Draft Report
February 2004

Characterization of Benthic Communities and Physical Habitat in Agricultural Streams in California's San Joaquin Valley in 2003

Lenwood W. Hall, Jr.
and
William D. Killen

University of Maryland
Agricultural Experiment Station
Wye Research and Education Center
P.O. Box 169
Queenstown, Maryland 21658

ABSTRACT

The primary goal of this study was to characterize physical habitat and benthic communities (macroinvertebrates) in three representative agricultural streams in California's San Joaquin Valley in 2003. These streams have been listed as impaired water bodies (303 (d) list) by the State of California due to the presence of organophosphate insecticides (OP) chlorpyrifos and diazinon. A secondary goal of this study was to compare the presence of OP-sensitive benthic species in these streams with available OP toxicity and exposure data to determine if these benthic species are present. Habitat requirements and to a lesser degree sampling gear limitations were considered in this comparison.

Based on 10 instream and riparian physical habitat metrics, total physical habitat scores in Del Puerto Creek ranged from 75 to 128 (maximum possible total score is 200). Most habitat metrics were highly variable among Del Puerto Creek sites. There appears to be no spatial trends in habitat metrics in Del Puerto Creek. Orestimba Creek physical habitat scores ranged from 80 to 124. The lowest habitat score was reported at one of the most upstream sites. In Orestimba Creek there was a significant spatial trend for bend/riffle frequency, i.e. decreasing values moving downstream. Salt Slough physical habitat scores ranged form 23 to 106. The habitat at the upstream site was extremely poor. Salt Slough appears to have the strongest gradient of physical habitat metrics as channel alteration and riparian buffer declined significantly from downstream to upstream.

Abundance measures of macroinvertebrates were similar among the three streams considering that 10 sites were sampled in Orestimba Creek while five sites were sampled

in both Del Puerto Creek and Salt Slough. The most dominant taxa in both Del Puerto Creek and Orestimba Creek were chironomids and oligochaetes. Chironomids can be either sensitive or tolerant to environmental stressors depending on the species while oligochaetes are generally found in stressful environments. The most dominant taxa found in Salt Slough was the amphipod species, *Corophium spinicorne*, which comprised 37% of the taxa collected. Amphipods are generally considered sensitive to OP insecticides as well as other stressors. The gastropod, *Physa sp.,* was the second most dominant species collected in Salt Slough. Gastropods are generally considered to be fairly tolerant of pollutant stress. Taxa richness was generally greater at upstreams sites in both Del Puerto Creek and Orestimba Creek; there appears to be no spatial trend in species richness in Salt Slough.

Riparian buffer and embeddedness were the most important physical habitat metrics influencing the various benthic metrics for these three streams. For the non-traditional habitat metrics, depth and canopy have the highest number of significant relationships with the various benthic metrics.

A qualitative comparison of OP-sensitives species in the three agricultural streams based on single species toxicity data was limited due to the lack of data. Species most sensitive to chlorpyrifos (*Chironomus sp.* and *Gammarus sp.*) were found in all three streams. However, *Chironomus sp.* were much less abundant in Del Puerto Creek while *Gammarus sp.* were much more abundant in Salt Slough. Species most sensitive to diazinon were the amphipod *Hyalella sp.* and the mayfly *Baetis sp. Hyalella* was more abundant in both Orestimba Creeka and Salt Slough than Del Puerto Creek. *Baetis sp.* was collected at the most upstream sites in both Del Puerto Creek and Orestimba Creek.

The presence of 81 taxa in Del Puerto Creek, 102 taxa in Orestimba Creek and 65 taxa in Salt Slough implies that the benthic communities in these streams are fairly diverse, considering their ephemeral environments, but without a clear definition of benthic community expectations it is unknown if these water bodies are actually impaired. Potential reference sites should be identified in agricultural streams in California's Central Valley in order to identify the range of benthic community taxa expected in non or minimally stressed environments. Extensive spatial and temporal assessments of benthic communities in concert with physical habitat assessments will be needed to accomplish this task.

ACKNOWLEDGEMENTS

We would like to thank Makhteshim Agan and the University of Maryland for supporting this study. Mr. Ron Anderson is acknowledged for assisting with the field work. Dr. Elgin Perry is acknowledged for conducting the statistical analysis. Jim Harrington and Angie Louis Montalvo of California Department of Fish and Game are acknowledged for directing the identification of benthic species. We would like to acknowledge the following individuals at Del Puerto Creek for allowing us to access their property: Mrs. Evelyn Vargas, Mrs. Carol Nunes, Mr. Jim Garner and Mr. Reese Cowdon. We would also like to thank the following landowners for allowing access to their property near Orestimba Creek: Mr. Glen Crow, Mr. Noman Crow, Mr. Marvin Kaminska, Mr. Anthony George, and Mr. Clyde Peters. At Salt Slough, we would like to acknowledge Mr. Chris Schoneman of the U.S. Fish and Wildlife Service for allowing us to access the stream via the San Luis National Wildlife Refuge.

TABLE OF CONTENTS

Appendices

Appendix A - California bioassessment worksheet including specific descriptions of the various physical habitat metrics.

Appendix B - Number of lowest identified taxa by transect and combined transects including tolerance values (TV) and feeding guilds (FFG) for Del Puerto Creek sites. Tolerance values for taxa range from 1 to 10 with 10 the most tolerant value. Feeding guilds are defined as follows: c=collector; f=filterer; g=gracer; p=producer and s=shredder.

Appendix C - Number of lowest identified taxa by transect and combined transects including tolerance values (TV) and feeding guilds (FFG) for Orestimba Creek sites. Tolerance values for taxa range from 1 to 10 with 10 the most tolerant value. Feeding guilds are defined as follows: c=collector; f=filterer; g=grazer; p=producer and s=shredder.

Appendix D - Number of lowest identified taxa by transect and combined transects including tolerance values (TV) and feeding guilds (FFG) for Salt Slough sites. Tolerance values for taxa range from 1 to 10 with 10 the most tolerant value. Feeding guilds are defined as follows: c=collector; f=filterer; g=grazer; p=producer and s=shredder.

INTRODUCTION

Due to abundant water and long growing seasons, California's San Joaquin Valley is one of the most productive agricultural areas in the United States (Dubrovsky et al., 1998). Intense agricultural development in the San Joaquin Valley has modified many of the natural lotic systems in this area (May and Brown, 2000). The changing landscape coupled with various other anthropogenic factors has created stressful conditions for resident aquatic biological communities. The following factors may have contributed to the decline of aquatic resources in California's Central Valley: water diversion, changes in basin hydrology, loss of habitat, introduction of exotic species and contaminants (e.g., organophosphate insecticides) (Foe, 1995). Activities such as diking, dredging, filling of wetlands and significant diversion of freshwater flows for irrigated agriculture and urban use have also altered fish habitat and resulted in adverse impacts on fish populations (Moyle et al, 1992).

In recent years, assessments of benthic invertebrate assemblages and physical habitat (bioassessments) have been initiated in wadeable streams in California's Central Valley (Hall and Killen, 2001; Hall and Killen, 2002; Hall and Killen, 2003; Brown and May, 2000; Jim Harrington, personal communication). These efforts are valuable for determining the status of aquatic biological communities across large spatial scales and landuse types (agricultural and urban). Information on the status of resident biological communities is particularly useful for determining impaired water bodies, developing Total Maximum Daily Loads (TMDLs), and measuring success of voluntary or regulatory actions. Bioassessments serve monitoring needs through three primary functions: (1) screening or initial assessment of conditions; (2) characterization of impairment and diagnosis; and (3) trend monitoring to evaluate improvements from mitigation practices or further degradation.

The primary goal of this study was to characterize physical habitat and benthic communities in three representative agricultural streams in California's San Joaquin Valley in 2003. All of these streams have been listed as impaired water bodies (303 d list) due to the presence of OP insecticides diazinon and chlorpyrifos (www.swrcb.ca.gov). The benthic community data was interpreted in the context of recent ecological risk assessments for the OP insecticides chlorpyrifos and diazinon which have identified OP-sensitive benthic species.

METHODS

Site Selection

The three second to fourth order wadeable streams sampled during this study were Del Puerto Creek (Figures 1 and 2), Orestimba Creek (Figures 1 and 3) and Salt Slough (Figures 1 and 4). The sites sampled covered approximately 8, 12 and 14 miles in Del Puerto Creek, Orestimba Creek and Salt Slough, respectively. The predominate land use type in all of these water bodies is agriculture. The upstream sites in Del Puerto Creek (DLP5) and Orestimba Creek (ORE10) were above agricultural activity but all the other sites were in areas dominated by agriculture. Downstream Salt Slough sites SSL1, SSL2 and SSL3 were located within the San Luis Wildlife Refuge and the Los Banos State Wildlife area; upstream sites SSL4 and SSL5 were in agricultural areas.

Five sample sites in both Del Puerto Creek and Salt Slough and ten sites in Orestimba Creek were selected for sampling using a stratified random design with approximate equal spacing among sample sites (Table 1; Figures 2-4). The Del Puerto Creek and Salt Slough sites were previously sampled in similar bioassessment studies in the late spring/early summer of 2001 (Hall and Killen, 2002) and 2002 (Hall and Killen, 2003). The ten sites in Orestimba Creek were also previously sampled in similar bioassessment studies conducted in the late spring/early summer of 2000 (Hall and Killen, 2001), 2001 (Hall and Killen, 2002) and 2002 (Hall and Killen, 2003). Initial site visits were conducted for all streams in April of 2003. Exact sample stations were determined in each stream and landowner contacts were made to access the sample sites for the late spring/early summer sampling.

Physical Habitat Assessments

Physical habitat was evaluated at each site concurrently with benthic collections and water quality evaluations. The physical habitat evaluation methods followed protocols described in Harrington and Born (2000). The physical habitat metrics used for this study are based on nationally standardized protocols described in Barbour et al. (1999). A total of 10 continuous metrics scored on a 0-20 scale were evaluated (Appendix A). Other non-continuous metrics including percent canopy, % gradient, and substrate composition that were also measured are described in Appendix A.

Benthic Macroinvertebrate Sampling

Benthic macroinvertebrates were collected in the late spring of 2003 from three replicate samples at sample sites in the three streams. The sample site selections and sampling procedures were conducted in accordance with methods described in Harrington and Born (2000). Sampling reaches were approximately equally spaced along the stream starting at the confluence. Within each of these sample reaches, a riffle was located (if possible) for the collection of benthic macroinvertebrates. A tape measure was placed along the riffle and potential sampling transects were located at each meter interval of the tape. Using a random numbers table, three transects were randomly selected for sampling from among those available within the riffle. Benthic samples were taken using a standard D-net with 0.5 mm mesh starting with the most downstream portion of the riffle. A 1x2 foot section of the riffle immediately upstream of the net was disturbed to a depth of 4-6 inches to dislodge and collect the benthic macroinvertebrates. Large rocks and woody debris were scrubbed and leaves were examined to dislodge organisms clinging to these substrates. Within each of the randomly chosen transects, three replicate samples were collected to reflect the structure and complexity of the habitat within the transect. If habitat complexity was lacking, samples were taken near the side margins and thalweg of the transect and the procedures described above were followed. All samples were preserved with 95% ethanol.

Due to the physical nature of these agricultural streams, it was often difficult to locate a substantial number of riffles to sample. In various cases, there was only a single section of riffle available within a selected reach to sample and in some instances there were no riffles present. In cases where riffles were lacking, alternative sampling methods for non-riffle areas were used as outlined in Harrington and Born (2000). This involved sampling the best available 1x2 foot sections of habitat throughout the reach using the same procedures described above. Nine 1x2 foot sections were randomly selected for sampling. Groups of three 1x2 foot sections were composited for each replicate for a total of three replicates per site.

Taxonomy of Benthic Macroinvertebrates

The goal of this study was to identify all benthic samples to the species level if possible. Species level identifications will be particularly useful if and when Indices of Biotic Integrity (IBIs) are developed for wadeable streams in California's Central Valley. For taxa such as oligochaetes and chironomids, family and genus level, respectively, were often the lowest level of identification possible.

The benthic macroinvertebrate subsampling (resulting in a maximum of 300 individuals) and identifications were supervised by Angie Montalvo of California's Department of Fish and Game (CDFG) in Rancho Cordova, California. The benthic macroinvertebrate samples were subsampled and sorted by personnel at the CDFG

Laboratory located at Chico State University campus. Level 3 identifications (species level identifications) followed protocols outlined in Harrington and Born (2000). Mr. Dan Pickard of CDFG conducted the taxonomic identifications. Slide preparations and mounting for species such as midges and oligochaetes followed protocols from the United States Geological Survey National Quality Control laboratory described in Moulton et al. 2000.

Water Quality Measurements

The following water quality parameters were measured at each stream site using procedures described in Kazyak (1997): temperature, pH, salinity, specific conductivity, dissolved oxygen, and turbidity.

Statistical Analysis

Principal components analysis (PCA) was used to determine the relationship among the various physical habitat and benthic metrics to identify groups of metrics that covary. Spatial trends (upstream to downstream) of both physical habitat and benthic metrics within each stream were examined using Spearmans Rank Correlation Coefficients and significance levels. The relationship among physical habitat and benthic metrics was also determined by using Spearmans Rank Correlation Analysis. The Wilcoxon Rank-Sum Test and Kruskal-Wallis test were used to compare habitat and benthic metrics among the three streams. The Wilcoxon signed rank test and the Friedman test were used to compare among years within a stream.

RESULTS

Physical Habitat

Del Puerto Creek

The total physical habitat scores in Del Puerto Creek ranged from 75 to 128 for the ten metrics that were scored on a 0 to 20 scale (Table 2). Most of the metrics were highly variable across the five stations within Del Puerto Creek indicating diverse physical habitat conditions in this waterbody. For example, embeddedness ranged from 6 to 13, channel flow status ranged from 6 to 16, and frequency of bend/riffles ranged from 6 to 15. The site with the lowest total physical habitat score (DLP4) had particularly low scores for channel flow status, channel alteration, and frequency of bends/riffles. In contrast, the site with the highest physical habitat score (DLP1) had higher scores for all of these metrics.

Other descriptive physical habitat metrics that were not scored on a 0-20 scale are presented in Table 3. These metrics are not scored on a 0-20 scale because some are bimodal (too much or too little canopy can be advantageous) and others are just descriptive. Mean flow by site ranged from 0.22 m/s upstream to 0.64 m/s downstream. The mean value across all five sites was 0.43 m/s. The percent canopy for the five Del Puerto Creek sites ranged from 0% at DLP4 and DLP5 to 77% at downstream site DLP1. Gradient was consistent at all sties (1%). The percent fines for substrate percentages ranged from 20% DLP5 (upstream site) to 50% at DLP3.

Orestimba Creek

Orestimba Creek total physical habitat scores for the 10 metrics that were scored on a 0 to 20 scale ranged from 80 to 124 (Table 2). The lowest total habitat score (80) was reported for upstream site ORE9 (Figure 3). This site had particularly low scores for embeddedness, velocity/depth/diversity, and various riparian zone metrics. The highest total habitat score (124) was reported at ORE7. The following metrics were reasonably high at this site: sediment deposition, channel flow status and channel alteration. Other descriptive habitat metrics for the 10 Orestimba Creek sties in Table 3 showed that mean site flow ranged from 0.09 to 0.65 m/s (mean stream value of 0.35 m/s), % canopy ranged from 0 to 93%, % gradient was consistently 1%, and % fines ranged from 20% to 95%.

Salt Slough

The total physical habitat scores in Salt Slough ranged from 23 to 106 for the 10 metrics that were scored on a 0 to 20 scale (Table 2). The lowest total physical habitat score (23) was reported at the most upstream site (SSL5). This site had particularly low scores for embeddedness, velocity/depth/diversity, sediment deposition, channel alteration, frequency of bends/riffles, bank stability, vegetative protection, and riparian vegetation. The highest total physical habitat score (106) was reported at the downstream site (SSL2). Channel flow status, and channel alteration were optimal (a high rating) at this site. The embeddedness metric, which is a rough measure of sediment loading, was particularly low at all sites in this stream when compared with either Del Puerto Creek or Orestimba Creek.

Other descriptive physical habitat metrics for the five Salt Slough sites in Table 3 showed that mean site flow ranged from 0 to 0.34 m/s (mean stream value was 0.21 m/s), 0% canopy at all sties, % gradient was consistently 1% and % fines were 100% at all sites. The low flow conditions, lack of canopy, and dominance of substrate by % fines clearly shows different physical features for this stream when compared with either Del Puerto Creek or Orestimba Creek.

Summary Statistical Analysis for All Creeks

Principal Components Analysis (PCA) was used to determine the relationship among habitat metrics and identify metrics that covary (i.e., increase or decrease together). The 10 habitat metrics that were scored on a 0 to 20 scale had two eigenvalues that were greater than 1 (Table 4). The significance of this finding is that 10 habitat metrics contain two important factors which explained 71% of the variance in the data set. The metrics important to each factor are presented in Table 5. Bend/riffle frequency, sediment deposition, and velocity/depth/diversity were heavily loaded on the first factor. All of these metrics are related to water movement processes. Metric loading on factor two included: riparian buffer, bank vegetations, and channel alteration. Riparian buffer and bank vegetation are related as both are riparian metrics. Factor three only had loading for channel flow.

Correlations among raw physical habitat metrics grouped by factors identified by PCA showed correlations are high among the three metrics supporting factor 1 (Table 6). In factor 2, correlations among the three significant metrics genrally occurred with the exception of channel alteration and bend/riffle frequency. Significant loading for factor three only occurred for channel flow. Channel flow was the only habitat metric that had a relatively low correlation (0.25) with total habitat score.

The correlation matrix in Table 7 showed significant correlations among stream characteristics that were not scored on a 0 to 20 scale (i.e., width, depth) and some metrics that were scored on a 0 to 20 scale. The largest number of significant correlations occurred for the stream depth metric. Depth was negatively correlated with bank stability, bend/riffle frequency, sediment deposition, velocity/depth/diversity, embeddedness and total score. Stream width was negatively correlated with bend/riffle frequency, epifaunal substrate, and sediment deposition. Stream width was positively correlated with riparian buffer. Velocity was positively correlated with bend/riffle frequency, sediment deposition, velocity/depth/diversity, embeddedness and total score. Canopy was significantly correlated with embeddedness.

The Spearman rank test for trends was conducted for each physical habitat metric in each stream to examine trends that might be associated with changing morphology of the stream between upstream and downstream (Table 8). Salt Slough appears to have the strongest gradient from upstream to downstream in physical habitat metrics. Channel alteration and riparian buffer showed a significant negative correlation with site indicating a decrease in values moving upstream. Although only two individual metrics have significant trends in Salt Slough, the lack of significance for other metrics may be due to small sample size. In Orestimba Creek, there was a significant spatial trend for bend/riffle frequency, i.e. a decrease in value moving downstream. There appears to be no significant spatial trends in habitat metrics in Del Puerto Creek.

Approximately half of the mean habitat metrics were greater in Del Puerto Creek when compared with the other two agricultural streams (Table 9). Significant differences were reported for five metrics among the three streams. Pairwise regression showed that velocity/depth/diversity was significantly greater in Del Puerto Creek when compared with Salt Slough. Epifaunal substrate was significantly higher in Del Puerto Creek when compared to Orestimba Creek or Salt Slough and this metric was also greater in

Orestimba Creek when compared to Salt Slough. Pairwise regression also showed that bend/riffle frequency was greater in both Del Puerto Creek and Orestimba Creek when compared to Salt Slough. Sediment deposition and embeddedness were also greater in both Del Puerto Creek and Orestimba Creek when compared to Salt Slough. The total physical habitat score in Orestimba Creek was significantly higher than Salt Slough.

Benthic Macroinvertebrates

Del Puerto Creek

Approximately 3,900 individual macroinvertebrates were picked and identified from 81 taxa collected from five Del Puerto Creek sites (Table 10; Appendix B). The four most abundant taxa - *Simulium sp., Nais communis/variabilis*, *Dicrotendipes sp*., and *Cricotopus sp*.- comprised over 58% of the total individuals collected (Table 10). Chironomids and oligochaetes were generally the most dominant taxa. Chironomids can be either sensitive or tolerant to environmental stressors depending on the species (Stribling et al., 1998) while oligochaetes are generally found in stressful environments (Harrington and Born, 2000). Pollution sensitive species such as Ephemeroptera (mayflies), Plecoptera (stoneflies) and Tricoptera (caddisflies), i.e. EPT taxa, were generally found in low numbers at most of the sites.

Total taxa richness ranged from 21 at upstream site (DLP4) to 46 at the most upstream site (DLP5) (Figure 5). The most upstream site (DLP5) was above the agricultural activity in this stream. Taxa richness was reasonably consistent among the three transects at each site but the number of individuals per site was more variable (Figure 6). The number of individuals collected at each site did not show a consistent pattern from upstream to downstream; although the greatest number of individuals were collected at the upstream site.

Most of the benthic metrics summarized in Table 11 were generally consistent among sites with only a few exceptions. EPT taxa and percent Baetidae (mayflies) were more dominant at the upstream site (DLP5). The mean % Chironomidae were higher at DLP4 when compared with the other sites. Percent collectors - a feeding guild typically dominant in a stressed environment (Harrington and Born, 2000) - were dominant at DLP4 and DLP5. Percent shredders (macrobenthos that shred coarse material) were only found at DLP1 (one specimen). Shredders are typically found in non-stressed environments (Harrington and Born, 2000).

<u>Orestimba Creek</u>

Approximately 7,700 individual macroinvertebrates were picked and identified from 106 taxa collected from 10 sites in Orestimba Creek (Table 12; Appendix C). The following taxa comprised over 50% of the total number of individuals collected: *Cricotpus sp.*, *Nais communis/variabilis*, *Cricotopus bicinctus* group, *Ophidonais serpentina*, and *Physa sp*. Chironomids and oligochaetes were the two most dominant taxa collected. As discussed above, chironomids can be either sensitive or tolerant depending on the species while oligochaetes are generally found in stressful environmnents. Pollution-sensitive species (EPT taxa) were generally collected in low numbers in this creek with the highest numbers collected at the upstream site (ORE10).

Total taxa richness ranged from 25 at ORE9 to 48 at the most upstream site ORE10 (Figure 7). Richness was fairly consistent among the transects at most of the sites. The number of individuals per transect at each site was somewhat variable for most of the sites (Figure 8). Benthic abundance was greater at the upstream site (ORE10).

Various benthic metrics for the Orestimba Creek sites summarized in Table 13 showed the following: (1) EPT taxa (taxa associated with non-stressed environments) were primarily found at ORE10; (2) % tolerant taxa were highly variable among sites; and (3) % chironomidae were higher at ORE7, ORE1 and ORE4. The % collectors (generally associated with stressed environments) were higher at ORE6 and ORE1. Shredders - taxa associated with non-stress environments - were not found at any of the sites.

Salt Slough

Approximately 3,700 individual macroinvertebrates were picked and identified from 65 taxa in five Salt Slough sites (Table 14, Appendix D). *Corophium spinicorne*, *Physa sp.*, *Chironomus sp.*, and *Ophidonais serpentina* comprised over 68% of the individuals collected. The most dominant species (C. *spinicorne*) is an amphipod. Amphipods are generally considered sensitive to OP insecticides (Giesy et al., 1999; Giddings et al., 2000) as well as other stressors (Harrington and Born, 2000). The second most dominant species (*Physa sp.*) is a gastropod – an assemblage of species generally considered to be fairly tolerant of pollutant stress (Harrington and Born, 2000). Chironomids - the third most taxa collected in this stream – can be either tolerant or sensitive to environmental degradation depending upon the species (Stribling et al., 1998). Oligochaetes - the fourth most dominant taxa collected in Salt Slough - are generally found in stressed environments.

Total taxa richness ranged from 36 at SSL3 (the mid-stream site) to 26 at SSL4 (Figure 9). Richness was variable by site among the transects. The number of individuals per transect at each site was also variable (Figure 10). Benthic abundance was higher at the downstream site (SSL1).

The % chironomidae and % collectors (generally associated with stressed environments) were higher at the upstream site (Table 15). Shredders (associated with non-stressed environments) were not found at any of the sites. The percent filterers (taxa associated with stressed environments) were higher at the three downstream sites (SSL1, SSL2 and SSL3).

Summary Statistical Analysis for All Creeks

PCA was used to determine the relationship among the benthic metrics and identify metrics that covary (Table 16). Five eigenvalues exceeded 1 indicating that there were five important factors in these data. EPT taxa, percent intolerant taxa, % Baetidae, sensitive EPT index, EPT index, taxonomic richness, and abundance were heavily loaded on factor 1 (Table 17). Factor 2 was composed of % filterers, % collectors, % dominant taxon, % Hydropsychidae, and Shannon Diversity. Percent scrapers, % tolerant taxa and % chironomidae were significant for Factor 3. Factor 4 was composed of % shredders and Trichoptera taxa. Percent predators were the only significant metric in Factor 5 (Table 17).

Spearmans Rank Correlation Analysis showed a significant ($p<0.05$) spatial trend for % collectors, % dominant taxa, and Shannon Diversity in Salt Slough (Table 18). Percent collectors and Shannon Diversity showed a significant increase from downstream to upstream; % dominant taxa showed a significant decrease from downstream to upstream. Percent filterers in Orestimba Creek showed a significant decrease from downstream to upstream (Table 18).

A comparison among benthic metrics in Del Puerto Creek, Orestimba Creek and Salt Slough in Table 19 showed the following: (1) % collectors were significantly higher in Orestimba Creek compared to Salt Slough; (2) % dominant taxa were higher in both Del Puerto Creek and Salt Slough compared to Orestimba Creek; and (3) Shannon Diversity index and taxonomic richness were higher in Orestimba Creek than in either Del Puerto Creek or Salt Slough.

Relationship of Physical Habitat and Benthos

Spearman's Rank Correlation Analysis showed that riparian buffer and embeddedness were the most important physical habitat metrics influencing the various benthic metrics (Table 20). Riparian buffer was positively correlated with EPT index, EPT taxa, % Hydropsychidae, and Trichoptera taxa. Embeddedness was negatively correlated with % dominant taxa and positively correlated with Shannon diversity and taxonomic richness. The total physical habitat score was not correlated with any of the benthic metrics.

The correlation matrix in Table 21 for habitat metrics not scored on a 0-20 scale shows that depth and canopy have the highest number of significant relationships with the various benthic metrics. Depth was negatively correlated with abundance, percent intolerant taxa and sensitive EPT Index. Canopy was negatively correlated with percent dominant taxon and positively correlated with Shannon Diversity. Width was positively correlated with % Hydropsychidae. Velocity was negatively correlated with % scrapers.

Water Quality

Del Puerto Creek

The only consistent water quality condition at all five sample sites in Del Puerto Creek was pH (Table 1). Parameters such as temperature (18.7 to 31.4 C), conductivity (564 to 1,336 umhos/L), dissolved oxygen (6.35 to 9.19 mg/L) and turbidity (1.53 to 3.3 NTU) were variable across the various study sites. Spatial patterns showed that dissolved oxygen and pH was higher at the two downstream sites (DLP1 and DLP2). Both turbidity and temperature were higher at one of the upstream sites (DLP4).

A comparison of water quality measurements in Table 22 for the five Del Puerto Creek sites sampled in 2001 (Hall and Killen, 2002), 2002 (Hall and Killen, 2003) and 2003 showed the following: (1) temperature was greater at DLP1, DLP2 and DLP4 in 2003; (2) conductivity was higher at the three downstream sites in 2003; (3) pH was fairly consistent at all sites among the three years; (4) dissolved oxygen was consistently lower at all five sites in 2001 and (5) turbidity showed no consistent spatial pattern between years except the upstream site had significantly lower turbidity for 2001 and 2002.

Orestimba Creek

The pH was fairly consistent among all 10 sites in Orestimba Creek in 2003 (Table 1). Temperature ranged from 18.7 to 28.5 C with the lowest value at the most downstream site. Conductivity ranged from 596 to 933 umhos/L. Dissolved oxygen varied from 5.78 mg/L at the one upstream site (ORE9) to 7.9 mg/L at downstream site ORE7. There were no dissolved oxygen values below 5.0 mg/L in Orestimba Creek - a concentration likely to be stressful to aquatic life (Lee and Jones-Lee, 2000). Turbidity was much lower at the upstream site (ORE10) when compared with the nine downstream sites. The lower turbidity at this upstream site likely occurs because there is no suspended sediment coming from eroded soil in irrigated agricultural fields (sites ORE 1-9).

A comparison of water quality data in Table 22 for the 10 Orestimba Creek sites sampled in 2000 (Hall and Killen, 2001), 2001 (Hall and Killen, 2002), 2002 (Hall and Killen, 2003) and 2003 showed the following: (1) temperature was lower at seven of the sites in 2002; (2) specific conductance was lower for half of the sites in 2001; (3) pH was fairly consistent among all sites for the four years; (4) dissolved oxygen was lower at most of the sites in 2001 except ORE1 and (5) turbidity was higher at nine of the ten sites in 2002.

Salt Slough

The following ranges of water quality conditions were reported in Salt Slough in 2003: temperature (22.6 to 28.6 C), conductivity (956 to 1957 umhos/L), pH (6.96 to 7.68), dissolved oxygen (4.06 to 5.44 mg/L), and turbidity (43.1 to 80.1 NTU) (Table 1). Temperature, conductivity, pH and dissolved oxygen were generally lower at the upstream site (SSL5).

A comparison of water quality data in Table 22 for the five Salt Slough sites sampled in 2001 (Hall and Killen, 2002), 2002 (Hall and Killen, 2003) and 2003 showed the following: (1) temperature was lower for four sites in 2002; (2) conductivity was higher at four sites in 2003; (3) pH was consistent among sites for all three years; (4) dissolved oxygen was lower at all sites in 2001 and (5) turbidity was lower at four sites in 2002.

DISCUSSION

Physical Habitat

Water augmentation, sediment loading and impaired physical habitat have been identified as the three major stressors to aquatic life in California streams (Jim Harrington, California Department of Fish and Game, personal communication). Altered physical habitat structure is also considered one of the major stressors of aquatic systems throughout the United States resulting in extinctions, local expirations and population reductions of aquatic fauna (Karr et al., 1986; Rankin, 1995). Identifying degraded physical habitat in streams is particularly critical for bioassessments as failure to do so can sometimes hinder investigations on the effects of toxic chemicals or other water quality related stressors. There is a small but still significant risk of reporting a water quality related impact when one does not exist (false positive) when habitat assessments are insufficient or absent (Rankin, 1995). Physical habitat evaluations are not intended to replace biological assessments but rather to add an additional line of evidence about the status of lotic systems when conducted in concert with biological assessments. Evaluation of physical habitat in agricultural streams in California's Central Valley is particularly important due to the intensive development and landscape modifications in these areas.

Due to the limited number of sites sampled in the three agricultural streams in the present study, an extensive discussion or comparison of these physical habitat data across large spatial scales is problematic. Based on our limited sampling during 2003, the total physical habitat score in Orestimba Creek was significantly higher than Salt Slough (Table 9). Various metrics such as epifaunal substrate, bend/riffle frequency, sediment deposition, and embeddedness were significantly higher in Orestimba Creek when compared with Salt Slough. Although the total habitat score in Del Puerto Creek was not significantly higher than Salt Slough the following metrics were significantly higher: velocity/depth/diversity, epifaunal substrate, bend/riffle frequency, sediment deposition, and embeddedness (Table 9).

An exact extensive historical comparison of total physical habitat scores (maximum of 200) for Del Puerto Creek (75 to 128), Orestimba Creek (80 to 124) and Salt Slough (23 to 106) is not possible because historical physical habitat data for California's Central Valley streams has not been summarized in a published format (Table 2). However, based on best professional judgement from other physical habitat assessments in the area, the range of physical habitat scores reported for the three streams in our study is generally considered low (Peter Ode, California Department of Fish and Game, personal communication).

Physical habitat scores for the 10 Orestimba Creek sites sampled in 2003 can be cautiously compared with same type of assessments conducted in 2000 (Hall and Killen, 2001), 2001 (Hall and Killen, 2002) and 2002 (Hall and Killen, 2003) with the caveat that these are only three temporally limited evaluations (Table 23). Total physical habitat scores across the four years were variable for all sites with somewhat less variability for sites ORE6, ORE8 and ORE10. The habitat metrics that showed the highest number of significant changes for year-to-year comparisons were depth and embeddedness (Table 24a). The high number of significant differences in depth for the various year-to-year comparisons suggests that aquatic habitat available to aquatic species was highly variable during the four-year period. Total physical habitat scores were: (1) higher in 2000 than in 2003; (2) higher in 2001 than 2002; and (3) higher in 2001 than 2003.

