5.7.3 FACTORS LIMITING BENTHIC INVERTEBRATE PRODUCTION

There are many factors that can limit BMI composition and abundance. Physical characteristics include substratum, current velocity, food availability, water temperature, dissolved oxygen concentration, and water chemistry. On the local level, substrate size and current velocity are often the most important factors affecting the types of BMI present (Naiman and Bilby, 2001). Factors contributing to streams with productive and diverse benthic fauna include mixtures of loosely consolidated coarse substrate, abundant CPOM and LWD, a natural hydrograph, consistent gravel inputs with retention, and good water quality (e.g. Alan 1995, Petts 1984).

These conditions become altered in urban areas where upstream impervious landscape surfaces alter the natural hydrograph and interfere with the production, transport and retention of suitable material (Williams and Feltmate 1992, Schueler 1995, and Karr and Chu 1999). While bank sloughing is a natural phenomenon of stream systems, urban streams are characterized as having higher peak discharges, which contribute to reduced bank stability, increased channel cross-sectional area and higher sediment discharge (Trimble 1997). Excessive sediment fills the interstitial spaces, decreasing the area within the substrate available for colonization of benthic fauna (Allan 1995). Often, a shift in benthic fauna occurs with increases in sedimentation resulting in increases in burrowing forms such as oligochaetes and clams and potentially contributes to lower richness and diversity. Furthermore, altered hydrographs resulting from instream impoundment may affect benthic fauna that are dependent on cyclic thermal cues for their development (Ward and Stanford 1979). Benthic fauna of urban streams may also be affected by constituents from storm water runoff such as petroleum hydrocarbons, fine sediment, pesticides, fertilizers and detergents (Schueler 1987) as well as discharge from septic systems.

While the primary objective of the three-year Carmel River Bioassessment monitoring program (2000 to 2003) was to establish a baseline of data, several interim results of the program are worth noting. First, there was a trend of higher quality BMI assemblages sampled from the lowest elevation site in the drainage at Red Rock (CRRR, near mid-Carmel Valley) when compared to the other sites (BioAssessment Services, 2004) **(Figure 5.7.3-A)**. This was demonstrated by the composite metric scores but was also supported by CRRR's relatively high Taxa Richness values, and higher abundance values for the two lower elevation sites, CRSP (at the confluence of Tularcitos Creek with the main stem) and CRRR **(Appendix 5.7.1-E)**. Second, the highest elevation site at Cachagua had consistently lower quality macroinvertebrate assemblages when compared to the other sites in both the spring and fall season samples. Third, there was a trend of decreasing BMI assemblage quality during the three-year monitoring period. Finally, there was a weak relationship between substrate size class and macroinvertebrate assemblage quality. Samples collected in substrate consisting of boulder and large cobble had generally lower quality macroinvertebrate assemblages when compared to macroinvertebrate assemblages sampled in substrate consisting of mixtures of gravel and cobble.

Site **CRRR**'s relatively high BMI assemblage quality is important because the site receives a more urbanized flow from the Carmel Valley downstream of River Mile 15 when compared to sites upstream of Carmel Valley Village, especially site CRCA (immediately downstream of Los Padres Dam). In addition to more of an urbanized flow, site CRRR also receives more flow from un-regulated tributaries, such as Pine, San Clemente, Tularcitos, and Garzas creeks. Sensitive taxa were also better represented at both downstream sites (CRRR and CRSP) as well as longer-lived taxa such as elmid beetles. Long-lived taxa that use cyclic thermal cues for their development are more sensitive to alterations in annual temperature regime.

