Summary
This Project was developed by MWH to characterize the stream health of areas related to canal inputs from the Placer County Water Agency operations.

Bioassessment is a widely accepted method of evaluating water quality and watershed health. Dry Creek Conservancy gathers data in accordance with the California Stream Bioassessment Procedure. Samples were identified by Wayne Fields of Hydrozoology. Tom King of BioAssessment Services analyzed the data and calculated an index of biotic integrity (IBI) for each sample site based on the Southern California IBI method. This IBI is considered appropriate for local watersheds in the absence of a foothill or valley IBI.

Three sites chosen for the study were:

- A site on Auburn Ravine immediately downstream of the outlet of the American River tunnel.
- A Secret Ravine site in Loomis Basin Park near King Road.
- A Miners Ravine Site immediately downstream of the off-stream detention basin recently constructed by Placer County Flood Control and Water Conservation District.

Results of the analysis were:

- The Secret Ravine site IBI value was higher than any previously sampled sites in Dry Creek Watershed.
- The Auburn Ravine site IBI value was higher than most Dry Creek Watershed sites but lower than might be expected by its apparently excellent habitat.
- The Miners Ravine site IBI value fell within the range expected.

The project results suggest that upstream areas of Secret Ravine may provide the best habitat in Dry Creek Watershed. The surprisingly low IBI score for the Auburn Ravine site may be related to tunnel operations. Further sampling is necessary to confirm that these results are a true representation of the sites and not normal variation. Sampling should be designed to discover the reason for the high IBI score at the Secret Ravine site, to discover the reason for the lower than expected IBI score at the Auburn Ravine site, and to track the evolution of the Miners Ravine stream channel as it adjusts to the newly constructed detention basin.

Report on Benthic Macroinverebrate Data

Introduction

Biological monitoring (bioassessment) is becoming a widely used and accepted method for evaluating water quality throughout the United States (SWRCB, 2003). Periphyton, aquatic vertebrate and benthic macroinvertebrates (BMI) are commonly monitored aquatic assemblages in bioassessment monitoring (U.S. EPA, 1999). In order to conduct a cost-effective, scientifically valid rapid biological assessment, monitoring may be reduced to one aquatic assemblage (U.S. EPA, 1999). BMI are the common aquatic assemblages measured in rapid monitoring protocols. They are useful in evaluating the overall health of flowing water systems, and are affected by changes in a stream's chemical and or physical structure (Karr and Kerans, 1991). Their sensitivity to stresses (temperature, dissolved oxygen, chemical and organic pollution) makes them effective indicators of specific anthropogenic disturbances (House et al., 1993). Streams within the California central valley have been greatly altered to accommodate urban and agricultural development. Physical habitat (vegetation and substrate) is often reduced or removed completely, greatly impacting aquatic organisms within the stream. (The paragraph above is from Department of Pesticide Regulation Environmental Monitoring Branch Study Proposal #233)

Purpose

This Project was developed by MWH to characterize the stream health of areas related to canal inputs from the Placer County Water Agency operations.

Methods

DCC collects and processes samples following the targeted riffle method of *Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*, February 2007, Aquatic Bioassessment Laboratory, California Department of Fish and Game. (http://www.dfg.ca.gov/abl/Field/datacollection.asp) The protocol describes methods to sample eight square feet of riffle area in a 150 meter reach. Previous to fall 2005 DCC sampled with the California Stream Bioassessment procedure protocol. DCC recently engaged BioAssessment Services to standardize the pre 2005 data so metrics from the two protocols could be compared. Since 2000 DCC has sent samples to the professional taxonomy laboratory of Wayne Fields for identification. Wayne sub samples 500 organisms and identifies them to the lowest taxa possible; his identification is attached as Attachment 1.