A comparison of physical habitat metrics in Table 23, Table 24b and Table 24c among the five Del Puerto Creek and Salt Slough sites sampled in 2001 (Hall and Killen, 2002), 2002 (Hall and Killen, 2003) and 2003 is possible with the caveat that these are only three temporally limited evaluations. The final habitat scores in Del Puerto Creek sites DLP2 and DLP4 were more consistent among years than the other three sites (Table 23). The only mean metrics to show significant differences among years were epifaunal substrate and depth (Table 24b). The mean total physical habitat scores were consistent among the three years (Table 24b).

A comparison of total physical habitat scores among the five Salt Slough sites in 2001, 2002, and 2003 shows higher variability at SSL1 when compared with the other sites (Table 23). There was a significant difference in total mean habitat scores among the three years ($p<0.05$) with a lower score reported in 2002 (Table 24c). Other mean habitat metrics that showed significant differences among the three years were embeddedness, channel flow, bend/riffle frequency, bank stability, depth and velocity (Table 24c).

Presence of OP-Sensitive Species

A secondary goal of this study was to compare the presence of benthic macroinvertebrates in all three agricultural streams with available organophosphate (OP) single-species toxicity data. The intent of this comparison is to determine if OP-sensitive benthic species are present in these streams. In order to conduct a valid comparison, the following issues must be addressed: (1) Are the OP-sensitive benthic species determined from single species toxicity tests expected to be found in these systems based on their habitat requirements? and (2) Are the sampling techniques used in our study (D-net sampling with 0.5 mm mesh) appropriate for collecting all OP-sensitive benthic species? Ranges of chlorpyrifos and diazinon concentrations presented in Table 25 have been reported during high use periods for the various streams (Poletika and Robb, 1998; Waterborne Environmental Inc., 2002). These exposure data are used in a comparative analysis with the OP toxicity data presented below.

Chlorpyrifos acute toxicity data were available for 13 different taxa collected in the three streams sampled during our study (Table 26). The most sensitive taxa to chlorpyrifos that could be affected at environmentally realistic concentrations in any stream (concentrations < 2,282 ng/L based on the highest concentration in any stream) were *Chironomus sp.* (LC50 = 70 ng/L), *Gammarus sp.* (LC50 = 110 ng/L), *Hyalella sp.,* (LC50 = 1,300 ng/L), *Tanypus sp.* (LC50 = 1,500 ng/L), *Paratanytarsus sp.* (LC50 < 1,600 ng/L), and *Dugesia tigrina* (LC50 = 2,000 – 4,300 ng/L). The species most sensitive to chlorpyrifos (*Chironomus sp.*) was found in all three streams but was clearly less abundant in Del Puerto Creek. *Gammarus sp.* are also predicted to be sensitive to chlorpyrifos based on single species toxicity tests and the effect concentrations are environmentally realistic. This amphipod was found in all three streams but was more abundant in Salt Slough.

The amphipod, *Hyalella sp.,* was collected in all three streams but was clearly less abundant in Del Puerto Creek. The chironomid, *Tanypus sp.*, was only colleted in low numbers in Salt Slough. The chironomid, *Paratanytarsus sp.*, was collected in all three streams but was clearly more dominant in Salt Slough. The flatworm, *Dugesia* *tigrina* was found at most sites in both Del Puerto and Orestimba Creeks but was not collected in Salt Slough.

Diazinon acute toxicity data were available for five different taxa collected in either Del Puerto Creek, Orestimba Creek, or Salt Slough (Table 27). The most sensitive taxa to diazinon that could be affected at environmentally realistic concentrations in any stream (concentrations < 29,371 ng/L based on the highest value in any stream) were: *Hyalella sp.* (LC50 = 22,000 ng/L) and *Baetis sp.* (LC50 = 24,000 ng/L). The amphipod, *Hyalella sp.,* was more abundant in both Orestimba Creek and Salt Slough than Del Puerto Creek (only 1 specimen collected). The mayfly *Baetis sp.* - a species potentially sensitive to maximum reported environmental concentrations of diazinon - was collected at the most upstream sites in both Del Puerto Creek and Orestimba Creek.

Historical Comparisons of Benthic Data

Historical comparisons of our data with other benthic data from these three streams were limited. In 1993, the U.S. Geological Survey collected benthic macroinvertebrates at one site in Orestimba Creek that was approximately half way between our stations ORE2 and ORE3 (Larry Brown, personal communication). Dominant taxa reported by these investigators were mayflies, oligochaetes and gastropods. The dominant taxa we reported in Orestimba Creek (particularly at ORE2 and ORE3) were oligochaetes and chironomids. Mayflies were not collected during our 2003 sampling at these two sites and gastropods were collected in low numbers. Due to the nine year time period between the two sampling events, it is difficult to explain possible factors contributing to the differences in dominant taxa.

Benthic community assessments conducted during the present study at the 10 Orestimba Creek sties can be compared with similar studies conducted at the same sites in 2000 (Hall and Killen, 2001), 2001 (Hall and Killen, 2002) and 2002 (Hall and Killen, 2003). A comparison of mean benthic metrics across all 10 sites for 2000, 2001, 2002 and 2003 showed that percent chironomidae, percent collectors, percent filterers and percent shredders showed the highest number of significant differences for between year comparisons (Table 28a). Abundance and taxonomic richness – two commonly used metrics in IBI development - did not show any significant differences during the four-year period. In general, most of the metrics (~75%) did not show any significant differences over the four-year period thus suggesting that dramatic changes in benthic communities were not evident.

A comparison of mean benthic metrics in Del Puerto Creek for 2001, 2002, and 2003 showed a significant differences ($p<0.05$) for percent shredders (Table 28b). The value in 2003 was significantly lower than the previous years two years. Using a slightly higher statistical cutpoint ($p<0.10$), differences among years were reported for percent dominant taxa, percent grazers, percent predators, Shannon Diversity, and tolerance value. The critical metrics – abundance and taxonomic richness – were similar among the three years.

A comparison of mean benthic metrics reported for the five Salt Slough sites in 2001, 2002 and 2003 showed significant differences ($p<0.05$) for percent collectors, percent dominant taxon, percent predators, percent shredders, Shannon Diversity, and taxonomic richness (Table 28c). In contrast to relatively consistent benthic metrics among years discussed above for Del Puerto Creek, the benthic metrics reported for Salt slough were more variable over the 2001 to 2003 time period.

Regulatory and Ecological Implications

The state of California has classified Del Puerto Creek, Orestimba Creek and Salt Slough as impaired water bodies (303d list) due to the presence of chlorpyrifos and diazinon (www.swrcb.ca.gov). These water bodies were listed as impaired based on either OP concentrations exceeding a threshold (water quality criteria) or toxicity reported from single species toxicity tests (i.e. *Ceriodaphnia dubia* toxicity tests). Unfortunately, the status of resident biological communities was not considered when these water bodies were classified as impaired because these data were not available. The benthic community data generated form these three streams in 2003 as well as previous bioassessment efforts in these streams (Hall and Killen, 2001; Hall and Killen, 2002; Hall and Killen, 2003) is therefore useful for providing another line of evidence for determining the biological condition of these water bodies. A recent report by the NRC (National Research Council, 2001), addressing various issues associated with TMDLs and impaired water bodies, stated that biological criteria should be used in conjunction with physical and chemical criteria to determine whether a water body is meeting its designated use. This NRC report further supports the use of biological data for determining the status (or potential impairment) of water bodies by stating that biological criteria are more closely related to designated uses of a waterbody than are chemical or physical measurements. A recent EPA report entitled "*Consolidated Assessment and Listing Methodology*" (CALM document) clearly supports the use of bioassessments for determining attainment of aquatic life based water quality standards by stating that bioassessment data are core indicators (critical or essential indicators) (U.S. EPA, 2002). This CALM document also endorses the use of multiple lines of evidence (chemical, toxicity and bioassessment data) for making valid designations of impaired water bodies (U.S. EPA, 2002).

Benthic communities in all three agricultural streams were generally comprised of tolerant species such as oligochaetes and chironomids with the exception of Salt Slough where amphipods (an OP sensitive species) were dominant. The dominant presence of the OP sensitive amphipod (i.e., *Corophium spinicorne* comprised 37% of the taxa collected) suggests that the laboratory toxicity data used to generate the "effects benchmarks" for OPs may not accurately predict the status of resident biota in Salt Slough. Dominance by tolerant species is expected in these streams due to fluctuating flow conditions and stressful water quality conditions such elevated temperature and low dissolved oxygen. For example, historical data from permanent gauging stations near ORE10 (USGS) and ORE8 (CA DWR) shows that in most years Orestimba Creek is ephemeral in the reach with no commercial agriculture but generally has continuous low flow (in non-drought years) in most of the lower reach which receives irrigation return water (Poletika and Robb, 1998).

Critical issues to address with the benthic community data from these streams are: (1) What are the biological (benthic) expectations for these agricultural streams? and (2) Do these streams meet these biological expectations and are they impaired based on the status of resident benthic communities? Unfortunately, an agricultural reference stream is not available for this watershed to compare benthic communities for each stream. Therefore, the traditional approach often used to interpret the status of benthic communities is not feasible. The presence of 81 taxa in Del Puerto Creek, 102 taxa in Orestimiba Creek, and 65 taxa in Salt Slough implies that the benthic communities in these streams are fairly diverse, considering their ephemeral environments, but without a clear definition of benthic community expectations it is unknown if these water bodies are actually impaired. Extensive spatial and temporal assessments of benthic communities in concert with physical habitat assessments are needed in agricultural streams of California's Central Valley in order to identify the range of benthic community taxa assemblages by stream orders and identify potential reference sites.

REFERENCES

Barbour, M.T., J. Gerritson, B.D. Snyder, and S. Stribling. 1999. Rapid Bioassessment protocols for use in wadeable streams and rivers. EPA-841-B-99-002. Washington D.C.

Brown, L. R. and J. T. May. 2000. Macroinvertebrate assemblages on woody debris and their relations with environmental variable in the lower Sacramento and San Joaquin river drainages, California. Environ. Monitor. Assess. 64: 311-329.

Dubrovsky, N. M., C. R. Kratzer, L. R. Brown, J. M. Gronberg, and K. R. Burow. 1998. Water quality in the San Joquin-Tulare basins, California, 1992-1995. U.S. Geological Survey Circular 1159, Sacramento, CA.

Foe, C. 1995. Evaluation of the potential impact of contaminants on aquatic resources in the Central Valley and Sacramento-San Joaquin Delta estuary. Report. Central Valley Regional Water Quality Control Board, Sacarmento, CA.

Giddings, J. M., L. W. Hall, Jr. and K. R. Solomon. 2000. Ecological risks of diazinon from agricultural use in the Sacramento – San Joaquin river basins, California. Risk Analysis 20: 545-572.

Giesy, J. P., K. R. Solomon, J. R. Coats, K. R. Dixon, J. M. Giddings and E. Kenaga. 1999. Chlorpyrifos: Ecological risk assessment in North American aquatic environments. Rev. Environ. Contam. Toxicol. 160: 1-129.

Hall, L. W. Jr. and W. D. Killen. 2001. Characterization of benthic communities and physical habitat in an agricultural and urban stream in California's Central Valley. Final report prepared by the University of Maryland, Wye Research and Education Center, Queenstown, MD.

Hall, L. W. Jr. and W. D. Killen. 2002. Characterization of benthic communities and physical habitat in agricultural streams in California's San Joaquin Valley. Final report prepared by University of Maryland, Wye Research and Education Center, Queenstown, MD.

Hall, L. W. Jr. and W. D. Killen. 2003. Characterization of benthic communities and physical habitat in agricultural streams in California's San Joaquin Valley in 2003. Final Report prepared by the University of Maryland, Wye Research and Education Center, Queenstown, MD.

Harrington, J. and M. Born. 2000. Measuring the health of California streams and rivers. – A methods manual for water resource professionals, citizen monitors and natural resource students. Report. Sustainable Land Stewardship International Institute, Sacramento, CA.

Karr, J. R., K. D. Fausch, P. L. Angermeier, P. R. Yant and I. J. Schlosser. 1986. Assessing biological integrity in running waters: A method and its rationale. Illinois Natural History Survey Special Publication 5, Champaign, IL.

Kazyak, P. F. 1997. Maryland Biological Stream Survey Sampling Manual. Maryland Department of Natural Resources, Chesapeake Bay Research and Monitoring Division, Annapolis, MD.

Lee, G. F. and Jones-Lee, A. 2000. Synopsis of issues in developing the San Joaquin River deep Water ship channel DO TMDL. Report. G. Fred Lee and Associates, El Macero, CA.

May, J. T. and L. R. Brown. 2000. Fish community structure in relation to environmental variables within the Sacramento River basin and implications for the greater Central Valley, California. Report 00-247, U.S. Geological Survey, Sacramento, CA.

Moyle, P. B., B. Herbold, D. E. Stevens and L. W. Miller. 1992. Life history and status of the delta smelt in the Sacramento-San Joaquin estuary in California. Trans. Am. Fish. Soc. 121: 67-77.

Moulton, S. R. II, J. L. Carter, S. A. Grotheer, T. F. Cuffney, and T. M. Short. 2000. Methods of analysis by the U. S. Geological Survey National Water Quality Laboratory – Processing, taxonomy and quality control of benthic macroinvertebrate samples. Report 00-212, U. S. Geological Survey, Sacramento, CA.

National Research Council. 2001. Assessing the TMDL Approach to Water Quality Management. National Academy Press, Washington, DC.

Poletika, N. N. and C. K. Robb. 1998. A monitoring study to characterize chlorpyrifos concentration patterns and ecological risk in an agricultural dominated tributary of the San Joaquin River. Report GH-C 4854. Dow Agro-Sciences LLC, Indianapolis, IN.

Rankin, E. T. 1995. Habitat indices in water resource quality assessments. Pages 181-208 In W. S. Davis and T. P. Simon editors. *Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making*. Lewis Publishers, Boca Raton, FL.

Stribling, J. B., J. S. White, B. J. Jessup, D. Boward, and M. Hurd. 1998. Development of a benthic index of biotic integrity for Maryland streams. Report. Tetra Tech Incorporated, Owings, MD.

U. S. EPA (United States Environmental Protection Agency). 2002. Consolidated Assessment and Listing Methodology – Towards a Compendium of Best Practices. Report. USEPA Office of Wetlands, Oceans, and Watersheds, Washington, DC.

Waterborne Environmental, Inc. 2002. Surface water monitoring information on selected insecticides in the San Joaquin River and Sacramento/San Joaquin River Delta watersheds correlated with pesticide use data, 1990-1998. Report. Waterborne Environmental Inc., Leesburg, VA.

Table 1. Sample site names, coordinates and water quality parameters measured during late spring 2003 in Del Puerto Creek, Orestimba Creek and Salt Slough.

Site	Latitude	Longitude	Water Temperature (C)	Specific Conductivity µmhos/L	pH	Dissolved Oxygen mg/L	Salinity ppt	Turbidity NTU
DLP1	37 32 25	121 07 07	22.9	1199	8.62	9.19	-	3.33
DLP2	37 32 03	121 07 46	25.6	1336	8.82	9.19	-	1.70
DLP3	37 31 20	121 08 54	24.1	1143	8.12	8.06	-	1.93
DLP4	37 30 43	121 09 38	31.4	564	8.50	6.35	-	6.5
DLP5	37 28 59	121 12 41	18.7	1287	8.30	8.24	-	1.53
ORE1	37 25 10	121 00 09	18.7	659	7.28	6.92	-	109.7
ORE2	37 25 12	121 00 21	20.3	644	8.01	7.90	-	102.8
ORE3	37 24 47	121 00 59	22.7	672	8.10	7.70	-	119
ORE4	37 24 19	121 01 28	22.1	653	7.98	7.72	-	135.6
ORE5	37 23 54	121 02 02	20.4	596	7.15	6.86	-	130
ORE6	37 23 21	121 02 34	21.8	681	7.01	7.14	-	99.7
ORE7	37 22 59	121 03 00	24.4	745	7.73	7.99	-	71.2
ORE8	37 22 37	121 03 31	25.0	755	7.89	7.07	-	116
ORE9	37 21 53	121 03 45	28.5	933	7.91	5.78	-	144
ORE10	37 19 08	121 07 18	21.9	780	7.88	7.18	-	0.07
SSL1	37 14 54	120 51 12	28.6	1957	7.68	5.37	-	43.1
SSL2	37 11 59	120 49 33	26.1	1844	7.37	5.12	-	80.1
SSL3	37 09 33	120 48 44	27.4	1616	7.51	5.25	-	66.4
SSL4	37 08 21	120 46 04	24.6	1139	7.35	5.44	-	60.3
SSL5	37 07 45	120 42 28	22.6	956	6.96	4.06	-	78.6

Table 2. Scoring of individual physical habitat metrics (0-20 scale) and final habitat score (maximum of 200) for sites in Del Puerto Creek, Orestimba Creek and Salt Slough.

Site	Epi Subs	Embedd	Veloc Depth Divers	Sedim Depos	Chan Flow Status	Chan Alt	Freq Bends Riffles	Left Bank Stab	Right Bank Stab	L Bank Veget. Protect	R Bank Veget. Protect	L Bank Ripar Zone	R Bank Ripar Zone	Total
DPL1	13	12	16	15	16	15	15	5	6	5	5	2	3	128
DPL2	13	12	15	14	16	10	10	4	2	4	1	3	3	107
DPL3	12	6	9	11	14	14	11	8	6	5	3	3	4	106
DPL4	10	8	10	10	6	6	6	5	4	3	3	2	2	75
DPL5	13	13	9	11	14	17	11	8	8	5	4	6	5	124
ORE1	15	1	6	5	14	16	5	5	4	6	6	6	3	92
ORE2	7	10	10	9	14	13	8	6	6	6	6	5	3	103
ORE3	10	13	9	10	16	7	6	3	3	3	6	2	4	92
ORE4	11	8	10	13	16	16	10	6	3	4	4	3	5	109
ORE5	10	8	8	12	16	14	11	6	6	6	6	6	5	114
ORE6	6	8	9	11	16	11	9	8	7	6	6	5	3	105
ORE7	12	8	10	15	16	15	12	7	6	6	8	4	5	124
ORE8	9	7	14	12	13	13	13	5	7	5	6	2	4	110
ORE9	10	6	6	8	9	13	10	3	3	3	3	3	3	80
ORE10	10	10	10	13	14	12	12	3	2	1	1	3	3	94
SSL1	5	0	9	1	14	16	4	3	3	3	3	6	3	70
SSL2	6	0	6	6	19	16	5	10	6	8	6	10	8	106
SSL3	6	0	9	4	15	15	5	6	7	6	6	3	5	87
SSL4	8	0	7	5	19	13	6	0	6	3	7	1	6	81
SSL5	2	0	1	1	15	2	0	0	0	0	0	1	1	23

Table 3. Physical habitat characteristics for Del Puerto Creek, Orestimba Creek and Salt Slough that were not scored on a 0 - 20 scale.

Site	Mean Flow m/s	Canopy Cover %	Gradient %	Fines %	Gravel %	Cobble %	Boulder %	Bedrock %
DLP 1	0.64	77	1	20	40	40	0	0
DLP 2	0.67	35	1	40	40	20	0	0
DLP 3	0.52	20	1	50	40	10	0	0
DLP 4	0.10	0	1	40	55	5	0	0
DLP 5	0.22	0	1	20	50	30	0	0
ORE 1	0.08	13	1	80	20	0	0	0
ORE 2	0.32	93	1	60	40	0	0	0
ORE 3	0.45	66	1	45	45	5	5	0
ORE 4	0.58	60	1	40	55	5	0	0
ORE 5*	0.27	50	1	65	30	5	0	0
ORE 6	0.39	8	1	50	50	0	0	0
ORE 7	0.53	22	1	20	50	25	0	5
ORE 8	0.65	0	1	30	40	30	0	0
ORE 9	0.15	0	1	95	5	0	0	0
ORE 10	0.09	0	1	60	20	20	0	0
SSL 1	0.32	0	1	100	0	0	0	0
SSL 2	0.24	0	1	100	0	0	0	0
SSL 3	0.34	0	1	100	0	0	0	0
SSL 4	0.14	0	1	100	0	0	0	0
SSL 5	0	0	1	100	0	0	0	0

* Beaver dam just downstream of original sample site. Sample was taken ~150 meters downstream at first available riffle.

Table 4. Eigenvalues and proportion of variance explained for the correlation matrix of the ten habitat metrics.

	Eigenvalue	Proportion	Cumulative
Factor 1	4.19	0.4189	0.4189
Factor 2	2.91	0.2907	0.7097
Factor 3	0.86	0.0858	0.7955
Factor 4	0.66	0.0660	0.8615
Factor 5	0.49	0.0495	0.9110
Factor 6	0.37	0.0367	0.9477
Factor 7	0.25	0.0249	0.9726
Factor 8	0.13	0.0127	0.9853
Factor 9	0.12	0.0118	0.9971
Factor10	0.03	0.0029	1.0000

*eigenvalue > 1.0

Table 5. Eigenvectors for the three dominant factors of the correlation matrix of habitat metrics.

Metric	Factor 1	Factor 2	Factor 3
BANKSTAB	0.3178+	0.3319+	-0.2419
BANKVEG	0.2493	0.4127*	-0.0569
CHAN ALT	0.2795	0.3587*	-0.2002
BENRIFF	0.4359*	-0.1515	0.0322
EPI SUB	0.3522*	-0.1422	-0.2275
RIPBUFF	0.1357	0.5017*	-0.0274
SED DEP	0.4207*	-0.2263	0.1699
VEL DPTH	0.3691*	-0.1907	0.1515
CH FLOW	0.0461	0.3161+	0.8782*
EMBEDDED	0.3330+	-0.3293+	0.1470

* coefficients > = 0.35 for each factor
+ 0.30 <= coefficient < 0.35 for each factor

Table 6. Correlation matrix for raw physical habitat metrics grouped by factors identified by the PCA. In the body of the table the correlation coefficients (top) are paired with the p-value (bottom) for the null hypothesis that the correlation is 0.0.

Metric	BANK STAB	BANK VEG	CHAN ALT	BEN RIFF	EPI SUB	RIP BUFF	SED DEP	VEL DPTH	CH FLOW	EMBEDD	TOTAL
BANKSTAB	1.0000	0.7827	0.6039	0.4089	0.2185	0.6447	0.3436	0.2743	0.1481	0.1635	0.7373
		<.0001	0.0048	0.0734	0.3547	0.0021	0.138	0.2418	0.5333	0.4911	0.0002
BANKVEG	0.7827	1.0000	0.5872	0.2158	0.1759	0.6369	0.1715	0.1755	0.3596	-0.0410	0.6336
	<.0001		0.0065	0.3608	0.4583	0.0025	0.4697	0.4591	0.1194	0.8638	0.0027
CHAN ALT	0.6039	0.5872	1.0000	0.4212	0.3747	0.6599	0.1507	0.2571	0.2771	-0.0692	0.6567
	0.0048	0.0065		0.0644	0.1036	0.0015	0.5261	0.2738	0.2369	0.7718	0.0017
BENRIFF	0.4089	0.2158	0.4212	1.0000	0.6290	-0.0013	0.8858	0.7238	-0.0311	0.6878	0.8133
	0.0734	0.3608	0.0644		0.003	0.9956	<.0001	0.0003	0.8966	0.0008	<.0001
EPI SUB	0.2185	0.1759	0.3747	0.6290	1.0000	0.0118	0.6520	0.4854	-0.1303	0.5470	0.6444
	0.3547	0.4583	0.1036	0.003		0.9606	0.0018	0.03	0.5839	0.0126	0.0022
RIPBUFF	0.6447	0.6369	0.6599	-0.0013	0.0118	1.0000	-0.0568	-0.1313	0.4442	-0.2017	0.4499
	0.0021	0.0025	0.0015	0.9956	0.9606		0.812	0.581	0.0497	0.3937	0.0465
SED DEP	0.3436	0.1715	0.1507	0.8858	0.6520	-0.0568	1.0000	0.7108	-0.0150	0.8345	0.7782
	0.138	0.4697	0.5261	<.0001	0.0018	0.812		0.0004	0.95	<.0001	<.0001
VEL DPTH	0.2743	0.1755	0.2571	0.7238	0.4854	-0.1313	0.7108	1.0000	-0.0259	0.6249	0.6704
	0.2418	0.4591	0.2738	0.0003	0.03	0.581	0.0004		0.9136	0.0032	0.0012
CH FLOW	0.1481	0.3596	0.2771	-0.0311	-0.1303	0.4442	-0.0150	-0.0259	1.0000	-0.1562	0.2530
	0.5333	0.1194	0.2369	0.8966	0.5839	0.0497	0.95	0.9136		0.5107	0.2819
EMBEDDED	0.1635	-0.0410	-0.0692	0.6878	0.5470	-0.2017	0.8345	0.6249	-0.1562	1.0000	0.5842
	0.4911	0.8638	0.7718	0.0008	0.0126	0.3937	<.0001	0.0032	0.5107		0.0068
TOTAL	0.7373	0.6336	0.6567	0.8133	0.6444	0.4499	0.7782	0.6704	0.2530	0.5842	1.0000
	0.0002	0.0027	0.0017	<.0001	0.0022	0.0465	<.0001	0.0012	0.2819	0.0068	

Table 7. Correlation matrix for stream width, depth, velocity, and canopy measurements against raw physical habitat metrics and the total habitat metric score. In the body of the table are the correlation coefficient (top) and the p-value (bottom) for the null hypothesis that the correlation is 0.0.

Metric	Width	Depth	Velocity	Canopy
BANKSTAB	0.1018	-0.5752*	0.3327	0.0648
	0.6694	0.008	0.1518	0.786
BANKVEG	0.2189	-0.2983	0.3066	0.2290
	0.3539	0.2014	0.1885	0.3314
CHAN ALT	0.2183	-0.2964	0.2634	0.0463
	0.3551	0.2044	0.2620	0.8465
BENRIFF	-0.5534*	-0.6268*	0.5910*	0.3106
	0.0114	0.0031	0.0061	0.1825
EPI SUB	-0.6296*	-0.4433	0.3285	0.2642
	0.0029	0.0503	0.1574	0.2604
RIPBUFF	0.5278*	-0.1782	-0.0145	-0.0716
	0.0168	0.4522	0.9515	0.7641
SED DEP	-0.6522*	-0.6963*	0.6128*	0.4399
	0.0018	0.0006	0.0041	0.0523
VEL DPTH	-0.3112	-0.5591*	0.7802*	0.4001
	0.1817	0.0104	<.0001	0.0805
CH FLOW	0.3940	0.2131	0.2627	0.2189
	0.0856	0.3671	0.2632	0.3539
EMBEDDED	-0.6870*	-0.6836*	0.4544*	0.5507*
	0.0008	0.0009	0.0441	0.0119
TOTAL	-0.2613	-0.6966*	0.6298*	0.4026
	0.2659	0.0006	0.0029	0.0784

Number of observations = 20
* p-value < 0.05

Table 8. Spearman rank correlation coefficients (top) and significance levels (bottom) for upstream-downstream trend in the physical habitat metrics and the total physical habitat index.

Physical Habitat metric	Del Puerto	Orestimba	Salt Slough
VEL DPTH	-0.82078 0.0886	0.25805 0.4716	-0.61559 0.269
EPI SUB	-0.33541 0.5811	-0.18759 0.6038	-0.0513 0.9347
BENRIFF	-0.41039 0.4925	0.7988* 0.0056	-0.0513 0.9347
CHAN ALT	0.1 0.8729	-0.29542 0.4073	-0.97468* 0.0048
BANKVEG	-0.1 0.8729	-0.44397 0.1987	-0.4 0.5046
RIPBUFF	0.4 0.5046	-0.47673 0.1636	-0.9* 0.0374
SED DEP	-0.82078 0.0886	0.46342 0.1774	-0.1026 0.8696
EMBEDDED	0.1539 0.8048	-0.08155 0.8228	. .
BANKSTAB	0.5 0.391	-0.14817 0.6829	-0.56429 0.3217
CH FLOW	-0.79057 0.1114	-0.33436 0.345	0.31623 0.6042
TOTAL	-0.4 0.5046	0.1155 0.7507	-0.4 0.5046
Sample Size	5	10	5

* P-value < 0.05

Table 9. Mean scores for each physical habitat metric and the total for each creek with the p-values for comparing the means among creeks based on the Kruskal-Wallis test. Pairwise comparisons between creeks are based on the Wilcoxon rank-sum test.

	Mean for each Creek				Pairwise Comparisons		
Physical Habitat Metric	Del Puerto	Orestimba	Salt Slough	Kruskal Wallace p-value	DO	DS	OS
VEL DPTH	11.8	9.2	6.4	0.0373		*	
EPI SUB	12.2	10.0	5.4	0.0003	*	*	*
BENRIFF	10.6	9.6	4.0	0.0037		*	*
CHAN ALT	12.4	13.0	12.4	0.8753			
BANKVEG	7.6	9.8	8.4	0.3499			
RIPBUFF	6.6	7.7	8.8	0.5008			
SED DEP	12.2	10.8	3.4	0.0017		*	*
EMBEDDED	10.2	7.9	0.0	0.0004		*	*
BANKSTAB	11.2	9.9	8.2	0.7042			
CH FLOW	13.2	14.4	16.4	0.4276			
TOTAL	108.0	102.3	73.4	0.0560			*

DO – Del Puerto vs Orestimba
DS – Del Puerto vs Salt Slough
OS – Orestimba vs Salt Slough
* - p-value < 0.05

Table 10. Total and taxon abundance for benthic macroinvertebrates in Del Puerto Creek.

Lowest Taxa	Higher Taxa	Total N	Total %	Cumulative %
Simulium sp.	Simuliidae/Diptera	1104	28.424	28.424
Nais communis/ variabilis	Naididae/Oligochaeta	562	14.47	42.894
Dicrotendipes sp.	Chironomidae/Diptera	314	8.084	50.978
Cricotopus sp.	Chironomidae/Diptera	310	7.981	58.96
Physa sp.	Physidae/Gastropoda	261	6.72	65.68
Tubificidae	Tubificida/Oligochaeta	191	4.918	70.597
Cricotopus bicinctus group	Chironimidae/Diptera	178	4.583	75.18
Lumbricina	Oligochaeta	115	2.961	78.141
Helobdella stagnalis	Glossiphoniidae/Hirudinea	113	2.909	81.05
Dugesia tigrina	Planariidae/Turbellaria	98	2.523	83.574
Eukiefferiella sp.	Chironimidae/Diptera	65	1.674	85.247
Ostracoda	Malacostraca	65	1.674	86.921
Rheotanytarsus sp.	Chironomidae/Diptera	49	1.262	88.182
Orthocladius complex	Chironomidae/Diptera	46	1.184	89.367
Baetis tricaudatus	Baetidae/Ephemeroptera	42	1.081	90.448
Paratanytarsus sp.	Chironomidae/Diptera	37	0.953	91.401
Fallceon quilleri	Baetidae/Ephemeroptera	26	0.669	92.07
Parachironomus sp.	Chironomidae/Diptera	25	0.644	92.714
Cricotopus trifascia group	Chironomidae/Diptera	23	0.592	93.306
Apedilum sp.	Chironomidae/Diptera	21	0.541	93.847
Slavina appendiculata	Naididae/Oligochaeta	21	0.541	94.387
Cladotanytarsus sp.	Chironomidae/Diptera	19	0.489	94.876
Tanytarsus sp.	Chironomidae/Diptera	14	0.36	95.237
Rheocricotopus sp.	Chironomidae/Diptera	13	0.335	95.572
Enchytraeidae	Tubificida/Oligochaeta	13	0.335	95.906
Gyraulus parvus	Planorbidae/Gastropoda	10	0.257	96.164
Tricorythodes sp.	Leptohyphidae/Ephemeroptera	9	0.232	96.395
Fossaria sp.	Lymnaeidae/Gastropoda	9	0.232	96.627
Muscidae	Diptera	9	0.232	96.859
Planorbella sp.	Planorbidae/Gastropoda	8	0.206	97.065
Thienemanniella sp.	Chironomidae/Diptera	6	0.154	97.219
Oxyethira sp.	Hydroptilidae/Trichoptera	6	0.154	97.374
Sperchon sp.	Sperchontidae/Arachnida	6	0.154	97.528
Prostoma sp.	Tertastemmatidae/Enopla	6	0.154	97.683
Chironomus sp.	Chironomidae/Diptera	4	0.103	97.786
Gymnometriocnemus sp.	Chironomidae/Diptera	4	0.103	97.889
Pentaneura sp.	Chironomidae/Diptera	4	0.103	97.992
Corbicula sp.	Corbiculidae/Bivalvia	4	0.103	98.095
Corixidae	Hemiptera	4	0.103	98.198
Erpobdellidae	Hirudinea	4	0.103	98.301
Sphaerium sp.	Sphaeriidae/Bivalvia	4	0.103	98.404
Bezzia/ Palpomyia	Ceratopogonidae/Diptera	3	0.077	98.481
Limnophyes sp.	Chironomidae/Diptera	3	0.077	98.558
Coenagrionidae	Odonata	3	0.077	98.635
Hydrobiidae	Gastropoda	3	0.077	98.713

Table 10. Contunued.

