Report
January 2007

Characterization of Benthic Communities and Physical Habitat in Agricultural Streams in California's San Joaquin Valley in 2006

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 major objective of this study was to characterize physical habitat and benthic communities (macroinvertebrates) in three agricultural streams in California's San Joaquin Valley in 2006. The State of California has listed these three streams as impaired (303 d list) due to the presence of organophosphate insecticides (OP) chlorpyrifos and diazinon. A secondary goal of this study was to qualitatively 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 57 to 151 (maximum possible total score is 200). Most habitat metrics were highly variable among Del Puerto Creek sites indicating diverse physical habitat conditions in this stream. Orestimba Creek physical habitat scores ranged from 35 to 155. The lowest habitat score was reported at one of the most upstream sites. Salt Slough physical habitat scores ranged from 56 to 108 and the lowest habitat score was reported at the most upstream site. A comparison of mean habitat metrics among the three streams showed no significant differences for the various metrics among the streams. In general, the range of physical habitat scores in these streams is considered low.

Most of the macroinvertebrates collected in the three streams were tolerant taxa (i.e., oligochaetes and chironomids). Benthic metrics such as species richness, % dominant taxa and % intolerant taxa were generally similar among the three streams.

Abundance was reported to be higher at upstream sites above agricultural activity in both Del Puerto Creek and Orestimba Creek.

Sediment deposition, bank stability and embeddedness were the most important physical habitat metrics influencing the various benthic metrics for these three streams. For the non-continuous habitat metrics, percent fines and percent cobble had 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. Species most sensitive to diazinon were the amphipod *Hyalella sp.* and the mayfly *Baetis sp. Hyalella* were collected in all three streams *Baetis sp.* was only collected at upstream sites in both Del Puerto Creek and Orestimba Creek.

The presence of 94 taxa in Del Puerto Creek, 122 taxa in Orestimba Creek and 82 taxa in Salt Slough implies that the benthic communities in these streams are fairly diverse, considering their ephemeral environments and numerous physical habitat limitations, but without a clear definition of benthic community expectations it is unknown if these water bodies are actually impaired. Monitoring efforts to identify potential reference sites are recommended 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. To accomplish this task extensive spatial and temporal assessments of benthic communities in concert with physical habitat assessments will be needed.

ACKNOWLEDGEMENTS

We would like to thank the San Joaquin Valley Drainage Authority, Makhteshim Agan of North America, Dow AgroSciences, 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. Karl Stromayer 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 worksheets 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: CG = collector-gatherer; CF = collector-filterer; SC = scraper; SH = shredder; P = predator; MH = macrophyte herbivore; OM = omnivore; PA = parasite; and XY = Xylophage.

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: CG = collector-gatherer; CF = collector-filterer; SC = scraper; SH = shredder; P = predator; MH = macrophyte herbivore; OM = omnivore; PA = parasite; and XY = Xylophage.

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: CG = collector-gatherer; CF = collector-filterer; SC = scraper; SH = shredder; P = predator; MH = macrophyte herbivore; OM = omnivore; PA = parasite; and XY = Xylophage.

INTRODUCTION

California's San Joaquin Valley, the nation's number one agricultural area, has a highly productive agricultural economy primarily due to abundant water and long growing seasons (Dubrovsky et al., 1998). Approximately 10.2% of the total value of agricultural production in the United States originated from California in 1987 – approximately half of this total valued at $6.82 billion came from the San Joaquin Valley (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. Foe (1995) has reported that 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). 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).

Bioassessments, the science of describing the ecological condition of waterbodies from the assemblages of organisms they contain, is a well established tool for determining the ecological condition of stream and river systems (Yoder and Rankin, 1995; Karr and Chu, 1999; Barbour et al. 1996; Wright et al., 2000; Bailey et al. 2004). Assessments of benthic invertebrate assemblages and physical habitat (bioassessments) have been initiated in wadeable streams in California's Central Valley (Bacey, 2005; Brown and May, 2004; Hall and Killen, 2001; Hall and Killen, 2002; Hall and Killen, 2003; Hall and Killen, 2004; Hall and Killen 2005a, Hall and Killen 2005b; Hall and Killen, 2006; Hall et al., in press; Tetra Tech, 2003). Bioassessments provide a useful approach for integrating effects from physical, chemical, and biological stressors on aquatic organisms. Bioassessments are based upon the premise that the structure and function of an aquatic biological community can provide critical information about the quality of the surface water. These efforts are valuable for determining the status of aquatic biological communities across large spatial scales and land use 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 benthic communities and physical habitat in three representative agricultural streams in California's San Joaquin Valley in 2006. 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), 2002 (Hall and Killen, 2003), 2003 (Hall and Killen, 2004), 2004 (Hall and Killen, 2005b) and 2005 (Hall and Killen, 2006). 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), 2002 (Hall and Killen, 2003), 2003 (Hall and Killen, 2004), 2004 (Hall and Killen, 2005b), and 2005 (Hall and Killen, 2006). The water levels in all three streams were much higher in the spring of 2006 than in previous years (2000 – 2005). These high water levels prevented sampling one site in Del Puerto

Creek, three sites in Orestimba Creek, and all five Salt Slough sites during the normal sampling period in late May. All of these sites were therefore sampled in July when water levels had declined. Exact sample stations were determined in each stream and landowner contacts were made to access the sample sites for the late spring/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, percent gradient, and substrate composition that were also measured are described in Appendix A.

Benthic Macroinvertebrate Sampling

Benthic macroinvertebrates were collected in the late spring and summer of 2006 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. Analysis of CoVariance (ANCOVA) was used to determine temporal and spatial trends in both benthic metrics and habitat metrics in the agricultural streams. In this analysis year is the categorical variable and stream location is the covariate. Linear contrasts were used to test for linear trends over years.

RESULTS

Physical Habitat

Del Puerto Creek

The total physical habitat scores in Del Puerto Creek ranged from 57 to 151 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 stream. For example, sediment deposition ranged from 5 to 16, channel alteration ranged from 6 to 19, and frequency of bend/riffles ranged from 5 to 16. The total physical habitat score at DLP4 (57) was particularly low as this site was drastically altered. The most upstream site in Del Puerto Creek (DLP5) – located above agricultural activity - had the highest total physical habitat score.

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 0.01 m/s at DLP4 to 0.60 m/s at DLP3. The mean value across all five sites was 0.36 m/s. The percent canopy for the five Del Puerto Creek sites ranged from 0% at four upstream sites to 68% at downstream site DLP1. Gradient was consistent at all sties (1%). The percent fines for substrate percentages ranged from 10% DLP5 to 60% at DLP4.

Orestimba Creek

Orestimba Creek total physical habitat scores for the 10 metrics that were scored on a 0 to 20 scale ranged from 35 to 155 (Table 2). The total physical habitat score at ORE9 was particularly low. This site had particularly low scores for epifaunal substrate, embeddedness, velocity/depth/diversity, and various riparian zone metrics. The highest total habitat score (155) was reported at upstream site (ORE10). The following metrics were reasonably high at this site: sediment deposition, channel flow status, channel alteration, embeddedness and frequency of bends/riffles. Other descriptive habitat metrics for the 10 Orestimba Creek sties in Table 3 showed that mean site flow ranged from 0 to 0.81 m/s (mean stream value of 0.40 m/s), % canopy ranged from 0 to 90%, % gradient was consistently 1%, and % fines ranged from 10% to 100%.

Salt Slough

The total physical habitat scores in Salt Slough ranged from 56 to 108 for the 10 metrics that were scored on a 0 to 20 scale (Table 2). The lowest total physical habitat score (56) was reported at the most upstream site (SSL5). This site had particularly low scores for embeddedness, velocity/depth/diversity, and sediment deposition. The highest total physical habitat score (108) 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 (0 to 1) at all sites in this stream when compared with either Del Puerto Creek or Orestimba Creek as presented above.

