**ABCL (Aquatic Bioassay & Consulting Laboratories), "2007 Annual Bioassessment Monitoring of the Santa Clara River at Newhall Ranch" (March 2008)**

# 2007 ANNUAL BIOASSESSMENT MONITORING OF THE SANTA CLARA RIVER AT NEWHALL RANCH

Prepared by:

**Aquatic Bioassay & Consulting Laboratories**
29 N. Olive St
Ventura, CA 93001
805 643 5621

**March 2008**

February 25th, 2008

Mr. Brandon Steets
Geosyntec Consultants
924 Anacapa St. Suite 4A
Santa Barbara, CA 93101

Dear Mr. Steets:

In accordance with the agreement between Geosyntec Consultants and Aquatic Bioassay and Consulting Laboratories, Inc., we are pleased to present the 2007 Bioassessment Monitoring Report for the pre-discharge monitoring requirements for the Newhall Wastewater Reclamation Plant on the Santa Clara River.

Yours very truly,

Scott C. Johnson

Scott C. Johnson
Director of Environmental Programs
Aquatic Bioassay & Consulting Laboratories
29 N. Olive St.
Ventura, CA 93001

# Newhall Wastewater Reclamation Plant Spring & Fall 2007 Bioassessment Monitoring Report

Submitted to:

Geosyntec Consultants
924 Anacapa St., Suite 4A
Santa Barbara, CA 93101

Submitted by:

Aquatic Bioassay and Consulting Laboratories
29 N Olive Street
Ventura, CA 93001

March 2008

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## INTRODUCTION

This report is submitted to Geosyntec as part of the pre-discharge monitoring requirements for the Newhall Wastewater Reclamation Plant (WRP). This study included bioassessment monitoring on the Santa Clara River east of the City of Piru, at the Los Angeles and Ventura County Line using protocols specified by in the State of California, Surface Water Ambient Monitoring Program (SWAMP 2007). Aquatic Bioassay and Consulting Laboratory scientists conducted sampling on July 27th and October 31st, 2007. The goals of the bioassessment study were to:

1. Provide a comparison of the benthic macroinvertebrate (BMI) assemblages present in the Santa Clara River upstream and downstream of the future Newhall WRP discharge site.
2. Evaluate the physical/habitat condition of these sampling sites.

This report includes all of the physical, chemical and biological data collected during the spring and fall surveys. These include photographic documentation of each site, QA/QC procedures and documentation, followed by a presentation of the calculated metrics specified in the SWAMP protocols, the Southern California IBI and interpretation of the results. In addition, this report includes a summary of BMI data collected since 2004.

## BACKGROUND

Major issues facing streams and rivers in California include modification of in-stream and riparian structure, contaminated water and increases in impervious surfaces which have led to the increased frequency of flooding. There have been many studies and reports showing the deleterious effects of land-use activities to macroinvertebrate and fish communities (Jones and Clark 1987; Lenat and Crawford 1994; Weaver and Garman 1994; and Karr 1998).

During the past 150 years, direct measurements of biological communities including plants, invertebrates, fish, and microbial life have been used as indicators of degraded water quality. In addition, biological assessments (bioassessments) can be used as a watershed management tool for surveillance and compliance of land-use best management practices. Combined with measurements of watershed characteristics, land-use practices, in-stream habitat, and water chemistry, bioassessment can be a cost-effective tool for long-term trend monitoring of watershed conditions (Davis and Simons 1996).

Biological communities act to integrate the effects of water quality conditions in a stream by responding with changes in their population abundances and species composition over time. These populations are sensitive to multiple aspects of water and habitat quality and provide the public with more familiar expressions of ecological health than the results of chemical and toxicity tests (Gibson 1996). Furthermore, biological assessments when integrated with physical and chemical assessments better define the effects of point-source discharges of contaminants and provide a more appropriate means for evaluating discharges of non-chemical substances (e.g. nutrients and sediment).

Benthic macroinvertebrates (BMIs) are ubiquitous, relatively stationary and their diversity provides a spectrum of responses to environmental stresses (Rosenberg and Resh 1993). Individual species of BMIs reside in the aquatic environment for a period of months to several years and are sensitive, in varying degrees, to temperature, dissolved oxygen, sedimentation, scouring, nutrient enrichment and chemical and organic pollution (Resh and Jackson 1993). Finally, BMIs represent a significant food source for aquatic and terrestrial animals and provide a wealth of ecological and bio-geographical information (Erman 1996).

In the United States the evaluation of biotic conditions from BMI community data uses a combination of multimetric and multivariate techniques. In multimetric techniques, a set of biological measurements ("metrics"), each representing a different aspect of the community data, is calculated for each site. An overall site score is calculated as the sum of individual metric scores. Sites are then ranked according to their scores and classified into groups with "good", "fair" and "poor" water quality. This system of scoring and ranking sites is referred to as an Index of Biotic Integrity (IBI) and is the end point of a multi-metric analytical approach recommended by the EPA for development of biocriteria (Davis and Simon 1995). The original IBI was created for assessment of fish communities (Karr 1981), but was subsequently adapted for BMI communities (Kerans and Karr 1994).

The first demonstration of a California regional IBI was applied to the Russian River watershed in 1999 (DFG 1998). As the Russian River IBI was being developed, the California Department of Fish and Game (CADFG) began a much larger project for the San Diego Regional Board. After a pilot project conducted on the San Diego River in 1995 and 1996, the San Diego Regional Board incorporated bioassessment into their ambient water quality monitoring program. Finally, between 2000 and 2003, bioassessment data were collected from the Mexican border to the south, Monterey County to the north and to the eastern extent of the coastal mountain range. These data were used to create an IBI that is applicable to southern California and is applied to the data in this report (Ode et al. 2005). While many low gradient reference sites were included in the development of the IBI, it has become apparent that the further work may be necessary to make the IBI applicable to low gradient systems in southern California.

## MATERIALS AND METHODS

### Sampling Site Descriptions

Two sampling locations (NR1 upstream and NR3 downstream) were visited in the Santa Clara River on July 27th and October 31st, 2007 (Table 1, Figure 1). Photographs of each site are displayed in Figure 2. These sites were selected so that the biological communities at the future discharge location for the Newhall WRP could be evaluated. It is important that these sites are similar to one another in terms of physical habitat. If they are not, future comparisons between the BMI communities residing at sites upstream and downstream of the WRP could be confounded by habitat differences.

During dry weather this section of the Santa Clara River sustains a low flow of water which is fed to it by several upstream waste treatment facilities. This is not a typical condition during the dry summer months in southern California where even large rivers such as the Santa Clara are historically dry. The land surrounding the river at both the upstream and downstream sites have been used during the past century for agriculture. As a result there are dirt roads, irrigation ditches and heavy machinery present throughout the area.

The Station NR1 was located 300 feet upstream of the Los Angeles/Ventura County Line, at an elevation of 835 feet. This site will be the location of the new waste discharge from the treatment facility. The River is located in a relatively natural southern California river habitat with a sand, cobble and gravel streambed. The channel with flowing water is normally small in comparison to the entire width of the Santa Clara River which is dry during most of the year except during rain storms. Station NR3 was located 2.74 miles downstream of the Los Angeles/Ventura County Line, at an elevation of 724 feet. Here the river filled more than 75% of the streambed and was bordered on each side by thick vegetation. This site was situated just upstream of a bridge and was composed of sand, cobble and gravel.

**Table 1.** Sampling locations and descriptions for 2 sites on the Santa Clara River.

| Sta.ID | Description and Comments | Latitude | Longitude | Elev. (ft) |
|---|---|---|---|---|
| NR1 Upstream | Located 300 ft. upstream of the Los Angeles/Ventura County Line. | 34° 24.193' N | 118° 41.391' W | 835 |
| NR3 Downstream | Located 2.74 mi. downstream of the Los Angeles/Ventura County Line | 34° 24.232' N | 118° 44.363' W | 724 |

Figure 1. BMI sampling locations for the two sites on Santa Clara River.

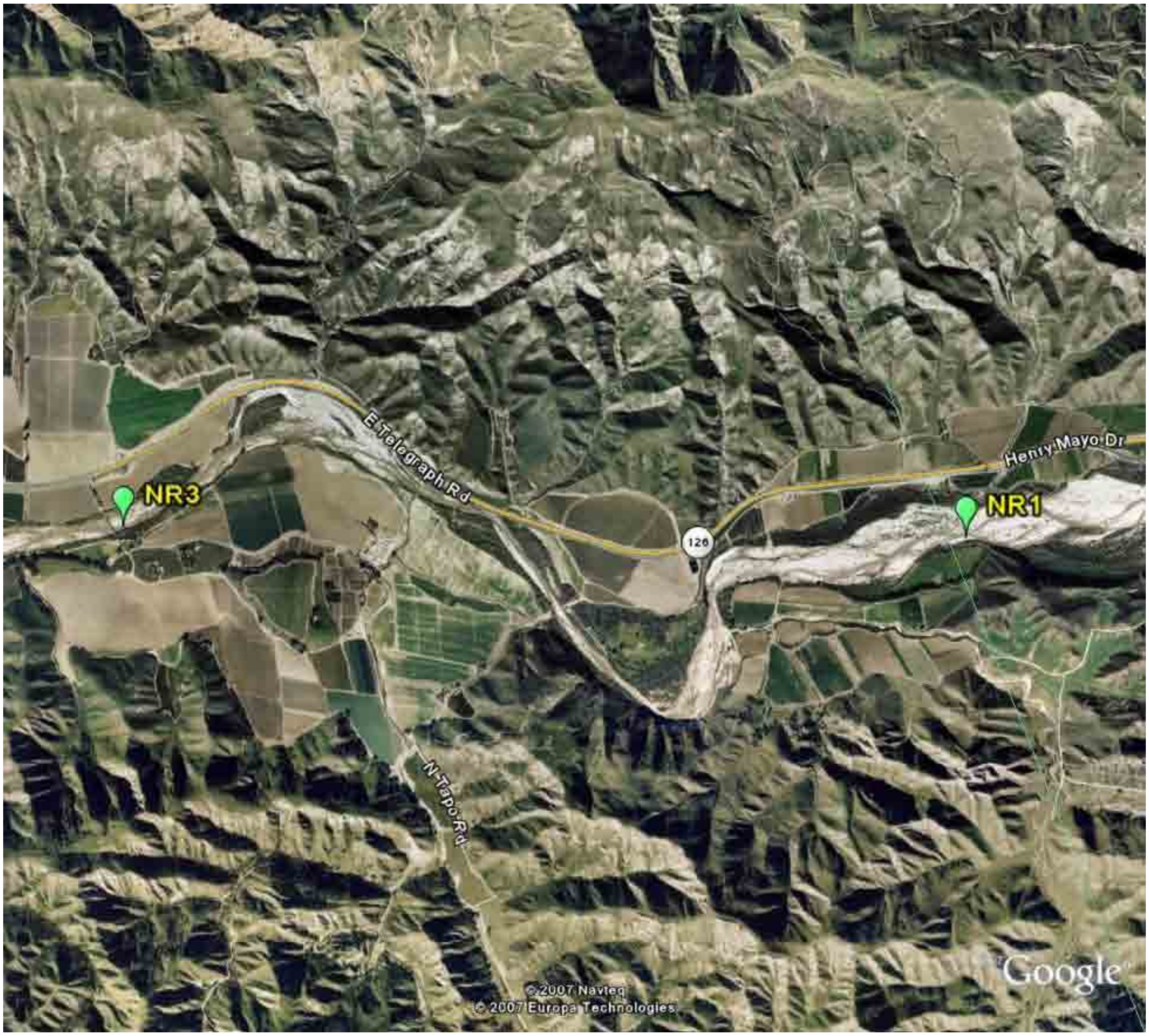

**Figure 2:** Sampling location photos of upstream Station NR1 and downstream Station NR3 in the Santa Clara River.

| | | | |
|---|---|---|---|
|  NR1 - Spring |  NR1 - Spring |  NR1 - Fall |  NR1 - Fall |
|  NR3 - Spring |  NR3 - Spring |  NR3 - Fall |  NR3 - Fall |

## Collection of Benthic Macroinvertebrates

*Wadeable Streams Protocols*

The field protocols and assessment procedures followed the draft Surface Water Ambient Monitoring Program (SWAMP) protocols which were taken from existing California Department of Fish and Game protocols (CDFG 2003) and the United States Environmental Protection Agencies (USEPA) Western Environmental Monitoring Assessment Program (EMAP). These protocols have since been promulgated and will be used throughout the State of California in coming years (SWAMP 2007).

