SANTA ROSA CREEK
BENTHIC MACROINVERTEBRATE (BMI)
ASSESSMENT REPORT

San Luis Obispo, CA
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1 INTRODUCTION

1.1 Project Overview

This Benthic Macroinvertebrate Assessment Report is part of the Santa Rosa Creek Watershed Management Plan, a project funded by a California Department of Fish and Game (CDFG) grant received by Greenspace-The Cambria Land Trust. The purpose of the project is to obtain a more comprehensive assessment of the Santa Rosa Creek watershed and to evaluate the ecological processes and impacts affecting the water quality and stream habitat for southern Steelhead Salmon (*Oncorhynchus mykiss*).

This report is organized in six sections: Section 1 - the Introduction discusses the purpose and advantages of evaluating a stream's health by assessing the benthic macroinvertebrates (BMI) of a stream, Section 2 - describes the BMI Sampling Methods, Section 3 - Water Quality and Physical Measurements, Section 4 -makes clear the Results of the lab analysis, Section 5 - Discussion, and finally Section 6 - the References used.

1.2 Purpose for the Bioassessment of Santa Rosa Creek

The water quality of a stream can be measured using physical, chemical, and biological information. Ambient or surface water information such a temperature, pH, and dissolved oxygen are commonly used to assess the water quality of a stream. However, benthic macroinvertebrate sampling data has been recognized as an important diagnostic tool for assessing water quality and biological conditions of stream habitat. The methods are employed in stream monitoring programs of the United States Environmental Protection Agency, California Water Board, California Department of Fish and Game and other local advocacy groups.

The distribution of benthic macroinvertebrates is dependent on seasonal variations in the weather and food availability. Seasonal weather variations affect the instream conditions of a stream such as the volume, velocity and temperature of the water (Plotnikoff et al, 1997). Food sources can originate within the stream (algae) and food falls into the stream from outside sources (sticks, leaves, twigs). The presence of benthic macroinvertebrates communities corresponds to a certain habitat in which they can survive (Plotnikoff et al, 1997).

Stream benthic macroinvertebrates respond to impacts related to pollution, sedimentation, or other small changes in their habitat. The numbers, composition, and distribution of these benthic macroinvertebrate organisms can be a strong indicator to quality of the stream's habitat.

These benthic macroinvertebrates are known as a primary food source for the southern steelhead salmon *(Oncorhynchus mykiss*). BMI assessment will provide valuable insight into potential limiting factors for steelhead productivity.

1.3 Why Benthic Macroinvertebrate are Used to Measure Stream Quality

- The benthic macroinvertebrate community is very diverse. Each species has its own structural or functional characteristics and requires a unique and specialized living habitat. Some need specific water temperatures, substrate composition, or a specific food source to survive. Stream degradation can be show by the presence or absence of certain percentages of specialized species.
- Some benthic macroinvertebrates are very sensitive to pollution, sedimentation, and other small changes in their habitat. This vulnerability makes them useful in determining the types and source of impacts affecting a stream.
- The life span of some species of benthic macroinvertebrates can be up to several years. This long life span can provide clues to the quality of the habitat over a period of time.
- Most benthic macroinvertebrates are stationary organisms. Therefore, they cannot move away from the source of pollution and impacts.

2 BMI SAMPLING METHODS

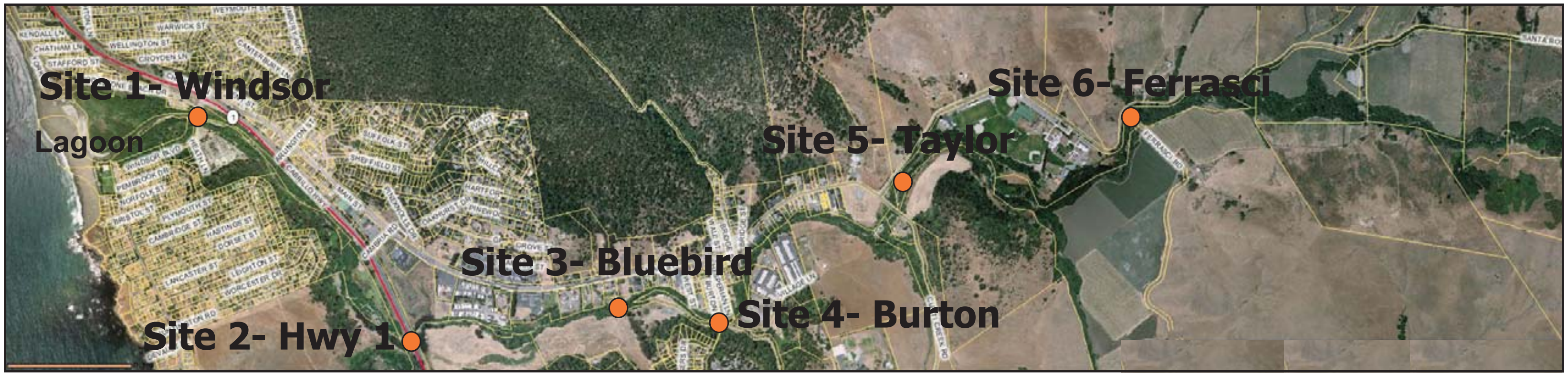
On May 5, 6, and 7th 2010, Central Coast Salmon Enhancement collected benthic macroinvertebrates (BMI) utilizing an abridged version of the California Water Board's Surface Water Ambient Monitoring Program (SWAMP) bioassessment protocol (Ode, 2007). The collection of benthic macroinvertebrates samples was accompanied by the collection of associated physical habitat and ambient water quality data.

2.1 Site Selection

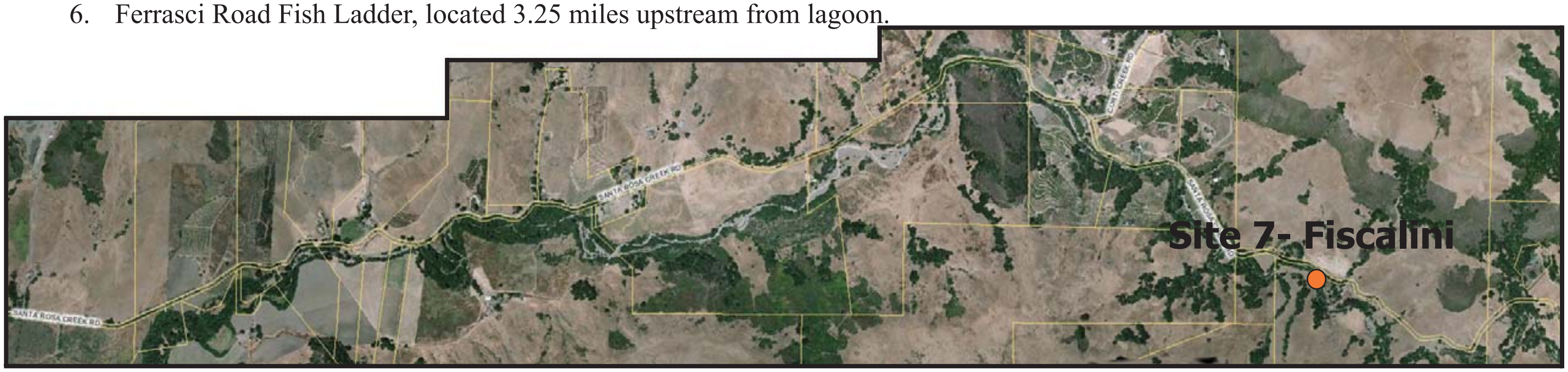
Seven sites with the presence of riffle habitat were sampled along the lower 7 miles of Santa Rosa Creek. Site selection was determined in part by personal communication with Mary Adams of the Central Coast Regional Water Quality Control Board's Ambient Monitoring Program (CCAMP) and Jennifer Nelson of the California Department of Fish and Game, both of whom have experience on the Santa Rosa Creek. Physical accessibility and permission for access from the landowners also played a role in site selection. The sites chosen for sampling reflect a variety of land uses and human influences including urbanization, agriculture, and ranching.

The sites start 0.3 miles upstream from the Santa Rosa Creek lagoon (where the creek empties into the Pacific Ocean) and continues upstream to the last site at 7 miles. Six of the sites are located below the so-called "Narrows" including four sites within the town of Cambria (Figure 2.1)

Figure 2.1 Santa Rosa Creek BMI Sampling Sites



1. Windsor Street Bridge, located .3 miles upstream from lagoon.
2. Highway One Bridge, located 1 mile upstream from lagoon.
3. Bluebird Hotel Foot Bridge, located 1.5 miles upstream from lagoon.
4. Burton Bridge, located 1.8 miles upstream from lagoon.
5. Taylor, located 2.75 miles upstream from lagoon.
6. Ferrasci Road Fish Ladder, located 3.25 miles upstream from lagoon.



7. Fiscalini - Above the “Narrows”, located 7 miles upstream from lagoon.

2.2 Habitat and Reach Identification

The benthic macroinvertebrate (BMI) sampling event took place at base flow conditions using SWAMP's targeted riffle composite (TRC) procedure (Ode, 2007). A stream reach of 450 feet of riffle habitat was defined at each site. Riffles are the shallower portions of stream habitat characterized by water that flows over rocks creating a mild to moderate turbulence in the surface water (Ode, 2007). Riffles are commonly used for BMI sampling because they are considered the "richest" habitat and usually offer the highest diversity of benthic macroinvertebrates (Ode, 2007). All sampling took place at riffles no deeper than 2 feet of water.

Each 450 feet reach was randomly divided into eight transects, the only criteria being the presence of riffle habitat. The sampling began at the lower most end of the reach at the first sizeable riffle location and progressed upstream, so as to not disturb the substrate of the upstream sampling locations. Contamination of the downstream sampling sites with sediment and disturbed BMI could result if the sampling did not occur in an upstream direction.