Tom King of BioAssessment Services analyzed the data by calculating an index of biotic integrity (IBI) for each sample site. After standardizing the data to be used in the IBI calculation (shown in Attachment 1) Tom used the Index of Biotic Integrity for coastal southern California (SoCal B-IBI) described in *Ode, P.R., A.C. Rehn and J.T. May. 2005. A quantitative tool for assessing the integrity of southern coastal California streams. Environmental Management Vol. 35, No. 4, pp. 493-504. Springer Science+Business Media, Inc.* as being the most appropriate for our area. The following description of the SoCal ecoregion from Ode et al shows similarities to our local watersheds.

The SoCal B-IBI is the most comprehensive assessment to date of freshwater biological integrity in California. As in other Mediterranean climate regions, the combination of aridity, geology, and high-amplitude cycles of seasonal flooding and drying in southern coastal California makes its streams and rivers particularly sensitive to disturbance (Gasith and Resh 1999). This sensitivity, coupled with the burgeoning human population and vast conversion of natural landscapes to agriculture and urban areas, has made it the focus of both state and federal attempts to maintain the ecological integrity of these strained aquatic resources.

The SoCal B-IBI assigns scores to data based on the relative quality of BMI assemblages as defined by seven metrics described in Ode et al. The seven metrics are:

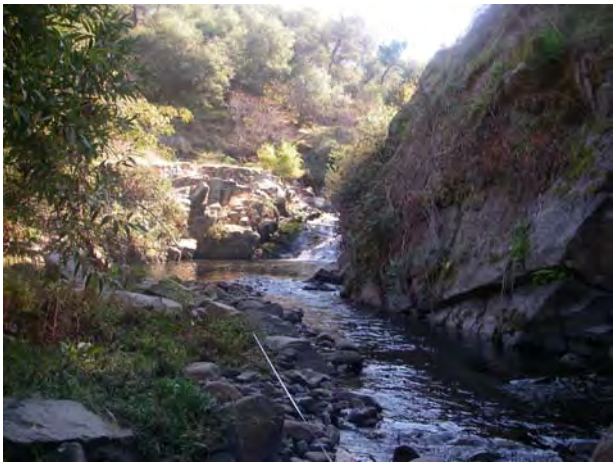
- Coleoptera Richness – the total number of Coleoptera taxa present in the sub samples.
- EPT Richness – the total number of taxa from the Ephemeroptera, Plecoptera and Trichoptera insect orders.
- Predator Richness – total number of taxa categorized as predators.
- Collectors (%) – the percent of individuals present in the sub sample categorized as collectors.
- Intolerant Organisms (%) (0-3) - the percent of individuals present in the sub sample categorized as having a tolerance value of 0 to 3.
- Non-insect Taxa (%) – The percent of the sub sample taxa that are non-insect.
- Tolerant Taxa (%) – The percent of taxa from the sub sample that are considered tolerant of stream degradation.

The IBI is based on scores assigned to empirically determined ranges of metric values from very large regional data sets. The IBI scores are calculated by applying the scoring ranges as described in Ode et al. to each mean metric value. A factor of 1.43 is multiplied to the summed metric scores yielding the IBI. The IBI can range from 0 to 100. Because an IBI hasn‘t been developed for the local ecoregion, Tom warns that the metrics and IBI should be used with caution.

Sampling Sites

Because of limited funds only three sites were chosen for sampling.

- The site on Auburn Ravine (ARTM) is immediately downstream of the outlet of the American River tunnel and incorporated flows from that source as well as flows from Auburn Ravine.
- The Secret Ravine site (SRLB) is in Loomis Basin Park near King Road which is considerably upstream of the most upstream regular DCC sampling site at Rocklin Road (DCC5). It reflects a different set of PCWA outputs than the regular DCC sampling sites since it is upstream of the Boardman Canal output.
- The Miners Ravine Site (MRSC) is immediately downstream of the off-stream detention basin recently constructed by Placer County Flood Control and Water Conservation District. This sample can be a baseline for assessing changes after construction of the detention basin. It also reflects input from the Placer County Wastewater Treatment Plant near Dick Road and all PCWA canal tributaries to Miners Ravine.



Auburn Ravine - top of reach. Tunnel is to left. Riffle habitat with riparian vegetation.

