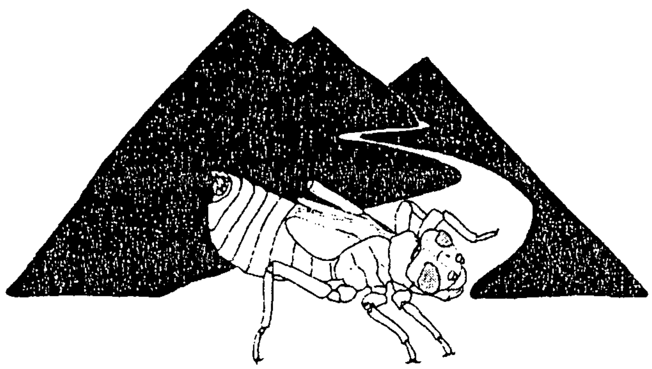
A WATER QUALITY INVENTORY SERIES

BIOLOGICAL AND PHYSICAL/HABITAT ASSESSMENT OF CALIFORNIA WATER BODIES

Calleguas Creek Characterization Study
Benthic Macroinvertebrates
November, 1998



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Program Manager
James M. Harrington

Project Leaders
Peter Ode
Angie Montalvo

Laboratory and Field Technicians
Doug Post
Christopher Sheehy
Mike Dawson

California Department of Fish and Game
Office of Spill Prevention and Response
Water Pollution Control Laboratory
2005 Nimbus Road, Rancho Cordova, Ca. 95670
(916) 358-2858; jharr@sna.com

INTRODUCTION TO THE WATER QUALITY INVENTORY SERIES

Throughout the past century, the California Department of Fish and Game (DFG) has been the leading force in developing new techniques and conducting biological and physical habitat surveys of the state's water resources. Besides managing fish and wildlife population, DFG has also been active in investigating and enforcing pollution cases. This is somewhat unique among state fish and wildlife agencies and stems from DFG's close involvement with the State Water Resources Control Board (and the Board's nine regions) and its own anti-pollution laws contained in Fish and Game Code 5650.

The DFG's Water Pollution Control Laboratory (WPCL) was established by the State Legislature in 1967 to provide laboratory services to DFG and branches of State and Federal government which deal in environmental monitoring and regulation. The WPCL began as a analytical chemistry laboratory, developing aquatic toxicological capabilities in the 1970's and then in 1992, established the Aquatic Bioassessment Laboratory (ABL) to perform biological and physical/habitat assessment surveys, specializing in invertebrate ecology and taxonomy. The combination of these functions allows the WPCL to utilize the investigative triad (chemical, toxicological and biological) when addressing water quality concerns.

In 1993, DFG introduced standardized field sampling, laboratory identification and quality assurance/quality control (QA/QC) procedures for assessing wadeable streams utilizing benthic macroinvertebrates. These California Stream Bioassessment Procedure (CSBP) were developed from EPA guidelines (Plafkin et al. 1989) and input from aquatic biologists throughout California involved with biological monitoring. The CSBP is continually reviewed and refined through annual meetings of the California Aquatic Bioassessment Workgroup (CABW) sponsored by DFG, the State Water Resources Control Board and EPA. Now in its third revision, the CSBP is a regional adaptation of the EPA Rapid Bioassessment Protocols (Barbour et al. 1997) and is listed by the EPA as the protocol used in California to develop biocriteria (Davis et al. 1996). In 1996, DFG has also introduced a CSBP for citizen monitors and the draft California Lentic Bioassessment Protocols (CLBP) for sampling lakes, reservoirs and lagoons.

The CSBP is being used by environmental consulting firms and state water resource agencies throughout California in watershed based assessments, point-source assessment of waste discharges, evaluation of toxic spill events and ambient bioassessment programs. The DFG projects which demonstrate the use of the CSBP and other bioassessment techniques fall within three categories:

> **Watershed Based Surveys** with the objective to assess the biological and physical/habitat condition of an entire watershed or a significant portion of its tributaries;
>
> **Point-Source Impact Assessments (Enforcement)** with the objective to assess the discharge of a known deleterious pollutant on the biological and physical/habitat condition of a water body; and
>
> **Water Body Health Surveys and Special Studies** with the objective to measure changes in the biological and physical/habitat condition of a water body resulting from either a specific resource management technique or land-use practice.

INTRODUCTION

In October 1998, the California Department of Fish and Game's Aquatic Bioassessment Laboratory (ABL) was contracted by Larry Walker Associates (LWA) to initiate a biological monitoring program in the Calleguas Creek watershed in Ventura County. ABL's bioassessment will contribute to a characterization of the Calleguas Creek watershed requested by the Los Angeles Regional Water Quality Control Board and coordinated by LWA. The primary focus of this assessment is the influence of several municipal waste discharge facilities and agricultural discharge on water quality within the watershed, but the impact of agricultural discharge is also involved.

The California Stream Bioassessment Procedure (CSBP), developed by the California Department of Fish and Game (DFG), was used to evaluate the benthic macroinvertebrate communities (Harrington 1996). The CSBP is a regional adaptation of the U.S. Environmental Protection Agency (EPA) Rapid Bioassessment Protocols (Plafkin et al. 1989) and is recognized by the EPA as California's standardized bioassessment procedure (Davis et al. 1996).

The CSBP is a cost effective tool which utilizes measures of the stream's benthic macroinvertebrate (BMI) community and its physical/ habitat structure. BMIs can have a diverse community structure with individual species residing within the stream for a period of months to several years. They are also sensitive, in varying degrees, to temperature, dissolved oxygen, sedimentation, scouring, nutrient enrichment and chemical and organic pollution (Resh and Jackson 1993). Together, biological and physical assessments integrate the effects of water quality over time, are sensitive to multiple aspects of water and habitat quality, and provide the public with more familiar expressions of ecological health (Gibson 1996).

This report presents results from samples collected in November 1998.

MATERIALS AND METHODS

Monitoring Reach Descriptions

Monitoring reach descriptions are summarized in Table 1 and a map of the Calleguas Creek watershed and monitoring reaches is shown in Figure 2. Reaches were selected by LWA to correspond with concurrent physical and chemical monitoring in the watershed.

Benthic Macroinvertebrate Sampling

BMIs were sampled 4-6 November 1998 using the California Stream Bioassessment Protocols (CSBPs) for non-point source assessments (Harrington 1996).

Riffle length was determined for each riffle and a random number table was used to establish a point randomly along the length of the riffle from which a transect was established perpendicular to the stream flow. Starting with the transect at the lowermost riffle, the benthos within a two ft^2 area was disturbed upstream of a one ft wide, 0.5 mm mesh D-frame kick-net. Sampling of the benthos was performed manually by rubbing cobble and boulder substrates in front of the net followed by "kicking" the upper layers of substrate to dislodge any invertebrates remaining in the

Table 1. Benthic macroinvertebrate sampling location information for reaches sampled between 4-6 November 1998 within the Calleguas Creek watershed.