Hydroptila sp.	Hydroptilidae/Trichoptera	3	0.077	98.79
Chaetogaster diaphanus	Naididae/Oligochaeta	3	0.077	98.867
Ophidonais serpentina	Naididae/Oligochaeta	3	0.077	98.944
Quistadrilus multisetosus	Tubificidae/Oligochaeta	3	0.077	99.022
Corynoneura sp.	Chironomidae/Diptera	2	0.051	99.073
Paraphaenocladius sp.	Chironomidae/Diptera	2	0.051	99.125
Lebertia sp.	Lebertiidae/Arachnida	2	0.051	99.176
Nemotelus sp.	Stratiomyidae/Diptera	2	0.051	99.228
Odontomyia sp.	Stratiomyidae/Diptera	2	0.051	99.279
Ormosia sp.	Tipulidae/Diptera	2	0.051	99.331
Belostoma flumineum	Belostomatidae/Hemiptera	1	0.026	99.356
Culicoides sp.	Ceratopogonidae /Diptera	1	0.026	99.382
Dasyhelea sp.	Ceratopogonidae/Diptera	1	0.026	99.408
Forcipomyia sp.	Ceratopogonidae/Diptera	1	0.026	99.434
Micropsectra sp.	Chironomidae/Diptera	1	0.026	99.459
Microtendipes pedellus group	Chironomidae/Diptera	1	0.026	99.485
Parachaetocladius sp.	Chironomidae/Diptera	1	0.026	99.511
Phaenopsectra sp.	Chironomidae/Diptera	1	0.026	99.537
Polypedilum sp.	Chironomidae/Diptera	1	0.026	99.562
Pseudosmittia sp.	Chironomidae/Diptera	1	0.026	99.588
Sigara sp.	Coxidae/Hemiptera	1	0.026	99.614
Hydrellia sp.	Ephydridae/Diptera	1	0.026	99.64
Gammarus sp.	Gammaridae/Malacostraca	1	0.026	99.665
Glossiphoniidae	Glossiphoniidae/Hirudinea	1	0.026	99.691
Peltodytes sp.	Haliplidae/Coleoptera	1	0.026	99.717
Hyalella sp.	Hyalellidae/Malacostraca	1	0.026	99.743
Hydrophilidae	Coleoptera	1	0.026	99.768
Cheumatopsyche sp.	Hydropsychidae/Trichoptera	1	0.026	99.794
Pristina leidyi	Naididae/Oligochaeta	1	0.026	99.82
Pristina osborni	Naididae/Oligochaeta	1	0.026	99.846
Naucoridae	Hemiptera	1	0.026	99.871
Menetus opercularis	Planorbidae/Gastropoda	1	0.026	99.897
Pericoma/ Telmatoscopus	Psychodidae/Diptera	1	0.026	99.923
Tinodes sp.	Psychomyiidae/Trichoptera	1	0.026	99.949
Pisidium sp.	Sphaeriidae/Bivalvia	1	0.026	99.974
Branchiura sowerbyi	Tubificidae/Oligochaeta	1	0.026	100
	Total	3884		

Table 11. Benthic metrics by transect (including the means) for the 5 Del Puerto Creek sites.

	DLP 1					DLP 2					DLP 3					DLP 4					DLP 5				
Transect Number:	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV
Taxonomic Richness	22	15	17	18	20	18	17	22	19	14	14	14	16	15	8	16	13	14	14	11	28	24	32	28	14
Cumulative Taxa				30					32					23					21					46	
Percent Dominant Taxon	46	39	21	35	37	25	61	39	42	43	48	61	65	58	15	45	43	33	40	16	34	45	50	43	19
Plecoptera Taxa	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-
Trichoptera Taxa	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	4	2	1	2	65
EPT Taxa	0	0	0	0	-	1	1	1	1	0	1	1	1	1	0	0	0	0	0	-	7	5	3	5	40
EPT Index (%)	0	0	0	0	-	1	2	2	2	25	0	1	1	1	65	0	0	0	0	-	11	8	2	7	70
Sensitive EPT Index (%)	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	1	1	1	1	23
Shannon Diversity	1.9	2.1	2.2	2	9	2.1	1.5	1.7	2	18	1.7	1.5	1.4	2	11	1.7	1.6	1.8	2	6	2.3	2.0	1.8	2	13
Tolerance Value	7.3	6.9	7.7	7	5	6.0	5.9	5.9	6	1	7.3	6.6	6.8	7	5	7.4	7.4	7.2	7	2	7.3	6.8	6.8	7	4
Percent Intolerant Taxa (0-2)	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	1	0	97
Percent Tolerant Taxa (8-10)	38	38	57	44	25	15	5	6	9	61	34	21	24	26	26	53	48	37	46	17	64	22	20	35	70
Percent Baetidae	0	0	0	0	-	1	2	2	2	25	0	1	1	1	65	0	0	0	0	-	8	7	0	5	82
Percent Chironomidae	15	30	29	25	35	7	5	7	6	23	19	18	9	15	37	89	90	55	78	26	16	27	37	27	40
Percent Hydropsychidae	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	173
Percent Collectors	40	30	44	38	19	24	13	48	28	62	40	21	25	29	35	92	91	86	90	3	47	77	83	69	28
Percent Filterers	47	41	23	37	33	27	62	38	43	43	50	63	66	60	15	5	8	3	5	49	10	10	7	9	17
Percent Scrapers	1	4	0	2	116	11	4	2	6	87	6	13	5	8	54	1	1	3	2	65	38	9	5	17	105
Percent Predators	2	3	7	4	74	15	10	6	11	45	4	2	2	3	35	1	1	7	3	123	3	1	4	3	49
Percent Shredders	0	1	0	0	173	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-
Abundance (#/sample)	472	70	82	208	110	1531	2487	1616	1878	28	940	2643	6900	3494	88	887	492	117	499	77	3841	9401	8900	7381	42

Table 12. Total and taxon abundance for benthic macroinvertebrates in Orestimba Creek.

Lowest Taxa	Higher Taxa	Total N	Total %	Cumulative %
Cricotopus sp.	Chironomidae/Diptera	1166	15.065	15.065
Nais communis/ variabilis	Naididae/Oligochaeta	956	12.351	27.416
Cricotopus bicinctus group	Chironomidae/Diptera	854	11.034	38.45
Ophidonais serpentina	Naididae/Oligochaeta	549	7.093	45.543
Physa sp.	Physidae/Gastropoda	457	5.904	51.447
Tubificidae	Tubificida/Oligochaeta	335	4.328	55.775
Simulium sp.	Simulidae/Diptera	321	4.147	59.922
Slavina appendiculata	Naididae/Oligochaeta	244	3.152	63.075
Orthocladius complex	Chironomidae/Diptera	226	2.92	65.995
Dicrotendipes sp.	Chironomidae/Diptera	224	2.894	68.889
Eudistylia vancouveri	Sabellidae/Polychaeta	192	2.481	71.37
Eukiefferiella sp.	Chironomidae/Diptera	174	2.248	73.618
Ostracoda	Malacostraca	169	2.183	75.801
Corbicula sp.	Corbiculidae/Bivalvia	143	1.848	77.649
Menetus opercularis	Planorbidae/Gastropoda	139	1.796	79.444
Hyalella sp.	Hyalellidae/Malacostraca	105	1.357	80.801
Chironomus sp.	Chironomidae/Diptera	104	1.344	82.145
Prostoma sp.	Tertastemmatidae/Enopla	84	1.085	83.23
Rheocricotopus sp.	Chironomidae/Diptera	83	1.072	84.302
Nais barbata	Naididae/Oligochaeta	78	1.008	85.31
Hydropsyche californica	Hydropsychidae/Trichoptera	70	0.904	86.214
Planorbella sp.	Planorbidae/Gastropoda	70	0.904	87.119
Oxyethira sp.	Hydroptilidae/Trichoptera	69	0.891	88.01
Lumbricina	Oligochaeta	61	0.788	88.798
Dugesia tigrina	Planariidae/Turbellaria	51	0.659	89.457
Caenis latipennis	Caenidae/Ephemeroptera	50	0.646	90.103
Cricotopus trifascia group	Chironimidae/Diptera	47	0.607	90.711
Chaetogaster diaphanus	Naididae/Oligochaeta	47	0.607	91.318
Rheotanytarsus sp.	Chironomidae/Diptera	46	0.594	91.912
Torrenticola sp.	Torrenticolidae/Arachnida	44	0.568	92.481
Paratanytarsus sp.	Chironomidae/Diptera	39	0.504	92.984
Sperchon sp.	Sperchontidae/Arachnida	39	0.504	93.488
Enchytraeidae	Tubificida/Oligochaeta	37	0.478	93.966
Fossaria sp.	Lymnaeidae/Gastropoda	31	0.401	94.367
Branchiura sowerbyi	Tubificidae/Oligochaeta	28	0.362	94.729
Micropsectra sp.	Chironomidae/Diptera	27	0.349	95.078
Limnodrilus hoffmeisteri	Tubificidae/Oligochaeta	26	0.336	95.413
Phaenopsectra sp.	Chironomidae/Diptera	23	0.297	95.711
Baetis adonis	Baetidae/Ephemeroptera	22	0.284	95.995
Nanocladius sp.	Chironomidae/Diptera	21	0.271	96.266
Fallceon quilleri	Baetidae/Ephemeroptera	17	0.22	96.486
Gammarus sp.	Gammaridae/Malacostraca	17	0.22	96.705
Corynoneura sp.	Chironomidae/Diptera	16	0.207	96.912
Orthocladius sp.	Chironomidae/Diptera	16	0.207	97.119
Thienemanniella sp.	Chironomidae/Diptera	15	0.194	97.313

Table 12. Continued.

Tribelos sp.	Chironomidae/Diptera	14	0.181	97.494
Erpobdellidae	Hirudinea	14	0.181	97.674
Centroptilum sp.	Baetidae/Ephemeroptera	13	0.168	97.842
Tanytarsus sp.	Chironomidae/Diptera	13	0.168	98.01
Nereis limnicola	Nereididae/Polychaeta	12	0.155	98.165
Polypedilum sp.	Chironimidae/Diptera	11	0.142	98.307
Cladotanytarsus sp.	Chironomidae/Diptera	10	0.129	98.437
Parachironomus sp.	Chironomidae/Diptera	8	0.103	98.54
Glossiphoniidae	Hirudinea	8	0.103	98.643
Procladius sp.	Chironomidae/Diptera	7	0.09	98.734
Limnophyes sp.	Chironomidae/Diptera	5	0.065	98.798
Callibaetis sp.	Baetidae/Ephemeroptera	4	0.052	98.85
Paracladopelma sp.	Chironomidae/Diptera	4	0.052	98.902
Acari	Arachnida	4	0.052	98.953
Pristina leidyi	Naididae/Oligochaeta	4	0.052	99.005
Psychoda sp.	Chironomidae/Diptera	4	0.052	99.057
Gastropoda	Mollusca	4	0.052	99.109
Limnodrilus sp.	Tubificidae/Oligochaeta	4	0.052	99.16
Parametriocnemus sp.	Chironomidae/Diptera	3	0.039	99.199
Pseudochironomus sp.	Chironomidae/Diptera	3	0.039	99.238
Corixidae	Hemiptera	3	0.039	99.276
Hydroptila sp.	Hydroptilidae/Trichoptera	3	0.039	99.315
Dero nivea	Naididae/Oligochaeta	3	0.039	99.354
Pristina aequiseta	Naididae/Oligochaeta	3	0.039	99.393
Staphylinidae	Coleoptera	3	0.039	99.432
Odontomyia/ Hedriodiscus	Chironomidae/Diptera	3	0.039	99.47
Ablabesmyia sp.	Chironomidae/Diptera	2	0.026	99.496
Gymnometriocnemus sp.	Chironomidae/Diptera	2	0.026	99.522
Thienemannimyia group	Chironimidae/Diptera	2	0.026	99.548
Coenagrionidae	Odonata	2	0.026	99.574
Dolichopodidae	Chironimidae/Diptera	2	0.026	99.599
Stictotarsus striatellus	Dytiscidae/Coleoptera	2	0.026	99.625
Anisogammarus sp.	Malacostraca	2	0.026	99.651
Laccobius sp.	Dytiscidae/Coleoptera	2	0.026	99.677
Stylaria lacustris	Naididae/Oligochaeta	2	0.026	99.703
Gyraulus parvus	Planorbidae/Gastropoda	2	0.026	99.729
Hexatoma sp.	Tipulidae/Diptera	2	0.026	99.755
Baetis sp.	Baetidae/Ephemeroptera	1	0.013	99.767
Bezzia/ Palpomyia	Ceratopogonidae/Diptera	1	0.013	99.78
Apedilum sp.	Chironomidae/Diptera	1	0.013	99.793
Chironomini	Chironimidae/Diptera	1	0.013	99.806
Demicryptochironomus sp.	Chironomidae/Diptera	1	0.013	99.819
Endotribelos sp.	Chironomidae/Diptera	1	0.013	99.832
Microchironomus nigrovittatus	Chironomidae/Diptera	1	0.013	99.845
Parakiefferiella sp.	Chironomidae/Diptera	1	0.013	99.858
Paraphaenocladius sp.	Chironomidae/Diptera	1	0.013	99.871

Table 12. Continued.

Pseudosmittia sp.	Chironomidae/Diptera	1	0.013	99.884
Corisella sp.	Corixidae/Hemiptera	1	0.013	99.897
Stictotarsus sp.	Dytiscidae/Coleoptera	1	0.013	99.91
Hydra sp.	Hydridae/Coelentrata	1	0.013	99.922
Tropisternus sp.	Hydrophilidae/Coleoptera	1	0.013	99.935
Cheumatopsyche sp.	Hydropsychidae/Trichoptera	1	0.013	99.948
Lymnaeidae	Gastropoda	1	0.013	99.961
Muscidae	Diptera	1	0.013	99.974
Dero digitata	Naididae/Oligochaeta	1	0.013	99.987
Ormosia sp.	Tipulidae/Diptera	1	0.013	100
	Total	7740		

Table 13. Benthic metrics by transect (including the means) for the 10 Orestimba Creek sites.

	ORE 1					ORE 2					ORE 3					ORE 4					ORE 5				
Transect Number	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV
Taxonomic Richness	18	23	23	21	14	18	27	24	23	20	20	22	22	21	5	22	20	24	22	9	26	25	27	26	4
Cumulative Taxa				39					35					33					32					41	
Percent Dominant Taxon	17	28	23	23	25	19	18	17	18	6	18	20	19	19	6	22	31	23	25	18	24	24	36	28	25
Plecoptera Taxa	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-
Trichoptera Taxa	1	0	0	0	173	0	0	0	0	-	1	1	1	1	0	0	1	1	1	87	0	1	1	1	87
EPT Taxa	2	0	0	1	173	0	0	0	0	-	1	1	1	1	0	1	2	1	1	43	0	1	1	1	87
EPT Index (%)	2	0	0	1	173	0	0	0	0	-	1	1	3	1	83	0	3	4	3	77	0	1	1	1	87
Sensitive EPT Index (%)	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-
Shannon Diversity	2.5	2.3	2.2	2	7	2.5	2.9	2.6	3	9	2.6	2.4	2.7	3	4	2.2	2.1	2.5	2	8	2.6	2.5	2.2	2	8
Tolerance Value	7.9	7.6	7.2	8	4	7.3	7.0	6.5	7	5	6.6	6.4	6.4	6	2	6.8	6.7	7.0	7	2	8.6	7.4	7.6	8	8
Percent Intolerant Taxa (0-2)	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-
Percent Tolerant Taxa (8-10)	54	60	32	49	31	33	30	9	24	56	11	10	15	12	22	11	15	25	17	43	81	46	52	60	31
Percent Baetidae	1	0	0	0	173	0	0	0	0	-	0	0	0	0	-	0	1	0	0	103	0	0	0	0	-
Percent Chironomidae	50	51	51	51	1	36	52	47	45	18	54	37	46	46	19	46	66	52	54	19	31	31	20	27	23
Percent Hydropsychidae	1	0	0	0	173	0	0	0	0	-	1	1	3	1	83	0	3	4	2	92	0	1	1	1	87
Percent Collectors	73	80	89	81	10	75	68	64	69	8	61	61	46	56	16	74	61	57	64	14	70	72	80	74	7
Percent Filterers	9	5	5	6	39	16	15	30	21	41	24	28	40	31	26	10	21	24	18	41	2	8	6	6	57
Percent Scrapers	16	11	2	10	79	0	3	3	2	88	1	4	1	2	85	4	1	1	2	89	26	4	7	12	98
Percent Predators	1	5	2	3	69	4	8	3	5	50	1	1	3	2	81	2	4	7	4	60	2	5	6	4	56
Percent Shredders	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-
Abundance (#/sample)	82	190	608	293	95	73	163	123	120	38	417	820	160	466	71	4494	386	223	1701	142	559	2472	740	1257	84

Table 13. Continued.

Transect Number:	ORE 6 T1	ORE 6 T2	ORE 6 T3	ORE 6 Mean	ORE 6 CV	ORE 7 T1	ORE 7 T2	ORE 7 T3	ORE 7 Mean	ORE 7 CV	ORE 8 T1	ORE 8 T2	ORE 8 T3	ORE 8 Mean	ORE 8 CV	ORE 9 T1	ORE 9 T2	ORE 9 T3	ORE 9 Mean	ORE 9 CV	ORE 10 T1	ORE 10 T2	ORE 10 T3	ORE 10 Mean	ORE 10 CV
Taxonomic Richness	20	25	24	23	12	19	24	18	20	16	19	24	19	21	14	18	20	20	19	6	32	31	38	34	11
				34					30					30					25					48	
Percent Dominant Taxon	21	44	22	29	45	33	26	20	26	25	21	22	29	24	19	52	28	26	36	41	17	23	21	20	13
Plecoptera Taxa	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-
Trichoptera Taxa	1	1	1	1	0	1	1	1	1	0	0	0	0	0	-	1	0	0	0	173	1	1	2	1	43
EPT Taxa	1	2	2	2	35	1	1	1	1	0	0	0	0	0	-	1	0	0	0	173	6	6	7	6	9
EPT Index (%)	0	1	2	1	87	1	4	6	4	75	0	0	0	0	-	0	0	0	0	173	19	14	21	18	18
Sensitive EPT Index (%)	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	8	8	10	9	11
Shannon Diversity	2.3	2.0	2.5	2	12	2.2	2.5	2.3	2	7	2.2	2.4	2.2	2	6	1.8	2.2	2.3	2	14	2.8	2.7	2.9	3	3
Tolerance Value	8.0	8.4	7.8	8	4	7.0	6.9	6.2	7	7	7.5	7.1	7.1	7	3	7.8	7.8	8.1	8	2	6.1	5.8	5.8	6	3
Percent Intolerant Taxa (0-2)	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	2	2	4	2	48
Percent Tolerant Taxa (8-10)	46	59	40	48	19	23	35	9	23	57	55	25	20	33	57	81	82	83	82	1	15	5	16	12	53
Percent Baetidae	0	0	1	1	124	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	4	3	8	5	47
Percent Chironomidae	54	25	51	44	36	76	60	52	63	19	35	46	51	44	19	9	6	7	7	20	27	27	22	25	11
Percent Hydropsychidae	0	0	1	0	42	1	4	6	4	75	0	0	0	0	-	0	0	0	0	173	0	0	0	0	-
Percent Collectors	89	93	89	90	3	84	63	77	75	14	70	82	81	78	9	30	49	59	46	32	59	62	70	64	9
Percent Filterers	5	4	5	5	19	2	7	9	6	59	4	7	5	5	28	2	1	4	2	89	6	8	4	6	33
Percent Scrapers	2	1	4	2	69	9	17	2	9	78	24	0	1	9	156	66	44	31	47	38	21	15	12	16	27
Percent Predators	0	1	1	1	68	4	11	9	8	44	3	10	6	6	61	2	6	5	4	54	7	7	4	6	25
Percent Shredders	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-
Abundance (#/sample)	407	531	383	440	18	707	2071	606	1128	73	1002	1023	1698	1241	32	242	207	163	204	19	2890	10068	7471	6810	53

Table 14. Total and taxon abundance for benthic macroinvertebrates in Salt Slough.

Lowest Taxa	Higher Taxa	Total N	Total %	Cumulative %
Corophium spinicorne	Corophiidae/Malacostraca	1373	37.088	37.088
Physa sp.	Physidae/Gastropoda	456	12.318	49.406
Cricotopus sp.	Chironomidae/Diptera	407	10.994	60.4
Ophidonais serpentina	Naididae/Oligochaeta	287	7.753	68.152
Hydropsyche californica	Hydropsychidae/Trichoptera	133	3.593	71.745
Paratanytarsus sp.	Chironomidae/Diptera	119	3.214	74.959
Corixidae	Hemiptera	105	2.836	77.796
Corbicula sp.	Corbiculidae/Bivalvia	104	2.809	80.605
Cricotopus bicinctus group	Chironomidae/Diptera	89	2.404	83.009
Crangonyx sp.	Crangonyctidae/Malacostraca	73	1.972	84.981
Tubificidae	Oligochaeta	72	1.945	86.926
Gammarus sp.	Gammaridae/Malacostraca	57	1.54	88.466
Eudistylia vancouveri	Sabellidae/Polychaeta	55	1.486	89.951
Slavina appendiculata	Naididae/Oligochaeta	52	1.405	91.356
Chironomus sp.	Chironomidae/Diptera	41	1.108	92.464
Hyalella sp.	Hyalellidae/Malacostraca	40	1.08	93.544
Nais communis/ variabilis	Naididae/Oligochaeta	21	0.567	94.111
Menetus opercularis	Planorbidae/Gastropoda	18	0.486	94.598
Limnodrilus hoffmeisteri	Tubificidae/Oligochaeta	17	0.459	95.057
Polypedilum sp.	Chironomidae/Diptera	16	0.432	95.489
Corisella decolor	Corixidae/Hemiptera	16	0.432	95.921
Ferrissia rivularis	Ancylidae/Gastropoda	12	0.324	96.245
Prostoma sp.	Tertastemmatidae/Enopla	10	0.27	96.515
Coenagrionidae	Odonata	9	0.243	96.759
Trichocorixa calva	Corixidae/Hemiptera	9	0.243	97.002
Hydroptila sp.	Hydroptilidae/Trichoptera	9	0.243	97.245
Harnischia sp.	Chironomidae/Diptera	8	0.216	97.461
Dicrotendipes sp.	Chironomidae/Diptera	7	0.189	97.65
Limnophyes sp.	Chironomidae/Diptera	7	0.189	97.839
Simulium sp.	Simulidae/Diptera	7	0.189	98.028
Procladius sp.	Chironomidae/Diptera	6	0.162	98.19
Cladotanytarsus sp.	Chironomidae/Diptera	5	0.135	98.325
Tanypus sp.	Chironomidae/Diptera	5	0.135	98.46
Trichocorixa sp.	Corixidae/Hemiptera	5	0.135	98.595
Apedilum sp.	Chironomidae/Diptera	4	0.108	98.703
Parachironomus sp.	Chironomidae/Diptera	4	0.108	98.811
Decapoda	Malacostraca	4	0.108	98.92
Orthocladiinae	Chironomidae/Diptera	3	0.081	99.001
Ischnura sp.	Coenagrionidae/Odonata	3	0.081	99.082
Zoniagrion exlamationis	Coenagrionidae/Odonata	3	0.081	99.163
Lymnaeidae	Gastropoda	3	0.081	99.244
Lumbricina	Oligochaeta	2	0.054	99.298
Fossaria sp.	Lymnaeidae/Gastropoda	2	0.054	99.352
Staphylinidae	Coleoptera	2	0.054	99.406
Branchiura sowerbyi	Tubificidae/Oligochaeta	2	0.054	99.46

Table 14. Continued.

Chironomidae	Chironomidae/Diptera	1	0.027	99.487
Endochironomus sp.	Chironomidae/Diptera	1	0.027	99.514
Glyptotendipes sp.	Chironomidae/Diptera	1	0.027	99.541
Goeldichironomus sp.	Chironomidae/Diptera	1	0.027	99.568
Microtendipes pedellus group	Chironomidae/Diptera	1	0.027	99.595
Nanocladius sp.	Chironomidae/Diptera	1	0.027	99.622
Orthocladius complex	Chironomidae/Diptera	1	0.027	99.649
Phaenopsectra sp.	Chironomidae/Diptera	1	0.027	99.676
Corisella sp.	Corixidae/Hemiptera	1	0.027	99.703
Palmacorixa sp.	Corixidae/Hemiptera	1	0.027	99.73
Laccophilus sp.	Dytiscidae/Coleoptera	1	0.027	99.757
Liodessus obscurellus	Dytiscidae/Coleoptera	1	0.027	99.784
Ephydridae	Diptera	1	0.027	99.811
Hydrobiidae	Gastropoda	1	0.027	99.838
Berosus sp.	Hydrophilidae/Coleoptera	1	0.027	99.865
Tropisternus sp.	Hydrophilidae/Coleoptera	1	0.027	99.892
Chaetogaster diaphanus	Naididae/Oligochaeta	1	0.027	99.919
Dero sp.	Naididae/Oligochaeta	1	0.027	99.946
Gyraulus parvus	Planorbidae/Gastropoda	1	0.027	99.973
Psychoda sp.	Psychodidae/Diptera	1	0.027	100
	Total	3702		

Table 15. Benthic metrics by transect (including the means) for the 5 Salt Slough sites.

	SSL 1					SSL 2					SSL 3					SSL 4					SSL 5				
Transect Number	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV
Taxonomic Richness	15	8	18	14	38	14	19	18	17	16	23	20	14	19	24	15	18	15	16	11	18	16	19	18	9
Cumulative Taxa				27					30					36					26					31	
Percent Dominant Taxon	85	72	33	64	43	60	50	72	61	18	40	63	58	54	22	40	37	64	47	32	34	35	54	41	27
Plecoptera Taxa	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-
Trichoptera Taxa	1	2	2	2	35	1	1	1	1	0	2	2	2	2	0	0	0	0	0	-	0	0	0	0	-
EPT Taxa	1	2	2	2	35	1	1	1	1	0	2	2	2	2	0	0	0	0	0	-	0	0	0	0	-
EPT Index (%)	0	18	2	7	148	5	1	2	3	73	11	1	11	8	79	0	0	0	0	-	0	0	0	0	-
Sensitive EPT Index (%)	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-
Shannon Diversity	0.7	0.9	1.9	1	55	1.6	1.6	1.3	2	10	2.0	1.5	1.6	2	17	2.1	1.8	1.3	2	22	1.6	2.0	1.6	2	12
Tolerance Value	4.3	4.2	7.0	5	31	4.7	4.7	4.6	5	1	5.2	5.2	4.7	5	5	8.1	7.8	8.0	8	2	7.2	8.2	7.6	8	7
Percent Intolerant Taxa (0-2)	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-
Percent Tolerant Taxa (8-10)	4	0	56	20	156	2	15	9	9	72	5	15	1	7	103	82	81	84	83	2	39	56	34	43	27
Percent Baetidae	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-
Percent Chironomidae	1	4	18	8	117	8	7	14	10	40	25	9	17	17	46	19	3	4	9	105	60	49	68	59	16
Percent Hydropsychidae	0	18	1	6	155	5	1	2	3	73	10	0	10	7	82	0	0	0	0	-	0	0	0	0	-
Percent Collectors	6	5	15	9	63	13	39	8	20	82	32	8	20	20	62	43	26	43	37	27	39	61	73	58	31
Percent Filterers	91	94	30	72	50	82	58	86	75	20	64	77	79	73	12	0	3	4	2	90	23	4	7	11	90
Percent Scrapers	0	0	36	12	168	3	2	1	2	39	2	1	0	1	111	55	69	50	58	17	36	20	18	25	41
Percent Predators	3	0	18	7	138	1	1	4	2	87	1	14	0	5	151	2	3	3	3	22	2	15	1	6	129
Percent Shredders	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	173
Abundance (#/sample)	517	2578	3245	2113	67	97	942	154	398	119	562	306	458	442	29	58	372	956	462	99	800	175	235	403	85

Table 16. Eigenvalues and proportion of variance explained for the correlation matrix of the benthic metrics.

Factor	Eigenvalue	Proportion	Cumulative
Factor 1	6.3692	0.3538	0.3538
Factor 2	4.6063	0.2559	0.6098
Factor 3	2.2216	0.1234	0.7332
Factor 4	1.3326	0.0740	0.8072
Factor 5	1.1284	0.0627	0.8699
Factor 6	0.8495	0.0472	0.9171
Factor 7	0.5951	0.0331	0.9502
Factor 8	0.5832	0.0324	0.9825
Factor 9	0.1488	0.0083	0.9908
Factor 10	0.0751	0.0042	0.9950
Factor 11	0.0419	0.0023	0.9973
Factor 12	0.0160	0.0009	0.9982
Factor 13	0.0134	0.0007	0.9990
Factor 14	0.0107	0.0006	0.9995
Factor 15	0.0055	0.0003	0.9998
Factor 16	0.0022	0.0001	1.0000
Factor 17	0.0006	0.0000	1.0000
Factor 18	0.0000	0.0000	1.0000

Table 17. Eigenvectors for the five dominant factors of the correlation matrix of benthic metrics.

Metric	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Factor 1					
EPT Taxa	0.3710	0.1266	0.0331	0.1270	-0.1054
Percent Intolerant Taxa (0-2)	0.3553	0.0050	0.0921	-0.1996	0.0548
Percent Baetidae	0.3545	0.0428	0.1475	-0.0046	-0.0999
Sensitive EPT Index (%)	0.3540	0.0047	0.0909	-0.2030	0.0577
EPT Index (%)	0.3446	0.1909	-0.0262	-0.0065	0.0846
Taxonomic Richness	0.3414	-0.1562	-0.0512	0.0212	-0.0570
Abundance (#/sample)	0.3302	0.0998	0.1384	0.0507	-0.0781
Factor 2					
Percent Filterers	-0.0921	0.4156	-0.1531	-0.1264	-0.1546
Percent Collectors	0.0913	-0.4032	-0.1636	0.2273	-0.0164
Percent Dominant Taxon	-0.1285	0.3812	0.2153	0.1227	-0.0799
Percent Hydropsychidae	-0.0389	0.3283	-0.2818	0.2287	0.1860
Shannon Diversity	0.1979	-0.3268	-0.1788	-0.1003	-0.0162
Factor 3					
Percent Scrapers	-0.0189	-0.0611	0.5908	0.1346	0.2736
Percent Tolerant Taxa (8-10)	-0.1238	-0.2415	0.4680	0.1620	-0.0613
Percent Chironomidae	-0.0131	-0.2946	-0.3722	0.1622	0.0693
Factor 4					
Percent Shredders	-0.0660	-0.0119	0.0148	-0.5624	-0.5441
Trichoptera Taxa	0.2118	0.2400	-0.1283	0.4366	-0.1314
Factor 5					
Percent Predators	0.0407	0.0980	-0.0819	-0.4208	0.7028

Table 18. Spearman rank correlation coefficients (top) and p-values (bottom) for upstream-downstream trend in the benthic metrics.

