SWAMP
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FINAL REPORT
WADEABLE STREAMS BIOASSESSMENT
REGION 8
Sites Sampled: May – July 2009

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California State University Long Beach
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Executive Summary

The Santa Ana Regional Water Quality Control Board contracted California State University Long Beach's Stream Ecology and Assessment Laboratory, through the Institute for Integrated Research in Materials Environments and Society, to conduct a six year study (2006-2011) of the waterways within the Santa Ana and San Jacinto watersheds. This study is designed to address the federal Environmental Protection Agency-mandated requirement (EPA requirement 305(b)) for an assessment of the integrity of surface waters in the watersheds of the Santa Ana and San Jacinto Rivers 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 six year period, the data collected will be used to estimate the number of wadeable stream kilometers (perennial and ephemeral) that are in one of five categories of health (very good, good, fair, poor, and very poor). Annual reports during these six years will provide information on the quality of the individual sites sampled.

During the 2009 bioassessment sampling events, a total of 181 distinct benthic macroinvertebrate taxa were identified from the 35 sampled locations. Taxa were identified to Level II of the Standard Taxonomic Effort compiled by the Southwestern Association of Freshwater Invertebrate Taxonomists. Sample locations were divided into three categories: low-elevation (0 meters to 350 meters), mid-elevation (350 meters to 700 meters), and high-elevation (700 meters and higher). 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 of health (very poor, poor, fair, good, and very good). Southern California Coastal Index of Biological Integrity scores (adjusted to a scale of 0 to 100) ranged from 1 to 40 with a mean of 14 (very poor to poor) for low-elevation sites, 9 to 40 with a mean of 26 (very poor to poor) for mid-elevation sites, and 21 to 66 with a mean of 43 (poor to good) for high-elevation sites. The Southern California Coastal Index of Biological Integrity scores were positively correlated with elevation. IBI scores were also negatively correlated with temperature, conductivity, and alkalinity. 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 52.6 and ranging from 42 to 59), followed by mid-elevation channels (averaging 35.0 and ranging from 23 to 60), and finally the low-elevation channels had the lowest values (averaging 29.6 and ranging from 1 to 56). The water quality characteristics were relatively consistent among sites with near neutral to alkaline mean pH values (7.48 to 9.48), adequate levels of mean dissolved oxygen (4.8 to 16.4), and highly variable conductivity values (58 to 2559 uS/cm). Natural inland waters usually contain small amounts of dissolved mineral salts.

Although the data collected during the 2009 bioassessment sampling events are only a small subset of the proposed sites to be collected within the region over the five year experimental period, the results obtained during 2009 provide baseline information to begin assessing 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), which was 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 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 and San Jacinto watersheds (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 (perennial and ephermeral) 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 six-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 six-year bioassessment project described within this report is to address the federal Environmental 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 wadeable 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 within the SWAMP-mandated index period of May 15 to July 15.

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 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 3^{rd} 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 35 for the 2009 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 15 and July 15 in 2009, and the samples were transported to the laboratory within 48 hours 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 2009 bioassessment survey followed the FULL level of the *Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California* (Ode 2007), which is 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 established (250-meters for streams with wetted-widths greater than 10 meters). Each reach was broken into 11 equidistant transects, spaced every 15 meters (25 meters for streams with widths greater than 10 meters), with each transect designated with a number representing its location along the reach (0 meters through 150/ 250 meters, downstream to upstream). BMI sample locations for each transect followed the reach-wide benthos procedure (RWB) for streams with gradients greater than 1%; the margin-center-margin (MCM) was used for streams with gradients less than 1%.

Table 1. Sites sampled during the 2009 index period (May 15 – July 15 2009). Codes SMCR8_XXX denote sites from the original probablisitic draw with the three numbers corresponding to the SWAMP code and Master List site ID.

			Field Recorded			
Site Code	Stream name	County	Latitude	Longitude	Elevation (m)	Collection date
			NAD 83			
SMCR8_026	Los Trancos Canyon	Orange	33.57734	-117.83974	11	5/31/09
SMCR8_124	Upper Santa Ana River	San Bernardino	34.12656	-117.07716	699	6/24/09
SMCR8_131	Deer Creek	San Bernardino	34.18485	-116.97868	1514	6/16/09
SMCR8_175	Carbon Creek	Orange	33.85884	-117.87957	57	6/9/09
SMCR8_179	Temescal Wash	Riverside	33.77052	-117.46747	297	6/1/09
SMCR8_184	Bear Creek	San Bernardino	34.16546	-117.01553	1080	7/7/09
SMCR8_191	Middle Santa Ana	Riverside	33.96461	-117.47637	201	6/2/09
SMCR8_196	Stone Creek	Riverside	33.77593	-116.73138	1897	5/24/09
SMCR8_197	Chino Creek	Riverside	33.98315	-117.70070	180	6/4/09
SMCR8_207	San Timoteo Creek	Riverside	33.97496	-117.09231	593	6/7/09
SMCR8_218	Fuller Mill Creek	Riverside	33.80978	-116.74030	1780	6/23/09
SMCR8_219	Mountain Home Creek	San Bernardino	34.11105	-116.99195	1265	7/6/09
SMCR8_229	Temescal Wash	Riverside	33.83826	-117.51148	227	6/1/09
SMCR8_254	Deer Creek	San Bernardino	34.10430	-116.59037	1363	6/16/09
SMCR8_262	Temescal Wash	Riverside	33.89382	-117.57668	170	6/7/09
SMCR8_275	Carbon Creek	Orange	33.85796	-117.89170	52	6/9/09
SMCR8_289	Cajon Creek	San Bernardino	34.28415	-117.45549	843	6/3/09
SMCR8_299	Santa Ana Channel	Orange	33.68481	-117.88348	8	6/9/09
SMCR8_312	Middle Santa Ana	Riverside	33.95582	-117.53091	181	6/14/09
SMCR8_317	Cable Canyon	San Bernardino	34.23158	-117.37280	812	6/3/09
SMCR8_327	Cajon Creek	San Bernardino	34.23294	-117.42894	678	6/28/09
SMCR8_333	Mill Creek	San Bernardino	34.07909	-116.88055	1940	6/17/09
SMCR8_339	Temescal Wash	Riverside	33.76355	-117.46544	298	6/8/09

SMCR8_344	South Fork Santa Ana	San Bernardino	34.16708	-116.81406	1968	6/15/09
SMCR8_376	South Fork Santa Ana	San Bernardino	34.17238	-116.83539	1885	6/17/09
SMCR8_415	Mill Creek	San Bernardino	34.07681	-117.06621	738	7/8/09
SMCR8_418	San Diego Creek	Orange	33.68077	-117.80690	19	6/8/09
SMCR8_474	Icehouse Canyon	San Bernardino	34.24826	-117.62775	1631	7/5/09
SMCR8_513	Strawberry Creek	Riverside	33.71777	-116.76274	1034	6/22/09
SMCR8_572	Middle Santa Ana	San Bernardino	34.07720	-117.29323	294	6/30/09
SMCR8_600	Lytle Creek	San Bernardino	34.23092	-117.48291	815	6/28/09
SMCR8_601	Feeder to Cucamonga Ck	Riverside	34.02789	-117.58527	247	6/24/09
SMCR8_605	Strawberry Creek	Riverside	33.73776	-116.72825	1586	7/1/09
SMCR8_613	San Timoteo Creek	Riverside	33.98574	-117.13166	523	6/29/09
SMCR8_688	Strawberry Creek	Riverside	33.75289	-116.70609	1700	7/1/09

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-millimeter 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). For streams with insufficient current to bring the suspended BMIs into the net, these sites were sampled using the standard figure-eight collecting procedure. This procedure was repeated at each of the 11 transects.

The resulting 11 samples from a site were composited into 1-liter jars 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 70% ethanol.

Physical Habitat Quality Assessment and Water Quality Measurements

The physical habitat quality was surveyed along the entire reach of each sampling location following the Full Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California (Ode 2007). At every 15-meter intervals along the 150-meter reach (25-meter intervals along the 250-meter reach), starting at transect 0-meters, physical habitat quality was determined by observing substrate complexity, consolidation, embeddedness, sediment depth, identifying human influences, and determining canopy cover. At each transect, a depth profile was obtained at five equidistant points starting at banks edge and ending on the opposite banks edge. Additional substrate measurements and depth profiles were measured midway between main transects throughout the entire reach. 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 (buoyant object method was used when 60% depth method cannot be preformed due to obstructions or depth limitations).

Four water quality parameters were collected on site at each sample location using a YSI 556 environmental monitoring unit and these included pH, dissolved oxygen (mg/l), conductivity (uS/cm), and water temperature (°C). 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 IIRMES and include the quantification of ammonia as nitrogen, dissolved orthophosphate as P, nitrate-nitrogen, nitrite-nitrogen, total nitrogen, alkalinity, turbidity, phosphate as total P, 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 70% ethanol. This process was continued until 600 organisms were removed from each sample. The material left from the processed grids was transferred into a jar with 70% ethanol and labeled as "remnant" material. Any remaining unprocessed sample from the tray was transferred back to the original sample container with 70% ethanol and archived. BMIs were then identified to standard taxonomic levels established by the Southwestern Association of Freshwater Invertebrate Taxonomists (SAFIT) using standard taxonomic keys, typically genus or species level for insects and order or family 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 standalone 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 (fewer than 500 organisms were used only if the total number of organisms in a sample was fewer than 500). Current SWAMP protocols require a sample of 600 BMIs; however, the SCC-IBI was built using counts of 500 BMIs. To generate the seven biological metrics (Table 2) used to calculate the SCC-IBI, all samples were statistically subsampled to 500 BMIs. Each of the seven metrics is included in one of the following major categories:

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 were measured, but only those that showed responsiveness to watershed-scale and reach-scale disturbance variables and lacked correlation with other responsive metrics were used (Ode et al. 2005). The IBI used to evaluate the 35 sampled sites was developed from 2000 to 2003 and was 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 (CSULB 2006) during the 2009 sampling events. An auditor from the Southern California Coastal Water Research Project (SCCWRP) accompanied sampling personnel during the 2009 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 2009 sampling events. All internal QA/QC procedures were followed and none of the limits described in the document were violated. Picking error also occurred in certain samples during sample processing leading to greater than 600 BMIs being picked, when this occurred 600 BMIs were randomly subsampled from the overall data set from that specific location. Two sites (SMCR8_327 and SMCR8_415) had fewer than 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, are 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 scores so that they range from 0 to 100, multiply the total IBI score by 10/7; 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

Electronic Location of Data

All data are available electronically from the Southern California Coastal Water Research Project (SCCWRP) (www.sccwrp.org).

BMI Community Structure

During the 2009 bioassessment sampling events, 181 distinct BMI taxa were identified from the 35 sampled locations (Appendix D). Low elevation sites were dominated by mayfly larvae *Baetis spp*. and *Tricorythodes spp*., caddisfly larvae *Hydropysche spp*. and immature Hydroptilidae, aquatic fly larvae from the family Chironomidae, aquatic crustacean *Hyalella sp*. and seed-shrimp from the order Ostracoda, aquatic worms from the class Oligochaeta, and aquatic snails *Physa sp*. Mid elevation sites were dominated by mayfly larvae *Baetis spp*., caddisfly larvae *Hydropsyche/Ceratopsyche sp*., aquatic fly larvae from the family Chironomidae, *Simulium sp*., *Caloparyphus/Euparyphus sp*., aquatic beetle larvae *Optioservus sp*., and seed-shrimp from the order Ostracoda. High elevation sites were dominated by mayfly larvae *Baetis sp*., stonefly larvae *Malenka sp*., *Yoraperla sp*., and *Zapada sp*., aquatic fly larvae from the family Chironomidae, *Simulium sp*., *Prosimulium sp*., and *Caloparyphus/Euparyphus sp*., seed shrimp from the order Ostracoda, bivalves *Pisidium sp*., and aquatic mites *Sperchon sp*.

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 2009 bioassessment sampling events ranged from 1 to 66 (Table 4, Figure 1). SCC-IBI scores were positively correlated with elevation (R^2=0.4797, Figure 2) but not the overall habitat characterization scores (R^2=0.0025, Figure 12), and negatively correlated with water temperature (R^2=0.4064, Figure 3), conductivity (R^2=0.4756, Figure 6), and alkalinity (R^2=0.1955, Figure 7). SCC-IBI scores showed no correlation with dissolved oxygen (R^2=0.0123, Figure 4), turbidity (R^2=0.0297, Figure 5), dissolved orthophosphate (R^2=0.059, Figure 8), ammonia (R^2=0.1217, Figure 9), nitrate (R^2=0.1546, Figure 10), and nitrite (R^2=0.2043, Figure 11).