Stream Name	Location Description	LWA Site Number	Latitude/ Longitude
Arroyo Simi	Reach consisted of 5 riffles above SVWQCP	1	N34°16' 40.3", W118° 48' 01.4"
Arroyo Simi	Reach consisted of 5 riffles downstream of SVWQCP	2	N34°17' 00.3", W118° 49' 02.6"
Arroyo Los Posas	Reach consisted of 5 riffles upstream of MPWWTP at Hitch Blvd.	4	N34°16' 17.8", W118° 55' 26.6"
Arroyo Los Posas	Reach consisted of 5 riffles downstream of MPWWTP near Somis Road	5	N34°15' 09.8", W118° 59' 30.3"
Calleguas Creek	Reach consisted of 5 riffles downstream of Camrosa WWTP discharge at Camarillo Drive	6	N34°10' 47.2", W119° 02' 25.9"
South Fork Arroyo Conejo	Reach consisted of 5 riffles upstream of confluence with N. Fork Arroyo Conejo	9	N34°12' 56.5", W118° 54' 04.6"
Arroyo Conejo	Reach consisted of 5 riffles downstream of confluence with N. Fork Arroyo Conejo	10	N34°12' 39.7", W118° 55' 25.5"
Conejo Creek	Reach consisted of 5 riffles downstream of Adolfo Road	11	N34°12' 40.5", W118° 59' 27.4"
Conejo Creek	Reach consisted of 5 riffles downstream of Camarillo WWTP	12	N34°11' 28.1", W119° 00' 16.7"
Revolon Slough	Reach consisted of 5 riffles upstream of Wood Road	13	N34°10' 04.1", W119° 05' 33.8"

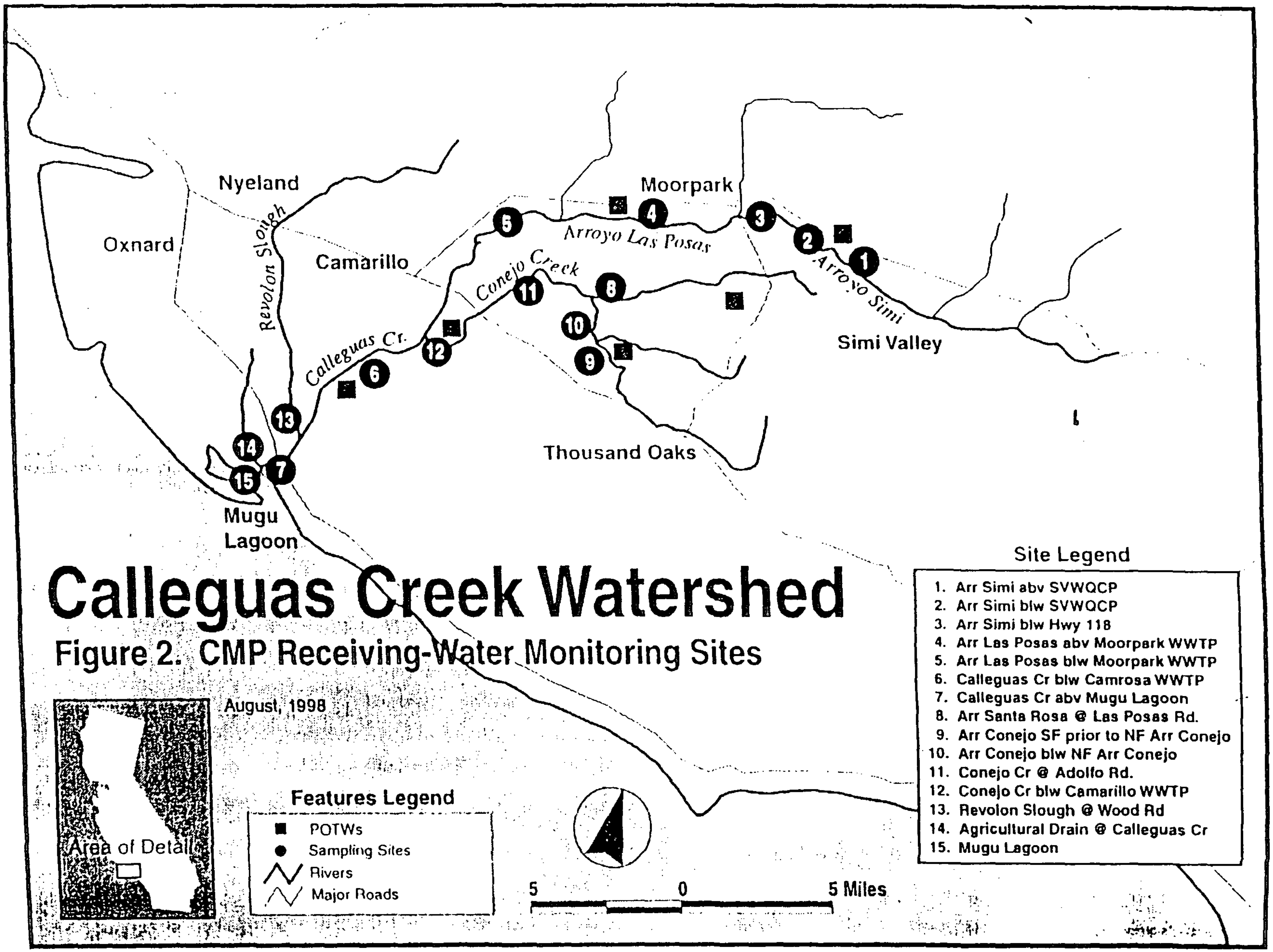


Figure 1. Monitoring sites for benthic macroinvertebrates in the Calleguas Creek watershed.

substrates. The duration of sampling ranged from 60-120 seconds, depending on the amount of boulder and cobble-sized substrates that required rubbing by hand; more and larger substrates required more time to process. Three locations representing the habitats along the transect were sampled and combined into a composite sample (representing a six ft^2 area). This composite sample was transferred into a 500 ml wide-mouth plastic jar containing approximately 200 ml of 95% ethanol. This technique was repeated for each of three riffles in each reach.

BMI Laboratory Analysis

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 detritus was removed from one randomly selected grid at a time and placed in 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 and 2% glycerol. This process was continued until 300 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. Macroinvertebrates were then identified to a standard taxonomic level, typically genus level for insects and order or class for non-insects using standard taxonomic keys (Brown 1972, Edmunds et al. 1976, 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 benthic macroinvertebrates identified from the samples was entered into a Microsoft Excel® spreadsheet program. Excel® was used also to calculate and summarize macroinvertebrate community based metric values. A description of the metric values used to describe the community is shown in Table 2.

Each of the monitoring reaches was given a relative BMI Ranking Score based on six of the BMI metric values (Table 2; metrics 1,2,4,5,7, and 8). The scores were computed as follows:

$$\textbf{Ranking Score} = \sum(\mathbf{x}_i - \times_i)/\mathbf{sem}_i$$

where: x_i = site value for the *i*-th metric; $\times_i$ = overall mean for the *i*-th metric; sem_i = standard error of the mean for the *i*-th metric.

Physical Habitat Quality Assessment

Physical habitat quality was assessed for the monitoring reaches using U.S. Environmental Protection Agency (EPA) Rapid Bioassessment Protocols (RBPs) (Plafkin *et al.* 1989). Habitat quality assessments were recorded for each monitoring reach during macroinvertebrate sampling events within riffle/ run habitats in late April 1998. Photographs were taken within each of the monitoring reaches to document overall reach condition at the time of sampling.

Table 2. Bioassessment metrics used to describe characteristics of the benthic macroinvertebrate (BMI) community at sampling reaches within the Calleguas Creek watershed.

BMI Metric	Description	Response to Impairment
Richness Measures		
1. Taxa Richness	Total number of individual taxa	decrease
2. EPT Taxa	Number of taxa in the Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) insect orders	decrease
Composition Measures		
3. EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae	decrease
4. Percent Dominant Taxa	Percent composition of the single most abundant taxon	increase
5. Shannon Diversity Index	General measure of sample diversity that incorporates richness and evenness (Shannon and Weaver 1963)	decrease
Tolerance/Intolerance Measures		
6. Tolerance Value	Value between 0 and 10 weighted for abundance of individuals designated as pollution tolerant (higher values) or intolerant (lower values)	increase
7. Percent Intolerant Organisms	Percent of organisms in sample that are highly intolerant to impairment as indicated by a tolerance value of 0, 1 or 2	decrease
8. Percent Tolerant Organisms	Percent of organisms in sample that are highly tolerant to impairment as indicated by a tolerance value of 8, 9 or 10	increase
Functional Feeding Groups (FFG)		
9. Percent Collectors	Percent of macrobenthos that collect or gather fine particulate matter	increase
10. Percent Filterers	Percent of macrobenthos that filter fine particulate matter	increase
11. Percent Grazers	Percent of macrobenthos that graze upon periphyton	variable
12. Percent Predators	Percent of macrobenthos that feed on other organisms	variable
13. Percent Shredders	Percent of macrobenthos that shreds coarse particulate matter	decrease
Abundance		
14. Estimated Abundance	Estimated number of macroinvertebrates in sample calculated by extrapolating from the proportion of organisms counted in the subsample.	variable

RESULTS

Dominant BMI Taxa/ General Taxonomic Notes

The five dominant taxa observed in each of the monitoring reaches are presented in Table 3. A complete list of macroinvertebrates identified from the samples is presented in Appendix 2.

