BENTHIC MACROINVERTEBRATE SAMPLING IN THE ARROYO CORTE MADERA DEL PRESIDIO WATERSHED MARIN COUNTY, CALIFORNIA SPRING 2005

PREPARED FOR

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INTRODUCTION

Benthic macroinvertebrates (BMIs) are a diverse category of animals that share a dependency on the streambed as habitat. While primarily represented by aquatic insects, the category may also include mites, crustaceans, mollusks and worms. The actual constituency of BMIs is strongly influenced by substrate and water quality. Consequently, assessments of stream habitat condition commonly focus on BMI investigations and this type of bioassessment is considered cost-effective for detecting changes in water quality (Diamond 1996).

The Marin County Stormwater Pollution Prevention Program (MCSTOPPP, see http://www.mcstoppp.org) initiated a bioassessment program for county streams in 1999, following guidelines provided in the California Stream Bioassessment Procedure and with assistance from the Sustainable Land Stewardship Institute. Arroyo Corte Madera del Presidio was one of four watersheds included in MCSTOPPP's bioassessment program. The field procedures used in 1999 and 2000 included a physical habitat assessment following EPA protocols (Barbour et al. 1999). Arroyo Corte Madera del Presidio was not included in the sampling program during recent years due to budget constraints and a priority for watersheds with greater sampling variability or a higher degree of impairment (Liz Lewis, pers. comm.).

The non-profit Mill Valley StreamKeepers (MVSK, http://www.millvalleystreamkeepers.org) undertook BMI sampling in Arroyo Corte Madera[1] in 2005 using funds granted by the San Francisco Estuary Project (http://www.abag.ca.gov/bayarea/sfep/sfep.html). The MVSK have also initiated monitoring of V* (proportion of pool-filling by fine sediment) in the Arroyo Corte Madera watershed and those data are reported separately.

The purpose of the 2005 monitoring is to document baseline conditions for tracking changes or trends in stream condition which may be associated with changing land use policies or watershed restoration activities. A substantial investment in watershed restoration projects by the Marin Municipal Water District and the California Department of Fish and Game is currently under preparation.

This report summarizes BMI sampling results from 2005 using a variety of metrics including richness (number of taxa) and EPT indices. EPT refers to the families Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) which are generally more sensitive to water pollution and habitat impairment than are other subcategories of BMIs. This report also briefly discusses inference regarding water quality at Arroyo Corte Madera sites.

[1] This shortened name for Arroyo Corte Madera del Presidio is used throughout the remainder of the report and is inclusive of the primary tributary, Old Mill Creek.

METHODS

Procedures for collecting samples in the field and processing samples followed the revised (CDFG 2003) California Stream Bioassessment Procedure (CSBP). Sampling sites consisted of 100-meter reaches. Three transects were randomly selected from the available riffle habitat at each site. At three locations along each transect, we captured animals in a D-shaped net by dislodging and washing bed particles upstream 1 ft and to a depth of 15 cm. In the laboratory space, we removed 500 animals from each composite sample using a randomization grid procedure and dissecting microscopes.

Field sampling occurred on May 26, 2005. Dr. Morgan Hannaford supervised field sampling and sample sorting. Jonathan Lee provided taxonomic identification following the California list of standard taxonomic effort and also provided summaries of standard metrics using the California Tolerance Values (Ode and CAMLnet 2003). Identified animals and remnant samples were preserved in 90% ethanol.

The location of five sampling sites (Figure 1) was determined by MCSTOPPP in 1999. ACM1 represents the lowest reach in Arroyo Corte Madera not associated with estuarine habitat or tides. ACM2 is located in the reach immediately above a long culvert section of the creek underneath the downtown portion of Mill Valley. ACM4 and ACM5 are located on Old Mill Creek, the largest tributary of Arroyo Corte Madera. Site elevation ranges from 26 feet at ACM1 to 350 feet at ACM3. Latitude and longitude of the sites is provided in MCSTOPPP (2000) and KRIS East Marin-Sonoma.

The location of the five sites sampled in 2005 (Table 1) deviated from the description of sites reported in MCSTOPPP (2000) in only one case. We located ACM4 below Cascade Ave and previous sampling located the site above Cascade Ave[2]. The locations were adjacent and within Old Mill Park.