Benthic Habitat Metric	Del Puerto	Orestimba	Salt Slough
Abundance (#/sample)	0.7000 0.1881	0.4061 0.2443	-0.3000 0.6238
EPT Index (%)	0.4617 0.4338	0.1785 0.6218	-0.6669 0.2189
EPT Taxa	0.5271 0.3615	0.2141 0.5526	-0.6669 0.2189
Percent Baetidae	0.4617 0.4338	0.0624 0.8640	. .
Percent Chironomidae	0.6000 0.2848	-0.5758 0.0816	0.7000 0.1881
Percent Collectors	0.6000 0.2848	-0.2364 0.5109	0.9747 0.0048
Percent Dominant Taxon	0.5000 0.3910	0.4424 0.2004	-1.0000 <.0001
Percent Filterers	-0.5000 0.3910	-0.6768 0.0316	-0.6000 0.2848
Percent Hydropsychidae	. .	-0.3325 0.3479	-0.6669 0.2189
Percent Intolerant Taxa (0-2)	0.7071 0.1817	0.5222 0.1215	. .
Percent Predators	-0.7182 0.1718	0.4724 0.1680	-0.1000 0.8729
Percent Scrapers	0.5643 0.3217	0.5951 0.0695	0.5000 0.3910
Percent Shredders	-0.7071 0.1817	. .	. .
Percent Tolerant Taxa (8-10)	0.2000 0.7471	0.0000 1.0000	0.5000 0.3910

Table 18. Continued

Benthic Habitat Metric	Del Puerto	Orestimba	Salt Slough
Sensitive EPT Index (%)	0.7071	0.5222	.
	0.1817	0.1215	.
Shannon Diversity	-0.3000	-0.2622	0.9747
	0.6238	0.4643	0.0048
Taxonomic Richness	0.1000	-0.1037	0.5000
	0.8729	0.7757	0.3910
Tolerance Value	0.2000	-0.0424	0.6000
	0.7471	0.9074	0.2848
Trichoptera Taxa	0.7071	0.3097	-0.6669
	0.1817	0.3839	0.2189

Table 19. Mean scores for each benthic metric for each creek with the p-values for comparing the means among creeks based on the Kruskal-Wallis test. Pairwise comparisons between creeks are based on the Wilcoxon rank-sum test.

	Mean for each Creek				Pairwise Comparisons		
Benthic Metric	Del Puerto	Orestimba	Salt Slough	Kruskal-Wallace p-value	DO	DS	OS
Abundance (#/sample)	2691.93	1365.97	763.67	0.4091			
EPT Index (%)	1.87	2.80	3.40	0.8253			
EPT Taxa	1.40	1.30	0.93	0.9780			
Percent Baetidae	1.47	0.60	0.00	0.0994			
Percent Chironomidae	30.20	40.60	20.40	0.2107			
Percent Collectors	50.73	69.60	28.73	0.0062*			*
Percent Dominant Taxon	43.67	24.80	53.13	<0.0001*	*		*
Percent Filterers	30.67	10.53	46.80	0.1048			
Percent Hydropsychidae	0.00	0.90	3.13	0.0654			
Percent Intolerant Taxa (0-2)	0.07	0.27	0.00	1.0000			
Percent Predators	4.53	4.33	4.53	0.9220			
Percent Scrapers	6.87	11.10	19.53	0.6096			
Percent Shredders	0.07	0.00	0.00	0.5000			
Percent Tolerant Taxa (8-10)	32.13	35.93	32.20	0.7364			
Plecoptera Taxa	0.00	0.00	0.00	1.0000			
Sensitive EPT Index (%)	0.20	0.87	0.00	1.0000			
Shannon Diversity	1.82	2.40	1.57	<0.0001*	*		*
Taxonomic Richness	18.80	23.07	16.67	0.0017*	*		*
Tolerance Value	6.89	7.15	6.10	0.5797			
Trichoptera Taxa	0.47	0.63	0.93	0.4297			

DO – Del Puerto vs Orestimba
DS – Del Puerto vs Salt Slough
OS – Orestimba vs Salt Slough
* - p-value < 0.05

Table 20. Spearman rank correlation coefficients (top) and p-values (bottom) for benthic metrics versus habitat metrics.

Benthic Metric	BANK STAB	BANK VEG	BEN RIFF	CHAN ALT	CH FLOW	EMBE DDED	EPI SUB	RIP BUFF	SED DEP	VEL DPTH	TOTAL
Abundance (#/sample)	0.0084	-0.3769	0.3292	0.1306	-0.0975	0.2393	0.2448	0.1418	0.3570	0.2938	0.2507
	0.9721	0.1014	0.1564	0.5833	0.6827	0.3095	0.2983	0.5510	0.1223	0.2086	0.2865
EPT Index (%)	0.2087	0.0689	-0.0209	0.4367	0.1860	0.0986	0.0405	0.5182*	0.1070	0.0602	0.1668
	0.3773	0.7730	0.9303	0.0542	0.4324	0.6791	0.8655	0.0193	0.6534	0.8008	0.4820
EPT Taxa	0.2285	-0.0303	0.0186	0.3654	0.0960	0.1352	0.0389	0.4574*	0.1065	0.0212	0.1273
	0.3325	0.8991	0.9381	0.1131	0.6872	0.5698	0.8708	0.0426	0.6551	0.9292	0.5927
Percent Baetidae	0.0837	-0.2990	0.2871	0.1232	-0.0926	0.3778	0.5089*	0.1081	0.3609	0.1724	0.2758
	0.7259	0.2003	0.2197	0.6047	0.6977	0.1005	0.0219	0.6502	0.1180	0.4674	0.2391
Percent Chironomidae	0.0434	0.1581	-0.0121	-0.1738	-0.1279	0.1965	0.0692	-0.1014	0.1260	0.1069	0.0489
	0.8560	0.5057	0.9596	0.4636	0.5911	0.4063	0.7720	0.6706	0.5965	0.6537	0.8377
Percent Collectors	0.1830	0.2365	0.2794	-0.1922	-0.2715	0.3283	0.2168	-0.0004	0.2991	0.1378	0.2109
	0.4399	0.3154	0.2328	0.4169	0.2469	0.1576	0.3585	0.9987	0.2002	0.5624	0.3720
Percent Dominant Taxon	0.1902	-0.1357	-0.3361	0.2624	0.1318	-0.5217*	-0.2449	0.1640	-0.3802	-0.2970	-0.1950
	0.4219	0.5684	0.1474	0.2638	0.5796	0.0183	0.2981	0.4898	0.0983	0.2035	0.4099
Percent Filterers	0.1719	0.0183	-0.2791	0.3454	0.1938	-0.0621	-0.0499	0.1799	-0.1343	0.1133	0.0645
	0.4687	0.9390	0.2334	0.1358	0.4130	0.7949	0.8345	0.4478	0.5725	0.6343	0.7870
Percent Hydropsychidae	0.2532	0.4810*	-0.3563	0.4643*	0.3855	-0.2989	-0.2498	0.6048*	-0.1814	-0.1866	-0.0029
	0.2815	0.0318	0.1230	0.0392	0.0932	0.2004	0.2882	0.0047	0.4440	0.4309	0.9904

* p-value < 0.05

Table 20. Continued

Benthic Metric	BANK STAB	BANK VEG	BEN RIFF	CHAN ALT	CH FLOW	EMBE DDED	EPI SUB	RIP BUFF	SED DEP	VEL DPTH	TOTAL
Percent Intolerant Taxa	-0.0110	-0.2881	0.3377	0.1253	-0.2394	0.4051	0.2233	0.0841	0.2238	0.1115	0.1741
	0.9635	0.2181	0.1453	0.5986	0.3093	0.0764	0.3441	0.7244	0.3428	0.6399	0.4629
Percent Predators	-0.3611	-0.2901	0.1755	-0.0810	-0.2290	-0.0392	-0.0623	-0.1783	0.1921	0.4113	0.0125
	0.1177	0.2146	0.4593	0.7344	0.3314	0.8696	0.7940	0.4520	0.4171	0.0716	0.9583
Percent Scrapers	-0.3624	-0.3014	0.0388	-0.0187	-0.1276	-0.2238	-0.0168	0.0758	-0.1864	-0.4877*	-0.1875
	0.1164	0.1965	0.8711	0.9377	0.5919	0.3428	0.9440	0.7508	0.4313	0.0291	0.4287
Percent Shredders	0.0201	0.0402	0.3804	0.1406	0.1856	0.2832	0.3017	-0.3025	0.3594	0.3866	0.3784
	0.9329	0.8663	0.0980	0.5544	0.4333	0.2263	0.1961	0.1948	0.1196	0.0922	0.1000
Percent Tolerant Taxa	-0.0727	0.0319	0.0897	-0.1174	-0.1740	-0.1228	0.1050	-0.1053	-0.1156	-0.3475	-0.1055
	0.7607	0.8937	0.7067	0.6222	0.4632	0.6060	0.6596	0.6587	0.6276	0.1333	0.6581
Sensitive EPT Index (%)	-0.0110	-0.2881	0.3377	0.1253	-0.2394	0.4051	0.2233	0.0841	0.2238	0.1115	0.1741
	0.9635	0.2181	0.1453	0.5986	0.3093	0.0764	0.3441	0.7244	0.3428	0.6399	0.4629
Shannon Diversity	-0.1356	0.1849	0.4248	-0.1608	0.0063	0.5743*	0.2943	0.0088	0.4497*	0.2303	0.3106
	0.5687	0.4350	0.0619	0.4983	0.9791	0.0081	0.2079	0.9707	0.0466	0.3286	0.1826
Taxonomic Richness	0.1527	0.2096	0.4144	0.0600	-0.0035	0.5753*	0.2474	0.2675	0.4042	0.1290	0.4311
	0.5205	0.3751	0.0693	0.8015	0.9883	0.0080	0.2931	0.2542	0.0771	0.5879	0.0578
Trichoptera Taxa	0.2582	0.1992	-0.1096	0.4606*	0.0963	0.0326	-0.1318	0.5872*	-0.0932	-0.1793	0.0465
	0.2718	0.3998	0.6456	0.0410	0.6862	0.8917	0.5796	0.0065	0.6958	0.4495	0.8457

* p-value < 0.05

Table 21. Spearman Rank Correlation coefficients (top) and p-values (bottom) for benthic metrics vs. physical habitat measurements (not scored on a 0-20 scale).

Benthic Metric	Width	Depth	Velocity	Canopy
Abundance (#/sample)	-0.3183	-0.4644*	0.1911	-0.1559
	0.1714	0.0391	0.4197	0.5117
EPT Index (%)	0.1926	-0.2987	0.0886	-0.1398
	0.4160	0.2008	0.7104	0.5566
EPT Taxa	0.0704	-0.3294	0.0915	-0.1449
	0.7681	0.1561	0.7013	0.5421
Percent Baetidae	-0.4395	-0.3321	0.0283	0.0331
	0.0525	0.1525	0.9057	0.8899
Percent Chironomidae	-0.1189	-0.3249	-0.1271	0.2338
	0.6176	0.1622	0.5933	0.3212
Percent Collectors	-0.3392	-0.2935	-0.1359	0.1395
	0.1434	0.2092	0.5679	0.5575
Percent Dominant Taxon	0.1686	0.3216	-0.0564	-0.5027*
	0.4773	0.1667	0.8132	0.0239
Percent Filterers	0.2971	-0.0707	0.3174	0.2009
	0.2033	0.7673	0.1727	0.3957
Percent Hydropsychidae	0.5212*	0.0623	0.1730	0.0730
	0.0184	0.7940	0.4658	0.7596
Percent Intolerant Taxa (0-2)	-0.1798	-0.4522*	-0.3234	-0.3084
	0.4481	0.0453	0.1643	0.1859
Percent Predators	-0.0322	0.1699	0.2229	-0.0513
	0.8929	0.4739	0.3450	0.8299
Percent Scrapers	0.0011	0.3248	-0.4891*	-0.4130
	0.9962	0.1624	0.0286	0.0703
Percent Shredders	-0.0597	0.0000	0.2985	0.3613
	0.8025	1.0000	0.2011	0.1175
Percent Tolerant Taxa (8-10)	-0.1875	0.2531	-0.3952	-0.0820
	0.4286	0.2816	0.0846	0.7311

* p-value < 0.05

Table 21. Continued.

Benthic Metric	Width	Depth	Velocity	Canopy
Sensitive EPT Index (%)	-0.1798	-0.4522*	-0.3234	-0.3084
	0.4481	0.0453	0.1643	0.1859
Shannon Diversity	-0.1036	-0.3439	0.0422	0.5226*
	0.6638	0.1376	0.8598	0.0181
Taxonomic Richness	-0.0727	-0.3747	0.0004	0.3044
	0.7607	0.1036	0.9987	0.1919
Trichoptera Taxa	0.3129	-0.2180	-0.1035	-0.2477
	0.1793	0.3559	0.6642	0.2924

* p-value < 0.05

Table 22. Comparison of individual water quality measurements for sites sampled over the last three (Del Puerto Creek and Salt Slough) and four (Orestimba Creek) years.

	Temperature (C)				Specific Conductance µmhos/L)				pH				Dissolved Oxygen (mg/L)				Salinity* ppt				Turbidity (NTU)			
Site	2003	2002	2001	2000	2003	2002	2001	2000	2003	2002	2001	2000	2003	2002	2001	2000	2003	2002	2001	2000	2003	2002	2001	2000
DLP1	22.9	15.6	20.2	n/a	1199	704	910	n/a	8.62	8.06	8.17	n/a	9.19	9.5	9	n/a	-	0.4	0.4	-	3.33	84	103	n/a
DLP2	25.6	20.6	23.7	n/a	1336	709	900	n/a	8.82	8.58	-	n/a	9.19	8.8	5.9	n/a	-	0.4	0.5	-	1.70	130	59	n/a
DLP3	24.1	22.2	30.5	n/a	1143	742	1086	n/a	8.12	8.34	8.51	n/a	8.06	9.1	4.7	n/a	-	0.4	0.5	-	1.93	112	25	n/a
DLP4	31.4	28.3	18.2	n/a	564	520	628	n/a	8.50	7.55	8.05	n/a	6.35	5.4	4.5	n/a	-	0.2	0.4	-	6.5	20	56	n/a
DLP5	18.7	22.7	22.1	n/a	1287	1689	992	n/a	8.30	8.51	8.32	n/a	8.24	12.2	4.0	n/a	-	0.9	0.5	-	1.53	1.1	0.64	n/a
ORE1	18.7	18.1	18.8	21.5	659	663	648	754	7.28	7.80	7.96	8.01	6.92	7.6	8.4	6.7	-	0.4	0.4	-	109.7	376	142	115
ORE2	20.3	19.9	20.3	22.5	644	605	662	744	8.01	8.01	8.12	8.23	7.90	7.8	5.0	8.2	-	0.3	0.4	-	102.8	207	126	158
ORE3	22.7	21.1	20.3	23.0	672	653	675	739	8.10	8.12	7.86	8.18	7.70	8.1	4.9	7.5	-	0.3	0.4	-	119	153	142	156
ORE4	22.1	21.0	21.4	21.4	653	640	334	683	7.98	8.09	8.17	8.01	7.72	8.3	4.2	7.8	-	0.3	0.2	-	135.6	226	104	107
ORE5	20.4	18.8	22.8	22.0	596	656	636	654	7.15	8.06	8.08	8.1	6.86	7.6	4.3	8.1	-	0.4	0.3	-	130	201	110	107
ORE6	21.8	18.7	24.7	22.9	681	696	584	644	7.01	8.21	7.8	8.25	7.14	8.1	4.0	8.9	-	0.4	0.3	-	99.7	178	128	131
ORE7	24.4	20.1	19.5	29.5	745	711	663	620	7.73	8.14	8.04	8.48	7.99	8.4	4.2	8.9	-	0.4	0.4	-	71.2	166	136	153
ORE8	25.0	22.6	21.6	22.9	755	763	695	840	7.89	8.08	7.87	8.21	7.07	7.9	3.3	8.2	-	0.4	0.4	-	116	150	92	80
ORE9	28.5	23.1	30.3	27.7	933	697	1000	857	7.91	8.13	8.59	8.4	5.78	8.0	4.0	7.8	-	0.4	0.4	-	144	236	108	213
ORE10	21.9	18.1	27.1	27.4	780	825	1044	878	7.88	8.25	8.37	8.37	7.18	3.2	4.8	13.0	-	0.1	0.5	-	0.07	0.88	0.82	0.51
SSL1	28.6	18.5	22.1	n/a	1957	1885	989	n/a	7.68	7.69	7.62	n/a	5.37	6.4	2.8	n/a	-	0.9	0.5	-	43.1	46	61	n/a
SSL2	26.1	19.3	22.1	n/a	1844	1339	1011	n/a	7.37	7.43	7.73	n/a	5.12	6.0	3.2	n/a	-	0.8	0.5	-	80.1	41	78	n/a
SSL3	27.4	20.8	24.5	n/a	1616	1256	495	n/a	7.51	7.56	7.74	n/a	5.25	6.7	2.8	n/a	-	0.7	0.3	-	66.4	52	68	n/a
SSL4	24.6	23.5	20.6	n/a	1139	1073	542	n/a	7.35	7.75	7.30	n/a	5.44	7.4	2.9	n/a	-	0.6	0.3	-	60.3	52	65	n/a
SSL5	22.6	18.0	23.2	n/a	956	1473	552	n/a	6.96	7.37	7.37	n/a	4.06	4.8	2.7	n/a	-	0.7	0.3	-	78.6	37	80	n/a

* Salinity not measured in 2000 and 2003.

Table 23. Comparison of individual physical habitat metrics (0-20 scale) and total scores for sites sampled over the last three (Del Puerto Creek and Salt Slough) or four (Orestimba Creek) years.

Site & Date	Epifaunal Substrate				Embeddedness				Velocity Depth/Divers.				Sediment Deposition				Channel Flow Status			
	00	01	02	03	00	01	02	03	00	01	02	03	00	01	02	03	00	01	02	03
DLP1	n/a	9	10	13	n/a	7	8	12	n/a	16	17	16	n/a	14	12	15	n/a	19	14	16
DLP2	n/a	7	11	13	n/a	7	7	12	n/a	14	10	15	n/a	16	12	14	n/a	16	15	16
DLP3	n/a	6	10	12	n/a	5	4	6	n/a	7	10	9	n/a	7	12	11	n/a	15	16	14
DLP4	n/a	2	9	10	n/a	10	4	8	n/a	5	10	10	n/a	6	6	10	n/a	8	8	6
DLP5	n/a	10	3	13	n/a	11	16	13	n/a	13	3	9	n/a	11	13	11	n/a	9	7	14
ORE1	6	13	9	15	4	6	0	1	7	13	6	6	4	6	1	5	16	17	14	14
ORE2	10	14	10	7	13	11	13	10	10	16	9	10	5	10	14	9	15	20	16	14
ORE3	14	15	11	10	14	16	15	13	10	18	10	9	15	16	10	10	19	20	14	16
ORE4	15	12	8	11	14	16	14	8	17	19	10	10	16	15	16	13	15	20	10	16
ORE5	17	16	10	10	13	15	7	8	19	19	17	8	15	9	14	12	15	15	15	16
ORE6	10	13	7	6	11	16	9	8	13	16	5	9	10	13	16	11	15	15	19	16
ORE7	8	10	8	12	13	16	10	8	12	18	10	10	14	16	17	15	11	20	18	16
ORE8	13	11	9	9	11	15	7	7	10	15	16	14	14	15	16	12	10	20	19	13
ORE9	14	10	11	10	14	12	9	6	10	14	10	6	14	5	16	8	15	20	9	9
ORE10	10	7	8	10	7	6	14	10	13	7	3	10	12	5	8	13	9	6	6	14
SSL1	n/a	8	2	5	n/a	1	0	0	n/a	11	11	9	n/a	4	2	1	n/a	20	13	14
SSL2	n/a	5	1	6	n/a	1	0	0	n/a	12	13	6	n/a	5	2	6	n/a	19	14	19
SSL3	n/a	2	1	6	n/a	1	0	0	n/a	11	9	9	n/a	4	2	4	n/a	19	11	15
SSL4	n/a	6	6	8	n/a	0	0	0	n/a	12	6	7	n/a	2	3	5	n/a	20	13	19
SSL5	n/a	2	6	2	n/a	0	0	0	n/a	2	0	1	n/a	1	3	1	n/a	18	9	15

Table 23. Continued.

Site & Date	Channel Alteration				Frequency Bends/Riffles				Left Bank Stability				Right Bank Stability				Left Bank Veget. Protect.			
	00	01	02	03	00	01	02	03	00	01	02	03	00	01	02	03	00	01	02	03
DLP1	n/a	15	14	15	n/a	18	15	15	n/a	7	5	5	n/a	8	5	6	n/a	7	3	5
DLP2	n/a	12	8	10	n/a	7	12	10	n/a	2	3	4	n/a	2	3	2	n/a	2	3	4
DLP3	n/a	13	14	14	n/a	7	14	11	n/a	6	7	8	n/a	4	7	6	n/a	6	7	5
DLP4	n/a	2	11	6	n/a	2	8	6	n/a	5	6	5	n/a	3	7	4	n/a	5	4	3
DLP5	n/a	17	16	17	n/a	15	9	11	n/a	7	7	8	n/a	9	7	8	n/a	7	5	5
ORE1	18	16	14	16	5	15	4	5	1	8	6	5	1	2	3	4	2	9	6	6
ORE2	18	15	15	13	17	12	11	8	1	5	6	6	1	6	6	6	2	9	6	6
ORE3	15	15	8	7	18	15	7	6	7	3	3	3	7	6	7	3	6	6	4	3
ORE4	15	14	14	16	10	11	6	10	5	4	4	6	5	2	2	3	4	5	3	4
ORE5	15	15	14	14	18	16	16	11	7	6	7	6	6	5	7	6	9	8	7	6
ORE6	14	14	13	11	8	15	15	9	8	8	8	8	8	8	8	7	9	6	6	6
ORE7	15	15	14	15	10	16	7	12	4	8	7	7	5	6	6	6	6	6	7	6
ORE8	13	13	14	13	15	10	11	13	7	8	4	5	9	8	6	7	7	6	7	5
ORE9	15	15	15	13	10	15	9	10	9	8	7	3	9	8	8	3	8	7	7	3
ORE10	19	15	13	12	16	13	11	12	7	5	4	3	7	6	4	2	3	4	4	1
SSL1	n/a	15	14	16	n/a	15	7	4	n/a	7	5	3	n/a	6	3	3	n/a	8	6	3
SSL2	n/a	16	15	16	n/a	7	1	5	n/a	9	8	10	n/a	9	8	6	n/a	7	7	8
SSL3	n/a	14	14	15	n/a	8	2	5	n/a	8	6	6	n/a	8	6	7	n/a	6	7	6
SSL4	n/a	15	13	13	n/a	11	5	6	n/a	5	2	0	n/a	6	7	6	n/a	4	4	3
SSL5	n/a	6	0	2	n/a	6	0	0	n/a	1	0	0	n/a	1	0	0	n/a	1	0	0

Table 23. Continued.

Site & Date	Right Bank Veget. Protect.				Left Bank Ripar. Zone				Right Bank Ripar. Zone				Total Score			
	00	01	02	03	00	01	02	03	00	01	02	03	00	01	02	03
DLP1	n/a	8	4	5	n/a	5	1	2	n/a	7	3	3	n/a	140	111	128
DLP2	n/a	2	3	1	n/a	1	1	3	n/a	1	1	3	n/a	89	89	107
DLP3	n/a	6	7	3	n/a	3	4	3	n/a	4	4	4	n/a	89	116	106
DLP4	n/a	3	4	3	n/a	4	1	2	n/a	4	1	2	n/a	59	79	75
DLP5	n/a	7	5	4	n/a	8	6	6	n/a	8	6	5	n/a	132	103	124
ORE1	2	7	6	6	5	8	4	6	3	8	4	3	74	128	77	92
ORE2	2	9	6	6	5	8	5	5	5	6	3	3	104	141	120	103
ORE3	6	4	7	6	3	3	1	2	3	3	4	4	137	140	101	92
ORE4	4	3	3	4	4	3	2	3	5	3	2	5	129	127	94	109
ORE5	8	8	7	6	8	5	4	6	8	5	3	5	158	142	128	114
ORE6	8	5	6	6	6	3	5	5	4	2	4	3	124	134	121	105
ORE7	9	9	7	8	3	3	4	4	6	6	4	5	116	149	119	124
ORE8	7	6	7	6	6	3	4	2	6	3	5	4	128	133	125	110
ORE9	8	7	7	3	7	5	3	3	8	5	5	3	141	131	116	80
ORE10	3	3	4	1	3	3	6	3	3	3	6	3	112	83	91	94
SSL1	n/a	6	6	3	n/a	9	8	6	n/a	9	8	3	n/a	119	85	70
SSL2	n/a	7	7	6	n/a	9	8	10	n/a	9	8	8	n/a	115	92	106
SSL3	n/a	6	7	6	n/a	8	4	3	n/a	5	5	5	n/a	100	74	87
SSL4	n/a	4	6	7	n/a	3	4	1	n/a	3	4	6	n/a	91	73	81
SSL5	n/a	1	0	0	n/a	0	0	1	n/a	0	0	1	n/a	39	18	23

Table 24a. Mean Scores for each physical habitat metric, total score, and stream measurement for years 2000, 2001, 2002 and 2003 for Orestimba creek. The p-value is based on Friedman's test and the pairwise comparisons are based on the Wilcoxon signed rank test.

Habitat Metric	2000	2001	2002	2003	Friedman p-value	00 vs 01	00 vs 02	00 vs 03	01 vs 02	01 vs 03	02 vs 03
EPI SUB	11.7	12.1	9.1	10	0.0880						
EMBEDDED	11.4	12.9	9.8	7.9	0.0042			*		*	*
VEL DPTH	12.1	15.5	9.6	9.2	0.0012				*	*	
SED DEP	11.9	11	12.8	10.8	0.3103						
CH FLOW	14	17.3	14	14.4	0.1198						
CHAN ALT	15.7	14.7	13.4	13	0.0110		*	*			
BENRIFF	12.7	13.8	9.7	9.6	0.0160				*	*	
BANKSTAB	11.4	12	11.3	9.9	0.3816						
BANKVEG	11.3	12.7	11.7	9.8	0.0855						
RIPBUFF	10.1	8.8	7.8	7.7	0.0781			*			
TOTAL	122.3	130.8	109.2	102.3	0.0109			*	*	*	
WIDTH	3.86	6.17	4.58	4.54	0.0143	*			*		
DEPTH	0.22	0.479	0.2	18.4	0.0001	*		*	*	*	*
VELOCITY	0.445	0.514	0.351	0.351	0.0421				*	*	
CANOPY	32.9	28.9	50.1	31.2	0.2578				*		

Table 24b. Mean Scores for each physical habitat metric, total score, and stream measurement for years 2001, 2002 and 2003 for Del Puerto creek. The p-value is based on Friedman's test.

Habitat Metric	2001	2002	2003	Friedman p-value
EPI SUB	6.8	8.6	12.2	0.0150*
EMBEDDED	8	7.8	10.2	0.2415
VEL DPTH	11	10	11.8	0.6778
SED DEP	10.8	11	12.2	0.6778
CH FLOW	13.4	12	13.2	0.4857
CHAN ALT	11.8	12.6	12.4	0.5890
BENRIFF	9.8	11.6	10.6	0.6918
BANKSTAB	10.6	11.4	11.2	0.5890
BANKVEG	10.6	9	7.6	0.2415
RIPBUFF	9	5.6	6.6	0.4857
TOTAL	101.8	99.6	108	0.8539
WIDTH	2.18	2.92	2.28	0.6918
DEPTH	0.382	0.138	15.6	0.0150*
VELOCITY	0.446	0.42	0.43	0.8187
CANOPY	15.2	24.8	26.4	0.6065

* $p < 0.05$

Table 24c. Mean Scores for each physical habitat metric, total score, and stream measurement for years 2001, 2002 and 2003 for Salt Slough. The p-value is based on Friedman's test.

Habitat Metric	2001	2002	2003	Friedman p-value
EPI SUB	4.6	3.2	5.4	0.2494
EMBEDDED	0.6	0	0	0.0498 *
VEL DPTH	9.6	7.8	6.4	0.1146
SED DEP	3.2	2.4	3.4	0.8007
CH FLOW	19.2	12	16.4	0.0083 *
CHAN ALT	13.2	11.2	12.4	0.0594
BENRIFF	9.4	3	4	0.0156 *
BANKSTAB	12	9	8.2	0.0147 *
BANKVEG	10	10	8.4	0.5836
RIPBUFF	11	9.8	8.8	0.8465
TOTAL	92.8	68.4	73.4	0.0150 *
WIDTH	20.8	18.96	17.92	0.1040
DEPTH	0.79	0.586	45.2	0.0224 *
VELOCITY	0.28	0.208	0.208	0.0242 *
CANOPY	0.2	0	0	0.3679

* $p < 0.05$

Table 25. Range of chlorpyrifos and diazinon concentrations measured historically in Del Puerto Creek, Orestimba Creek and Salt Slough.

OP Pesticide	Location	Range Conc (ng/L)	Years	Reference
Chlorpyrifos	Del Puerto Creek	0 - 120	1991/93	Poletika, 2001
Chlorpyrifos	Orestimba Creek	0 - 2,282	1996/97	Poletika and Robb, 1998
Chlorpyrifos	Salt Slough	0 - 120	1991/93	Poletika, 2001
Diazinon	Del Puerto Creek	0 - 2,600	1991/93	Poletika, 2001
Diazinon	Orestimba Creek	0 - 29,371	1996/97	Poletika and Robb, 1998
Diazinon	Salt Slough	0 - 330	1991/93	Poletika, 2001

Table 26. Comparison of resident benthic species by site in Del Puerto Creek, Orestimba Creek and Salt Slough with acute chlorpyrifos toxicity data from Giesy et al.1999 and Barron and Woodburn. 1995.

Species	Collection Site	Abundance	EC or LC50 Values (μg/L)
Cheumatopsyche sp.	DLP 5	1	30.6[A]
Cheumatopsyche sp.	ORE 1	1	30.6[A]
Hydropsyche californica	ORE 3	8	30.6[A]
Hydropsyche californica	ORE 4	17	30.6[A]
Hydropsyche californica	ORE 5	6	30.6[A]
Hydropsyche californica	ORE 6	4	30.6[A]
Hydropsyche californica	ORE 7	34	30.6[A]
Hydropsyche californica	ORE 9	1	30.6[A]
Hydropsyche californica	SSL 1	58	30.6[A]
Hydropsyche californica	SSL 2	12	30.6[A]
Hydropsyche californica	SSL 3	63	30.6[A]
Chironomus sp.	DLP 1	1	0.07[B]
Chironomus sp.	DLP 4	3	0.07[B]
Chironomus sp.	ORE 1	15	0.07[B]
Chironomus sp.	ORE 2	1	0.07[B]
Chironomus sp.	ORE 5	31	0.07[B]
Chironomus sp.	ORE 6	45	0.07[B]
Chironomus sp.	ORE 9	12	0.07[B]
Chironomus sp.	SSL 1	5	0.07[B]
Chironomus sp.	SSL 2	3	0.07[B]
Chironomus sp.	SSL 3	3	0.07[B]
Chironomus sp.	SSL 5	30	0.07[B]
Cricotopus sp.	DLP 1	7	3.5-90
Cricotopus sp.	DLP 2	10	3.5-90
Cricotopus sp.	DLP 3	69	3.5-90
Cricotopus sp.	DLP 4	209	3.5-90

Table 26. Continued.