Other descriptive physical habitat metrics for the five Salt Slough sites in Table 3 showed that mean site flow ranged from 0.14 to 0.31 m/s (mean stream value was 0.23 m/s), 0% canopy at all sties but one, % gradient was consistently 1% and % fines were 100% at all sites. The 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 three eigenvalues that were greater than 1 (Table 4). The significance of this finding is that 10 habitat metrics contain three important factors which explained 82% of the variance in the data set. The metrics important to each factor are presented in Table 5. Total score, sediment deposition, bank stability, velocity/depth/diversity and bend riffle frequency were heavily loaded on factor 1. Factor 2 is composed of riparian buffer, channel alteration, and embeddedness. Channel flow status, epifaunal substrate, and bank vegetation were heavily loaded on Factor 3. Metrics loaded on all three factors included both instream as well as riparian metrics.

Correlations among raw physical habitat metrics grouped by factors and identified by PCA showed the following significant correlations for Factor 1: total score and bank stability, sediment deposition, velocity/depth, and bend/riffle frequency; sediment deposition and bank stability, velocity/depth, and bend/riffle frequency; bank stability and velocity/depth and bend/riffle frequency (Table 6). For factor 2, significant correlations were found between riparian buffer and channel alteration. For factor 3, significant correlations were found between channel flow and epifaunal substrate.

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 % fines, % gravel, % cobble and mean flow. Percent fines were negatively correlated with total score, sediment deposition, bank stability, velocity/depth/diversity, embeddedness, and epifaunal substrate. Percent gravel was positively correlated with total score, sediment deposition, bank stability, velocity/depth/diversity, embeddedness, and epifaunal substrate. Percent cobble was positively correlated with total score, sediment deposition, bank stability, velocity/depth/diversity and embeddedness. Mean flow was reported to be positively correlated with total score, velocity/depth/diversity, channel flow status, epifaunal substrate, and bank vegetation.

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 only metric showing a gradient between upstream and downstream. Epifaunal substrate showed a positive correlation with site indicating an increase in values moving upstream.

A comparison of mean physical habitat metrics among the three streams in Table 9 showed no significant differences for the various metrics among the three streams using a p value of 0.05 (Table 9). Although at a significance level of $p = 0.06$ velocity/depth and embeddedness were lower in Salt Slough when compared with the other two streams.

Benthic Macroinvertebrates

Del Puerto Creek

Approximately 3,700 individual macroinvertebrates were picked and identified from 94 taxa collected from five Del Puerto Creek sites (Table 10; Appendix B). The five most abundant taxa - *Nais communis/variabilis, Chircotopus sp., Physa sp., Cricotopus bicinctus* group, and *Simulium sp.* comprised ~ 51% of the total individuals collected (Table 10). These five taxa are generally considered tolerant to moderately tolerant (i.e., *Simulium sp.*) of environmental stressors (Harrington and Born, 2000; Stribling et al., 1998). Pollution sensitive species such as Ephemeroptera (mayflies), Plecoptera (stoneflies) and Tricoptera (caddisflies), i.e. EPT taxa, were found in very low numbers at most of the sites.

Total taxa richness ranged from 24 at downstream site (DLP1) to 47 at upstream site (DLP5) (Table 11). The number of individuals collected at each site (total abundance) was higher at the upstream site (DLP5) and midstream site (DLP3) (Table 11). Lowest abundance was reported at DLP1 (Table 11).

Most of the other benthic metrics summarized in Table 11 were consistent among sites with a few exceptions. The % dominant taxa were higher at downstream site DLP1 when compared with the other sites. Although low in numbers, EPT taxa were higher at DLP5, a site above agricultural activity. The % chironomidae (tolerant taxa) were lower at downstream site (DLP1). It is also important to note that % shredders – a feeding guild that decreases in stressed environments – were not reported at any site.

<u>Orestimba Creek</u>

Approximately 5,300 individual macroinvertebrates were picked and identified from 122 taxa collected from ten sites in Orestimba Creek (Table 12; Appendix C). The following taxa comprised ~ 49% of the total number of individuals collected: Tubificidae unidentified immatures, *Cricotopus bicinctus* group, *Slavina appendiculata*, *Physa sp.*, and *Cricotopus sp.* These taxa are generally tolerant of environmental degradation (Harrington and Born, 2000; Stribling et al., 1998).

Total taxa richness ranged from 15 at ORE3 to 47 at ORE6 (Table 13). The total number of individuals per site (total abundance) was much higher at upstream site ORE10 when compared with the other sites (Table 13).

Various benthic metrics for the Orestimba Creek sites summarized in Table 13 showed the following: (1) percent dominant taxa were generally higher at the three downstream sites: (2) EPT taxa (taxa associated with non-stressed environments) was higher at upstream site ORE10 above agricultural activity; (3) percent chironomidae were higher at the five upstream sites; (4) percent hydropsychidae (caddisflies) were higher at ORE4; (5) percent collectors/gatherers – a feeding guild that dominates in stressed environments - were higher at the three downstream sites and (6) percent collectors/filterers – a feeding guild that dominates in stressed environments - were higher at ORE8.

Salt Slough

Approximately 2,500 individual macroinvertebrates were picked and identified from 82 taxa in five Salt Slough sites (Table 14, Appendix D). *Dero digitata*, *Tubificidae* unidentified immatures, *Ferrissia sp.*, *Cricotopus bicinctus* group, and *Tubificidae* with hair comprised ~ 51% of the individuals collected. All of these taxa are generally considered tolerant of environmental degradation (Harrington and Born, 2000).

Total taxa richness ranged from 33 at SSL3 to 43 at SSL4 (Table 15). Total abundance by site was generally much higher at SSL5 (Table 15). The other benthic metrics in Table 15 were generally consistent among the five Salt Slough sites with the following exceptions: (1) percent dominant taxa were higher at upstream site SSL5; (2) percent chironomidae were higher at downstream site SSL1; (3) percent collectors/gatherers (a feeding guild that dominates in stressed environments) were higher at SSL1; and (4) percent scrapers were higher at SSL2.

Summary Statistical Analysis for All Creeks

PCA was used to determine the relationship among the benthic metrics and identify metrics that covary (Table 16). Four eigenvalues exceeded 1 indicating that there were four important factors in these data. EPT taxa, number of Ephemeroptera taxa, tolerance value, sensitive EPT index (%), percent intolerant taxa, percent tolerant taxa, and EPT index (%) were heavily loaded on factor 1 (Table 17). Factor 2 was composed of percent scrapers, percent dominant taxon, Shannon Diversity, and taxonomic richness. Abundance and number of Trichoptera taxa were heavily loaded on factor 3. Factor 4 was composed of percent shredders, percent collectors/gatherers, percent collectors/filterers and percent predators.

Spearmans Rank Correlation Analysis showed a significant ($p<0.05$) spatial trend for percent predators, percent tolerant taxa, and taxonomic richness in Del Puerto Creek; percent collectors/filterers, percent collectors/gatherers, percent dominant taxa, Shannon Diversity, taxonomic richness, and tolerance value in Orestimba Creek; and percent predators and percent tolerant taxa in Salt Slough (Table 18). In Del Puerto Creek, the percent predators and percent tolerant taxa decrease from downstream to upstream while taxonomic richness increases from downstream to upstream. Percent collectors/gatherers, percent dominant taxon, and tolerance value were reported to decrease from downstream to upstream in Orestimba Creek. In contrast, percent collectors/filterers, Shannon Diversity, and taxonomic richness were reported to increase from downstream to upstream in this stream. For Salt Slough, percent predators and percent tolerant taxa were reported to increase from downstream to upstream.

A comparison among benthic metrics in Del Puerto Creek, Orestimba Creek and Salt Slough in Table 19 showed that there were no significant differences among benthic metrics for these three streams using a p value of 0.05.

Relationship of Physical Habitat and Benthos

Spearman's Rank Correlation Analysis showed that sediment deposition, bank stability and embeddedness were the most important physical habitat metrics influencing the various benthic metrics (Table 20). Sediment deposition was negatively correlated with percent collectors/gatherers, percent dominant taxa, and tolerance value. Sediment deposition was positively correlated with EPT index, EPT taxa, Number of Ephemeroptera taxa, percent collectors/filterers, percent intolerant taxa, sensitive EPT index, Shannon Diversity, and taxonomic richness. Bank stability was negatively correlated with percent collectors/gatherers, percent dominant taxa, and tolerance value. In contrast, bank stability was positively correlated with EPT index, EPT taxa, number of Ephemeroptera taxa, percent collectors/filterers, percent intolerant, sensitive EPT index, Shannon Diversity, and taxonomic richness. Embeddedness was reported to be positively correlated with EPT index, EPT taxa, number of Ephemeroptera taxa, number of Trichoptera taxa, percent collectors/filterers, sensitive EPT index, Shannon Diversity, and taxonomic richness.