Benthic macroinvertebrate (BMI) samples were collected in strict adherence to the SWAMP in terms of both sampling methodology and QC procedures. At each station, a 150 m reach was measured and 11 transects were established equidistance apart from the downstream to upstream end of the reach. If access to the full 150 m reach was not possible due to obstacles (i.e. heavy vegetation), the total reach length was divided by 11 and transects were established as above. At each site the SWAMP Worksheet was used to collect all of the necessary station information and physical habitat data.

BMI samples were collected starting with the downstream transect and working upstream. Since the percent streambed gradient was <1%, the Reach Wide Benthos (RWB) sampling protocol was used:

- At the most downstream transect a single location was sampled 25% of the distance from the right wetted width. On the second upstream transect a sample was collected 50% of the distance from the right wetted width and, on the third transect, 75% of the distance from the right wetted width. This process was repeated until each of the eleven transects had been sampled.

All samples of the benthos were collected within a 1 $ft^2$ area upstream of a 1 ft wide, 0.5 mm mesh D-frame kick-net at each transect. Sampling of the benthos was performed manually by rubbing cobble and boulder substrates in front of the net, followed by "kicking" the upper layers of substrate to dislodge any remaining invertebrates. The duration of sampling ranged from 60-120 seconds, depending on the amount of boulder and cobble-sized substrate that required rubbing by hand; more and larger substrates required more time to process.

Each of the 11 samples was combined into a single composite sample that represented an 11 $ft^2$ area of the total reach. The composite sample was transferred into a 1/2 gallon wide-mouth plastic jar containing approximately 300 ml of 95% ethanol. Chain of Custody (COC) sheets were completed for samples as each station was completed.

## Physical / Habitat Quality Assessment and Water Quality

Bioassessment sampling included a measure of the instream physical habitat conditions using a method originally developed by the USEPA and modified by SWAMP (2007) for use in California. This method focuses on the habitat conditions found in the streambed and banks. The team collected the physical/habitat measurements at each station according to the Basic method outlined in the SWAMP manual and recorded the information on the SWAMP worksheets. To maintain a historical record of physical habitat quality, both reaches were also assessed using the California Stream Bioassessment Procedure (CSBP, 1999) Visual-Based Habitat Assessment method developed by USEPA for its Rapid Bioassessment Procedures (RBP; Barbour et al 1999).

These measurements are summarized as follows:

1. Water temperature, specific conductance, pH and dissolved oxygen were measured using a hand held YSI 85 water quality meter that was pre-calibrated in the laboratory. A water sample was collected for alkalinity and analyzed by titration in the lab.
2. Wetted width was measured in meters using a stadia rod or measuring tape at each transect.
3. Velocity was measured in the spring and discharge was measured in the fall on a single transect using a hand held flow meter.
4. A densitometer was used to measure % canopy cover.
5. Stream gradient was measured using either an auto leve, and sinuosity was measured using a compass working downstream from the most upstream transect.

**Sample Analysis/Taxonomic Identification of Benthic Macroinvertebrates (BMIs)**

Sample sorting and taxonomy were conducted by Aquatic Bioassay and Consulting Laboratories. Sorting and taxonomice identifications were conducted at the Aquatic Bioassay laboratory in Ventura, CA and taxonomic identifications were conducted by Craig Pernot. Identifications were made using standard taxonomic keys (Literature Cited, Taxonomic References). In most cases taxa for this study were identified to the species level in adherence with Professional Taxonomic Effort Level 2 specified by the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT). All taxa identifications were rolled up to the appropriate taxonomic level for the calculation of biological metrics and the Southern California IBI. Samples entering the lab were processed as follows:

A maximum number of 500 organisms were sub-sampled from the composite sample using a divided tray, and then sorted into major taxonomic groups. All remnants were stored for future reference. The 500 organisms were identified to the genus level for most insects and order or class for non-insects. As new species to the survey area were identified, examples of each were added to the voucher collection. The voucher collection includes at least one individual of each species collected and ensures that naming conventions can be maintained and changed as necessary into the future.

The taxonomic quality control (QC) procedures followed for this survey included:

- Sorting efficiencies were checked on all samples. The leftover material from each sample was inspected by the laboratory supervisor. Minimum required sorting efficiency was 95%, i.e. no more than 5% of the total number of organisms sorted from the grids could be left in the remnants. Sorting efficiency results were documented on each station's sample tracking sheet.
- Once identification work was completed, 10% of all samples were sent to the Department of Fish and Game (DF&G) offices in Rancho Cordova for a QC check. Samples were sorted by species into individual vials that included an internal label. Any discrepancies in counts or identification found by the DF&G taxonomists were discussed, and then resolved. All data sheets were corrected and, when necessary, bioassessment metrics were updated.

### Data Development and Analysis

As species were identified, they were included in an Excel data sheet, checked for errors and then imported into the Aquatic Bioassay BMI database system. All biological metrics, figures and tables were then automatically generated. These bioassessment metrics were then used to assess the spatial and temporal distributions of the BMI community or were used to calculate the southern California IBI (Ode et al. 2005). The following metrics were calculated and their responses to impaired conditions are listed in Table 2:

1. Richness measures: taxa richness, cumulative taxa, EPT taxa, cumulative EPT taxa, Coleopteran taxa.
2. Composition measures: EPT index, sensitive EPT index, Shannon diversity.
3. Tolerance/intolerance measures: mean tolerance value, intolerant organisms (%), tolerant organisms (%),tolerant taxa (%), dominant taxa (%), Chironomidae (%), non-insect taxa (%).
4. Functional feeding group: collectors (%), filterers (%), grazers (%), predators (%), shredders (%).

Table 2. Bioassessment metrics used to describe characteristics of the BMI community results.

| BMI Metric | Description | Response to Impairment |
|---|---|---|
| **Richness Measures** | | |
| Taxa Richness | Total number of individual taxa | decrease |
| EPT Taxa | Number of taxa in the Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) insect orders | decrease |
| Ephemeroptera Taxa | Number of taxa in the insect order Ephemeroptera (mayflies) | decrease |
| Plecoptera Taxa | Number of taxa in the insect order Plecoptera (stoneflies) | decrease |
| Trichoptera Taxa | Number of taxa in the insect order Trichoptera (caddisflies) | decrease |
| **Composition Measures** | | |
| EPT Index<br>Sensitive EPT Index | Percent composition of mayfly, stonefly and caddisfly larvae<br>Percent composition of mayfly, stonefly and caddisfly larvae with tolerance values between 0 and 3 | decrease<br>decrease |
| Shannon Diversity | General measure of sample diversity that incorporates richness and evenness (Shannon and Weaver 1963) | decrease |
| **Tolerance / Intolerance Measures** | | |
| Tolerance Value | Value between 0 and 10 weighted for abundance of individuals designated as pollution tolerant (higher values) or intolerant (lower values) | increase |
| Percent Intolerant Organisms | Percent of organisms in sample that are highly intolerant to impairment as indicated by a tolerance value of 0, 1 or 2 | decrease |
| Percent Tolerant Organisms | Percent of organisms in sample that are highly tolerant to impairment as indicated by a tolerance value of 8, 9 or 10 | increase |
| Percent Dominant Taxa | Percent composition of the single most abundant taxon | increase |
| Percent Hydropsychidae | Percent of organisms in the caddisfly family Hydropsychidae | increase |
| Percent Baetidae | Percent of organisms in the mayfly family Baetidae | increase |
| **Functional Feeding Groups (FFG)** | | |
| Percent Collectors | Percent of macrobenthos that collect or gather fine particulate matter | increase |
| Percent Filterers | Percent of macrobenthos that filter fine particulate matter | increase |
| Percent Grazers | Percent of macrobenthos that graze upon periphyton | variable |
| Percent Predators | Percent of macrobenthos that feed on other organisms | variable |
| Percent Shredders | Percent of macrobenthos that shreds coarse particulate matter | decrease |
| Estimated Abundance | Estimated number of BMIs in sample calculated by extrapolating from the proportion of organisms counted in the subsample | variable |

*Parametric Testing*

Replicate biological metric data were used to statistically test for differences among stations using analysis of variance (ANOVA). When assumptions of parametric statistics could not be met (such as non-normality or excessive variability), the tests were replaced with nonparametric analogues (Kruskal-Wallis One-Way ANOVA on Ranks and Kruskal-Wallace Rank Test, respectively). Significance was noted when $p \leq 0.05$ and marginal significance was noted when $0.05 < p \leq 0.10$).

*Southern California IBI*

The seven biological metric values used to compute the Southern California Index of Biological Integrity (So CA IBI) are presented in Table 3 (Ode et al. 2005). The So CA IBI is based on the calculation of biological metrics from a group of 500 organisms from a composite sample collected at each stream reach. Since 900 organisms were identified from each sample for this survey (3 replicates, 300 organisms each), Monte Carlo randomization was used to select 500 organisms from the 900 collected at each station before the IBI metrics were calculated. This procedure was validated by Ode et al. (2005).

The IBI calculation for data collected for this program from spring 2005 to fall 2006 inadvertently used % non-insect individuals and % tolerant individuals, instead of % non-insect taxa and % tolerant taxa. The re-computed index scores and ranks for each sampling event are presented in Appendix B (Table 10, Figure 10).

Table 3. Scoring ranges for the seven metrics included in the southern California IBI and the IBI values.

**Metric Scoring Ranges for the Southern California IBI**

| Metric Score | Coleoptera Taxa | EPT Taxa | | Predator Taxa | % Collector Individuals | | % Intolerant Individuals | | % Non-Insect Taxa | % Tolerant Taxa |
|---|---|---|---|---|---|---|---|---|---|---|
| | All Sites | 6 | 8 | All Sites | 6 | 8 | 6 | 8 | All Sites | All Sites |
| **10** | >5 | >17 | >18 | >12 | 0-59 | 0-39 | 25-100 | 42-100 | 0-8 | 0-4 |
| **9** | | 16-17 | 17-18 | 12 | 60-63 | 40-46 | 23-24 | 37-41 | 9-12 | 5-8 |
| **8** | 5 | 15 | 16 | 11 | 64-67 | 47-52 | 21-22 | 32-36 | 13-17 | 9-12 |
| **7** | 4 | 13-14 | 14-15 | 10 | 68-71 | 53-58 | 19-20 | 27-31 | 18-21 | 13-16 |
| **6** | | 11-12 | 13 | 9 | 72-75 | 59-64 | 16-18 | 23-26 | 22-25 | 17-19 |
| **5** | 3 | 9-10 | 11-12 | 8 | 76-80 | 65-70 | 13-15 | 19-22 | 26-29 | 20-22 |
| **4** | 2 | 7-8 | 10 | 7 | 81-84 | 71-76 | 10-12 | 14-18 | 30-34 | 23-25 |
| **3** | | 5-6 | 8-9 | 6 | 85-88 | 77-82 | 7-9 | 10-13 | 35-38 | 26-29 |
| **2** | 1 | 4 | 7 | 5 | 89-92 | 83-88 | 4-6 | 6-9 | 39-42 | 30-33 |
| **1** | | 2-3 | 5-6 | 4 | 93-96 | 89-94 | 1-3 | 2-5 | 43-46 | 34-37 |
| **0** | 0 | 0-1 | 0-4 | 0-3 | 97-100 | 95-100 | 0 | 0-1 | 47-100 | 38-100 |

**Cumulative IBI Scores**

| Very Poor | Poor | Fair | Good | Very Good |
|---|---|---|---|---|
| 0-19 | 20-39 | 40-59 | 60-79 | 80-100 |

## RESULTS

### Habitat Characteristics and Water Quality

The physical characteristics of the transects sampled at Stations NR1 (upstream) and NR3 (downstream) in the Santa Clara River were low gradient (<1%) (Table 4). Average wetted width was similar at both sites and depth was greater at Station NR1 during both seasons. Bank stability was 100% at Station NR1 during both seasons owing to dense vegetation along both banks. Station NR3 had banks that were 100% vulnerable to erosion in the spring and 50% eroded by the fall survey. Vegetative canopy cover was greatest at Station NR3 during both seasons. The dominate flow habitat found at the two sites were runs during both seasons, except at Station NR1 in the spring where riffles dominated the reach.