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

Physical Habitat Quality

During the 2009 bioassessment sampling events, samples were collected from a wide array of landuse and channel types, which is presented in Table 5. Low elevation streams consisted of mix of streams surrounded by urban/suburb landcover with concrete-lined and natural channel types; mid elevation streams were predominantly urban/suburban landcover with man-made embankments and natural stream bottoms; and high elevation streams were all surrounded by forest landcover with natural channel types (Table 5). Landuse/landcover categories follow those used on the SWAMP field data sheets. Overall habitat characterization scores for the 2009 sampling year ranged from 1 to 60 (poor to optimal; Table 5) with low elevation streams averaging 29.6 ± 4.4 (marginal), mid elevation streams averaging 35.0 ± 8.6 (suboptimal), and high elevation streams averaging 52.6 ± 1.3 (optimal).

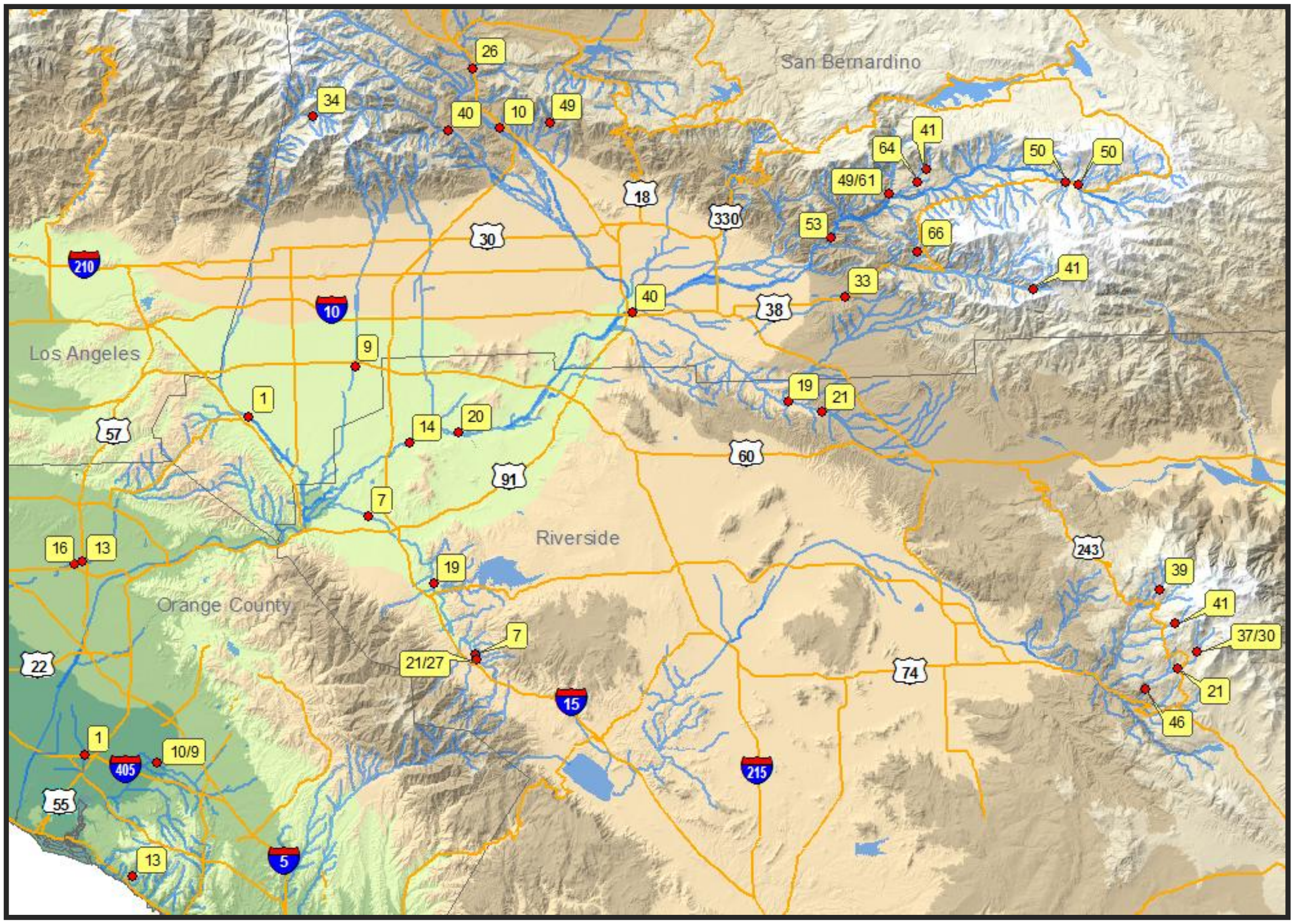

Figure 1. SCC-IBI scores for sites sampled during the 2009 bioassessment survey.

Table 4. IBI metrics and overall rating for each location sampled during the 2009 bioassessment survey. The two sites reported in italics had fewer than 500 BMIs collected.

Site	EPT Taxa	Predator Taxa	Coleoptera Taxa	Percent Non-Insect Taxa	Percent Intolerant Individuals	Percent Tolerant Taxa	Percent Collector Individuals	IBI	IBI (100)	IBI Rating
SMCR8_026R1	1	0	0	3	0	2	3	9	13	Very Poor
SMCR8_124R1	6	7	4	6	4	5	5	37	53	Fair
SMCR8_131R1	3	10	0	4	2	4	6	29	41	Fair
SMCR8_175R1	2	0	0	1	0	3	3	9	13	Very Poor
SMCR8_179R1	1	0	0	1	0	0	3	5	7	Very Poor
SMCR8_184R1	8	0	2	9	4	7	4	34	49	Fair
SMCR8_184R2	9	8	4	8	3	7	4	43	61	Good
SMCR8_191R1	3	0	2	4	0	3	2	14	20	Very Poor
SMCR8_196R1	3	6	2	8	1	8	1	29	41	Fair
SMCR8_197R1	0	0	0	0	0	0	1	1	1	Very Poor
SMCR8_207R1	2	0	0	7	1	4	1	15	21	Poor
SMCR8_218R1	3	5	4	4	3	6	2	27	39	Poor
SMCR8_219R1	8	10	4	5	7	7	5	46	66	Good
SMCR8_229R1	3	2	0	4	0	2	2	13	19	Very Poor
SMCR8_254R1	9	10	0	4	9	5	8	45	64	Good
SMCR8_262R1	1	1	0	2	0	1	0	5	7	Very Poor
SMCR8_275R1	1	0	0	3	0	1	6	11	16	Very Poor
SMCR8_289R1	0	3	5	8	0	0	2	18	26	Poor
SMCR8_299R1	0	0	0	0	0	0	1	1	1	Very Poor
SMCR8_312R1	2	0	0	4	0	0	4	10	14	Very Poor
SMCR8_317R1	5	4	2	8	3	9	3	34	49	Fair
SMCR8_327R1	0	0	0	5	0	2	0	7	10	Very Poor
SMCR8_333R1	1	3	2	10	3	10	0	29	41	Fair
SMCR8_339R1	4	1	0	2	0	3	5	15	21	Poor
SMCR8_339R2	4	3	0	4	0	5	3	19	27	Poor
SMCR8_344R1	5	5	2	5	7	6	5	35	50	Fair
SMCR8_376R1	9	5	2	7	4	7	1	35	50	Fair
SMCR8_415R1	2	4	7	8	0	0	2	23	33	Poor
SMCR8_418R1	1	0	2	4	0	0	0	7	10	Very Poor
SMCR8_418R2	0	0	2	2	0	2	0	6	9	Very Poor
SMCR8_474R1	5	5	0	4	4	3	3	24	34	Poor
SMCR8_513R1	5	8	4	6	3	3	3	32	46	Fair
SMCR8_572R1	2	6	10	6	0	0	4	28	40	Poor
SMCR8_600R1	5	5	2	5	3	4	4	28	40	Poor
SMCR8_601R1	0	0	0	6	0	0	0	6	9	Very Poor
SMCR8_605R1	1	2	2	2	1	2	5	15	21	Poor
SMCR8_613R1	1	2	2	6	0	0	2	13	19	Very Poor
SMCR8_688R1	3	5	0	6	3	7	2	26	37	Poor
SMCR8_688R2	3	3	2	5	3	4	1	21	30	Poor

Table 5. Physical habitat characterization and overall rating for each location sampled during the 2009 bioassessment survey

Site Code	Dominant landuse/ landcover	Epifaunal Substrate/Cover (0 to 20)	Sediment Deposition (0 to 20)	Channel Alteration (0 to 20)	Overall Habitat Characterization score (0 to 60)	Overall Habitat Characterization score Rating
SMCR8_026	Suburban/Town	15	15	20	50	optimal
SMCR8_124	Other	20	20	20	60	optimal
SMCR8_131	Forest	17	18	20	55	optimal
SMCR8_175	Urban/Industrial	0	20	0	20	marginal
SMCR8_179	Not Recorded	10	12	16	38	suboptimal
SMCR8_184	Forest	18	20	20	58	optimal
SMCR8_191	Suburban/Town	3	7	11	21	marginal
SMCR8_196	Forest	16	17	20	53	optimal
SMCR8_197	Urban/Industrial	0	20	0	20	marginal
SMCR8_207	Other	6	7	20	33	suboptimal
SMCR8_218	Forest	18	20	20	58	optimal
SMCR8_219	Forest	20	18	20	58	optimal
SMCR8_229	Urban/Industrial	18	18	20	56	optimal
SMCR8_254	Forest	13	11	20	44	suboptimal
SMCR8_262	Urban/Industrial	3	20	0	23	marginal
SMCR8_275	Urban/Industrial	7	12	0	19	marginal
SMCR8_289	Other	12	15	19	46	optimal
SMCR8_299	Urban/Industrial	1	20	0	21	marginal
SMCR8_312	Suburban/Town	7	12	20	39	suboptimal
SMCR8_317	Forest	16	20	20	56	optimal
SMCR8_327	Other	1	2	20	23	marginal
SMCR8_333	Forest	11	11	20	42	suboptimal
SMCR8_339	Other	16	17	20	53	optimal
SMCR8_344	Forest	14	20	20	54	optimal
SMCR8_376	Forest	16	19	12	47	optimal
SMCR8_415	Other	3	19	20	42	suboptimal
SMCR8_418	Urban/Industrial	1	0	0	1	poor
SMCR8_474	Forest	20	19	20	59	optimal
SMCR8_513	Forest	16	19	20	55	optimal
SMCR8_572	Other	11	8	20	39	suboptimal
SMCR8_600	Other	15	18	17	50	optimal
SMCR8_601	Urban/Industrial	0	20	0	20	marginal
SMCR8_605	Forest	NR	NR	NR	NR	NR
SMCR8_613	Other	2	2	20	24	marginal
SMCR8_688	Forest	18	18	20	56	optimal

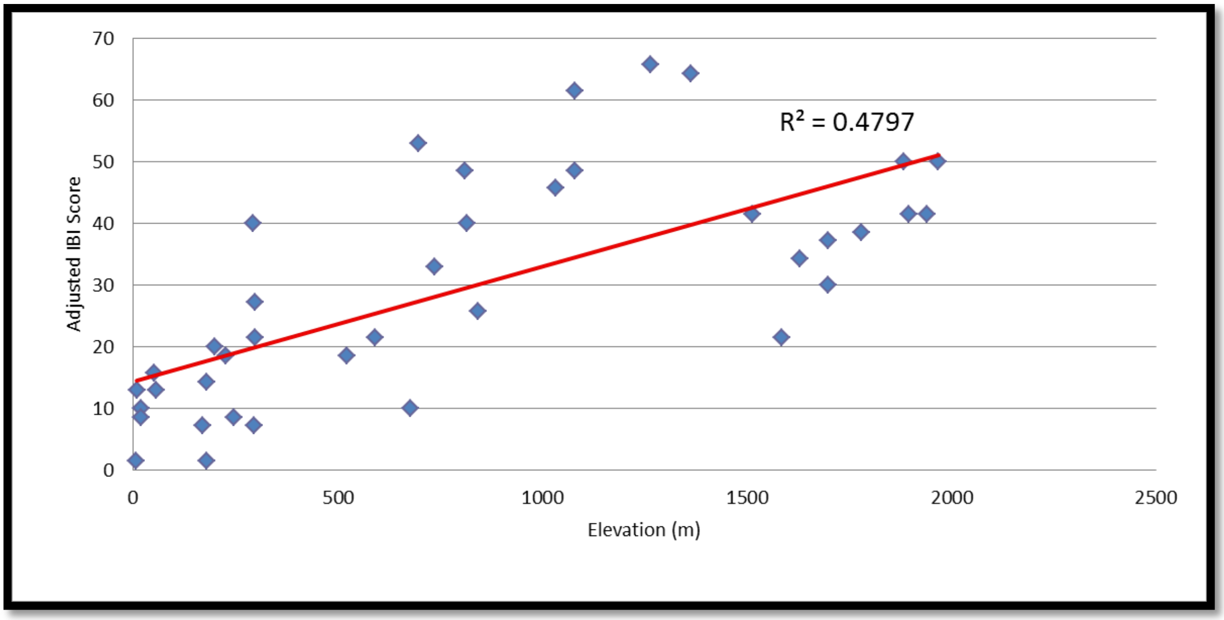

Figure 2. IBI scores as a function of elevation (IBI scores adjusted on a scale of 0 to 100).