The correlation matrix in Table 21 for habitat metrics not scored on a 0-20 scale shows that % fines and % cobble have the highest number of significant relationships with the various benthic metrics. Percent fines were negatively correlated with EPT index, EPT taxa, number of Ephemeroptera taxa, number of Trichoptera taxa, percent collectors/filterers, percent intolerant taxa, sensitive EPT index, Shannon Diversity, and taxonomic richness. Percent fines were positively correlated with percent collectors/gatherers, percent tolerant taxa, and tolerance value. Percent cobble was reported to be positively correlated with EPT Index, EPT taxa, number of Ephemeroptera taxa, number of Trichoptera taxa, percent intolerant taxa, sensitive EPT Index, Shannon Diversity, and taxonomic richness.

Water Quality

Del Puerto Creek

The only consistent water quality conditions at all five sample sites in Del Puerto Creek in 2006 were pH and salinity (Table 1). Parameters such as temperature (19.9 to 27.5 C), conductivity (525 to 1025 umhos/L), dissolved oxygen (7.01 to 13.5 mg/L) and turbidity (1.1 to 82.6 NTU) were variable across the various study sites. It should be noted however that all the water quality conditions at downstream station DLP1 were measured in July while the other sites were measured in May. Spatial patterns showed: (1) temperature was higher at the most downstream site; (2) conductivity was higher at the most downstream site; (3) dissolved oxygen was greater at upstream site DLP4; and (4) turbidity was much lower at upstream site DLP5.

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), 2003 (Hall and Killen, 2004), 2004 (Hall and Killen, 2005b), 2005 (Hall and Killen, 2006) and 2006 showed the following: (1) temperature was more variable across the five years at DLP4; (2) conductivity was generally more variable at DLP2 all years; (3) pH was fairly consistent at all sites among the six years; (4) dissolved oxygen was consistently lower at four of the five sites in 2001; (5) salinity was consistent among sites by year; and (5) turbidity was consistently lower at the most upstream site (DLP5) for all years.

Orestimba Creek

The pH was fairly consistent among all eight downstream sites in Orestimba Creek in 2006 with somewhat higher values at the two upstream sites (Table 1). Temperature ranged from 20 to 27.1 C with the lowest value at ORE4. Conductivity ranged from 153 to 647 umhos/L. Dissolved oxygen varied from 4.9 to 9.7 mg/L at all sites. There was one dissolved oxygen values below 5.0 mg/L at ORE1 in 2006 - a concentration likely to be stressful to aquatic life (Lee and Jones-Lee, 2000). Salinity ranged from 0 to 0.3 ppt across all sites. Turbidity was much lower at 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). As reported above for Del Puerto Creek, it should be noted that water quality measurements for the three downstream sites were conducted in July in contrast to the other seven sites which were measured in May of 2006.

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), 2003 (Hall and Killen, 2004), 2004 (Hall and Killen, 2005b), 2005 (Hall and Killen, 2006) and 2006 showed the following: (1) temperature was generally lower at downstream site ORE1 and higher at ORE9 for all six years (2) specific conductance was generally higher at upstream site ORE10 for all years; (3) pH was fairly consistent among all sites for the seven years; (4) dissolved oxygen was lower at most of the sites in 2001 except ORE1; (5) salinity was consistent among sites by year; and (6) turbidity was consistently lower at upstream site ORE10 for all years although the value reported in 2006 was much higher than in previous years.

Salt Slough

The following ranges of water quality conditions were reported in Salt Slough in 2006: temperature (26.1 to 28.1 C), conductivity (683 to 878 umhos/L), pH (7.3 to 7.6), dissolved oxygen (4.2 to 5.5 mg/L), salinity (0.3 to 0.4 ppt) and turbidity (84.1 to 132 NTU) (Table 1). Dissolved oxygen values less than 5.0 mg/L reported at two sites were potentially stressful to aquatic life (Lee and Lee-Jones, 2000).

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), 2003 (Hall and Killen, 2004), 2004 (Hall and Killen, 2005b), 2005 (Hall and Killen, 2006) and 2006 showed the following: (1) temperature was more variable at the most upstream and downstream sites across the six years; (2) mean conductivity for all sites was lower in 2005; (3) dissolved oxygen was consistently lower at all sites in 2001; (4) pH was generally consistent among sites for all six years; (5) salinity was higher at upstream site SSL5 in 2005 and 2004; and (6) turbidity was lower at four sites in 2002.

DISCUSSION

Physical Habitat

Physical habitat in streams is the place where organisms such as benthic macroinvertebrates live. The habitat assessments conducted during this study were used to determine the suitability of the physical environment for aquatic biota such as benthic macroinvertebrates. Impaired physical habitat (including sediment loading) has been identified as a major stressor 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. Rankin (1995) has reported that 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. 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.

An extensive discussion or comparison of our physical habitat data across large spatial scales is problematic due to the limited number of sites sampled in the three agricultural streams in the present study. Based on our limited sampling during 2006, the mean total physical habitat scores were not significantly different among the three streams using a p-value of < 0.05 (Table 9). Although Salt Slough did have significantly lower values for various metrics (i.e., velocity/depth, sediment deposition and embeddedness) when compared with Del Puerto or Orestimba Creek if a p-value of 0.10 was used (Table 9).

An exact historical comparison of total physical habitat scores (maximum of 200) for Del Puerto Creek (57 to 151), Orestimba Creek (35 to 155) and Salt Slough (56 to 108) as presented in Table 2 is not possible because historical physical habitat data for California's Central Valley streams has not been summarized in a published format. 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 2006 can be cautiously compared with same type of assessments conducted in 2000 (Hall and Killen, 2001), 2001 (Hall and Killen, 2002), 2002 (Hall and Killen, 2003), 2003 (Hall and Killen, 2004), 2004 (Hall and Killen, 2005b) and 2005 (Hall and Killen, 2006) with the caveat that these are only seven temporally limited evaluations (Table 23). Total physical habitat scores across the seven years were variable for all sites with somewhat more variability for upstream sites ORE9 and ORE10. Total physical habitat scores showed a significant downward trend from 2000 to 2006 (Table 24c). The qualitative habitat metrics that showed the highest number of significant changes (declines) over the years were embeddedness, velocity/depth, channel alteration and riffle/bends (Table 24c). Trends of habitat metrics over sites showed significant trends for embeddedness, sediment deposition, channel flow, riffles/bends, and bank stability (Table 24d). Embeddedness, sediment deposition, riffles/bends, and bank stability were reported to increase from downstream to upstream (Table 24d).

A comparison of physical habitat metrics in Table 23 and Tables 24a, b, e, and f among the five Del Puerto Creek and Salt Slough sites sampled in 2001 (Hall and Killen, 2002), 2002 (Hall and Killen, 2003), 2003 (Hall and Killen, 2004), 2004 (Hall and Killen, 2005b), 2005 (Hall and Killen, 2006) and 2006 is also possible with the caveat that these are only six temporally limited evaluations. The final habitat scores among years in Del Puerto Creek downstream sites DLP1 and DLP2 were more consistent than the other three sites (Table 23). Mean total physical scores, as well as metric scores, were not statistically different among the six years in Del Puerto Creek (Table 24a). There were however significant decreasing site trends for velocity/depth and channel flow from downstream to upstream (Table 24b).

A comparison of annual total physical habitat scores among the five Salt Slough sites from 2001 to 2006 shows higher variability at SSL1 and SSL5 when compared with the other sites (Table 23). Epifaunal substrate, velocity/depth, and channel flow were significantly different among years in Salt Slough (Table 24e). However, the mean total physical habitat scores were not significantly different over the six year period (Table 24e). The following habitat metrics showed a decreasing site trend from downstream to upstream in Salt Slough: velocity/depth; sediment deposition; channel alteration;

riffles/bends; bank stability; vegetative protection; and riparian vegetative zone (Table 24f).