Water quality measurements for each parameter were within normal ranges at both sites. Temperatures were warmest in the spring and cooler in the fall. Each of the other parameters were similar at both sites, during each season, except at Station NR1 in the spring when pH and dissolved oxygen were greater compared to NR3.

***Physical/Habitat Scores*:** Assessment of the physical/habitat conditions of a stream reach is necessary to determine its quality as a habitat for BMIs. In many cases organisms may not be exposed to chemical contaminants, yet their populations indicate that impairment has occurred. These population shifts can be the result of degraded stream bed and bank habitat. Excess sediment is the leading pollutant in streams and rivers of the United States (Harrington and Born 2000). Sediments fill pools and interstitial areas of the stream substrate where fish spawn and invertebrates live, causing their populations to decline or to be altered.

Out of a total possible score of 200, the physical/habitat score for Station NR3 was in the marginal range and NR1 was in the sub-optimal range during both seasons (Table 5 and Figure 3). Better physical habitat conditions at Station NR1, when compared to NR3, could be attributed to slightly less sediment deposition and channel alteration, coupled with better bank stability, vegetative canopy cover and riparian zone width. Scores were similar between seasons.

Table 4. Physical habitat measurements for 2 reaches in the Santa Clara River. Measurements are specified in by SWAMP (2007).

| Parameter | NR3 | | NR1 | |
|---|---|---|---|---|
| | Spring | Fall | Spring | Fall |
| **<u>Habitat Characteristics</u>** | | | | |
| **Reach Length (m)** | 150 | 150 | 150 | 150 |
| **Average Wetted Width (m)** | 7.6 | 9.4 | 5.4 | 5.0 |
| **Average Depth (cm)** | 28 | 23 | 36 | 32 |
| **Velocity (m/sec)** | 0.67 | NR | 0.55 | NR |
| **Discharge ($m^3$)** | NR | 0.70 | NR | 0.86 |
| **Bank Stability** | | | | |
| **% Stable** | 0 | 50 | 100 | 100 |
| **% Vulnerable** | 100 | 0 | 0 | 0 |
| **% Eroded** | 0 | 50 | 0 | 0 |
| **Vegetative Canopy Cover (%)** | 11.9 | 26.9 | 1.1 | 3.2 |
| **Flow Habitats (%)** | | | | |
| **Cascade/Fall** | 0 | 0 | 0 | 0 |
| **Rapid** | 0 | 0 | 0 | 0 |
| **Riffle** | 0 | 0 | 76 | 0 |
| **Run** | 89.5 | 100 | 18.5 | 100 |
| **Glide** | 10.5 | 0 | 5.5 | 0 |
| **Pool** | 0 | 0 | 0 | 0 |
| **Dry** | 0 | 0 | 0 | 0 |
| **Percent Gradient (%)** | 0.1 | | 0.2 | |
| **<u>Chemical Characteristics</u>** | | | | |
| **Water Temperature (C°)** | 20.17 | 16.75 | 23.52 | 19.27 |
| **pH** | 7.78 | 7.67 | 8.02 | 7.87 |
| **Alkalinity** | 240 | 245 | 238 | 230 |
| **DO** | 7.99 | 8.20 | 10.03 | 7.82 |
| **Specific Conductance (S/cm at 25EC)** | 1336 | 1201 | 1290 | 1186 |
| **Salinity (ppt)** | 0.74 | 0.72 | 0.66 | 0.67 |

Table 5. Physical habitat assessment for the two sampling sites in the Santa Clara River.

| **Habitat Parameter** | **NR3** | | **NR1** | |
|---|---|---|---|---|
| | **Spring** | **Fall** | **Spring** | **Fall** |
| **1. Instream Cover** | 6 | 10 | 11 | 10 |
| **2. Embeddedness** | 5 | 6 | 9 | 7 |
| **3. Velocity / Depth Regime** | 10 | 15 | 12 | 15 |
| **4. Sediment Deposition** | 6 | 8 | 11 | 11 |
| **5. Channel Flow** | 6 | 10 | 8 | 7 |
| **6. Channel Alteration** | 13 | 11 | 16 | 19 |
| **7. Riffle Frequency** | 6 | 6 | 10 | 6 |
| **8. Bank Stability** | 8 | 7 | 14 | 18 |
| **9. Vegetative Protection** | 8 | 10 | 14 | 14 |
| **10. Riparian Vegetative Zone Width** | 14 | 8 | 18 | 18 |
| ***Reach Total*** | **82** | **91** | **123** | **125** |
| ***Condition Category*** | **Marginal** | **Marginal** | **Suboptimal** | **Suboptimal** |

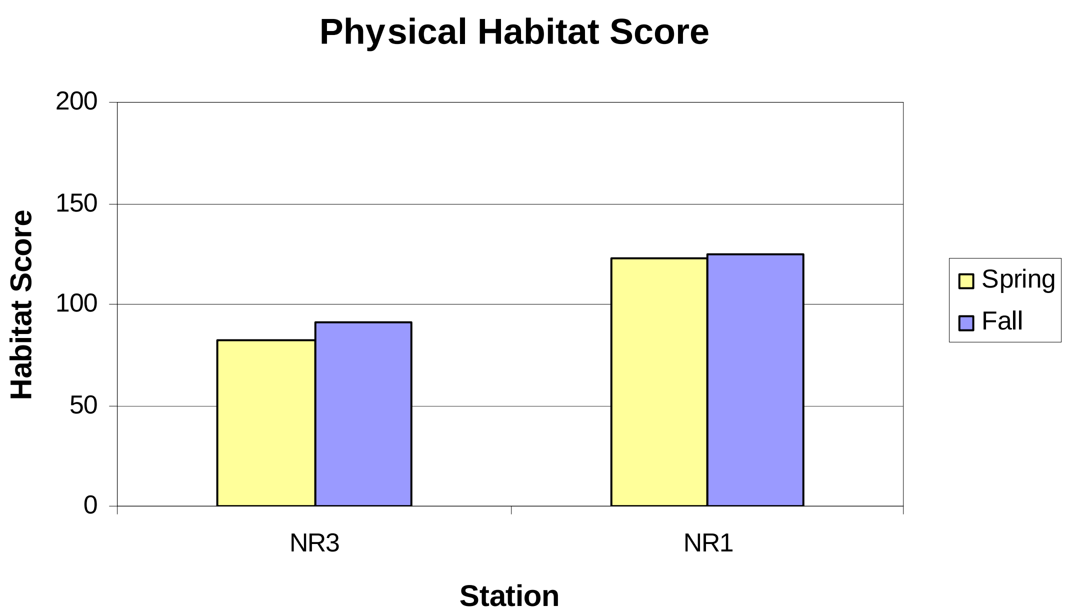


Figure 3. Physical/Habitat quality scores by season.

## BMI Community Structure

The BMIs identified from each site are listed in order of ranked abundance in Table 6. The biological metrics calculated from each BMI sample are listed in Table 7 and Figures 4 thru 7. The Southern California IBI scores for each site and season are presented in Table 8 and Figure 8, and averaged by site for each survey since 2004 in Figure 9. Raw BMI abundances, tolerance values and feeding groups are presented in the Appendix, Tables 9a and 9b.

A total of 3,620 BMIs were identified from the samples collected during the spring and fall at the two sampling sites. During the spring seed shrimp (Ostracoda) represented 23% and 37% of the population at Stations NR3 and NR1, respectively (Table 6). Other relatively abundant species at both stations included oligochaete worms (15%), midge flies (Chrionomidae), and the mayfly, *Fallceon quilleri*. During the fall survey the most abundant species at Stations NR1 and NR3 were nematodes, midge flies, flatworms (Turbellaria), and mayflies (*Fallceon quilleri* and *Tricorythodes sp*.).

## Biological Metrics

Each of the biological metrics listed in Table 2 above, was calculated for this survey and is presented in Table 7. Each metric is depicted graphically by community measure in Figures 4 to 7.

***Community Richness Measures*:** Taxa richness is a measure of the total number of species found at a site. This relatively simple index can provide much information about the integrity of the community. Few taxa at a site indicate that some species are being excluded, while a large number of species indicate a more healthy community. EPT taxa are the number of all of the mayflies (Ephemeroptera), caddisflies (Trichoptera), and stoneflies (Plecoptera) present at a location. These families are generally sensitive to impairment and, when present, are usually indicative of a healthier community than if any or all are absent. Metrics for Coleopteran and Predator taxa are included since they are used to calculate the So CA IBI.

Each of the community richness measures was similar between stations and seasons, and there were no significant differences among sites by ANOVA (Table 7 and Figure 4). Taxonomic richness ranged from 18 to 20, and EPT taxa ranged from 3 to 5. Numbers of Coleoptera were low during both seasons. Predator taxa ranged from 5 to 7.

***Composition Measures*:** The percent EPT taxa, sensitive EPT, percent non-insect taxa and the Shannon Diversity Index are all measures of community composition. Species diversity indices are similar to numbers of species; however they contain an evenness component as well. For example, two samples may have the same numbers of species and the same numbers of individuals. However, one station may have most of its numbers concentrated into only a few species while a second station may have its numbers evenly distributed among its species. The diversity index would be higher for the latter station. Percent EPT taxa are the proportion of the abundance at a site that is comprised of mayflies, stoneflies and caddisflies. Percent Sensitive EPT taxa are similar except it includes only those EPT taxa whose tolerance values range from 0 to 3. These taxa are very sensitive to impairment and, when present, can be indicative of better water quality conditions. Percent non-insect taxa is a measure of all other phyla represented at a site and, when elevated, generally indicate poorer water quality conditions.

The percentage of EPT taxa were somewhat greater at both Stations NR1 and NR3 during the spring compared to the fall (Table 7 and Figure 5). No sensitive EPT taxa were collected from the survey area. Shannon Diversity and non-insect individuals were nearly the same at each station, during both seasons. There were significantly greater numbers of non-insect taxa at Station NR3 in the fall compared to at Station NR1.

***Tolerance Measures*:** The Southern California IBI uses both the percent intolerant individuals and percent tolerant taxa to evaluate the overall sensitivity of organisms to pollution and habitat impairment. Each species is assigned a tolerance value from 0 (highly intolerant) to 10 (highly tolerant). The percent intolerance individuals for a site is calculated by multiplying the tolerance value of each species with a tolerance value ranging from 0 to 2, by its abundance, then dividing by the total abundance for the site. The percent tolerant taxa are similar except that only species with tolerance values ranging from 8 to 10 are included and total numbers of taxa, instead of individuals is used to derive the proportion. A site with many tolerant organisms present is considered to be less pristine or more impacted by human disturbance than one that has few tolerant species. The tolerance values for each species were developed in different parts of the United States and can therefore be region specific. Also, different organisms can be tolerant to one type of disturbance, but highly sensitive to another. For example, an organism that is highly sensitive to sediment deposition may be very insensitive to organic pollution. With these drawbacks in mind, the Tolerance measures generally depict disturbances in a stream that, when coupled with other metrics, can provide good water quality information regarding a stream reach.

Percent dominance reflects the proportion of the total abundance at a site represented by the most abundant species. For example, if 100 organisms are collected at a site and species A is the most abundant with 30 individuals, the percent dominance index score for the site is 30%. The benthic environment tends to be healthier when the dominance index is low, which indicates that more than just a few taxa make up the majority of the community.

The tolerance metrics reported for this survey indicated that Mean tolerance values were moderate (5 to 6) at both sites, during both seasons (Table 7 and Figure 6). Percent dominance and percent tolerant taxa were also similar during both seasons, at both sites. There were no intolerant organisms found in the survey area during either season. The percentage of Baetid mayflies was slightly greater in the fall and there were a significantly greater number of Baetid mayflies at Station NR3 during the fall, compared to Station NR1.

***Functional Feeding Groups*:** These indices provide information regarding the balance of feeding strategies represented in an aquatic assemblage. The combined feeding strategies of the organisms in a reach provide information regarding the form and transfer of energy in the habitat. When the feeding strategy of a stream system is out of balance it can be inferred that the habitat is stressed. For the purposes of this study, species were grouped by feeding strategy as percent collector-gatherers, collector-filterers, grazers, predators and shredders. The Southern California IBI uses the numbers of predators and percent collectors (gatherers + filterers) at a site to calculate the index.