2.3 Sampling Procedure

At each transect, a sampling location was determined closely upstream where a D-frame net with mesh size of 0.5 micrometers was used to collect the sample. The D-frame net was placed flat on the substrate where a one square foot sample was taken. Organisms in the sampling location were first removed from the larger rocks and then the substrate within the sampling area was disturbed by hand for 60 seconds. Care was taken to ensure that all sample material flowed downstream and was captured by the net.

Sample material from each transect was placed into one sample jar. A site's BMI sample is a composite of these eight individual transect samples. Each sample was preserved in 95% ethanol for lab analysis.

2.4 Sample Sorting

All seven BMI samples were sent to J. Thomas King BioAssessment Services (P.O. Box 0752 Folsom, CA 95763) for identification using the required chain of custody forms. The samples were randomly sub-sampled and sorted to 600 individual organisms per sample.

2.5 Taxonomic Identification of Benthic Macroinvertebrates

For each subsample, organisms were identified to the Safit level 1 standard taxonomic effort (Rodgers et al, 2006) by a qualified taxonomist.

Safit level 1 standard taxonomic effort identifies most organisms to the genus level, except chironomids, which are identified to subfamily. The non-insects such as segmented worms are identified to Class level (Oligochatea).

The sorted identified organisms labeled with scientific name, date, and the site location were returned to Central Coast Salmon Enhancement. Also, included was an individual taxonomic list for each site, and spreadsheets of data including raw taxa, formulated taxa, commonly reported biometric values (DeShon1995, Barbour et al 1996b, Fore et al 1996, Smith and Voshell 1997), and calculations for the Southern California Index of Biological Integrity (So Cal-IBI) scores (Ode et al, 2005) (Appendix B).

3 WATER QUALITY AND PHYSICAL HABITAT MEASUREMENTS

Water quality measurements and the assessment of the stream's habitat characteristics were recorded in association with the BMI sampling at each site. Together this data can provide an overall framework for assessing the biotic, physical and chemical conditions of a stream reach (Ode, 2007). These physical characteristics can be influenced by a small change to riparian habitat or by adjacent land uses. They can provide supporting data in the evaluation of the type and perhaps the source of stream pollution or degradation.

The chemical and physical data measured was documented on SWAMP's field forms (Appendix A). Several of the data modules were subtracted and were considered unnecessary for the specific objectives of this project. A minimum of two photographs were taken at each transect. One facing upstream and one facing downstream from the center of the transect. Any additional information (not included on the field forms) was recorded in detailed field notes.

3.1 Water Chemistry Measurements

Ambient water quality data was collected at the beginning of each reach. This included the stream's water temperature, pH, dissolved oxygen, and velocity. The water chemistry data was collected using Vernier's LabQuest.

3.2 Physical Measurements

The physical measurements included wetted width of the stream, depth of water, stream bottom substrate measurements, presence of organic matter, and cobble embeddedness.

The wetted width is the portion of the channel that is inundated with water (Ode, 2007). This distance between the sides of the channel where surface water is no longer present was measured using a stadia rod.

Each transect was then divided into five equidistant points (Left bank, Left Center, Center, Right

Center, and Right Bank). At each point, a substrate and water depth measurement was taken. The Wolman pebble count technique (Wolman, 1954) was used for estimating particle size distribution. Particle size frequency and distribution can provide valuable information about instream habitat conditions that can effect the distributions of benthic macroinvertebrates (Ode, 2007). Benthic macroinvertebrates are dependent on specific substrate conditions within the riffle habitat. The substrate needs to be a variety of sizes with a percentage of cobbles. Land uses that can disturb the substrate composition will be evident in the benthic macroinvertebrate organisms collected there (Ode, 2007).

The presence or absence of organic matter such as decaying leaves (but not algae) was noted at each of the five points along the transect. Coarse particulate organic matter can be a general indicator of the amount of food supply that is available at a site (Ode, 2007).

At each transect, cobble embeddedness was also measured. Five random cobbles were pulled from the streambed and an estimate of percent embeddendness of each was determined. Substrate embeddedness or the degree to which fine particles fill interstitial spaces on a streambed has a significant impact on the environment of benthic macoinvertebrates (Ode, 2007).

3.3 Visual Estimates and Habitat Scoring Method

In addition to the physical measurement, visual estimates and habitat scoring methods were used to assess the complexity of the instream habitat, riparian vegetation, bank stability, and the human influences at each transect. These semi-qualitative visual estimates assist in summarizing the overall characteristic and quality of the stream habitat.

3.3.1 Riparian Vegetation

At each transect a 30 x 30 foot section of both the left and the right sides of the stream bank habitat were visually assessed using categorical scoring charts. The riparian vegetation was divided into three zones according to height, 1) groundcover (< 0.5 m), 2) lower canopy (0.5-5m), and 3) upper canopy (> 5m)(Ode, 2007). Within each zone, the density of the vegetation was given a score between 0 and 4, with 0 being absent of vegetation (0%) and 4 being a very heavy density (greater than 75%). Riparian vegetation has a strong influence on the quality of a stream habitat. It can be a direct or indirect source of food, provide protection from bank erosion, and act as a buffer between the stream channel and adjacent land uses (Ode, 2007).

3.3.2 Instream Habitat Complex and Bank Stability

The instream habitat complexity was evaluated by scoring the areal coverage of nine different stream features such as algae, macrophytes, boulders, wood debris, undercut banks, overhanging vegetation, live tree roots and artificial structures (Ode, 2007). The scoring ranged from 0 to 4, with 0 being absent (0%) and 4 being a very heavy presence (greater than 75%). Visual estimates were done within a zone of 30 feet upstream and 30 feet downstream of the transect and included features within the stream as well as along the banks. Assessing the instream habitat complexity provides important information about the general condition and complexity of the stream channel as well as quantify fish concealment habitat (Ode, 2007).

Stability of both the right and left banks were also scored. The banks along a zone of 30 feet upstream and 30 feet downstream of each transect were visually assessed as being eroded, vulnerable, or stable. Bank stability influences the amount of sedimentation that might occur that can cause degradation to the stream's habitat.

3.3.3 Human Influences

At each transect, a 30 ft x 30 foot riparian area centered along the transect was divided into three zones 1) Left bank, 2) Center channel, and 3) Right bank (Ode, 2007). The presence and location of 14 human influence categories were recorded within each of the zones. These 14 human influence categories are 1) walls and riprap, 2) buildings, 3) pavement, 4) roads and railroads, 5) pipes, 6) trash, 7) lawn or park, 8) row crops, 9) pasture, 10) logging activity, 11) mining activity, 12) vegetation management, 13) bridges, and 14) orchard or vineyard. The influence of human activities and adjacent land uses are a critical concern to the quality of a stream's habitat. Recording the impacts and the locations at which they occur can often help explain the results in the BMI analysis (Ode, 2007).

4 RESULTS

4.1 Biometric Values

Biometric values were calculated for each of the seven samples (Appendix B). Each biometric is a characteristic of the stream's macroinvertebrate community that changes in some predictable way relative to a stressor (Fore, 1996). These biometrics are used as a diagnostic tool and are useful in evaluating stream health and for comparing conditions between sites, with other past sampling events, and other Southern California streams.

There are four types (or measures) of biometrics, each biometric responds in its own particular way to impacts to the environment due to pollution or other small physical changes.

1) Richness measures are the total number of individual taxa in a sample. It is an indicator of diversity and suggests an ecosystem that is able to support a variety of benthic macroinvertebrates.
2) Composition is the measure of a percentage (or relative abundance) of particular taxa in a sample. This measure is intended to show the overall make-up of the sample and the relative contribution of the populations to the total biological community.

3) Tolerance/Intolerance measures can be the number of individual taxa sensitive to disturbance or the percentage of tolerant to sensitive taxa. This biometric indicates the relative sensitivity to disturbances.

4) Functional Feeding Groups measures the proportions of different types of feeding among the taxa. This biometric provides information on the balance of feeding strategies among the benthic macroinvertebrate community.

Table 4.1 is a list of the biometrics used for water quality analysis of the Santa Rosa Creek (compiled from DeShon1995, Barbour et al 1996b, Fore et al 1996, Smith and Voshell 1997). Each biometric has a brief description and indicates how the metric would change in response to a disturbance.

Table 4.1

Biometric Descriptions and Response to Impairment
(compiled from DeShon 1995, Barbour et al. 1996, Fore et al. 1996, Smith and Voshell 1997).

BMI Metric	Description	Response to Impairment [1]
Richness Measures		
1. Taxonomic	Total number of individual taxa.	Decrease
2. EPT [2]	Number of taxa in the orders Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly)	Decrease
3. Ephemeroptera	Number of mayfly taxa	Decrease
4. Plecoptera	Number of stonefly taxa	Decrease
5. Trichoptera	Number of caddisfly taxa	Decrease
6. Coleoptera [2]	Number of beetle taxa	Decrease
7. Predator [2]	Number of predator taxa	Decrease
Composition Measures		
8. EPT Index (%)	Percent composition of mayfly, stonefly and caddisfly individuals	Decrease
9. Sensitive EPT Index (%)	Percent composition of mayfly, stonefly and caddisfly individuals with CTVs less than 4.	Decrease
8. Shannon Diversity Index	General measure of sample diversity that incorporates richness and evenness (Shannon and Weaver 1963).	Decrease
10. Non-insect Taxa (%) [2]	Percentage of taxa not within the class Insecta	Increase
Tolerance/Intolerance Measures		
11. California Tolerance Value (CTV)	CTVs between 0 and 10 weighted for abundance of individuals designated as pollution tolerant (higher values) and intolerant (lower values).	Increase
12. Intolerant Organisms (%) [2]	Percentage of organisms that are highly intolerant to water and/ or habitat quality impairment as indicated by CTVs of 0, 1 or 2.	Decrease
13. Tolerant Taxa (%) [2]	Percentage of taxa that are highly tolerant to water and/ or habitat quality impairment as indicated by CTVs of 8, 9 or 10.	Increase
Functional Feeding Groups (FFG)		
14. % Collector-gatherers (cg)	Percentage of macroinvertebrates that collect or gather material.	Increase
15. % Collector-filterers (cf)	Percentage of macroinvertebrates that filter suspended material from the water column.	Increase
16. % Collectors [2]	Percentage of macroinvertebrates that collect and filter suspended material from the water column.	Increase
17. % Scrapers (sc)	Percentage of macroinvertebrates that graze upon periphyton.	Variable
18. % Predators (p)	Percentage of macroinvertebrates that prey on living organisms.	Decrease
19. % Shredders (sh)	Percentage of macroinvertebrates that shred leaf litter.	Decrease
20. % Others (ot)	Percentage of macroinvertebrates that occupy an FFG not described above.	Variable
Other		
21. Abundance	Estimate of the number of organisms in a sample based on the proportion of organisms subsampled.	Variable

[1] The responses indicated are generalized and can follow natural gradients associated with elevation, water temperature and substrate composition.

