	7.06	26.3	0.001	<1.0	8.17	114	0.01	<0.0075	0.06	<0.01
346-R1	6.55	16.3	0.001	<1.0	8.65	162	<0.03	<0.0075	0.07	<0.01
346-R2			0.001	<1.0		168	<0.03	<0.0075	0.07	<0.01
361	6.5	27.0	0.001	3.2	5.9	250	0.02	0.4227	5.75	0.057
370-R1	8.24	18.6	0.001	1.0	7.3	146	0.01	<0.0075	0.22	0.02
370-R2			0.001	1.0		150	0.01	<0.0075	0.21	0.02
375	5.22	11.0	0.001	<1.0	10.84	39	0.01	0.1366	<0.01	<0.01
398-R1	8.2	21.0	0.001	2.1	7.6	120	0.02	<0.0075	0.02	<0.01
398-R2			0.001	2.0		124	0.02	<0.0075	0.02	<0.01
419-R1	6.29	7.6	0.001	<1.0	11.88	73	0.02	<0.0075	0.09	<0.01
419-R2			0.001	<1.0		73	0.02	<0.0075	0.09	<0.01
446	6.42	18.8	0.001	<1.0	6.3	108	<0.03	<0.0075	<0.01	<0.01
453	7.26	14.9	0.001	1.7	9.02	145	0.01	0.1432	<0.01	<0.01
530	N/A	10.3	0.001	<1.0	N/A	50	<0.03	<0.0075	<0.01	<0.01
543	5.76	11.0	0.001	2.1	10.09	N/A	<0.03	<0.0075	<0.01	<0.01
587-R1	6.83	21.5	0.001	<1.0	9.09	N/A	<0.03	<0.0075	<0.01	<0.01
587-R2			0.001	<1.0		N/A	<0.03	<0.0075	<0.01	<0.01
635	6.76	11.7	0.001	1.5	N/A	N/A	0.01	<0.0075	0.04	<0.01
686	5.48	11.1	0.001	<1.0	N/A	42	<0.03	<0.0075	<0.01	<0.01

Appendix D:

Benthic Macroinvertebrates collected

BMI taxa collected during the 2007 sampling events

Order	Family	Genus	25	69	087D	87	93	100	105	106	121	147	151	159	163	168	168D	203	208	271	346	361	370	370D	375	398	419	446	446D	453	530	543	587	635	686
Acari							1				11				1			2		1										2	1				
Acari	Hydryph	Partnunia	1					2																											
Acari	Hydryph	Thyopsoides						1																											
Acari	Hydryph	Wandesia																																	
Acari	Hygroba	Atractides					2	1																		1	3								
Acari	Lebertiid	Estelloxus								1															1										
Acari	Lebertiid	Lebertia	1		1		2	1		3						1	3								1		1				7	1			
Acari	Lebertiid	Scutolebertia													1																				
Acari	Limnesii	Limnesia						2					1			1					2														
Acari	Mideops	Mideopsis																																	
Acari	Spercho	Sperchon			1				1	1							3		42		1		1			5		4	1		2	1			
Acari	Spercho	Sperchonopsis							1																										
Acari	Torrentic	Pseudotorrenticola								1		1																							
Acari	Torrentic	Testudacarus								1							1																		
Acari	Torrentic	Torrenticola								4		1																			6				
Amphipoda																																			
Amphip	Hyalellid	Hyalella																																	
Amphip	Pontopor	Monoporeia					3																												
Basommatophora																																			
Basomn	Ancylida	Ferrissia																												7					
Basomn	Physidae																						2				1			9					
Basomn	Physidae	Physa		3					2					18						140	115			7		3		2							
Basomn	Planorbidae																																		
Basomn	Planorbi	Gyraulus												1																8					
Cladocera														1																				17	
Coleoptera																																			
Coleopt	Carabidae																																		
Coleopt	Curculionidae																																		
Coleopt	Dryopidae																																		
Coleopt	Dryopida	Helichus																																	
Coleopt	Dryopida	Postelichus																		3								2							
Coleopt	Dytiscidae																																		
Coleopt	Dytiscida	Agabinus																																	
Coleopt	Dytiscida	Agabus(l)																										1							
Coleopt	Dytiscida	Agabus(a)																																	
Coleopt	Dytiscida	Celina(a)																																	
Coleopt	Dytiscida	Copelatus (a)																							1										
Coleopt	Dytiscida	Dytiscus																																	
Coleopt	Dytiscida	Laccophilus (a)										1																							
Coleopt	Dytiscida	Laccophilus																																	
Coleopt	Dytiscida	Liodessus																																	
Coleopt	Dytiscida	Megadytes																														2			
Coleopt	Dytiscida	Oreodytes																																	