Secret Ravine - reach with eroded bank. Gravel habitat at eroded bank

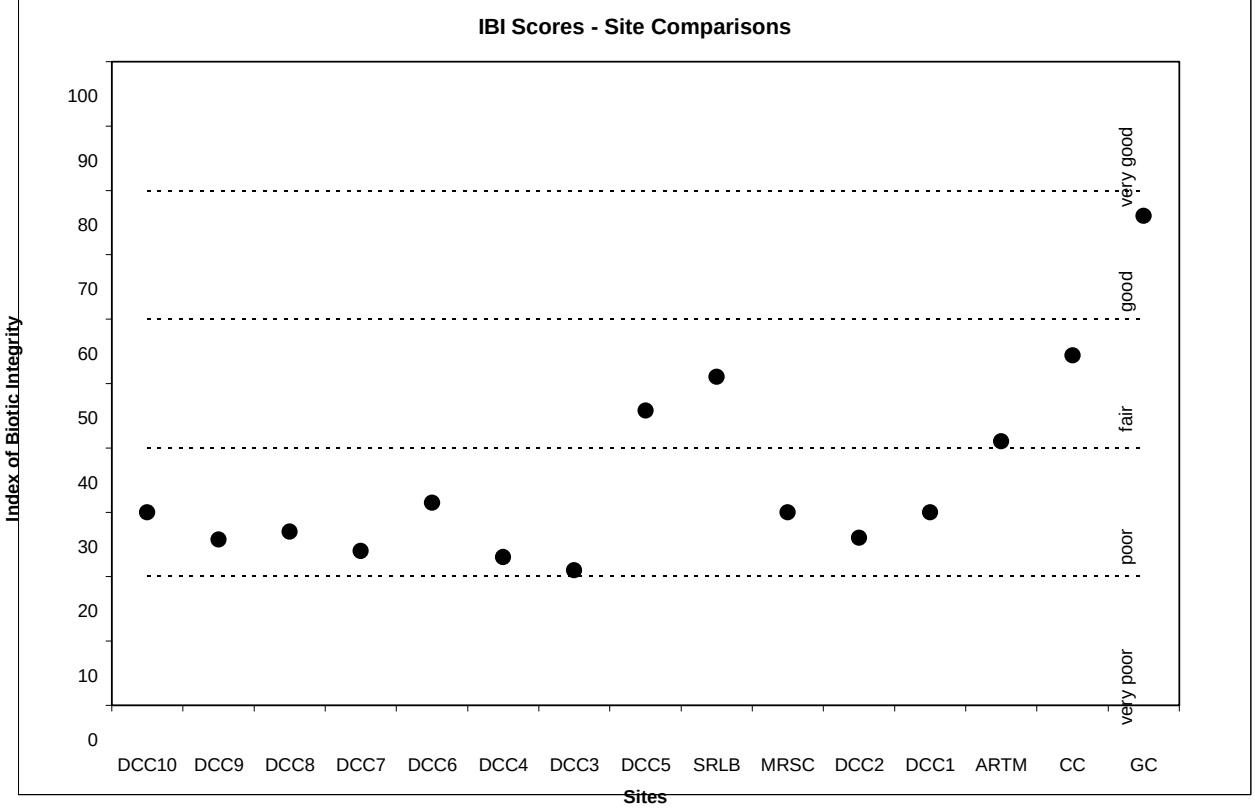
Miners Ravine – bottom of reach looking up. Riffle habitat.

Results

Figure 1 shows a plot of IBI scores for the three project sample sites, as well as comparison data for sample sites in the Dry Creek Watershed from 2000 through 2006, a composite of four sites from Coon Creek in 2005 (CC), and from Greenwood Creek(GC). Observations from the plot are:

- All but one Dry Creek site (DCC5, Secret Ravine at Rocklin Road) previously sampled fell in the poor range.
- The score for the Secret Ravine site sampled for the project is higher than any previous Dry Creek sites. There is no other data from this site for comparison.
- The score for the Auburn Ravine site fell at the break between poor and fair and was higher than all but one previously sampled Dry Creek site (DCC5).
- The score for the Miners Ravine site sampled for the project fell in the poor range along with previous Dry Creek sites but was slightly higher than the Dry Creek sites previously sampled, DCC7 and DCC 2.