Species using collecting and filtering, grazing and predation as their feeding strategy were the most common organisms collected during both seasons (Table 7). Collectors and filterers were dominant in the spring, followed by grazers and predators, at both stations. In the fall collectors and filterers were again dominant at Station NR3, but predators were dominant at Station NR1, followed by collectors and filterers. These differences among stations were significant. The increased numbers of predators at NR1 in the fall was due to large abundances of dragonflies (Odonata) and flatworms (Turbellaria).

***IBI Scores*:** Work conducted in the 1990's by the San Diego Regional Board and the California Department of Fish and Game, established an Index of Biotic Integrity (IBI) for the San Diego region and its watersheds (Ode and Harrington 2002). The index was recently expanded to include all of southern California (Ode et. al. 2005) and is used in this section.

The IBI is a multi-metric technique that employs seven biological metrics that were each found to respond to a habitat and/or water quality impairment at sites from Monterey, California to the Mexican boarder. Each of the seven biological metrics measured at a site are converted to an IBI score then summed. These cumulative scores can then be ranked according to very good (80-100), good (60-79), fair (40-59), poor (20-39) and very poor (0-19) habitat conditions. The threshold limit for this scoring index is 39. Despite the fact that rankings can be identified as "fair", sites with scores above 39 are within two standard deviations of the mean reference site conditions in southern California and are not considered to be impaired. Sites with scores below 39 are considered to have impaired conditions. The metric scoring ranges established for the Southern California IBI survey are listed in Table 4 and were used to classify the sites in this study.

*2007*

The Southern California IBI scores for 2007 ranged from 23 to 46, with each station ranking in the "poor" range, except Station NR1 in the fall which ranked as "fair" (Table 8 and Figure 8). Except for Station NR1 in the fall, the BMI communities at each of these sites were impaired when compared to conditions found at reference site locations throughout southern California. These impaired conditions appear to be due to habitat disruptions based on the low physical habitat scores measured at these sites (Table 5, Figure 3). Lower scores across sites and seasons were mostly due to the lack of EPT taxa and intolerant taxa and large abundances of relatively tolerant taxa. The improved IBI scores at NR1 in the fall were due to large numbers of predator organisms (predominately dragonflies), the presence of two species of beetle taxa (Coleoptera) and fewer collector taxa.

*2004 to 2007*

To assess the condition of BMI communities at Stations NR1 and NR3 over time, IBI scores were averaged (± 95% CI) by station and season for all surveys conducted between the spring of 2004 and the fall of 2007 (Figure 9). The average IBI scores at each site were in the poor range for the four year period. This shows that BMI habitat conditions upstream and downstream of the Newhall WRP were similar during this four year period. Importantly, the scores were similar between locations so that future comparisons between sites upstream and downstream of the discharge point will be possible.

## DISCUSSION

The Santa Clara River watershed is the longest free-flowing natural river in southern California. Its 70 mile length provides drainage to a 1,600 $mi^2$ watershed. Before reaching the Pacific Ocean in Ventura, it passes through the Santa Clarita Valley where a large urban development project is planned. A part of this project includes the construction of a Water Reclamation Plant (WRP) that will service the residences and commercial businesses that are included in this project. The future discharge site for the treatment plant is located on Newhall Ranch property in Los Angeles County just upstream of the border with Ventura County. The Newhall Ranch property, which borders both sides of the Santa Clara River, has been used historically for agriculture, ranching oil drilling operations.

For the most part, the Santa Clara River has been allowed to follow its natural course through the valley. The water flow in the river varies widely between wet weather, when the river typically reaches 100,000 cubic feet per second (cfs), and the summer and fall when the river bed can be nearly dry (Swanson et al. 1990). Presently, the combination of natural river flow, urban runoff and the discharge from upstream waste treatment facilities maintain a relatively constant low flow of water in the River, even during the driest summer months.

The goal of this project was to assess the baseline conditions of the benthic macro-invertebrate community in the Santa Clara River at sites located at the discharge point for the future WRP and downstream of it. These data will allow managers to assess if changes are occurring to the benthic community after the treatment plant is completed and discharge to the river has begun. Bioassessment samples were collected, and physical habitat assessments were made on July 27th and October 31st, 2007 at two locations in the Santa Clara River near the Los Angeles/Ventura County line. Site NR1 was located at the future discharge point for the WRP, while NR3 was located 2.7 miles downstream.

All samples and physical habitat surveys were collected and analyzed according to the protocols established in the recently promulgated State of California, Stormwater Ambient Monitoring Program (SWAMP 2007). These protocols were based on the California Stream Bioassessment Protocols (CSBP 2003) and the EPA's Environmental Monitoring and Assessment Program (EMAP). The results of BMI community metrics collected by each of these protocols were found to be comparable (Rehn et al. 2006). This means that BMI data collected by the CSBP method before 2007 are comparable. The quality assurance criteria specified in the SWAMP protocol were met for both the physical habitat and taxonomic portions of the program.

The Visual-Based Habitat (VBH, Barbour et al. 1999) physical/habitat assessment scores for both the upstream and downstream stations (NR1 and NR3, respectively) were marginal to sub-optimal, with the best conditions found at NR1 during both the spring and fall. The river beds at both stations were of relatively low gradient and composed of mostly sandy particles, with no cobble, boulders, undercut banks or branch fall. Combined, these habitat conditions do not provide for the types of complex habitat that will support a wide diversity of BMIs. Comparing the two sites, the better physical habitat conditions at Station NR1 were mostly associated with less channel alteration, better bank stability, vegetative cover and riparian zone width. The lower scores at Station NR3 were, for the most part, due to large amounts of sedimentation and channel alteration, poor bank stability, and less vegetative canopy cover and riparian zone.

The VBH scoring system used in the CSBP (2003) protocols were originally developed in the mid-west and eastern United States by the USEPA. As a result, the appropriateness of it's application to low gradient river wash systems such as the Santa Clara River have been questioned. However, since the VBH has been used since the inception of the BMI program in 2004, its use in 2007 was intended to help provide historical context for the physical habitat attributes found during the survey and to determine if any large scale changes to the streambed system had occurred at either site in the previous year. The new Basic SWAMP (2007) physical habitat assessment was also conducted in 2007 at each site. While useful, the scoring system for this protocol has not been completed, which makes judgment of habitat quality difficult.

The Santa Clara River is a large drainage for the Transverse Ranges of southern California and has ephemeral discharge due to winter rainfall and dry summers (Inman and Jenkins 1999). It is the largest contributor of sediment to the coastal ocean waters of the southern California bight due to its steep landscape, weak sedimentary rocks and intense seasonal rainfall (Schwalbach and Gorsline 1985, Scott and Williams 1978, Warrick 2002). Therefore, the large amounts of sediment present in the Santa Clara River bed at Stations NR1 and NR3 may be the result of naturally occurring processes. During a study of the Santa Clara River in 2001, Ambrose (et. al. 2003) also found that sites located at Newhall Ranch were characterized by sandy sediments.

The BMI population metrics measured at both NR1 and NR3 during 2007 was similar in terms of richness, composition, and tolerance measures. Several metrics were significantly different among stations by ANOVA, with the majority of these being community feeding group measures in the fall. These differences were mostly explained by the dominance of collectors and filterers at Station NR3 and a corresponding dominance of predators at Station NR1. The increase in predators at NR1 was due to the presence of large abundances of dragonflies (Odonata) and flatworms (Turbellaria).

The BMI population in this reach of the Santa Clara River is characterized by the absence of intolerant species (sensitive species) and sensitive EPT taxa. Intolerant organisms are those that have been assigned a tolerance value from zero to two. Sensitive EPT taxa are mayflies, stoneflies and caddisflies whose tolerance values range from 0 to 3. Each of these taxa groups are very sensitive to impairment and, when present, can be indicative of more natural conditions. During a 2001 watershed-wide survey conducted by Ambrose (et. al. 2003), investigators found similar BMI communities at sites near those used during the current study.

The IBI scores at both NR1 and NR3 indicated that the condition of the biological communities found there were impaired when compared to the conditions at reference sites in southern California. The exception to the low IBI scores was Station NR1 in the fall when the IBI score was in the fair range. It is possible that the physical habitat condition of this site, which was somewhat better than at Station NR3, is playing a role in this improvement. The increased IBI score at NR1 in the fall was due to large numbers of predator organisms (predominately dragonflies), the presence of two species of beetle taxa (Coleoptera) and fewer collector taxa. It should be noted that while low gradient reference sites were included in the development of the southern California IBI (Ode et al 2005), work is currently underway to determine if the index accurately characterizes large river wash systems such as the Santa Clara River. This work is being conducted by the Stormwater Monitoring Coalition (SMC), which is a consortium of watershed and stormwater agencies that are tasked with assessing the condition of southern California watersheds.

To assess the condition of BMI communities at Stations NR1 and NR3 over time, IBI scores were averaged (± 95% CI) by station and season for all surveys conducted between the spring of 2004 and the fall of 2007. The average IBI score at each site were in the poor range for the four year period. This shows that BMI habitat conditions upstream and downstream of the proposed Newhall WRP outfall location were similar during this four year period.

In prior reports (Aquatic Bioassay 2005 to 2007), the IBI scores were inadvertently miscalculated using % non-insect individuals and % tolerant individuals, instead of % non-insect taxa and % tolerant taxa. The IBI scores in this year's report are corrected. In addition, the IBI scores for the previous reports were recomputed and are presented in Appendix B. While the scores vary between old and new computations, the overall ranking of poor for both sites across each sampling event was unchanged.

The results of the 2007 survey on the Santa Clara River in the vicinity of the future WRP in the Santa Clarita Valley indicated that the river habitat is typical of a southern California river wash located in a heavily developed land use area. As a result, the BMI communities residing there are impaired. One likely disturbance is the high amount of sediments in the river bed and, therefore, the lack of complex habitat. This sedimentation may be the result of the natural geomorphic composition and ephemeral nature of the surrounding watershed and/or human activities.

Table 6. Average species ranked by abundance for each site and season for the Santa Clara River bioassessment survey.

| Spring | | | | Fall | | | |
|---|---|---|---|---|---|---|---|
| NR3 | | NR1 | | NR3 | | NR1 | |
| Species | % of Total Abund | Species | % of Total Abund | Species | % of Total Abund | Species | % of Total Abund |
| Ostracoda | 23.7 | Ostracoda | 37 | Nematoda | 21.8 | Turbellaria | 27 |
| Oligochaeta | 15.6 | Oligochaeta | 12.1 | Chironomidae | 19.2 | Nematoda | 16.1 |
| Chironomidae | 15.2 | Fallceon quilleri | 12 | Fallceon quilleri | 15.3 | Tricorythodes sp | 8.9 |
| Hydroptila sp | 13.8 | Turbellaria | 9.2 | Oligochaeta | 8.9 | Chironomidae | 7.3 |
| Hydroptilidae | 6.1 | Hydroptila sp | 6.8 | Ostracoda | 8.3 | Simulium sp | 6.7 |
| Nematoda | 5.9 | Tricorythodes sp | 6.6 | Turbellaria | 7.6 | Hetaerina sp | 6.4 |
| Fallceon quilleri | 4.5 | Chironomidae | 3.2 | Simulium sp | 5.9 | Argia sp | 5.8 |
| Hemerodromia sp | 4.5 | Simulium sp | 3.1 | Tricorythodes sp | 5.4 | Physa sp | 5.7 |
| Simulium sp | 3.3 | Caloparyphus/Euparyphus sp | 1.9 | Sperchon sp | 1.6 | Fallceon quilleri | 5.4 |
| Turbellaria | 2 | Hydroptilidae | 1.7 | Baetis sp | 1.6 | Coenagrionidae | 3 |
| Physa sp | 1.4 | Baetis sp | 1.1 | Physa sp | 0.8 | Ostracoda | 2.1 |
| Caloparyphus/Euparyphus sp | 0.8 | Caloparyphus sp | 1.1 | Copepoda | 0.8 | Oligochaeta | 1.4 |
| Sperchon sp | 0.7 | Physa sp | 0.9 | Coenagrionidae | 0.7 | Chrysomelidae | 0.8 |
| Pericoma/Telmatoscopus sp | 0.4 | Bezzia/Palpomyia sp | 0.6 | Ephydridae | 0.4 | Zoniagrion exclamationis | 0.4 |
| Baetis sp | 0.2 | Nematoda | 0.6 | Hemerodromia sp | 0.4 | Caloparyphus/Euparyphus sp | 0.3 |
| Euparyphus sp | 0.2 | Sperchon sp | 0.5 | Hydroptilidae | 0.2 | Postelichus sp | 0.3 |
| Zoniagrion exclamationis | 0.2 | Zoniagrion exclamationis | 0.4 | Hydrozetidae | 0.2 | Hemerodromia sp | 0.3 |
| Anisoptera | 0.1 | Culicoides sp | 0.3 | Hetaerina americana | 0.2 | Pericoma/Telmatoscopus sp | 0.2 |
| Atractides sp | 0.1 | Hemerodromia sp | 0.3 | Argia sp | 0.1 | Brechmorhoga mendax | 0.2 |
| Bezzia/Palpomyia sp | 0.1 | Coenagrionidae | 0.2 | Culicoides sp | 0.1 | Hydropsyche sp | 0.2 |
| Coenagrionidae | 0.1 | Euparyphus sp | 0.2 | Cladocera | 0.1 | Optioservus sp | 0.2 |
| Culicoides sp | 0.1 | Helochares sp | 0.1 | Ceratopogonidae | 0.1 | Libellulidae | 0.1 |
| Ephydridae | 0.1 | | | Caloparyphus/Euparyphus sp | 0.1 | Bezzia/Palpomyia sp | 0.1 |
| Helochares sp | 0.1 | | | Nemotelus sp | 0.1 | Ceratopogon sp | 0.1 |
| Heteroceridae | 0.1 | | | | | Baetis sp | 0.1 |
| Libellulidae | 0.1 | | | | | Ephydridae | 0.1 |
| Peltodytes sp | 0.1 | | | | | Libellula sp | 0.1 |
| Tropisternus sp | 0.1 | | | | | Petrophila sp | 0.1 |
| | | | | | | Psychodidae | 0.1 |
| | | | | | | Tyrrellia sp | 0.1 |
| | | | | | | Hydrozetidae | 0.1 |
| TOTAL | 100 | | 100 | | 100 | | 100 |