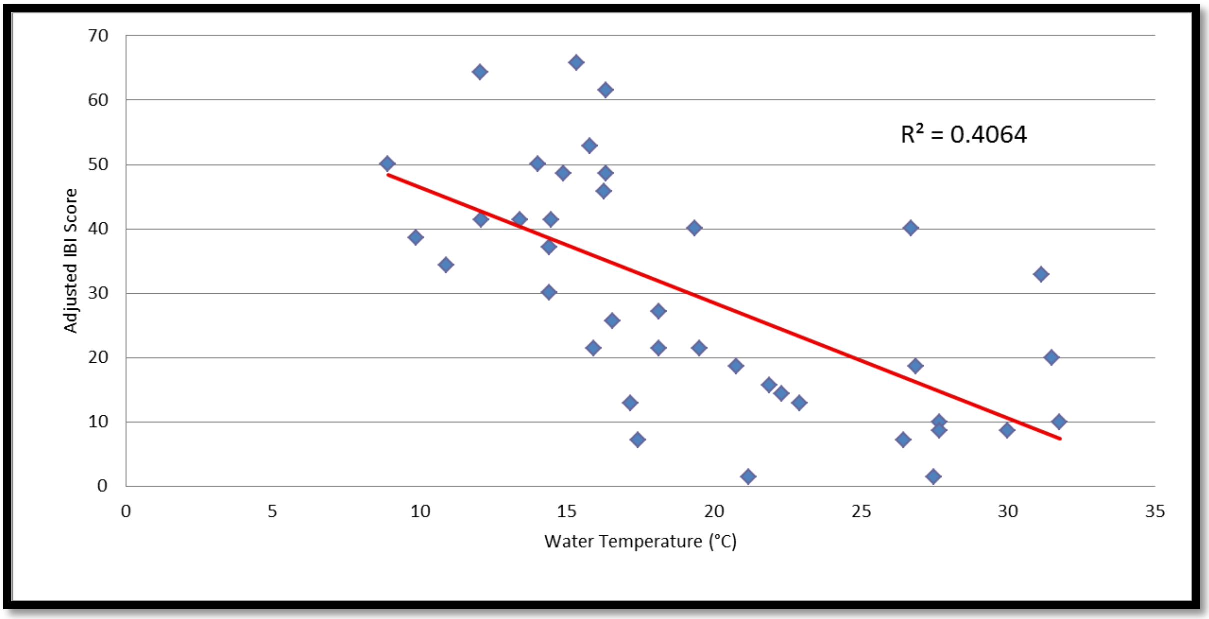

Figure 3. IBI scores as a function of water temperature (IBI scores adjusted on a scale of 0 to 100).

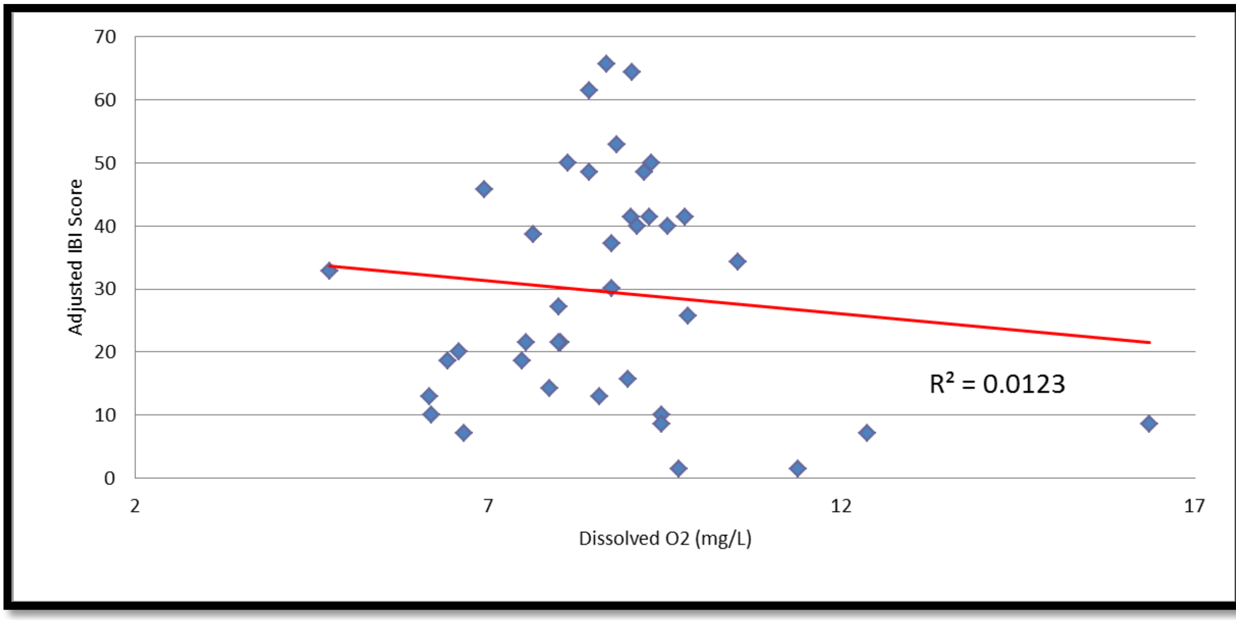

Figure 4. IBI scores as a function of dissolved oxygen (IBI scores adjusted on a scale of 0 to 100).

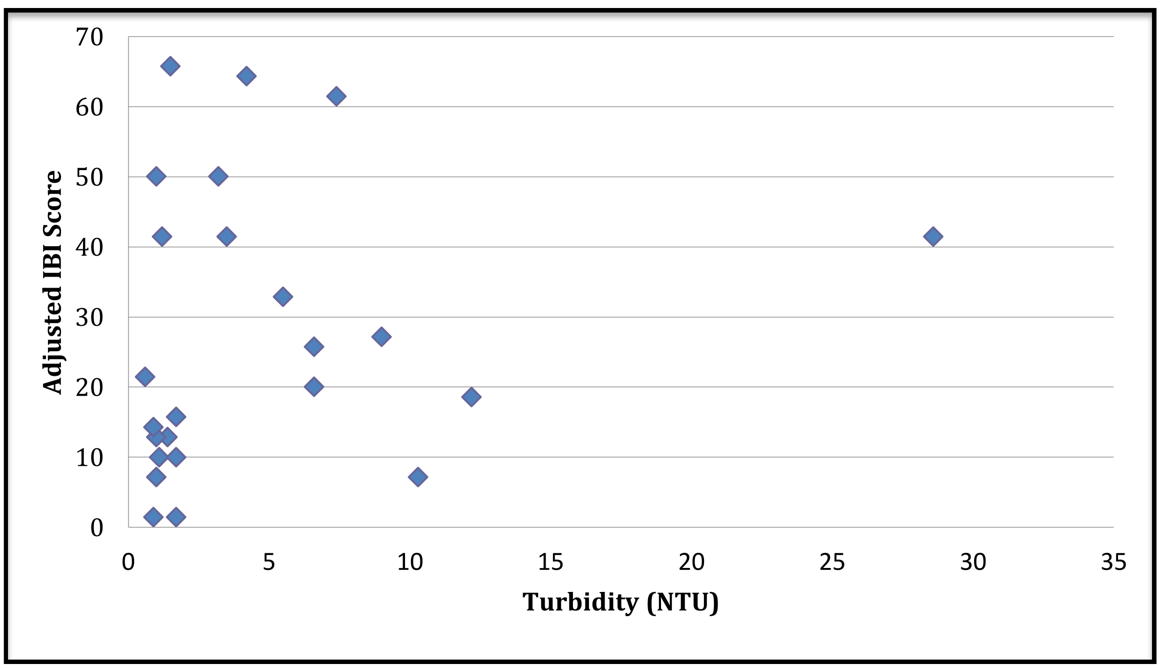

Figure 5. IBI scores as a function of turbidity (IBI scores adjusted on a scale of 0 to 100).

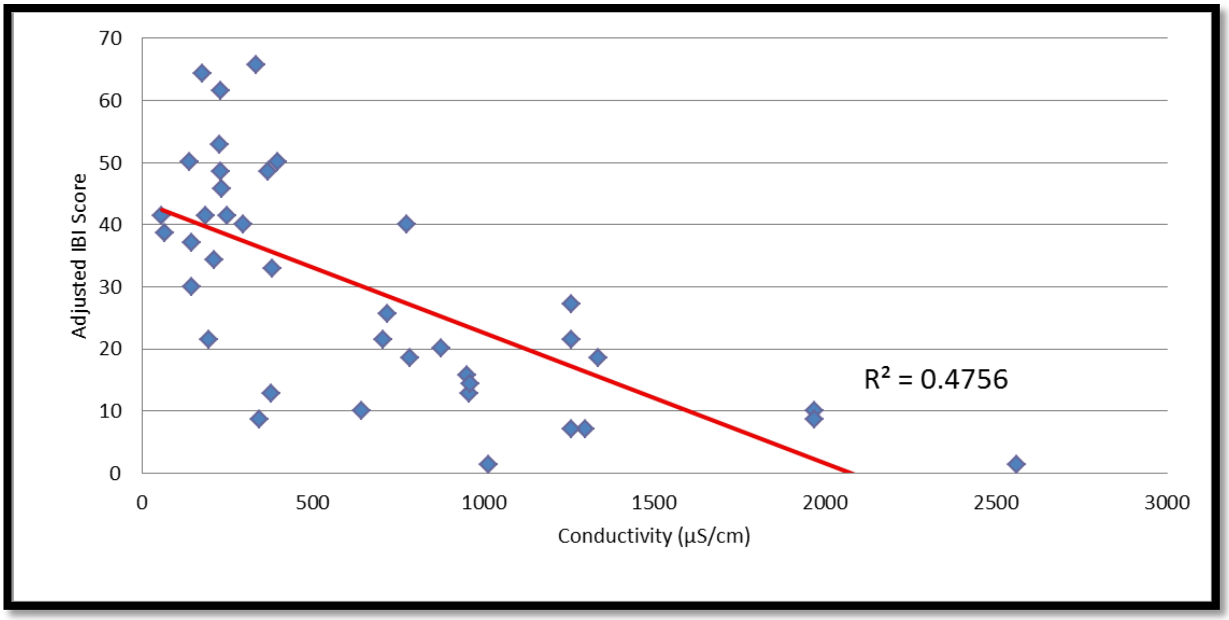

Figure 6. IBI scores as a function of conductivity (IBI scores adjusted on a scale of 0 to 100).

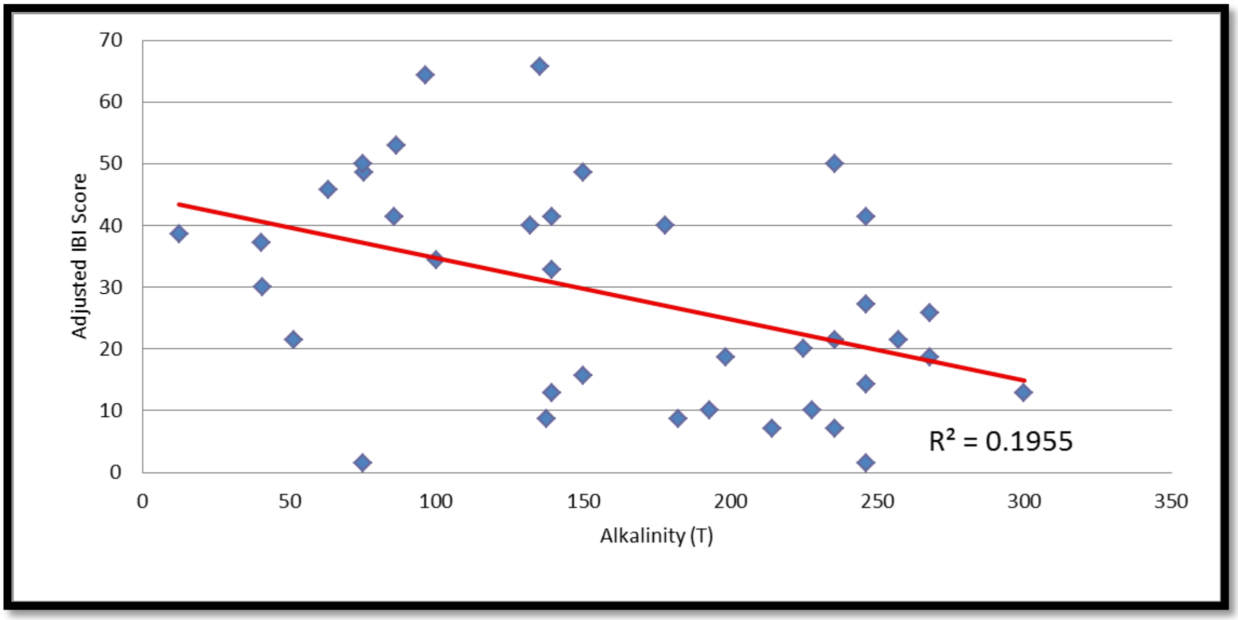

Figure 7. IBI scores as a function of alkalinity (IBI scores adjusted on a scale of 0 to 100).