Coleopt	Dytiscida	Sanfilippodytes																																
Coleopt	Dytiscida	Stictotarsus(a)																					1											
Coleopt	Dytiscida	Stictotarsus																																
Coleopt	Dytiscida	Uvarus																																
Coleopt	Elmidae				1																				1									
Coleopt	Elmidae	Ampumixis																																
Coleopt	Elmidae	Cleptelmis																																
Coleopt	Elmidae	Heterelmis(l)												2																				
Coleopt	Elmidae	Microcylloepus																								3								
Coleopt	Elmidae	Narpus				3										1				1														
Coleopt	Elmidae	Optioservus									2												4		5	13					13			
Coleopt	Elmidae	Ordobrevia																																
Coleopt	Elmidae	Zaitzevia																																
Coleopt	Gyrinidae																																	
Coleopt	Gyrinida	Gyrinus																																
Coleopt	Haliplidae																																	
Coleopt	Haliplida	Peltodytes																																
Coleopt	Hydraenidae																																	
Coleopt	Hydraen	Hydraena (a)																																
Coleopt	Hydraen	Ochthebius																																
Coleopt	Hydrophilidae																	1																
Coleopt	Hydroph	Anacaena																																
Coleopt	Hydroph	Berosus																																
Coleopt	Hydroph	Crenitis																																
Coleopt	Hydroph	Cymbiodyta																																
Coleopt	Hydroph	Enochrus																																
Coleopt	Hydroph	Helochares																																
Coleopt	Hydroph	Hydrobius														1																3		
Coleopt	Hydroph	Laccobius																																
Coleopt	Hydroph	Paracymus																																
Coleopt	Hydroph	Tropisternus																			1													
Coleopt	Hydroscaphidae																																	
Coleopt	Hydrosca	Hydroscapha																																
Coleopt	Psephenidae																																	
Coleopt	Psephen	Acneus																																
Coleopt	Psephen	Eubrianax																																
Coleopt	Psephen	Psephenus																																
Copepod							2						18							2									3		10	3	7	
Diptera				1				1																				2						
Diptera	Blephariceridae																																	
Diptera	Blephari	Blepharicera												1	1																			
Diptera	Blephari	Philous												1																				
Diptera	Ceratopogonidae			1									1													1						1	9	
Diptera	Ceratopo	Atrichopogon																																
Diptera	Ceratopo	Bezzia/Palpomyia									4					1																		
Diptera	Ceratopo	Ceratopogon					1																											