[2] Metrics used for southern coastal California index of biotic integrity

4.2 Calculated Data

The following (Table 4.2) is the calculated biometric values and Southern California Index of Biological Integrity scores for the seven sampling sites on the Santa Rosa Creek. The complete data set including the raw taxa, formulated taxa, and calculated data can be found in Appendices B-D. Also, additional past data from the Central Coast Regional Water Quality Control Board's Ambient Monitoring Program (CCAMP can be found in Appendix E for the Windsor and Ferrasci sites .

Table 4.2 **Santa Rosa Creek Calculated Metrics Data**

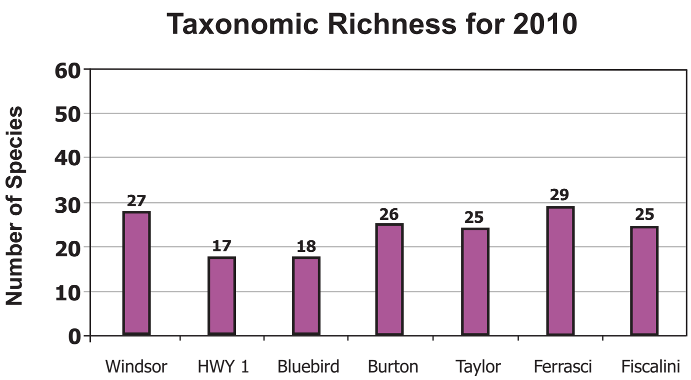
Metrics		Windsor	Highway 1	Bluebird	Burton	Taylor	Ferrasci	Fiscalini
Richness:								
	Taxonomic	27	17	18	26	25	29	25
	EPT *	9	7	8	10	11	11	12
	Ephemeroptera	3	2	3	4	4	4	5
	Plecoptera	0	1	0	1	0	0	2
	Trichoptera	6	4	5	5	7	7	5
	Coleoptera *	4	2	2	3	3	4	4
	Predator *	13	4	7	12	9	10	8
Composition:								
	EPT Index (%)	49	51	41	40	42	26	25
	Sensitive EPT Index (%)	3.0	1.5	3.0	3.9	5.5	6.4	5.9
	Shannon Diversity	1.9	1.4	1.3	1.8	1.9	2.3	2.1
	Dominant Taxon (%)	43	48	49	36	33	32	38
	Non-Insect Taxa (%) *	26	29	28	23	28	21	20
Tolerance:								
	Tolerance Value	5.3	5.3	5.3	5.3	5.1	5.1	5.2
	Intolerant Organisms (%) *	3.0	1.6	3.0	3.9	5.5	6.4	5.9
	Tolerant Organisms (%)	6.6	1.6	0.7	4.4	4.9	6.9	8.6
	Tolerant Taxa (%) *	26	18	22	23	24	17	16
Functional Feeding Groups:								
	Collector-Gatherers (%)	49	52	37	42	40	29	28
	Collector-Filterers (%)	26	36	50	37	32	33	38
	Collectors (%) *	76	88	87	79	71	62	66
	Scrapers (%)	9	5	9	9	16	18	15
	Predators (%)	15	6	3	12	11	16	16
	Shredders (%)	0.2	0.3	0.0	0.0	0.5	3.1	2.2
	Other (%)	0.2	0.8	1.3	0.2	0.6	0.9	0.7
	**IBI Score ** **	**51**	**34**	**37**	**51**	**50**	**63**	**60**
Estimated Abundance:								
	Composite sample (8 ft^2)	846	1130	2310	2820	1170	420	1580
	Site (BMIs/ft^2)	106	141	289	353	146	52	198
	Site (BMIs/m^2)	1139	1521	3109	3795	1575	560	2126

* Metrics used in SoCal B-IBI

** IBI scores range from 0 (poor) to 100 (very good). Scoring criteria described by Ode et al. 2005.

4.3 Evaluation of Biometric Values

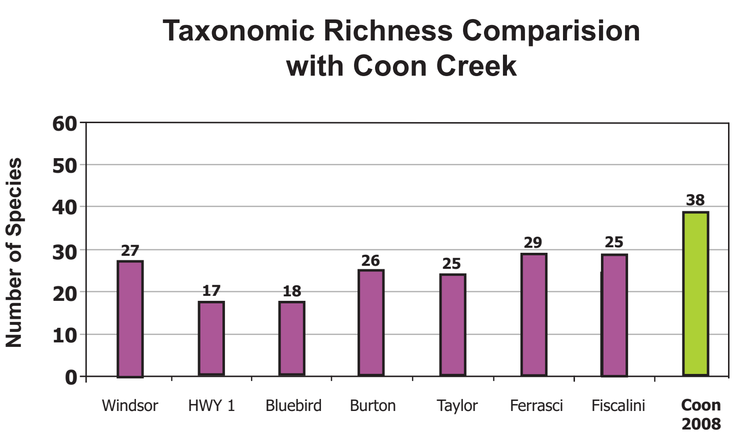
Figure 4.1



4.3.1 Richness Measures

The taxonomic richness metric identifies the total number of individual species found in the samples**.** It is an indicator of diversity and suggests an ecosystem that is healthy enough to support a wide variety of benthic macroinvertebrates. A decrease in this value indicates a lower diversity. The Highway 1 and Bluebird sites had the lowest values (17 and 18) and sites further upstream such as Ferrasci had higher diversity of species (29).

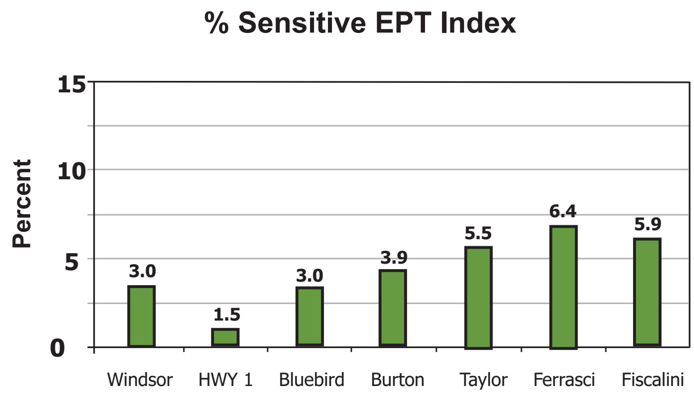
Figure 4.2



Coon Creek, located in southern San Luis Obispo County at Montana de Oro State Park, can be used as a base comparison. It is considered to have high quality habitat with adjacent land uses of mostly pristine open space and agriculture. There are few impacts due to urbanization along Coon Creek. As seen here, the taxonomic richness value for Coon Creek in 2008 (MBNEB, 2008) is much higher (38) than the Santa Rosa Creek values (17-29). A decrease in taxonomic richness shows a response by the BMI community to disturbance.

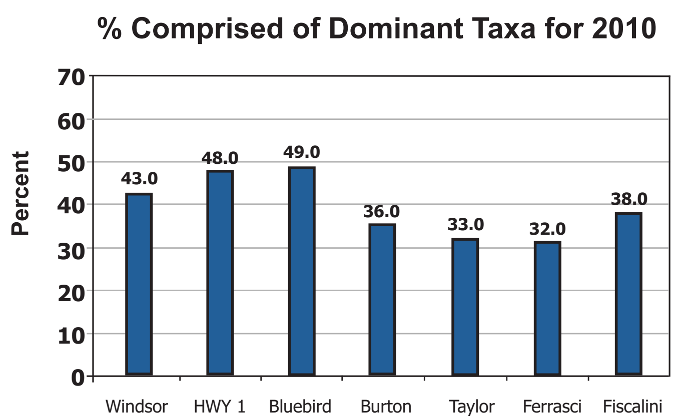
4.3.2 Composition Measures

Figure 4.3



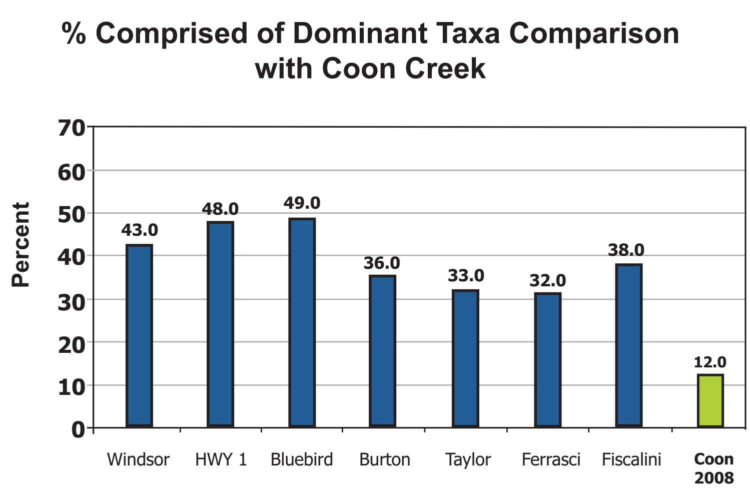
% Sensitive EPT Index metric is the percentage of three pollution sensitive species Ephemeroptera (mayflies), Plecoterea, (stoneflies) and Trichoptera (caddisflies). A stream with good water quality would have higher values for % Sensitive EPT Index. The four lower Santa Rosa creek sites ranged in values from 1.5% to 3.9%.