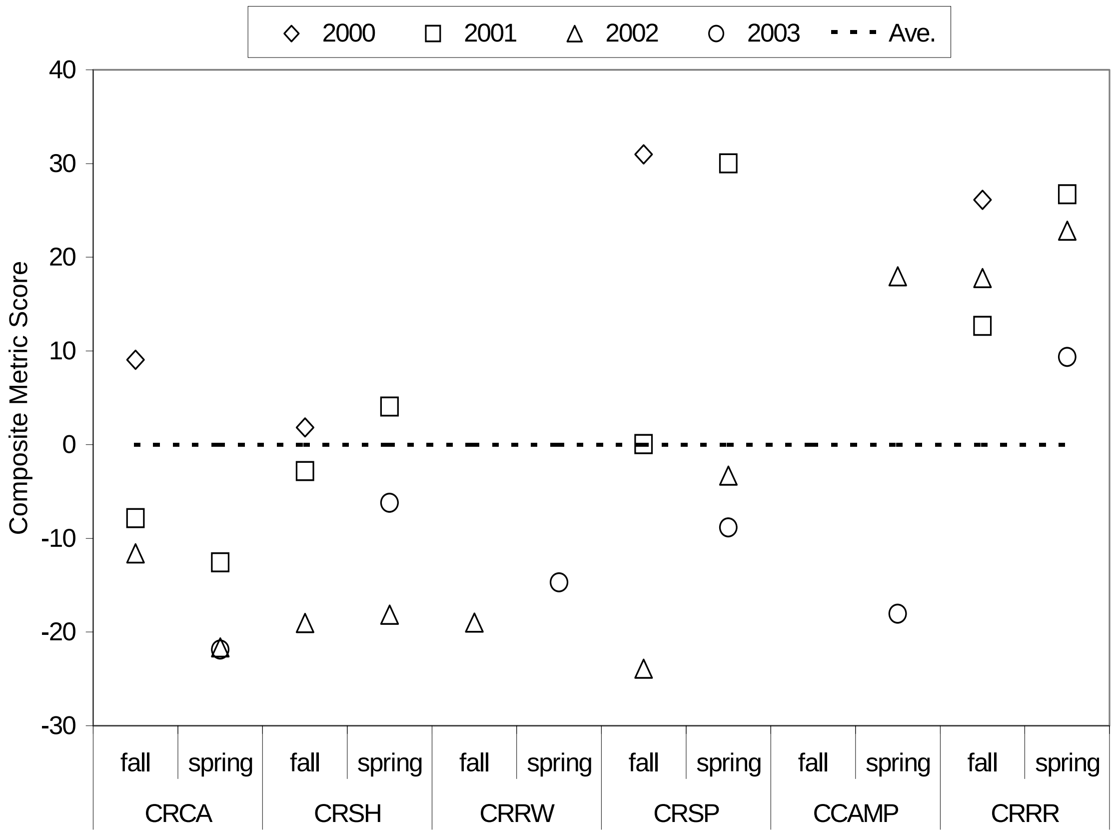

Figure 5.7.3-A. Composite metric scores for benthic macroinvertebrates collected from monitoring sites within the Carmel River. Sampling was initiated at site CRRW in the fall season of 2002. Data for composite metric scores for site CCAMP were derived from taxonomic lists provided by the Central Coast Regional Water Quality Control Board.

Conversely, site **CRCA**, which receives a regulated flow regime from Los Padres Dam with no influence from unregulated tributaries had a relatively poor BMI assemblage quality. This preliminary result suggests that the influence of Los Padres Dam may have had more of an effect on BMI assemblages than the more urbanized flow occurring lower in the watershed. The weak relationship between substrate size class and composite metric scores suggested that larger substrate at site CRCA may have contributed to lower quality of BMI assemblages **(Figure 5.7.3-B)**. Although inconclusive, other studies have suggested that while substrate consisting of gravel and cobble are optimal for colonization, diversity begins to decline when substrate composition shifts to large cobble and boulder (Alan 1995). Impoundments on main stem rivers, such as at Los Padres Dam and Reservoir, frequently block passage of bed material that would otherwise replenish the substrate downstream of the dam. Because the reservoir has little effect on peak flows, material downstream of the dam is scoured out, resulting in channel degradation and a substrate that coarsens over time. As the substrate coarsens, progressively higher flows are required to disturb the bed material. This armoring effect is common on main stem dams.

However, the weak relationship between substrate composition and BMI assemblage quality suggests that other factors may have contributed to the poorer relative quality of BMI assemblages at site CRCA. Other factors associated with the impoundment including alterations in temperature and flow regimes could have contributed to poor quality BMI assemblages. Fields (1984) documented poorer BMI assemblages at sites between San Clemente and Los Padres dams when compared to BMI assemblages sampled from unregulated tributary streams draining into the Carmel River, particularly Pine Creek.