The BMI community was dominated by a few abundant taxa at each site and there were generally very few taxa across all sites. Three groups of taxa were abundant at all sites: midges (Diptera: Chironomidae), minnow mayflies (Ephemeroptera: Baetidae) and blackflies (Diptera: Simuliidae). Several other taxa were abundant at only some sites. Freshwater scuds (Amphipoda: *Gammarus)* were extremely abundant at Sites 6, 11 and 12, aquatic worms (Oligochaeta) were abundant at Sites 5 and 13, *Tricorythodes sp.* (Ephemeroptera: Tricorythidae) was abundant only at Site 1 and the snail, *Physa/ Physella sp.*, although present at all sites, was only abundant at Site 10.

There was an unusually large dominance by true fly larvae (Insecta: Diptera) taxa in the Calleguas Creek watershed. Of the 41 insect taxa present, 24 taxa were dipterans. Beetles were rare; only four sites had any beetle taxa and only one sample contained more than one individual (Site 2). The remaining insects were limited to very tolerant taxa in the orders Hemiptera, Ephemeroptera, Trichoptera and Odonata.

Benthic Macroinvertebrate Community Metrics

BMI metric values are presented by transect in Table 4 and summarized by reach mean and coefficient of variation in Table 5. Results of the BMI ranking scores for the reaches are shown in Figure 2.

Richness and Tolerance

Metrics describing BMI richness generally were low in all of the monitoring reaches (Table 5). Average Taxonomic Richness ranged from a low of 9 taxa (Site 4) and highs of 20 and 26 taxa (Sites 4 and 5, respectively) with most sites having between 10 and 15 taxa. The sensitive EPT taxa were also very low. No sample had more than 6 EPT taxa and most had 3 or fewer.

Composition Measures

Shannon Diversity values were low at all sites, ranging from very low values at Sites 10, 11 and 12 (0.9, 0.9 and 1.1) to moderately low values at Site 4 and Site 13. Although there were very few EPT taxa, these taxa were occasionally the most abundant organisms in samples. EPT Index scores were highly variable, with 7 sites composed of fewer than 15 percent EPT individuals. All sites were dominated by one or a few taxa. The Percent Dominant Taxon metric indicates that the most abundant taxon comprised between 19 and 74 percent of the total BMI community. The Percent Dominant Taxon scores in half of the sites was over 55 percent. The top five most abundant taxa (Table 2) together comprised more than 95% of the community in 4 sites (Sites 6, 10, 11, and 12) and more than 75% of the community in all but one site (Site 4, 60%).

Table 3. Dominant macroinvertebrate taxa and their percent contribution by reach from samples collected 4-6 November 1998 within the Calleguas Creek watershed.

Monitoring Reach	**Dominant Taxa**				
	1	**2**	**3**	**4**	**5**
1	*Tricorythodes* (35)	*Baetis* (17)	Simuliidae (11)	*Fallceon* (10)	Orthocladiinae (7)
2	Simuliidae (39)	Chironomini (31)	*Baetis* (8)	Orthocladiinae (7)	*Tricorythodes* (3)
4	*Hydroptila* (18)	Cyprididae (14)	Chironomini (13)	Orthocladiinae (8)	*Baetis* (7)
5	Oligochaeta (44)	Orthocladiinae (20)	*Baetis* (7)	Simuliidae (3)	*Caloparyphus* (2)
6	*Gammarus* (58)	Orthocladiinae (19)	Simuliidae (10)	*Hydroptila* (5)	Planariidae (4)
9	*Hydropsyche* (34)	*Baetis* (29)	Simuliidae (19)	Sperchontidae (6)	*Fallceon* (3)
10	Simuliidae (56)	*Physa* (21)	Cyprididae (9)	*Baetis* (8)	Orthocladiinae (2)
11	*Gammarus* (74)	Simuliidae (12)	*Baetis* (9)	*Pericoma* (1)	*Probezzia* (1)
12	Simuliidae (62)	*Gammarus* (30)	Orthocladiinae (2)	*Baetis* (2)	*Physa* (1)
13	Orthocladiinae (24)	Oligochaeta (18)	Planariidae (16)	Cyprididae (15)	Tanytarsini (9)

Table 4. Bioassessment metrics calculated for macroinvertebrate samples collected from sites on the Calleguas Creek watershed on 4-6 November 1998.

	Arroyo Simi						**Arroyo Las Posas**						**Calleguas Creek**		
site:	Site 1			Site 2			Site 4			Site 5			Site 6		
Transect Number:	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
ABL Laboratory Number:	2823	2824	2825	2826	2827	2829	2830	2831	2832	2833	2834	2835	2836	2837	2838
Taxa Richness	18	16	13	11	18	16	19	25	17	28	25	25	8	10	12
Percent Dominant Taxon	29	24	62	82	40	50	17	16	22	51	58	27	37	53	74
EPT Taxa	5	5	5	5	6	5	3	3	3	3	1	3	0	1	1
EPT Index (%)	63	59	91	9	25	12	31	27	33	6	8	22	0	11	1
Shannon Diversity	2.2	2.1	1.3	0.8	2.1	1.6	2.4	2.6	2.2	1.8	1.9	2.1	1.4	1.4	1.0
Tolerance Value	5.1	4.9	4.9	4.2	5.7	5.3	5.7	6.2	6.2	6.7	7.1	6.0	4.5	4.6	4.3
Percent Intolerant (0-2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent Tolerant (8-10)	5	8	1	0	11	2	16	36	33	57	68	33	5	5	1
Percent Collectors	70	59	92	16	80	70	57	62	58	89	84	86	60	79	88
Percent Filterers	11	29	3	83	11	28	20	13	12	2	2	8	37	4	3
Percent Grazers	10	7	3	1	5	0	17	21	27	2	2	3	1	11	3
Percent Predators	10	4	2	0	3	2	4	3	3	4	6	3	2	6	4
Percent Shredders	0	0	0	0	0	0	2	1	0	3	5	1	0	0	1
Abundance (# /sample)	5757	3152	4607	12040	1887	4564	284	687	3695	286	183	580	121	294	615

Table 4. Bioassessment metrics calculated for macroinvertebrate samples collected from sites on the Calleguas Creek watershed on 4-6 November 1998.

	Arroyo Conejo						**Conejo Creek**						**Revolon Slough**		
site:	Site 9			Site 10			Site 11			Site 12			Site 13		
Transect Number:	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
ABL Laboratory Number:	2839	2840	2841	2842	2843	2844	2845	2846	2847	2848	2849	2850	2851	2852	2853
Taxa Richness	12	13	15	11	7	12	11	7	12	12	6	9	15	13	14
Percent Dominant Taxon	34	37	41	66	88	53	84	61	76	49	88	49	33	25	21
EPT Taxa	4	3	3	2	3	1	2	2	1	2	2	2	1	1	1
EPT Index (%)	61	62	75	13	7	5	4	9	14	5	2	1	3	2	1
Shannon Diversity	1.7	1.8	1.5	1.3	0.5	1.4	0.8	1.0	0.9	1.2	0.5	1.0	1.9	2.0	2.1
Tolerance Value	4.5	4.5	4.5	4.7	4.2	7.2	4.2	4.1	4.2	4.3	4.0	4.2	5.8	6.7	6.0
Percent Intolerant (0-2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent Tolerant (8-10)	0	2	1	14	1	77	3	1	1	4	0	3	29	55	33
Percent Collectors	41	30	36	20	9	31	90	70	92	46	11	46	60	70	56
Percent Filterers	44	57	56	68	89	14	4	28	5	49	88	49	10	7	13
Percent Grazers	1	0	0	7	2	53	1	2	0	3	1	2	9	9	5
Percent Predators	14	12	8	5	0	2	5	0	3	1	0	2	22	14	25
Percent Shredders	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Abundance (# /sample)	7934	1594	4377	9889	11376	11053	2040	7585	1865	2894	15644	3030	823	1068	615

Table 5. Means and coefficients of variation (CV) for bioassessment metrics calculated from samples collected on the Calleguas Creek watershed on 4-6 November 1998.