Figure 4.4



The % Dominant Taxa metric identifies the portion of the third, second, and single most dominant species in the sample. A stream with excellent water quality can support a greater number of taxa, each in moderate percentages of 20-30% or less (Plotnikoff, 1997). If the values for dominant taxa are 40% or greater, it's an indication of instability in the macroinvertebrate community and that a stressor is present (Plotnikoff, 1997). The three sites lower in the watershed all had higher percentages (43% to 49%) of dominant taxa compared to the other sites.

Figure 4.5



Again in comparison with Coon Creek, the Santa Rosa Creek sites have higher values for the percentage of the sample comprised of dominant taxa. The numbers range from 32.0% - 48.0% compared to Coon Creek's 12.0% (MNEB, 2008).

4.3.4 Functional Feeding Group Measures

% Scrappers taxa metric identifies the portion of macroinvertebrates that graze upon periphyton. The greater number of taxa indicates a higher level of primary productivity in the benthic macroinvertebrate community. Windsor (9%), Highway 1 (5%), Bluebird (9%) and Burton (9%) all showed lower values in % Scrappers compared to sites Taylor (16%), Ferrasci (18%), and Fiscalini (15%), located higher upstream in the watershed.

% Shredder taxa metric is the percentage of macroinvertebrates that shred leaf litter. This metric reflects macroinvertebrate habitats with high retention of organic matter and the presence of allochthonous sources of food such as overhanging leaves and sticks. The values where much higher for sites Ferrasci (3.1%) and Fiscalini (2.2%) compared to Bluebird and Burton where no taxa where identified in the samples.

4.4 Evaluation of Southern California Index of Biotic Integrity Scores

For each site, a standardized Southern California Index of Biotic Integrity (So Cal-IBI) score was determined. The So Cal-IBI has been adopted as a diagnostic tool for stream health and is the collective sum of seven uncorrelated biometric values. These being 1) the number of Coleoptra taxa, 2) the number of Ephemeroptera, Plecoterea, Trichoptera (EPT) taxa, and 3) the number of Predator taxa, 4) the percentage of sensitive individuals, 5) the percentage of Collector individuals, 6) the percentage of tolerant taxa, and 7) the percentage of non-insect taxa. (Table 4.3). The So Cal IBI is a "condition" score that expresses the health of site in a single qualitative number. It ranges from 0 to 100, with 0 representing an environment of very poor quality with low diversity and 100 being a very healthy environment with high diversity.

Table 4.3 Scoring Ranges for Seven Component Metrics in the SoCal B-IBI
(Ode, P.R., A.C. Rehn and J.T. May, 2005).

	% CF+CG	% Non-Insect Taxa	% Tolerant Taxa	Coleoptera Taxa	Predator Taxa	% Intolerant Individuals	EPT Taxa
Metric Score							
10	**0-51**	**0-8**	**0-5**	**>5**	**>12**	**32-100**	**>16**
9	**52-55**	**9-13**	**6-8**		**12**	**29-31**	**15-16**
8	**56-60**	**14-18**	**9-11**	**5**	**11**	**26-28**	**14**
7	**61-66**	**19-23**	**12-15**	**4**	**10**	**22-25**	**12-13**
6	**67-71**	**24-28**	**16-18**		**9**	**19-21**	**10-11**
5	**72-76**	**29-33**	**19-21**	**3**	**8**	**15-18**	**9**
4	**77-81**	**34-38**	**22-25**	**2**	**7**	**12-14**	**7-8**
3	**82-86**	**39-43**	**26-28**		**6**	**8-11**	**5-6**
2	**87-91**	**44-48**	**29-32**	**1**	**5**	**5-7**	**4**
1	**92-95**	**49-53**	**33-36**		**4**	**1-4**	**2-3**
0	**96-100**	**54-100**	**37-100**	**0**	**0-3**	**0**	**0-1**

The following tables 4.4 through 4.10 show the seven uncorrelated metric values and the final Southern California Index of Biological Integrity Scores for the seven sampling site on the Santa Rosa Creek.

Table 4.4

Site 1- Windsor
05-06-10

	Value	Score
Beetle Taxa	4	7
EPT Taxa	9	5
Predator Taxa	13	10
% Collector Individuals	76	5
% Sensitive Individuals	3	1
% Non-Insect Taxa	26	5
% Tolerant Taxa	26	3
Raw Score		36
Final SoCal IBI Score	51	

FAIR WATER QUALITY

Table 4.5

Site 2- Highway 1
05-07-10

	Value	Score
Beetle Taxa	2	4
EPT Taxa	7	4
Predator Taxa	4	1
% Collector Individuals	88	3
% Sensitive Individuals	2	1
% Non-Insect Taxa	29	5
% Tolerant Taxa	18	6
Raw Score		24
Final SoCal IBI Score	34	

POOR WATER QUALITY

Table 4.6

Site 3- Bluebird
05-07-10

	Value	Score
Beetle Taxa	2	4
EPT Taxa	8	4
Predator Taxa	7	4
% Collector Individuals	87	3
% Sensitive Individuals	3	1
% Non-Insect Taxa	28	5
% Tolerant Taxa	22	5
Raw Score		26
Final SoCal IBI Score	37	

POOR WATER QUALITY

Table 4.7

Site 4- Burton
05-07-10

	Value	Score
Beetle Taxa	3	5
EPT Taxa	10	5
Predator Taxa	12	9
% Collector Individuals	79	5
% Sensitive Individuals	4	2
% Non-Insect Taxa	23	6
% Tolerant Taxa	23	4
Raw Score		36
Final SoCal IBI Score	51	

FAIR WATER QUALITY

Table 4.8

Site 5- Taylor
05-06-10

	Value	Score
Beetle Taxa	3	5
EPT Taxa	11	6
Predator Taxa	9	6
% Collector Individuals	71	7
% Sensitive Individuals	6	2
% Non-Insect Taxa	28	5
% Tolerant Taxa	24	4
Raw Score		35
Final SoCal IBI Score	50	

FAIR WATER QUALITY

Table 4.9

Site 6- Ferrasci
05-05-10

	Value	Score
Beetle Taxa	4	7
EPT Taxa	11	6
Predator Taxa	10	7
% Collector Individuals	62	9
% Sensetive Individuals	6	2
% Non-Insect Taxa	21	7
% Tolerant Taxa	17	6
Raw Score		44
Final SoCal IBI Score	63	

GOOD WATER QUALITY

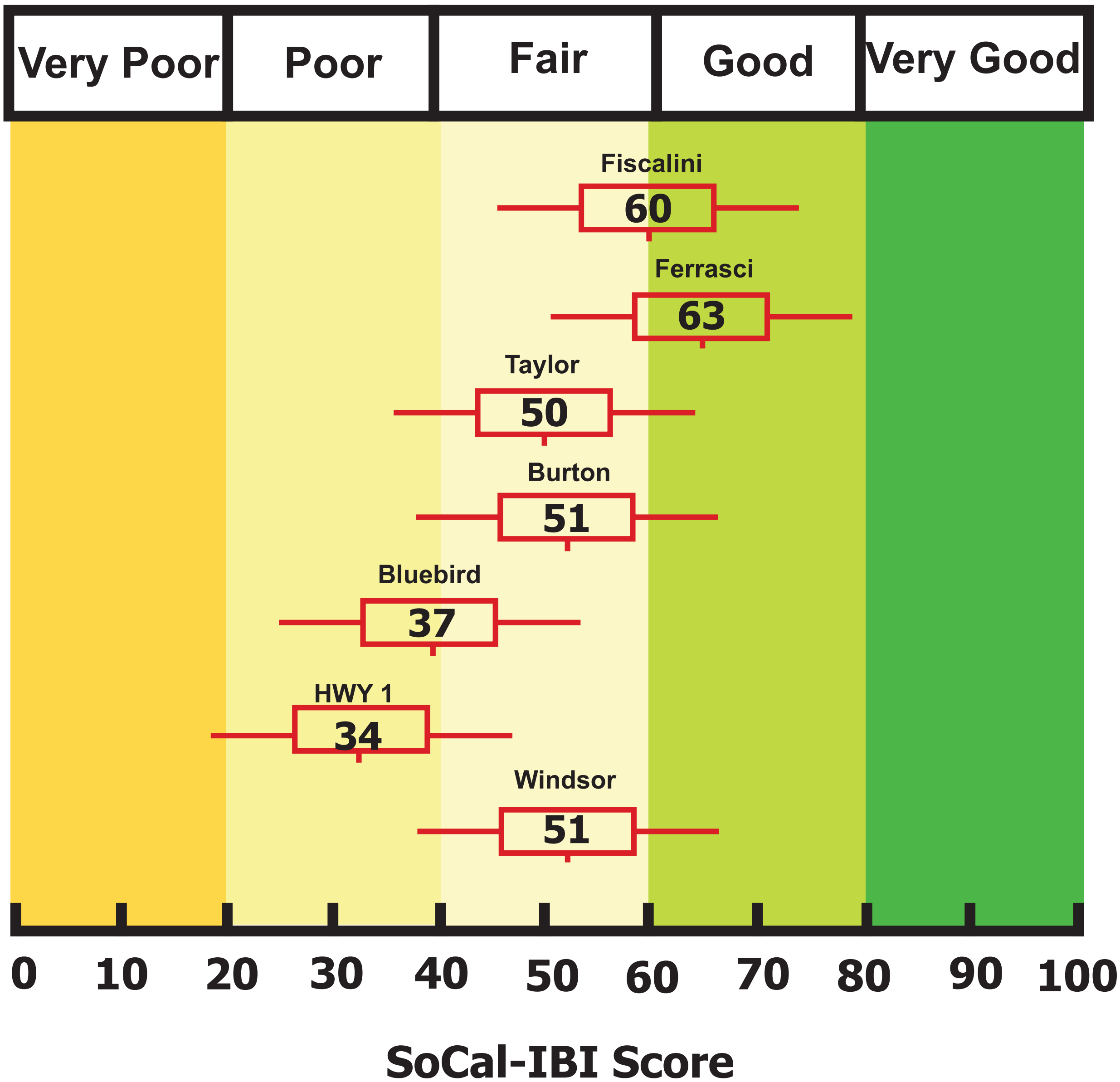
Table 4.10

Site 7- Fiscalini
05-05-10

	Value	Score
Beetle Taxa	4	7
EPT Taxa	12	6
Predator Taxa	8	5
% Collector Individuals	66	8
% SensItive Individuals	6	2
% Non-Insect Taxa	20	7
% Tolerant Taxa	16	7
Raw Score		42-
Final SoCal IBI Score	60	

GOOD WATER QUALITY

Table 4.5 A comparison of the final Southern California Index of Biological Integrity Scores for sites on Santa Rosa Creek.



