5.7 Conduct Assessment of Benthic Macroinvertebrate Community

5.7.1. Review existing information

Historic Information

The importance of aquatic benthic macroinvertebrates (BMI) as the major food source to a stream's native fish population has been well documented (Cummins 1975). The concept of using BMI as an indicator of water quality and stream health is relatively new with most of the literature on this topic coming from the past 20 years.

In 1997, the United States Environmental Protection Agency (EPA) developed a Rapid Bioassessment Protocol that used BMI as indicators of stream health. In 1999, the California Department of Fish and Game (CDFG) approved the California Stream Bioassessment Procedure (CSBP) based on the EPA protocol (Harrington 1999). CDFG has recommended the use of bioassessment techniques for determining the condition of streams. Further, monitoring of BMI using the CSBP has been required by the State Water Resources Control Board - Division of Water Quality, and the California Regional Water Quality Control Board (RWQCB) for National Pollutant Discharge Elimination System (NPDES) discharge permits, enforcement cases, storm water discharge, and for Agricultural and Timber Harvest Waivers.

On the Carmel River, there has been a limited amount of work done to date with BMI as either a water quality indicator or as they relate to the steelhead population. Three major studies have been completed, or are being worked on now in the Carmel River drainage: (1) the Central Coast Ambient Monitoring Program (CCAMP), 2000 to present; (2) the 1984, W. C. Fields studies, "Invertebrate Fauna of the Carmel River System" and "Food Habits of Fish in the Carmel River System"; and (3) the Monterey Peninsula Water Management District Bioassessment Program, 2000 to present.

Central Coast Ambient Monitoring Program (CCAMP)

As part of its Central Coast Ambient Monitoring Program, the Central Coast Regional Water Quality Control Board (CCRWQCB) has developed three regionally scaled water quality monitoring and assessment programs: (1) *Watershed Rotation Monitoring*, (2) *Coastal Confluence Monitoring and Assessment*, and (3) *Nearshore Monitoring*. The purpose of the program is to provide scientific information to CCRWQCB staff and the public, to protect, restore, and enhance the quality of the waters of Central California. Program data and information can be viewed on the CCAMP web site**:** **http://www.ccamp.org**.

The Watershed Rotation Monitoring Program divides the Region into five watershed rotation areas. Over a five-year period all the Hydrologic Units in the Region are monitored and evaluated. Within each rotation area, 30 permanent sites are established where CCAMP conducts monthly monitoring for conventional water quality parameters. Additional data, including benthic invertebrate community assessment, is collected at a subset of these sites twice every five years. On the Carmel River, two sites have been included in the BMI monitoring: Esquiline Road (River Mile, [RM, measured from the ocean] 14.45), in Carmel Valley Village (data is available over the web at http://www.ccamp.org/ca/3/Sites/307cmu/307CMU.htm), and

Highway 1 (RM 1.09) (for information available on the web, see http://www.ccamp.org/ca/3/Sites/307cml/307CML.htm). BMI data were collected in March 2002 and in April 2003 at Esquiline Road, and in April 2001 and April 2003 at Highway 1 **(Appendix 5.7.1- A)**. Not surprisingly, the BMI assemblages at the Esquiline site were of generally higher quality compared to those at the Highway 1 site where the substrate is very sandy and the river dries up in most years.

The Esquiline Road site had a higher EPT Index percentage[1], a greater number of EPT taxa, more species that are intolerant of poor water quality, and fewer species that are tolerant of poor water quality than the Highway 1 site. Numerically dominant BMI taxa sampled by CCAMP from the Carmel River Esquiline Road site included (in order of decreasing numerical dominance): Simulium (black fly larva), *Baetis* (mayfly), *Orthocladiinae,* and *Chironomidae* (midges). Numerically dominant BMI taxa sampled from the Carmel River Highway 1 site included: Simulium, *Baetis,* and *Orthocladiinae.*

In the Coastal Confluence Monitoring and Assessment Program, water quality is assessed at the confluence of freshwater streams within the central California coast region. The CDFG's Aquatic Bioassessment Laboratory participated in this effort by conducting a pilot study to evaluate the value of BMI bioassessment for monitoring water quality in these coastal lagoon environments. The objectives of the pilot study were to determine a chemical contaminant gradient for fourteen coastal lagoons; collect BMI samples using a standardized procedure to determine a biological gradient; assess whether the biological gradient correlated with the contaminant gradient; and provide recommendations for incorporating biological assessment data into the Coastal Confluence Monitoring and Assessment Program.