Table 7. Comparison of averaged biological metrics (± SD, CV & 95% CI) for each site by season, evaluated using ANOVA. Grayed F scores significant at p ≤ 0.05.

| | | Spring | | | | | Fall | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Station | | | Comparison | | Station | | | Comparison | |
| Metric | | NR3 | NR1 | Avg | F-Ratio | p | NR3 | NR1 | Avg | F-Ratio | p |
| **Community Richness Measures** | | | | | | | | | | | |
| **Taxonomic richness** | **mean** | 18 | 18 | 18 | 0.03 | 0.87 | 18 | 20 | 19 | 3.77 | 0.12 |
| | **st. dev.** | 3.1 | 1.7 | 2.4 | | | 1 | 2 | 1 | | |
| | **cv** | 17.3 | 9.6 | 13.4 | | | 3 | 10 | 7 | | |
| | **95% CI** | 3.5 | 2 | 2.8 | | | 1 | 2 | 2 | | |
| **EPT taxa** | **mean** | 4 | 5 | 4 | 4.50 | 0.10 | 3 | 3 | 3 | 2.00 | 0.23 |
| | **st. dev.** | 0.6 | 0.6 | 0.6 | | | 1 | 1 | 1 | | |
| | **cv** | 15.7 | 12.4 | 14 | | | 17 | 22 | 20 | | |
| | **95% CI** | 0.7 | 0.7 | 0.7 | | | 1 | 1 | 1 | | |
| **Cumulative EPT Taxa** | **mean** | 4 | 3 | 4 | N/A | | 4 | 4 | 4 | N/A | |
| **Coleoptera Taxa** | **mean** | 1 | 0 | 1 | 1.80 | 0.25 | 0 | 2 | 1 | **3.85**[1.] | **0.05** |
| | **st. dev.** | 1 | 1 | 0.9 | | | 0.0 | 0.0 | 0 | | |
| | **cv** | 87 | 173 | 129.9 | | | - | 0.0 | 0 | | |
| | **95% CI** | 1 | 1 | 1 | | | 0.0 | 0.0 | 0 | | |
| **Predator Taxa** | **mean** | 6 | 5 | 6 | 0.45 | 0.53 | 6 | 7 | 7 | 0.96 | 0.38 |
| | **st. dev.** | 3 | 1 | 2 | | | 2 | 3 | 2 | | |
| | **cv** | 40 | 11 | 25 | | | 27 | 34 | 31 | | |
| | **95% CI** | 3 | 1 | 2 | | | 2 | 3 | 2 | | |
| **Community Composition Measures** | | | | | | | | | | | |
| **EPT Index (%)** | **mean** | 24.6 | 28.0 | 26.3 | 0.19 | 0.68 | 22.5 | 14.6 | 18.6 | 2.13 | 0.22 |
| | **st. dev.** | 0.7 | 13.3 | 7.0 | | | 6.3 | 6.9 | 6.6 | | |
| | **cv** | 2.7 | 47.5 | 25.1 | | | 27.8 | 47.4 | 37.6 | | |
| | **95% CI** | 0.8 | 15.1 | 8 | | | 7.1 | 7.8 | 7.4 | | |
| **Sensitive EPT Index (%)** | **mean** | 0 | 0 | 0.0 | N/A | | 0.0 | 0.0 | 0.0 | N/A | |
| | **st. dev.** | 0 | 0 | 0.0 | | | 0.0 | 0.0 | 0.0 | | |
| | **cv** | - | - | - | | | | | | | |
| | **95% CI** | 0 | 0 | 0 | | | 0.0 | 0.0 | 0.0 | | |
| **Shannon Diversity** | **mean** | 2.2 | 2.0 | 2.1 | 2.03 | 0.23 | 2.2 | 2.2 | 2 | 0.06 | 0.82 |
| | **st. dev.** | 0.0 | 0.2 | 0.1 | | | 0.1 | 0.3 | 0 | | |
| | **cv** | 1.7 | 12.1 | 6.9 | | | 3.1 | 12.3 | 8 | | |
| | **95% CI** | 0.0 | 0.3 | 0 | | | 0.1 | 0.3 | 0 | | |
| **Percent Non-Insect Individuals** | **mean** | 50.1 | 60.5 | 55.3 | 1.91 | 0.24 | 50.1 | 52.6 | 51 | 0.76 | 0.43 |
| | **st. dev.** | 4.0 | 12.5 | 8.2 | | | 1.8 | 4.6 | 3 | | |
| | **cv** | 8.0 | 20.7 | 14.4 | | | 3.6 | 8.7 | 6 | | |
| | **95% CI** | 4.5 | 14.1 | 9 | | | 2.1 | 5.2 | 4 | | |
| **Percent Non-Insect Taxa** | **mean** | 34.2 | 33.2 | 33.7 | 0.30 | 0.62 | 45.3 | 27.0 | 36 | **29.97** | **0.01** |
| | **st. dev.** | 5.4 | 6.9 | 6.1 | | | 1.6 | 7.3 | 4 | | |
| | **cv** | 15.7 | 20.6 | 18.1 | | | 3.4 | 17.6 | 11 | | |
| | **95% CI** | 6.1 | 7.8 | 7 | | | 1.8 | 8.3 | 5 | | |
| **Community Tolerance Measures** | | | | | | | | | | | |
| **Mean Tolerance Value** | **mean** | 6.1 | 6.1 | 6.1 | 0.00 | 1.00 | 5.4 | 5.3 | 5 | 0.64 | 0.47 |
| | **st. dev.** | 0.3 | 0.7 | 0.5 | | | 0.2 | 0.2 | 0 | | |
| | **cv** | 4.9 | 11.5 | 8.2 | | | 2.8 | 2.9 | 3 | | |
| | **95% CI** | 0.3 | 0.8 | 1 | | | 0.2 | 0.2 | 0 | | |
| **% dominant taxa** | **mean** | 24.1 | 39.8 | 31.9 | 3.19 | 0.14 | 23.2 | 31.3 | 27.2 | 1.02 | 0.36 |
| | **st. dev.** | 4.1 | 14.7 | 9.4 | | | 6.0 | 12.5 | 9.2 | | |
| | **cv** | 17.1 | 36.9 | 27.0 | | | 26.1 | 40.0 | 33.0 | | |
| | **95% CI** | 4.7 | 16.6 | 11 | | | 6.8 | 14.1 | 10.4 | | |
| **Percent Tolerant Taxa** | **mean** | 30.6 | 29.7 | 30.1 | 0.03 | 0.87 | 37.3 | 26.3 | 31.8 | 2.10 | 0.22 |
| | **st. dev.** | 8.2 | 3.0 | 5.6 | | | 9.0 | 9.5 | 9.2 | | |
| | **cv** | 26.9 | 9.9 | 18.4 | | | 24.2 | 36.0 | 30.1 | | |
| | **95% CI** | 9.3 | 3.3 | 6 | | | 10.2 | 10.7 | 10.5 | | |

Table 7. (continued)

| Metric | | Spring Station NR3 | Spring Station NR1 | Spring Station Avg | Spring Comparison F-Ratio | Spring Comparison p | Fall Station NR3 | Fall Station NR1 | Fall Station Avg | Fall Comparison F-Ratio | Fall Comparison p |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Community Tolerance Measures (continued)** | | | | | | | | | | | |
| **Percent Tolerant Individuals (8-10)** | **mean** | 28.9 | 41.8 | 35.3 | 1.10 | 0.35 | 12.6 | 12.1 | 12.3 | 0.08 | 0.79 |
| | **st. dev.** | 7.3 | 20.0 | 13.6 | | | 1.8 | 2.2 | 2.0 | | |
| | **cv** | 25.2 | 47.8 | 36.5 | | | 14.4 | 17.9 | 16.2 | | |
| | **95% CI** | 8.2 | 22.6 | 15 | | | 2.0 | 2.4 | 2.2 | | |
| **Percent Intolerant Individuals (0-2)** | **mean** | 0.0 | 0.0 | 0.0 | N/A | | 0.0 | 0.0 | 0.0 | N/A | |
| | **st. dev.** | 0.0 | 0.0 | 0.0 | | | 0.0 | 0.0 | 0.0 | | |
| | **cv** | - | - | - | | | - | - | - | | |
| | **95% CI** | 0.0 | 0.0 | 0.0 | | | 0.0 | 0.0 | 0.0 | | |
| **Percent Hydropsychidae** | **mean** | 0.0 | 0.0 | 0.0 | N/A | | 0.0 | 0.2 | 0.1 | 1.00 | 0.37 |
| | **st. dev.** | 0.0 | 0.0 | 0.0 | | | 0.0 | 0.4 | 0.2 | | |
| | **cv** | - | - | - | | | | 173.2 | 173.2 | | |
| | **95% CI** | 0.0 | 0.0 | 0.0 | | | 0.0 | 0.5 | 0.2 | | |
| **Percent Baetidae** | **mean** | 4.5 | 13.0 | 8.8 | 1.60 | 0.27 | 17.0 | 5.6 | 11.3 | **10.00** | **0.03** |
| | **st. dev.** | 2.5 | 11.3 | 6.9 | | | 5.2 | 3.4 | 4.3 | | |
| | **cv** | 56.1 | 87.0 | 71.6 | | | 30.8 | 60.4 | 45.6 | | |
| | **95% CI** | 2.9 | 12.8 | 8 | | | 5.9 | 3.8 | 4.8 | | |
| **Community Feeding Group Measures** | | | | | | | | | | | |
| **Percent Collectors & Filterers** | **mean** | 64.0 | 78.8 | 71.4 | **6.52** | **0.06** | 66.2 | 33.0 | 49.6 | **24.86** | **0.01** |
| | **st. dev.** | 3.4 | 9.4 | 6.4 | | | 11.4 | 1.7 | 6.6 | | |
| | **cv** | 5.4 | 12.0 | 8.7 | | | 17.2 | 5.0 | 11.1 | | |
| | **95% CI** | 3.9 | 10.7 | 7.3 | | | 12.9 | 1.9 | 7.4 | | |
| **Percent Collectors** | **mean** | 61.1 | 75.7 | 68.4 | **6.28** | **0.06** | 60.2 | 26.1 | 43.1 | **27.16** | **0.01** |
| | **st. dev.** | 1.4 | 10.0 | 5.7 | | | 10.4 | 4.5 | 7.4 | | |
| | **cv** | 2.3 | 13.2 | 7.8 | | | 17.3 | 17.3 | 17.3 | | |
| | **95% CI** | 1.6 | 11.3 | 6 | | | 11.8 | 5.1 | 8.4 | | |
| **Percent Filterers** | **mean** | 2.9 | 3.1 | 3.0 | 0.01 | 0.91 | 6.0 | 6.9 | 6.5 | 0.08 | 0.79 |
| | **st. dev.** | 2.9 | 1.7 | 2.3 | | | 3.7 | 4.2 | 4.0 | | |
| | **cv** | 101.1 | 53.7 | 77.4 | | | 61.2 | 60.9 | 61.0 | | |
| | **95% CI** | 3.3 | 1.9 | 3 | | | 4.2 | 4.8 | 4.5 | | |
| **Percent Grazers** | **mean** | 22.1 | 9.3 | 15.7 | **14.90** | **0.02** | 1.0 | 6.0 | 3.5 | **34.34** | **<0.01** |
| | **st. dev.** | 3.8 | 4.3 | 4.0 | | | 0.3 | 1.5 | 0.9 | | |
| | **cv** | 17.2 | 45.9 | 31.6 | | | 30.0 | 24.2 | 27.1 | | |
| | **95% CI** | 4.3 | 4.8 | 5 | | | 0.3 | 1.6 | 1.0 | | |
| **Percent Predators** | **mean** | 13.8 | 11.9 | 12.8 | 0.30 | 0.61 | 32.8 | 60.2 | 46.5 | **17.94** | **0.01** |
| | **st. dev.** | 2.4 | 5.7 | 4.0 | | | 11.2 | 0.0 | 5.6 | | |
| | **cv** | 17.4 | 48.1 | 32.8 | | | 34.1 | 0.0 | 17.0 | | |
| | **95% CI** | 2.7 | 6.5 | 5 | | | 12.7 | 0.0 | 6.4 | | |
| **Percent Shredders** | **mean** | 0.0 | 0.0 | 0.0 | N/A | | 0.0 | 0.8 | 0.4 | **64.00** | **0.00** |
| | **st. dev.** | 0.0 | 0.0 | 0.0 | | | 0.0 | 0.2 | 0.1 | | |
| | **cv** | - | - | - | | | | 21.7 | 21.7 | | |
| | **95% CI** | 0.0 | 0.0 | 0.0 | | | 0.0 | 0.2 | 0.1 | | |
| **Percent Chironomidae** | **mean** | 15.2 | 3.2 | 9.2 | **61.39** | **<0.01** | 19.2 | 7.3 | 13 | **16.49** | **0.01** |
| | **st. dev.** | 2.4 | 1.2 | 1.8 | | | 3.8 | 3.4 | 4 | | |
| | **cv** | 15.6 | 37.7 | 26.6 | | | 19.7 | 45.7 | 33 | | |
| | **95% CI** | 2.7 | 1.4 | 2 | | | 4.3 | 3.8 | 4 | | |