5 DISCUSSION

The Southern California Index of Biotic Integrity (So Cal-IBI) scores for the Santa Rosa Creek sites range from 34 (Highway 1) to a moderate value of 63 (Ferrasci). The water quality ranges from Poor to Moderately Good.

Highway 1 (34) and Bluebird (37) had the two lowest scores and were determined to have poor water quality. All the sites adjacent to the town of Cambria receive urban runoff, which can affect the benthic macroinvertebrate community. Any increase in impervious surfaces near the Santa Rosa Creek will cause impacts to both the physical habitat and water quality of Santa Rosa Creek. Also, in the habitat scoring data for these sites, the presence and location of human influences was much higher. There was more evidence of urbanization in the creek bed such as rip-rap, concrete, and trash.

The two sites, Ferrasci (63) and Fiscalini (60), upstream from Cambria, were determined to have Moderately Good water quality. These sites are not as affected by urban runoff but may possibly be impacted by their adjacent lands uses of agriculture and ranching.

Another result of this study was to verify if the food supply in the Santa Rosa Creek is adequate to sustain populations of the southern steelhead salmon (*Oncorhynchus mykiss*). The taxonomic lists for each site proved to have large populations of *Baetis* (mayflies) and *Simulium* (blackfly) populations. These benthic macroinvertebrates are known as a valuable food source for salmonid populations.

This study should be valued as a baseline and used as a foundation for the establishment of a biomonitoring program of Santa Rosa Creek in the future. This kind of monitoring program would be helpful in keeping track of the impacts of increased urbanization, or other changes in land uses along the Santa Rosa Creek. This data can be helpful in identifying areas of the Santa Rosa Creek that are in need of restoration and used to help monitor the success of the restoration efforts at those sites.

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Appendix A
California Water Board's Surface Water Ambient Monitoring Program's (SWAMP) Field Forms

APPENDIX A

SWAMP Field Forms
(Ode, 20007)

SWAMP Stream Habitat Characterization Form *Revision Date: March 3rd, 2010*

REACH DOCUMENTATION	Standard Reach Length (wetted width ≤ 10 m) = 150 m Distance between transects = 15 m Alternate Reach Length (wetted width >10 m) = 250 m Distance between transects = 25 m	
Project Name:	Date: / / 2010	Time:
Stream Name:	Site Name/ Description:	
Site Code:	Crew Members:	
Latitude (actual – decimal degrees): °N		
Longitude (actual – decimal degrees): °W	GPS Device:	

AMBIENT WATER QUALITY MEASUREMENTS				*turbidity and silica are optional; calibration date required*			
Temp (°C)		pH				Turbidity (ntu)	
		cal. date				cal. date	
Dissolved O^2 (mg/L)							
cal. date		cal. date				cal. date	

REACH LENGTH	
Actual Length (m) *(see reach length guidelines at top of form)*	
Explanation:	

NOTABLE FIELD CONDITIONS (check one box per topic)						
Evidence of recent rainfall (enough to increase surface runoff)	NO		minimal		>10% flow increase	
Evidence of fires in reach or immediately upstream (<500 m)	NO		< 1 year		< 5 years	
Dominant landuse/ landcover in area surrounding reach	Agriculture		Forest		Rangeland	
	Urban/ Industrial		Suburb/Town		Other	

ADDITIONAL COBBLE EMBEDDEDNESS MEASURES (carry over from transect forms if needed; measure in %)	1	2	3	4	5	6	7	8	9	10	11	12	13
	14	15	16	17	18	19	20	21	22	23	24	25	

Page 1

SWAMP Stream Habitat Characterization Form — *Revision Date: March 3rd, 2010*

Site Code:	Site Name:		Date: __ __ / __ __ / 2010
Wetted Width (m):	Bankfull Width (m):	Bankfull Height (m):	**TRANSECT 1**

Transect Substrates

Position	Dist from LB (m)	Depth (cm)	mm/ size class	% Cobble Embed.	CPOM	Microalgae Thickness Code	Macroalgae Attached	Macroalgae Unattached	Macrophytes
Left Bank					P A		P A D	P A D	P A
Left Center					P A		P A D	P A D	P A
Center					P A		P A D	P A D	P A
Right Center					P A		P A D	P A D	P A
Right Bank					P A		P A D	P A D	P A

Note: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of the size class categories listed on the supplemental page (direct measurements preferred)

Microalgae Thickness Codes
- **0** = No microalgae present, Feels rough, not slimy;
- **1** = Present but not visible, Feels slimy;
- **2** = Present and visible but <1mm; Rubbing fingers on surface produces a brownish tint on them, scraping leaves visible trail.
- **3** = 1-5mm;
- **4** = 5-20mm;
- **5** = >20mm;
- **UD** = Cannot determine if microalgae present, substrate too small or covered with silt (formerly Z code).
- **D** = Dry, not assessed

RIPARIAN VEGETATION (facing downstream)

0 = Absent (0%); 1 = Sparse (<10%); 2 = Moderate (10-40%); 3 = Heavy (40-75%); 4 = Very Heavy (>75%)

Vegetation Class	Left Bank	Right Bank
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m-5 m high)		
All vegetation 0.5 m to 5 m	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Woody shrubs & saplings <0.5 m	0 1 2 3 4	0 1 2 3 4
Herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY

0 = Absent (0%); 1 = Sparse (<10%); 2 = Moderate (10-40%); 3 = Heavy (40-75%); 4 = Very Heavy (>75%)

Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes/ Emergent Vegetation	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3 m	0 1 2 3 4
Woody Debris <0.3 m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17) *count covered dots*

Center Left	
Center Upstream	
Center Right	
Center Downstream	
Optional	
Left Bank	
Right Bank	

HUMAN INFLUENCE (circle only the closest to wetted channel)

0 = Not Present; **B** = On Bank; **C** = Between Bank & 10m from Channel; **P** = >10m+<50m from Channel; **Channel** (record Yes or No)

	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	P C B 0	Y N	0 B C P
Buildings	P C B 0	Y N	0 B C P
Pavement/ Cleared Lot	P C B 0		0 B C P
Road/ Railroad	P C B 0	Y N	0 B C P
Pipes (Inlet/ Outlet)	P C B 0	Y N	0 B C P
Landfill/ Trash	P C B 0	Y N	0 B C P
Park/ Lawn	P C B 0		0 B C P
Row Crop	P C B 0		0 B C P
Pasture/ Range	P C B 0		0 B C P
Logging Operations	P C B 0		0 B C P
Mining Activity	P C B 0	Y N	0 B C P
Vegetation Management	P C B 0		0 B C P
Bridges/ Abutments	P C B 0	Y N	0 B C P
Orchards/ Vineyards	P C B 0		0 B C P

BANK STABILITY (score zone 5m upstream and 5m downstream of transect between bankfull - wetted width)

Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

TAKE PHOTOGRAPHS ***(check box if taken & record photo code)***

- Downstream (**optional**) ☐
- Upstream (**required**) ☐

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SWAMP Stream Habitat Characterization Form *Revision Date: March 3rd, 2010*

Flow Habitat Type	DESCRIPTION
Cascades	Short, high gradient drop in stream bed elevation often accompanied by boulders and considerable turbulence
Falls	High gradient drop in elevation of the stream bed associated with an abrupt change in the bedrock
Rapids	Sections of stream with swiftly flowing water and considerable surface turbulence. Rapids tend to have larger substrate sizes than riffles
Riffles	Shallow sections where the water flows over coarse stream bed particles that create mild to moderate surface turbulence; (< 0.5 m deep, > 0.3 m/s).
Runs	Long, relatively straight, low-gradient sections without flow obstructions. The stream bed is typically even and the water flows faster than it does in a pool; (> 0.5 m deep, > 0.3 m/s). A **step-run** is a series of runs separated by short riffles or flow obstructions that cause discontinuous breaks in slope
Glides	A section of stream with little or no turbulence, but faster velocity than pools; (< 0.5 m deep, < 0.3 m/s)
Pools	A reach of stream that is characterized by deep, low-velocity water and a smooth surface; (> 0.5 m deep, < 0.3 m/s)

Size Class Code	Size Class Range	Size Class Description	Common Size Reference
RS	> 4 m	bedrock, smooth	larger than a car
RR	> 4 m	bedrock, rough	larger than a car
XB	1 - 4 m	boulder, large	meter stick to car
SB	25 cm - 1.0 m	boulder, small	basketball to meter stick
CB	64 - 250 mm	cobble	tennis ball to basketball
GC	16 - 64 mm	gravel, coarse	marble to tennis ball
GF	2 – 16 mm	gravel, fine	ladybug to marble
SA	0.06 – 2 mm	sand	gritty to ladybug
FN	< 0.06 mm	fines	not gritty
HP	< 0.06 mm	hardpan (consolidated fines)	
WD	NA	wood	
RC	NA	concrete/ asphalt	
OT	NA	other	