For each of the fourteen lagoon sites, biological metrics (numerical attributes of BMI assemblages) were integrated into a site score, which provided a relative assessment of site quality as a function of BMI assemblage quality (see the CCAMP web site for more information). Also, organic chemical constituents (pesticides and PCBs) extracted from sampled sediments at the fourteen lagoon sites were analyzed. Resultant organic chemical values were integrated into a mean Sediment Quality Guideline Quotient (SQGQ). Results of the biological and chemical integrative indices were plotted to explore possible relationships.

One of the fourteen sites was located at the mouth of the Carmel River. Based on the CCAMP data, the Carmel River Lagoon appears to be healthy with a relatively high BMI metric score and a low SQGQ. The BMI metric site score for the Carmel River Lagoon site was above average when compared to the other sites; five sites ranked higher and eight sites ranked lower than the Carmel River Lagoon site. The SQGQ determined for the Carmel River Lagoon site was lowest when compared to the SQGQs determined for the other lagoon sediment samples. There was not a strong relationship determined for biological metric scores and SQGQs. The authors of the study suggested that factors associated with local habitat condition might have had a stronger influence on biological metric scores.

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[1] EPT index measures the percentage of the Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies), taxa generally considered to be of high value, in a sample.

Numerically dominant BMI taxa sampled from the Carmel River lagoon included (in order of decreasing numerical dominance): *Corophium*, Gnorimosphaeroma, Cyprididae, *Gammarus* (all amphipods) and Oligochaeta (worms).

<u>1982 Invertebrate Fauna of the Carmel River System</u>

As part of an assessment of Carmel River steelhead resource, a report by Hydrozoology (Fields 1984) was prepared for MPWMD. Fields' report on the Carmel River comprised elements associated with BMI including:

1. Benthic sampling (March and May) and diel drift on the lower river,
2. Terrestrial drift in open versus canopied stream reaches,
3. Benthic sampling on the river reach and tributaries between the San Clemente and Los Padres Reservoirs,
4. Food habits of trout in San Clemente and Los Padres Reservoirs, and
5. Food habits of steelhead for various river reaches including the lagoon.

For element 1, above, black fly (simuliids) and midge larvae (Chironomids) were the most numerically dominant BMI groups for both months but the benthic fauna was less diverse with fewer individuals in March than benthic fauna sampled in May. Although the mayfly *Baetis tricaudatus* was common in March, their abundance in May was much greater. In March, average BMI density at the sites was 1,800 BMI per m^2 (range 510 to 3,000); in May, average BMI density was 3,300 (range 620 to 5,500). There were fewer differences in abundance and composition of benthic fauna in March and May samples at sites where the substrate was relatively stable. Diel drift was highest in areas where substrate consisted of gravel and cobble and was approximately one-quarter as high in areas dominated by sand substrate. Chironomids, simuliids, baetid mayflies and oligochaetes comprised over 93 percent of drifting organisms.

For element 2, above, contributions of terrestrial organisms to drift as a food resource for steelhead was considerably higher (numerical abundance and biovolume) in canopied river reaches when compared to river reaches with no or little canopy cover.

For element 3, above, Fields reported the BMI assemblages of Pine Creek to be the most diverse and attributed the high diversity to the "unperturbed" condition of the site where samples were collected. Fields also found that while there was ample BMI drift downstream of San Clemente Reservoir, species diversity was low and almost all the food available as drift to steelhead consisted of black fly larvae.

For element 4, above, Fields found that trout inhabiting both San Clemente and Los Padres Reservoirs fed on invertebrates from three sources, in order of decreasing relative importance: riverine, lacustrine and terrestrial. By far, the terrestrial component was the least important food source to trout. Of the lacustrine food source, benthic invertebrates were more important than planktonic invertebrates.