Cricotopus sp.	DLP 5	15	3.5-90
Cricotopus sp.	ORE 1	37	3.5-90
Cricotopus sp.	ORE 2	35	3.5-90
Cricotopus sp.	ORE 4	123	3.5-90
Cricotopus sp.	ORE 4	198	3.5-90
Cricotopus sp.	ORE 5	49	3.5-90
Cricotopus sp.	ORE 6	174	3.5-90
Cricotopus sp.	ORE 7	295	3.5-90
Cricotopus sp.	ORE 8	199	3.5-90
Cricotopus sp.	ORE 9	6	3.5-90
Cricotopus sp.	ORE 10	50	3.5-90
Cricotopus sp.	SSL 1	18	3.5-90
Cricotopus sp.	SSL 2	11	3.5-90
Cricotopus sp.	SSL 2	2	3.5-90
Cricotopus sp.	SSL 3	73	3.5-90
Cricotopus sp.	SSL 4	10	3.5-90
Cricotopus sp.	SSL 5	293	3.5-90
Dicrotendipes sp.	DLP 1	5	7-40[C]
Dicrotendipes sp.	DLP 2	11	7-40[C]
Dicrotendipes sp.	DLP 3	4	7-40[C]
Dicrotendipes sp.	DLP 4	293	7-40[C]
Dicrotendipes sp.	DLP 5	1	7-40[C]
Dicrotendipes sp.	ORE 1	96	7-40[C]
Dicrotendipes sp.	ORE 2	11	7-40[C]
Dicrotendipes sp.	ORE 3	2	7-40[C]
Dicrotendipes sp.	ORE 5	20	7-40[C]
Dicrotendipes sp.	ORE 6	41	7-40[C]
Dicrotendipes sp.	ORE 7	10	7-40[C]

Table 26. Continued.

Dicrotendipes sp.	ORE 8	16	7-40[C]
Dicrotendipes sp.	ORE 10	28	7-40[C]
Dicrotendipes sp.	SSL 2	2	7-40[C]
Dicrotendipes sp.	SSL 4	4	7-40[C]
Dicrotendipes sp.	SSL 5	1	7-40[C]
Dugesia tigrina	DLP 1	7	2.0-4.3[D]
Dugesia tigrina	DLP 2	89	2.0-4.3[D]
Dugesia tigrina	DLP 5	2	2.0-4.3[D]
Dugesia tigrina	ORE 1	4	2.0-4.3[D]
Dugesia tigrina	ORE 3	1	2.0-4.3[D]
Dugesia tigrina	ORE 4	11	2.0-4.3[D]
Dugesia tigrina	ORE 5	3	2.0-4.3[D]
Dugesia tigrina	ORE 6	1	2.0-4.3[D]
Dugesia tigrina	ORE 7	20	2.0-4.3[D]
Dugesia tigrina	ORE 8	10	2.0-4.3[D]
Dugesia tigrina	ORE 10	1	2.0-4.3[D]
Gammarus sp.	DLP 1	1	0.11[E]
Gammarus sp.	ORE 2	4	0.11[E]
Gammarus sp.	ORE 3	8	0.11[E]
Gammarus sp.	ORE 4	4	0.11[E]
Gammarus sp.	ORE 9	1	0.11[E]
Gammarus sp.	SSL 1	24	0.11[E]
Gammarus sp.	SSL 2	9	0.11[E]
Gammarus sp.	SSL 3	24	0.11[E]
Hyalella sp.	DLP 5	1	1.3
Hyalella sp.	ORE 1	11	1.3
Hyalella sp.	ORE 4	1	1.3
Hyalella sp.	ORE 5	7	1.3

Table 26. Continued.

Hyalella sp.	ORE 6	3	1.3
Hyalella sp.	ORE 7	4	1.3
Hyalella sp.	ORE 8	78	1.3
Hyalella sp.	ORE 10	1	1.3
Hyalella sp.	SSL 2	30	1.3
Hyalella sp.	SSL 3	4	1.3
Hyalella sp.	SSL 4	6	1.3
Ischnura sp.	SSL 3	2	11.4[F]
Ischnura sp.	SSL 4	1	11.4[F]
Limnodrilus hoffmeisteri	ORE 1	4	>36
Limnodrilus hoffmeisteri	ORE 2	2	>36
Limnodrilus hoffmeisteri	ORE 5	1	>36
Limnodrilus hoffmeisteri	ORE 6	19	>36
Limnodrilus hoffmeisteri	SSL 3	5	>36
Limnodrilus hoffmeisteri	SSL 5	2	>36
Limnodrilus sp.	ORE 1	4	>36[G]
Paratanytarsus sp.	DLP 1	1	<1.6
Paratanytarsus sp.	DLP 2	9	<1.6
Paratanytarsus sp.	DLP 4	27	<1.6
Paratanytarsus sp.	ORE 1	18	<1.6
Paratanytarsus sp.	ORE 2	3	<1.6
Paratanytarsus sp.	ORE 4	1	<1.6
Paratanytarsus sp.	ORE 5	2	<1.6
Paratanytarsus sp.	ORE 8	12	<1.6
Paratanytarsus sp.	ORE 10	3	<1.6
Paratanytarsus sp.	SSL 1	3	<1.6
Paratanytarsus sp.	SSL 2	2	<1.6
Paratanytarsus sp.	SSL 3	12	<1.6

Table 26. Continued.

Paratanytarsus sp.	SSL 4	7	<1.6
Paratanytarsus sp.	SSL 5	88	<1.6
Simulium sp.	DLP 1	176	27[H]
Simulium sp.	DLP 2	367	27[H]
Simulium sp.	DLP 3	526	27[H]
Simulium sp.	DLP 4	1	27[H]
Simulium sp.	DLP 5	34	27[H]
Simulium sp.	ORE 2	26	27[H]
Simulium sp.	ORE 3	135	27[H]
Simulium sp.	ORE 4	121	27[H]
Simulium sp.	ORE 5	14	27[H]
Simulium sp.	ORE 6	1	27[H]
Simulium sp.	ORE 7	2	27[H]
Simulium sp.	ORE 8	4	27[H]
Simulium sp.	ORE 9	11	27[H]
Simulium sp.	ORE 10	7	27[H]
Simulium sp.	SSL 2	2	27[H]
Simulium sp.	SSL 3	5	27[H]
Tanypus sp.	SSL 2	2	1.5[I]
Tanypus sp.	SSL 3	2	1.5[I]
Tanypus sp.	SSL 5	1	1.5[I]

[A] Listed toxicity value was for *Hydropsyche/Cheumatopsyche sp.*
[B] Listed toxicity value was for *Chironomus tentans.*
[C] Listed toxicity value was for *Dicrotendipes californicus.*
[D] Listed toxicity value was for *Dugesia dorotocephala.*
[E] Listed toxicity value was for *Gammarus lacustris.* 2 values listed for this species.
Used conservative value, other value = 0.76 µg/L.
[F] Listed toxicity value was for *Enallagma/Ischnura sp.*
[G] Listed toxicity value was for *Limnodrilus hoffmeisteri.*
[H] Listed toxicity value was for *Simulium vitattum.*
[I] Listed toxicity value was for *Tanypus grodhaus.*

Table 27. Comparison of resident benthic species by site in Del Puerto Creek, Orestimba Creek and Salt Slough with acute diazinon toxicity data from Giddings et al. 2000.

Species	Collection Site	Abundance	EC or LC50 Values (µg/L)
Baetis adonis	ORE 10	22	24[A]
Baetis sp.	ORE 10	1	24[A]
Baetis tricaudatus	DLP 5	42	24[A]
Gammarus sp.	DLP 1	1	184[B]
Gammarus sp.	ORE 2	4	184[B]
Gammarus sp.	ORE 3	8	184[B]
Gammarus sp.	ORE 4	4	184[B]
Gammarus sp.	ORE 9	1	184[B]
Gammarus sp.	SSL 1	24	184[B]
Gammarus sp.	SSL 2	9	184[B]
Gammarus sp.	SSL 3	24	184[B]
Hyalella sp.	DLP 5	1	22[C]
Hyalella sp.	ORE 1	11	22[C]
Hyalella sp.	ORE 4	1	22[C]
Hyalella sp.	ORE 5	7	22[C]
Hyalella sp.	ORE 6	3	22[C]
Hyalella sp.	ORE 7	4	22[C]
Hyalella sp.	ORE 8	78	22[C]
Hyalella sp.	ORE 10	1	22[C]
Hyalella sp.	SSL 2	30	22[C]
Hyalella sp.	SSL 3	4	22[C]
Hyalella sp.	SSL 4	6	22[C]
Physa sp.	DLP 1	6	48[D]
Physa sp.	DLP 2	42	48[D]
Physa sp.	DLP 3	71	48[D]
Physa sp.	DLP 5	142	48[D]

Table 27. Continued.

Physa sp.	ORE 1	16	48[D]
Physa sp.	ORE 2	1	48[D]
Physa sp.	ORE 3	9	48[D]
Physa sp.	ORE 4	13	48[D]
Physa sp.	ORE 5	60	48[D]
Physa sp.	ORE 6	16	48[D]
Physa sp.	ORE 7	51	48[D]
Physa sp.	ORE 8	66	48[D]
Physa sp.	ORE 9	218	48[D]
Physa sp.	ORE 10	7	48[D]
Physa sp.	SSL 1	99	48[D]
Physa sp.	SSL 2	10	48[D]
Physa sp.	SSL 3	7	48[D]
Physa sp.	SSL 4	170	48[D]
Physa sp.	SSL 5	170	48[D]
Physa sp.	DLP 1	6	4800[E]
Physa sp.	DLP 2	42	4800[E]
Physa sp.	DLP 3	71	4800[E]
Physa sp.	DLP 5	142	4800[E]
Physa sp.	ORE 1	16	4800[E]
Physa sp.	ORE 2	1	4800[E]
Physa sp.	ORE 3	9	4800[E]
Physa sp.	ORE 4	13	4800[E]
Physa sp.	ORE 5	60	4800[E]
Physa sp.	ORE 6	16	4800[E]
Physa sp.	ORE 7	51	4800[E]
Physa sp.	ORE 8	66	4800[E]
Physa sp.	ORE 9	218	4800[E]

Table 27. Continued.

Physa sp.	ORE 10	7	4800[E]
Physa sp.	SSL 1	99	4800[E]
Physa sp.	SSL 2	10	4800[E]
Physa sp.	SSL 3	7	4800[E]
Physa sp.	SSL 4	170	4800[E]
Physa sp.	SSL 5	170	4800[E]
Undetermined Tubificidae	DLP 1	77	3160[F]
Undetermined Tubificidae	DLP 2	4	3160[F]
Undetermined Tubificidae	DLP 3	105	3160[F]
Undetermined Tubificidae	DLP 5	5	3160[F]
Undetermined Tubificidae	ORE 1	1	3160[F]
Undetermined Tubificidae	ORE 2	24	3160[F]
Undetermined Tubificidae	ORE 3	9	3160[F]
Undetermined Tubificidae	ORE 4	14	3160[F]
Undetermined Tubificidae	ORE 5	112	3160[F]
Undetermined Tubificidae	ORE 6	138	3160[F]
Undetermined Tubificidae	ORE 7	10	3160[F]
Undetermined Tubificidae	ORE 8	10	3160[F]
Undetermined Tubificidae	ORE 9	17	3160[F]
Undetermined Tubificidae	SSL 3	4	3160[F]
Undetermined Tubificidae	SSL 4	26	3160[F]
Undetermined Tubificidae	SSL 5	42	3160[F]

[A] Listed toxicity value was for *Baetis intermedius.*
[B] Listed toxicity value was for *Gammarus lacustris.*
[C] Listed toxicity value was for *Hyalella azteca.*
[D] Listed toxicity value was for *Physa gyrina.*
[E] Listed toxicity value was for *Physa acuta.*
[F] Listed toxicity value was for *Tubifex* species.

Table 28a. Mean scores for each benthic metric by year for Orestimba Creek with p-values for among years means comparison and pairwise comparisions between years.

Benthic Metric	2000	2001	2002	2003	Friedman p-value+	00 vs 01	00 vs 02	00 vs 03	01 vs 02	01 vs 03	02 vs 03
Abundance (#/ sample)	1012.00	588.03	1456.92	1365.97	0.1604	-	-	-	-	-	-
Cumulative EPT Taxa	.	1.90	1.30	.	0.4795	-	-	-	-	-	-
Cumulative Taxa	.	35.30	33.20	.	0.7389	-	-	-	-	-	-
Dipteran Taxa	.	1.53	.	.	.	-	-	-	-	-	-
EPT Index (%)	2.03	4.23	1.37	2.80	0.6274	-	-	-	-	-	-
EPT Taxa	0.93	1.00	0.93	1.30	0.3803	-	-	-	-	-	-
Ephemeroptera Taxa	0.60	0.57	0.40	.	0.5045	-	-	-	-	-	-
Non-Insect Taxa	.	11.63	.	.	.	-	-	-	-	-	-
Percent Baetidae	.	2.33	0.23	0.60	0.4204	-	-	-	-	-	-
Percent Chironomidae	.	18.37	34.40	40.60	0.0061	*	*	*	-	*	-
Percent Collectors	75.83	56.57	35.43	69.60	0.0002	*	*	-	*	-	*
Percent Diptera	.	9.07	.	.	.	-	-	-	-	-	-
Percent Dominant Taxon	44.20	32.13	35.10	24.80	0.0143	-	-	*	-	-	*
Percent Filterers	7.07	16.43	30.90	10.53	0.0059	*	*	-	-	-	*
Percent Grazers	3.73	3.37	8.10	.	0.4516	-	-	-	-	-	-
Percent Hydropsychidae	.	0.13	0.53	0.90	0.1667	-	-	-	-	-	-
Percent Intolerant Taxa (0-2)	0.30	0.23	0.03	0.27	0.3916	-	-	-	-	-	-
Percent Non-Insect Taxa	.	64.60	.	.	.	-	-	-	-	-	-
Percent Predators	7.10	10.40	13.77	4.33	0.6444	-	-	-	-	-	-
Percent Scrapers	.	.	.	11.10	.	-	-	-	-	-	-
Percent Shredders	6.07	6.73	11.77	0.00	0.0002	-	-	*	-	*	*
Percent Tolerant Taxa (8-10)	52.57	52.67	30.87	35.93	0.0223	-	-	-	-	*	-
Plecoptera Taxa	0.00	0.00	0.00	0.00	.	-	-	-	-	-	-
Sensitive EPT Index (%)	0.43	0.00	0.17	0.87	0.3916	-	-	-	-	-	-
Shannon Diversity	1.84	2.25	2.17	2.40	0.0223	-	-	*	-	-	*
Taxonomic Richness	17.33	22.37	21.90	23.07	0.0735	-	-	-	-	-	-
Tolerance Value	6.82	6.80	6.72	7.15	0.3686	-	-	-	-	-	-
Trichoptera Taxa	0.33	0.43	0.53	0.63	0.1403	-	-	-	-	-	-

+ Friedman test if three years, Wilcoxon signed rank test if two years. * $p < 0.05$ by Wilcoxon signed rank test.

Table 28b. Mean scores for each benthic metric by year for Del Puerto Creek with p-values for among years means comparison.

Benthic Metric	2001	2002	2003	Friedman p-value
Abundance (#/ sample)	864.87	1361.27	2691.93	0.2466
Cumulative EPT Taxa	1.40	1.80	.	1.0000
Cumulative Taxa	34.60	35.00	.	1.0000
Dipteran Taxa	1.27	.	.	.
EPT Index (%)	6.27	1.07	1.87	0.2319
EPT Taxa	1.07	0.80	1.40	0.1462
Ephemeroptera Taxa	0.80	0.53	.	0.5000
Non-Insect Taxa	9.93	.	.	.
Percent Baetidae	5.00	0.60	1.47	0.2319
Percent Chironomidae	36.27	25.13	30.20	0.4493
Percent Collectors	38.53	38.67	50.73	0.5488
Percent Diptera	12.60	.	.	.
Percent Dominant Taxon	29.87	38.13	43.67	0.0743
Percent Filterers	16.60	7.60	30.67	0.2466
Percent Grazers	3.67	15.93	.	0.0625
Percent Hydropsychidae	1.07	0.00	0.00	0.3679
Percent Intolerant Taxa (0-2)	0.00	0.07	0.07	0.3679
Percent Non-Insect Taxa	42.13	.	.	.
Percent Predators	14.80	22.47	4.53	0.0743
Percent Scrapers	.	.	6.87	.
Percent Shredders	16.07	15.13	0.07	0.0150*
Percent Tolerant Taxa (8-10)	41.67	45.20	32.13	0.8187
Plecoptera Taxa	0.00	0.00	0.00	.
Sensitive EPT Index (%)	0.00	0.40	0.20	0.3679
Shannon Diversity	2.19	2.05	1.82	0.0759
Taxonomic Richness	21.80	21.53	18.80	0.2466
Tolerance Value	6.47	7.17	6.89	0.0759
Trichoptera Taxa	0.27	0.27	0.47	0.3679

* $p < 0.05$

Table 28c. Mean scores for each benthic metric by year for Salt Slough with p-values for among years means comparison.

Benthic Metric	2001	2002	2003	Friedman p-value
Abundance (#/ sample)	399.53	1228.07	763.67	0.0743
Cumulative EPT Taxa	2.00	1.00	.	0.2500
Cumulative Taxa	35.60	40.20	.	0.1250
Dipteran Taxa	0.80	.	.	.
EPT Index (%)	2.87	2.47	3.40	0.3951
EPT Taxa	1.00	0.67	0.93	0.6918
Ephemeroptera Taxa	0.07	0.20	.	0.7500
Non-Insect Taxa	8.33	.	.	.
Percent Baetidae	0.00	0.00	0.00	.
Percent Chironomidae	35.13	33.33	20.40	0.4493
Percent Collectors	48.40	17.27	28.73	0.0408*
Percent Diptera	1.13	.	.	.
Percent Dominant Taxon	33.40	42.27	53.13	0.0150*
Percent Filterers	12.07	25.67	46.80	0.1653
Percent Grazers	8.80	14.60	.	0.3125
Percent Hydropsychidae	2.73	2.47	3.13	0.3951
Percent Intolerant Taxa (0-2)	0.00	0.00	0.00	.
Percent Non-Insect Taxa	46.27	.	.	.
Percent Predators	17.13	17.80	4.53	0.0224*
Percent Scrapers	.	.	19.53	.
Percent Shredders	10.80	24.67	0.00	0.0067*
Percent Tolerant Taxa (8-10)	71.87	43.73	32.20	0.0743
Plecoptera Taxa	0.00	0.00	0.00	.
Sensitive EPT Index (%)	0.00	0.00	0.00	.
Shannon Diversity	2.17	1.94	1.57	0.0214*
Taxonomic Richness	22.13	21.53	16.67	0.0403*
Tolerance Value	7.83	7.38	6.10	0.4493
Trichoptera Taxa	0.93	0.47	0.93	0.1009

* $p < 0.05$

Figure 1. San Joaquin River Basin showing relative locations of Del Puerto Creek, Orestimba Creek and Salt Slough.

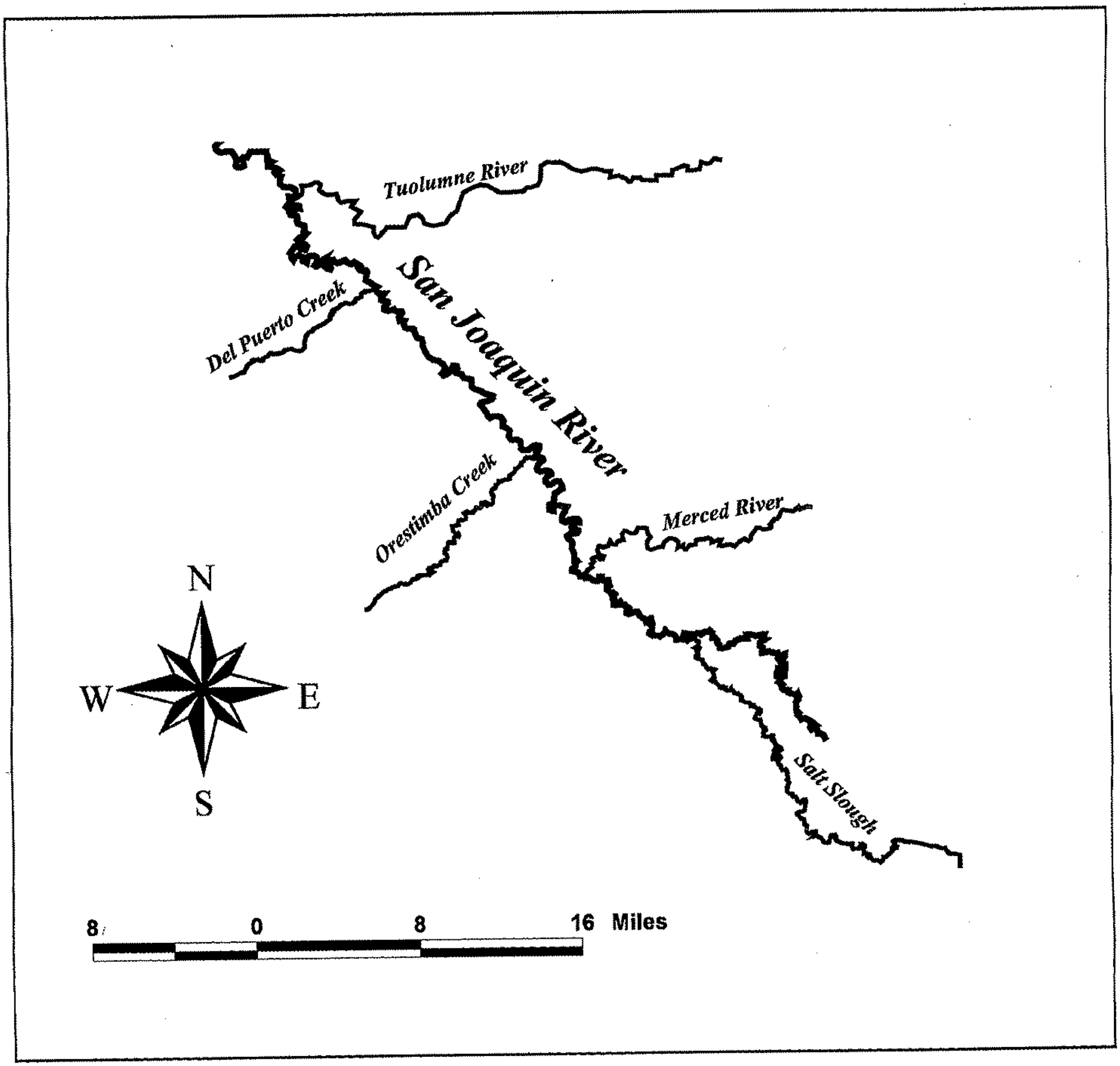
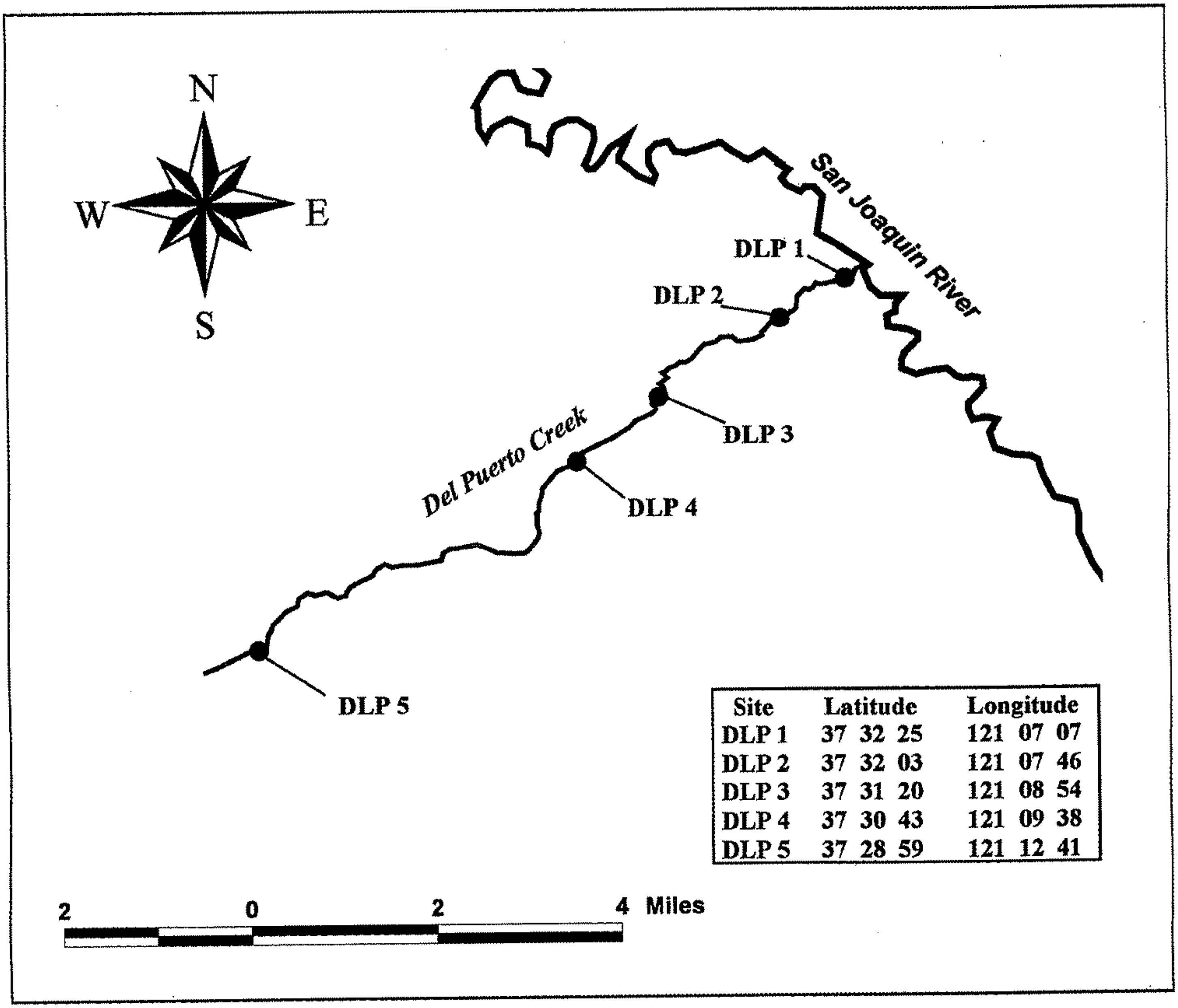
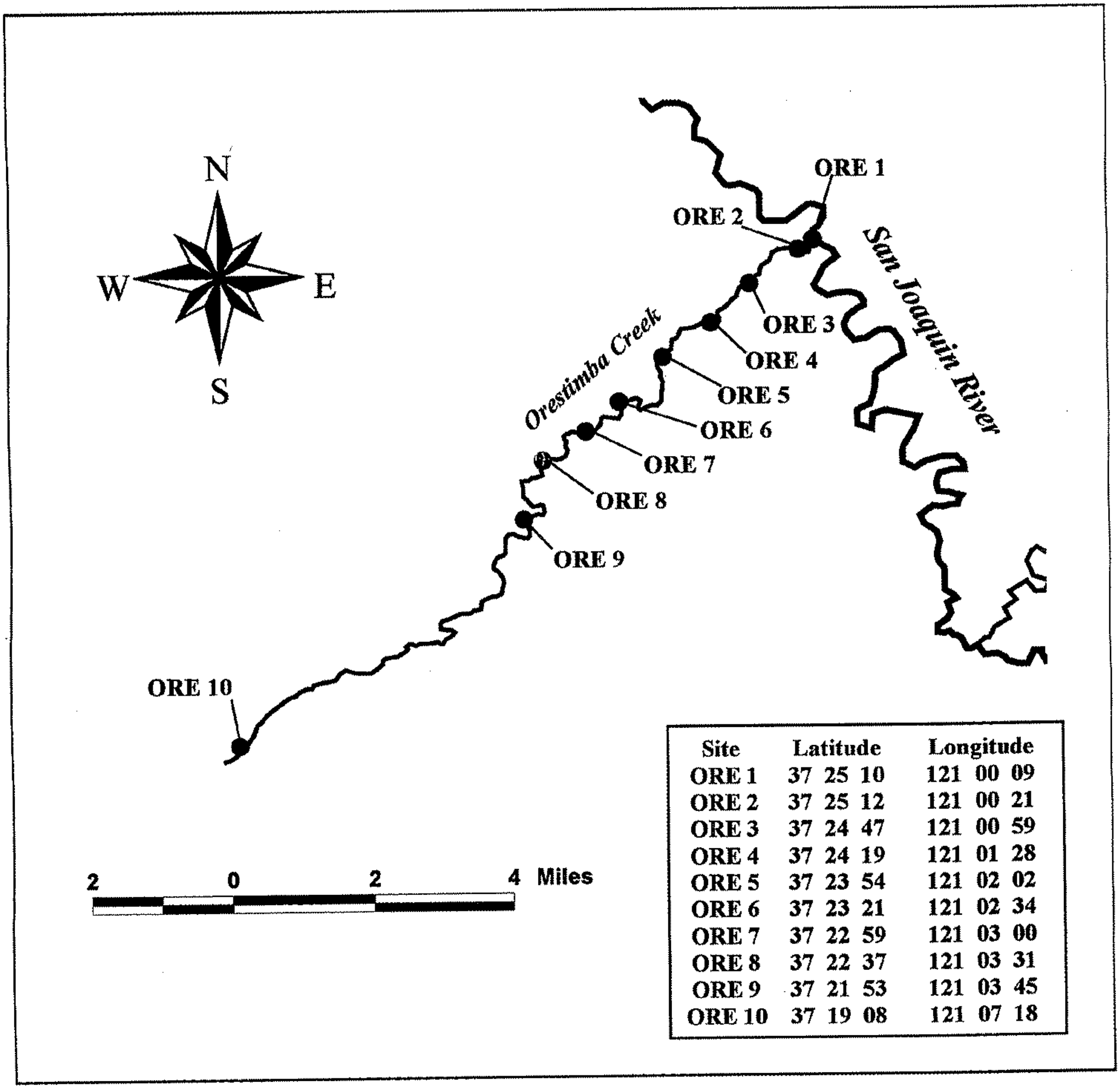


Figure 2. Del Puerto Creek sample sites.



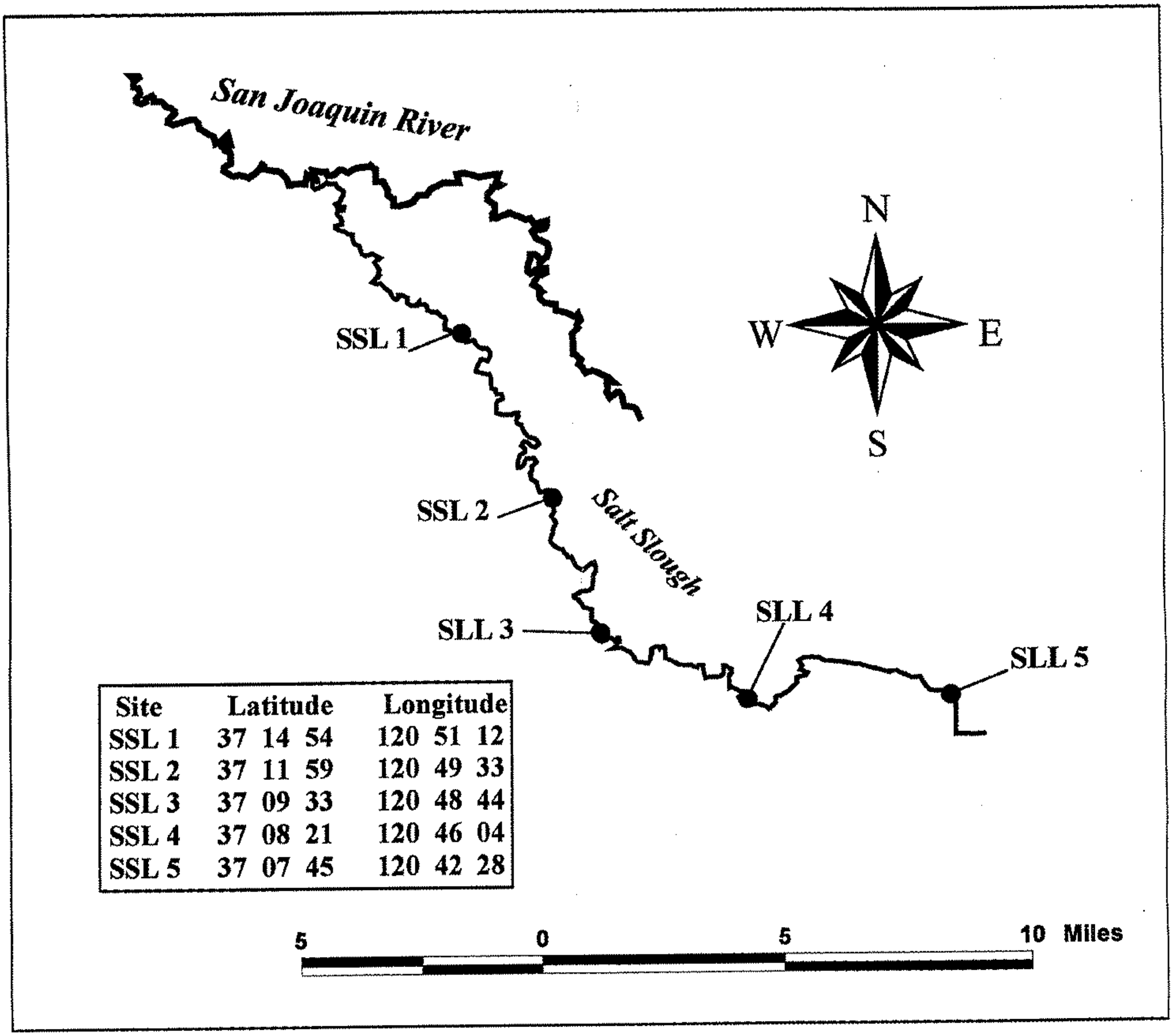
Site	Latitude	Longitude
DLP 1	37 32 25	121 07 07
DLP 2	37 32 03	121 07 46
DLP 3	37 31 20	121 08 54
DLP 4	37 30 43	121 09 38
DLP 5	37 28 59	121 12 41

Figure 3. Orestimba Creek sample sites.