[1] Variences not equal, ANOVA by Kruskall-Wallis one way ANOVA on ranks and multiple comparison by Kruskall-Wallis Z-test

**Marginally Significant** (0.05 < p < 0.10), difference generally not large enough for multiple comparisons to detect.

**Significant** (p <0.05)



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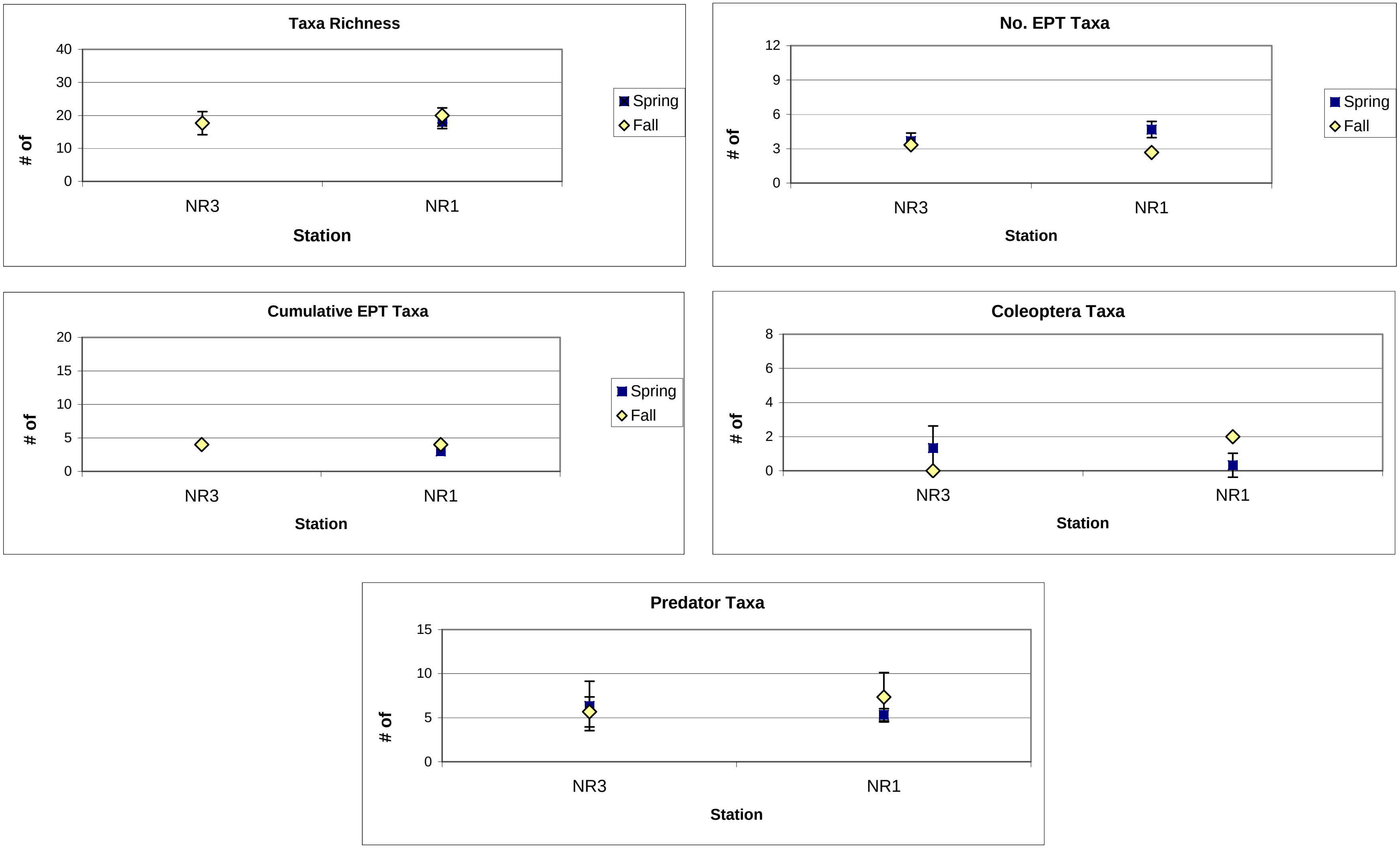



Figure 4. Averaged community richness metrics (± 95% CI) by season for each site.

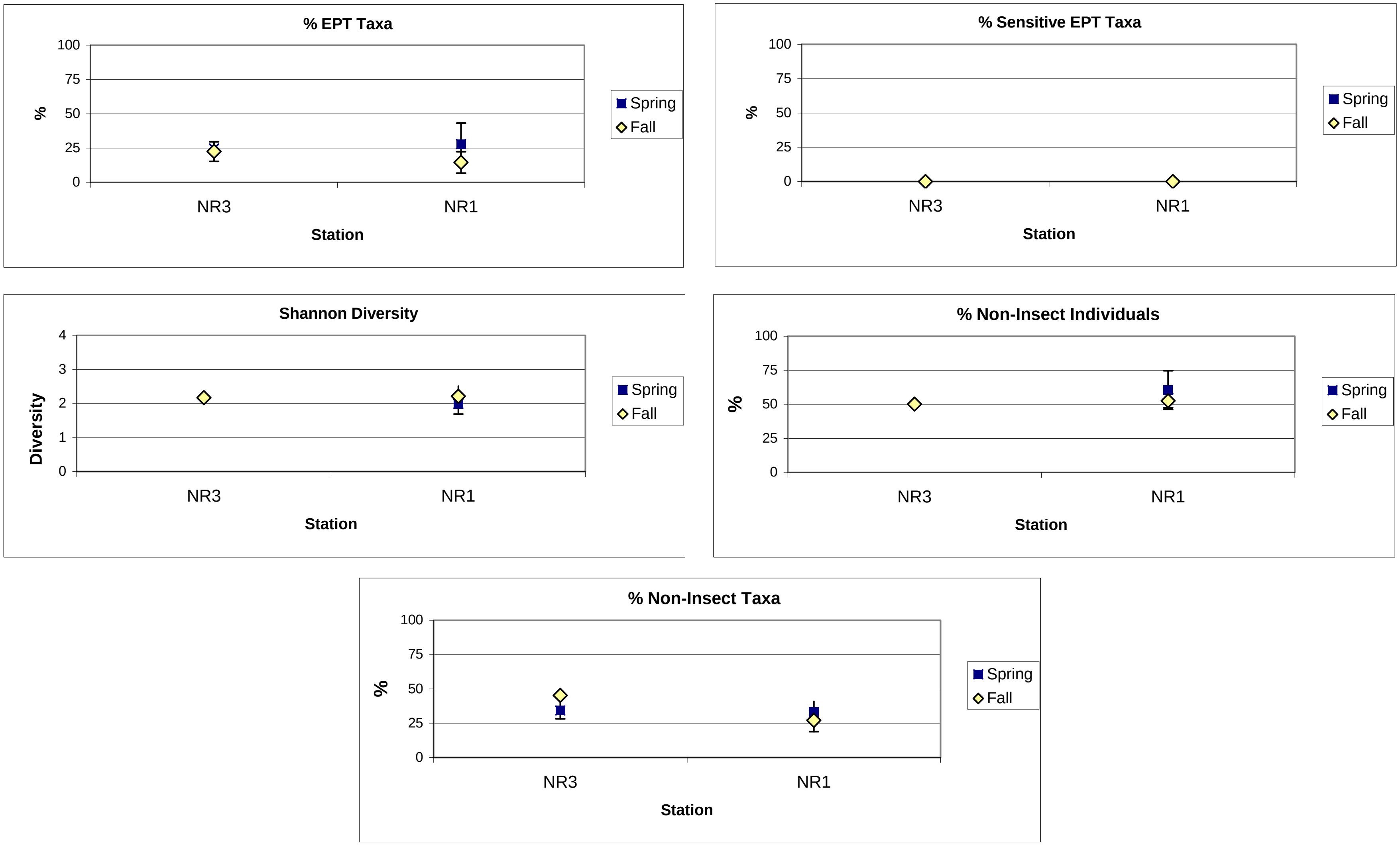



Figure 5. Averaged community composition metrics (± 95% CI) by season for each site.