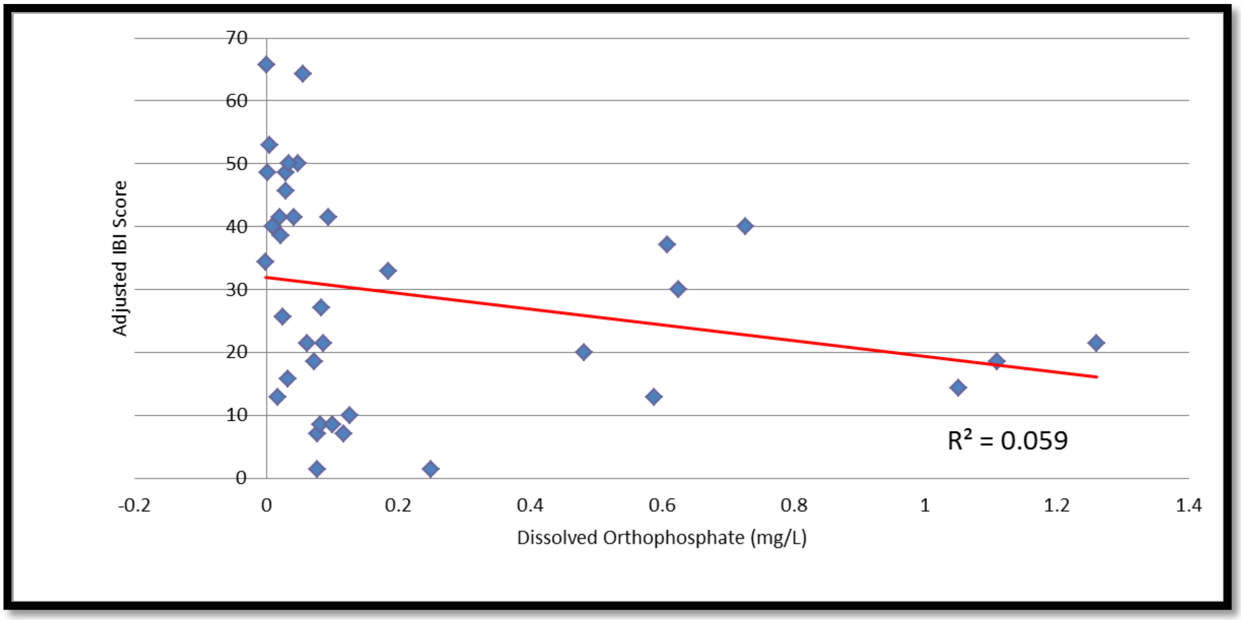

Figure 8. IBI scores as a function of dissolved orthophosphate (IBI scores adjusted on a scale of 0 to 100).

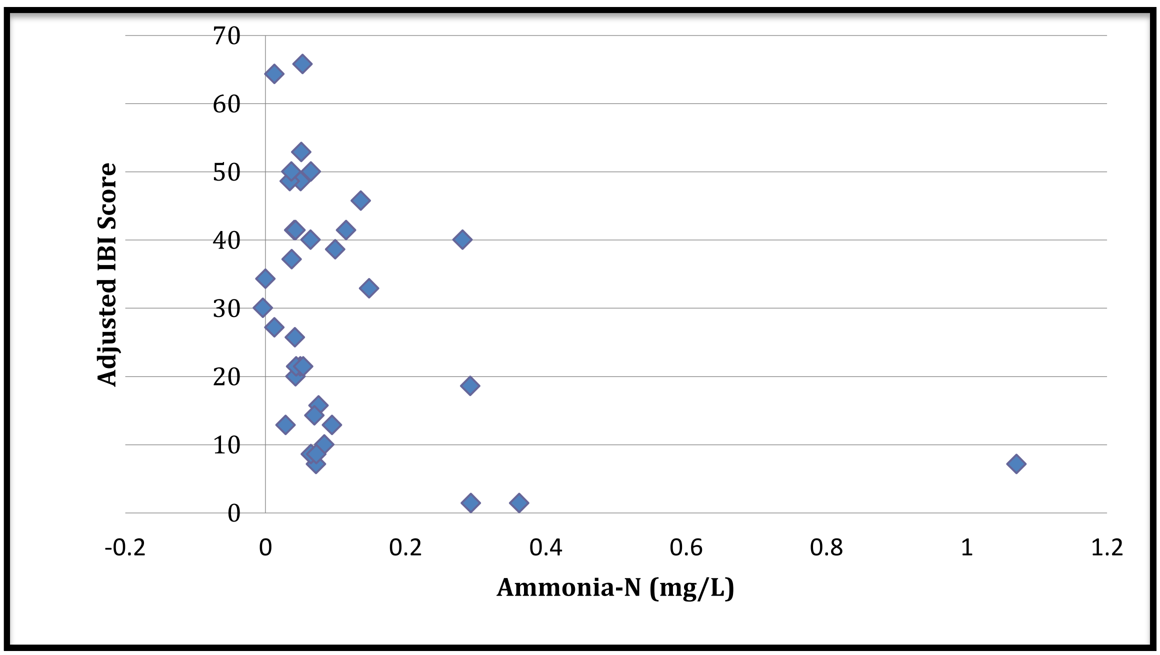

Figure 9. IBI scores as a function of ammonia (IBI scores adjusted on a scale of 0 to 100).

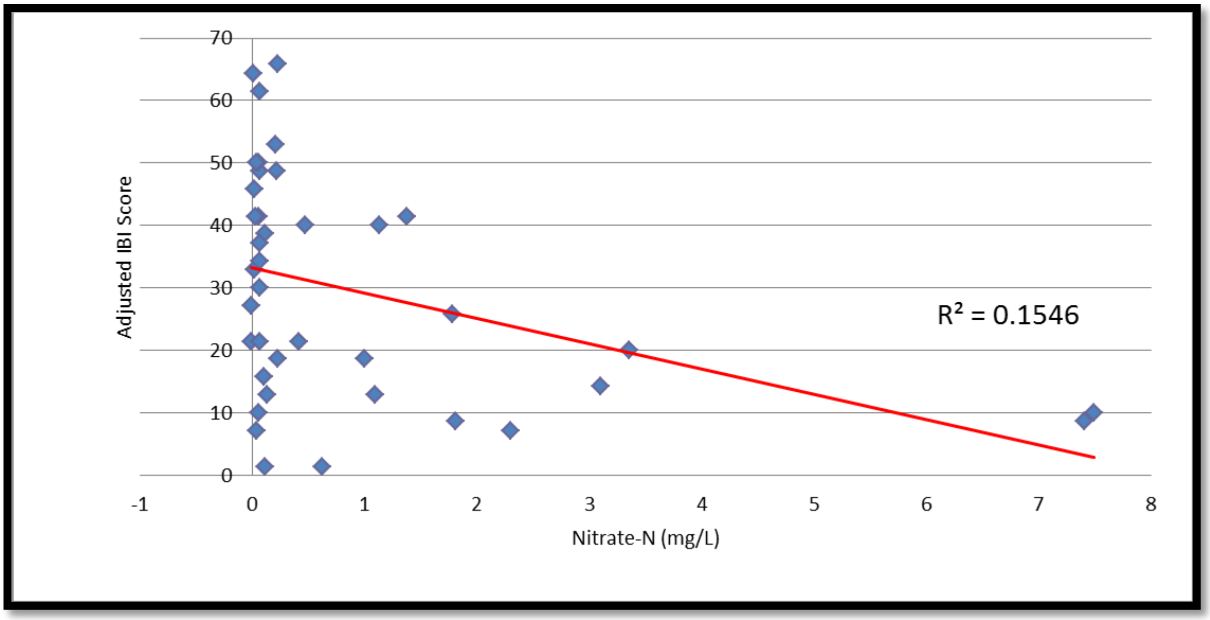

Figure 10. IBI scores as a function of nitrate (IBI scores adjusted on a scale of 0 to 100).

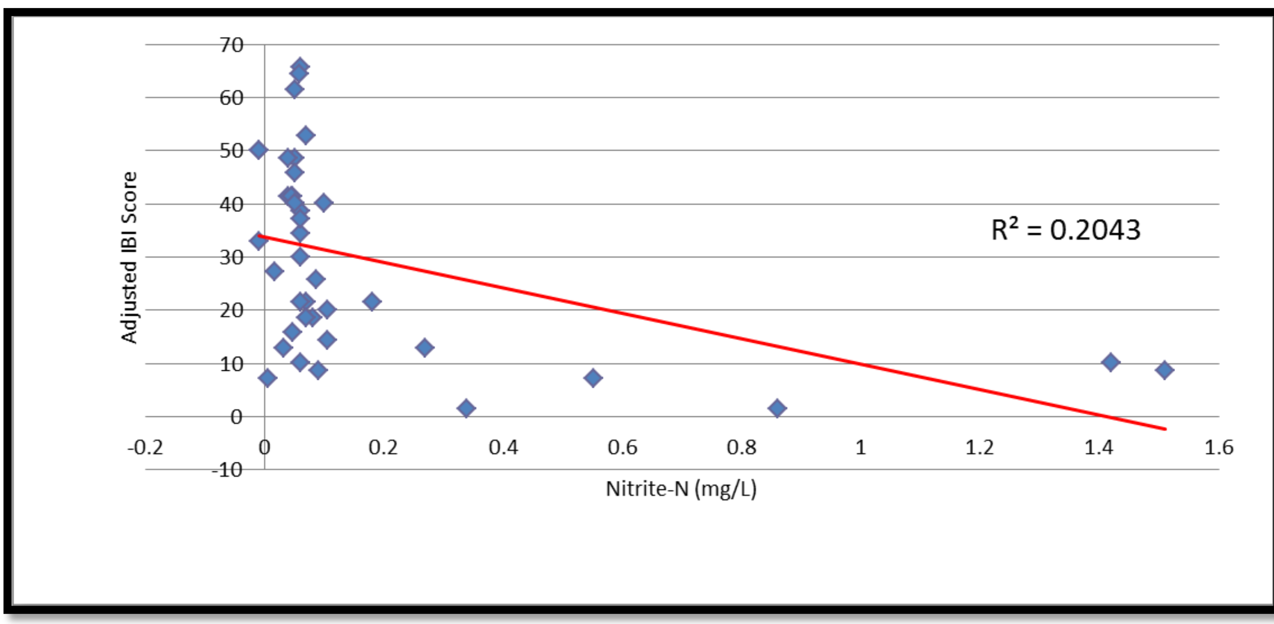

Figure 11. IBI scores as a function of nitrite (IBI scores adjusted on a scale of 0 to 100).

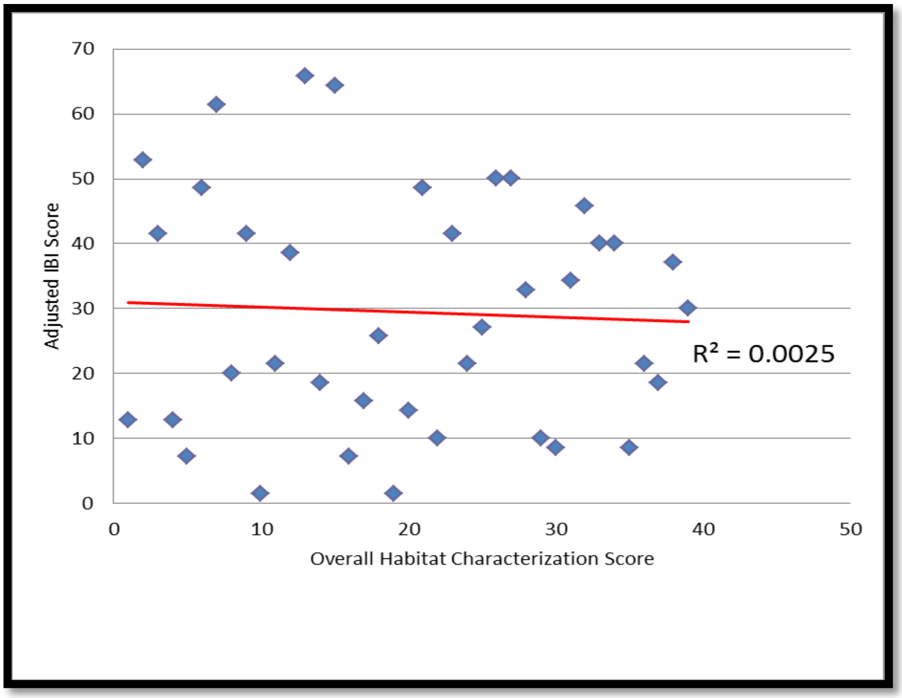

Figure 12. IBI scores as a function of overall habitat characterization (IBI scores adjusted on a scale of 0 to 100).