Site	Latitude	Longitude
ORE 1	37 25 10	121 00 09
ORE 2	37 25 12	121 00 21
ORE 3	37 24 47	121 00 59
ORE 4	37 24 19	121 01 28
ORE 5	37 23 54	121 02 02
ORE 6	37 23 21	121 02 34
ORE 7	37 22 59	121 03 00
ORE 8	37 22 37	121 03 31
ORE 9	37 21 53	121 03 45
ORE 10	37 19 08	121 07 18

Figure 4. Salt Slough sample sites.



Site	Latitude	Longitude
SSL 1	37 14 54	120 51 12
SSL 2	37 11 59	120 49 33
SSL 3	37 09 33	120 48 44
SSL 4	37 08 21	120 46 04
SSL 5	37 07 45	120 42 28

Figure 5. Macroinvertebrate richness for each transect and site total for the 5 Del Puerto Creek sites.

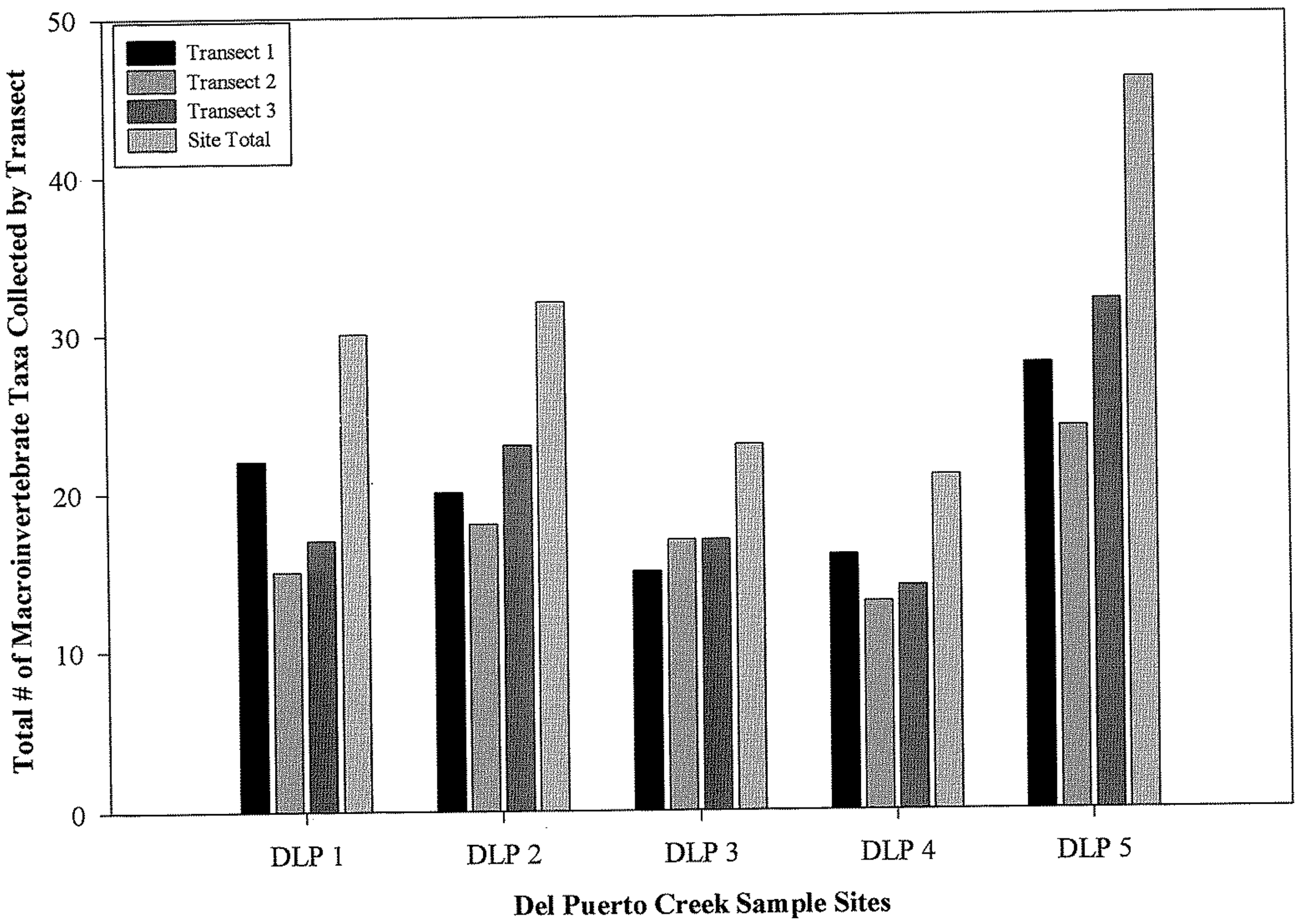


Figure 6. Macroinvertebrate abundance for each transect and site total for the 5 Del Puerto Creek sites.

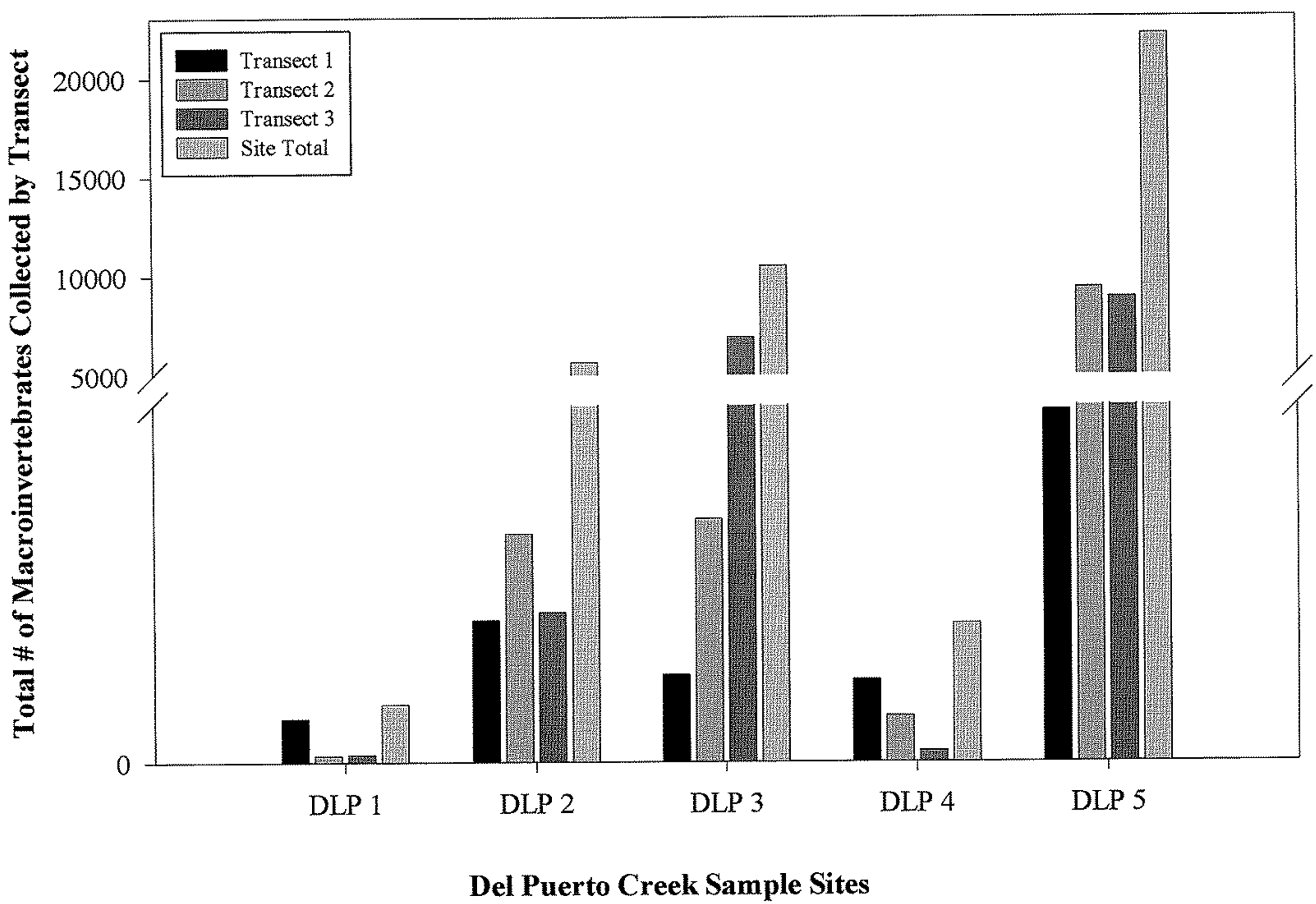


Figure 7. Macroinvertebrate richness for each transect and site total for the 10 Orestimba Creek sites.

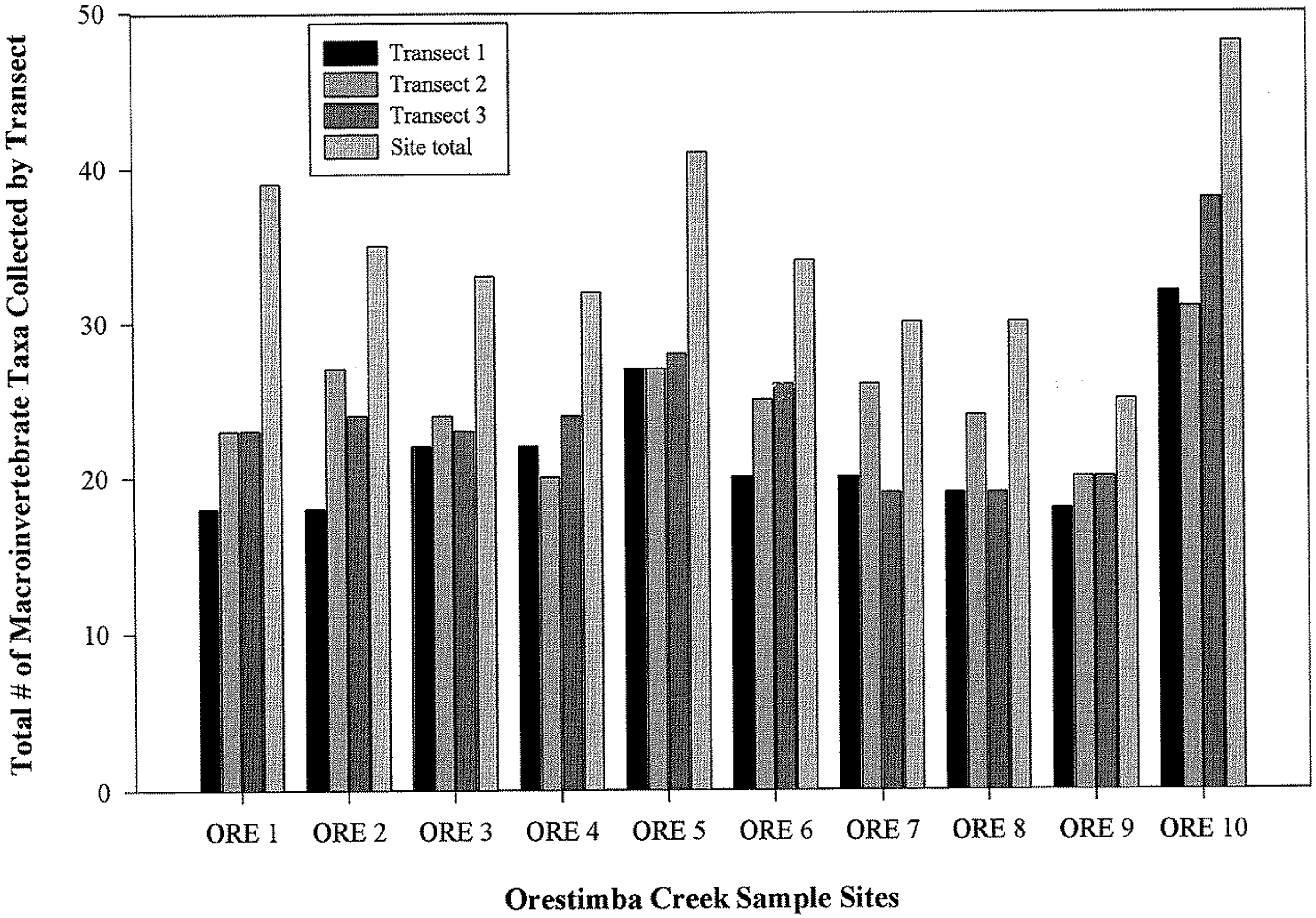


Figure 8. Macroinvertebrate abundance for each transect and site total for the 10 Orestimba Creek sites.

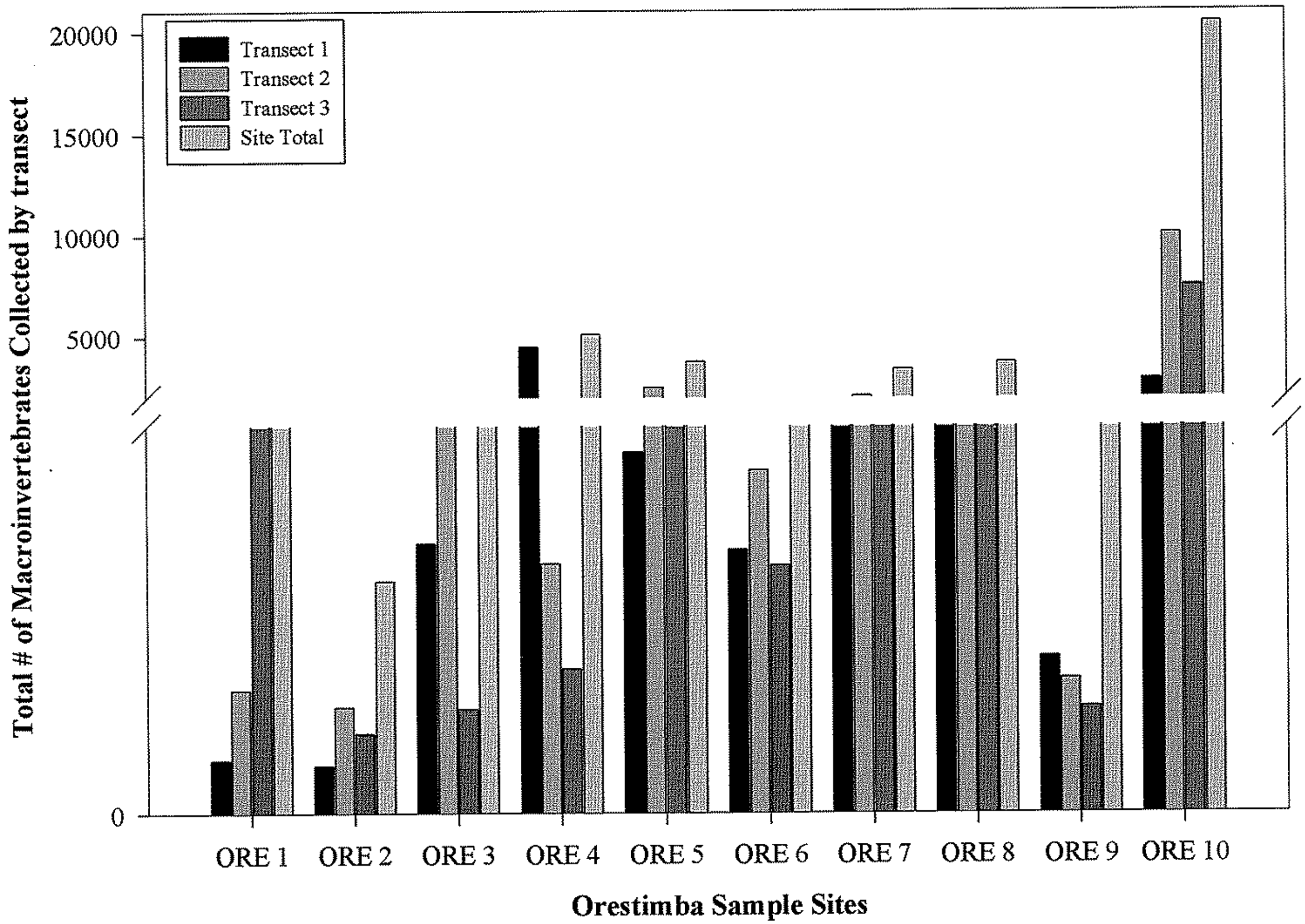


Figure 9. Macroinvertebrate richness for each transect and site totals for the 5 Salt Slough sites.

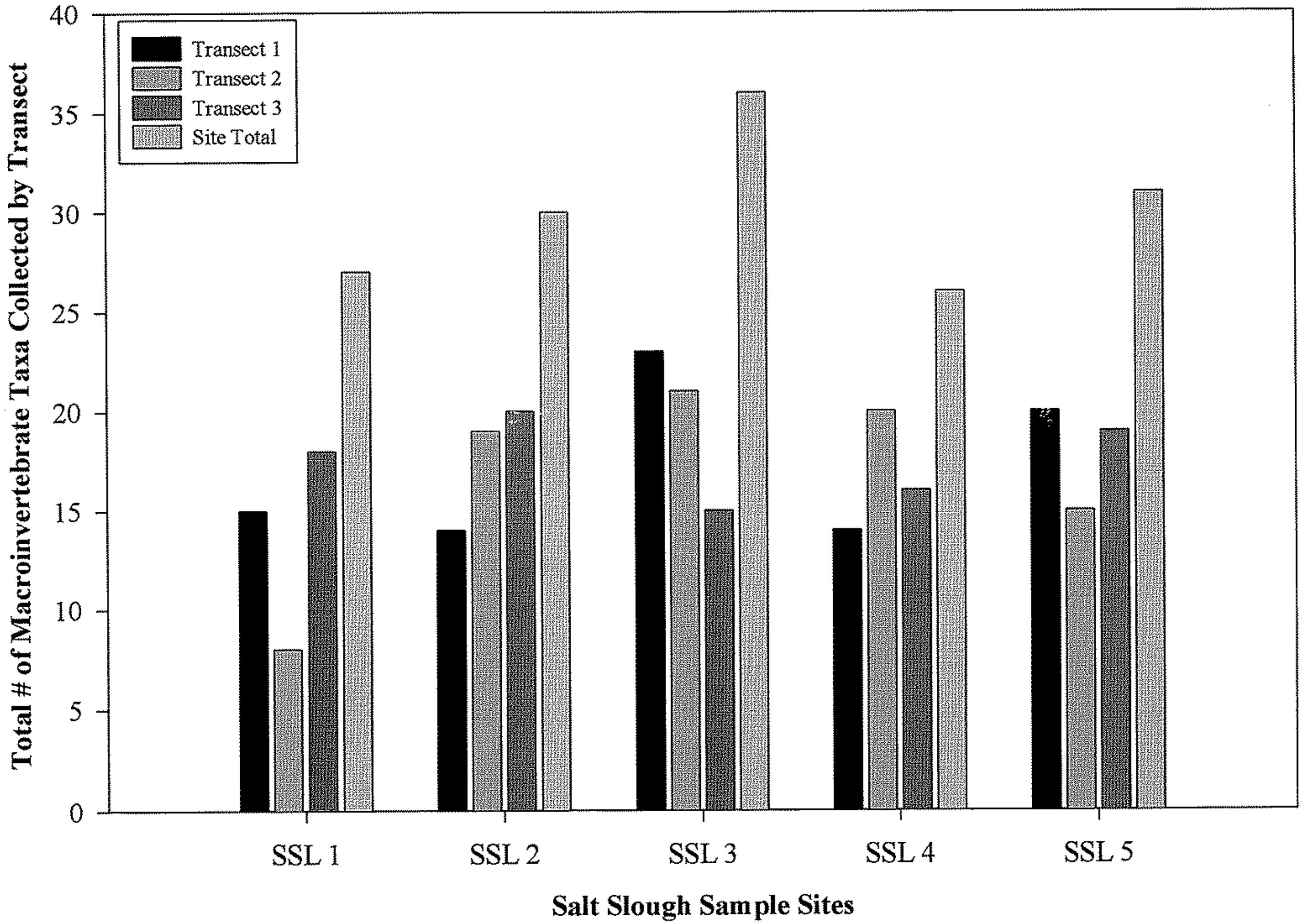
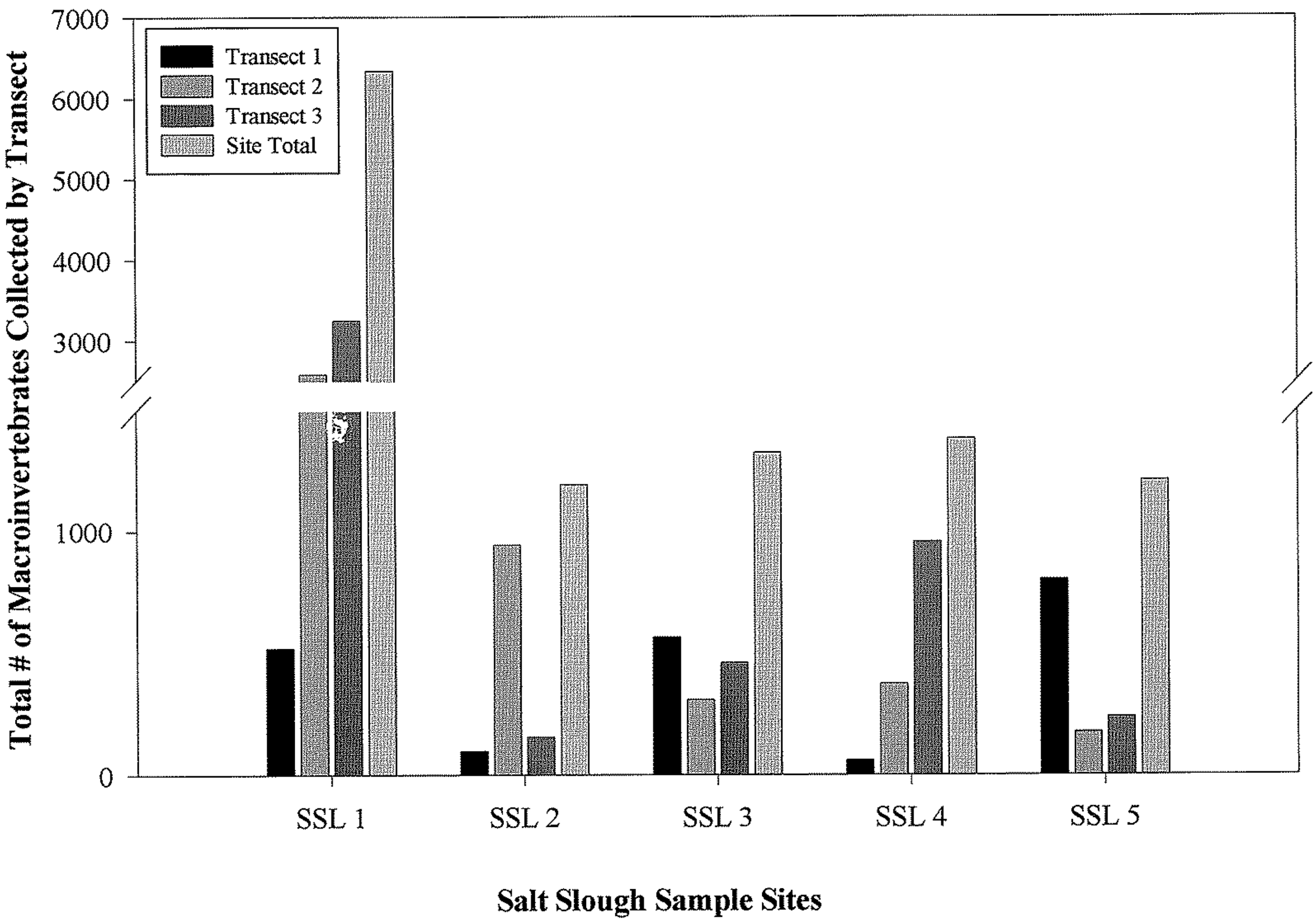


Figure 10. Macroinvertebrate abundance for each transect and site total for the 5 Salt Slough sites.



Appendix A
California bioassessment worksheets including specific descriptions of the various physical habitat metrics

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/ STREAM: ______________________

DATE/ TIME: ______________________

COMPANY/ AGENCY: ______________________

SAMPLE ID #: ______________________

SITE DESCRIPTION: ______________________

SAMPLING CREW

____

____

____

SITE INFORMATION

GPS Coordinates:

Latitude: ______________

Longitude: ______________

Elevation: ______________

Ecoregion: ______________

COMMENTS:

____

____

____

____

____

CHEMICAL CHARACTERISTICS

Water Temperature: __________

Specific Conductance: __________

pH: __________

Dissolved Oxygen: __________

Bioassessment Laboratory Information:

____

____

____

____

____

SEND A COPY OF THIS FORM TO:
DFG/ WPCL
2005 Nimbus Road
Rancho Cordova, CA 95670
(916) 358-2858
website: www.dfg.ca.gov/cabw/cabwhome.html

RIFFLE/ REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length: ______

Transect 1: ______

Transect 2: ______

Transect 3: ______

(record Physical/ Habitat Characteristics in Riffle 1 column)

Non-Point Source Sampling Design

Reach Length: ______

Physical Habitat Quality Score: ______

Physical/ Habitat Characteristics

	Riffle 1	Riffle 2	Riffle 3
Riffle Length:			
Transect Location:			
Avg. Riffle Width:			
Avg. Riffle Depth:			
Riffle Velocity:			
% Canopy Cover:			
Substrate Complexity:			
Embeddedness:			
Substrate Composition:			
Fines (<0.1"):			
Gravel (0.1-2"):			
Cobble (2-10"):			
Boulder (>10"):			
Bedrock (solid):			
Substrate Consolidation:			
Percent Gradient:			

CALIFORNIA STREAM BIOASSESSMENT PROCEDURE
CHAIN OF CUSTODY (COC) RECORD

Project Name: ______________________ Date/ Time: ______________________

Watershed Name: ______________________ Boiassessment Lab: ______________________

Sample Number	Lab Number	Sample Date	Sample Description

Sampled by: (sign and date)	Relinquished by: (sign and date)	Received by: (sign and date)
Received by: (sign and date)	Received by: (sign and date)	Received by: (sign and date)

Address of Sampler:

____

____

____

____

Address of Project Advisor:

____

____

____

____

BIOLOGICAL METRICS USED TO DESCRIBE BENTHIC MACROINVERTEBRATE (BMI) SAMPLES COLLECTED FOLLOWING THE CALIFORNIA STREAM BIOASSESSMENT PROCEDURE (CSBP)

Biological Metrics	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 mayfly taxa (genus or species)	decrease
Plecoptera Taxa	Number of stonefly taxa (genus or species)	decrease
Trichoptera Taxa	Number of caddisfly taxa (genus or species)	decrease
Composition Measures		
EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae	decrease
Sensitive EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae with Tolerance Values of 0 through 3	decrease
Shannon Diversity Index	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) and 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 Hydropsychidae	Percent of organisms in the caddisfly family Hydropsychidae	increase
Percent Baetidae	Percent of organisms in the mayfly family Baetidae	increase
Percent Dominant Taxa	Percent composition of the single most abundant taxon	increase
Functional Feeding Groups		
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 Scrapers (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

PHYSICAL HABITAT QUALITY
(California Stream Bioassessment Procedure)

WATERSHED/ STREAM: ____________________ DATE/ TIME: ____________________

COMPANY/ AGENCY: ____________________ SAMPLE ID NUMBER: ____________________

SITE DESCRIPTION: ____________________

Circle the appropriate score for all 20 habitat parameters. Record the total score on the front page of the CBW.

Parameters to be evaluated within the sampling reach

HABITAT PARAMETER	CONDITION CATEGORY			
	OPTIMAL	**SUBOPTIMAL**	**MARGINAL**	**POOR**
1. Epifaunal Substrate/ Available Cover	Greater than 70% (50% for low gradient streams) of substrate favorable for epifaunal colonization and fish cover; most favorable is a mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	40-70% (30-50% for low gradient streams) mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% (10-30% for low gradient streams) mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% (10% for low gradient streams) stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/ Depth Regimes *(deep<0.5 m, slow<0.3 m/s)*	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameters to be evaluated in an area longer than the sampling reach

HABITAT PARAMETER	CONDITION CATEGORY			
	OPTIMAL	SUBOPTIMAL	MARGINAL	POOR
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left of right side by facing downstream	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zones covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities haveimpacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Appendix B

Number of lowest identified taxa by transect and combined transects including tolerance values (TV) and feeding guilds (FFG) for Del Puerto Creek sites. Tolerance values for taxa range from 1 to 10 with 10 being the most tolerant value. Feeding guilds are defined as follows: CG = collector-gatherer; CF = collector-filterer; SC = scraper; SH = shredder; P = predator; MH = macrophyte herbivore; OM = omnivore; PA = parasite; XY = Xylophage.