Table 1: Description of five sites used for BMI sampling in Arroyo Corte Madera Watershed. Each site is a reach of 100 meters and comprised of a number of riffles.

Code	Location	Description
ACM1	Above tidewater	Downstream of La Goma St. bridge (4 riffles)
ACM2	Behind City Hall	Below footbridge up to Gardner St. bridge (5 riffles)
ACM3	Blithedale Canyon	From culvert up to Blithedale Park sign (3 riffles)
ACM4	Lower Old Mill Cr.	Sewer pipe crossing up to Cascade Ave bridge (7 riffles)
ACM5	Upper Old Mill Cr.	Bridge crossing up to cement riprap near inkwells (6 riffles)

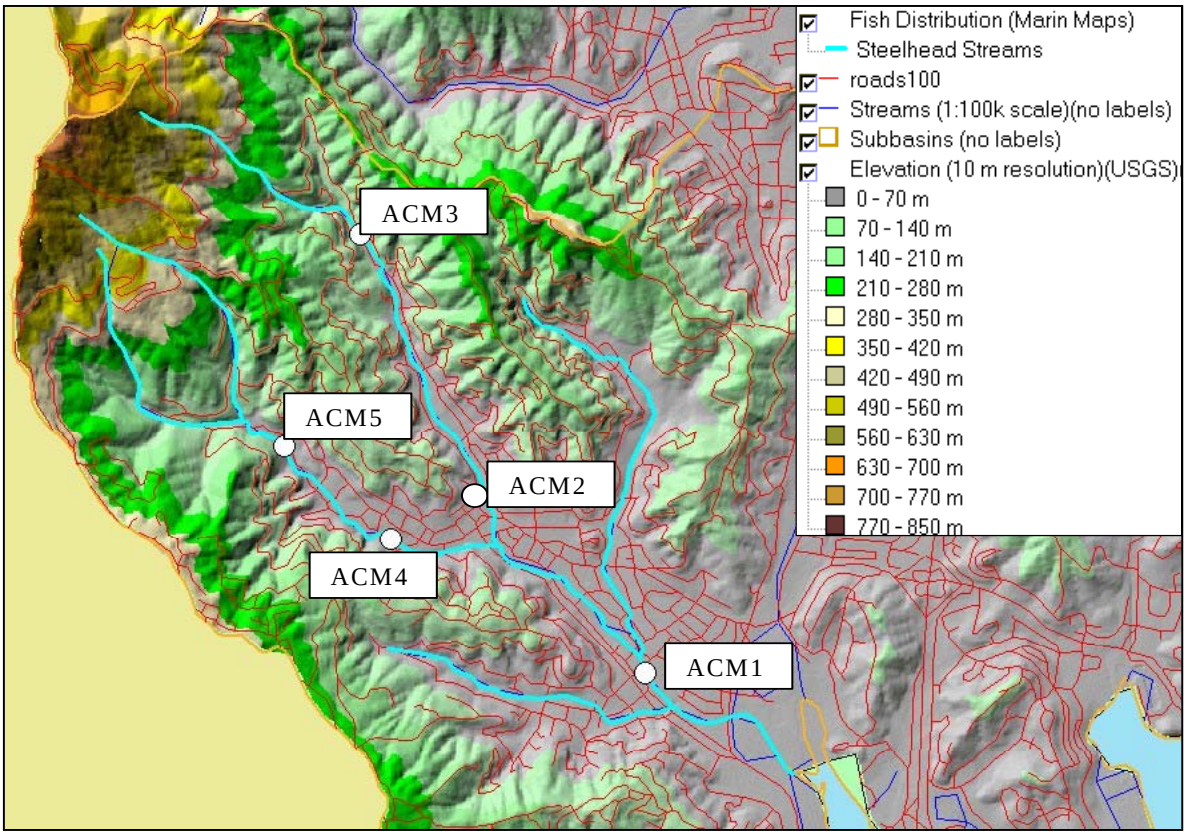

Figure 1: The Arroyo Corte Madera watershed with location of five benthic macroinvertebrate sampling sites. Old Mill Creek is the large western tributary to Arroyo Corte Madera. The legend refers to data layers in KRIS East Marin-Sonoma.