Conclusion

This report provides the results from the fourth year of an ongoing six-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, worms Oligochaeta, as well as mayflies *Baetis* sp. High-elevations sites were not only dominated by the aforementioned organisms (with the exception of Oligochaeta and *Hyalella* sp.), but were also dominated by semi-intolerant blackfly larvae *Simulium* sp., intolerant blackfly larvae *Prosimulium* sp., and intolerant stoneflies *Malenka* sp., *Yoraperla* sp., and *Zapada* 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 nearly all sites, their presence was not entirely 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 stoneflies *Malenka* sp., *Yoraperla* sp., and *Zapada* sp. within high-elevation sites indicates relatively pristine habitat conditions for these sensitive organisms.

Physical/Habitat Quality and Chemical Characteristics – "Poor" scores for physical habitat condition at low elevation streams were primarily driven by the lack of epifaunal substrate cover coupled with channel alterations for flood control purposes; concrete-lined channels' physical habitat conditions scored higher than expected due to the lack of sediment within these systems, which is considered beneficial for inhabiting BMIs; on the contrary, concrete-lined channels lack micro-topography that many sensitive BMIs require to survive. "Marginal" scores for physical habitat condition of mid elevation streams were due to an increase in epifaunal substrate cover, when compared to low gradient streams. "Optimal" scores for physical habitat condition of high elevation streams were due to pristine habitat conditions, although a few locations were lacking in epifaunal substrate cover and had increased sedimentation.

The water quality characteristics were relatively consistent among sites with near neutral to moderately alkaline mean pH field values (7.48 to 9.48; Appendix C), more than adequate levels of mean dissolved oxygen (4.76 to 16.35; Appendix C), and highly variable conductivity values (58 to 2959 uS/cm; Appendix C). Natural inland waters usually contain small amounts of dissolved mineral salts; low and high 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 uS/cm and that the upper tolerance limit for freshwater organisms is 2000 uS/cm (McKee and Wolf 1971). Within this study, the highest levels of conductivity were found within our urban low elevation streams and are typical of systems with flows fed by urban influence.

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 comprise 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 were few sites from this area reflected in the developed SCC-IBI and this may partially explain the variability in IBI scores observed among the low gradient sites within Region 8. Moreover, 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, many sites in Region 8 were low elevation, were characterized as low gradient, and many site reaches were located in channelized environments. 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.

Additionally, the SCC-IBI was developed by adjusting total counts of BMIs to 500 by means of Monte Carlo. This was necessary as the current SWAMP protocols require a sample of 600 BMIs, but the SCC-IBI was built using a 500 count. Two streams sampled during the 2009 bioassessment survey were whole-sorted and obtained fewer than 450 organisms; although IBI scores were generated for these locations, caution should be used when interpreting these scores being that they do not adhere to the statistical tools used to generate the SCC-IBI.

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Appendix A: Location Photos from Transect A

Photos from Transects F (upstream and downstream) and K (downstream) are available upon request.

SMCR8_026: Transect A

SMCR8_124: Transect A

SMCR8_131: Transect A

SMCR8_175: Transect A

SMCR8_179: Transect A

SMCR8_184: Transect A

 SMCR8_191: Transect A	 SMCR8_196: Transect A
 SMCR8_197: Transect A	 SMCR8_207: Transect A
 SMCR8_218: Transect A	 SMCR8_219: Transect A

SMCR8_229: Transect A

SMCR8_254: Transect A

SMCR8_262: Transect A

SMCR8_275: Transect A

SMCR8_289: Transect A

SMCR8_299: Transect A

 SMCR8_312: Transect A	 SMCR8_317: Transect A
 SMCR8_327: Transect A	 SMCR8_333: Transect A
 SMCR8_339: Transect A	 SMCR8_344: Transect A

SMCR8_376: Transect A

SMCR8_415: Transect A

SMCR8_418: Transect A

SMCR8_474: Transect A

SMCR8_513: Transect A

SMCR8_572: Transect A

 SMCR8_600: Transect A	 SMCR8_601: Transect A
 SMCR8_605: Transect A	 SMCR8_613: Transect A
 SMCR8_688: Transect A	

Appendix B: Standard Operating Procedures

STANDARD OPERATING PROCEDURES FOR COLLECTING BENTHIC MACROINVERTEBRATE SAMPLES AND ASSOCIATED PHYSICAL AND CHEMICAL DATA FOR AMBIENT BIOASSESSMENTS IN CALIFORNIA (UPDATED 02/01/07) CAN BE DOWNLOADED FROM:

http://swamp.mpsl.mlml.calstate.edu/wp-content/uploads/2009/04/swamp_sop_bioassessment_collection_020107.pdf

Appendix C: Water Chemistry Data

Appendix C. Water chemistry data (including field and lab analyses).

Site Code	Lab Replicate	Field Replicate	Dissolved Oxygen (mg/L)	Field pH	Temperature (°C)	Specific Conductivity (µs/cm)	Alkalinity as CaCO3 (T)	Ammonia as N (mg/L)	Nitrate + Nitrite as N (mg/L)	Nitrate as N (mg/L)	Nitrite as N (mg/L)	OrthroPhosphate as P (mg/L)	Lab pH	Phosphorus as P (mg/L)	Suspended Solids (mg/L)	Total Nitrogen	Turbidity (NTU)
SMCR8_026	1	1	6.16	7.92	17.15	379	299.90	0.095	1.360	1.091	0.269	0.588	7.68	0.753	10.4	3.030	1.40
SMCR8_124	1	1	8.82	8.10	15.79	227	86.48	0.0511	0.273	0.203	0.070	0.004	N/A	0.032	1.5	0.201	N/A
SMCR8_131	1	1	9.78	8.12	14.46	185	246.30	0.041	0.092	0.053	0.039	0.041	7.96	0.081	79.6	0.060	28.60
SMCR8_175	1	1	8.57	8.26	22.92	958	139.20	0.029	0.164	0.132	0.032	0.017	8.37	0.031	8.4	0.370	1.00
SMCR8_179	1	1	6.66	8.25	17.41	1299	235.60	0.072	0.042	0.037	0.005	0.077	7.78	0.120	4.8	-2.000	10.30
SMCR8_184	1	1	8.43	7.86	16.31	231	75.48	0.0505	0.118	0.068	0.050	0.001	N/A	0.029	0.5	0.032	N/A
SMCR8_191	1	1	6.58	8.35	31.50	875	224.90	0.043	3.460	3.355	0.105	0.482	8.30	1.100	6.0	5.900	7.40
SMCR8_196	1	1	9.28	8.87	12.07	58	85.70	0.115	0.074	0.028	0.047	0.094	7.43	0.071	26.0	-2.000	6.60
SMCR8_197	1	1	11.38	8.98	27.48	1015	75.00	0.362	0.455	0.116	0.339	0.077	8.97	0.051	24.8	1.180	3.50
SMCR8_207	1	1	8.03	8.37	19.51	705	257.00	0.05	0.486	0.417	0.069	1.260	8.35	1.890	9.2	0.690	1.70
SMCR8_218	1	1	7.63	8.52	9.87	65	12.30	0.0996	0.173	0.113	0.060	0.021	N/A	0.041	1.0	0.017	N/A
SMCR8_219	1	1	8.67	7.73	15.33	335	135.08	0.0531	0.286	0.226	0.060	0.000	N/A	0.032	3.0	0.157	N/A
SMCR8_229	1	1	7.48	8.09	20.75	1335	267.80	0.292	1.080	1.000	0.080	0.073	7.76	0.088	3.6	2.040	1.50
SMCR8_254	1	1	9.04	8.17	12.06	175	96.40	0.013	0.065	0.007	0.058	0.056	7.87	0.030	12.4	-2.000	12.20
SMCR8_262	1	1	12.36	8.88	26.44	1257	214.20	1.071	2.850	2.299	0.551	0.117	8.87	0.070	9.6	5.260	4.20
SMCR8_275	1	1	8.98	8.51	21.88	952	149.90	0.076	0.151	0.104	0.047	0.033	8.44	0.032	5.2	0.010	1.00
SMCR8_289	1	1	9.83	8.48	16.56	719	267.80	0.042	1.870	1.784	0.086	0.025	7.99	0.006	2.8	2.790	1.70
SMCR8_299	1	1	9.70	8.05	21.17	2559	246.30	0.293	1.480	0.620	0.860	0.249	8.15	0.015	6.4	2.690	6.60
SMCR8_312	1	1	7.87	7.74	22.30	960	246.30	0.07	3.210	3.104	0.106	1.050	8.21	1.510	6.4	6.350	0.90
SMCR8_317	1	1	9.21	8.60	14.87	368	149.90	0.035	0.252	0.212	0.040	0.029	8.15	0.009	6.8	-2.000	0.90
SMCR8_327	1	1	6.20	7.78	31.76	643	227.84	-99	1.437	1.377	0.060	-99	N/A	0.016	1.0	0.089	N/A
SMCR8_333	1	1	9.02	8.00	13.41	249	139.20	0.043	0.098	0.052	0.046	0.020	8.35	0.013	2.8	-2.000	1.10
SMCR8_339	1	1	7.99	8.16	18.13	1258	235.60	0.044	0.007	-0.010	0.180	0.086	7.95	0.122	2.0	0.170	1.20
SMCR8_339	2	2	7.99	8.16	18.13	1258	246.30	0.013	0.007	-0.010	0.016	0.084	7.94	0.110	3.6	0.290	0.60
SMCR8_344	1	1	8.12	8.10	14.02	398	235.60	0.065	0.052	0.052	-0.010	0.048	8.23	0.048	12.4	-2.000	9.00
SMCR8_376	1	1	9.31	7.81	8.91	137	75.00	0.037	0.039	0.039	-0.010	0.034	7.94	0.024	9.6	-2.000	3.20
SMCR8_415	1	1	4.76	8.29	31.12	381	139.20	0.148	0.016	0.016	-0.010	0.185	8.55	-0.020	0.4	-2.000	1.00
SMCR8_418	1	1	9.45	8.36	27.66	1969	192.80	0.084	8.910	7.490	1.420	0.127	8.35	0.051	14.0	17.300	5.50
SMCR8_418	2	2	9.45	8.36	27.66	1969	182.10	0.065	8.920	7.410	1.510	0.082	8.39	0.048	15.6	17.400	1.70
SMCR8_474	1	1	10.53	7.66	10.90	211	99.92	-0.0001	0.128	0.068	0.060	-0.002	N/A	0.507	2.0	0.117	N/A
SMCR8_513	1	1	6.95	7.92	16.26	233	63.10	0.1359	0.073	0.023	0.050	0.030	N/A	0.071	-99.0	0.448	N/A
SMCR8_572	1	1	9.10	8.71	26.69	775	177.82	0.2812	1.229	1.129	0.100	0.727	N/A	0.840	7.5	0.763	N/A
SMCR8_600	1	1	9.54	7.63	19.33	296	131.71	0.0644	0.524	0.474	0.050	0.010	N/A	0.016	-99.0	0.048	N/A
SMCR8_601	1	1	16.35	9.48	29.97	343	137.33	0.0728	1.896	1.806	0.090	0.101	N/A	0.226	10.0	0.943	N/A
SMCR8_605	1	1	7.54	7.48	15.90	195	51.44	0.0538	0.128	0.068	0.060	0.061	N/A	0.080	-1.0	0.234	N/A
SMCR8_613	1	1	6.42	7.98	26.87	784	198.49	-99	0.296	0.226	0.070	1.108	N/A	1.318	9.0	0.296	N/A
SMCR8_688	1	1	8.74	7.58	14.39	144	40.29	0.0374	0.128	0.068	0.060	0.609	N/A	0.053	3.0	0.265	N/A
SMCR8_688	2	2	8.74	7.58	14.39	144	40.63	-0.0034	0.128	0.068	0.060	0.626	N/A	0.044	2.0	0.160	N/A

Appendix D: Benthic Macroinvertebrates Used for Calculating IBI Metrics

BMIs collected, adjusted to counts of 500 via Monte Carlo method.