BANK STABILITY	
Although this measure of the degree of erosive potential is subjective, it can provide clues to the erosive potential of the banks within the reach. Assign the category whose description best fits the conditions in the area between the wetted channel and bankfull channel (see figure below)	
Eroded	Banks show obvious signs of erosion from the current or previous water year; banks are usually bare or nearly bare
Vulnerable	Banks have some vegetative protection (usually annual growth), but not enough to prevent erosion during flooding
Stable	Bank vegetation has well-developed roots that protect banks from erosion; alternately, bedrock or artificial structures (e.g., concrete/ rip-rap) prevent bank erosion

CPOM/ COBBLE EMBEDDEDNESS

CPOM: Record presence (P) or absence (A) of coarse particulate organic matter (>1.0 mm particles) within 1 cm of each substrate particle

Cobble Embeddedness: Visually estimate % embedded by fine particles (record to nearest 5%)

ADDITIONAL COBBLE EMBEDDEDNESS MEASURES (carry over from transect forms if needed; measure in %)	1	2	3	4	5	6	7	8	9	10	11	12	13
	14	15	16	17	18	19	20	21	22	23	24	25	

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Appendix B
Lab Documentation and Santa Rosa Creek Metrics Data

APPENDIX B

Lab Documentation

Date of preparation: May 31, 2010
Prepared by: Tom King
Project: Santa Rosa Creek Bioassessment
Project Manager: Virginia Brown, Central Coast Salmon
Background:

1) Benthic samples collected in the spring season of 2010 by Virginia Brown using the SWAMP targeted riffle sampling strategy.

2) Benthic samples processed by BioAssessment Services.
a) Identifier: Tom King
b) Subsampler: Monica Murray

3) 600 (±5%) invertebrates were subsampled and identified to standard taxonomic level (STL) I specified by the Southwest Association of Freshwater Invertebrate Taxonomists (http://www.waterboards.ca.gov/swamp.
a) STL exceptions: chironomids identified to subfamily/tribe instead of family and less precise identifications for empidid pupae.
b) 600 (±5%) organisms subsampled. One sample, Fiscalini #1, contained less than 600 organisms.

4)Chironomids converted to family for metric calculations and generation of coastal southern California B-IBI.

5)Tolerance values and functional feeding group designations from CAMLnet 27 January 2003 revision.

6)Piercer herbivore, omnivore, macrophyte herbivore and parasite functional feeding groups converted. to “other” category for metric calculation.

*Ode, P.R., A.C. Rehn and J.T. May. 2005. A quantitative tool for assessing the integrity of southern coastal Calirornia streams.
Environmental Management Vol. 35, No. 1, pp. 1□13. Springer Science+Business Media, Inc.

SANTA ROSA CREEK METRICS DATA

Metrics	Windsor	Highway 1	Bluebird	Burton	Taylor	Ferrasci	Fiscalini
Richness:							
Taxonomic	27	17	18	26	25	29	25
EPT*	9	7	8	10	11	11	12
Ephemeroptera	3	2	3	4	4	4	5
Plecoptera	0	1	0	1	0	0	2
Trichoptera	6	4	5	5	7	7	5
Coleoptera*	4	2	2	3	3	4	4
Predator*	13	4	7	12	9	10	8
Composition:							
EPT Index (%)	49	51	41	40	42	26	25
Sensitive EPT Index (%)	3.0	1.5	3.0	3.9	5.5	6.4	5.9
Shannon Diversity	1.9	1.4	1.3	1.8	1.9	2.3	2.1
Dominant Taxon (%)	43	48	49	36	33	32	38
Non-Insect Taxa (%)*	26	29	28	23	28	21	20
Tolerance:							
Tolerance Value	5.3	5.3	5.3	5.3	5.1	5.1	5.2
Intolerant Organisms (%)*	3.0	1.6	3.0	3.9	5.5	6.4	5.9
Tolerant Organisms (%)	6.6	1.6	0.7	4.4	4.9	6.9	8.6
Tolerant Taxa (%)*	26	18	22	23	24	17	16
Functional Feeding Groups:							
Collector-Gatherers (%)	49	52	37	42	40	29	28
Collector-Filterers (%)	26	36	50	37	32	33	38
Collectors (%)*	76	88	87	79	71	62	66
Scrapers (%)	9	5	9	9	16	18	15
Predators (%)	15	6	3	12	11	16	16
Shredders (%)	0.2	0.3	0.0	0.0	0.5	3.1	2.2
Other (%)	0.2	0.8	1.3	0.2	0.6	0.9	0.7
IBI Score**	**51**	**34**	**37**	**51**	**50**	**63**	**60**
Estimated Abundance:							
Composite sample (8 ft^2)	846	1130	2310	2820	1170	420	1580
Site (BMIs/ft^2)	106	141	289	353	146	52	198
Site (BMIs/m^2)	1139	1521	3109	3795	1575	560	2126

* Metrics used in SoCal B-IBI

** IBI scores range from 0 (poor) to 100 (very good). Scoring criteria described by Ode et al. 2005.

Appendix C
Santa Rosa Creek Taxa List

APPENDIX C

SANTA ROSA CREEK TAXA LIST

Phylum / Class / Order / Family / Final ID	CTV[1]	FFG[2]	Windsor	HWY 1	Bluebird	Burton	Taylor	Ferrasci	Fiscalini
Hemiptera									
Naucoridae									
Ambrysus	5	p				1			
Odonata									
Coenagrionidae									
Argia	7	p	2			1		2	
Plecoptera									
Chloroperlidae									
Suwallia	1	p				1			
Nemouridae									
Malenka	2	sh		1					2
Pteronarcyidae									
Pteronarcys	0	om							2
Trichoptera									
Brachycentridae									
Micrasema	1	mh					1	2	
Glossosomatidae									
Agapetus	0	sc	6	8	16	10	24	19	10
Hydropsychidae									
Cheumatopsyci	5	cf			1	1	5	1	
Hydropsyche	4	cf	4	3	2	4	4	4	1
Hydroptilidae									
Ochrotrichia	4	ph	1	4	8	1	3		2
Philopotamidae									
Wormaldia	3	cf	2			2			

SANTA ROSA CREEK TAXA LIST (continued)

Phylum / Class / Order / Family / Final ID	CTV[1]	FFG[2]	Windsor	HWY 1	Bluebird	Burton	Taylor	Ferrasci	Fiscalini
Psychomyiidae									
Tinodes	2	sc						2	
Rhyacophilidae									
Rhyacophila	0	p	1		1		1	2	4
Sericostomatidae									
Gumaga	3	sh	1	1			3	12	1
Arachnoidea									
Acari									
Hydryphantidae									
Protzia	8	p	2				3	1	
Hygrobatidae									
Atractides	8	p	16	5	1	8	7	7	5
Hygrobates	8	p				1			
Lebertiidae									
Lebertia	8	p	10	2	1	2	6		4
Mideopsidae									
Mideopsis	5	p							2
Malenka	2	sh		1					2
Pteronarcyidae									
Pteronarcys	0	om							2
Trichoptera									
Brachycentridae									
Micrasema	1	mh					1	2	
Glossosomatidae									
Agapetus	0	sc	6	8	16	10	24	19	10

SANTA ROSA CREEK TAXA LIST (continued)

Phylum / Class / Order / Family / Final ID	CTV[1]	FFG[2]	Windsor	HWY 1	Bluebird	Burton	Taylor	Ferrasci	Fiscalini
Hydropsychidae									
Cheumatopsyci	5	cf			1	1	5	1	
Hydropsyche	4	cf	4	3	2	4	4	4	1
Hydroptilidae									
Ochrotrichia	4	ph	1	4	8	1	3		2
Philopotamidae									
Wormaldia	3	cf	2			2			
Psychomyiidae									
Tinodes	2	sc						2	
Rhyacophilidae									
Rhyacophila	0	p	1		1		1	2	4
Sericostomatidae									
Gumaga	3	sh	1	1			3	12	1
Arachnoidea									
Acari									
Hydryphantidae									
Protzia	8	p	2				3	1	
Hygrobatidae									
Atractides	8	p	16	5	1	8	7	7	5
Hygrobates	8	p				1			
Lebertiidae									
Lebertia	8	p	10	2	1	2	6		4
Mideopsidae									
Mideopsis	5	p							2

SANTA ROSA CREEK TAXA LIST (continued)

Phylum / Class / Order / Family / Final ID	CTV[1]	FFG[2]	Windsor	HWY 1	Bluebird	Burton	Taylor	Ferrasci	Fiscalini
Oligochaeta	5	cg	1	1		1	1	3	
Mollusca									
Bivalvia									
Veneroida									
Sphaeriidae									
Pisidium	8	cf	2						
Gastropoda									
Hypsogastropoda									
Hydrobiidae									
Hydrobiidae	8	sc						5	
			608	607	597	611	617	423	595

[1] California Tolerance Value based on a scale from 0 (intolerant) to 10 (tolerant).