	Arroyo Simi				**Arroyo Las Posas**				**Calleguas Creek**		**Arroyo Conejo**				**Conejo Creek**				**Revolon Slough**	
site:	Site 1		Site 2		Site 4		Site 5		Site 6		Site 9		Site 10		Site 11		Site 12		Site 13	
	Mean	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**
Taxa Richness	16	16	15	24	20	20	26	7	10	20	13	11	10	26	10	26	9	33	14	7
Percent Dominant Taxon	38	54	57	39	19	18	46	35	55	33	38	9	69	26	74	16	62	36	26	22
EPT Taxa	5	0	5	11	3	0	2	49	1	87	3	17	2	50	2	35	2	0	1	0
EPT Index (%)	71	25	15	58	30	9	12	73	4	151	66	12	8	53	9	55	3	72	2	51
Shannon Diversity	1.9	26	1.5	46	2.4	7	1.9	8	1.3	16	1.7	10	1.1	43	0.9	13	0.9	45	2.0	5
Tolerance Value	5.0	2	5.1	15	6.0	5	6.6	8	4.5	4	4.5	0	5.4	30	4.2	1	4.2	3	6.2	7
Percent Intolerant (0-2)	0	--	0	--	0	--	0	--	0	--	0	--	0	--	0	--	0	--	0	--
Percent Tolerant (8-10)	5	77	4	124	28	37	53	34	4	55	1	92	31	132	2	100	2	75	39	36
Percent Collectors	74	23	55	62	59	4	87	3	76	19	36	15	20	53	84	14	34	59	62	12
Percent Filterers	14	94	41	92	15	30	4	93	15	128	52	14	57	67	12	113	62	36	10	30
Percent Grazers	6	53	2	122	22	22	2	13	5	104	1	71	20	137	1	88	2	62	8	28
Percent Predators	5	80	2	97	3	16	4	41	4	57	11	28	2	97	3	92	1	92	20	28
Percent Shredders	0	--	0	--	1	97	3	76	0	--	0	--	0	--	0	--	0	--	0	--
Abundance (# /sample):	4505	29	6164	85	1555	120	325	72	318	89	4635	69	10773	7	3830	85	7189	102	835	27

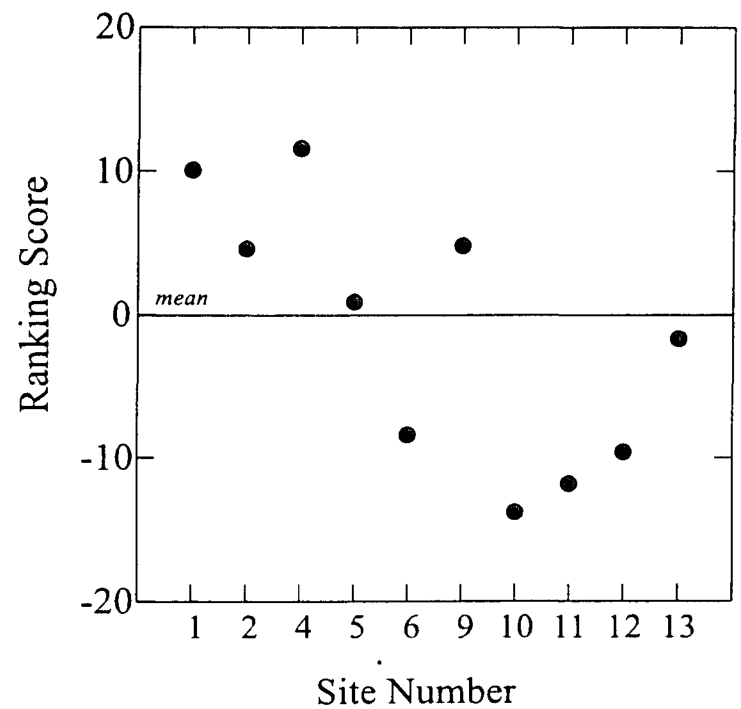


Figure 2. Benthic macroinvertebrate community ranking scores for monitoring reaches established in the Calleguas Creek watershed.

Tolerance Measures
All tolerance measures indicated communities that were very tolerant to disturbance or extremely tolerant to disturbance. Average tolerance value ranged between 4.2 and 6.6. Only one intolerant individual, the gomphid dragonfly *Progomphus sp.* found at Site 5, was present at any site. There were only two taxa with tolerance values less than 4 at any site and these were only found in the Arroyo Los Posas sites (Sites 4 and 5). Four sites (Sites 4, 5, 10 and 13) had relatively high proportions of highly tolerant taxa. The majority of taxa in the remaining sites were moderately tolerant to disturbance.

Functional Feeding Groups
All of the FFGs were present within the Calleguas Creek system, but shredders were encountered only rarely in a few sites (Table 6 and Figure 2). Shredders are usually associated with smaller stream systems where they feed mostly on accumulations of decomposing coarse particulate organic matter. Although there were many predator taxa, they rarely made up a significant proportion of the community, typically ranging between 1 and 5 % but reaching 20% in Site 13. Most organisms in this watershed were either collector-gatherers or filtering collectors, both of which feed on fine particulate organic matter (FPOM). In this system, FPOM feeders represented between 72 to 96 percent of the community across all sites. The relative proportion of collector-gatherers to filterers varied considerably. Grazing BMIs were sporadically abundant, representing up to 22 percent of the community in some cases (Sites 4 and 10) but there were generally fewer than 10 percent grazers in each site. The majority of the grazer population at each site was comprised of a few mayfly and snail taxa.

Abundance
Abundance of organisms was fairly high, ranging between lows of 318 and 325 in Sites 5 and 6 to a high of 10773 in Site 10. Variability in abundance among samples was fairly high; numbers varied in some cases by more than 10 fold.

BMI Ranking Score
Sites 1 and 4 consistently ranked highest in quality while Sites 6, 10, 11 and 12 consistently ranked poorest in overall quality and Sites 2, 5, 9 and 13 had average ranks (Figure 2).

<u>Physical Habitat Assessment</u>
Physical habitat quality scores are summarized in Table 6. Photographs of the reaches are shown in Appendix 2. Only two sites (9 and 10) had good physical habitat ranks (scores 140 and 133). All other monitoring reaches were scored as poor (scores 38 and 48) or fair (all other sites). With the exception of Sites 9 and 10, most sites had poor physical habitat qualities. The most common problems with physical habitat were associate with moderate to heavy channel alteration in the form of leveed and rip-rapped stream banks. Most sites suffered from extreme amounts of sediment (often completely covering larger substrates with heavy deposits of sand and silt). These high sediment levels were associated with high embeddedness, poor to nonexistent instream cover and low variation in velocity and depth regimes. Bank vegetation was often entirely absent, leaving no riparian zone.

Table 6. Physical habitat quality scores for sampling reaches within the Calleguas Creek watershed. Scores for each habitat parameter range from 0 (poor) to 20 (excellent).