Diptera	Ceratopc	Culicoides											3																12			12		
Diptera	Ceratopc	Dasyhelea																																		
Diptera	Ceratopc	Forcipomyia																																		
Diptera	Ceratopc	Monohelea																											3							
Diptera	Ceratopc	Probezzia	1										2																							
Diptera	Ceratopc	Stilobezzia																								1										
Diptera	Chaoboridae																																			
Diptera	Chaobor	Mochlonyx																																		
Diptera	Chironomidae		269	118	312	290	261	80	146	197	101	191	68	385	169	111	115	128	21	113	137	44	329	192	132	104	72	167	98	351	143	284	317	113	324
Diptera	Culicidae																																			
Diptera	Culicidae	Culex																																		
Diptera	Dixidae																																			
Diptera	Dixidae	Dixa	1		1					2		1															1			2					2
Diptera	Dixidae	Dixella																																		
Diptera	Dixidae	Meringodixa																																		
Diptera	Dolichopodidae																							1												
Diptera	Empidid	Chelifera/Metachela							9	1		1				1	4				1			6			1	1		1	2				
Diptera	Empidid	Clinocera	1	1				1								3	2																		
Diptera	Empidid	Hemerodromia			2								2						4			1				18			1				1		
Diptera	Empidid	Neoplasta																4			3														
Diptera	Empidid	Oreogeton																						3												
Diptera	Empididae			2							3		1		1	1	1	1			2			1						1	1				
Diptera	Ephydric	allcombined																												5						
Diptera	Muscidae				9				2		1						1													1			1		
Diptera	Pelecorhynchidae																																			
Diptera	Pelecorh	Glutops								1																					1					
Diptera	Psychod	Maruina	3	1			4					1						1						1	4	5	11	14	1			1	1			
Diptera	Psychod	Pericoma	1					2																												2
Diptera	Psychod	Psychoda																																		
Diptera	Psychodidae																													2						
Diptera	Sciomyzidae																															1				
Diptera	Simuliid	Prosimulium						16		2		2			2	122	54				9			34								2				
Diptera	Simuliid	Simulium	23	4				37	130		157		303	4		16		5	249	2		1	8			87		23	7	49		1	50		6
Diptera	Simuliidae									1	4																									
Diptera	Syrphidae												2																							
Diptera	Stratiom	Caloparyphus/Euparyphus combined									1		1				1			21			41	46		7										
Diptera	Stratiom	Myxosar	1																														11			
Diptera	Stratiom	Nemotelus																																		
Diptera	Stratiom	Odontomyia							1																											
Diptera	Stratiom	Oxycera																											8							
Diptera	Stratiom	Stratiomys																																		
Diptera	Stratiomyidae																			2									1							
Diptera	Tabanidae																																			
Diptera	Tabanid	Chrysops																																		
Diptera	Tabanid	Atylotus/Tabanus																																		
Diptera	Tipulidae		1						1																											

Diptera	Tipulidae	Antocha																																			
Diptera	Tipulidae	Cryptolal	1																																		
Diptera	Tipulidae	Dicranot	1				2			5		2				1	2	4							1		2				2				10	
Diptera	Tipulidae	Erioptera																																			
Diptera	Tipulidae	Gonomyia																																			
Diptera	Tipulidae	Hexatoma																							1							4					
Diptera	Tipulidae	Holorusia																																			
Diptera	Tipulidae	Limonia																													1						
Diptera	Tipulidae	Limnophila						2									1															1					
Diptera	Tipulidae	Ormosia																																			
Diptera	Tipulidae	Prionocera																																			1
Diptera	Tipulidae	Rhabdomastix																																			
Diptera	Tipulidae	Tipula																						1													
Ephemeroptera			5				6			3										3								1	1		16	2	3	8	
Epheme	Ameletidae																																				
Epheme	Ameletic	Ameletus				3				4					2		4	2							52		1					3					
Epheme	Baetidae			6					4	1	45	1								12								10							7	
Epheme	Baetidae	Acentrella								1																											
Epheme	Baetidae	Acerpenna						26																													
Epheme	Baetidae	Baetis	11	64	23	38	4	29	154		109		48			76	99	67	140	7	135		60	93	2	90	6	13	148	6	42	3	8		32	
Epheme	Baetidae	Callibaetis													24																					
Epheme	Baetidae	Camelobaetis																																			
Epheme	Baetidae	Centroptilum																																			
Epheme	Baetidae	Cloeodes																																			
Epheme	Baetidae	Diphetor						1		11										1																	
Epheme	Baetidae	Fallceon		1							2				4					4		1		4	16		3	31			19					
Epheme	Baetidae	Paracloeodes																																			
Epheme	Baetidae	Procloeon																																			
Epheme	Caenidae																																				
Epheme	Caenida	Caenis																																			
Epheme	Ephemerellidae				2				4			2			1										32			7								
Epheme	Epheme	Attenella																																			2
Epheme	Epheme	Caudatella					6								1	76	34	149																			
Epheme	Epheme	Drunella	20	18	30	31	14									1	21	15			11			1	55		176				27				11	
Epheme	Epheme	Ephemerella							8									5							3		1				27					
Epheme	Epheme	Serratella			2	31	7									12	22	2															3			
Epheme	Heptageniidae		3	65			23	1		6					1										1		2								25	
Epheme	Heptage	Cinygmula				2										6		7																	5	
Epheme	Heptage	Epeorus	22	30	9	1	31	33	4	16		7			2	35	46	22			2			17	13	1	49	4			16				14	
Epheme	Heptage	Heptagenia															0																			
Epheme	Heptage	Ironodes	3	3		8	10	15	11	16							2				1				30		15				1	2		2		
Epheme	Heptage	Nixe																																			
Epheme	Heptage	Rhithrogena														2	16	26																			
Epheme	Leptohyphidae										3			2				1								3											
Epheme	Leptohyp	Tricorythodes									2			8						97	5			7		9			116							
Epheme	Leptophl	Choroterpes																																			