Del Puerto 1

Lowest Taxa	T1
Simulium sp.	132
Tubificidae	56
Nais communis/ variabilis	26
Eukiefferiella sp.	21
Slavina appendiculata	12
Rheocricotopus sp.	7
Lumbricina	7
Dicrotendipes sp.	4
Cricotopus bicinctus group	3
Cricotopus sp.	3
Enchytraeidae	3
Physa sp.	3
Dugesia tigrina	3
Parachironomus sp.	2
Forcipomyia sp.	1
Chironomus sp.	1
Phaenopsectra sp.	1
Cladotanytarsus sp.	1
Pericoma/ Telmatoscopus	1
Chaetogaster diaphanus	1
Ophidonais serpentina	1
Corbicula sp.	1
	290

Lowest Taxa	T2
Simulium sp.	27
Eukiefferiella sp.	12
Nais communis/ variabilis	5
Lumbricina	4
Slavina appendiculata	4
Tubificidae	4
Physa sp.	3
Parachironomus sp.	2
Cladotanytarsus sp.	2
Rheocricotopus sp.	2
Paratanytarsus sp.	1
Paraphaenocladius sp.	1
Cricotopus sp.	1
Hydrellia sp.	1
Gammarus sp.	1
	70

Lowest Taxa	T3
Eukiefferiella sp.	17
Simulium sp.	17
Tubificidae	17
Lumbricina	6
Nais communis/ variabilis	6
Dugesia tigrina	4
Cricotopus sp.	3
Rheocricotopus sp.	2
Corbicula sp.	2
Dicrotendipes sp.	1
Cricotopus bicinctus group	1
Corixidae	1
Helobdella stagnalis	1
Enchytraeidae	1
Chaetogaster diaphanus	1
Quistadrilus multisetosus	1
Prostoma sp.	1
	82

Lowest Taxa	TV	FFG	TOTAL
Simulium sp.	6	CF	176
Tubificidae	10	CG	77
Eukiefferiella sp.	8	OM	50
Nais communis/ variabilis		CG	37
Lumbricina		CG	17
Slavina appendiculata		CG	16
Rheocricotopus sp.	6	OM	11
Dugesia tigrina	4	P	7
Cricotopus sp.	7	CG	7
Physa sp.	8	SC	6
Dicrotendipes sp.	8	CG	5
Parachironomus sp.	10	P	4
Enchytraeidae	10	CG	4
Cricotopus bicinctus group	7	CG	4
Corbicula sp.	6	CF	3
Cladotanytarsus sp.	7	CG	3
Chaetogaster diaphanus			2
Quistadrilus multisetosus	10	CG	1
Prostoma sp.	8	P	1
Phaenopsectra sp.	7	SC	1
Pericoma/ Telmatoscopus	4	CG	1
Paratanytarsus sp.	6	CF	1
Paraphaenocladius sp.	4	CG	1
Ophidonais serpentina			1
Hydrellia sp.	6	SH	1
Helobdella stagnalis	6	PA	1
Gammarus sp.	6	CG	1
Forcipomyia sp.	6	CG	1
Corixidae	10	P	1
Chironomus sp.	10	CG	1
			442

Del Puerto 2

Lowest Taxa	T1
Simulium sp.	72
Helobdella stagnalis	62
Dugesia tigrina	43
Nais communis/ variabilis	42
Physa sp.	27
Cladotanytarsus sp.	7
Planorbella sp.	5
Dicrotendipes sp.	4
Paratanytarsus sp.	4
Cricotopus sp.	4
Fallceon quilleri	4
Lumbricina	4
Tubificidae	2
Dicrotendipes sp.	1
Cricotopus sp.	1
Naucoridae	1
Ophidonais serpentina	1
Quistadrilus multisetosus	1
Corbicula sp.	1
Sphaerium sp.	1
	287

Lowest Taxa	T2
Simulium sp.	186
Helobdella stagnalis	32
Dugesia tigrina	29
Nais communis/ variabilis	24
Physa sp.	10
Fallceon quilleri	6
Dicrotendipes sp.	3
Orthocladius complex	3
Cladotanytarsus sp.	2
Paratanytarsus sp.	2
Dicrotendipes sp.	1
Parachironomus sp.	1
Cricotopus sp.	1
Eukiefferiella sp.	1
Lumbricina	1
Enchytraeidae	1
Quistadrilus multisetosus	1
Planorbella sp.	1
	305

Lowest Taxa	T3
Nais communis/ variabilis	117
Simulium sp.	109
Dugesia tigrina	17
Helobdella stagnalis	16
Fallceon quilleri	7
Physa sp.	5
Gymnometriocnemus sp.	4
Cladotanytarsus sp.	3
Paratanytarsus sp.	3
Dicrotendipes sp.	2
Cricotopus sp.	2
Cricotopus sp.	2
Enchytraeidae	2
Tubificidae	2
Polypedilum sp.	1
Orthocladius complex	1
Eukiefferiella sp.	1
Rheocricotopus sp.	1
Sigara sp.	1
Erpobdellidae	1
Pristina osborni	1
Slavina appendiculata	1
Menetus opercularis	1
	300

Lowest Taxa	TV	FFG	TOTAL
Simulium sp.	6	CF	367
Nais communis/ variabilis		CG	183
Helobdella stagnalis	6	PA	110
Dugesia tigrina	4	P	89
Physa sp.	8	SC	42
Fallceon quilleri	4	CG	17
Cladotanytarsus sp.	7	CG	12
Paratanytarsus sp.	6	CF	9
Cricotopus sp.	7	CG	7
Planorbella sp.	6	SC	6
Dicrotendipes sp.			6
Lumbricina		CG	5
Dicrotendipes sp.	8	CG	5
Tubificidae	10	CG	4
Orthocladius complex	6	CG	4
Gymnometriocnemus sp.	5	CG	4
Enchytraeidae	10	CG	3
Cricotopus sp.			3
Quistadrilus multisetosus	10	CG	2
Eukiefferiella sp.			2
Sphaerium sp.	8	CG	1
Slavina appendiculata		CG	1
Sigara sp.			1
Rheocricotopus sp.	6	OM	1
Pristina osborni		CG	1
Polypedilum sp.	6	CG	1
Parachironomus sp.	10	P	1
Ophidonais serpentina			1
Naucoridae	5	P	1
Menetus opercularis	6	SC	1
Erpobdellidae	8	P	1
Corbicula sp.	6	CF	1
			892

Del Puerto 3

Lowest Taxa	T1
Simulium sp.	134
Tubificidae	55
Cricotopus sp.	20
Physa sp.	15
Orthocladius complex	12
Nais communis/ variabilis	11
Parachironomus sp.	10
Cricotopus sp.	9
Slavina appendiculata	4
Dicrotendipes sp.	2
Enchytraeidae	2
Eukiefferiella sp.	1
Fallceon quilleri	1
Lumbricina	1
Chaetogaster diaphanus	1
	278

Lowest Taxa	T2
Simulium sp.	197
Physa sp.	40
Orthocladius complex	21
Cricotopus sp.	19
Tubificidae	11
Cricotopus sp.	8
Nais communis/ variabilis	7
Parachironomus sp.	5
Dicrotendipes sp.	2
Fallceon quilleri	2
Erpobdellidae	2
Lumbricina	2
Parachironomus sp.	1
Eukiefferiella sp.	1
Eukiefferiella sp.	1
Helobdella stagnalis	1
Enchytraeidae	1
	321

Lowest Taxa	T3
Simulium sp.	195
Tubificidae	39
Physa sp.	16
Cricotopus sp.	10
Nais communis/ variabilis	9
Orthocladius complex	7
Parachironomus sp.	4
Fallceon quilleri	4
Cricotopus sp.	3
Sphaerium sp.	3
Eukiefferiella sp.	2
Enchytraeidae	2
Prostoma sp.	2
Microtendipes pedellus group	1
Helobdella stagnalis	1
Lumbricina	1
Pisidium sp.	1
	300

Lowest Taxa	TV	FFG	TOTAL
Simulium sp.	6	CF	526
Tubificidae	10	CG	105
Physa sp.	8	SC	71
Cricotopus sp.	7	CG	49
Orthocladius complex	6	CG	40
Nais communis/ variabilis		CG	27
Cricotopus sp.			20
Parachironomus sp.	10	P	19
Fallceon quilleri	4	CG	7
Enchytraeidae	10	CG	5
Slavina appendiculata		CG	4
Lumbricina		CG	4
Eukiefferiella sp.	8	OM	4
Dicrotendipes sp.	8	CG	4
Sphaerium sp.	8	CG	3
Prostoma sp.	8	P	2
Helobdella stagnalis	6	PA	2
Erpobdellidae	8	P	2
Pisidium sp.	8	CF	1
Parachironomus sp.			1
Microtendipes pedellus group	6	CF	1
Eukiefferiella sp.			1
Chaetogaster diaphanus			1
			899

Del Puerto 4

Lowest Taxa	T1
Dicrotendipes sp.	136
Cricotopus sp.	78
Lumbricina	25
Cricotopus bicinctus group	20
Paratanytarsus sp.	9
Apedilum sp.	7
Tanytarsus sp.	6
Fossaria sp.	4
Chironomus sp.	3
Cladotanytarsus sp.	3
Orthocladius complex	2
Muscidae	2
Odontomyia sp.	2
Eukiefferiella sp.	1
Pseudosmittia sp.	1
Corixidae	1
	300

Lowest Taxa	T2
Dicrotendipes sp.	137
Cricotopus sp.	96
Lumbricina	25
Cricotopus bicinctus group	18
Paratanytarsus sp.	16
Apedilum sp.	13
Tanytarsus sp.	7
Muscidae	2
Fossaria sp.	2
Cladotanytarsus sp.	1
Eukiefferiella sp.	1
Simulium sp.	1
Branchiura sowerbyi	1
	320

Lowest Taxa	T3
Lumbricina	39
Cricotopus sp.	35
Dicrotendipes sp.	20
Muscidae	5
Cricotopus bicinctus group	3
Fossaria sp.	3
Paratanytarsus sp.	2
Eukiefferiella sp.	2
Ormosia sp.	2
Corixidae	2
Apedilum sp.	1
Tanytarsus sp.	1
Belostoma flumineum	1
Ostracoda	1
	117

Lowest Taxa	TV	FFG	TOTAL
Dicrotendipes sp.	8	CG	293
Cricotopus sp.	7	CG	209
Lumbricina		CG	89
Cricotopus bicinctus group	7	CG	41
Paratanytarsus sp.	6	CF	27
Apedilum sp.	6	CG	21
Tanytarsus sp.	6	CF	14
Muscidae	6	P	9
Fossaria sp.	8	SC	9
Eukiefferiella sp.	8	OM	4
Cladotanytarsus sp.	7	CG	4
Corixidae		P	3
Chironomus sp.	10	CG	3
Orthocladius complex	6	CG	2
Ormosia sp.	3	CG	2
Odontomyia sp.	5	CG	2
Simulium sp.	6	CF	1
Pseudosmittia sp.		CG	1
Ostracoda		CG	1
Branchiura sowerbyi	10	CG	1
Belostoma flumineum	8	P	1
			737

Del Puerto 5

Lowest Taxa	T1
Physa sp.	105
Ostracoda	53
Nais communis/ variabilis	29
Baetis tricaudatus	23
Simulium sp.	16
Rheotanytarsus sp.	14
Cricotopus trifascia group	14
Cricotopus bicinctus group	11
Gyraulus parvus	7
Tricorythodes sp.	6
Sperchon sp.	5
Eukiefferiella sp.	3
Thienemanniella sp.	3
Tubificidae	3
Oxyethira sp.	2
Lebertia sp.	2
Planorbella sp.	2
Hydrobiidae	2
Hydrophilidae	1
Culicoides sp.	1
Cricotopus sp.	1
Limnophyes sp.	1
Rheocricotopus sp.	1
Pentaneura sp.	1
Fallceon quilleri	1
Cheumatopsyche sp.	1
Hydroptila sp.	1
Tinodes sp.	1
	310

Lowest Taxa	T2
Nais communis/ variabilis	130
Cricotopus bicinctus group	51
Physa sp.	24
Simulium sp.	18
Baetis tricaudatus	18
Rheotanytarsus sp.	12
Ostracoda	8
Cricotopus sp.	7
Cricotopus trifascia group	5
Thienemanniella sp.	2
Hydroptila sp.	2
Oxyethira sp.	2
Gyraulus parvus	2
Peltodytes sp.	1
Bezzia/ Palpomyia	1
Micropsectra sp.	1
Pentaneura sp.	1
Fallceon quilleri	1
Tricorythodes sp.	1
Coenagrionidae	1
Pristina leidyi	1
Tubificidae	1
Hydrobiidae	1
Prostoma sp.	1
	292

Lowest Taxa	T3
Nais communis/ variabilis	156
Cricotopus bicinctus group	71
Rheotanytarsus sp.	23
Physa sp.	13
Cricotopus sp.	7
Cricotopus trifascia group	4
Ostracoda	3
Bezzia/ Palpomyia	2
Limnophyes sp.	2
Corynoneura sp.	2
Pentaneura sp.	2
Nemotelus sp.	2
Tricorythodes sp.	2
Coenagrionidae	2
Oxyethira sp.	2
Prostoma sp.	2
Dugesia tigrina	2
Dasyhelea sp.	1
Dicrotendipes sp.	1
Eukiefferiella sp.	1
Parachaetocladius sp.	1
Paraphaenocladius sp.	1
Thienemanniella sp.	1
Baetis tricaudatus	1
Hyalella sp.	1
Sperchon sp.	1
Erpobdellidae	1
Glossiphoniidae	1
Enchytraeidae	1
Ophidonais serpentina	1
Tubificidae	1
Gyraulus parvus	1
	312

Lowest Taxa	TV	FFG	TOTAL
Nais communis/ variabilis		CG	315
Physa sp.	8	SC	142
Cricotopus bicinctus group	7	CG	133
Ostracoda	8	CG	64
Rheotanytarsus sp.	6	CF	49
Baetis tricaudatus	6	CG	42
Simulium sp.	6	CF	34
Cricotopus trifascia group	7	CG	23
Cricotopus sp.	7	CG	15
Gyraulus parvus		SC	10
Tricorythodes sp.	4	CG	9
Thienemanniella sp.	6	CG	6
Sperchon sp.	8	P	6
Oxyethira sp.	3	PH	6
Tubificidae	10	CG	5
Pentaneura sp.	6	P	4
Eukiefferiella sp.	8	OM	4
Prostoma sp.	8	P	3
Limnophyes sp.	8	CG	3
Hydroptila sp.	6	PH	3
Hydrobiidae	8	SC	3
Coenagrionidae		P	3
Bezzia/ Palpomyia	6	P	3
Planorbella sp.	6	SC	2
Nemotelus sp.	8	CG	2
Lebertia sp.	8	P	2
Fallceon quilleri	4	CG	2
Dugesia tigrina	4	P	2
Corynoneura sp.	7	CG	2
Tinodes sp.	2	SC	1
Rheocricotopus sp.	6	OM	1
Pristina leidyi		CG	1
Peltodytes sp.	5	MH	1
Paraphaenocladius sp.	4	CG	1
Parachaetocladius sp.	2	CG	1
Ophidonais serpentina			1
Micropsectra sp.	7	CG	1
Hydrophilidae	5	P	1
Hyalella sp.	8	CG	1
Glossiphoniidae	8	P	1
Erpobdellidae	8	P	1
Enchytraeidae	10	CG	1
Dicrotendipes sp.	8	CG	1
Dasyhelea sp.	6	CG	1
Culicoides sp.	6	P	1
Cheumatopsyche sp.	5	CF	1
			914

Appendix C

Number of lowest identified taxa by transect and combined transects including tolerance values (TV) and feeding guilds (FFG) for Orestimba Creek sites. Tolerance values for taxa range from 1 to 10 with 10 being the most tolerant value. Feeding guilds are defined as follows: CG = collector-gatherer; CF = collector-filterer; SC = scraper; SH = shredder; P = predator; MH = macrophyte herbivore; OM = omnivore; PA = parasite; XY = Xylophage.

Orestimba I

Lowest Taxa	T1
Ophidonais serpentina	14
Chironomus sp.	12
Nais communis/ variabilis	11
Cricotopus bicinctus group	10
Physa sp.	7
Hyalella sp.	6
Phaenopsectra sp.	4
Dicrotendipes sp.	3
Paratanytarsus sp.	3
Cricotopus sp.	3
Tanytarsus sp.	2
Paracladopelma sp.	1
Microchironomus nigrovittatus	1
Micropsectra sp.	1
Procladius sp.	1
Callibaetis sp.	1
Cheumatopsyche sp.	1
Ostracoda	1
	82

Lowest Taxa	T2
Dicrotendipes sp.	54
Ophidonais serpentina	48
Cricotopus sp.	20
Eudistylia vancouveri	10
Cricotopus bicinctus group	9
Phaenopsectra sp.	7
Physa sp.	6
Hyalella sp.	4
Enchytraeidae	4
Limnodrilus hoffmeisteri	4
Corbicula sp.	4
Nais communis/ variabilis	3
Dugesia tigrina	3
Polypedilum sp.	2
Paratanytarsus sp.	2
Corixidae	2
Limnodrilus sp.	2
Chironomus sp.	1
Paraphaenocladius sp.	1
Sperchon sp.	1
Lumbricina	1
Tubificidae	1
Menetus opercularis	1
	190

Lowest Taxa	T3
Cricotopus bicinctus group	71
Nais communis/ variabilis	70
Ophidonais serpentina	48
Dicrotendipes sp.	39
Slavina appendiculata	18
Cricotopus sp.	14
Paratanytarsus sp.	13
Micropsectra sp.	5
Rheocricotopus sp.	4
Nanocladius sp.	3
Physa sp.	3
Chironomus sp.	2
Eukiefferiella sp.	2
Anisogammarus sp.	2
Limnodrilus sp.	2
Parachironomus sp.	1
Phaenopsectra sp.	1
Polypedilum sp.	1
Corixidae	1
Corisella sp.	1
Hyalella sp.	1
Chaetogaster diaphanus	1
Dugesia tigrina	1
	304

Lowest Taxa	TV	FFG	TOTAL
Ophidonais serpentina			110
Dicrotendipes sp.	8	CG	96
Cricotopus bicinctus group	7	CG	90
Nais communis/ variabilis		CG	84
Cricotopus sp.	7	CG	37
Slavina appendiculata		CG	18
Paratanytarsus sp.	6	CF	18
Physa sp.	8	SC	16
Chironomus sp.	10	CG	15
Phaenopsectra sp.	7	SC	12
Hyalella sp.	8	CG	11
Eudistylia vancouveri			10
Micropsectra sp.	7	CG	6
Rheocricotopus sp.	6	OM	4
Limnodrilus sp.	10	CG	4
Limnodrilus hoffmeisteri		CG	4
Enchytraeidae	10	CG	4
Dugesia tigrina	4	P	4
Corbicula sp.	6	CF	4
Polypedilum sp.	6	CG	3
Nanocladius sp.	3	CG	3
Corixidae	10	P	3
Tanytarsus sp.	6	CF	2
Eukiefferiella sp.	8	OM	2
Anisogammarus sp.		CG	2
Tubificidae	10	CG	1
Sperchon sp.	8	P	1
Procladius sp.	9	P	1
Paraphaenocladius sp.	4	CG	1
Paracladopelma sp.	7		1
Parachironomus sp.	10	P	1
Ostracoda		CG	1
Microchironomus nigrovittatus	6	CG	1
Menetus opercularis	6	SC	1
Lumbricina		CG	1
Corisella sp.	8	P	1
Cheumatopsyche sp.	5	CF	1
Chaetogaster diaphanus			1
Callibaetis sp.	9	CG	1
			576

Orestimba 2

Lowest Taxa	T1
Nais communis/ variabilis	14
Cricotopus bicinctus group	12
Tubificidae	9
Corbicula sp.	9
Slavina appendiculata	6
Cricotopus sp.	4
Eukiefferiella sp.	3
Prostoma sp.	3
Nanocladius sp.	2
Simulium sp.	2
Ophidonais serpentina	2
Chironomus sp.	1
Chironomini	1
Cladotanytarsus sp.	1
Orthocladius complex	1
Cricotopus trifascia group	1
Gammarus sp.	1
Eudistylia vancouveri	1
	73

Lowest Taxa	T2
Cricotopus bicinctus group	29
Simulium sp.	13
Tubificidae	13
Eudistylia vancouveri	12
Cricotopus sp.	11
Nanocladius sp.	10
Dicrotendipes sp.	9
Nais communis/ variabilis	8
Ophidonais serpentina	8
Corbicula sp.	6
Prostoma sp.	6
Parachironomus sp.	5
Rheocricotopus sp.	5
Slavina appendiculata	5
Phaenopsectra sp.	4
Eukiefferiella sp.	3
Lumbricina	3
Paratanytarsus sp.	2
Gammarus sp.	2
Limnodrilus hoffmeisteri	2
Apedilum sp.	1
Polypedilum sp.	1
Cladotanytarsus sp.	1
Tanytarsus sp.	1
Orthocladius complex	1
Parakiefferiella sp.	1
Fossaria sp.	1
	163

Lowest Taxa	T3
Cricotopus bicinctus group	21
Cricotopus sp.	20
Corbicula sp.	20
Ophidonais serpentina	12
Simulium sp.	11
Nais communis/ variabilis	8
Nanocladius sp.	5
Eudistylia vancouveri	3
Slavina appendiculata	3
Dicrotendipes sp.	2
Phaenopsectra sp.	2
Micropsectra sp.	2
Orthocladius complex	2
Tubificidae	2
Parachironomus sp.	1
Polypedilum sp.	1
Paratanytarsus sp.	1
Eukiefferiella sp.	1
Gammarus sp.	1
Nereis limnicola	1
Erpobdellidae	1
Lumbricina	1
Physa sp.	1
Prostoma sp.	1
	123

Lowest Taxa	TV	FFG	TOTAL
Cricotopus bicinctus group	7	CG	62
Cricotopus sp.	7	CG	35
Corbicula sp.	6	CF	35
Nais communis/ variabilis		CG	30
Simulium sp.	6	CF	26
Tubificidae	10	CG	24
Ophidonais serpentina			22
Nanocladius sp.	3	CG	17
Eudistylia vancouveri			16
Slavina appendiculata		CG	14
Dicrotendipes sp.	8	CG	11
Prostoma sp.	8	P	10
Phaenopsectra sp.	7	SC	6
Parachironomus sp.	10	P	6
Eukiefferiella sp.	8	OM	6
Rheocricotopus sp.	6	OM	5
Orthocladius complex	6	CG	4
Lumbricina		CG	4
Gammarus sp.	6	CG	4
Paratanytarsus sp.	6	CF	3
Polypedilum sp.	6	CG	2
Micropsectra sp.	7	CG	2
Limnodrilus hoffmeisteri		CG	2
Cladotanytarsus sp.	7	CG	2
Tanytarsus sp.	6	CF	1
Physa sp.	8	SC	1
Parakiefferiella sp.	4	CG	1
Nereis limnicola			1
Fossaria sp.	8	SC	1
Eukiefferiella sp.			1
Erpobdellidae	8	P	1
Cricotopus trifascia group	7	CG	1
Chironomus sp.	10	CG	1
Chironomini			1
Apedilum sp.	6	CG	1
			359

Orestimba 3

Lowest Taxa	T1
Cricotopus bicinctus group	56
Simulium sp.	47
Nais communis/ variabilis	38
Cricotopus sp.	28
Cricotopus sp.	22
Orthocladius complex	20
Rheocricotopus sp.	18
Ophidonais serpentina	18
Corbicula sp.	14
Eukiefferiella sp.	11
Lumbricina	7
Tubificidae	5
Eukiefferiella sp.	4
Orthocladius sp.	4
Acari	4
Slavina appendiculata	4
Cricotopus trifascia group	3
Physa sp.	3
Dicrotendipes sp.	2
Hydropsyche californica	2
Sperchon sp.	2
Stylaria lacustris	1
	313

Lowest Taxa	T2
Simulium sp.	58
Nais communis/ variabilis	43
Ophidonais serpentina	43
Orthocladius complex	29
Cricotopus sp.	22
Cricotopus sp.	21
Slavina appendiculata	19
Cricotopus bicinctus group	13
Rheocricotopus sp.	9
Physa sp.	5
Eukiefferiella sp.	4
Eukiefferiella sp.	3
Fossaria sp.	3
Orthocladius sp.	2
Hydropsyche californica	2
Sperchon sp.	2
Eudistylia vancouveri	2
Polypedilum sp.	1
Micropsectra sp.	1
Lumbricina	1
Pristina leidyi	1
Stylaria lacustris	1
Tubificidae	1
Corbicula sp.	1
	287

Lowest Taxa	T3
Simulium sp.	30
Cricotopus sp.	17
Corbicula sp.	16
Orthocladius complex	14
Cricotopus sp.	13
Eukiefferiella sp.	13
Lumbricina	12
Gammarus sp.	8
Cricotopus bicinctus group	6
Eukiefferiella sp.	6
Ophidonais serpentina	5
Hydropsyche californica	4
Staphylinidae	3
Tubificidae	3
Nais communis/ variabilis	2
Rheotanytarsus sp.	1
Tanytarsus sp.	1
Parametriocnemus sp.	1
Rheocricotopus sp.	1
Orthocladius sp.	1
Slavina appendiculata	1
Physa sp.	1
Dugesia tigrina	1
	160

Lowest Taxa	TV	FFG	TOTAL
Simulium sp.	6	CF	135
Nais communis/ variabilis		CG	83
Cricotopus bicinctus group	7	CG	75
Ophidonais serpentina			66
Cricotopus sp.			66
Orthocladius complex	6	CG	63
Cricotopus sp.	7	CG	57
Corbicula sp.	6	CF	31
Rheocricotopus sp.	6	OM	28
Eukiefferiella sp.	8	OM	28
Slavina appendiculata		CG	24
Lumbricina		CG	20
Eukiefferiella sp.			13
Tubificidae	10	CG	9
Physa sp.	8	SC	9
Hydropsyche californica	4	CF	8
Gammarus sp.	6	CG	8
Orthocladius sp.			7
Sperchon sp.	8	P	4
Acari	5	PA	4
Staphylinidae		P	3
Fossaria sp.	8	SC	3
Cricotopus trifascia group	7	CG	3
Stylaria lacustris		CG	2
Eudistylia vancouveri			2
Dicrotendipes sp.	8	CG	2
Tanytarsus sp.	6	CF	1
Rheotanytarsus sp.	6	CF	1
Pristina leidyi		CG	1
Polypedilum sp.	6	CG	1
Parametriocnemus sp.	5	CG	1
Micropsectra sp.	7	CG	1
Dugesia tigrina	4	P	1
			760

Orestimba 4

Lowest Taxa	T1
Nais communis/ variabilis	73
Cricotopus sp.	56
Cricotopus bicinctus group	56
Ophidonais serpentina	41
Simulium sp.	27
Rheocricotopus sp.	25
Slavina appendiculata	15
Physa sp.	9
Eukiefferiella sp.	5
Sperchon sp.	4
Pristina aequiseta	3
Micropsectra sp.	2
Cricotopus trifascia group	2
Phaenopsectra sp.	1
Cladotanytarsus sp.	1
Paratanytarsus sp.	1
Fallceon quilleri	1
Chaetogaster diaphanus	1
Tubificidae	1
Fossaria sp.	1
Menetus opercularis	1
Prostoma sp.	1
	327

Lowest Taxa	T2
Cricotopus sp.	91
Simulium sp.	53
Cricotopus bicinctus group	51
Eukiefferiella sp.	36
Hydropsyche californica	8
Dugesia tigrina	8
Lumbricina	7
Nais communis/ variabilis	7
Micropsectra sp.	6
Cricotopus trifascia group	6
Rheocricotopus sp.	5
Gammarus sp.	4
Slavina appendiculata	4
Fallceon quilleri	2
Ophidonais serpentina	2
Physa sp.	2
Prostoma sp.	2
Sperchon sp.	1
Tubificidae	1
Corbicula sp.	1
	297

Lowest Taxa	T3
Cricotopus sp.	51
Simulium sp.	41
Cricotopus bicinctus group	28
Eukiefferiella sp.	21
Tubificidae	12
Lumbricina	10
Hydropsyche californica	9
Ophidonais serpentina	8
Cricotopus trifascia group	7
Sperchon sp.	7
Micropsectra sp.	4
Nais communis/ variabilis	4
Prostoma sp.	4
Slavina appendiculata	3
Dugesia tigrina	3
Rheocricotopus sp.	2
Physa sp.	2
Phaenopsectra sp.	1
Limnophyes sp.	1
Pseudosmittia sp.	1
Hyalella sp.	1
Eudistylia vancouveri	1
Corbicula sp.	1
Fossaria sp.	1
	223

Lowest Taxa	TV	FFG	TOTAL
Cricotopus sp.	7	CG	198
Cricotopus bicinctus group	7	CG	135
Simulium sp.	6	CF	121
Nais communis/ variabilis		CG	84
Eukiefferiella sp.	8	OM	62
Ophidonais serpentina			51
Rheocricotopus sp.	6	OM	32
Slavina appendiculata		CG	22
Lumbricina		CG	17
Hydropsyche californica	4	CF	17
Cricotopus trifascia group	7	CG	15
Tubificidae	10	CG	14
Physa sp.	8	SC	13
Sperchon sp.	8	P	12
Micropsectra sp.	7	CG	12
Dugesia tigrina	4	P	11
Prostoma sp.	8	P	7
Gammarus sp.	6	CG	4
Pristina aequiseta		CG	3
Fallceon quilleri	4	CG	3
Fossaria sp.	8	SC	2
Corbicula sp.	6	CF	2
Pseudosmittia sp.		CG	1
Phaenopsectra sp.	7	SC	1
Phaenopsectra sp.			1
Paratanytarsus sp.	6	CF	1
Menetus opercularis	6	SC	1
Limnophyes sp.	8	CG	1
Hyalella sp.	8	CG	1
Eudistylia vancouveri			1
Cladotanytarsus sp.	7	CG	1
Chaetogaster diaphanus			1
			847

Orestimba 5

Lowest Taxa	T1	Lowest Taxa	T2	Lowest Taxa	T3
Tubificidae	67	*Nais communis/ variabilis*	74	*Ophidonais serpentina*	109
Physa sp.	52	*Ophidonais serpentina*	66	*Nais communis/ variabilis*	74
Chironomus sp.	27	Tubificidae	28	*Cricotopus bicinctus group*	20
Ophidonais serpentina	26	*Orthocladius complex*	27	Tubificidae	17
Cricotopus sp.	13	*Cricotopus sp.*	22	*Dicrotendipes sp.*	11
Orthocladius complex	11	*Eukiefferiella sp.*	15	*Orthocladius complex*	8
Tribelos sp.	10	*Simulium sp.*	14	*Corbicula sp.*	8
Branchiura sowerbyi	10	*Rheocricotopus sp.*	9	*Sperchon sp.*	6
Dicrotendipes sp.	9	*Sperchon sp.*	9	*Fossaria sp.*	6
Fossaria sp.	7	*Cricotopus bicinctus group*	7	*Physa sp.*	6
Cricotopus bicinctus group	5	*Fossaria sp.*	5	*Chironomus sp.*	4
Nais communis/ variabilis	5	*Micropsectra sp.*	4	*Tribelos sp.*	4
Corbicula sp.	5	*Cricotopus sp.*	4	*Cricotopus sp.*	4
Cricotopus sp.	4	*Orthocladius sp.*	4	*Hydropsyche californica*	3
Psychoda sp.	4	*Slavina appendiculata*	4	*Branchiura sowerbyi*	3
Hyalella sp.	4	*Hydropsyche californica*	3	*Dugesia tigrina*	3
Eudistylia vancouveri	4	*Paratanytarsus sp.*	2	*Micropsectra sp.*	2
Paracladopelma sp.	2	*Eudistylia vancouveri*	2	*Cricotopus sp.*	2
Gymnometriocnemus sp.	2	*Physa sp.*	2	*Orthocladius sp.*	2
Erpobdellidae	2	*Cladotanytarsus sp.*	1	*Hyalella sp.*	2
Lumbricina	2	*Eukiefferiella sp.*	1	*Prostoma sp.*	2
Menetus opercularis	2	*Hyalella sp.*	1	*Paracladopelma sp.*	1
Tropisternus sp.	1	Lumbricina	1	*Tanytarsus sp.*	1
Polypedilum sp.	1	*Limnodrilus hoffmeisteri*	1	*Eukiefferiella sp.*	1
Ablabesmyia sp.	1	*Corbicula sp.*	1	*Procladius sp.*	1
Procladius sp.	1	*Menetus opercularis*	1	*Eudistylia vancouveri*	1
Sperchon sp.	1	*Prostoma sp.*	1	Lumbricina	1
				Menetus opercularis	1
	278		309		303

Lowest Taxa	TV	FFG	TOTAL
Ophidonais serpentina			201
Nais communis/ variabilis		CG	153
Tubificidae	10	CG	112
Physa sp.	8	SC	60
Orthocladius complex	6	CG	46
Cricotopus sp.			39
Cricotopus bicinctus group	7	CG	32
Chironomus sp.	10	CG	31
Dicrotendipes sp.	8	CG	20
Fossaria sp.	8	SC	18
Sperchon sp.	8	P	16
Eukiefferiella sp.	8	OM	15
Tribelos sp.	5	CG	14
Simulium sp.	6	CF	14
Corbicula sp.	6	CF	14
Branchiura sowerbyi	10	CG	13
Cricotopus sp.	7	CG	10
Rheocricotopus sp.	6	OM	9
Hyalella sp.	8	CG	7
Eudistylia vancouveri			7
Orthocladius sp.			6
Micropsectra sp.	7	CG	6
Hydropsyche californica	4	CF	6
Slavina appendiculata		CG	4
Psychoda sp.	10	CG	4
Menetus opercularis	6	SC	4
Lumbricina		CG	4
Prostoma sp.	8	P	3
Paracladopelma sp.	7		3
Dugesia tigrina	4	P	3
Procladius sp.	9	P	2
Paratanytarsus sp.			2
Gymnometriocnemus sp.	5	CG	2
Eukiefferiella sp.			2
Erpobdellidae	8	P	2
Tropisternus sp.	5	CG	1
Tanytarsus sp.	6	CF	1
Polypedilum sp.	6	CG	1
Limnodrilus hoffmeisteri		CG	1
Cladotanytarsus sp.	7	CG	1
Ablabesmyia sp.	8	CG	1
			890