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_026	SMCR8_124	SMCR8_131	SMCR8_175	SMCR8_179	SMCR8_184 1	SMCR8_184 2	SMCR8_191
Insecta Taxa										
Ephemeroptera										
Ameletus	0	cg								
Baetidae	4	cg								
Baetis	5	cg			2	14			28	
Baetis adonis	5	cg								
Baetis tricaudatus	6	cg		85	2			110	103	3
Callibaetis	9	cg								
Caudatella heterocaudata	1	cg						1		
Caudatella hystrix	1	cg							1	
Centroptilum	2	cg							4	
Cinygmula	4	sc								
Diphetor hageni	5	cg				2			1	
Drunella	0	cg						3		
Drunella coloradensis	0	p								
Drunella flavilinea	0	cg								
Epeorus	0	sc		6				6	4	
Ephemerella	1	cg								
Ephemerella dorothea	1	cg								
Ephemerella maculata	1	cg								
Ephemerellidae	1	cg						1		
Ephemeroptera				3			1			1
Fallceon quilleri	4	cg		10			1			123
Heptageniidae	4	sc								
Ironodes	3	sc								
Leptohyphidae	4	cg				1				
Leptophlebiidae	2	cg								
Paraleptophlebia	4	cg								
Rhithrogena	0	sc								
Serratella	2	cg		2						
Serratella micheneri	2	cg						15		
Serratella teresa	2	cg								
Tricorythodes minutus	4	cg		13		1	4	89	72	99
Odonata										
Argia	7	p		20	1		5			
Coenagrionidae	9	p								
Cordulegaster dorsalis	3	p			2				1	
Hetaerina americana	6	p								2
Libellulidae	9	p								

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_026	SMCR8_124	SMCR8_131	SMCR8_175	SMCR8_179	SMCR8_184		SMCR8_191
								1	2	
Insecta Taxa										
Odonata										
Octogomphus specularis	4	p			10					
Odonata				1						
Paltothemis lineatipes	9	p								
Progomphus borealis	4	p								5
Zoniagrion exclamationis	9	p								
Zygoptera										2
Plecoptera										
Calineuria californica	2	p								
Chloroperlidae	1	p								
Hesperoperla	2	p							1	
Isoperla	2	p								
Malenka	2	sh			1			2		
Nemouridae	2	sh						3	1	
Osobenus yakimae	2	p								
Perlidae	1	p								
Plecoptera			1							
Suwallia	1	p								
Zapada cinctipes	2	sh		1						
Hemiptera										
Belostomatidae	8	p		1						
Corisella decolor	8	p								
Corixidae	8	p								
Trichocorixa calva	8	p								
Trichoptera										
Agapetus	0	sc		3				23	22	
Brachycentridae	1									
Cheumatopsyche	5	cf								
Glossosoma	1	sc							1	
Glossosomatidae	0	sc								
Gumaga	3	sh								
Helicopsyche	3	sc		5				1		
Hesperophylax	3	om								
Hydropsyche	4	cf		60				12	8	1
Hydropsyche morosa	6	ph						16	8	
Hydropsychidae	4	cf			4			3	3	
Hydroptila	6	ph	58				3	19	9	30
Hydroptilidae	4	ph	15			8		13	6	3

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_026	SMCR8_124	SMCR8_131	SMCR8_175	SMCR8_179	SMCR8_184		SMCR8_191
								1	2	
Insecta Taxa										
Trichoptera										
Lepidostoma	1	sh		15	6			6	14	
Micrasema	1	mh		53	14				1	
Neophylax	3	sc			6					
Ochrotrichia	4	ph				19		9	11	
Parapsyche	0	p			3					
Philopotamidae	3	cf		2				1		
Polycentropus	6	p								
Psychoglypha	2	sh								
Rhyacophila	0	p		1	1			5	5	
Sericostomatidae	3	sh								
Tinodes	2	sc			1					
Trichoptera				5	10			3	1	1
Wormaldia	3	cf		6				1	3	
Coleoptera										
Agabus	8	p								
Berosus	5	p								
Coleoptera				2					1	
Dytiscidae	5	p								
Enochrus	5	cg								
Hydraena	5	p								
Hydrobius	8	p								
Hydrophilidae	5	p								
Hydroporinae	5	p								
Hygrotus	5	p								
Laccobius	5	cg								
Laccophilus	5	p								
Liodessus	5	p								
Narpus	4	cg								
Optioservus	4	sc		14				22	22	
Peltodytes		mh								
Postelichus	5									
Sanfilippodytes	5	p								
Stictotarsus	5	p		2						
Tropisternus	5	p								1
Zaitzevia	4	sc							1	
Diptera										
Anopheles	8	cg					2			
Atylotus/Tabanus	5	p								
Bezzia/Palpomyia	6	p			2				1	

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_026	SMCR8_124	SMCR8_131	SMCR8_175	SMCR8_179	SMCR8_184 1	SMCR8_184 2	SMCR8_191
Insecta Taxa										
Diptera										
Brachycera									1	
Caloparyphus/Euparyphus	8	cg			1	1	1	5		1
Ceratopogonidae	6	p								
Chelifera/Metachela	6	p			5					
Chironomidae	6	cg	258	115	103	323	140	107	99	111
Clinocera	6	p								
Culicoides										
Dasyhelea	6	cg								
Dicranota	3	p			1					
Diptera				1						
Dixa	2	cg		1						
Empididae	6	p								
Ephydridae	6									1
Euparyphus	8	cg		1					3	
Forcipomyia	6	cg								
Glutops	3	p			1					
Hemerodromia	6	p		1					2	
Hexatoma	2	p								
Holorusia hespera	5	sh			1					
Limonia	6	sh			2					
Maruina lanceolata	2	sc		1	4			2	1	
Muscidae	6	p								
Nemotelus	8	cg								
Neoplasta	6	p		1	3			4	1	
Pericoma/Telmatoscopus	4	cg			1		1			
Probezzia	6	p								
Prosimulium	3	cf								
Psychoda	10	cg								
Psychodidae		cg		1						
Simuliidae	6	cf		1				1		
Simulium		cf	47	15	16			11	31	44
Stilobezzia	6	p								
Stratiomyidae	8	cg								
Tipula	4	om								
Tipulidae	3									1
Tipulinae	3		3		1					
Trichoclinocera	6	p								

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_026	SMCR8_124	SMCR8_131	SMCR8_175	SMCR8_179	SMCR8_184		SMCR8_191
								1	2	
Insecta Taxa										
Diptera										
Wiedemannia	6	p							2	
Lepidoptera										
Lepidoptera										
Megaloptera										
Neohermes	0	p								
Non-Insecta Taxa										
Acari	5	p		1	7					
Annelida										
Ljania	5	p		1						
Pulmonata										5
Hirudinea	10	pa								
Oligochaeta	5	cg	4	2	21	1	20	3	1	2
Ostracoda	8	cg	111	16	129	36	261	1	21	33
Turbellaria	4	p				16				
Amphipoda										
Amphipoda	4	cg				50				21
Hyalella	8	cg								
Arhynchobdellida										
Mooreobdella	8	p								
Basommatophora										
Ferrissia	6	sc								
Lymnaea	6	sc								
Menetus opercularis							4			
Physa	8	sc	3	28	65	28	49			4
Hydridae										
Hydra	5	p								
Hypsogastropoda										
Hydrobiidae	8	sc								
Rhynchobdellida										
Helobdella	6	pa								
Trombidiformes										
Arrenurus	5	p								
Atractides	8	p					6	2	1	
Estelloxus	8	p			3					
Lebertia	8	p		1	5				1	
Mesobates	8	p								
Mideopsis	5	p			1					

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_026	SMCR8_124	SMCR8_131	SMCR8_175	SMCR8_179	SMCR8_184		SMCR8_191
								1	2	
Insecta Taxa										
Trombidiformes										
Pionidae										
Protzia	8	p								
Sperchon	8	p		2	3		2		1	
Sperchonopsis	8	p			4					
Testudacarus	5	p			9					
Torrenticola	5	p		1	26				2	
Veneroida										
Corbicula	8	cf								1
Pisidium	8	cf			23					5
Sphaeriidae	8	cf								
Veneroida										
TOTAL			**500**	**500**	**500**	**500**	**500**	**500**	**500**	**500**

BMIs collected, adjusted to counts of 500 via Monte Carlo method.

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_196	SMCR8_197	SMCR8_207	SMCR8_218	SMCR8_219	SMCR8_229	SMCR8_254
Insecta Taxa									
Ephemeroptera									
Ameletus	0	cg							
Baetidae	4	cg		1					
Baetis	5	cg	46			3	97	6	8
Baetis adonis	5	cg							
Baetis tricaudatus	6	cg	2		32		9		9
Callibaetis	9	cg							
Caudatella heterocaudata	1	cg					2		
Caudatella hystrix	1	cg							
Centroptilum	2	cg				2			
Cinygmula	4	sc							
Diphetor hageni	5	cg							
Drunella	0	cg					20		15
Drunella coloradensis	0	p							6
Drunella flavilinea	0	cg							
Epeorus	0	sc					23		6
Ephemerella	1	cg							
Ephemerella dorothea	1	cg							
Ephemerella maculata	1	cg					4		1
Ephemerellidae	1	cg							
Ephemeroptera			5						
Fallceon quilleri	4	cg						39	
Heptageniidae	4	sc							
Ironodes	3	sc					4		5
Leptohyphidae	4	cg							
Leptophlebiidae	2	cg							
Paraleptophlebia	4	cg				22			
Rhithrogena	0	sc							
Serratella	2	cg	1						3
Serratella micheneri	2	cg							
Serratella teresa	2	cg					2		
Tricorythodes minutus	4	cg						11	
Odonata									
Argia	7	p						13	2
Coenagrionidae	9	p							
Cordulegaster dorsalis	3	p				1	2		4
Hetaerina americana	6	p							
Libellulidae	9	p						1	

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_196	SMCR8_197	SMCR8_207	SMCR8_218	SMCR8_219	SMCR8_229	SMCR8_254
Insecta Taxa									
Odonata									
Octogomphus specularis	4	p							
Odonata					2				
Paltothemis lineatipes	9	p							
Progomphus borealis	4	p							
Zoniagrion exclamationis	9	p							
Zygoptera					1				
Plecoptera									
Calineuria californica	2	p							
Chloroperlidae	1	p							
Hesperoperla	2	p					2		
Isoperla	2	p							1
Malenka	2	sh				21	32		6
Nemouridae	2	sh	1			29	2		4
Osobenus yakimae	2	p							
Perlidae	1	p							
Plecoptera			3						
Suwallia	1	p							
Zapada cinctipes	2	sh							
Hemiptera									
Belostomatidae	8	p							
Corisella decolor	8	p							
Corixidae	8	p							
Trichocorixa calva	8	p							
Trichoptera									
Agapetus	0	sc					12		30
Brachycentridae	1								
Cheumatopsyche	5	cf						7	
Glossosoma	1	sc							2
Glossosomatidae	0	sc							
Gumaga	3	sh				8			8
Helicopsyche	3	sc							
Hesperophylax	3	om							
Hydropsyche	4	cf			4		19		
Hydropsyche morosa	6	ph							16
Hydropsychidae	4	cf					5	1	4
Hydroptila	6	ph						24	
Hydroptilidae	4	ph			1			4	

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_196	SMCR8_197	SMCR8_207	SMCR8_218	SMCR8_219	SMCR8_229	SMCR8_254
Insecta Taxa									
Trichoptera									
Lepidostoma	1	sh	9			2			33
Micrasema	1	mh	4		1		4		8
Neophylax	3	sc	1				1		3
Ochrotrichia	4	ph			1				
Parapsyche	0	p					6		51
Philopotamidae	3	cf							
Polycentropus	6	p	1			2			
Psychoglypha	2	sh	7			1	1		
Rhyacophila	0	p	3				15		9
Sericostomatidae	3	sh					3		2
Tinodes	2	sc				1			
Trichoptera							1		6
Wormaldia	3	cf							
Coleoptera									
Agabus	8	p							
Berosus	5	p							
Coleoptera									
Dytiscidae	5	p	1						
Enochrus	5	cg							
Hydraena	5	p					2		
Hydrobius	8	p							
Hydrophilidae	5	p							
Hydroporinae	5	p	1						
Hygrotus	5	p							
Laccobius	5	cg							
Laccophilus	5	p							
Liodessus	5	p							
Narpus	4	cg							
Optioservus	4	sc					2		
Peltodytes		mh							
Postelichus	5								
Sanfilippodytes	5	p				1			
Stictotarsus	5	p							
Tropisternus	5	p							
Zaitzevia	4	sc				2			
Diptera									
Anopheles	8	cg							

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_196	SMCR8_197	SMCR8_207	SMCR8_218	SMCR8_219	SMCR8_229	SMCR8_254
Insecta Taxa									
Diptera									
Atylotus/Tabanus	5	p							
Bezzia/Palpomyia	6	p	2				1		4
Brachycera					1				
Caloparyphus/Euparyphus	8	cg		5	2			1	
Ceratopogonidae	6	p	2		1				2
Chelifera/Metachela	6	p							
Chironomidae	6	cg	334	59	112	379	146	115	156
Clinocera	6	p	2				3		
Culicoides									
Dasyhelea	6	cg	2		2	1		1	
Dicranota	3	p	4						3
Diptera					1				
Dixa	2	cg				2	3		3
Empididae	6	p	1						
Ephydridae	6								
Euparyphus	8	cg							
Forcipomyia	6	cg							
Glutops	3	p							1
Hemerodromia	6	p						2	1
Hexatoma	2	p	1			1	1		
Holorusia hespera	5	sh							
Limonia	6	sh							
Maruina lanceolata	2	sc					13		8
Muscidae	6	p			7				
Nemotelus	8	cg							
Neoplasta	6	p					5		5
Pericoma/Telmatoscopus	4	cg			1		1		
Probezzia	6	p							
Prosimulium	3	cf	7						
Psychoda	10	cg							
Psychodidae		cg							
Simuliidae	6	cf	1						
Simulium		cf	1		321	7	9	4	6
Stilobezzia	6	p							
Stratiomyidae	8	cg							
Tipula	4	om			2			1	
Tipulidae	3								