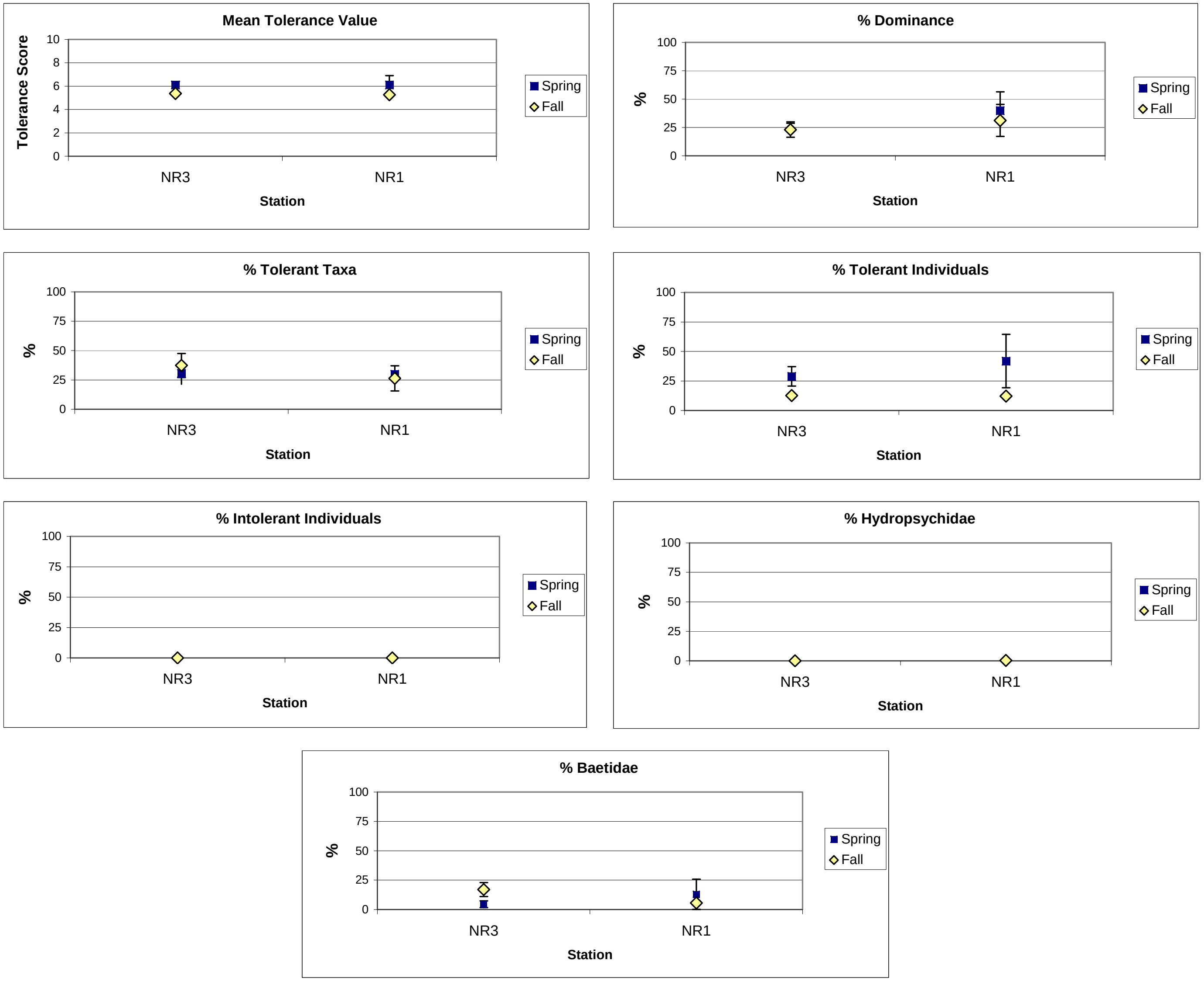



Figure 6. Averaged community tolerance metrics (± 95% CI) by season for each site.

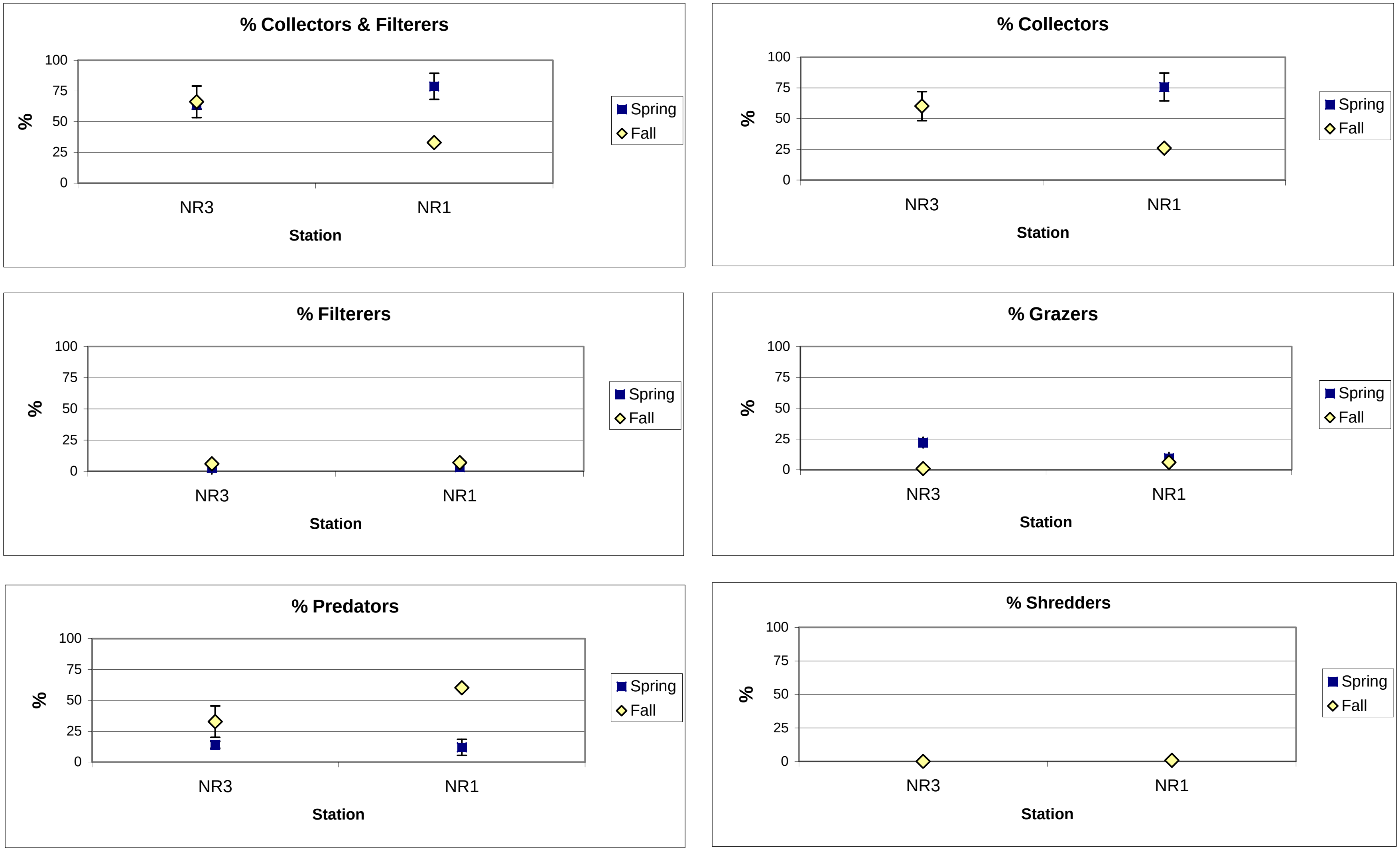
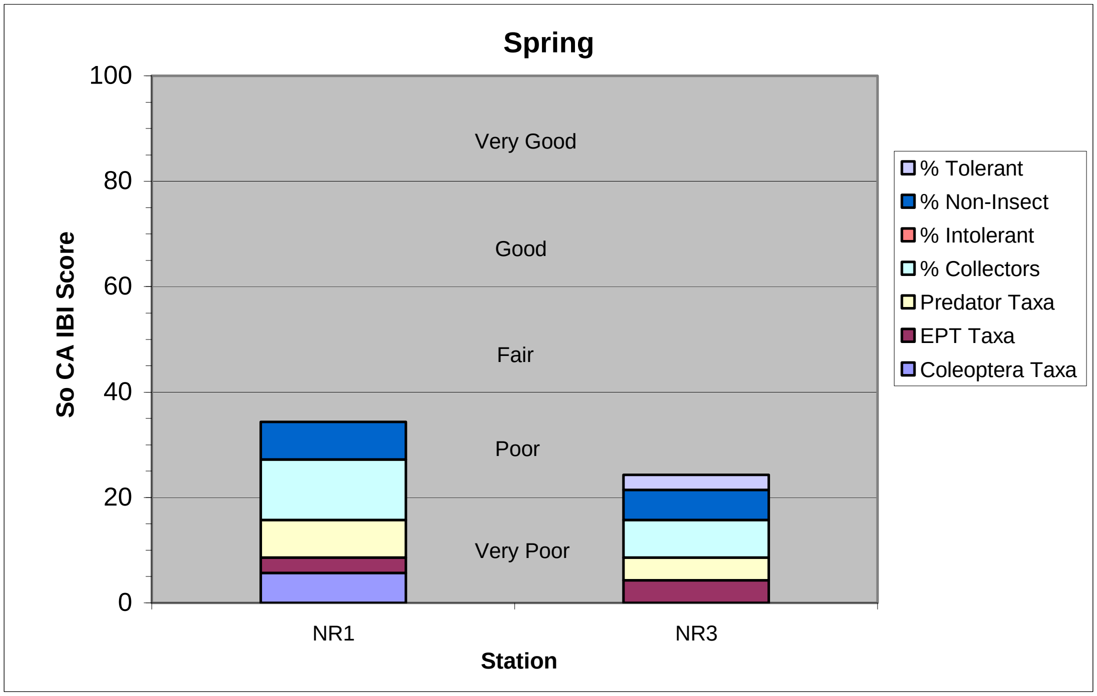



Figure 7. Averaged community feeding metrics (± 95% CI) by season for each site.

Table 8. Southern California IBI calculations for each of the Santa Clara River locations by season.

| Station / Metric | NR3 | | NR1 | |
|---|---|---|---|---|
| | **Spring** | **Fall** | **Spring** | **Fall** |
| **EPT Taxa** | 2 | 1 | 3 | 2 |
| **Predator Taxa** | 5 | 4 | 3 | 6 |
| **Coleoptera Taxa** | 4 | 0 | 0 | 5 |
| **% Non-Insect** | 5 | 3 | 4 | 6 |
| **% Intolerant Taxa** | 0 | 0 | 0 | 0 |
| **% Tolerant** | 0 | 0 | 2 | 3 |
| **% Collector Taxa** | 8 | 8 | 5 | 10 |
| **Total** | **24** | **16** | **17** | **32** |
| **Adjusted Score (1.43)** | **34** | **23** | **24** | **46** |
| **So. Cal. IBI Rating** | **Poor** | **Poor** | **Poor** | **Fair** |



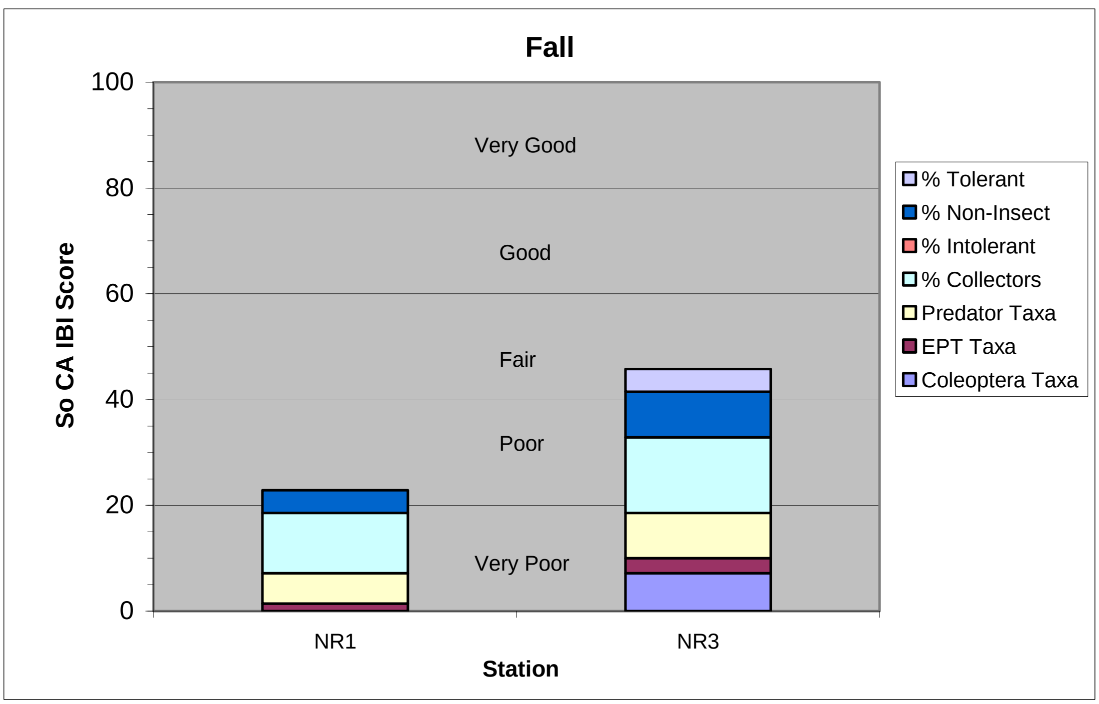




Figure 8. Southern California IBI Scores for sites that were sampled in the Santa Clara River.