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 qualitative comparison was 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 et al., 2002; 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 16 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), *Culicoides sp.* (LC50 = 500 – 1000 ng/L), *Peltodytes sp.* (LC50 = 800 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. *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. *Culicoides sp.* (midge) was found in low numbers in both Orestimba Creek and Salt Slough but was absent in Del Puerto Creek. *Peltodytes sp.* (beetle) was collected in Del Puerto Creek and Orestimba Creek but was not collected in Salt Slough.

The amphipod, *Hyalella sp.,* was collected in all three streams. The chironomid, *Tanypus sp.* (one organism) was also collected in all three streams but was more abundant in Salt Slough. The chironomid, *Paratanytarsus sp.* and the flatworm, *Dugesia tigrina,* were collected in all three streams.

Diazinon acute toxicity data were available for six 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 adonis* (LC50 = 24,000 ng/L). The amphipod, *Hyalella sp.,* was collected in all three streams. The mayfly *Baetis sp.* - a species potentially sensitive to maximum reported environmental concentrations of diazinon - was collected primarily at the most upstream sites in both Del Puerto Creek and Orestimba Creek.

<u>Historical Comparisons of Benthic Data</u>

Historical comparisons of our data with other benthic data from these three streams were limited. The U.S. Geological Survey collected benthic macroinvertebrates in 1993 at one site in Orestimba Creek that was approximately half way between our stations ORE2 and ORE3 (Larry Brown, U. S. Geological Survey, personal communication). Dominant taxa reported by these investigators were mayflies, oligochaetes and gastropods. The dominant taxa we collected at ORE2 and ORE3 in 2006 were oligochaetes and chironomids. Mayflies were not collected during our 2006 sampling at these two sites and gastropods were collected in low numbers. It is difficult to explain possible factors contributing to differences in dominant taxa due to the twelve year time period between the two studies.

Benthic community assessments conducted during the present 2006 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), 2002 (Hall and Killen, 2003), 2003 (Hall and Killen, 2004), 2004 (Hall and Killen, 2005b) and 2005 (Hall and Killen, 2006). An annual comparison of mean benthic metrics across all sites from 2000 to 2006 showed that abundance, number of trichoptera taxa, and tolerance value showed a significant trend over time (Table 28c). Both abundance and number of trichoptera taxa showed an increase over time while the tolerance value metric showed a slight decrease over seven years. Significant site trends were reported for abundance, EPT taxa, number of ephemeroptera taxa, number of trichoptera taxa, % collectors/gatherers, % dominant taxa, taxomonic richness, and tolerance value (Table 28d). Abundance, EPT taxa, number of ephemeroptera taxa, number of trichoptera taxa, and taxonomic richness were reported to increase from downstream to upstream. In contrast, % collectors/gatherers, % dominant taxa, and tolerance value were reported to decrease from downstream to upstream.

An annual comparison of mean benthic metrics reported for the five Del Puerto Creek sites from 2001 to 2006 showed significant trends for EPT Index (%), number of ephemeroptera taxa, % collectors/filterers, % collectors/gatherers, % dominant taxa, % predators, % scrapers, % shredders, % tolerant taxa, and taxonomic richness (Table 28a). All of these metrics (except % shredders) were reported to increase over time. In general, most of the benthic metrics in Del Puerto Creek showed a change over the seven year period. Significant site trends were reported for abundance, ETP taxa, number of ephemeroptera taxa, number of trichoptera taxa, and % tolerant taxa (Table 28b). All metrics except % tolerant taxa showed an increase from downstream to upstream.

An annual comparison of mean benthic metrics in Salt Slough from 2001 to 2006 showed significant trends for EPT Index (%), number of ephemeroptera taxa, % collectors/filterers, % collectors/gatherers, % dominant taxa, % predators, % scrapers, % tolerant taxa, Shannon diversity, and taxonomic richness (Table 28e). All of these metrics were reported to increase over time. Significant site effects were reported for EPT taxa, number of ephemeroptera taxa, number of trichoptera taxa, Shannon Diversity, and tolerance value (Table 28f). Number of ephemeroptera taxa, Shannon Diversity, and tolerance value were reported to increase from downstream to upstream. In contrast, EPT taxa and number of trichoptera taxa were reported to decrease from downstream to upstream.

Regulatory and Ecological Implications

Del Puerto Creek, Orestimba Creek and Salt Slough have been classified as impaired water bodies (303 (d) list) by the state of California due to the presence of chlorpyrifos and diazinon (www.swrcb.ca.gov). Impairment was based on either OP concentrations exceeding a threshold (water quality criteria or target) or toxicity reported from single species toxicity tests (i.e., *Ceriodaphnia dubia* toxicity tests). Unfortunately, both the chemical monitoring and toxicity data used for these listings were based on data collected prior to 2001 and may not reflect the present use patterns of these OP insecticides. For example, in a recent analysis of diazinon and chlorpyrifos monitoring data (2001 to 2004) from the Sacramento and San Joaquin River watershed, target concentrations of these two OP insecticides were rarely exceeded (L. W. Hall, University of Maryland, personnel communication). The decline in OP insecticide use in the Central Valley has been documented as the use of pyrethroid insecticides has increased (Weston et al., 2004).

The status of resident biological communities was not considered when Del Puerto Creek, Orestimba Creek, and Salt Slough were classified as impaired because these data were not available. The benthic community data generated from these three streams in 2006, as well as previous bioassessment efforts in these streams (Hall and Killen, 2001; Hall and Killen, 2002; Hall and Killen, 2003; Hall and Killen, 2004; Hall and Killen, 2005b; Hall and Killen, 2006), provides 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).

As expected, benthic communities in all three agricultural streams were generally comprised of tolerant species. From an ecological perspective, dominance by tolerant species is expected in these streams due to generally poor physical habitat conditions, 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).

Attempts to interpret our benthic data within the context of "biological expectations" for these habitat impaired streams are hindered due to the absence of a defined reference condition (reference stream). Fortunately, California Department of Fish and Game is making progress in the development of reference streams for low gradient lotic waterbodies such as agricultural streams (Peter Ode, personnel communication, California Department of Fish and Game). The traditional reference stream approach often used to interpret the status of benthic communities is not possible with our data set. However, the presence of 94 taxa in Del Puerto Creek, 122 taxa in Orestimiba Creek, and 82 taxa in Salt Slough suggests that the benthic communities in these streams are fairly diverse, considering their ephemeral environments and numerous physical habitat limitations, but without a clear definition of benthic community expectations it is unknown if these water bodies are actually impaired. Additional bioassessment research (including physical habitat assessments) is recommended in low gradient agricultural streams of California's Central valley to identify the range of benthic community assemblages and identify potential reference sites.

REFERENCES

Bacey, J. 2005. Biological assessment of urban and agricultural streams in the California Central Valley (Fall 2002 through Spring 2004). California Environmental Protection Agency, California Department of Pesticide Regulation, Sacramento, CA.

Bailey, R. C., R. H. Norris, and T. B. Reynoldson. 2004. Bioassessment of freshwater ecosystems using the reference condition approach. Kluwer Academic Publishers, Boston, MA.

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.

Barron, M. G. and K. B. Woodburn. 1995. Ecotoxicology of chlorpyrifos. Reviews of Environmental Contamination and Toxicology 144: 1-93.

Brown, L. and J. May. 2004. Periphyton and macroinvertebrate communities at five sites in the San Joaquin river basin, California during June and September 2001. U. S. Geological Survey Report No. 2004-5098, Sacramento, CA.

Dubrovsky, N. M., C. R. Kratzer, L. R. Brown, J. M. Gronberg, and K. R. Burow. 1998. Water quality in the San Joaquin-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 2002. Final Report prepared by the University of Maryland, Wye Research and Education Center, Queenstown, MD.

Hall, L. W., Jr. and W. D. Killen. 2004. 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.