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_196	SMCR8_197	SMCR8_207	SMCR8_218	SMCR8_219	SMCR8_229	SMCR8_254
Insecta Taxa									
Diptera									
Tipulinae	3								
Trichoclinocera	6	p							
Wiedemannia	6	p							
Lepidoptera									
Lepidoptera							1		
Megaloptera									
Neohermes	0	p							
Non-Insecta Taxa									
Acari	5	p							
Annelida						3	7		
Ljania	5	p							
Pulmonata									
Hirudinea	10	pa							
Oligochaeta	5	cg	11	18	2			151	23
Ostracoda	8	cg	43	397		6	5	53	3
Turbellaria	4	p		18				1	
Amphipoda									
Amphipoda	4	cg		1					
Hyalella	8	cg						56	
Arhynchobdellida									
Mooreobdella	8	p							
Basommatophora									
Ferrissia	6	sc							
Lymnaea	6	sc					3		2
Menetus opercularis									
Physa	8	sc			1			3	1
Hydridae									
Hydra	5	p							
Hypsogastropoda									
Hydrobiidae	8	sc							1
Rhynchobdellida									
Helobdella	6	pa							
Trombidiformes									
Arrenurus	5	p							
Atractides	8	p							
Estelloxus	8	p				1			1
Lebertia	8	p	4				7		6

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_196	SMCR8_197	SMCR8_207	SMCR8_218	SMCR8_219	SMCR8_229	SMCR8_254
Insecta Taxa									
Trombidiformes									
Mesobates	8	p							
Mideopsis	5	p				1	1		
Pionidae									
Protzia	8	p							2
Sperchon	8	p		1	5	2	3	6	
Sperchonopsis	8	p							2
Testudacarus	5	p				1	1		3
Torrenticola	5	p					4		1
Veneroida									
Corbicula	8	cf					3		
Pisidium	8	cf				1	13		24
Sphaeriidae	8	cf							
Veneroida									
TOTAL			**500**	**500**	**500**	**500**	**500**	**500**	**500**

BMIs collected, adjusted to counts of 500 via Monte Carlo method.

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_262	SMCR8_275	SMCR8_289	SMCR8_299	SMCR8_312	SMCR8_317	SMCR8_327
Insecta Taxa									
Ephemeroptera									
Ameletus	0	cg							
Baetidae	4	cg		1	1				
Baetis	5	cg						8	
Baetis adonis	5	cg							
Baetis tricaudatus	6	cg						2	
Callibaetis	9	cg							
Caudatella heterocaudata	1	cg							
Caudatella hystrix	1	cg							
Centroptilum	2	cg							
Cinygmula	4	sc							
Diphetor hageni	5	cg	4						
Drunella	0	cg						3	
Drunella coloradensis	0	p							
Drunella flavilinea	0	cg							
Epeorus	0	sc							
Ephemerella	1	cg							
Ephemerella dorothea	1	cg							
Ephemerella maculata	1	cg							
Ephemerellidae	1	cg							
Ephemeroptera			1						
Fallceon quilleri	4	cg			6		64		
Heptageniidae	4	sc							
Ironodes	3	sc							
Leptohyphidae	4	cg		1					
Leptophlebiidae	2	cg							
Paraleptophlebia	4	cg							
Rhithrogena	0	sc							
Serratella	2	cg							
Serratella micheneri	2	cg							
Serratella teresa	2	cg							
Tricorythodes minutus	4	cg	4				73		
Odonata									
Argia	7	p			1			42	
Coenagrionidae	9	p					1		
Cordulegaster dorsalis	3	p							
Hetaerina americana	6	p							
Libellulidae	9	p			1				

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_262	SMCR8_275	SMCR8_289	SMCR8_299	SMCR8_312	SMCR8_317	SMCR8_327
Insecta Taxa									
Odonata									
Octogomphus specularis	4	p							
Odonata									
Paltothemis lineatipes	9	p							
Progomphus borealis	4	p							
Zoniagrion exclamationis	9	p					1		
Zygoptera			2						
Plecoptera									
Calineuria californica	2	p							
Chloroperlidae	1	p							
Hesperoperla	2	p							
Isoperla	2	p							
Malenka	2	sh							
Nemouridae	2	sh						3	
Osobenus yakimae	2	p							
Perlidae	1	p							
Plecoptera								1	
Suwallia	1	p							
Zapada cinctipes	2	sh							
Hemiptera									
Belostomatidae	8	p							
Corisella decolor	8	p	1						
Corixidae	8	p	4						
Trichocorixa calva	8	p							
Trichoptera									
Agapetus	0	sc						17	
Brachycentridae	1								
Cheumatopsyche	5	cf							
Glossosoma	1	sc							
Glossosomatidae	0	sc						5	
Gumaga	3	sh						1	
Helicopsyche	3	sc							
Hesperophylax	3	om							
Hydropsyche	4	cf			21			18	
Hydropsyche morosa	6	ph							
Hydropsychidae	4	cf						1	3
Hydroptila	6	ph		4	15		4		1
Hydroptilidae	4	ph	2		1				

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_262	SMCR8_275	SMCR8_289	SMCR8_299	SMCR8_312	SMCR8_317	SMCR8_327
Insecta Taxa									
Trichoptera									
Lepidostoma	1	sh					1	5	
Micrasema	1	mh			6			1	
Neophylax	3	sc							
Ochrotrichia	4	ph	1						
Parapsyche	0	p							
Philopotamidae	3	cf						1	
Polycentropus	6	p							
Psychoglypha	2	sh							
Rhyacophila	0	p						7	
Sericostomatidae	3	sh							
Tinodes	2	sc						1	
Trichoptera									
Wormaldia	3	cf						1	
Coleoptera									
Agabus	8	p			1				
Berosus	5	p							
Coleoptera									
Dytiscidae	5	p							
Enochrus	5	cg							
Hydraena	5	p							
Hydrobius	8	p							
Hydrophilidae	5	p							
Hydroporinae	5	p							
Hygrotus	5	p							
Laccobius	5	cg			1				
Laccophilus	5	p							
Liodessus	5	p							
Narpus	4	cg							
Optioservus	4	sc						4	
Peltodytes		mh			24				
Postelichus	5								
Sanfilippodytes	5	p							
Stictotarsus	5	p							
Tropisternus	5	p							
Zaitzevia	4	sc							
Diptera									
Anopheles	8	cg							

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_262	SMCR8_275	SMCR8_289	SMCR8_299	SMCR8_312	SMCR8_317	SMCR8_327
Insecta Taxa									
Diptera									
Atylotus/Tabanus	5	p						3	
Bezzia/Palpomyia	6	p	2				6	4	
Brachycera							1	1	
Caloparyphus/Euparyphus	8	cg	1	2	23	1	3		9
Ceratopogonidae	6	p					2		
Chelifera/Metachela	6	p							
Chironomidae	6	cg	42	147	351	183	73	306	10
Clinocera	6	p							
Culicoides									
Dasyhelea	6	cg		1					
Dicranota	3	p							
Diptera									
Dixa	2	cg							
Empididae	6	p			1			1	
Ephydridae	6						1		
Euparyphus	8	cg			4				3
Forcipomyia	6	cg							
Glutops	3	p							
Hemerodromia	6	p			1				
Hexatoma	2	p							
Holorusia hespera	5	sh							
Limonia	6	sh							
Maruina lanceolata	2	sc						6	
Muscidae	6	p			1				
Nemotelus	8	cg		1					
Neoplasta	6	p						8	
Pericoma/Telmatoscopus	4	cg		1					
Probezzia	6	p							
Prosimulium	3	cf							
Psychoda	10	cg		1					
Psychodidae		cg							
Simuliidae	6	cf							
Simulium		cf			2			21	6
Stilobezzia	6	p						1	
Stratiomyidae	8	cg							
Tipula	4	om							
Tipulidae	3				1				

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_262	SMCR8_275	SMCR8_289	SMCR8_299	SMCR8_312	SMCR8_317	SMCR8_327
Insecta Taxa									
Diptera									
Tipulinae	3								
Trichoclinocera	6	p							
Wiedemannia	6	p							
Lepidoptera									
Lepidoptera									
Megaloptera									
Neohermes	0	p							
Non-Insecta Taxa									
Acari	5	p							
Annelida									
Ljania	5	p							
Pulmonata									
Hirudinea	10	pa		1					
Oligochaeta	5	cg		86		62	1	2	1
Ostracoda	8	cg	401	32	26	137	139	24	1
Turbellaria	4	p	3	123		4			
Amphipoda									
Amphipoda	4	cg	28	99		97			
Hyalella	8	cg					67		
Arhynchobdellida									
Mooreobdella	8	p							
Basommatophora									
Ferrissia	6	sc							
Lymnaea	6	sc							
Menetus opercularis									
Physa	8	sc			1	15	63		
Hydridae									
Hydra	5	p							
Hypsogastropoda									
Hydrobiidae	8	sc							
Rhynchobdellida									
Helobdella	6	pa				1			
Trombidiformes									
Arrenurus	5	p						2	
Atractides	8	p							
Estelloxus	8	p							
Lebertia	8	p							
Mesobates	8	p							

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_262	SMCR8_275	SMCR8_289	SMCR8_299	SMCR8_312	SMCR8_317	SMCR8_327
Insecta Taxa									
Trombidiformes									
Mideopsis	5	p							
Pionidae			2						
Protzia	8	p							
Sperchon	8	p	2		11				
Sperchonopsis	8	p							
Testudacarus	5	p							
Torrenticola	5	p							
Veneroida									
Corbicula	8	**cf**							
Pisidium	8	cf							
Sphaeriidae	8	cf							
Veneroida									
TOTAL			**500**	**500**	**500**	**500**	**500**	**500**	**34**

BMIs collected, adjusted to counts of 500 via Monte Carlo method.

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_333	SMCR8_339		SMCR8_344	SMCR8_376	SMCR8_418		SMCR8_474	SMCR8_513
				1	2			1	2		
Insecta Taxa											
Ephemeroptera											
Ameletus	0	cg					1			1	2
Baetidae	4	cg							1		
Baetis	5	cg	3		18	3	4			25	21
Baetis adonis	5	cg		27							
Baetis tricaudatus	6	cg	85			16	6			22	49
Callibaetis	9	cg									
Caudatella heterocaudata	1	cg					3				
Caudatella hystrix	1	cg									
Centroptilum	2	cg									1
Cinygmula	4	sc					3				
Diphetor hageni	5	cg									
Drunella	0	cg	15			5	3				3
Drunella coloradensis	0	p									
Drunella flavilinea	0	cg					3				
Epeorus	0	sc					2			9	
Ephemerella	1	cg					1				
Ephemerella dorothea	1	cg					20				
Ephemerella maculata	1	cg									
Ephemerellidae	1	cg					1			2	
Ephemeroptera									1	5	
Fallceon quilleri	4	cg						50	60	7	
Heptageniidae	4	sc				3	1				
Ironodes	3	sc				17					
Leptohyphidae	4	cg			16						
Leptophlebiidae	2	cg				4	1				
Paraleptophlebia	4	cg									
Rhithrogena	0	sc					1				
Serratella	2	cg				15	15				
Serratella micheneri	2	cg									
Serratella teresa	2	cg					3				
Tricorythodes minutus	4	cg		27	10						
Odonata											
Argia	7	p		32							
Coenagrionidae	9	p		1							
Cordulegaster dorsalis	3	p									
Hetaerina americana	6	p		16							
Libellulidae	9	p			1						

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_333	SMCR8_339 1	SMCR8_339 2	SMCR8_344	SMCR8_376	SMCR8_418 1	SMCR8_418 2	SMCR8_474	SMCR8_513
Insecta Taxa											
Odonata											
Octogomphus specularis	4	p									
Odonata											
Paltothemis lineatipes	9	p									
Progomphus borealis	4	p									
Zoniagrion exclamationis	9	p									
Zygoptera					50						
Plecoptera											
Calineuria californica	2	p								1	
Chloroperlidae	1	p				5	2			3	
Hesperoperla	2	p									
Isoperla	2	p				3					
Malenka	2	sh				95					2
Nemouridae	2	sh				7					
Osobenus yakimae	2	p				1					
Perlidae	1	p								5	
Plecoptera						1				2	1
Suwallia	1	p					2				
Zapada cinctipes	2	sh	1				1			21	
Hemiptera											
Belostomatidae	8	p									
Corisella decolor	8	p									
Corixidae	8	p						1			
Trichocorixa calva	8	p									
Trichoptera											
Agapetus	0	sc				1					3
Brachycentridae	1							1			
Cheumatopsyche	5	cf		10	8						
Glossosoma	1	sc									
Glossosomatidae	0	sc									10
Gumaga	3	sh									
Helicopsyche	3	sc		3							
Hesperophylax	3	om				1					
Hydropsyche	4	cf		40	39						
Hydropsyche morosa	6	ph					3				
Hydropsychidae	4	cf	2		7			1			3
Hydroptila	6	ph		7	2						1
Hydroptilidae	4	ph		1	2						