Habitat Parameter	Monitoring Reach									
	1	2	4	5	6	9	10	11	12	13
1. Instream Cover	7	7	1	1	6	14	13	1	2	5
2. Embeddedness	6	7	0	0	3	10	14	0	4	3
3. Velocity/ Depth Regimes	5	7	1	4	4	15	18	3	3	8
4. Sediment Deposition	5	10	1	0	3	12	18	1	2	4
5. Channel Flow	5	9	5	5	3	5	8	4	6	4
6. Channel Alteration	2	17	0	15	0	20	20	0	8	0
7. Riffle Frequency	17	18	1	5	3	18	16	15	10	10
8. Bank Vegetation	0	7	5	10	0	10	6	0	8	5
9. Bank Stability	20	5	20	12	20	10	7	20	8	20
10. Riparian Zone	0	10	0	8	0	17	3	0	5	0
TOTAL	**67**	**99**	**38**	**65**	**48**	**140**	**133**	**55**	**68**	**72**
Physical Condition	**Fair**	**Fair**	**Poor**	**Fair**	**Poor**	**Good**	**Good**	**Fair**	**Fair**	**Fair**

DISCUSSION

Incorporation of data into a regional Index of Biological Integrity

The information in this report provides a baseline from which future bioassessment data sets for the same sites may be compared. This BMI data set can also contribute to the development of a regional Index of Biological Integrity (IBI) which could be used for evaluating the biological condition of these and other regional stream reaches. Efforts at developing regional IBIs are on-going in various areas of California (DFG 1998) using a modification of the approaches outlined in the EPA's conceptual model for implementation of biological criteria (EPA 1990), the Rapid Bioassessment Protocols (Barbour et al. 1997) and Karr and Chu (1999).

An IBI is the preferred evaluation tool to measure the biological condition of water resources (Davis and Simon 1995, Karr and Chu 1999). Lacking an IBI specific to the southern Central Coast region, we determined biotic condition for stream reaches based on evaluation of biological metric performance and a ranking procedure based solely on these sites. The BMI Ranking Score used in this report evaluates biotic condition of the sites relative to other sites in the study. The better sites in the data set rank higher than the average value and the worst rank lower than the average value. This does not mean that the sites would have had a high or low biologic condition using a regional IBI value. Using scoring criteria from a regional IBI for first to third order tributaries to the Russian River (DFG 1998), all the sites in Calleguas Creek would be assigned a rating of "poor", the lowest rating, with sites scoring between 6 and 13 points out of a total of 30.

Influence of Sediment

All of the sites in this watershed show typical signs of heavily sediment impacted streams. Low physical habitat scores primarily reflect the influence of heavy sediments in causing reduced habitat availability and reduced habitat quality for macroinvertebrates. The dominant taxa in these sites are all sediment tolerant, rapid colonizers which are adapted to collecting organic matter and algae in a constantly changing sandy substrate. The low diversity of substrates and simplicity of the physical environment are primarily responsible for the overall low bioassessment scores in this watershed. Aquatic organisms can respond as negatively to inorganic sediment as they do to other environmental contaminants (Newcombe and MacDonald 1991). Healthy communities of benthic macroinvertebrates that depend on diverse substrate particle size, available interstitial spaces and a complex habitat can be significantly affected or eliminated by sediment deposition (Waters 1995). Benthic macroinvertebrates can be killed directly by suffocation or affected indirectly through the loss of food sources and habitat (Johnson et al. 1993).

Influence of WWTPs

One of the objectives of this project was to assess the influence of WWTPs on the BMI community. Four upstream/ downstream comparisons (Site 1 vs. Site 2, Site 4 vs. Site 5, Site 9 vs. Site 10, and Site 11 vs. Site 12) were established for this purpose. Of the four WWTP comparisons, three suggest some influence of the WWTPs on the BMI communities at these sites (Site 1 vs. Site 2, Site 4 vs. Site 5 and Site 9 vs. Site 10) and one indicates a weaker or negligible influence (Site 11 vs. Site 12). In the Site 1 vs 2 comparison, most of the influence was reflected in the decreased diversity and increased dominance of filter feeding blackflies, a common effect of WWTP outfall. Although Site 5 had more taxa than Site 4, it also had a higher degree of single species dominance, fewer EPT taxa, a lower EPT index, lower diversity and more tolerant organisms. The comparison between Sites 9 and 10 was the most dramatic. Site 10 had fewer taxa, fewer EPT taxa, more tolerant taxa, lower diversity, a lower EPT Index and a higher Percent Dominant Taxon score. Although the physical habitat scores were very similar overall, the riparian zone in Site 10 was negligible compared to an intact riparian zone in Site 9. There were no significant differences between the BMI communities in Sites 11 and 12.

Site 6, which receives the waters of all the other sites except Site 13 ranked near the bottom in almost all the ranking criteria. This site was particularly strongly affected by sediment. Larger substrates at this site were buried by as much as 12 inches of sand and finer substrates. Site 13, in a tributary which enters the Calleguas watershed near its mouth, receives the discharge of at least two agricultural drains and appears to be influenced by sedimentation as much as the other sites in the watershed. Most BMI metrics fit in the middle of the range observed in the other reaches.

CONCLUSIONS/ RECOMMEDATIONS

The information in this report provides a baseline from which future bioassessment data sets for the same sites may be compared. This BMI data set can also contribute to the development of a regional Index of Biological Integrity (IBI). DFG recommends using this baseline information from BMI communities as to develop a regional IBI. A regional IBI will be a valuable tool for evaluating the biotic condition of these and other regional stream reaches.

Using an IBI developed for the Russian River watershed (the nearest IBI currently available), all sites in the Calleguas Creek were rated as having "poor" biotic condition.

The benthic macroinvertebrate communities sampled in this study are indicative of a heavily sediment-impacted watershed. In addition to the overall poor biotic condition caused by sediment, the data presented here suggest that the water quality of Calleguas Creek may also be slightly affected by the effluent of many of the wastewater treatment facilities in the watershed.

LITERATURE CITED

Barbour, M.T., J. Gerritsen, B.D. Snyder and J.B. Stribling. 1997. Revision to rapid bioassessment protocols for use in stream and rivers: periphyton, benthic macroinvertebrates and fish. EPA 841-D-97-002. U.S. Environmental Protection Agency. Washington DC.

Baumann, R.W., A.R. Gaufin and R.R. Surdick. 1977. The Stoneflies (Plecoptera) of the Rocky Mountains. American Entomological Society, Philadelphia, PA.

Brown, H.P. 1972. Aquatic Dryopoid Beetles (Coleoptera) of the United States. U.S. Environmental Protection Agency Project, # 18050 ELD. Washington D.C.

Clifford, H.F. 1991. Aquatic invertebrates of Alberta. The University of Alberta, Calgary, Alberta.

Davis, W. S., B. D. Syder, J. B. Stribling and C. Stoughton. 1996. Summary of state biological assessment program for streams and wadeable rivers. EPA 230-R-96-007. U.S. Environmental Protection Agency; Office of Policy, Planning and Evaluation: Washington, DC.

Davis, W. S. and T.P. Simons, eds. 1995. Biological Assessment and Criteria: Tools for Resource Planning and Decision Making. Lewis Publishers. Boca Raton, FL.

Department of Fish and Game (DFG). 1998. An Index of Biological Integrity for Russian River First to Third Order Tributary Streams, A Water Quality Inventory Report. Water Pollution Control Laboratory, Rancho Cordova, CA.

Gibson, G. R. 1996. Biological Criteria: Technical guidance for streams and small rivers. EPA 822-B-96-001. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

Harrington, J. M. 1996. California stream bioassess ment procedures. California Department of Fish and Game, Water Pollution Control Laboratory. Rancho Cordova, CA.

Hilsenhoff, W. L. 1987. An improved biotic index of organic stream pollution. Great Lakes Entomologist 20: 31-39.

Johnson, R. K., T. Wiederhold, and D. M. Rosenberg. 1993. Freshwater biomonitoring using individual organisms, populations and species assemblages of benthic macroinvertebrates. In: Rosenberg, D. M. and V. H. Resh (editors). 1993. Freshwater Biomonitoring and Benthic Macroinvertebrates, Chapman and Hall, New York, NY.

Karr, J. R. and E. W. Chu. 1999. Restoring Life in Running Waters -- Better Biological Monitoring. Island Press, Covelo, CA

Klemm, D.J. 1985. A guide to the freshwater Annelida (Polychaeta, Naidid and Tubificid Oligochaeta, and Hirudinea of North America. Kendall/Hunt Publishing Co., Dubuque, Iowa.