Figure 1



Site codes represent the following streams:

DCC: streams draining the Dry Creek watershed including -

1) Antelope Creek at King Road
2) Miner's Ravine above Cottonwood Dam and at Dick Cook Road
3) Linda Creek at Barton
4) Clover Valley Creek u/s Golf course

5) Secret Ravine at Sierra College
6) Secret Ravine at Miner's Ravine
7) Miner's Ravine at Secret Ravine
8) Antelope at Atlantic
9) Linda/Kirby u/s Dry Creek Confluence
10) Dry Creek above Rio Linda Blvd Bridge
CC: Coon Creek
GC: Greenwood Creek at an elevation of approximately 600 feet, which drains into the South Fork American River

MWH Project sites –
SRLB: Secret Ravine at Loomis Basin Park
MRSC: Miners Ravine downstream of Sierra College Blvd.
ARTM: Auburn Ravine at the tunnel mouth

Table 1 shows IBI scores for each of the seven metrics for the three project sites and for additional sites shown for comparison.

Table 1 –Scores for the seven metrics

(IBI scores are calculated by multiplying metric scores by a factor of 1.43.)						
	DCC5	CC	GC	ARTM	SRLB	MRSC
Coleoptera taxa	0	6	5	4	4	0
EPT taxa	6	5	10	5	6	5
Predator Taxa	8	5	8	2	5	4
Collectors (%)	6	4	6	5	5	4
Intolerant (%)	3	4	6	1	2	1
Non-Insect (%)	4	6	8	4	7	2
Tolerant (%)	5	8	10	8	7	5
Total	32	38	53	29	36	21

Along with BMI sampling the California Stream Bioassessment Procedure specifies a set of physical habitat assessments that may be used to explain BMI data. Some data from the physical habitat assessment that might be useful to explain BMI results are shown in Table 2 below.

Table 2 – Selected Physical Habitat Scores	DCC5	ARTM	SRLB	MRSC
	2006			
Flow (cfs)	6.9	9.6	3.0	1.7
Temp (C)	15.9	14.1	13.2	12.9
Habitat types: (% riffle)	10	41	15	11
Slope (average %)	1.45	2.5	0.5	1.4
Instream Habitat (20 possible)	13	14	11	5
Sediment Deposition (20 possible)	10	19	11	5
Channel Alteration (20 possible)	15	15	11	18

Discussion

The data suggest the following questions:

- Why are SRLB scores higher than previously sampled Dry Creek sites?

The Physical habitat data don't seem to offer an explanation since several of the parameters actually indicate higher quality at the DCC5 site. The most notable difference in IBI metric scores shown in Table 1 is for Coleoptera taxa which are 4 at SRLB and 0 at DCC5. The absence of Coleoptera taxa has been noted in *Preliminary Report on Benthic Macroinverebrate Data Dry Creek Conservancy Bioassessment Program 2000 to 2006, Dry Creek Conservancy, June 2007.* No good explanation has been offered other than the general high level of sediment in Dry Creek Watershed. It may be that the healthier bmi community at SRLB is simply a reflection of fewer urban inputs due to less impervious surface.

- Why aren't ARTM scores higher given its high physical habitat scores?

The habitat quality at the Auburn Ravine site is strikingly good compared to any site in Dry Creek Watershed. There is a high percentage of riffles and very little sediment as shown in Table 2. The major human influence is a gravel road that runs parallel to the bank about 30 feet from the stream channel and about 12 feet above water surface elevation. In spite of the road there is very little sediment in the substrate; the cobble and gravel are very clean.