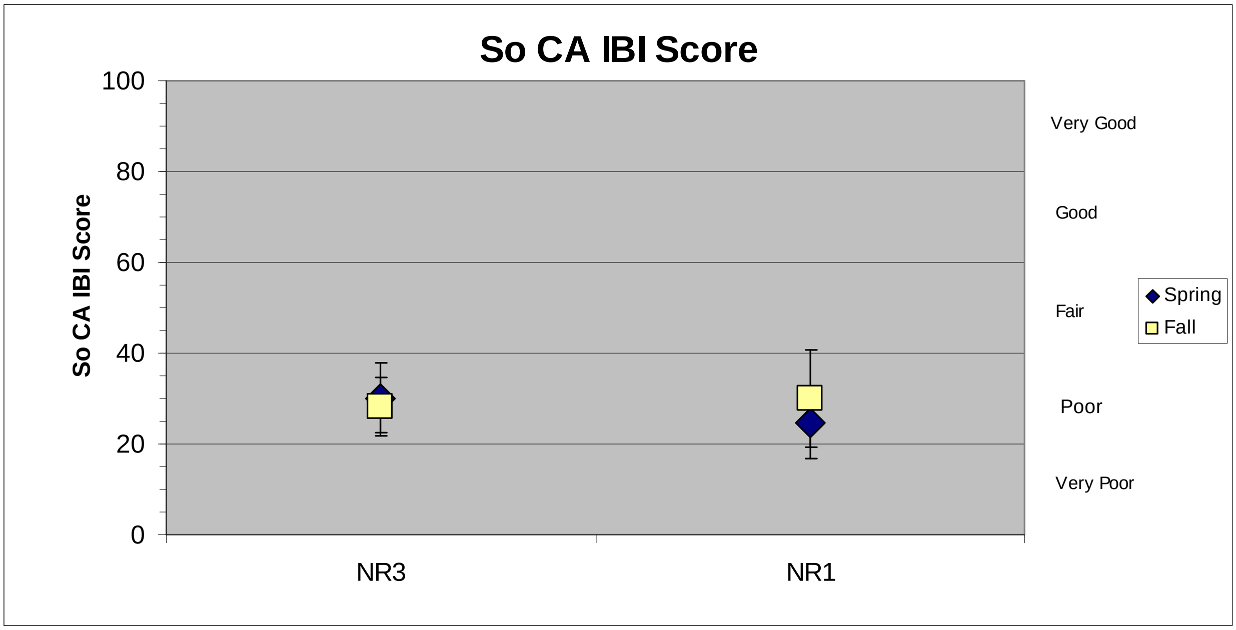



Figure 9. Average Southern California IBI Scores (± 95% CI) for sites that were sampled in the Santa Clara River from the spring of 2004 to the fall of 2007 (n = 4 for each site during each season).

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## APPENDIX A – BENTHIC MACROINVERTEBRATE DATA

Table 9a. Spring infauna abundances by station at each site in the Santa Clara River.

| Identified Taxa | Tol Val (TV) | Func Feed Grp | NR3 1 | NR3 2 | NR3 3 | NR1 1 | NR1 2 | NR1 3 |
|---|---|---|---|---|---|---|---|---|
| **Insecta Taxa** | | | | | | | | |
| **Ephemeroptera** | | | | | | | | |
| *Baetis sp* | 5 | cg | | 1 | 1 | 7 | | 4 |
| *Fallceon quilleri* | 4 | cg | 7 | 24 | 7 | 76 | 35 | 5 |
| *Tricorythodes sp* | 4 | cg | | | | 19 | 35 | 10 |
| **Odonata** | | | | | | | | |
| *Anisoptera* | | | 1 | | | | | |
| *Coenagrionidae* | 9 | p | | | 1 | | | 2 |
| *Libellulidae* | 9 | p | | | 1 | | | |
| *Zoniagrion exclamationis* | 9 | p | | | 2 | | 4 | |
| **Trichoptera** | | | | | | | | |
| *Hydroptila sp* | 6 | sc | 38 | 41 | 38 | 36 | 8 | 22 |
| *Hydroptilidae* | 4 | sc | 28 | 21 | 3 | 2 | 4 | 10 |
| **Coleoptera** | | | | | | | | |
| *Helochares sp* | 5 | p | 1 | | | 1 | | |
| *Heteroceridae* | | | | | 1 | | | |
| *Peltodytes sp* | 5 | mh | 1 | | | | | |
| *Tropisternus sp* | 5 | p | | | 1 | | | |
| **Diptera** | | | | | | | | |
| *Bezzia/Palpomyia sp* | 6 | p | 1 | | | 1 | | 5 |
| *Caloparyphus sp* | 7 | cg | | | | 4 | 6 | 1 |
| *Caloparyphus/Euparyphus sp* | 8 | cg | | 3 | 4 | 4 | 1 | 13 |
| *Chironomidae* | 6 | cg | 54 | 47 | 28 | 15 | 7 | 9 |
| *Culicoides sp* | 8 | cg | 1 | | | 3 | | |
| *Ephydridae* | 6 | | | | 1 | | | |
| *Euparyphus sp* | 8 | cg | 2 | | | 1 | | 1 |
| *Hemerodromia sp* | 6 | p | 21 | 14 | 3 | 1 | 1 | 1 |
| *Pericoma/Telmatoscopus sp* | 4 | cg | | 3 | | | | |
| *Simulium sp* | 6 | cf | 6 | 21 | 1 | 8 | 6 | 16 |
| **Non-Insecta Taxa** | | | | | | | | |
| **Nematoda** | 5 | p | 14 | 27 | 9 | 4 | 1 | 1 |
| **Oligochaeta** | 5 | cg | 32 | 67 | 33 | 42 | 32 | 43 |
| **Ostracoda** | 8 | cg | 83 | 67 | 51 | 52 | 159 | 148 |
| **Turbellaria** | 4 | p | 9 | 4 | 4 | 53 | 13 | 23 |
| **Basommatophora** | | | | | | | | |
| *Physa sp* | 8 | sc | | 1 | 11 | 2 | 2 | 5 |
| **Trombidformes** | | | | | | | | |
| *Atractides sp* | 8 | p | | | 1 | | | |
| *Sperchon sp* | 8 | p | 3 | 2 | 1 | | 3 | 2 |
| **TOTAL** | | | **302** | **343** | **202** | **331** | **317** | **321** |

Table 9b. Fall infauna abundances by station at each site in the Santa Clara River.

| Identified Taxa | Tol Val (TV) | Func Feed Grp | NR3 | | | NR1 | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 1 | 2 | 3 |
| **Insecta Taxa** | | | | | | | | |
| **Ephemeroptera** | | | | | | | | |
| *Baetis sp* | 5 | cg | 5 | 5 | 4 | | | 1 |
| *Fallceon quilleri* | 4 | cg | 33 | 63 | 42 | 5 | 23 | 21 |
| *Tricorythodes sp* | 4 | cg | 13 | 20 | 16 | 13 | 36 | 31 |
| **Odonata** | | | | | | | | |
| *Argia sp* | 7 | p | | | 1 | 16 | 17 | 19 |
| *Brechmorhoga mendax* | 9 | p | | | | | 2 | |
| *Coenagrionidae* | 9 | p | 3 | 2 | 1 | | 15 | 12 |
| *Hetaerina americana* | 6 | p | 2 | | | | | |
| *Hetaerina sp* | 5 | p | | | | 25 | 21 | 12 |
| *Libellula sp* | 9 | p | | | | | 1 | |
| *Libellulidae* | 9 | p | | | | | 1 | |
| *Zoniagrion exclamationis* | 9 | p | | | | | 4 | |
| **Trichoptera** | | | | | | | | |
| *Hydropsyche sp* | 4 | cf | | | | 2 | | |
| *Hydroptilidae* | 4 | sc | | | 2 | | | |
| **Coleoptera** | | | | | | | | |
| *Chrysomelidae* | 5 | sh | | | | 2 | 2 | 3 |
| *Optioservus sp* | 4 | sc | | | | 2 | | |
| *Postelichus sp* | 5 | | | | | | 2 | 1 |
| **Diptera** | | | | | | | | |
| *Bezzia/Palpomyia sp* | 6 | p | | | | | | 1 |
| *Caloparyphus/Euparyphus sp* | 8 | cg | | 1 | | 1 | 1 | 1 |
| *Ceratopogon sp* | 6 | p | | | | | 1 | |
| *Ceratopogonidae* | 6 | p | 1 | | | | | |
| *Chironomidae* | 6 | cg | 70 | 55 | 48 | 32 | 22 | 12 |
| *Culicoides sp* | 8 | cg | 1 | | | | | |
| *Ephydridae* | 6 | | | 2 | 2 | | 1 | |
| *Hemerodromia sp* | 6 | p | 2 | | 2 | 1 | | 2 |
| *Nemotelus sp* | 8 | cg | | 1 | | | | |
| *Pericoma/Telmatoscopus sp* | 4 | cg | | | | | 1 | 1 |
| *Psychodidae* | 10 | cg | | | | | | 1 |
| *Simulium sp* | 6 | cf | 16 | 7 | 30 | 32 | 9 | 19 |
| **Lepidoptera** | | | | | | | | |
| *Petrophila sp* | 5 | sc | | | | 1 | | |
| **Non-Insecta Taxa** | | | | | | | | |
| **Copepoda** | 8 | cg | 1 | 2 | 4 | | | |
| **Nematoda** | 5 | p | 90 | 51 | 56 | | 72 | 73 |
| **Oligochaeta** | 5 | cg | 5 | 28 | 47 | 1 | 7 | 5 |
| **Ostracoda** | 8 | cg | 16 | 24 | 35 | 15 | 3 | 1 |
| **Turbellaria** | 4 | p | 30 | 31 | 8 | 137 | 46 | 61 |
| **Acariformes** | | | | | | | | |
| *Hydrozetidae* | | | 1 | | 1 | 1 | | |
| **Basommatophora** | | | | | | | | |
| *Physa sp* | 8 | sc | 4 | 2 | 1 | 13 | 15 | 23 |
| **Diplostraca** | | | | | | | | |
| *Cladocera* | 8 | cf | | 1 | | | | |
| **Trombidformes** | | | | | | | | |
| *Sperchon sp* | 8 | p | 7 | 5 | 2 | | | |
| *Tyrrellia sp* | 5 | p | | | | 1 | | |
| **TOTAL** | | | **300** | **300** | **302** | **300** | **302** | **300** |



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## APPENDIX B – RE-COMPUTED SOUTHERN CALIFORNIA IBI SCORES

Table 10. Comparison of original and re-computed Southern California IBI scores and their ranks for BMI data collected from 2004 to 2006. 2007 scores are also included.

| Station | Year | Season | Old IBI Score | Old Rank | New IBI Score | New Rank |
|---|---|---|---|---|---|---|
| NR1 | 2004 | Spring | 35.75 | Poor | 17.16 | Very Poor |
| NR3 | 2004 | Spring | 32.89 | Poor | 21.45 | Poor |
| NR1 | 2004 | Fall | 30.03 | Poor | 24.31 | Poor |
| NR3 | 2004 | Fall | 37.18 | Poor | 31.46 | Poor |
| NR1 | 2005 | Spring | 34.32 | Poor | 35.75 | Poor |
| NR3 | 2005 | Spring | 30.03 | Poor | 25.74 | Poor |
| NR1 | 2005 | Fall | 41.47 | Fair | 28.6 | Poor |
| NR3 | 2005 | Fall | 30.03 | Poor | 22.88 | Poor |
| NR1 | 2006 | Spring | 22.88 | Poor | 21.45 | Poor |
| NR3 | 2006 | Spring | 27.17 | Poor | 38.61 | Poor |
| NR1 | 2006 | Fall | 41.47 | Fair | 21.45 | Poor |
| NR3 | 2006 | Fall | 38.61 | Poor | 35.75 | Poor |
| NR1 | 2007 | Spring | - | - | 24.31 | Poor |
| NR3 | 2007 | Spring | - | - | 34.3 | Poor |
| NR1 | 2007 | Fall | - | - | 46 | Fair |
| NR3 | 2007 | Fall | - | - | 23 | Poor |


Figure 10. Original (old) vs. new IBI (recomputed) IBI scores for Santa Clara River sites from 2004 to 2007.