MPWMD Carmel River Bioassessment Program (CRBP)

Among other responsibilities, MPWMD fishery personnel regularly monitor surface water quality parameters that affect steelhead (i.e., dissolved oxygen, carbon dioxide and temperature) at stations along the Carmel River. Other staff and contractors monitor the effects of water production on the status of riparian and wetland vegetation along the river. However, other than the 1984 Fields investigation of the invertebrate fauna and feeding requirements of steelhead on the Carmel River, there was limited information available about the aquatic macro invertebrates (BMI) until MPWMD implemented a bioassessment program in the year 2000 (BioAssessment Services. April, 2004).

MPWMD staff recognized that monitoring of BMI could supplement and complement their ongoing surface water quality sampling. Reasons cited to implement a BMI monitoring program (Peckarsky 1997) include:

- BMI are relatively easy to collect and identify.
- BMI have cosmopolitan distribution (are present in a wide variety of habitats).
- BMI have a diversity of species that are responsive to conditions ranging from healthy to degraded.
- BMI are abundant enough that reasonable sampling does not deplete the overall population.
- Many BMI have well-documented natural histories and tolerances to environmental conditions.
- Many have limited mobility, so BMI do not move in and out of habitats seasonally, or in response to degradation.
- Some BMI are relatively long-lived, so chronic degradation can be detected.

Conventional water quality programs focus on chemical contamination, but degradation often stems from other factors, such as sedimentation. In some cases, BMI provide a more effective analytical tool. MPWMD staff also recognized that they had primarily been managing the watershed for a single species (i.e., steelhead), but individual species do not thrive outside of a sustaining biological context.

The objectives of the Bioassessment Program were to:

- Document biological integrity of the Carmel River using BMI assemblages at selected stream locations;
- Consolidate existing BMI data and associated information for the Carmel River;
- Establish a baseline data set using a standardized procedure from which future biological assessments may be compared;
- To contribute data to a Monterey region-wide data set intended to characterize watershed "health" and development of an Index of Biological Integrity (IBI).

Monitoring Sites
In fall of 2000, MPWMD established four sites on the Carmel River to conduct the CRBP. Two additional sites were each sampled once (SHRC in 2000 and CRDD in 2001). A summary of all BMI sites monitored by MPWMD is provided in **Table 5.7.1-A**. The site locations are shown on **Figure 5.7.1-A**, along with the approximate location of sampling sites used by other investigators. The four original sites were selected because they were established steelhead population survey sites and they were representative of most reaches of the Carmel River. The CRRW site was added in 2002 to determine if detrimental effects were occurring as a result of the operation of MPWMD's Sleepy Hollow Steelhead Rearing Facility, and to better detect anticipated effects of sedimentation from Tularcitos Creek. This site may also provide information on the effects of sedimentation and turbidity associated with the lowering of the elevation of San Clemente Reservoir, which began in June 2003, in response to an order from the State Department of Water Resources, Division of Safety of Dams.

Site locations are summarized below:
- Cachagua: between Los Padres Dam and Cachagua Creek;
- Sleepy Hollow: about one mile downstream from San Clemente Dam;
- Sleepy Hollow Rearing Channel: artificial off-channel steelhead rearing facility (sampled once in Fall 2000);
- Russell Wells: added in 2002, between Sleepy Hollow and Stonepine;
- Stonepine: just below confluence with Tularcitos Creek;
- DeDampierre: sampled once in Spring 2001, prior to a restoration project that installed large-woody debris (LWD) in channel;
- Red Rock: Mid-Valley, below the Narrows; channel dries up here some years.

Table 5.7.1-A Carmel River monitoring locations including year and season of sampling for benthic macroinvertebrates (BMI) and habitat assessment (HAB).

Site Name	Site Code	River Mile	GPS Location UTM (10S)	Site Elev. (ft)	2000	2001		2002		2003
					Fall	Spring	Fall	Spring	Fall	Spring
Monitoring Sites										
Cachagua	CRCA	23.5	0619965 4028670	820	BMI/ HAB	BMI/ HAB	BMI/ HAB	BMI/ HAB	BMI/ HAB	BMI/ HAB
Sleepy Hollow	CRSH	17.6	0615287 4034061	380	BMI/ HAB	BMI/ HAB	BMI/ HAB	BMI/ HAB	BMI/ HAB	BMI/ HAB
Russell Wells	CRRW	16.2	0615228 4035817	360					BMI/ HAB	BMI/ HAB
Stonepine	CRSP	15.7	0615162 4036428	280	BMI/ HAB	BMI/ HAB	BMI/ HAB	BMI/ HAB	BMI/ HAB	BMI/ HAB
Red Rock	CRRR	7.7	0605866 4042701	200	BMI/ HAB	BMI/ HAB	BMI/ HAB	BMI/ HAB	BMI/ HAB	BMI/ HAB
Other Sites										
DeDampierre	CRDD	13.9		250		BMI				
SHSRF Channel	SHRC	17.5		380	BMI/ HAB					