[2] Functional Feeding Group:

collector-gatherer (cg); collector-filterer (cf); scraper (sc); predator (p); shredder (sh)

Note: omnivore (om), piercer herbivore (ph), parasite (pa) and macrophyte herbivore (mh) placed into other (ot) category for metric calculations

Appendix D
Santa Rosa Creek BMI Calculations

APPENDIX D

SANTA ROSA CREEK CALCULATIONS

			Windsor	Highway 1	Bluebird	Burton	Taylor	Ferrasci	Fiscalini
Final ID	CTV	FFG	3012	3015	3013	3014	3011	3009	3010
Helichus	5	sh							1
Agabus	8	p	1			1			
Sanfillipodytes	5	p	5			1	4	4	2
Stictotarsus	5	p	6					1	21
Dubiraphia	6	cg		2			2		
Optioservus	4	sc	39	19	32	38	73	48	71
Zaitzevia	4	sc			1				
Peltodytes	5	ot						2	
Bezzia/ Palpomyia	6	p	3		1	1		1	
Chironomidae	6	cg	19	20	9	24	24	40	7
Empididae	6	p						2	
Neoplasta	6	p	1			2	1	1	
Muscidae	6	p	1						
Simulium	6	cf	153	215	294	221	187	134	228
Caloparyphus/Euparyp	8	cg	5			11	3	15	41
Tanyderidae	1	ot		1					
Cryptolabis	3	sh						1	9
Baetis	5	cg	263	293	210	205	205	60	99
Caenis	7	cg							1
Drunella	0	cg				1			
Ephemerella	1	cg	11		1	12	8	2	17
Ecdyonurus criddlei	4	sc	8	1	3	9	4	2	7
Tricorythodes	4	cg						2	1
Paraleptophlebia	4	cg					1		
Suwallia	1	p				1			
Malenka	2	sh		1					2
Pteronarcys	0	ot							2

SANTA ROSA CREEK CALCULATIONS (continued)

			Windsor	Highway 1	Bluebird	Burton	Taylor	Ferrasci	Fiscalini
Micrasema	1	ot					1	2	
Agapetus	0	sc	6	8	16	10	24	19	10
Cheumatopsyche	5	cf			1	1	5	1	
Hydropsyche	4	cf	4	3	2	4	4	4	1
Ochrotrichia	4	ot	1	4	8	1	3		2
Wormaldia	3	cf	2			2			
Tinodes	2	sc						2	
Rhyacophila	0	p	1		1		1	2	4
Gumaga	3	sh	1	1			3	12	1
Ambrysus	5	p				1			
Argia	7	p	2			1		2	
Protzia	8	p	2				3	1	
Atractides	8	p	16	5	1	8	7	7	5
Hygrobates	8	p				1			
Lebertia	8	p	10	2	1	2	6		4
Mideopsis	5	p							2
Sperchon	8	p	4	3	1	4	10	1	1
Sperchonopsis	8	p			1				
Torrenticola	5	p	41	28	14	48	36	47	56
Erpobdellidae	8	p					1		
Oligochaeta	5	cg	1	1		1	1	3	
Pisidium	8	cf	2						
Hydrobiidae	8	sc						5	
			608	607	597	611	617	423	595

SANTA ROSA CREEK CALCULATIONS (continued)

	Windsor	Highway 1	Bluebird	Burton	Taylor	Ferrasci	Fiscalini
Taxonomic Richness	27	17	18	26	25	29	25
EPT Taxa	9	7	8	10	11	11	12
Ephemeroptera Taxa	3	2	3	4	4	4	5
Plecoptera Taxa	0	1	0	1	0	0	2
Trichoptera Taxa	6	4	5	5	7	7	5
EPT Index (%)	49	51	41	40	42	26	25
Sensitive EPT Index (%)	3.0	1.5	3.0	3.9	5.5	6.4	5.9
Shannon Diversity	1.9	1.4	1.3	1.8	1.9	2.3	2.1
Dominant Taxon (%)	43	48	49	36	33	32	38
Tolerance Value	5.3	5.3	5.3	5.3	5.1	5.1	5.2
Intolerant Organisms (%)	3.0	1.6	3.0	3.9	5.5	6.4	5.9
Tolerant Organisms (%)	6.6	1.6	0.7	4.4	4.9	6.9	8.6
Collector-Gatherers	49	52	37	42	40	29	28
Collector-Filterers	26	36	50	37	32	33	38
Scrapers	9	5	9	9	16	18	15
Predators	15	6	3	12	11	16	16
Shredders	0.2	0.3	0.0	0.0	0.5	3.1	2.2
Other	0.2	0.8	1.3	0.2	0.6	0.9	0.7
	100	100	100	100	100	100	100

SANTA ROSA CREEK CALCULATIONS (continued)

			Windsor	Highway 1	Bluebird	Burton	Taylor	Ferrasci	Fiscalini
SoCal B-IBI metrics								Values:	
Coleoptera Richness			4	2	2	3	3	4	4
EPT Richness			9	7	8	10	11	11	12
Predator Richness			13	4	7	12	9	10	8
Collectors (%)			76	88	87	79	71	62	66
:olerant Individuals (%)			3	2	3	4	6	6	6
Non-Insect Taxa (%)			26	29	28	23	28	21	20
Tolerant Taxa (%)			26	18	22	23	24	17	16
								Scores:	
Coleoptera Richness			7	4	4	5	5	7	7
EPT Richness			5	4	4	5	6	6	6
Predator Richness			10	1	4	9	6	7	5
Collectors (%)			5	3	3	5	7	9	8
:olerant Individuals (%)			1	1	1	2	2	2	2
Non-Insect Taxa (%)			5	5	5	6	5	7	7
Tolerant Taxa (%)			3	6	5	4	4	6	7
Total x 1.43	1.43	**IBI:**	**51**	**34**	**37**	**51**	**50**	**63**	**60**
			fair	poor	poor	fair	fair	good	good
Estimated Abundance									
Composite sample (8 ft^2)			846	1130	2310	2820	1170	420	1580
Site (BMIs/ft^2)	8		106	141	289	353	146	52	198
Site (BMIs/m^2)	0.09288		1139	1521	3109	3795	1575	560	2126

Appendix E
Central Coast Regional Water Quality Control Board's Ambient Monitoring Program (CCAMP) Past Data for Windsor and Ferrasci

Note: The CCAMP data was collected using the California Stream Bioassessment Procedure. The protocol and sorted sampling sizes are different than the California Water Board's Surface Water Ambient Monitoring Program's (SWAMP) bioassessment protocol which was used for the seven Santa Rosa Creek sites in this study. TheCCAMP data was not standardized to the SWAMP protocol and therefore is not compared to results of this study. It is included here to capture previously collected BMI data for the watershed.

APPENDIX E

CCAMP'S BMI DATA

		Total Taxa	EPT Index (%)	EPT Taxa	Number Amphipoda Individuals	Number Baetidae Individuals	Number CF + CG Individuals	Number CF + CG Taxa
Windsor 5/1/2001	CSBP-Transects Benthics- 9 900count	36	26	9	0	202	487	10
Windsor 3/29/2002	CSBP-Transects Benthics- 9 900count	28	3	3	3	0	449	9
Windsor 3/25/2003	CSBP-Transects Benthics- 9 900count	38	20	9	4	20	316	14
Windsor 4/8/2004	CSBP-Transects Benthics- 9 900count	37	17	9	39	26	557	11
Windsor 5/4/2005	Margin-Ctr-Margin	11	1	2	0	0	488	5
Windsor 5/4/2005	Multi-Habitat	18	1	2	0	1	479	7
Ferrasci 3/25/2003	CSBP-Transects Benthics- 9 900count	38	14	11	0	14	351	11
Ferrasci 3/25/2003	CSBP-Transects Benthics- 9 900count	45	59	16	0	180	386	15

CCAMP'S BMI DATA

	Number Chironomidae Individuals	Number Chironomidae Taxa	Number Chironominae Taxa	Number Coleoptera Taxa	Number Collector Filterer Individuals	Number Collector Filterer Taxa	Number Collector Gatherer Individuals	Number Collector Gatherer Taxa	Number Corbicula Individuals	Number Crustacea + Mollusca Individuals	Number Crustacea Individuals
Windsor 5/1/2001	167	1	0	8	19	1	468	9	0	64	64
Windsor 3/29/2002	121	1	0	4	2	1	447	8	0	29	19
Windsor 3/25/2003	52	1	0	6	4	1	312	13	0	14	13
Windsor 4/8/2004	46	1	0	4	0	0	557	11	0	76	62
Windsor 5/4/2005	142	1	0	1	0	0	488	5	0	0	0
Windsor 5/4/2005	332	1	0	2	1	1	478	6	0	0	0
Ferrasci 3/25/2003	288	1	0	4	12	2	339	9	0	2	2
Ferrasci 3/25/2003	32	1	0	5	13	2	373	13	0	2	0

CCAMP'S BMI DATA

	Number Diptera Individuals	Number Diptera Taxa	Number Elmidae Individuals	Number Elmidae Taxa	Number Ephemerellidae Taxa	Number Ephemeroptera Individuals	Number Ephemeroptera Taxa	Number EPT Individuals	Number Gastropoda Individuals	Number Glossosomatidae Individuals
Windsor 5/1/2001	225	7	12	2	1	205	3	240	0	22
Windsor 3/29/2002	164	8	4	1	0	1	1	24	10	0
Windsor 3/25/2003	83	8	4	1	2	121	6	183	1	1
Windsor 4/8/2004	53	6	3	1	0	126	6	155	14	0
Windsor 5/4/2005	149	3	1	1	0	2	1	4	0	0
Windsor 5/4/2005	340	6	2	1	0	1	1	7	0	0
Ferrasci 3/25/2003	453	12	7	1	1	20	5	124	0	30
Ferrasci 3/25/2003	147	10	60	2	2	276	8	519	0	38

CCAMP'S BMI DATA

	Number Grazer Individuals	Number Grazer Taxa	Number Hydropsychidae Individuals	Number Hydropsychidae Taxa	Number Hydroptilidae Individuals	Number Individuals per Reach	Number Individuals per Replicate	Number Intolerant Diptera Individuals	Number Intolerant Ephemeroptera Individuals	Number Intolerant EPT Taxa
Windsor 5/1/2001	0	0	0	0	0	911	911	29	3	6
Windsor 3/29/2002	0	0	0	0	0	893	893	0	0	1
Windsor 3/25/2003	0	0	0	0	0	913	913	5	18	4
Windsor 4/8/2004	0	0	0	0	7	891	891	5	22	2
Windsor 5/4/2005	0	0	0	0	0	499	499	0	0	0
Windsor 5/4/2005	0	0	0	0	0	502	502	1	1	1
Ferrasci 3/25/2003	0	0	1	1	5	906	906	1	2	4
Ferrasci 3/25/2003	0	0	0	0	1	887	887	8	62	7