Merritt, R. W. and K. W. Cummins. 1995. An introduction to the aquatic insects of North America. Second Edition. Kendall/Hunt Publishing Co., Dubuque, Iowa

Newcombe, C. P. and D. D. McDonald. 1991. Effects of suspended sediments on aquatic ecosystems. North American Journal of Fisheries Management 111: 73-82.

Pennak, R. W. 1989. Freshwater invertebrates of the United States, 3rd Ed. John Wiley and Sons, Inc., New York.

Plafkin, J. L., M. T. Barbour, K. D. Porter, S. K. Gross, and R. M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates and fish. EPA 444/4-89-001. U.S. Environmental Protection Agency, Washington, D.C.

Resh, V. H. and J. K. Jackson. 1993. Rapid assessment approaches to biomonitoring using benthic macroinvertebrates. In: D. M. Rosenberg and V. H. Resh, eds., Chapman and Hall, New York.

Rosenberg, D. M. and V. H. Resh (eds). 1993. Freshwater biomonitoring and benthic macroinvertebrates. Chapman and Hall, New York.

Stewart, K. W. and B. P. Stark. 1993. Nymphs of North American stonefly genera (Plecoptera). University of North Texas Press, Denton, Texas.

Surdick, R.F. 1985. Nearctic Genera of Chloroperlinae (Plecoptera: Chloroperlidae). University of Illinois Press. Chicago, IL.

Thorp, J. H. and A. P. Covich (eds.). 1991. Ecology and classification of North American invertebrates. Academic Press, San Diego, CA.

Usinger, R. L. Aquatic Insects of California. University of California Press. Berkeley, Ca.

Waters, T. F. 1995. Sediment in streams: sources, biological effects and control. American Fisheries Society Monograph 7.

Wiederholm, T. 1983. Chironomidae of the Holarctic region - Part 1. Larvae. Entomologica Scandinavica, Supplement No. 19. Sandby, Sweden.

______. 1986. Chironomidae of the Holarctic region - Part 2. Pupae. Entomologica Scandinavica, Supplement No.28. Sandby, Sweden.

Wiggins, G. B. 1996. Larva of North American caddisfly genera (Trichoptera), 2nd ed. University of Toronto Press, Toronto.

Wold, J.L. 1974. Systematics of the genus *Rhyacophila* (Trichoptera: Rhyacophilidae) in western North America with special reference to the immature stages. Master of Science Thesis. Oregon State University, Corvallis, OR.

APPENDIX 1

Taxonomic list of benthic macroinvertebrates identified from samples collected 4-6 November 1998 from monitoring reaches within the Calleguas Creek watershed

			Arroyo Simi						Arroyo Las Posas						Calleguas Creek		
site:			Site 1			Site 2			Site 4			Site 5			Site 6		
Transect Number:			T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
ABL Laboratory Number:			2823	2824	2825	2826	2827	2829	2830	2831	2832	2833	2834	2835	2836	2837	2838
PHYLUM ARTHROPODA	TV	FFG															
Class Insecta																	
Coleoptera (Adults)																	
Hydrophilidae																	
Paracymus sp.	5	c	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Coleoptera (Larvae)																	
Dytiscidae																	
Agabinus sp.		p	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Hydroporus sp.	5	p	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Hydrophilidae																	
Laccobius sp.	5	p	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Tropisternus sp.	5	p	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Diptera																	
Canacidae		g	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Ceratopogonidae																	
Culicoides sp.	6	p	-	-	-	-	-	-	2	1	-	2	2	3	-	-	-
Probezzia sp.	6	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined	6		-	-	-	-	-	-	-	1	-	1	2	-	-	-	1
Chironomidae																	
Chironominae																	
Chironomini	6	c	7	-	-	16	119	150	38	33	39	3	-	4	1	-	1
Tanytarsini	6	f	-	-	-	-	5	4	18	4	4	2	1	3	-	-	-
Orthocladiinae	5	c	33	14	10	8	35	17	30	23	16	66	9	78	32	66	36
Tanypodinae	6	p	3	1	2	-	5	4	4	4	6	-	-	-	-	1	-
Dolichopodidae	4	p	-	-	-	-	-	-	-	-	-	2	5	-	-	-	-
Empididae																	
Hemerodromia sp.	6	p	1	4	2	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined	6	p	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Ephydridae																	
Hydrellia sp.	6	s	-	-	-	-	-	-	5	3	-	4	4	1	-	-	2
Scatella sp.	6	c	-	-	-	-	-	-	-	1	-	2	3	1	-	-	-
Setacera sp.	6	s	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-
Undetermined	6		-	-	-	-	-	-	-	-	-	3	4	-	-	-	-
Muscidae	6	p	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Psychodidae																	
Pericoma sp./Telmatoscopus sp.	4	c	-	-	-	-	-	3	5	1	1	5	1	3	-	-	-
Psychoda sp.	10	c	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Undetermined		c	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Simuliidae	4	f	18	65	7	248	25	79	40	36	31	3	2	20	45	13	10
Stratiomyidae																	
Caloparyphus sp.	7	c	2	-	2	1	-	-	-	2	-	4	2	13	-	-	-
Euparyphus sp.	8	c	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Tipulidae																	
Limonia sp.	6	s	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Ormosia sp.	3	c	-	-	-	-	-	-	3	-	-	2	1	4	-	-	-

			Arroyo Simi						Arroyo Las Posas						Calleguas Creek		
site:			Site 1			Site 2			Site 4			Site 5			Site 6		
Transect Number:			T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
ABL Laboratory Number:			2823	2824	2825	2826	2827	2829	2830	2831	2832	2833	2834	2835	2836	2837	2838
<u>Hemiptera</u>																	
Corixidae																	
Corisella sp.	10	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined	10	p	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
<u>Odonata</u>																	
Coenagrionidae																	
Argia sp.	7	p	-	1	-	-	3	-	-	-	-	1	-	-	-	-	1
Coenagrion sp./ Enallagma sp.	9	p	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-
Enallagma sp.	9	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gomphidae																	
Progomphus sp.	1	p	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
<u>Ephemeroptera</u>																	
Baetidae																	
Baetis sp.	5	c	40	70	35	20	30	19	32	14	14	15	15	60	-	-	-
Callibaetis sp.	9	c	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Fallceon quilleri	4	c	17	30	38	2	12	6	7	21	22	1	-	2	-	-	-
Leptohyphidae																	
Tricorythodes sp.	5	c	77	41	178	1	22	7	-	-	-	-	-	-	-	-	-
<u>Trichoptera</u>																	
Hydropsychidae																	
Hydropsyche sp.	4	f	11	16	2	2	4	2	-	-	-	-	-	-	-	-	-
Hydroptilidae																	
Hydroptila sp.	6	g	24	11	7	1	6	1	49	49	57	1	-	5	-	31	3
Subphylum Chelicerata																	
Class Arachnoidea																	
<u>Acari</u>																	
Hygrobatidae	5	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnesiidae	5	p	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-
Sperchontidae	5	p	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Undetermined	5	p	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-
Subphylum Crustacea																	
Class Copepoda																	
<u>Cyclopoida</u>																	
Cyclopidae	8	c	1	-	-	-	2	-	5	1	5	-	2	-	1	-	-
Class Malacostraca																	
<u>Amphipoda</u>																	
Gammaridae																	
Gammarus lacustris	4	c	-	-	-	-	-	-	-	-	-	-	2	-	35	157	216
<u>Cladocera</u>																	
Chydoridae			-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Daphniidae	8	c	-	-	-	-	-	-	-	5	5	2	6	1	-	-	-
Macrothricidae			2	1	-	-	1	-	-	25	1	1	5	2	-	-	-