Hall, L. W. Jr. and W. D. Killen. 2005a. Temporal and spatial assessment of water quality, physical habitat and benthic communities in an impaired stream in California's San Joaquin Valley. J. Environ. Sci. Hlth. 40:959-989.

Hall, L. W., Jr. and W. D. Killen. 2005b. Characterization of benthic communities and physical habitat in agricultural streams in California's San Joaquin Valley in 2004. Final Report prepared by the University of Maryland, Wye Research and Education Center, Queenstown, MD.

Hall, L. W., Jr. and W. D. Killen. 2006. Characterization of benthic communities and physical habitat in agricultural streams in California's San Joaquin Valley in 2005. Final Report prepared by the University of Maryland, Wye Research and Education Center, Queenstown, MD.

Hall, L. W., Jr., W. D. Killen and R. W. Alden III. in press. Relationship of farm level pesticide use and physical habitat on benthic community status in a California agricultural stream. Human and Ecological Risk Assessment.

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. and E. W. Chu. 1999. Restoring Life in Running Water – Better Biological Monitoring. Island Press, Covelo, 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.

Poletika, N., K. B. Woodburn, and K. S. Henry. 2002. A ecological risk assessment for chlorpyrifos in an agriculturally dominated tributary of the San Joaquin River. Risk Analysis 22: 291-308.

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.

Tetra Tech Inc. 2003. The status and future of biological assessment for California Streams. Prepared for the California State Water Resources Control Board Division of Water Quality, Sacramento, CA.

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.

Weston, D. P., J. You, and M. J. Lydy. 2004. Distribution and toxicity of sediment-associated pesticides in agricultural-dominated water bodies of California's Central Valley. Environ. Sci. Tech. 38: 2752-2759.

Wright, J. F., D. W. Sutcliffe and M. T. Furse. 2000. Assessing the biological quality of freshwater: RIVPACS and other techniques. Freshwater Biological Association, Ableside, Cumbria, UK.

Yoder, C. O. and E. T. Rankin. 1995. Biological criteria program development and implementation in Ohio. In W. S. Davis and T. P. Simon (eds.). Biological Assessment and Criteria: Tools of Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL, pp 109-144.

Table 1. Sample site names, coordinates and water quality parameters measured during late spring and summer 2006 in Del Puerto Creek, Orestimba Creek and Salt Slough.

Site	Latitude	Longitude	Water Temperature (C)	Specific Conductivity (µS)	pH	Dissolved Oxygen (mg/L)	Salinity (ppt)	Turbidity (NTU)
DLP1*	37 32 25	121 07 07	27.5	1025	8.27	7.01	0.5	82.6
DLP2	37 32 03	121 07 46	19.9	525	8.29	8.85	0.3	35.9
DLP3	37 31 20	121 08 54	22.1	541	8.51	9.86	0.3	50.1
DLP4	37 30 43	121 09 38	26.4	836	8.86	13.48	0.4	6.53
DLP5	37 28 59	121 12 41	27.7	988	8.87	10.02	0.5	1.13
ORE1*	37 25 10	121 00 09	25.7	628	7.37	4.88	0.3	143
ORE2*	37 25 12	121 00 21	25.7	547	7.54	6.21	0.2	228
ORE3*	37 24 47	121 00 59	27.6	472	7.83	6.43	0.2	372
ORE4	37 24 19	121 01 28	20.0	167	7.68	9.70	0.1	117
ORE5	37 23 54	121 02 02	20.2	173	7.72	8.31	0.1	118
ORE6	37 23 21	121 02 34	21.7	157	7.71	8.67	0.1	182
ORE7	37 22 59	121 03 00	22.1	153	7.68	8.54	0.1	252
ORE8	37 22 37	121 03 31	23.2	155	7.67	8.41	0.1	162
ORE9	37 21 53	121 03 45	27.1	156	9.18	7.41	0	168
ORE10	37 19 08	121 07 18	24.5	647	8.56	9.47	0.2	22.8
SSL1*	37 14 54	120 51 12	26.6	869	7.59	5.43	0.4	113
SSL2*	37 11 59	120 49 33	26.1	856	7.41	4.79	0.4	84.5
SSL3*	37 09 33	120 48 44	26.6	878	7.42	5.19	0.4	84.1
SSL4*	37 08 21	120 46 04	27.6	723	7.48	5.47	0.3	132
SSL5*	37 07 45	120 42 28	28.1	683	7.34	4.20	0.3	91.5

* These sites were sampled at a later date due to high water levels (July vs. May).

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 in 2006. Sites marked with an asterisk * were sampled at a later date due to high water levels.

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*	8	11	11	5	19	13	12	3	4	5	6	6	6	109
DPL2	8	8	10	15	20	14	6	6	7	8	5	4	3	114
DPL3	7	7	15	15	20	15	15	8	8	8	8	4	4	134
DPL4	6	6	5	6	11	6	5	2	4	3	3	0	0	57
DPL5	12	11	15	16	20	19	16	7	9	5	5	8	8	151
ORE1*	3	0	3	0	20	17	9	2	1	8	5	6	4	78
ORE2*	2	0	3	0	20	15	4	3	3	2	2	6	6	66
ORE3*	3	0	6	0	19	13	12	1	1	6	6	3	3	73
ORE4	8	10	12	10	20	14	11	7	7	7	7	3	3	119
ORE5	13	14	11	10	20	14	5	5	3	6	8	5	4	118
ORE6	11	13	14	10	20	15	12	6	8	7	6	6	3	131
ORE7	11	12	10	8	20	14	8	8	5	6	9	3	9	123
ORE8	11	7	16	6	20	13	9	3	7	6	6	3	6	113
ORE9	0	0	0	0	5	5	3	3	3	5	5	3	3	35
ORE10	8	17	9	18	19	20	16	9	9	7	7	8	8	155
SSL1*	6	0	2	1	20	17	13	4	4	7	6	7	7	94
SSL2*	6	0	4	4	20	19	10	8	7	9	6	9	6	108
SSL3*	7	0	5	1	20	14	9	7	7	7	7	4	5	93
SSL4*	10	1	6	3	20	16	13	3	6	3	6	5	6	98
SSL5*	11	0	1	1	20	7	2	3	3	2	2	2	2	56

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	Ave. Width m	Ave. Depth cm	Canopy Cover %	Gradient %	Fines %	Gravel %	Cobble %	Boulder %	Bedrock %
DLP 1*	0.23	3.1	21	68	1	30	70	0	0	0
DLP 2	0.39	1.6	24	0	1	40	60	0	0	0
DLP 3	0.60	1.8	22	0	1	40	60	0	0	0
DLP 4	0.01	2.2	15	0	1	60	40	0	0	0
DLP 5	0.59	2.4	11	0	1	10	50	40	0	0
ORE 1*	-	-	-	12.5	1	100	0	0	0	0
ORE 2*	0.11	6.7	57	17	1	100	0	0	0	0
ORE 3*	0.18	4.4	34	90	1	100	0	0	0	0
ORE 4	0.54	6.0	62	97	1	30	70	0	0	0
ORE 5	0.42	6.0	81	44	1	30	70	0	0	0
ORE 6	0.71	7.0	30	19	1	20	20	60	0	0
ORE 7	0.81	4.0	60	90	1	30	35	35	0	0
ORE 8	0.71	4.0	50	0	1	50	50	0	0	0
ORE 9	0	0.30	7	0	1	90	10	0	0	0
ORE 10	0.12	7.5	9	0	1	10	70	20	0	0
SSL 1*	-	-	-	0	1	100	0	0	0	0
SSL 2*	0.31	25.0	72	5	1	100	0	0	0	0
SSL 3*	0.14	22.8	65	0	1	100	0	0	0	0
SSL 4*	-	-	-	0	1	100	0	0	0	0
SSL 5*	-	-	-	0	1	100	0	0	0	0

* These sites were sampled at a later date due to high water levels (July vs. May).
- No flow measurements due to high water levels.