RESULTS

The number of discrete taxa identified from Arroyo Corte Madera samples ranged from 19 to 36 (Table 2). The number of taxa within the families Ephemeroptera, Trichoptera or Plecoptera (EPT Taxa) ranged from 3 to 18. Both forms of richness were highest at site ACM3. Taxa Richness was lowest at ACM1 and EPT Richness was lowest at ACM4.

The Sensitive EPT Index ranged from 1.4% at ACM1 to 35% at ACM5. The Sensitive EPT Index (similar to the outmoded Modified EPT Index) is the percentage of a sample comprised of EPT not including taxa with a tolerance value greater than 3. Standard California Tolerance Values range from 0 (highly intolerant) to 10 (highly tolerant) and are reported in Appendix A with the taxonomic counts of each sample. The mean tolerance value for each sample ranged from 4.2 at ACM3 to 5.3 at ACM1.

The dominant taxon was a chironomid at four sites and Baetis at ACM1. The dominant taxon comprised from 13 to 45 percent of the total sample. Baetis, which has a tolerance value of 5, comprised 25% of the samples from ACM1 and ACM4. Table 3 shows the sample percentage of the top-five most dominant animals, according to the standard taxonomic effort of the CSBP.

Table 2: Summary metrics for benthic macroinvertebrates sampled at five sites in the Arroyo Corte Madera watershed, spring 2005. For each metric, the values reflecting best condition are bolded and values reflecting worst condition are italicized.

Metric	ACM1	ACM2	ACM3	ACM4	ACM5
Taxa Richness	*19*	31	**36**	21	32
EPT Taxa Richness	5	9	**18**	*3*	16
Sensitive EPT Index (%)	*1.4*	13.0	25.1	4.2	**34.6**
Dominant Taxon (%)	26.4	27.5	**13.3**	*44.5*	20.2
Mean Tolerance Value	*5.3*	4.8	**4.2**	4.9	3.9
Shannon's Diversity Index	1.9	2.3	**2.8**	*1.7*	2.5
RR Index of Biological Integrity	8	12	**22**	*6*	18

Table 3: The top five ranked taxa from sites in Arroyo Corte Madera watershed, spring 2005. Numbers are percent of sample. Genus names are italicized. Non-italicized names are subfamily or higher taxanomic level.

ACM1		ACM2		ACM3		ACM4		ACM5	
Baetis	26.4	Orthocladiinae	27.5	Chironomini	13.3	Orthocladiinae	44.5	Orthocladiinae	20.2
Chironomini	21.2	Chironomini	15.4	Orthocladiinae	13.3	*Baetis*	25.1	*Baetis*	19.8
Oligochaeta	20.4	*Baetis*	13.5	*Optioservus*	11.8	Chironomini	7.7	*Cinygma*	12.5
Orthocladiinae	18.8	*Lepidostoma*	9.7	*Baetis*	11.8	Tanytarsini	5.4	*Malenka*	12.4
Tanytarsini	5.2	Oligochaeta	8.3	*Neophylax*	7.6	Oligochaeta	5.0	*Simulium*	8.9

The Russian River Index of Biotic Integrity (RRIBI) is a scoring system for inferring water quality impairment and was developed from analysis of BMI results and habitat condition factors from sixty sites from tributaries of the Russian River watershed (CDFG 1999). The RRIBI was used in MCSTOPPP (2000) and is still considered suitable for use in Marin County, despite the development of other IBIs (Peter Ode, pers. comm.). The RRIBI draws upon the six other metrics presented in Table 2 and provides the following result: Sites ACM1 and AMC4 scored below 12 or "poor"; site ACM2 scored "fair"; sites ACM3 and ACM5 scored between 18 and 23 or "good". None of the sites scored above 23 or "excellent".

BMI sampling results for Arroyo Corte Madera were published in MCSTOPPP (2000) and data from spring 2000 and 2002 are in the KRIS East Marin-Sonoma database (Institute for Fisheries Resources 2002). Figure 3 charts the RRIBI for the five sites in all three years of spring sampling by comparable methods. The same pattern of IBI score among the sites persists in each year. In fact, the IBI score evaluations (poor, fair or good) for 2005 are equivalent to the evaluations per site for 2000 and 2002, except that ACM5 formerly scored four points lower and with a "fair" rating.