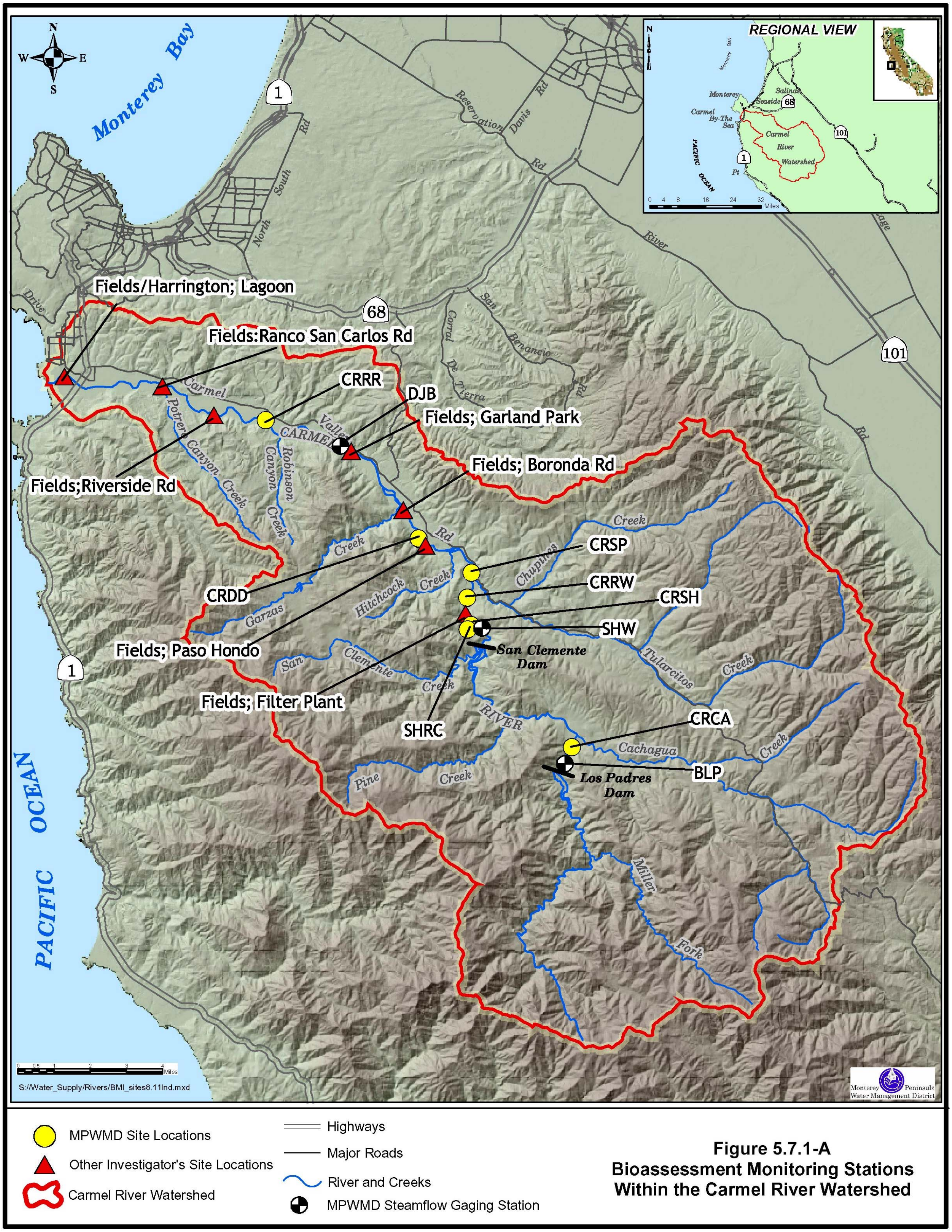

Figure 5.7.1-A
Bioassessment Monitoring Stations Within the Carmel River Watershed

Macroinvertebrate Metrics
BMI taxa and the numbers of BMIs comprising each taxonomic group were entered into a Microsoft Access® database. A taxonomic list and a table of the five most numerically abundant (dominant) taxa for each site were generated using Microsoft Excel®. Cumulative site totals were determined by pooling the BMIs from the three replicate samples collected at each site.