There are several possible impacts on the bmi community at ARTM. The American River Tunnel operations may flush the channel of bugs and biotic material leaving it clean of sediment but relatively barren of bmi. Less manipulation of instream flows has been suggested as a reason that DCC5 has a much higher score than other Dry Creek sites as discussed in the excerpt below. (Dry Creek Conservancy, June 2007.)

> "The Dry Creek Watershed receives imported water in its major tributaries.
>
> - Can water deliveries explain the very low Clover Valley IBI since Clover Valley flows in summer are almost entirely due to imported water?
> - Can the higher quality BMI community in Coon Creek be explained by relatively smaller amounts of imported water?
> - Can the higher quality BMI community at SR5 be due to it being above the outlet of the Boardman Canal, a major contributor to dry season Secret Ravine flows? In a 1999 report on BMI fauna in Secret Ravine Wayne Fields noted in-stream flow changes as follows:
>
> The almost daily occurrence of an artificial increase in flow which was observed during habitat mapping and was estimated to sometimes double or even triple the flow in the stream…since the fauna in streams at this elevation is adapted to a regime in which fluctuations in flow are limited to the rainy period, the addition of this much extra water on an irregular basis can only serve to disrupt the usual pattern of life.
>
> In fact, much recent work has been done on the impact on BMI of allochthonous material, which in streams is organic material from outside the stream flow that contributes to stream ecology and the vigor of BMI. (Tom King, personal communication; Lotic System Ecology, Wikipedia) Manipulated flows have been shown to flush this material from streams resulting in a depressed BMI community."

Another impact could be inputs from the City of Auburn wastewater treatment plant upstream. But the lack of algae growth suggest that there is not a high level of nutrients in the water as

might be expected downstream of a treatment plant. Other water quality parameters such as dissolved oxygen, pH, and conductivity are similar to other sampling sites and at healthy levels.

The MRSC IBI scores don't raise questions since they are similar to previous Dry Creek Watershed and Miners Ravine results. Low scores can be explained by lack of habitat complexity and high amounts of sediment. It is also worth noting that the channel immediately upstream of the sampling reach which is alongside the detention basin is very lacking in instream habitat. The channel is straight due to constraint by a levee. Previous to the project there was a large beaver pond alongside the levee that probably held back a large amount of sediment. Currently the substrate is a homogenous run of fine sediment with no boulders, cobble, woody debris or other complexity. It will be interesting to see if the channel can improve from natural processes. A large amount of riparian vegetation planted on the project side of the stream has been established successfully and may contribute to improvement in instream habitat depending on how it's managed. It will also be interesting to see if the lack of complexity will have an impact on the downstream reach that was sampled.

In general we should be cautious about giving too much significance to only one sampling event. There is significant variation from season to season and also within a given season at a site. A longer record is needed to establish that the project results are representative of the sites.

Conclusions and Recommendations

The project results add another site in Dry Creek Watershed to the "fair" range of IBI ranking and suggest that upstream areas of Secret Ravine may provide the best habitat in Dry Creek Watershed. The IBI score for the Auburn Ravine site is surprisingly low given the high quality of the habitat. The low score may be related to tunnel operations. The Miners Ravine site results fall within the range of previous sampling results in Dry Creek Watershed. Habitat alongside the detention basin immediately upstream of the sampling site is notably lacking in complexity. Further sampling is necessary to confirm that these results are a true representation of the sites and not normal variation. Sampling should be designed to discover the reason for the high IBI score at the Secret Ravine site and the lower than indicated IBI score at the Auburn Ravine site.