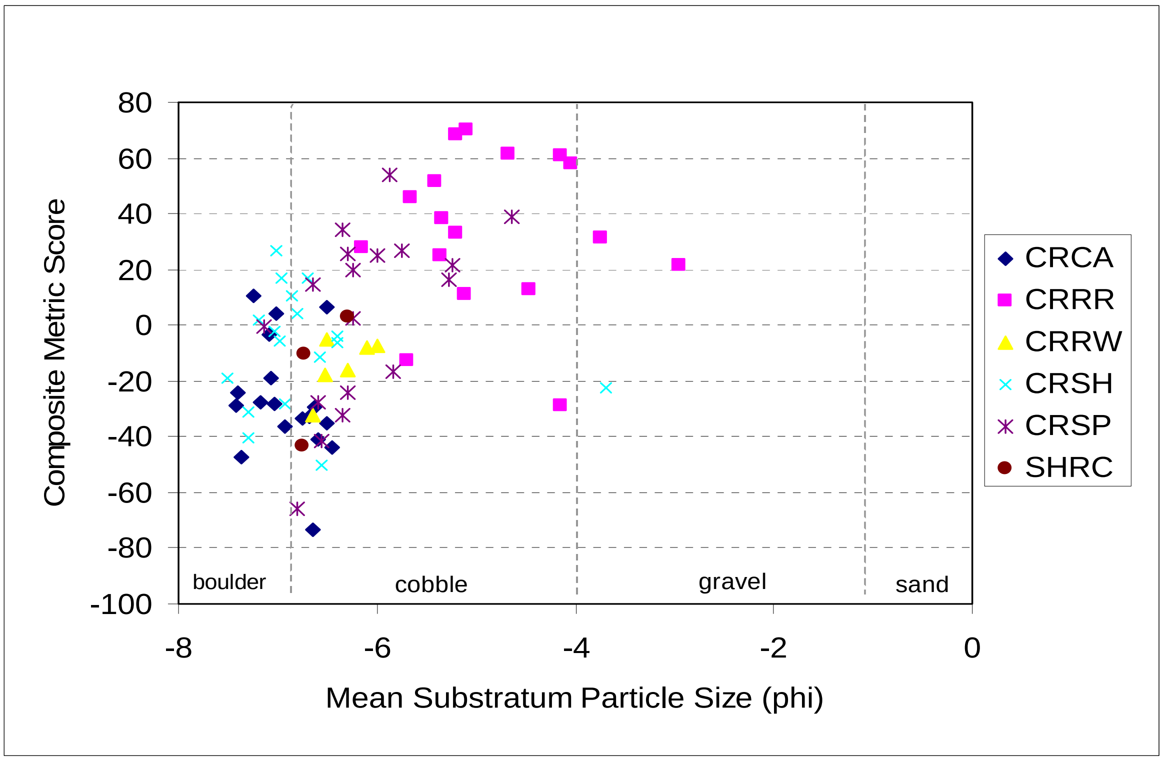

Figure 5.7.3-B. Benthic macroinvertebrate composite metric scores vs. weighted mean substratum size class for Carmel River samples collected at indicated sites

<u>Potential BMI Limiting Factors By Reach:</u>

(1) *Carmel River Lagoon to Valley Greens Drive Bridge* (RM 4.8) – This reach has two major constraints to BMI production. The most serious of these is the annual summer drying up of the river by pumping. In the past 40 years, the river has flowed year-round

to the lagoon only twice, in 1983 and 1998. The sandy substrate also limits the quality of the BMI assemblage due to the constant shifting of the bed material and the lack of habitable surface area.

(2) *Valley Greens Drive Bridge to Schulte Road Bridge* (RM 6.7) – As in the previous reach, this section dries up during most years, but the riffle substrate consists of more gravel and less sand.

(3) *Schulte Bridge to Esquiline Road Bridge* (RM 14.5) – This reach is highly influenced by urban activities such as channelization and bank hardening, vegetation removal, street runoff, and septic system drain fields. Despite these problems, the BMI assemblages are surprisingly healthy here. Consistent year-round flow, a good gravel/cobble substrate mix, combined with the influence of several tributaries make this reach highly productive.

(4) *Esquiline Bridge to San Clemente Dam* (RM 18.6) – The dam is the biggest factor influencing BMI in this reach. Built in 1921, the reservoir has been trapping sand, gravel and cobble for over 80 years. The result is a substrate consisting mostly of boulders and large cobbles that lack the interstitial space required for many BMI taxa to thrive. The MPWMD has been adding 2 – 4 inch gravel to this reach the past 10 years as part of its steelhead spawning habitat restoration project. The continuation and expansion of this program would help improve BMI habitat. Ironically, the reservoir is now nearly full of sand, which may begin spilling over the dam in the near future. This fine material will likely fill the remaining, limited interstitial spaces between the cobbles and boulders leading to additional scour of existing BMI and less habitat space for BMI.

(5) *San Clemente Reservoir to Cachagua Creek confluence* (RM 23.8) - This reach has few apparent constraints to BMI production. Its relative isolation and pristine condition, good mix of substrate size classes, and year-around flow should make this section of river one of the best for BMI production. No BMI survey work has been done in this reach since 1982 when Fields found both a high number of species and very high population densities.

(6) *Cachagua Creek to Los Padres Dam* (RM 24.8) – Like San Clemente Dam, Los Padres Dam, built in 1948, blocks the downstream passage of cobble and gravel, leaving boulders as the primary substrate below the dam. In addition, the reservoir increases stream temperatures, and reduces the water quality downstream.

(7) *Above Los Padres Reservoir to the Head Waters* – This reach is within the Los Padres National Forest and is in generally pristine condition. BMI production and assemblage quality should be in a natural state with very few constraints.