Biological metrics (numerical attributes of biotic assemblages) suggested by the CDFG were generated using Excel® and are described in **Appendix 5.7.1-B**. Tolerance values and functional feeding group designations were obtained from the California Macroinvertebrate Laboratory network (CAMLnet) short list of taxonomic effort, January 2003 revision. Biological metric values were tabulated by sample and summarized by site using mean, standard error and cumulative site totals.

The various metrics can be categorized into five main types:

- Richness Measures (reflects one component of diversity);
- Composition Measures (reflects the relative contribution of individual taxon to the total benthic fauna);
- Tolerance/Intolerance Measures (reflects the relative sensitivity of the assemblage to disturbances such as sediment loading/transport, water quality, and floods);
- Functional Feeding Groups (shows the balance of feeding strategies in the aquatic assemblage);
- Abundance (estimate total number of organisms in sample based on a six square foot sampling area)

Composite Metric Score
To assess the biological integrity of the sites, seven metrics were integrated into a single score for each site. The seven metrics, developed by Ode et al. (2003; in review), were a product of analysis and screening of a large suite of sites and biological metrics for the development of a central coast region Index of Biological Integrity (IBI [P. Ode, personal communication]). The purpose of a regional IBI is to incorporate metrics that are the most responsive and selective for assessing anthropogenic stress on benthic fauna that inhabit wadeable stream systems within a region with similar ecological attributes.

While the development of the central coast region IBI is incomplete, the seven metrics used to develop the IBI have already been evaluated and were thus integrated into composite metric scores for each of the Carmel River monitoring sites using cumulative site totals (metrics based on 900 individuals instead of 300). The seven metrics used to develop the composite metric scores were:

1. Percent Intolerant Individuals
2. Percent Collector-Gatherer + Collector-Filterer Individuals
3. Percent Non-Insect Taxa
4. Percent Tolerant Taxa
5. Coleoptera Richness
6. Predator Richness
7. EPT Richness (includes the Ephemeroptera, Plecoptera and Trichoptera taxonomic orders)

Sites that score high in this integrative index have better than average scores for most or all of the metrics, while sites that score low have poorer scores for most or all of the component metrics **(see section 5.7.3)**. Average ranking sites either have average scores for the component metrics or have a combination of high and low scores[2].

In addition to plotting composite metric scores by site, composite metric scores determined for each sample were plotted against mean substratum particle size **(see section 5.7.3)**. Mean substratum particle size was assessed using substrate composition estimated visually at each sampling location: boulder (phi –8), cobble (phi –7), gravel (phi –4) and sand (phi –1). The phi values ($-\log_2$) were weighted by percent substrate composition at each location where benthic samples were collected.

Benthic Macroinvertebrates
From the 86 samples collected, 25,603 BMIs were processed comprising 87 total taxa, 31 EPT taxa, nine mayfly taxa, two stonefly taxa and 20 caddisfly taxa **(Table 5.7.1-B)**. Tolerance and Shannon Diversity for the pooled samples was 4.9 and 2.7, respectively. Median sample Taxa Richness was 18 (range 8 - 32), median EPT Richness was 7.1 (range 2 – 12), median mayfly richness was 1.9 (range 1 – 5), median stonefly richness was 0.2 (range 0 – 2) and median caddisfly richness was 5.1 (range 1 – 9). Median Tolerance of the samples was 5.0 (range 3.5 – 6.8) and median sample Shannon Diversity was 2.0 (range 0.5 – 2.7).

A project taxa list indicating California Tolerance Values (CTV) and Functional Feeding Group designations is shown in **Appendix 5.7.1-C**; taxonomic lists by season and year are shown in **Appendix 5.7.1-D**. Biological metric values are presented by sample and summarized by site as site mean, standard deviation and cumulative site totals in **Appendix 5.7.1-E**.