PHYLUM/	FAMILY	GENUS and SPECIES	Level I Final ID	AUBURN RAVINE (11/01/2007)	SECRET RAVINE (11/02/2007)	MINERS RAVINE (11/05/2007)
	NON-INSECTS					
PHYLUM/CLASS/ORDER						
Platyhelminthes	Planariidae	*Dugesia tigrina*	Turbellaria	66	8	66
Nemertea	Tetrastemmatidae	*Prostoma graecense*	*Prostoma*	8	27	9
Annelida/Oligochaeta			Oligochaeta	36	87	152
Hirudinea	Erpobdellidae	*Mooreobella microstoma*	*Mooreobella*			1
Arthropoda/Amphipoda						
Amphipoda	Crangonyctidae	*Crangonyx floridanus*	*Crangonyx*	7	15	6
		Stygobromus sp.	*Stygobromus*	2		
	Hyalellidae	*Hyalella azteca*	*Hyalella*			17
Arachnida/						
Hydracarina	Sperchontidae	*Sperchon sp. A*	*Sperchon*		6	4
Mollusca/						
Gastropoda	Ancylidae	*Ferrissia californica*	*Ferrissia*			3
	Planorbidae	*Gyraulus deflectus*	*Gyraulus*	8		
		Micromenetus dilatatus	*Micromenetus*	3		1
		Planorbella tenuis	*Planorbella*			1
Bivalvia	Corbiculidae	*Corbicula fluminea*	*Corbicula*		6	15
	Sphaeriidae	*Pisidium casertanum*	*Pisidium*	4		
	INSECTS					
ORDER	FAMILY	GENUS and SPECIES				
Ephemeroptera	Baetidae	*Baetis tricaudatus*	*Baetis*	310	52	41
		Fallceon quilleri	*Fallceon quilleri*		4	8
	Caenidae	*Caenis latipennis*	*Caenis*			1
	Ephemerellidae	*Eurylophella lodi*	*Eurylophella lodi*	1		
	Leptohyphidae	*Tricorythodes minutus*	*Tricorythodes*	1	24	14
Odonata	Gomphidae	*Ophiogomphus occidentis*	*Ophiogomphus*		1	
	Libellulidae	*Brechmorhoga mendax*	*Brechmorhoga mendax*		12	5
	Calopterygidae	*Hetaerina americana*	*Hetaerina americana*		1	1
	Coenagrionidae	*Argia vivida*	*Argia*		15	9
Plecoptera	Perlodidae	*Isoperla sp.*	*Isoperla*		2	
Trichoptera	Brachycentridae	*Brachycentrus occidentalis*	*Brachycentrus*	5		
		Micrasema sp.	*Micrasema*		11	
	Glossosomatidae	*Glossosoma sp.*	*Glossosoma*	1	2	
		Protoptila sp.	*Protoptila*	1	3	1
	Helicopsychidae	*Helicopsyche borealis*	*Helicopsyche*			1
	Hydropsychidae	*Hydropsyche californica*	*Hydropsyche*	45	33	102
	Hydroptilidae	*Hydroptila sp. A*	*Hydroptila*		1	
		Leucotrichia pictipes	*Leucotrichia pictipes*		1	
		Oxyethira sp.	*Oxyethira*			3
	Leptoceridae	*Nectopsyche gracilis*	*Nectopsyche*		3	1
	Philopotamidae	*Chimarra sp.*	*Chimarra*	2	19	31
	Rhyacophilidae	*Rhyacophila coloradensis*	*Rhyacophila*	1		
Lepidoptera	Pyralidae	*Parapoynx sp.*	*Parapoynx*		2	
Coleoptera	Elmidae	*Cleptelmis sp.*	*Cleptelmis*	2	1	
		Dubiraphia giulianii	*Dubiraphia*		1	
		Ordobrevia nubifera	*Ordobrevia nubifera*	7		
Diptera	Chironomidae	*Pentaneura sp.*	Tanypodinae	1		
			Orthocladiinae	4	40	44
		Rheotanytarsus sp.	Tanytarsini		16	6
	Simuliidae		*Simulium*	0	84	23
	Tipulidae	*Antocha monticola*	*Antocha*	1		
		Tipula sp.	*Tipula*		1	
	Empididae	*Neoplasta sp.*	*Neoplasta*	1		
	Stratiomyidae	*Caloparyphus sp.*	*Caloparyphus*			1
				517	478	567
			NUMBER OF SPECIES	**29**	**48**	**41**
			TOTAL NUMBER OF ORGANISMS	**517**	**494**	**570**
			TOTAL NUMBER OF SQUARES PICKED (OF 24)	**3**	**5**	**4**
			EXTRAPOLATED NUMBER OF ORGANISMS	**4136**	**2371**	**3420**