			Arroyo Simi						Arroyo Las Posas						Calleguas Creek		
site:			Site 1			Site 2			Site 4			Site 5			Site 6		
Transect Number:			T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
ABL Laboratory Number:			2823	2824	2825	2826	2827	2829	2830	2831	2832	2833	2834	2835	2836	2837	2838
Class Ostracoda																	
Ostracoda																	
Cyprididae	8	c	7	11	2	-	3	3	10	47	64	8	-	9	-	-	-
PHYLUM MOLLUSCA																	
Class Gastropoda																	
Limnophila																	
Ancylidae																	
Ferrissia sp.	6	g	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
Lymnaeidae	6	g	-	-	-	-	-	-	-	2	-	-	1	1	-	-	-
Physidae																	
Physa sp./Physella sp.	8	g	2	9	1	1	10	-	-	13	18	5	3	2	1	1	-
Planorbidae																	
Gyraulus sp.	8	g	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Class Bivalvia																	
Pelecypoda																	
Corbiculidae																	
Corbicula fluminea	10	f	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PHYLUM NEMATODA	5	p	22	5	-	-	-	-	3	-	1	2	2	2	-	-	-
PHYLUM PLATYHELMINTHES																	
Class Turbellaria																	
Tricladia																	
Planariidae	4	p	1	-	-	-	-	-	1	2	-	-	-	-	2	12	11
PHYLUM ANNELIDA																	
Class Hirudinea																	
Pharyngobdellida																	
Erpobdellidae	8	p	-	-	-	-	-	-	-	1	1	-	1	1	-	2	-
Class Oligochaeta	8	c	1	3	-	-	15	4	30	17	-	146	107	83	4	8	4
Total Organisms*			269	283	287	301	299	302	284	308	286	286	183	302	121	294	293

* Total organisms will deviate from 300 when the sample contains less than 300 organisms and/or when organisms are discarded in taxonomic identification (see ABAL Laboratory Procedures).

Recovered:	269	283	287	301	.299	302	284	308	286	286	183	302	121	294	293
Extras:	21	10	1	700	55	40	0	1	23	0	0	17	0	0	15
Total Organisms (includes extras):	321	310	301	1000	355	340	279	301	323	290	195	317	140	287	315
Grids Processed:	2	3	2	2	3	3	20	9	2	8	20	11	20	12	6
Total Grids Possible:	40	32	32	24	16	40	20	20	24	8	20	20	20	12	12
Sorted:	280	286	287	303	300	299	278	300	286	289	194	300	136	283	297
Discards:	14	12	9	0	0	1	1	0	8	1	1	0	3	2	3
Abundance (# /sample):	5757	3119	4607	12040	1887	4564	284	687	3695	286	183	580	121	294	615

			Arroyo Conejo						Conejo Creek						Revolon Slough		
site:			Site 9			Site 10			Site 11			Site 12			Site 13		
Transect Number:			T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
ABL Laboratory Number:			2839	2840	2841	2842	2843	2844	2845	2846	2847	2848	2849	2850	2851	2852	2853
PHYLUM ARTHROPODA	TV	FFG															
Class Insecta																	
Coleoptera (Adults)																	
Hydrophilidae																	
Paracymus sp.	5	c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coleoptera (Larvae)																	
Dytiscidae																	
Agabinus sp.		p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydroporus sp.	5	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydrophilidae																	
Laccobius sp.	5	p	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Tropisternus sp.	5	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diptera																	
Canacidae		g	-	-	-	-	-	-	-	-	-	-	-	-			
Ceratopogonidae															-	-	-
Culicoides sp.	6	p	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Probezzia sp.	6	p	-	-	-	-	-	-	1	-	5	-	-	-	-	-	-
Undetermined	6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Chironomidae																	
Chironominae																	
Chironomini	6	c	-	-	-	-	-	1	-	-	-	4	-	-	6	14	14
Tanytarsini	6	f	-	-	1	2	-	1	-	-	-	-	-	-	26	16	34
Orthocladiinae	5	c	7	14	1	5	10	7	-	1	2	9	2	6	93	46	58
Tanypodinae	6	p	-	-	-	-	-	-	4	-	1	-	-	-	-	1	2
Dolichopodidae	4	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Empididae																	
Hemerodromia sp.	6	p	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined	6	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Ephydridae																	
Hydrellia sp.	6	s	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Scatella sp.	6	c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Setacera sp.	6	s	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined	6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Muscidae	6	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psychodidae																	
Pericoma sp./Telmatoscopus sp.	4	c	-	-	-	-	-	-	5	-	1	-	-	-	1	-	-
Psychoda sp.	10	c	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Undetermined		c	-	-	-	-	-	-	-	-	3	-	-	-	1	-	-
Simuliidae	4	f	64	57	43	200	263	43	11	85	14	148	264	148	1	2	-
Stratiomyidae																	
Caloparyphus sp.	7	c	2	2	4	-	-	-	-	-	-	-	-	-	2	-	-
Euparyphus sp.	8	c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tipulidae																	
Limonia sp.	6	s	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ormosia sp.	3	c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

			Arroyo Conejo						Conejo Creek						Revolon Slough		
site:			Site 9			Site 10			Site 11			Site 12			Site 13		
Transect Number:			T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
ABL Laboratory Number:			2839	2840	2841	2842	2843	2844	2845	2846	2847	2848	2849	2850	2851	2852	2853
<u>Hemiptera</u>																	
Corixidae																	
Corisella sp.	10	p	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-
Undetermined	10	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Odonata</u>																	
Coenagrionidae																	
Argia sp.	7	p	2	9	2	3	1	-	-	-	-	-	-	-	-	-	-
Coenagrion sp./ Enallagma sp.	9	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Enallagma sp.	9	p	-	-	-	-	-	-	5	-	-	3	-	-	-	-	-
Gomphidae																	
Progomphus sp.	1	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Ephemeroptera</u>																	
Baetidae																	
Baetis sp.	5	c	99	56	100	37	18	14	11	24	42	11	3	2	-	-	-
Callibaetis sp.	9	c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fallceon quilleri	4	c	11	15	2	-	-	-	-	-	-	-	-	-	-	-	-
Leptohyphidae																	
Tricorythodes sp.	5	c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<u>Trichoptera</u>																	
Hydropsychidae																	
Hydropsyche sp.	4	f	64	110	123	3	3	-	-	-	-	-	-	-	-	-	-
Hydroptilidae																	
Hydroptila sp.	6	g	3	-	-	-	1	-	1	4	-	3	2	2	9	5	3
Subphylum Chelicerata																	
Class Arachnoidea																	
<u>Acari</u>																	
Hygrobatidae	5	p	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Limnesiidae	5	p	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Sperchontidae	5	p	26	18	11	-	-	-	-	-	-	-	-	-	-	-	-
Undetermined	5	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Subphylum Crustacea																	
Class Copepoda																	
<u>Cyclopoida</u>																	
Cyclopidae	8	c	-	-	-	-	-	-	-	-	-	-	-	-	2	-	3
Class Malacostraca																	
<u>Amphipoda</u>																	
Gammaridae																	
Gammarus lacustris	4	c	-	-	-	-	-	-	248	185	226	111	27	130	1	-	-
<u>Cladocera</u>																	
Chydoridae			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Daphniidae	8	c	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Macrothricidae			-	-	-	-	-	1	-	-	-	-	-	-	-	-	-