Table 5.7.1-B. Commonly reported biological metric values including cumulative project totals and sample statistics for the Carmel River Bioassessment Program.

Metric	Project Totals	Sample Statistics (n = 86)		
		Median	Min	Max
Taxa Richness	87	17	8	32
EPT Taxa	31	7	2	12
Ephemeroptera (mayflies)	9	2	1	5
Plecoptera (stoneflies)	2	0	0	2
Trichoptera (caddisflies)	20	5	1	9
Tolerance Value	4.9	4.9	3.5	6.8
Shannon Diversity	2.7	2.0	0.5	2.7

[2] The formula for computing the composite metric score is as follows: **Composite Metric Score = $\sum \pm(\mathbf{x}_i - \mathbf{x}_i)/\mathbf{sem}_i$**
where: $\mathbf{x}_i$ = sample value for the i-th metric; x_i = overall mean for the i-th metric; sem_i = standard error of the mean for the i-th metric; ±: a plus sign denotes a metric that decreases with response to impairment (e.g. Taxonomic Richness) while a minus sign denotes a metric that increases with response to impairment (e.g. Tolerance Value).

Dominant Taxa

Numerically dominant BMI taxa sampled at the monitoring sites in the spring and fall seasons are presented in **Table 5.7.1-C.** Black flies (*Simulium/Prosimulium*) were by far the most numerically dominant at all sites for both seasons, but with somewhat inconsistent seasonal representation. Percentages of black flies at sites CRSH, CRRW and CRSP were similar for both seasons but their percentages were seasonally variable at sites CRCA and CRRR. The mayfly *Baetis* was consistently dominant at all sites during both seasons. Other taxa were either more seasonal or site specific. Seasonal taxa included the hydroptilid caddisfly *Leucotrichia pictipes*, which was dominant only in fall samples at all sites except site CRRR. The fixed-retreat making caddisfly, *Wormaldia*, was dominant at the three middle sites (CRSH, CRRW and CRSP), but only in the spring. With the exception of *Leucotrichia pictipes*, there did not appear to be a strong and consistent seasonal component influencing composition of dominant taxa.

Several taxa were site specific or specific to groups of sites. The amphipod *Hyalella*, was sampled only from spring season samples at site CRCA, the mayfly *Tricorythodes*, was dominant only at site CRRR and the caddisfly *Cheumatopsyche*, was dominant in fall samples at site CRSP. The portable case making caddisfly *Micrasema*, was most abundant at the two lowermost sites: CRSP and CRRR. *Micrasema* was the most dominant taxon in spring samples at the lowermost site (CRRR). Midges within the subfamily Orthocladiinae and tribe Tanytarsini were consistently more abundant at the three uppermost sites (CRCA, CRSH and CRRW) when compared to the two lowermost sites (CRSP and CRRR).

Intolerant Taxa

Entomologists have developed tolerance values for many common aquatic macroinvertebrate species, based on their abilities to thrive in disturbed conditions. Generally, BMIs that require well oxygenated, cool, flowing water are assigned low values while BMIs that are less sensitive to low dissolved oxygen and elevated temperature are assigned higher tolerance values. The assignment of tolerance values is complicated by potential variation in tolerance of the life stages of any given BMI taxon and by potential variation exhibited at the species level.

BMI taxa with tolerance values less than three are shown for the monitoring sites in **Table 5.7.1-D.** There were two intolerant taxa within the Diptera (true flies) insect order but most taxa were within the insect orders usually associated with intolerance: Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). The mayflies, *Ephemerella* and *Serratella* were most abundant within the lower elevation sites (CRSP and CRRR). A baetid mayfly, *Centroptilum* (one individual) was sampled from site CRSP. Stoneflies were scarce at the Carmel River monitoring sites; the only individuals sampled are shown in Table 5.7.1-D (*Malenka* and *Isoperla*). The three *Isoperla* individuals were collected in the first sample set from the fall of 2000. Most intolerant taxa were sampled from site CRSP but site CRRR had by far the most individuals represented by sensitive groups.

Tolerant Taxa

There were seventeen BMI taxa sampled with tolerance values greater than 7 as shown in **Appendix 5.7.1-C,** but only a few of these were members of the seven numerically dominate taxa for any of the five main sites **(Table 5.7.1-C)**. The amphipod *Hyalella*; the tubifida worm, Naididae; and the seed shrimp, Ostracoda all have tolerance values of eight and are part of the collector-gatherer feeding group. None comprised more than 14% of any sample (CRRW Fall), and were generally less than 5% of the total sample.