CCAMP'S BMI DATA

	Number Intolerant Individuals	Number Intolerant Scraper Individuals	Number Intolerant Taxa	Number Intolerant Trichoptera Individuals	Number Mollusca Individuals	Number Mollusca Taxa
Windsor 5/1/2001	66	22	7	22	0	0
Windsor 3/29/2002	1	0	1	1	10	1
Windsor 3/25/2003	24	1	6	1	1	1
Windsor 4/8/2004	28	0	5	0	14	4
Windsor 5/4/2005	0	0	0	0	0	0
Windsor 5/4/2005	2	0	2	0	0	0
Ferrasci 3/25/2003	36	30	5	30	0	0
Ferrasci 3/25/2003	166	38	9	45	2	1

CCAMP'S BMI DATA

	Number Oligochaeta Taxa	Number Orthocladiinae Taxa	Number Other FFG Individuals	Number Other FFG Taxa	Number Perlodidae Individuals	Number Philopotamidae Individuals	Number Plecoptera Individuals	Number Plecoptera Taxa	Number Predator Individuals	Number Predator Taxa
Windsor 5/1/2001	1	0	4	3	7	0	12	4	383	19
Windsor 3/29/2002	1	0	1	1	0	0	0	0	380	12
Windsor 3/25/2003	1	0	2	1	0	0	0	0	526	18
Windsor 4/8/2004	1	0	10	2	0	0	1	1	285	17
Windsor 5/4/2005	1	0	0	0	0	0	0	0	8	4
Windsor 5/4/2005	1	0	0	0	0	0	0	0	15	9
Ferrasci 3/25/2003	1	0	6	2	2	0	3	2	344	18
Ferrasci 3/25/2003	1	0	7	2	36	0	51	2	221	20

CCAMP'S BMI DATA

	Number Rhyacophilidae Individuals	Number Scraper Individuals	Number Scraper Taxa	Number Sensitive EPT Individuals	Number Shredder Individuals	Number Shredder Taxa	Number Simuliidae Individuals	Number Tolerant Individuals	Number Trichoptera Individuals	Number Trichoptera Taxa	Percent Amphipoda
Windsor 5/1/2001	0	34	3	38	3	1	19	157	23	2	0
Windsor 3/29/2002	0	14	2	23	45	3	2	144	23	2	0
Windsor 3/25/2003	0	6	3	78	63	2	4	262	62	3	0
Windsor 4/8/2004	0	18	6	51	21	1	0	186	28	2	4
Windsor 5/4/2005	0	1	1	2	2	1	0	4	2	1	0
Windsor 5/4/2005	0	2	1	7	6	1	1	8	6	1	0
Ferrasci 3/25/2003	0	39	3	100	166	4	11	196	101	4	0
Ferrasci 3/25/2003	0	101	5	302	172	3	11	137	192	6	0

CCAMP'S BMI DATA

	Percent Baetidae	Percent Burrowers	Percent CF + CG Individuals	Percent CF + CG Taxa	Percent CF Taxa	Percent CG Taxa	Percent Chironomidae	Percent Chironomidae Taxa	Percent Chironominae Taxa	Percent Clinger Taxa	Percent Collector-Filterers
Windsor 5/1/2001	22	41	53	28	3	25	18	3	0	48	2
Windsor 3/29/2002	0	81	51	32	4	29	14	4	0	17	0
Windsor 3/25/2003	2	14	35	37	3	34	6	3	0	28	0
Windsor 4/8/2004	3	17	63	30	0	30	5	3	0	16	0
Windsor 5/4/2005	0	90	98	45	0	45	28	9	0	12	0
Windsor 5/4/2005	0	95	95	39	6	33	66	6	0	20	0
Ferrasci 3/25/2003	2	71	39	29	5	24	32	3	0	33	1
Ferrasci 3/25/2003	20	10	44	33	4	29	4	2	0	41	1

CCAMP'S BMI DATA

	Percent Collectors Gatherers	Percent Corbicula	Percent Crustacea	Percent Diptera	Percent Diptera Taxa	Percent Dominant Taxon	Percent Elmidae	Percent Ephemeroptera	Percent Ephemeroptera Taxa	Percent EPT Taxa	Percent Gastropoda
Windsor 5/1/2001	51	0	7	25	19	22	1	23	8	25	0
Windsor 3/29/2002	50	0	2	18	29	33.6	0	0	4	11	1
Windsor 3/25/2003	34	0	1	9	21	15.8	0	13	16	24	0
Windsor 4/8/2004	63	0	7	6	16	36	0	14	16	24	2
Windsor 5/4/2005	98	0	0	30	27	67.5	0	0	9	18	0
Windsor 5/4/2005	95	0	0	68	33	66.1	0	0	6	11	0
Ferrasci 3/25/2003	37	0	0	50	32	21.3	1	2	13	29	0
Ferrasci 3/25/2003	42	0	0	17	22	19.5	7	31	18	36	0

CCAMP'S BMI DATA

	Percent Glossosomatidae	Percent Grazer Taxa	Percent Grazers	Percent Hydropsychidae	Percent Hydroptilidae	Percent Intolerant	Percent Intolerant Diptera	Percent Intolerant Ephemeroptera	Percent Intolerant Scrapers	Percent Intolerant Taxa (0-2)
Windsor 5/1/2001	2	0	0	0	0	8	3	0	3	20
Windsor 3/29/2002	0	0	0	0	0	0	0	0	0	4
Windsor 3/25/2003	0	0	0	0	0	3	1	2	0	16
Windsor 4/8/2004	0	0	0	0	1	3	1	2	0	14
Windsor 5/4/2005	0	0	0	0	0	0	0	0	0	0
Windsor 5/4/2005	0	0	0	0	0	0	0	0	0	11
Ferrasci 3/25/2003	3	0	0	0	1	4	0	0	3	13
Ferrasci 3/25/2003	4	0	0	0	0	19	1	7	4	20

CCAMP'S BMI DATA

	Percent Intolerant Trichoptera	Percent Mollusca	Percent Non Baetis Fallceon Ephemeroptera	Percent Non Hydro Cheumato Trichoptera	Percent Non-Gastropoda Scrapers	Percent Non-Hydropsyche Hydropsychidae	Percent Non-Insecta Taxa
Windsor 5/1/2001	3	0	0	2	4	0	31
Windsor 3/29/2002	0	1	0	3	0	0	46
Windsor 3/25/2003	0	0	12	7	1	0	34
Windsor 4/8/2004	0	2	14	3	0	0	41
Windsor 5/4/2005	0	0	0	0	0	0	27
Windsor 5/4/2005	0	0	0	1	0	0	44
Ferrasci 3/25/2003	3	0	1	11	4	0	26
Ferrasci 3/25/2003	5	0	11	22	11	0	24

CCAMP'S BMI DATA

	Percent of Intolerant Ephemeroptera	Percent of Intolerant Trichoptera	Percent of IntolerantTrichoptera	Percent Oligochaeta Taxa	Percent Omnivore Taxa	Percent Orthocladiinae Taxa	Percent Other FFG	Percent Other FFG Taxa
Windsor 5/1/2001	1	96	3	3	2.8	0	0	8
Windsor 3/29/2002	0	4	34	4	3.6	0	0	4
Windsor 3/25/2003	15	2	12	3	0	0	0	3
Windsor 4/8/2004	18	0	36	3	0	0	1	5
Windsor 5/4/2005	0	0	68	9	0	0	0	0
Windsor 5/4/2005	100	0	28	6	0	0	0	0
Ferrasci 3/25/2003	10	30	1	3	2.6	0	1	5
Ferrasci 3/25/2003	22	23	0	2	0	0	1	4

CCAMP'S BMI DATA

	Percent Perlodidae	Percent Philopotamidae	Percent Plecoptera	Percent Plecoptera Taxa	Percent Predator Taxa	Percent Predators	Percent Rhyacophildae	Percent Scraper Taxa	Percent Scrapers	Percent Shredder Taxa
Windsor 5/1/2001	1	0	1	11	53	42	0	8	4	3
Windsor 3/29/2002	0	0	0	0	43	43	0	7	2	11
Windsor 3/25/2003	0	0	0	0	47	58	0	8	1	5
Windsor 4/8/2004	0	0	0	3	46	32	0	16	2	3
Windsor 5/4/2005	0	0	0	0	36	2	0	9	0	9
Windsor 5/4/2005	0	0	0	0	50	3	0	6	0	6
Ferrasci 3/25/2003	0	0	0	5	47	38	0	8	4	11
Ferrasci 3/25/2003	4	0	6	4	44	25	0	11	11	7

CCAMP'S BMI DATA

	Percent Shredders	Percent Simuliidae	Percent Tolerant	Percent Tolerant Taxa (8-10)	Percent Trichoptera	Percent Trichoptera Taxa	Sensitive EPT Index (%)	Shannon Diversity	Simpsons Index	Taxonomic Richness	Tolerance Value
Windsor 5/1/2001	0	2	19	17	3	6	4	2.5	0	36	5.44
Windsor 3/29/2002	5	0	16	36	3	7	3	2.25	0	28	5.52
Windsor 3/25/2003	7	0	29	29	7	8	9	2.64	0	38	5.95
Windsor 4/8/2004	2	0	21	28	3	5	6	2.32	0	37	5.54
Windsor 5/4/2005	0	0	1	18	0	9	0	0.84	1	11	5.31
Windsor 5/4/2005	1	0	2	33	1	6	1	0.96	1	18	5.68
Ferrasci 3/25/2003	18	1	22	18	11	11	11	2.64	0	38	5.42
Ferrasci 3/25/2003	19	1	15	20	22	13	34	2.87	0	45	4.28