Level I Final ID[1]	CTV[2]	FFG[3]	AUBURN RAVINE 110107	SECRET RAVINE 110207	MINER'S RAVINE 110507
Cleptelmis	4	cg	2	1	
Dubiraphia	6	cg		1	
Ordobrevia nubifera	4	sc	7		
Tanypodinae	7	p	1		
Orthocladiinae	5	cg	4	40	44
Tanytarsini	6	cg		16	6
Simulium	6	cf		84	23
Antocha	3	cg	1		
Tipula	4	ot		1	
Neoplasta	6	p	1		
Caloparyphus	7	cg			1
Baetis	5	cg	310	52	41
Fallceon quilleri	4	cg		4	8
Caenis	7	cg			1
Eurylophella lodi	1	cg	1		
Tricorythodes	4	cg	1	24	14
Isoperla	2	p		2	
Brachycentrus	1	ot	5		
Micrasema	1	ot		11	
Glossosoma	1	sc	1	2	
Protoptila	1	sc	1	3	1
Helicopsyche	3	sc			1
Hydropsyche	4	cf	45	33	102
Hydroptila	6	ot		1	
Leucotrichia pictipes	6	sc		1	
Oxyethira	3	ot			3
Nectopsyche	3	ot		3	1
Chimarra	4	cf	2	19	31
Rhyacophila	0	p	1		
Parapoynx	5	sh		2	
Ophiogomphus	4	p		1	
Brechmorhoga mendax	9	p		12	5
Hetaerina americana	6	p		1	1
Argia	7	p		15	9
Turbellaria	4	p	66	8	66
Prostoma	8	p	8	27	9
Oligochaeta	5	cg	36	87	152
Mooreobella	8	p			1
Crangonyx	4	cg	7	15	6
Stygobromus	4	cg	2		
Hyalella	8	cg			17
Sperchon	8	p		6	4
Ferrissia	6	sc			3
Gyraulus	8	sc	8		
Micromenetus	6	sc	3		1
Planorbella	6	sc			1
Corbicula	10	cf		6	15
Pisidium	8	cf	4		
Total			**517**	**478**	**567**

Taxa Richness (mod level 1)		23	29	28
CG		70	50	51
CF		9.9	30	30
SoCal IBI Metrics [4]				
Coleoptera Taxa		2	2	0
EPT Taxa		9	12	10
Predator Taxa		5	8	7
CG Taxa + CF Individuals (%)		80	80	81
Intolerant Organisms (%) (0-3)		1.9	4.4	1.1
Non-insect Taxa (%)		35	21	39
Tolerant Taxa (%)		13	14	21
SoCal IBI Scores [4]				
Coleoptera Taxa		4	4	0
EPT Taxa		5	6	5
Predator Taxa		2	5	4
CG Taxa + CF Individuals (%)		5	5	4
Intolerant Organisms (%) (0-3)		1	2	1
Non-insect Taxa (%)		4	7	2
Tolerant Taxa (%)		8	7	5
Score Sum		**29**	**36**	**21**
SoCal IBI (possible range: 0-100)	**1.429**	**41**	**51**	**30**

[1] Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) level 1 with modification including chironomids to subfamily/ tribe
Nematodes removed from list

[2] California Tolerance Value from California Aquatic Macroinvertebrate Laboratory Network (CAMLnet), 27 January 2003 revision

[3] Functional Feeding Groups from CAMLnet, 27 January 2003 revision

[4] Ode, P.R., A.C. Rehn and J.T. May. 2005. A quantitative tool for assessing the integrity of southern coastal California streams.
Environmental Management Vol. 35, No. 4, pp. 493–504. Springer Science+Business Media, Inc.

Note: Use SoCal IBI for this data set with caution. While relative biological signals are insightful, the metrics and scoring criteria were not optimized for the Dry Creek watershed.