Table 5.7.1-C. Numerically dominant benthic macroinvertebrate taxa sampled from the Carmel River in the fall season (years 2000 to 2002 and in the spring season (years 2001 to 2003). Also shown is the percentage of individuals subsampled that comprised the seven most dominant groups.

Site	Season	Dominant Taxa 1	2	3	4	5	6	7	Total
CRCA	Spring	*Simulium/ Prosimulium* 30%	*Baetis* 22%	Orthocladiinae 12%	*Hyalella* 11%	Tanytarsini 6%	*Hydropsyche* 4%	Naididae 4%	89%
	Fall	*Baetis* 20%	*Leucotrichia pictipes* 17%	*Hydropsyche* 14%	Orthocladiinae 10%	Tanytarsini 10%	*Argia* 6%	*Simulium/ Prosimulium* 5%	82%
CRSH	Spring	*Simulium/ Prosimulium* 32%	*Baetis* 30%	Orthocladiinae 14%	Naididae 5%	*Antocha* 4%	Tanytarsini 2%	*Wormaldia* 2%	89%
	Fall	*Simulium/ Prosimulium* 31%	*Baetis* 26%	*Leucotrichia pictipes* 14%	Orthocladiinae 8%	*Hydropsyche* 3%	*Argia* 3%	*Antocha* 3%	71%
CRRW	Spring	*Baetis* 35%	*Simulium/ Prosimulium* 33%	Orthocladiinae 12%	*Wormaldia* 4%	*Antocha* 4%	*Micrasema* 3%	*Hydropsyche* 3%	94%
	Fall	*Simulium/ Prosimulium* 23%	*Baetis* 21%	Orthocladiinae 18%	Ostracoda 14%	*Leucotrichia pictipes* 5%	*Hydropsyche* 4%	*Ochrotrichia* 3%	67%
CRSP	Spring	*Baetis* 40%	*Simulium/ Prosimulium* 19%	*Hydropsyche* 12%	*Micrasema* 6%	*Wormaldia* 6%	Orthocladiinae 5%	*Antocha* 2%	89%
	Fall	*Hydropsyche* 26%	*Baetis* 22%	*Simulium/ Prosimulium* 13%	*Cheumatopsyche* 6%	*Micrasema* 6%	*Leucotrichia pictipes* 4%	Naididae 3%	72%
CRRR	Spring	*Micrasema* 22%	*Baetis* 15%	*Hydropsyche* 11%	Tanytarsini 8%	*Simulium/ Prosimulium* 5%	Ostracoda 5%	*Tricorythodes* 5%	72%
	Fall	*Simulium/ Prosimulium* 20%	*Tricorythodes* 12%	*Hydropsyche* 10%	*Baetis* 8%	*Micrasema* 8%	Tanytarsini 5%	Orthocladiinae 4%	66%

Table 5.7.1-D. Intolerant benthic macroinvertebrate taxa sampled from Carmel River monitoring sites. CTV=California Tolerance Value.

Taxa	CTV	Sites				
		CRCA	CRSH	CRRW	CRSP	CRRR
Diptera (true flies)						
Dixidae						
Dixa	2	1	4		2	
Psychodidae						
Maruina lanceolata	2				1	
Ephemeroptera (mayflies)						
Baetidae						
Centroptilum	2				1	
Ephemerellidae						
Ephemerella	1			2	4	50
Serratella	2	1	1		12	77
Plecoptera (stoneflies)						
Nemouridae						
Malenka	2	2	1	2	10	
Perlodidae						
Isoperla	2				3	
Trichoptera (caddisflies)						
Brachycentridae						
Micrasema	1	167	35	37	316	814
Glossosomatidae						
Agapetus	0				9	
Glossosoma	1				2	
Glossosomatidae (pupae)	0					3
Lepidostomatidae						
Lepidostoma	1	2			5	12
Psychomyiidae						
Tinodes	2				3	38
Rhyacophilidae						
Rhyacophila	0	1	15	2	31	
Total Taxa:		6	5	4	13	6
Total Intolerant Individuals:		174	56	43	399	994