Orestimba 6

Lowest Taxa	T1
Nais communis/ variabilis	64
Cricotopus sp.	59
Tubificidae	43
Cricotopus bicinctus group	41
Chironomus sp.	25
Dicrotendipes sp.	21
Corbicula sp.	11
Eukiefferiella sp.	10
Limnodrilus hoffmeisteri	7
Physa sp.	5
Tanytarsus sp.	4
Ophidonais serpentina	4
Cladotanytarsus sp.	3
Eudistylia vancouveri	2
Endotribelos sp.	1
Phaenopsectra sp.	1
Polypedilum sp.	1
Hydropsyche californica	1
Hyalella sp.	1
Prostoma sp.	1
	305

Lowest Taxa	T2
Nais communis/ variabilis	136
Tubificidae	56
Cricotopus sp.	31
Cricotopus bicinctus group	18
Chironomus sp.	12
Eudistylia vancouveri	8
Corbicula sp.	7
Eukiefferiella sp.	6
Dicrotendipes sp.	5
Branchiura sowerbyi	5
Tanytarsus sp.	3
Ophidonais serpentina	3
Nereis limnicola	2
Slavina appendiculata	2
Limnodrilus hoffmeisteri	2
Physa sp.	2
Polypedilum sp.	1
Phaenopsectra sp.	1
Nanocladius sp.	1
Ormosia sp.	1
Fallceon quilleri	1
Hydropsyche californica	1
Hyalella sp.	1
Sperchon sp.	1
Prostoma sp.	1
	307

Lowest Taxa	T3
Cricotopus sp.	68
Nais communis/ variabilis	47
Cricotopus bicinctus group	44
Tubificidae	39
Cricotopus sp.	16
Dicrotendipes sp.	15
Corbicula sp.	12
Branchiura sowerbyi	10
Limnodrilus hoffmeisteri	10
Physa sp.	9
Chironomus sp.	8
Ophidonais serpentina	8
Fallceon quilleri	4
Eudistylia vancouveri	4
Eukiefferiella sp.	3
Orthocladius sp.	2
Hydropsyche californica	2
Prostoma sp.	2
Phaenopsectra sp.	1
Eukiefferiella sp.	1
Simulium sp.	1
Hyalella sp.	1
Sperchon sp.	1
Enchytraeidae	1
Slavina appendiculata	1
Dugesia tigrina	1
	311

Lowest Taxa	TV	FFG	TOTAL
Nais communis/ variabilis	-	CG	247
Cricotopus sp.	7	CG	158
Tubificidae	10	CG	138
Cricotopus bicinctus group	7	CG	103
Chironomus sp.	10	CG	45
Dicrotendipes sp.	8	CG	41
Corbicula sp.	6	CF	30
Limnodrilus hoffmeisteri		CG	19
Eukiefferiella sp.	8	OM	19
Physa sp.	8	SC	16
Cricotopus sp.			16
Ophidonais serpentina			15
Branchiura sowerbyi	10	CG	15
Eudistylia vancouveri			14
Tanytarsus sp.	6	CF	7
Fallceon quilleri	4	CG	5
Prostoma sp.	8	P	4
Hydropsyche californica	4	CF	4
Slavina appendiculata		CG	3
Hyalella sp.	8	CG	3
Cladotanytarsus sp.	7	CG	3
Sperchon sp.	8	P	2
Polypedilum sp.	6	CG	2
Phaenopsectra sp.	7	SC	2
Orthocladius sp.			2
Nereis limnicola			2
Simulium sp.	6	CF	1
Phaenopsectra sp.			1
Ormosia sp.	3	CG	1
Nanocladius sp.			1
Eukiefferiella sp.			1
Endotribelos sp.	6	CG	1
Enchytraeidae	10	CG	1
Dugesia tigrina	4	P	1
			923

Orestimba 7

Lowest Taxa	T1
Cricotopus sp.	100
Cricotopus bicinctus group	50
Orthocladius complex	35
Cricotopus sp.	29
Slavina appendiculata	23
Physa sp.	14
Dicrotendipes sp.	8
Eudistylia vancouveri	8
Tubificidae	7
Prostoma sp.	5
Cricotopus trifascia group	4
Hyalella sp.	3
Menetus opercularis	3
Hydropsyche californica	2
Nais communis/ variabilis	2
Corbicula sp.	2
Dugesia tigrina	2
Cladotanytarsus sp.	1
Erpobdellidae	1
Fossaria sp.	1
	300

Lowest Taxa	T2
Cricotopus sp.	76
Cricotopus bicinctus group	32
Physa sp.	32
Orthocladius complex	29
Eudistylia vancouveri	18
Cricotopus sp.	17
Slavina appendiculata	17
Prostoma sp.	14
Hydropsyche californica	13
Cricotopus trifascia group	11
Nais communis/ variabilis	8
Eukiefferiella sp.	3
Sperchon sp.	3
Ophidonais serpentina	3
Cladotanytarsus sp.	2
Eukiefferiella sp.	2
Tubificidae	2
Dugesia tigrina	2
Dicrotendipes sp.	1
Parachironomus sp.	1
Orthocladius sp.	1
Simulium sp.	1
Hyalella sp.	1
Erpobdellidae	1
Lumbricina	1
Chaetogaster diaphanus	1
	292

Lowest Taxa	T3
Slavina appendiculata	61
Cricotopus sp.	49
Cricotopus bicinctus group	40
Orthocladius complex	38
Cricotopus sp.	24
Nais communis/ variabilis	21
Hydropsyche californica	19
Dugesia tigrina	16
Eudistylia vancouveri	11
Prostoma sp.	6
Physa sp.	5
Rheocricotopus sp.	4
Eukiefferiella sp.	2
Corbicula sp.	2
Dicrotendipes sp.	1
Cricotopus trifascia group	1
Simulium sp.	1
Lumbricina	1
Tubificidae	1
	303

Lowest Taxa	TV	FFG	TOTAL
Cricotopus sp.			225
Cricotopus bicinctus group	7	CG	122
Orthocladius complex	6	CG	102
Slavina appendiculata		CG	101
Cricotopus sp.	7	CG	70
Physa sp.	8	SC	51
Eudistylia vancouveri			37
Hydropsyche californica	4	CF	34
Nais communis/ variabilis		CG	31
Prostoma sp.	8	P	25
Dugesia tigrina	4	P	20
Cricotopus trifascia group	7	CG	16
Tubificidae	10	CG	10
Dicrotendipes sp.	8	CG	10
Eukiefferiella sp.	8	OM	5
Rheocricotopus sp.	6	OM	4
Hyalella sp.	8	CG	4
Corbicula sp.	6	CF	4
Sperchon sp.	8	P	3
Ophidonais serpentina			3
Menetus opercularis	6	SC	3
Cladotanytarsus sp.	7	CG	3
Simulium sp.	6	CF	2
Lumbricina		CG	2
Eukiefferiella sp.			2
Erpobdellidae	8	P	2
Parachironomus sp.	10	P	1
Orthocladius sp.			1
Fossaria sp.	8	SC	1
Chaetogaster diaphanus			1
			895

Orestimba 8

Lowest Taxa	T1
Physa sp.	62
Hyalella sp.	58
Cricotopus bicinctus group	48
Cricotopus sp.	45
Ophidonais serpentina	27
Nais communis/ variabilis	15
Slavina appendiculata	13
Paratanytarsus sp.	6
Eudistylia vancouveri	4
Corbicula sp.	4
Dicrotendipes sp.	3
Eukiefferiella sp.	2
Coenagrionidae	2
Tubificidae	2
Prostoma sp.	2
Dugesia tigrina	2
Thienemanniella sp.	1
Hydra sp.	1
Gyraulus parvus	1
	298

Lowest Taxa	T2
Cricotopus bicinctus group	72
Cricotopus sp.	63
Ophidonais serpentina	47
Eudistylia vancouveri	25
Nais communis/ variabilis	21
Slavina appendiculata	20
Hyalella sp.	16
Prostoma sp.	16
Corbicula sp.	12
Dicrotendipes sp.	9
Erpobdellidae	6
Paratanytarsus sp.	3
Tubificidae	3
Dugesia tigrina	3
Simulium sp.	2
Chaetogaster diaphanus	2
Polypedilum sp.	1
Limnophyes sp.	1
Rheocricotopus sp.	1
Cricotopus trifascia group	1
Eukiefferiella sp.	1
Sperchon sp.	1
Nereis limnicola	1
Physa sp.	1
	328

Lowest Taxa	T3
Cricotopus sp.	91
Eudistylia vancouveri	76
Cricotopus bicinctus group	46
Eukiefferiella sp.	14
Nais communis/ variabilis	14
Slavina appendiculata	13
Nereis limnicola	8
Prostoma sp.	8
Ophidonais serpentina	7
Corbicula sp.	7
Tubificidae	5
Dugesia tigrina	5
Dicrotendipes sp.	4
Hyalella sp.	4
Paratanytarsus sp.	3
Physa sp.	3
Simulium sp.	2
Orthocladius complex	1
Cricotopus trifascia group	1
	312

Lowest Taxa	TV	FFG	TOTAL
Cricotopus sp.	7	CG	199
Cricotopus bicinctus group	7	CG	166
Eudistylia vancouveri			105
Ophidonais serpentina			81
Hyalella sp.	8	CG	78
Physa sp.	8	SC	66
Nais communis/ variabilis		CG	50
Slavina appendiculata		CG	46
Prostoma sp.	8	P	26
Corbicula sp.	6	CF	23
Dicrotendipes sp.	8	CG	16
Eukiefferiella sp.	8	OM	14
Paratanytarsus sp.	6	CF	12
Tubificidae	10	CG	10
Dugesia tigrina	4	P	10
Nereis limnicola			9
Erpobdellidae	8	P	6
Simulium sp.	6	CF	4
Eukiefferiella sp.			3
Cricotopus trifascia group	7	CG	2
Coenagrionidae		P	2
Chaetogaster diaphanus			2
Thienemanniella sp.			1
Sperchon sp.	8	P	1
Rheocricotopus sp.	6	OM	1
Polypedilum sp.	6	CG	1
Orthocladius complex	6	CG	1
Limnophyes sp.	8	CG	1
Hydra sp.	5	P	1
Gyraulus parvus		SC	1
			938

Orestimba 9

Lowest Taxa	T1	Lowest Taxa	T2	Lowest Taxa	T3
Physa sp.	127	**Ostracoda**	58	**Ostracoda**	43
Ostracoda	36	*Physa sp.*	57	*Physa sp.*	34
Planorbella sp.	21	*Planorbella sp.*	24	Enchytraeidae	20
Cricotopus bicinctus group	12	*Chaetogaster diaphanus*	16	Tubificidae	11
Chironomus sp.	8	Enchytraeidae	9	*Planorbella sp.*	10
Chaetogaster diaphanus	8	*Slavina appendiculata*	7	*Simulium sp.*	7
Menetus opercularis	5	*Cricotopus bicinctus group*	5	Lumbricina	7
Nais communis/ variabilis	4	Lumbricina	5	*Cricotopus bicinctus group*	4
Simulium sp.	3	Glossiphoniidae	4	Glossiphoniidae	4
Enchytraeidae	3	*Procladius sp.*	3	*Cricotopus sp.*	3
Slavina appendiculata	3	Tubificidae	3	*Dero nivea*	3
Tubificidae	3	*Prostoma sp.*	3	*Fossaria sp.*	3
Prostoma sp.	3	*Chironomus sp.*	2	*Menetus opercularis*	3
Cricotopus sp.	2	*Limnophyes sp.*	2	*Prostoma sp.*	3
Hydropsyche californica	1	Erpobdellidae	2	*Chironomus sp.*	2
Erpobdellidae	1	*Nais communis/ variabilis*	2	*Slavina appendiculata*	2
Lumbricina	1	*Menetus opercularis*	2	*Limnophyes sp.*	1
Gyraulus parvus	1	*Cricotopus sp.*	1	*Procladius sp.*	1
	242	*Simulium sp.*	1	*Gammarus sp.*	1
		Dero digitata	1	*Chaetogaster diaphanus*	1
			207		163

Lowest Taxa	TV	FFG	TOTAL
Physa sp.	8	SC	218
Ostracoda	8	CG	137
Planorbella sp.	6	SC	55
Enchytraeidae		CG	32
Chaetogaster diaphanus			25
Cricotopus bicinctus group	7	CG	21
Tubificidae	10	CG	17
Lumbricina		CG	13
Slavina appendiculata		CG	12
Chironomus sp.	10	CG	12
Simulium sp.	6	CF	11
Menetus opercularis	6	SC	10
Prostoma sp.	8	P	9
Glossiphoniidae	8	P	8
Nais communis/ variabilis		CG	6
Cricotopus sp.			6
Procladius sp.	9	P	4
Limnophyes sp.	8	CG	3
Fossaria sp.	8	SC	3
Erpobdellidae	8	P	3
Dero nivea		CG	3
Hydropsyche californica	4	CF	1
Gyraulus parvus		SC	1
Gammarus sp.	6	CG	1
Dero digitata		CG	1
			612

Orestimba 10

Lowest Taxa	T1
Menetus opercularis	56
Nais communis/ variabilis	53
Caenis latipennis	26
Oxyethira sp.	22
Ostracoda	22
Cricotopus sp.	21
Torrenticola sp.	19
Cricotopus bicinctus group	17
Rheotanytarsus sp.	16
Cricotopus trifascia group	7
Baetis adonis	7
Dicrotendipes sp.	6
Thienemanniella sp.	6
Planorbella sp.	6
Orthocladius complex	4
Corynoneura sp.	4
Centroptilum sp.	4
Chaetogaster diaphanus	4
Nais barbata	4
Physa sp.	4
Simulium sp.	2
Odontomyia/ Hedriodiscus	2
Callibaetis sp.	2
Laccobius sp.	1
Polypedilum sp.	1
Pseudochironomus sp.	1
Eukiefferiella sp.	1
Thienemannimyia group	1
Ablabesmyia sp.	1
Hexatoma sp.	1
Fallceon quilleri	1
Lymnaeidae	1
	323

Lowest Taxa	T2
Nais communis/ variabilis	70
Menetus opercularis	36
Nais barbata	34
Oxyethira sp.	23
Rheotanytarsus sp.	20
Cricotopus bicinctus group	19
Torrenticola sp.	18
Cricotopus sp.	17
Caenis latipennis	12
Dicrotendipes sp.	8
Chaetogaster diaphanus	8
Planorbella sp.	7
Orthocladius complex	5
Thienemanniella sp.	5
Corynoneura sp.	3
Simulium sp.	3
Centroptilum sp.	3
Baetis adonis	3
Fallceon quilleri	3
Stictotarsus striatellus	2
Gastropoda	2
Bezzia/ Palpomyia	1
Demicryptochironomus sp.	1
Paratanytarsus sp.	1
Tanytarsus sp.	1
Parametriocnemus sp.	1
Cricotopus trifascia group	1
Thienemannimyia group	1
Baetis sp.	1
Pristina leidyi	1
Fossaria sp.	1
	311

Lowest Taxa	T3
Nais communis/ variabilis	65
Nais barbata	40
Menetus opercularis	28
Oxyethira sp.	24
Dicrotendipes sp.	14
Cricotopus sp.	12
Cricotopus bicinctus group	12
Baetis adonis	12
Caenis latipennis	12
Rheotanytarsus sp.	9
Corynoneura sp.	9
Ostracoda	9
Torrenticola sp.	7
Centroptilum sp.	6
Fallceon quilleri	5
Chaetogaster diaphanus	5
Thienemanniella sp.	3
Hydroptila sp.	3
Physa sp.	3
Pseudochironomus sp.	2
Paratanytarsus sp.	2
Cricotopus trifascia group	2
Dolichopodidae	2
Simulium sp.	2
Pristina leidyi	2
Gastropoda	2
Fossaria sp.	2
Planorbella sp.	2
Stictotarsus sp.	1
Laccobius sp.	1
Orthocladius complex	1
Parametriocnemus sp.	1
Muscidae	1
Odontomyia/ Hedriodiscus	1
Hexatoma sp.	1
Callibaetis sp.	1
Hyalella sp.	1
Dugesia tigrina	1
	306

Lowest Taxa	TV	FFG	TOTAL
Nais communis/ variabilis		CG	188
Menetus opercularis	6	SC	120
Nais barbata		CG	78
Oxyethira sp.	3	PH	69
Cricotopus sp.	7	CG	50
Caenis latipennis	7	CG	50
Cricotopus bicinctus group	7	CG	48
Rheotanytarsus sp.	6	CF	45
Torrenticola sp.	5	P	44
Ostracoda	8	CG	31
Dicrotendipes sp.	8	CG	28
Baetis adonis	5	CG	22
Chaetogaster diaphanus			17
Corynoneura sp.	7	CG	16
Planorbella sp.	6	SC	15
Thienemanniella sp.	6	CG	14
Centroptilum sp.	2	CG	13
Orthocladius complex	6	CG	10
Cricotopus trifascia group	7	CG	10
Fallceon quilleri	4	CG	9
Simulium sp.	6	CF	7
Physa sp.	8	SC	7
Gastropoda		SC	4
Pseudochironomus sp.	5	CG	3
Pristina leidyi		CG	3
Paratanytarsus sp.	6	CF	3
Odontomyia/ Hedriodiscus	8	CG	3
Hydroptila sp.	6	PH	3
Fossaria sp.	8	SC	3
Callibaetis sp.	9	CG	3
Thienemannimyia group	6	P	2
Stictotarsus striatellus	5	P	2
Parametriocnemus sp.	5	CG	2
Laccobius sp.	5	MH	2
Hexatoma sp.	2	P	2
Dolichopodidae	4	P	2
Tanytarsus sp.	6	CF	1
Stictotarsus sp.	5	P	1
Polypedilum sp.	6	CG	1
Muscidae	6	P	1
Lymnaeidae	6	SC	1
Hyalella sp.	8	CG	1
Eukiefferiella sp.	8	OM	1
Dugesia tigrina	4	P	1
Demicryptochironomus sp.	6	CG	1
Bezzia/ Palpomyia	6	P	1
Baetis sp.	5	CG	1
Ablabesmyia sp.	8	CG	1
			940

Appendix D

Number of lowest identified taxa by transect and combined transects including tolerance values (TV) and feeding guilds (FFG) for Salt Slough sites. Tolerance values for taxa range from 1 to 10 with 10 being the most tolerant value. Feeding guilds are defined as follows: CG = collector-gatherer; CF = collector-filterer; SC = scraper; SH = shredder; P = predator; MH = macrophyte herbivore; OM = omnivore; PA = parasite; XY = Xylophage.

Salt Slough 1

Lowest Taxa	T1
Corophium spinicorne	263
Corbicula sp.	14
Gammarus sp.	9
Prostoma sp.	6
Slavina appendiculata	5
Limnophyes sp.	2
Liodessus obscurellus	1
Staphylinidae	1
Parachironomus sp.	1
Orthocladius complex	1
Psychoda sp.	1
Hydropsyche californica	1
Lumbricina	1
Chaetogaster diaphanus	1
Physa sp.	1
	308

Lowest Taxa	T2
Corophium spinicorne	217
Hydropsyche californica	54
Gammarus sp.	8
Corbicula sp.	8
Cricotopus bicinctus group	7
Cricotopus sp.	4
Hydroptila sp.	1
Physa sp.	1
	300

Lowest Taxa	T3
Physa sp.	97
Corophium spinicorne	74
Corixidae	46
Cricotopus bicinctus group	25
Cricotopus sp.	14
Gammarus sp.	7
Chironomus sp.	5
Trichocorixa sp.	5
Cladotanytarsus sp.	3
Paratanytarsus sp.	3
Corisella decolor	3
Trichocorixa calva	3
Hydropsyche californica	3
Zoniagrion exlamationis	2
Hydroptila sp.	2
Microtendipes pedellus group	1
Limnophyes sp.	1
Corbicula sp.	1
	295

Lowest Taxa	TV	FFG	TOTAL
Corophium spinicorne	4	CF	554
Physa sp.	8	SC	99
Hydropsyche californica	4	CF	58
Corixidae	10	P	46
Cricotopus bicinctus group	7	CG	32
Gammarus sp.	6	CG	24
Corbicula sp.	6	CF	23
Cricotopus sp.			18
Prostoma sp.	8	P	6
Trichocorixa sp.			5
Slavina appendiculata		CG	5
Chironomus sp.	10	CG	5
Trichocorixa calva			3
Paratanytarsus sp.	6	CF	3
Limnophyes sp.	8	CG	3
Hydroptila sp.	6	PH	3
Corisella decolor			3
Cladotanytarsus sp.	7	CG	3
Zoniagrion exlamationis	9	P	2
Staphylinidae		P	1
Psychoda sp.	10	CG	1
Parachironomus sp.	10	P	1
Orthocladius complex	6	CG	1
Microtendipes pedellus group	6	CF	1
Lumbricina		CG	1
Liodessus obscurellus	5	P	1
Chaetogaster diaphanus			1
			903

Salt Slough 2

Lowest Taxa	T1
Corophium spinicorne	58
Corbicula sp.	8
Eudistylia vancouveri	7
Gammarus sp.	6
Hydropsyche californica	5
Cricotopus bicinctus group	3
Polypedilum sp.	2
Simulium sp.	2
Phaenopsectra sp.	1
Cladotanytarsus sp.	1
Cricotopus sp.	1
Coenagrionidae	1
Physa sp.	1
Hydrobiidae	1
	97

Lowest Taxa	T2
Corophium spinicorne	151
Crangonyx sp.	72
Hyalella sp.	29
Corbicula sp.	7
Physa sp.	7
Cricotopus sp.	5
Eudistylia vancouveri	5
Paratanytarsus sp.	4
Hydropsyche californica	4
Polypedilum sp.	3
Gammarus sp.	3
Orthocladiinae	2
Tanypus sp.	2
Chironomidae	1
Chironomus sp.	1
Dicrotendipes sp.	1
Limnophyes sp.	1
Cricotopus bicinctus group	1
Corixidae	1
	300

Lowest Taxa	T3
Corophium spinicorne	111
Eudistylia vancouveri	10
Cricotopus sp.	5
Paratanytarsus sp.	3
Hydropsyche californica	3
Chironomus sp.	2
Paratanytarsus sp.	2
Cricotopus sp.	2
Cricotopus bicinctus group	2
Procladius sp.	2
Corixidae	2
Physa sp.	2
Dicrotendipes sp.	1
Harnischia sp.	1
Parachironomus sp.	1
Polypedilum sp.	1
Zoniagrion exlamationis	1
Crangonyx sp.	1
Hyalella sp.	1
Corbicula sp.	1
	154

Lowest Taxa	TV	FFG	TOTAL
Corophium spinicorne	4	CF	320
Crangonyx sp.	4	CG	73
Hyalella sp.	8	CG	30
Eudistylia vancouveri			22
Corbicula sp.	6	CF	16
Hydropsyche californica	4	CF	12
Cricotopus sp.			11
Physa sp.	8	SC	10
Gammarus sp.	6	CG	9
Paratanytarsus sp.	6	CF	7
Polypedilum sp.	6	CG	6
Cricotopus bicinctus group	7	CG	6
Corixidae	10	P	3
Chironomus sp.	10	CG	3
Tanypus sp.	10	P	2
Simulium sp.	6	CF	2
Procladius sp.	9	P	2
Paratanytarsus sp.			2
Orthocladiinae			2
Dicrotendipes sp.	8	CG	2
Cricotopus sp.	7	CG	2
Zoniagrion exlamationis	9	P	1
Phaenopsectra sp.	7	SC	1
Parachironomus sp.	10	P	1
Limnophyes sp.	8	CG	1
Hydrobiidae	8	SC	1
Harnischia sp.	6	CG	1
Coenagrionidae		P	1
Cladotanytarsus sp.	7	CG	1
Chironomidae	6	CG	1
			551

Salt Slough 3

Lowest Taxa	T1
Corophium spinicorne	124
Cricotopus sp.	37
Cricotopus bicinctus group	31
Hydropsyche californica	31
Corbicula sp.	30
Gammarus sp.	19
Physa sp.	5
Paratanytarsus sp.	4
Hyalella sp.	4
Ophidonais serpentina	4
Simulium sp.	3
Polypedilum sp.	2
Ischnura sp.	2
Hydroptila sp.	2
Laccophilus sp.	1
Limnophyes sp.	1
Nanocladius sp.	1
Corixidae	1
Eudistylia vancouveri	1
Dero sp.	1
Tubificidae	1
Limnodrilus hoffmeisteri	1
Ferrissia rivularis	1
	307

Lowest Taxa	T2
Corophium spinicorne	194
Corixidae	31
Eudistylia vancouveri	24
Corbicula sp.	14
Cricotopus sp.	9
Harnischia sp.	4
Limnodrilus hoffmeisteri	4
Chironomus sp.	3
Harnischia sp.	3
Paratanytarsus sp.	3
Procladius sp.	3
Trichocorixa calva	3
Tanypus sp.	2
Physa sp.	2
Berosus sp.	1
Cladotanytarsus sp.	1
Palmacorixa sp.	1
Corisella decolor	1
Coenagrionidae	1
Hydropsyche californica	1
Hydroptila sp.	1
	306

Lowest Taxa	T3
Corophium spinicorne	177
Hydropsyche californica	31
Cricotopus sp.	27
Corbicula sp.	20
Cricotopus bicinctus group	15
Paratanytarsus sp.	5
Gammarus sp.	5
Nais communis/ variabilis	5
Ophidonais serpentina	4
Hydroptila sp.	3
Slavina appendiculata	3
Tubificidae	3
Polypedilum sp.	2
Simulium sp.	2
Polypedilum sp.	1
	303

Lowest Taxa	TV	FFG	TOTAL
Corophium spinicorne	4	CF	495
Cricotopus sp.	7	CG	73
Corbicula sp.	6	CF	64
Hydropsyche californica	4	CF	63
Cricotopus bicinctus group	7	CG	46
Corixidae	10	P	32
Eudistylia vancouveri			25
Gammarus sp.	6	CG	24
Paratanytarsus sp.	6	CF	12
Ophidonais serpentina			8
Physa sp.	8	SC	7
Harnischia sp.	6	CG	7
Hydroptila sp.	6	PH	6
Simulium sp.	6	CF	5
Nais communis/ variabilis		CG	5
Limnodrilus hoffmeisteri		CG	5
Tubificidae	10	CG	4
Hyalella sp.	8	CG	4
Trichocorixa calva			3
Slavina appendiculata		CG	3
Procladius sp.	9	P	3
Polypedilum sp.	6	CG	3
Chironomus sp.	10	CG	3
Tanypus sp.	10	P	2
Polypedilum sp.			2
Ischnura sp.	9	P	2
Palmacorixa sp.			1
Nanocladius sp.	3	CG	1
Limnophyes sp.	8	CG	1
Laccophilus sp.	5	P	1
Ferrissia rivularis	6	SC	1
Dero sp.	10	CG	1
Corisella decolor			1
Coenagrionidae		P	1
Cladotanytarsus sp.	7	CG	1
Berosus sp.	5	P	1
			916

Salt Slough 4

Lowest Taxa	T1
Physa sp.	23
Tubificidae	8
Limnodrilus hoffmeisteri	6
Cricotopus sp.	4
Dicrotendipes sp.	3
Cricotopus bicinctus group	3
Ferrissia rivularis	3
Eudistylia vancouveri	2
Polypedilum sp.	1
Ischnura sp.	1
Ophidonais serpentina	1
Branchiura sowerbyi	1
Gyraulus parvus	1
Menetus opercularis	1
	58

Lowest Taxa	T2
Physa sp.	102
Ophidonais serpentina	95
Slavina appendiculata	18
Menetus opercularis	12
Tubificidae	11
Ferrissia rivularis	7
Eudistylia vancouveri	5
Nais communis/ variabilis	5
Cricotopus sp.	4
Prostoma sp.	4
Corophium spinicorne	3
Limnodrilus hoffmeisteri	3
Paratanytarsus sp.	2
Hyalella sp.	2
Staphylinidae	1
Dicrotendipes sp.	1
Paratanytarsus sp.	1
Cricotopus sp.	1
Corisella sp.	1
Branchiura sowerbyi	1
	279

Lowest Taxa	T3
Ophidonais serpentina	182
Physa sp.	45
Slavina appendiculata	26
Tubificidae	7
Menetus opercularis	5
Hyalella sp.	4
Paratanytarsus sp.	3
Nais communis/ variabilis	3
Parachironomus sp.	2
Cricotopus bicinctus group	2
Paratanytarsus sp.	1
Cricotopus sp.	1
Procladius sp.	1
Corophium spinicorne	1
Eudistylia vancouveri	1
Limnodrilus hoffmeisteri	1
	285

Lowest Taxa	TV	FFG	TOTAL
Ophidonais serpentina			278
Physa sp.	8	SC	170
Slavina appendiculata		CG	44
Tubificidae	10	CG	26
Menetus opercularis	6	SC	18
Limnodrilus hoffmeisteri		CG	10
Ferrissia rivularis	6	SC	10
Nais communis/ variabilis		CG	8
Eudistylia vancouveri			8
Hyalella sp.	8	CG	6
Cricotopus sp.			6
Paratanytarsus sp.	6	CF	5
Cricotopus bicinctus group	7	CG	5
Prostoma sp.	8	P	4
Dicrotendipes sp.	8	CG	4
Cricotopus sp.	7	CG	4
Corophium spinicorne	4	CF	4
Paratanytarsus sp.			2
Parachironomus sp.	10	P	2
Branchiura sowerbyi	10	CG	2
Staphylinidae		P	1
Procladius sp.	9	P	1
Polypedilum sp.	6	CG	1
Ischnura sp.	9	P	1
Gyraulus parvus		SC	1
Corisella sp.			1
			622

Salt Slough 5

Lowest Taxa	T1
Physa sp.	101
Cricotopus sp.	94
Paratanytarsus sp.	66
Cricotopus sp.	11
Nais communis/ variabilis	7
Coenagrionidae	4
Apedilum sp.	3
Tubificidae	2
Chironomus sp.	1
Endochironomus sp.	1
Glyptotendipes sp.	1
Goeldichironomus sp.	1
Polypedilum sp.	1
Apedilum sp.	1
Orthocladiinae	1
Corixidae	1
Corisella decolor	1
Decapoda	1
Ferrissia rivularis	1
Lymnaeidae	1
	300

Lowest Taxa	T2
Cricotopus sp.	62
Physa sp.	29
Corixidae	22
Tubificidae	19
Chironomus sp.	16
Corisella decolor	9
Paratanytarsus sp.	6
Decapoda	3
Coenagrionidae	2
Fossaria sp.	2
Limnophyes sp.	1
Tanypus sp.	1
Trichocorixa calva	1
Ophidonais serpentina	1
Lymnaeidae	1
	175

Lowest Taxa	T3
Cricotopus sp.	126
Physa sp.	40
Tubificidae	21
Paratanytarsus sp.	16
Chironomus sp.	13
Polypedilum sp.	3
Corisella decolor	2
Trichocorixa calva	2
Limnodrilus hoffmeisteri	2
Tropisternus sp.	1
Dicrotendipes sp.	1
Limnophyes sp.	1
Ephydridae	1
Corixidae	1
Coenagrionidae	1
Lumbricina	1
Nais communis/ variabilis	1
Corbicula sp.	1
Lymnaeidae	1
	235

Lowest Taxa	TV	FFG	TOTAL
Cricotopus sp.	7	CG	282
Physa sp.	8	SC	170
Paratanytarsus sp.	6	CF	88
Tubificidae	10	CG	42
Chironomus sp.	10	CG	30
Corixidae	10	P	24
Corisella decolor			12
Cricotopus sp.			11
Nais communis/ variabilis		CG	8
Coenagrionidae		P	7
Polypedilum sp.	6	CG	4
Decapoda			4
Trichocorixa calva			3
Lymnaeidae	6	SC	3
Apedilum sp.	6	CG	3
Limnophyes sp.	8	CG	2
Limnodrilus hoffmeisteri		CG	2
Fossaria sp.	8	SC	2
Tropisternus sp.	5	P	1
Tanypus sp.			1
Orthocladiinae			1
Ophidonais serpentina			1
Lumbricina		CG	1
Goeldichironomus sp.	6	CG	1
Glyptotendipes sp.	10	SH	1
Ferrissia rivularis	6	SC	1
Ephydridae			1
Endochironomus sp.	10	CG	1
Dicrotendipes sp.	8	CG	1
Corbicula sp.	6	CF	1
Apedilum sp.			1
			710