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

	Eigen Value	Proportion Variance Explained	Cumulative Variance Explained
Factor 1 *	6.0956	0.55	0.55
Factor 2 *	1.8623	0.17	0.72
Factor 3 *	1.0172	0.09	0.82
Factor 4	0.6202	0.06	0.87
Factor 5	0.4759	0.04	0.92
Factor 6	0.3692	0.03	0.95
Factor 7	0.2771	0.03	0.97
Factor 8	0.1664	0.02	0.99
Factor 9	0.0796	0.01	1.00
Factor 10	0.0365	0.00	1.00
Factor 11	0.0000	0.00	1.00

* eigenvalue > 1.0

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

Habitat Metric	Factor 1	Factor 2	Factor 3
Factor 1	.	.	.
TOTAL	0.40	-0.02	-0.00
SED DEP	0.33	-0.31	-0.19
BANK STAB	0.33	-0.06	-0.23
VEL DPTH	0.32	-0.30	0.05
BEN RIFF	0.30	0.26	-0.20
Factor 2	.	.	.
RIP BUFF	0.24	0.46	0.01
CHAN ALT	0.30	0.45	0.05
EMBEDD	0.30	-0.39	-0.06
Factor 3	.	.	.
CHAN FLOW	0.24	0.26	0.62
EPI SUB	0.26	-0.30	0.55
BANK VEG	0.26	0.12	-0.43

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.

Habitat Metric	Bank Stab	Chan Alt	Vel Dpth	Epi Sub	Bank Veg	Sed Dep	Embedd	Rip Buff	Ben Riff	Chan Flow	Total
Bank Stab	1.00 –	0.52 * 0.0190	0.56 * 0.0095	0.46 * 0.0425	0.53 * 0.0165	0.76 * 0.0001	0.55 * 0.0128	0.44 0.0514	0.51 * 0.0204	0.31 0.1863	0.81 * 0.0000
Chan Alt	0.52 * 0.0190	1.00 –	0.33 0.1523	0.21 0.3675	0.51 * 0.0211	0.38 0.0959	0.25 0.2844	0.84 * 0.0000	0.72 * 0.0003	0.70 * 0.0006	0.73 * 0.0003
Vel Dpth	0.56 * 0.0095	0.33 0.1523	1.00 –	0.63 * 0.0027	0.44 0.0525	0.75 * 0.0001	0.75 * 0.0001	0.16 0.5005	0.51 * 0.0231	0.39 0.0868	0.81 * 0.0000
Epi Sub	0.46 * 0.0425	0.21 0.3675	0.63 * 0.0027	1.00 –	0.16 0.5061	0.53 * 0.0166	0.62 * 0.0036	0.16 0.5071	0.21 0.3746	0.51 * 0.0214	0.64 * 0.0025
Bank Veg	0.53 * 0.0165	0.51 * 0.0211	0.44 0.0525	0.16 0.5061	1.00 –	0.40 0.0772	0.36 0.1154	0.34 0.1462	0.51 * 0.0211	0.29 0.2205	0.62 * 0.0036
Sed Dep	0.76 * 0.0001	0.38 0.0959	0.75 * 0.0001	0.53 * 0.0166	0.40 0.0772	1.00 –	0.83 * 0.0000	0.23 0.3352	0.46 * 0.0407	0.22 0.3413	0.83 * 0.0000
Embedd	0.55 * 0.0128	0.25 0.2844	0.75 * 0.0001	0.62 * 0.0036	0.36 0.1154	0.83 * 0.0000	1.00 –	0.21 0.3788	0.34 0.1480	0.18 0.4481	0.76 * 0.0001
Rip Buff	0.44 0.0514	0.84 * 0.0000	0.16 0.5005	0.16 0.5071	0.34 0.1462	0.23 0.3352	0.21 0.3788	1.00 –	0.57 * 0.0082	0.45 * 0.0459	0.58 * 0.0070
Ben Riff	0.51 * 0.0204	0.72 * 0.0003	0.51 * 0.0231	0.21 0.3746	0.51 * 0.0211	0.46 * 0.0407	0.34 0.1480	0.57 * 0.0082	1.00 –	0.41 0.0707	0.72 * 0.0003
Chan Flow	0.31 0.1863	0.70 * 0.0006	0.39 0.0868	0.51 * 0.0214	0.29 0.2205	0.22 0.3413	0.18 0.4481	0.45 * 0.0459	0.41 0.0707	1.00 –	0.58 * 0.0069
Total	0.81 * 0.0000	0.73 * 0.0003	0.81 * 0.0000	0.64 * 0.0025	0.62 * 0.0036	0.83 * 0.0000	0.76 * 0.0001	0.58 * 0.0070	0.72 * 0.0003	0.58 * 0.0069	1.00 –

* $p < 0.05$

Table 7. Correlations matrix for stream measurements against raw physical habitat metrics and the total habitat metric score. 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.

Benthic Metric	Stream Width	Stream Depth	Mean Flow	Percent Canopy	Fines	Gravel	Cobble
BANKSTAB	0.32 0.2315	-0.00 0.9992	0.47 0.0692	-0.16 0.5033	-0.59 * 0.0060	0.45 * 0.0473	0.46 * 0.0394
CHAN LT	0.41 0.1182	0.22 0.4064	0.37 0.1641	-0.02 0.9258	-0.22 0.3571	0.10 0.6852	0.29 0.2170
VEL DPTH	-0.32 0.2272	-0.05 0.8489	0.82 * 0.0001	0.21 0.3655	-0.83 * 0.0000	0.74 * 0.0002	0.45 * 0.0449
EPI SUB	-0.03 0.9012	0.23 0.3918	0.74 * 0.0011	0.05 0.8295	-0.59 * 0.0065	0.46 * 0.0435	0.44 0.0509
BANKVEG	0.30 0.2553	0.27 0.3084	0.50 * 0.0473	0.25 0.2961	-0.35 0.1282	0.33 0.1527	0.16 0.4912
SED DEP	-0.30 0.2664	-0.32 0.2254	0.45 0.0767	-0.04 0.8552	-0.88 * 0.0000	0.80 * 0.0000	0.45 * 0.0477
EMBEDD	-0.36 0.1682	-0.16 0.5558	0.48 0.0591	0.28 0.2404	-0.97 * 0.0000	0.85 * 0.0000	0.56 * 0.0103
RIPBUFF	0.33 0.2052	0.10 0.7044	0.22 0.4153	-0.09 0.7168	-0.17 0.4721	0.02 0.9395	0.33 0.1603
BENRIFF	0.06 0.8387	-0.30 0.2568	0.34 0.1923	0.06 0.8154	-0.37 0.1085	0.25 0.2959	0.35 0.1303
CHAN FLOW	0.31 0.2461	0.48 0.0614	0.55 * 0.0260	0.17 0.4613	-0.14 0.5642	0.08 0.7442	0.15 0.5200
TOTAL	0.04 0.8688	0.02 0.9402	0.66 * 0.0054	0.10 0.6805	-0.77 * 0.0001	0.63 * 0.0032	0.53 * 0.0161

* $p < 0.05$

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

Habitat Metric	Del Puerto	Orestimba	Salt Slough
BANK STAB	0.31	0.59	-0.40
	0.6144	0.0754	0.5046
CHAN ALT	0.40	-0.21	-0.80
	0.5046	0.5605	0.1041
VEL DPTH	0.21	0.23	0.00
	0.7406	0.5208	1.0000
EPI SUB	0.05	0.24	0.97 *
	0.9347	0.5028	0.0048
BANK VEG	-0.50	0.20	-0.70
	0.3910	0.5724	0.1881
SED DEP	0.67	0.47	-0.11
	0.2189	0.1717	0.8579
EMBEDD	-0.21	0.51	0.35
	0.7406	0.1296	0.5594
RIP BUFF	0.10	0.10	-0.80
	0.8729	0.7840	0.1041
BEN RIFF	0.30	0.09	-0.56
	0.6238	0.8016	0.3217
CHAN FLOW	0.11	-0.45	.
	0.8579	0.1925	.
TOTAL	0.40	0.38	-0.50
	0.5046	0.2763	0.3910

* Significant trends

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.