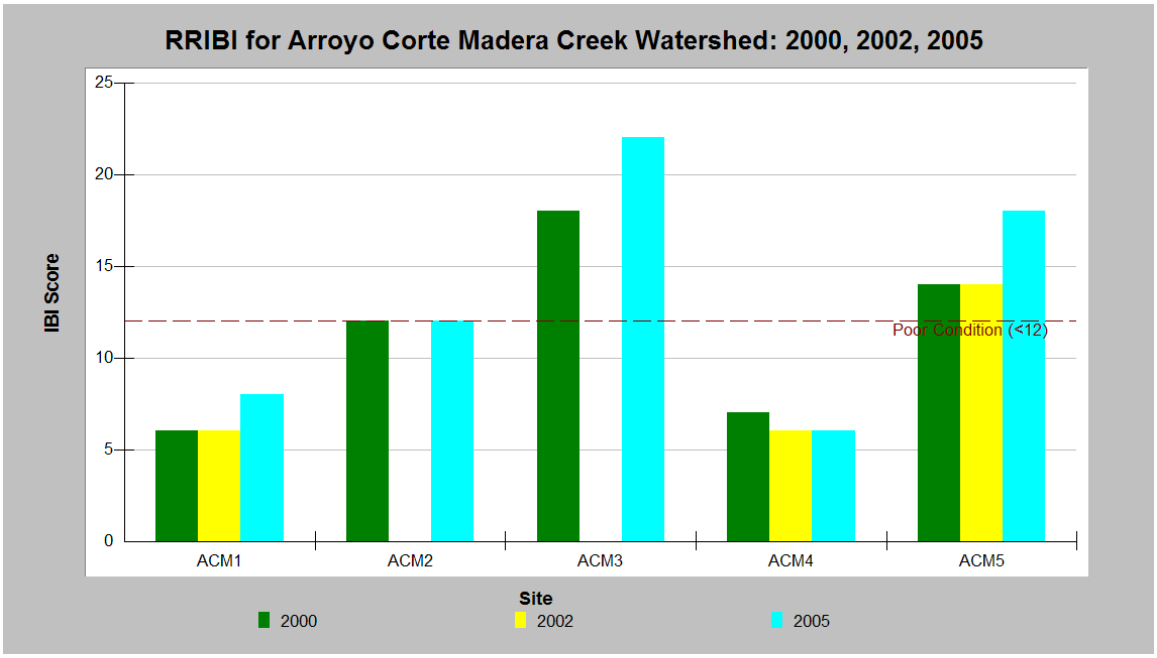

Figure 3: Scoring of five sites in the Arroyo Corte Madera Watershed by the Russian River Index of Biological Integrity (RRIBI). All sampling occurred in spring following the California Stream Bioassessment Procedure. Previous data found in KRIS East Marin-Sonoma.

DISCUSSION

MCSTOPPP (2000) noted that among all four Marin County watersheds, a pattern of impairment could be seen where lower sites showed less BMI health than upper sites. The 2005 BMI data for Arroyo Corte Madera confirms this pattern. The upper most site (ACM3) shows the best condition and the lowest site (ACM1) shows the worst condition. The pattern is repeated on Old Mill Creek where ACM4 is impaired relative to ACM5.

BMI samples from the upper sites (ACM3 and ACM5) of Arroyo Corte Madera watershed reflect reference conditions for minimal water quality impacts. The top-five dominant taxa at these sites included sensitive EPT. Oligochaete worms (tolerance 5) ranked in the top-five for the other sites, but not these upper sites. The reference condition of these sites can be partially explained by physical habitat parameters. The habitat assessments in fall 1999

and Spring 2000 rate the upper two sites as "optimal" and the other three sites as "sub-optimal" (MCSTOPPP 2000).

Samples from ACM1 or ACM4 exhibited signs of water quality impairment. At ACM1, we observed embeddedness of substrate by fine sediment and smaller bed particle size. High rates of sediment mobility, as indicated by these observations, causes reduced benthic habitat for supporting diverse BMI communities. At low flows, such sites typically develop a community composed of small grazing organisms capable of rapid colonization and reproduction (Lenant et al. 1981).