Epheme	Leptophlebiidae		2					1		4																		1		1								
Epheme	Leptophl	Paraleptophlebia								1																												
Gastrop	Viviparic	Bellamya	5																																			
Hemiptera																																						
Hemipte	Belostomatidae																																					
Hemipte	Beloston	Abedus																																				
Hemipte	Corixidae																																					
Hemipte	Corixida	Corisella																																				
Hemipte	Corixida	Trichocorixa																																				
Hemipte	Naucoric	Ambrysus																																				
Hemipte	Naucoridae																											1										
Isopoda																				2																		
Lepidop	Pyralidae					1																																
Lepidop	Pyralidae	Parapoynx																																				
Lepidop	Pyralidae	Petrophila																																				
Megalop	Corydalidae																																					
Megalop	Corydali	Corydalus																																				
Megalop	Corydali	Neohermes																																				
Megalop	Corydali	Orohermes																																				
Megalop	Sialidae																																					
Megalop	Sialidae	Sialis																																				
Odonata	Aeshnidae																																					
Odonata	Aeshnida	Anax																																				
Odonata	Aeshnida	Aeschna											1																									
Odonata	Calopterygidae																																					
Odonata	Calopter	Hetaerina																									4											
Odonata	Coenagr	Argia											2					2							2		28	6										
Odonata	Coenagr	Enallagma																																				
Odonata	Coenagrionidae																											1	1									
Odonata	Cordulegastridae																																					
Odonata	Corduleg	Cordulegaster																																				
Odonata	Corduliidae																																					
Odonata	Corduliic	Somatoc	2																																			
Odonata	Gomphidae																																					
Odonata	Gomphic	Erpetogomphus																											1									
Odonata	Gomphic	Progomphus																																				
Odonata	Lestidae																																					
Odonata	Lestidae	Archilestes																																				
Odonata	Lestidae	Lestes																																				
Odonata	Libellulic	Erythrodiplax																				1																
Odonata	Libellulic	Paltothemis									1												3		3													
Odonata	Libellulic	Plathemis																														5						
Odonata	Libellulidae																						1					1										
Odonata																											24	26										
Oligochaeta			3	18	1		4		1	8				8	1	16	4	9		2	6				28		6	2	1	2	5		8	61	2
Ostracoda			14	49	4		7	35	2	4		18		23	3		3	3			64		4		30	9	10	27	4	15	22	70	1	2	6