	Creek Means				Pairwise Comparisons		
Habitat Metric	Del Puerto	Orestimba	Salt Slough	Kruskal-Wallis p-value	DO	DS	OS
BANKSTAB	11.60	9.40	10.40	0.6831	.	.	.
CHAN ALT	13.40	14.00	14.60	0.7111	.	.	.
VEL DPTH	11.20	8.40	3.60	0.0541	.	.	.
EPI SUB	8.20	7.00	8.00	0.9501	.	.	.
BANK VEG	11.20	12.10	11.00	0.8606	.	.	.
SED DEP	11.40	6.20	2.00	0.0800	.	.	.
EMBEDD	8.60	7.30	0.20	0.0571	.	.	.
RIP BUFF	8.60	9.50	10.60	0.8296	.	.	.
BEN RIFF	10.80	8.90	9.40	0.6634	.	.	.
CHAN FLOW	18.00	18.30	20.00	0.4440	.	.	.
TOTAL	113.00	101.10	89.80	0.3163	.	.	.

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 Percent	Cumulative %
Nais communis/ variabilis	Naididae	708	19.19	19.19
Cricotopus sp.	Chironomidae	340	9.21	28.40
Physa sp.	Physidae	311	8.43	36.83
Cricotopus bicinctus group	Chironomidae	285	7.72	44.55
Simulium sp.	Simuliidae	223	6.04	50.60
Baetis tricaudatus	Baetidae	205	5.56	56.15
Paratanytarsus sp.	Chironomidae	159	4.31	60.46
Fallceon quilleri	Baetidae	145	3.93	64.39
Gyraulus sp.	Planorbidae	142	3.85	68.24
Tanytarsus sp.	Chironomidae	123	3.33	71.57
Cyprididae	Cyprididae	120	3.25	74.82
Tubificidae unid.imm.	Tubificidae	109	2.95	77.78
Prostoma sp.	Tertastemmatidae	95	2.57	80.35
Tricorythodes sp.	Leptohyphidae	87	2.36	82.71
Dicrotendipes sp.	Chironomidae	70	1.90	84.61
Rheotanytarsus sp.	Chironomidae	62	1.68	86.29
Corbicula sp.	Corbiculidae	46	1.25	87.53
Menetus opercularis	Planorbidae	43	1.17	88.70
Eukiefferiella sp.	Chironomidae	30	0.81	89.51
Lebertia sp.	Lebertiidae	30	0.81	90.33
Slavina appendiculata	Naididae	26	0.70	91.03
Hydrobiidae	Hydrobiidae	24	0.65	91.68
Cladotanytarsus sp.	Chironomidae	23	0.62	92.30
Dugesia tigrina	Planariidae	20	0.54	92.85
Corixidae	Corixidae	15	0.41	93.25
Sperchon sp.	Sperchontidae	15	0.41	93.66
Lumbricina	Glossiphoniidae	13	0.35	94.01
Peltodytes sp.	Haliplidae	13	0.35	94.36
Hyalella sp.	Hyalellidae	13	0.35	94.72
Hydra sp.	Hydridae	13	0.35	95.07
Corynoneura sp.	Chironomidae	10	0.27	95.34
Centroptilum sp.	Baetidae	9	0.24	95.58
Apedilum sp.	Chironomidae	8	0.22	95.80
Procladius sp.	Chironomidae	8	0.22	96.02
Limnodrilus hoffmeisteri	Tubificidae	8	0.22	96.23
Coenagrionidae	Coenagrionidae	7	0.19	96.42
Erpobdellidae	Erpobdellidae	7	0.19	96.61
Parachironomus sp.	Chironomidae	6	0.16	96.78
Thienemannimyia group	Chironomidae	6	0.16	96.94

Table 10. continued.

Lowest Taxa	Higher Taxa	Total N	Total Percent	Cumulative %
Enchytraeidae	Enchytraeidae	6	0.16	97.10
Planorbella sp.	Planorbidae	6	0.16	97.26
Orthocladius complex	Chironomidae	5	0.14	97.40
Chironomus sp.	Chironomidae	4	0.11	97.51
Gammarus sp.	Gammaridae	4	0.11	97.62
Libellulidae	Libellulidae	4	0.11	97.72
Planariidae	Planariidae	4	0.11	97.83
Eudistylia vancouveri	Sabellidae	4	0.11	97.94
Branchiura sowerbyi	Tubificidae	4	0.11	98.05
Chironomini	Chironomidae	3	0.08	98.13
Phaenopsectra sp.	Chironomidae	3	0.08	98.21
Psectrocladius sp.	Chironomidae	3	0.08	98.29
Laccobius sp.	Hydrophilidae	3	0.08	98.37
Libellula sp.	Libellulidae	3	0.08	98.46
Ophidonais serpentina	Naididae	3	0.08	98.54
Tubificidae w/hair	Tubificidae	3	0.08	98.62
Ceratopogonidae	Ceratopogonidae	2	0.05	98.67
Cricotopus trifascia group	Chironomidae	2	0.05	98.73
Nilothauma sp.	Chironomidae	2	0.05	98.78
Tanypodinae	Chironomidae	2	0.05	98.83
Corisella sp.	Corixidae	2	0.05	98.89
Ephydridae	Ephydridae	2	0.05	98.94
Erpobdella sp.	Erpobdellidae	2	0.05	99.00
Hydropsyche sp.	Hydropsychidae	2	0.05	99.05
Fossaria sp.	Lymnaeidae	2	0.05	99.11
Ambrysus sp.	Naucoridae	2	0.05	99.16
Nereis limnicola	Nereididae	2	0.05	99.21
Caloparyphus/ Euparyphus	Stratiomyidae	2	0.05	99.27
Procambarus clarkii	Cambaridae	1	0.03	99.30
Bezzia/ Palpomyia	Ceratopogonidae	1	0.03	99.32
Ceratopogon sp.	Ceratopogonidae	1	0.03	99.35
Larsia sp.	Chironomidae	1	0.03	99.38
Micropsectra sp.	Chironomidae	1	0.03	99.40
Tanypus sp.	Chironomidae	1	0.03	99.43
Tanytarsini	Chironomidae	1	0.03	99.46
Thienemanniella sp.	Chironomidae	1	0.03	99.49
Laccophilus sp.	Dytiscidae	1	0.03	99.51
Liodessus obscurellus	Dytiscidae	1	0.03	99.54

Table 10. continued.

Lowest Taxa	Higher Taxa	Total N	Total Percent	Cumulative %
Hydrellia sp.	Ephydridae	1	0.03	99.57
Mooreobdella microstoma	Erpobdellidae	1	0.03	99.59
Haliplus sp.	Haliplidae	1	0.03	99.62
Ochthebius sp.	Hydraenidae	1	0.03	99.65
Berosus sp.	Hydrophilidae	1	0.03	99.67
Helochares sp.	Hydrophilidae	1	0.03	99.70
Tropisternus lateralis	Hydrophilidae	1	0.03	99.73
Hydropsyche californica	Hydropsychidae	1	0.03	99.76
Hydroptila sp.	Hydroptilidae	1	0.03	99.78
Atractides sp.	Hygrobatidae	1	0.03	99.81
Hygrobates sp.	Hygrobatidae	1	0.03	99.84
Mideopsis sp.	Mideopsidae	1	0.03	99.86
Muscidae	Muscidae	1	0.03	99.89
Stylaria lacustris	Naididae	1	0.03	99.92
Psychoda sp.	Psychodidae	1	0.03	99.95
Stratiomyidae	Stratiomyidae	1	0.03	99.97
Ormosia sp.	Tipulidae	1	0.03	100.00
	Total	3690		

Table 11. Benthic metrics by site for the five Del Puerto Creek sites.