The cause of impairment at ACM4 is not clear. Tolerant taxa dominated the sample and we found only 3 EPT taxa. CDFG (1999) references 12 EPT Taxa as a benchmark for healthy streams in the vicinity of Arroyo Corte Madera. Moderate embeddedness was observed at ACM4, yet the particle size appeared larger than at ACM1. Results of V* sampling indicate that Old Mill Creek is not sediment impaired (Reedy 2005). ACM4 is located in Old Mill Park where the streambanks have recently been treated for erosion control. A potential impact at this site is nutrients from sewage pipe leakage or dog feces.

The Russian River IBI is a convenient tool for summarizing BMI results but its rankings are not strongly supported by statistics. As a new alternative, the North Coast IBI (Rhen and Ode 2005) draws in hundreds of sites throughout the region and is supported by statistical validation and could offer a more powerful tool for interpreting BMI results from Arroyo Corte Madera and other Marin County watersheds.

MCSTOPPP (2000) recommended that annual sampling be done in April when small streams would still be flowing adequately, even in dry years. Due to an unusually wet spring in 2005, we assume the results of our late May sampling to be comparable to results from April sampling in normal years.

The results of 2005 BMI sampling are similar to the results from 2000 and 2002 and do not indicate change in the condition of Arroyo Corte Madera sites. Additional years of data would provide statistical power for detecting change. Data from 2003 and 2004 was not yet available for analysis at the time of this report but could be included in future assessments. When changes in the condition of a BMI community are detected, other data on watershed condition will be required to infer cause. For this reason, the physical habitat assessment of 2000 should be repeated at some time.

ACKNOWLEDGEMENTS

Bill Kier provided essential leadership and expertise in establishing this project, and Dr. Morgan Hannaford provided the most qualified technical oversight possible. The Southern Marin Sanitation District provided laboratory and meeting room space. Liz Lewis of MCSTOPPP provided orientation to the sites. MVSK board president Betsy Bikle assisted tirelessly in the field and laboratory, and MVSK board member Joyce Britt volunteered her assistance in the laboratory. Thanks to all the Mill Valley StreamKeepers for their stewardship.

REFERENCES

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid bioassessment protocols for use in streams and wadeable rivers: Periphyton, benthic macroinvertebrates and fish, second edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

California Department of Fish and Game. 2003. California stream bioassessment procedure: Protocol brief for biological and physical/habitat assessment in wadeable streams. Aquatic Bioassessment/Water Pollution Control Laboratory. Rancho Cordova, CA. www.dfg.ca.gov/cabw/csbp_2003.pdf

California Department of Fish and Game. 1999. An index of biological integrity for first to third order Russian River tributary streams. Water Pollution Control Laboratory. Rancho Cordova, CA.

Diamond, J.M., M.T. Barbour and J.B. Stribling. 1996. Characterizing and comparing bioassessment methods and their results: a perspective. Journal of the North American Benthological Society. 15:13-727.

Institute for Fisheries Resources. 2003. KRIS East Marin-Sonoma (CD-based and online database). www.krisweb.com

Lenat, D.R., D.L. Penrose, and K.W. Eagleson. 1981. Variable effects of sediment addition on stream benthos. Hydrobiologia 79, 187-194.

MCSTOPPP. 2000. Marin County Stormwater Pollution Prevention Program benthic macroinvertebrate sampling report: Survey Fall 1999 - Spring 2000. San Rafael, CA.

Ode, P. and CAMLnet. 2003. List of Californian macroinvertebrate taxa and standard taxonomic effort. CDFG Aquatic Bioassessment Laboratory. Rancho Cordova, CA

Reedy, G. 2005. V* as an index of sedimnet impairment to stream habitat in the Arroyo Corte Madera del Presidio. Mill Valley StreamKeepers.

Rehn, A.C. and P. Ode. 2005. Draft --Development of a benthic index of biotic integrity (B-IBI) for wadeable streams in northern coastal California and its application to regional 305(b) assessment. California Department of Fish and Game Aquatic Bioassessment Laboratory, Rancho Cordova.