			Arroyo Conejo						Conejo Creek						Revolon Slough		
site:			Site 9			Site 10			Site 11			Site 12			Site 13		
Transect Number:			T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
ABL Laboratory Number:			2839	2840	2841	2842	2843	2844	2845	2846	2847	2848	2849	2850	2851	2852	2853
Class Ostracoda																	
Ostracoda																	
Cyprididae	8	c	-	2	1	14	-	64	-	-	-	-	-	-	29	62	29
PHYLUM MOLLUSCA																	
Class Gastropoda																	
Limnophila																	
Ancylidae																	
Ferrissia sp.	6	g	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lymnaeidae	6	g	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Physidae																	
Physa sp./Physella sp.	8	g	-	1	1	21	4	161	3	1	-	6	-	4	17	18	11
Planorbidae																	
Gyraulus sp.	8	g	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Class Bivalvia																	
Pelecypoda																	
Corbiculidae																	
Corbicula fluminea	10	f	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
PHYLUM NEMATODA	5	p	1	-	-	-	-	-	-	-	-	-	-	-	2	7	21
PHYLUM PLATYHELMINTHES																	
Class Turbellaria																	
Tricladia																	
Planariidae	4	p	10	7	6	10	-	5	3	-	-	1	-	1	60	28	45
PHYLUM ANNELIDA																	
Class Hirudinea																	
Pharyngobdellida																	
Erpobdellidae	8	p	-	2	2	2	-	1	2	-	1	-	-	5	-	-	-
Class Oligochaeta	8	c	-	-	-	5	-	6	-	1	-	1	1	1	34	66	47
Total Organisms*			290	294	299	302	300	305	294	301	298	299	299	299	284	267	272

* Total organisms will deviate from 300 when the sa

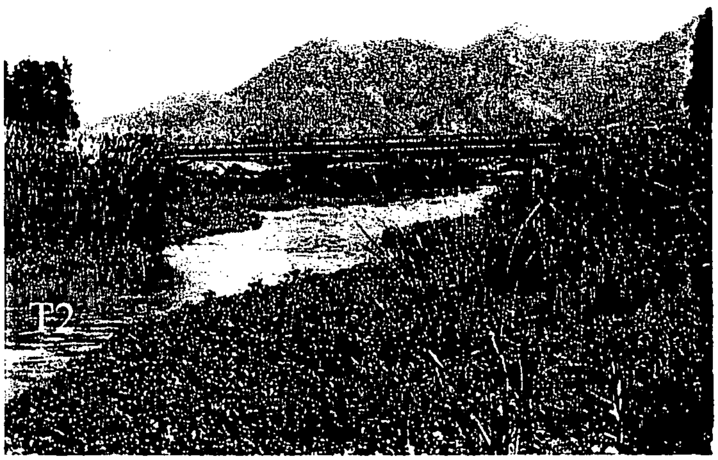
Recovered:	290	294	299	302	300	305	294	301	298	299	299	299	284	267	272
Extras:	42	5	249	314	411	153	47	15	52	63	354	80	26	0	39
Total Organisms (includes extras):	342	305	549	614	711	453	347	315	352	363	654	380	326	300	339
Grids Processed:	1	3	2	1	1	1	4	1	3	3	1	2	3	6	4
Total Grids Possible:	24	16	16	16	16	24	24	24	16	24	24	16	8	24	8
Sorted:	296	299	301	301	300	305	296	300	298	298	297	295	287	275	280
Discards:	3	1	0	0	0	0	4	0	2	2	3	2	6	16	12
Abundance (# /sample):	7934	1594	4377	9889	11376	11053	2040	7585	1865	2894	15644	3030	823	1068	615

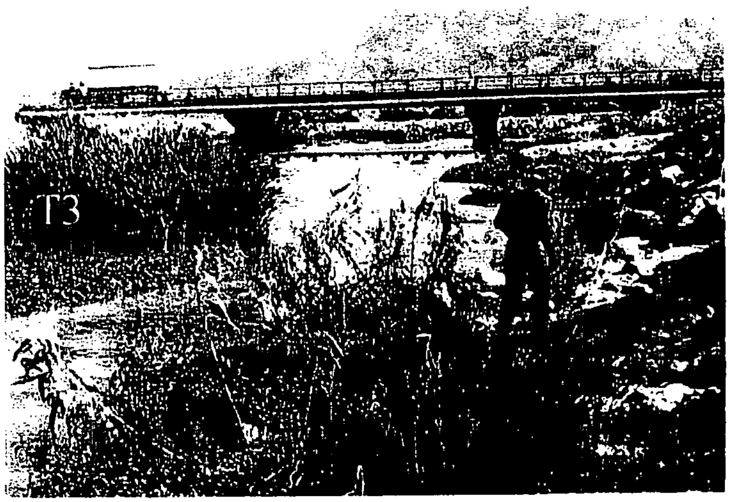
APPENDIX 2

Photographs taken 4-6 November 1998 of monitoring reaches
within the Calleguas Creek watershed

Site 1

Site 2



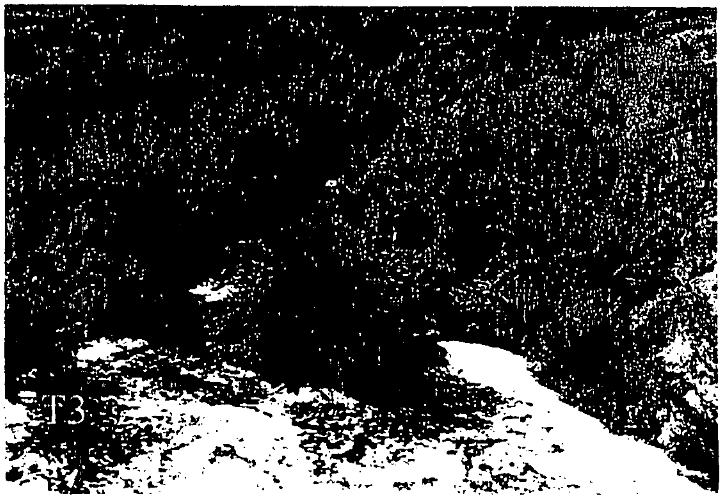


Site 4

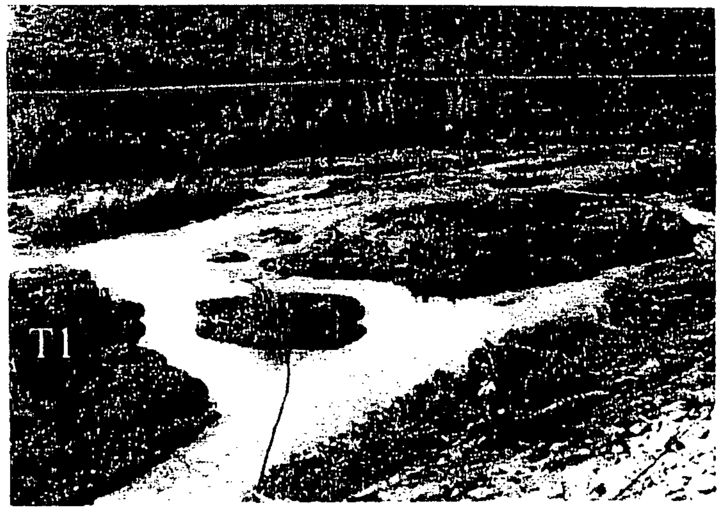
Site 5

Site 6

Site 9



Site 10



Site 11

Site 12

Site 13

Other projects which have been completed or are in progress include:

Watershed Based Surveys

Cosumnes River
Morro Bay
Sacramento River Tributaries
Russian River Tributaries
San Diego River
San Diego Board Ambient Bioassessment Project
Pajaro River Ambient Bioassessment Project
Calleguas Creek

Point-Source Impact Assessments (Enforcement)

Hot Creek
Deer Creek
Summit and Billy Mack Creeks
Van Norden Creek
Wild Iris Creek
Middle Butte Creek
Auburn Ravine
Philbrook Creek
Amerada - Hess
Hangtown Creek

Water Body Health Surveys and Special Studies

Biological Assessment of Forested Streams
Clear Lake Hydrilla Eradication
Lake Davis Rotenone Biosurvey
Santa Barbara/Ventura County Oiled Stream Project
San Luis Obispo County Mining Study
Guadalupe River Mining Study
American River Spawning Gravel Improvement Project
Bioassessment of Deep Water Areas of the Sacramento-San Joaquin Watersheds
San Luis Obispo County Golf Course - Dairy Creek
East Walker River Sediment Study

For more information on these projects contact:

Water Pollution Control Laboratory
2005 Nimbus Road, Rancho Cordova, Ca. 95670
(916) 358-2858; jharr@sna.com