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_333	SMCR8_339 1	SMCR8_339 2	SMCR8_344	SMCR8_376	SMCR8_418 1	SMCR8_418 2	SMCR8_474	SMCR8_513
Insecta Taxa											
Trichoptera											
Lepidostoma	1	sh					14			11	5
Micrasema	1	mh					1			30	21
Neophylax	3	sc									
Ochrotrichia	4	ph		1	1						
Parapsyche	0	p	11								
Philopotamidae	3	cf									
Polycentropus	6	p									
Psychoglypha	2	sh					2				1
Rhyacophila	0	p	4			6	1			2	
Sericostomatidae	3	sh									
Tinodes	2	sc								1	
Trichoptera						1				3	3
Wormaldia	3	cf									
Coleoptera											
Agabus	8	p									
Berosus	5	p									
Coleoptera											
Dytiscidae	5	p									
Enochrus	5	cg						1	4		
Hydraena	5	p									
Hydrobius	8	p									
Hydrophilidae	5	p									
Hydroporinae	5	p									
Hygrotus	5	p									
Laccobius	5	cg									
Laccophilus	5	p									
Liodessus	5	p									
Narpus	4	cg				2	1				
Optioservus	4	sc									
Peltodytes		mh									
Postelichus	5										
Sanfilippodytes	5	p									2
Stictotarsus	5	p	1								1
Tropisternus	5	p									
Zaitzevia	4	sc									
Diptera											
Anopheles	8	cg									

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_333	SMCR8_339		SMCR8_344	SMCR8_376	SMCR8_418		SMCR8_474	SMCR8_513
				1	2			1	2		
Insecta Taxa											
Diptera											
Atylotus/Tabanus	5	p									
Bezzia/Palpomyia	6	p			1		6				
Brachycera											
Caloparyphus/Euparyphus	8	cg						2	3		2
Ceratopogonidae	6	p						1			1
Chelifera/Metachela	6	p									
Chironomidae	6	cg	123	265	225	106	341	46	92	46	230
Clinocera	6	p	2				1				4
Culicoides						1					
Dasyhelea	6	cg						15	36		
Dicranota	3	p			1	4	1				1
Diptera							1				
Dixa	2	cg	1								8
Empididae	6	p									
Ephydridae	6										
Euparyphus	8	cg									
Forcipomyia	6	cg									
Glutops	3	p									
Hemerodromia	6	p			1					1	
Hexatoma	2	p				3					
Holorusia hespera	5	sh									
Limonia	6	sh									
Maruina lanceolata	2	sc								1	5
Muscidae	6	p	4								
Nemotelus	8	cg									
Neoplasta	6	p									3
Pericoma/Telmatoscopus	4	cg			1						
Probezzia	6	p						1			
Prosimulium	3	cf									
Psychoda	10	cg									
Psychodidae		cg						1	4		
Simuliidae	6	cf						1			
Simulium		cf	247		1	5	18			2	3
Stilobezzia	6	p	1								
Stratiomyidae	8	cg									
Tipula	4	om									1
Tipulidae	3					1					

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_333	SMCR8_339		SMCR8_344	SMCR8_376	SMCR8_418		SMCR8_474	SMCR8_513
				1	2			1	2		
Insecta Taxa											
Diptera											
Tipulinae	3										
Trichoclinocera	6	p									
Wiedemannia	6	p									
Lepidoptera											
Lepidoptera				3							
Megaloptera											
Neohermes	0	p									1
Non-Insecta Taxa											
Acari	5	p			1	3					
Annelida											
Ljania	5	p									
Pulmonata											
Hirudinea	10	pa									
Oligochaeta	5	cg			34	138	9	40	236	11	14
Ostracoda	8	cg		13	22	45	6	329	57	276	61
Turbellaria	4	p		3	17	1	10				
Amphipoda											
Amphipoda	4	cg									
Hyalella	8	cg		4				2			
Arhynchobdellida											
Mooreobdella	8	p									
Basommatophora											
Ferrissia	6	sc		2	1						
Lymnaea	6	sc							1		
Menetus opercularis				2	5						
Physa	8	sc		3				6	5		26
Hydridae											
Hydra	5	p									
Hypsogastropoda											
Hydrobiidae	8	sc									
Rhynchobdellida											
Helobdella	6	pa									
Trombidiformes											
Arrenurus	5	p									
Atractides	8	p					2			2	
Estelloxus	8	p								3	1
Lebertia	8	p				1	4			3	6

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_333	SMCR8_339 1	SMCR8_339 2	SMCR8_344	SMCR8_376	SMCR8_418 1	SMCR8_418 2	SMCR8_474	SMCR8_513
Insecta Taxa											
Trombidiformes											
Mesobates	8	p									2
Mideopsis	5	p									
Pionidae											
Protzia	8	p									
Sperchon	8	p		28	31	1				4	1
Sperchonopsis	8	p									
Testudacarus	5	p									
Torrenticola	5	p									
Veneroida											
Corbicula	8	cf		12	5			1		1	
Pisidium	8	cf				5	3				1
Sphaeriidae	8	cf									
Veneroida							3	1			
TOTAL			**500**	**500**	**500**	**500**	**500**	**500**	**500**	**500**	**500**

BMIs collected, adjusted to counts of 500 via Monte Carlo method.

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_572	SMCR8_600	SMCR8_601	SMCR8_605	SMCR8_613	SMCR8_688	
								1	2
Insecta Taxa									
Ephemeroptera									
Ameletus	0	cg							
Baetidae	4	cg	15				2		1
Baetis	5	cg				3	65	1	4
Baetis adonis	5	cg							
Baetis tricaudatus	6	cg		7		7	3		
Callibaetis	9	cg							
Caudatella heterocaudata	1	cg							
Caudatella hystrix	1	cg							
Centroptilum	2	cg							5
Cinygmula	4	sc							
Diphetor hageni	5	cg							
Drunella	0	cg		1					
Drunella coloradensis	0	p							
Drunella flavilinea	0	cg							
Epeorus	0	sc		3					
Ephemerella	1	cg							
Ephemerella dorothea	1	cg							
Ephemerella maculata	1	cg							
Ephemerellidae	1	cg							
Ephemeroptera			3				2		
Fallceon quilleri	4	cg	200	5	1		88	1	2
Heptageniidae	4	sc							
Ironodes	3	sc							
Leptohyphidae	4	cg	1						
Leptophlebiidae	2	cg				1		32	12
Paraleptophlebia	4	cg							
Rhithrogena	0	sc							
Serratella	2	cg							
Serratella micheneri	2	cg							
Serratella teresa	2	cg							
Tricorythodes minutus	4	cg	20	29					
Odonata									
Argia	7	p		2			6		
Coenagrionidae	9	p	5						
Cordulegaster dorsalis	3	p							
Hetaerina americana	6	p							
Libellulidae	9	p					1		

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_572	SMCR8_600	SMCR8_601	SMCR8_605	SMCR8_613	SMCR8_688	
								1	2
Insecta Taxa									
Odonata									
Octogomphus specularis	4	p							
Odonata									
Paltothemis lineatipes	9	p							
Progomphus borealis	4	p							
Zoniagrion exclamationis	9	p							
Zygoptera				10					
Plecoptera									
Calineuria californica	2	p							
Chloroperlidae	1	p							
Hesperoperla	2	p							
Isoperla	2	p							
Malenka	2	sh		2				7	6
Nemouridae	2	sh						12	
Osobenus yakimae	2	p							
Perlidae	1	p							
Plecoptera									
Suwallia	1	p							
Zapada cinctipes	2	sh						1	19
Hemiptera									
Belostomatidae	8	p							
Corisella decolor	8	p							
Corixidae	8	p	3						
Trichocorixa calva	8	p	3						
Trichoptera									
Agapetus	0	sc		6					
Brachycentridae	1								
Cheumatopsyche	5	cf							
Glossosoma	1	sc							
Glossosomatidae	0	sc		4					
Gumaga	3	sh							1
Helicopsyche	3	sc							
Hesperophylax	3	om						1	
Hydropsyche	4	cf		50					
Hydropsyche morosa	6	ph							
Hydropsychidae	4	cf		8		1			
Hydroptila	6	ph	9	17			20		
Hydroptilidae	4	ph	1				2		

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_572	SMCR8_600	SMCR8_601	SMCR8_605	SMCR8_613	SMCR8_688 1	SMCR8_688 2
Insecta Taxa									
Trichoptera									
Lepidostoma	1	sh		15		10		8	4
Micrasema	1	mh				2		1	1
Neophylax	3	sc							
Ochrotrichia	4	ph							
Parapsyche	0	p							
Philopotamidae	3	cf							
Polycentropus	6	p							
Psychoglypha	2	sh						1	
Rhyacophila	0	p		1					
Sericostomatidae	3	sh							
Tinodes	2	sc		16					
Trichoptera				6				3	
Wormaldia	3	cf							
Coleoptera									
Agabus	8	p	2						
Berosus	5	p							
Coleoptera									
Dytiscidae	5	p							
Enochrus	5	cg	4						
Hydraena	5	p							
Hydrobius	8	p							
Hydrophilidae	5	p					1		
Hydroporinae	5	p							
Hygrotus	5	p	3						
Laccobius	5	cg							
Laccophilus	5	p	1						
Liodessus	5	p							
Narpus	4	cg							1
Optioservus	4	sc		2					
Peltodytes		mh							
Postelichus	5								
Sanfilippodytes	5	p	1			1			
Stictotarsus	5	p							
Tropisternus	5	p	2						
Zaitzevia	4	sc							
Diptera									
Anopheles	8	cg							

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_572	SMCR8_600	SMCR8_601	SMCR8_605	SMCR8_613	SMCR8_688 1	SMCR8_688 2
Insecta Taxa									
Diptera									
Atylotus/Tabanus	5	p							
Bezzia/Palpomyia	6	p	5					7	6
Brachycera			1						
Caloparyphus/Euparyphus	8	cg	3	5			33		
Ceratopogonidae	6	p					2	2	
Chelifera/Metachela	6	p							
Chironomidae	6	cg	49	180	497	96	64	302	309
Clinocera	6	p						2	1
Culicoides									2
Dasyhelea	6	cg							
Dicranota	3	p						4	
Diptera									
Dixa	2	cg							
Empididae	6	p		2					
Ephydridae	6		1			1			
Euparyphus	8	cg	1	1			1		
Forcipomyia	6	cg							1
Glutops	3	p							
Hemerodromia	6	p		16					
Hexatoma	2	p						1	
Holorusia hespera	5	sh							
Limonia	6	sh							
Maruina lanceolata	2	sc							
Muscidae	6	p							
Nemotelus	8	cg					15		
Neoplasta	6	p		1				1	1
Pericoma/Telmatoscopus	4	cg					2		
Probezzia	6	p						11	
Prosimulium	3	cf							
Psychoda	10	cg			1				
Psychodidae		cg					1		
Simuliidae	6	cf							
Simulium		cf	6	35		87	68		13
Stilobezzia	6	p							
Stratiomyidae	8	cg							
Tipula	4	om					2		
Tipulidae	3								

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_572	SMCR8_600	SMCR8_601	SMCR8_605	SMCR8_613	SMCR8_688	
								1	2
Insecta Taxa									
Diptera									
Tipulinae	3								
Trichoclinocera	6	p				2			
Wiedemannia	6	p							
Lepidoptera									
Lepidoptera									
Megaloptera									
Neohermes	0	p							
Non-Insecta Taxa									
Acari	5	p		1				1	
Annelida									
Ljania	5	p							
Pulmonata									
Hirudinea	10	pa							
Oligochaeta	5	cg	7	6		75	108	15	10
Ostracoda	8	cg	57	30	1	64	3	78	94
Turbellaria	4	p		1					
Amphipoda									
Amphipoda	4	cg							
Hyalella	8	cg	49						
Arhynchobdellida									
Mooreobdella	8	p	1						
Basommatophora									
Ferrissia	6	sc							
Lymnaea	6	sc							
Menetus opercularis									
Physa	8	sc	47	30		135	2		
Hydridae									
Hydra	5	p				7			
Hypsogastropoda									
Hydrobiidae	8	sc							
Rhynchobdellida									
Helobdella	6	pa							
Trombidiformes									
Arrenurus	5	p							
Atractides	8	p		3		2			1
Estelloxus	8	p						2	1
Lebertia	8	p		2					2

Identified Taxa	Tol Val (TV)	Func Feed Grp	SMCR8_572	SMCR8_600	SMCR8_601	SMCR8_605	SMCR8_613	SMCR8_688 1	2
Insecta Taxa									
Trombidiformes									
Mesobates	8	p							
Mideopsis	5	p						1	
Pionidae									
Protzia	8	p							
Sperchon	8	p		3		1	9		
Sperchonopsis	8	p							
Testudacarus	5	p							
Torrenticola	5	p							
Veneroida									
Corbicula	8	cf							
Pisidium	8	cf							
Sphaeriidae	8	cf				5		4	3
Veneroida								1	
TOTAL			**500**	**500**	**500**	**500**	**500**	**500**	**500**