Plecoptera								1				1					2																	2	12
Plecopte	Capniidae																																		
Plecopte	Capniida	Mesocapnia																																	
Plecopte	Chloroperlidae			1														4																	
Plecopte	Chlorope	Alloperla																								1				2				
Plecopte	Chlorope	Sasquaperla								3																									
Plecopte	Chlorope	Sweltsa						29																	23		1								
Plecopte	Chlorope	suwallia			3											3	9								1										6
Plecopte	Chlorope	Utaperla																																	
Plecopte	Nemouridae		2	1	7			6							119										2			7				16		2	
Plecopte	Nemouri	Amphinemura			16																														
Plecopte	Nemouri	Podmosta						1																	5			18							
Plecopte	Nemouri	Prostoia										10																							
Plecopte	Nemouri	Malenka		2			3	16		1					19	3	1							1	2									3	11
Plecopte	Nemouri	Zapada								7							6																		
Plecopte	Peltoperlidae																																		
Plecopte	Peltoper	Yoraperla					2	69		53																					43				
Plecopte	Perlidae			3																															
Plecopte	Perlidae	Calineuri	1																								1								1
Plecopte	Perlidae	Claassenia					9			2																					3				
Plecopte	Perlidae	Diura																4																	
Plecopte	Perlodidae				4																										10			1	
Plecopte	Perlodida	Isoperla			1										1			3							3										
Plecopte	Perlodida	Kogotus										1																							
Plecopte	Perlodida	osobenus																3																	
Plecopte	Perlodida	Skwala																													7				
Plecopte	Taeniopterygidae																																		
Plecopte	Taeniopt	Taenionema																									1								
Trichoptera						1				2	5				1	3										7	1	3		1				1	
Trichopt	Apataniidae																																		
Trichopt	Apatanii	Apatania																																	
Trichopt	Brachycentridae																																		
Trichopt	Brachyce	Amiocentrus																													1				
Trichopt	Brachyce	Brachycentrus																																	
Trichopt	Brachyce	Micrasema		5	2		10			1		3			1	3	4								6		18	4			19	31	51		
Trichopt	Glossosomatidae			7																			1					1							
Trichopt	Glossosc	Agapetus	3	8																			13	15									1		
Trichopt	Glossosc	Glossosoma		2																															
Trichopt	Helicopsychidae																																		
Trichopt	Helicops	Helicopsyche				2																				1		1	66						
Trichopt	Hydropsychidae			71							8		1						6	6						7									
Trichopt	Hydrops	Arctopsyche																																	
Trichopt	Hydrops	Cheumatopsyche																															6		
Trichopt	Hydrops	Hydropsy	4				19		1		33	1	3		1	1	6	23	22	27	18		29	56	5	89	84	17	15				1		1
Trichopt	Hydrops	Parapsyc	12																																
Trichopt	Hydroptilidae										7		2	4						2			7			3									

Trichopt	Hydropti	Agraylea	3																																				
Trichopt	Hydropti	Hydroptila								16		68								21				1		43		13		2									
Trichopt	Hydropti	Neotrichia		2												15																	2						
Trichopt	Hydropti	Ochrotrichia		1									3							2				4									1						
Trichopt	Hydropti	Oxyethira											8																	7									
Trichopt	Hydropti	Stactobiella																	2																				
Trichopt	Lepidostomatidae					1			1					4																									
Trichopt	Lepidost	Lepidost	77			2				8		140			148			2			5				33		1	1			1	12	1	13	1
Trichopt	Leptoceridae																																						
Trichopt	Leptocer	Nectopsyche																																					
Trichopt	Leptocer	Oecetis																																					
Trichopt	Limnephilidae																																1					
Trichopt	Limneph	Dicosmoecus																							1														
Trichopt	Limneph	Ecclisomyia			1	2			3		2			5											1														
Trichopt	Limneph	Hesperophylax																									6												
Trichopt	Limneph	Psychoglypha					2																									4						
Trichopt	Odontoceridae																																						
Trichopt	Odontoc	Marilia																																					
Trichopt	Odontoc	Namamyia																									4												
Trichopt	Philopotamidae																																						
Trichopt	Philopot	Dolophilodes																																					
Trichopt	Philopot	Wormaldia							1											2																				
Trichopt	Phryganeidae						1		1																															
Trichopt	Phrygan	Banksiola					1																																
Trichopt	Polycentropodidae																								1	1													
Trichopt	Polycent	Paranyctiophylax																																					
Trichopt	Polycent	Polycentr	2	1			1	6			3			10							2			1	6		4				1	1	6	8				
Trichopt	Psychomyiidae																			6																			
Trichopt	Psychom	Psychomyia																											1										
Trichopt	Psychom	Tinodes																		30					4													
Trichopt	Rhyacophilidae														2													1										
Trichopt	Rhyacop	Himalopsyche				8	15	3																								4						
Trichopt	Rhyacop	Rhyacop	2	12	8	9	7		5	23				1		12	1					4		1		1				4								
Trichopt	Sericostomatidae																																						
Trichopt	Sericost	Gumaga	6			2							1																										
Trichopt	Uenoidae					42																																	
Trichopt	Uenoida	Neophyla	1			3										1								1		1				2								1
Tricladic	Turbellaria (Class)						36		71						2	1				1					4					9								
Veneroida																																							
Veneroi	Corbiculi	Corbicula				4																																	
Veneroi	Sphaerii	Pisidium	12				31		6		1					3										5					57	18		255				