Appendix A: Taxonomic counts of BMI samples from Arroyo Corte Madera in May, 2005 as identified by Jonathan Lee using the California Standard Taxonomic Effort. Most organisms are identified to the level of genus (italicized). The taxonomic levels above family appear in bold.

TAXA	TOLERANCE	NUMBER IN SAMPLE				
ARTHROPODA		**ACM1**	**ACM2**	**ACM3**	**ACM4**	**ACM5**
INSECTA						
Coleoptera						
Elmidae						
Narpus	*4*	1	2	6	2	6
Optioservus	*4*	1	25	59	15	4
Ordobrevia nubifera	*4*			6		1
Zaitzevia	*4*		1	16	1	1
Diptera						
Ceratopogonidae						
Bezzia/Palpomyia	*6*				1	
Chironomidae						
Chironominae						
Chironomini	*6*	107	89	67	40	7
Tanytarsini	*6*	26	38	23	28	8
Orthocladiinae	*5*	95	159	67	232	106
Tanypodinae	*7*	3	4	7		1
Empididae	*6*					
Neoplasta	*6*	2	2	9		1
Psychodidae						
Pericoma/Telmatoscopus	*4*		1			
Sciomyzidae	*6*					1
Simuliidae						
Simulium	*6*	13	30	3	13	47
Stratiomyidae						
Caloparyphus	*7*		2			
Tipulidae	*3*					
Antocha	*3*					1
Holorusia hespera	*5*				1	
Limonia	*6*				1	
Molophilus	*4*		1			
Ephemeroptera						
Baetidae						
Baetis	*5*	133	78	59	131	104
Ephemerellidae						
Drunella	*0*	4	11	5	22	3
Serratella	*2*		1	1		
Heptageniidae						
Cinygma	*2*		1	5		66
Ironodes	*3*			3		13
Nixe	*3*	1	2			
Leptophlebiidae						
Paraleptophlebia	*4*			2		15

TAXA (continued)	TOLERANCE	ACM1	ACM2	ACM3	ACM4	ACM5
Odonata						
Coenagrionidae						
Argia	*7*		3		1	
Cordulegastridae						
Cordulegaster dorsalis	*3*		1		1	
Gomphidae						
Octogomphus specularis	*4*		4	5	1	2
Plecoptera						
Chloroperlidae	*1*			1		
Nemouridae	*2*					
enka	*2*			8		65
Soyedina	*2*			4		1
Perlidae						
Calineuria californica	*2*					1
Trichoptera						
Apataniidae						
Apatania	*1*			1		
Brachycentridae						
Micrasema	*1*			1		
Glossosomatidae						
Glossosoma	*1*		1	24		1
Hydropsychidae						
Hydropsyche	*4*			18	1	26
Parapsyche	*0*			5		3
Hydroptilidae						
Hydroptila	*6*	4	1			
Lepidostomatidae						
Lepidostoma	*1*	2	56	26		8
Odontoceridae						
Parthina	*0*			1		1
Polycentropodidae						
Polycentropus	*6*					1
Rhyacophilidae						
Rhyacophila	*0*			3		17
Uenoidae						
Neophylax	*3*		3	38		3
Chelicerata						
ARACHNOIDEA						
Acarina	*5*					
Hydrovolziidae						
Hydrovolzia	*5*			1		
Hygrobatidae						
Atractides	*8*		1	1		1
Sperchontidae						
Sperchon	*8*	1				
Torrenticolidae						
Torrenticola	*5*			1		
Crustacea						
OSTRACODA	*8*			1	1	

TAXA (continued)	TOLERANCE	ACM1	ACM2	ACM3	ACM4	ACM5
COELENTERATA						
HYDROZOA						
Hydroida						
Hydridae						
Hydra	*5*	1	5	1	1	
MOLLUSCA						
GASTROPODA						
Pulmonata						
Ancylidae						
Ferrissia	*6*		1			
Planorbidae						
Gyraulus	*8*	4	3		1	
Menetus	*6*		4			
ANNELIDA						
OLIGOCHAETA	*5*	103	48	23	26	8
Megadrili	*5*	2			1	3
PLATYHELMINTHES						
TURBELLARIA						
Tricladida						
Planariidae	*4*	1	1	1		
Total specimens:		504	579	502	521	526