	Del Puerto 1	Del Puerto 2	Del Puerto 3	Del Puerto 4	Del Puerto 5
Taxonomic Richness	24	38	38	38	47
Percent Dominant Taxon	45	23	28	24	24
Number Plecoptera Taxa	0	0	0	0	0
Number Trichoptera Taxa	1	0	0	0	2
EPT Taxa	2	1	1	1	6
EPT Index (%)	11	1	2	0	46
Sensitive EPT Index (%)	0	0	0	0	1
Shannon Diversity	2.0	2.5	2.5	2.3	2.7
Tolerance Value	8.5	7.1	6.9	7.2	6.0
Percent Intolerant Taxa (0-2)	0	0	0	0	2
Percent Tolerant Taxa (8-10)	53	51	47	43	41
Percent Baetidae	10	1	2	0	36
Percent Chironomidae	5	46	24	46	17
Percent Hydropsychidae	0	0	0	0	0
Percent Collectors Gatherers	71	58	54	58	69
Percent Collector-Filterers	16	14	18	17	18
Percent Scrapers	0	19	19	19	5
Percent Predators	12	8	7	5	6
Percent Shredders	0	0	0	0	0
Total Abundance (#/sample)	217	3943	6752	2736	7320

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

Lowest Taxa	Higher Taxa	Total N	Total Percent	Cumulative %
Tubificidae unid.imm.	Tubificidae	1476	27.84	27.84
Cricotopus bicinctus group	Chironomidae	442	8.34	36.18
Slavina appendiculata	Naididae	284	5.36	41.54
Physa sp.	Physidae	193	3.64	45.18
Cricotopus sp.	Chironomidae	185	3.49	48.67
Limnodrilus hoffmeisteri	Tubificidae	185	3.49	52.16
Corbicula sp.	Corbiculidae	169	3.19	55.35
Tanytarsus sp.	Chironomidae	149	2.81	58.16
Torrenticola sp.	Torrenticolidae	140	2.64	60.80
Procladius sp.	Chironomidae	138	2.60	63.40
Branchiura sowerbyi	Tubificidae	116	2.19	65.59
Simulium sp.	Simuliidae	115	2.17	67.76
Rheotanytarsus sp.	Chironomidae	100	1.89	69.65
Americorophium sp.	Corophiidae	91	1.72	71.36
Fallceon quilleri	Baetidae	87	1.64	73.01
Paratanytarsus sp.	Chironomidae	81	1.53	74.53
Lumbricina	Glossiphoniidae	66	1.25	75.78
Chironomus sp.	Chironomidae	61	1.15	76.93
Dicrotendipes sp.	Chironomidae	58	1.09	78.02
Nais communis/ variabilis	Naididae	57	1.08	79.10
Sperchon sp.	Sperchontidae	52	0.98	80.08
Prostoma sp.	Tertastemmatidae	52	0.98	81.06
Caloparyphus/ Euparyphus	Stratiomyidae	48	0.91	81.97
Psectrocladius sp.	Chironomidae	45	0.85	82.81
Centroptilum sp.	Baetidae	43	0.81	83.63
Cyprididae	Cyprididae	43	0.81	84.44
Enchytraeidae	Enchytraeidae	37	0.70	85.13
Hyalella sp.	Hyalellidae	37	0.70	85.83
Hydropsyche californica	Hydropsychidae	37	0.70	86.53
Baetis sp.	Baetidae	34	0.64	87.17
Rheocricotopus sp.	Chironomidae	33	0.62	87.79
Tubificidae w/hair	Tubificidae	33	0.62	88.42
Polypedilum sp.	Chironomidae	31	0.58	89.00
Micropsectra sp.	Chironomidae	30	0.57	89.57
Hexatoma sp.	Tipulidae	30	0.57	90.13
Pristina leidyi	Naididae	29	0.55	90.68
Menetus opercularis	Planorbidae	29	0.55	91.23
Cladotanytarsus sp.	Chironomidae	28	0.53	91.76
Corynoneura sp.	Chironomidae	28	0.53	92.28
Ophidonais serpentina	Naididae	23	0.43	92.72
Bezzia/ Palpomyia	Ceratopogonidae	22	0.42	93.13
Odontomyia/ Hedriodiscus	Stratiomyidae	22	0.42	93.55
Baetis adonis	Baetidae	19	0.36	93.91
Thienemanniella sp.	Chironomidae	19	0.36	94.27

Table 12. continued.

Lowest Taxa	Higher Taxa	Total N	Total Percent	Cumulative %
Eukiefferiella sp.	Chironomidae	17	0.32	94.59
Orthocladiinae	Chironomidae	17	0.32	94.91
Dugesia tigrina	Planariidae	17	0.32	95.23
Dero digitata	Naididae	15	0.28	95.51
Eudistylia vancouveri	Sabellidae	14	0.26	95.77
Nereis limnicola	Nereididae	13	0.25	96.02
Ceratopogon sp.	Ceratopogonidae	12	0.23	96.25
Pseudochironomus sp.	Chironomidae	11	0.21	96.45
Corixidae	Corixidae	11	0.21	96.66
Lebertia sp.	Lebertiidae	11	0.21	96.87
Fossaria sp.	Lymnaeidae	8	0.15	97.02
Nanocladius sp.	Chironomidae	7	0.13	97.15
Hydropsyche sp.	Hydropsychidae	7	0.13	97.28
Planariidae	Planariidae	7	0.13	97.42
Chironomini	Chironomidae	6	0.11	97.53
Tanytarsini	Chironomidae	6	0.11	97.64
Coenagrionidae	Coenagrionidae	6	0.11	97.76
Hydra sp.	Hydridae	6	0.11	97.87
Hydroptila sp.	Hydroptilidae	6	0.11	97.98
Gammarus sp.	Gammaridae	5	0.09	98.08
Planorbella sp.	Planorbidae	5	0.09	98.17
Phaenopsectra sp.	Chironomidae	4	0.08	98.25
Chaetogaster diaphanus	Naididae	4	0.08	98.32
Gyraulus sp.	Planorbidae	4	0.08	98.40
Ormosia sp.	Tipulidae	4	0.08	98.47
Quistadrilus multisetosus	Tubificidae	4	0.08	98.55
Microchironomus sp.	Chironomidae	3	0.06	98.60
Sigara omani	Corixidae	3	0.06	98.66
Erpobdellidae	Erpobdellidae	3	0.06	98.72
Atractides sp.	Hygrobatidae	3	0.06	98.77
Paraleptophlebia sp.	Leptophlebiidae	3	0.06	98.83
Psychoda sp.	Psychodidae	3	0.06	98.89
Ferrissia sp.	Ancylidae	2	0.04	98.92
Procambarus clarkii	Cambaridae	2	0.04	98.96
Culicoides sp.	Ceratopogonidae	2	0.04	99.00
Ablabesmyia sp.	Chironomidae	2	0.04	99.04
Apedilum sp.	Chironomidae	2	0.04	99.08
Glyptotendipes sp.	Chironomidae	2	0.04	99.11
Dolichopodidae	Dolichopodidae	2	0.04	99.15
Erpobdella sp.	Erpobdellidae	2	0.04	99.19
Mooreobdella microstoma	Erpobdellidae	2	0.04	99.23
Lymnaea sp.	Lymnaeidae	2	0.04	99.26
Muscidae	Muscidae	2	0.04	99.30

Table 12. continued.

Lowest Taxa	Higher Taxa	Total N	Total Percent	Cumulative %
Dero borellii	Naididae	2	0.04	99.34
Paranais litoralis	Naididae	2	0.04	99.38
Baetis tricaudatus	Baetidae	1	0.02	99.40
Belostoma flumineum	Belostomatidae	1	0.02	99.42
Belostomatidae	Belostomatidae	1	0.02	99.43
Caenis sp.	Caenidae	1	0.02	99.45
Cambaridae	Cambaridae	1	0.02	99.47
Atrichopogon sp.	Ceratopogonidae	1	0.02	99.49
Stilobezzia sp.	Ceratopogonidae	1	0.02	99.51
Chironominae	Chironomidae	1	0.02	99.53
Cricotopus trifascia group	Chironomidae	1	0.02	99.55
Cryptochironomus sp.	Chironomidae	1	0.02	99.57
Parachironomus sp.	Chironomidae	1	0.02	99.58
Paracladopelma sp.	Chironomidae	1	0.02	99.60
Tanypodinae	Chironomidae	1	0.02	99.62
Tanypus sp.	Chironomidae	1	0.02	99.64
Thienemannimyia group	Chironomidae	1	0.02	99.66
Ischnura sp.	Coenagrionidae	1	0.02	99.68
Corisella inscripta	Corixidae	1	0.02	99.70
Corisella sp.	Corixidae	1	0.02	99.72
Trichocorixa calva	Corixidae	1	0.02	99.74
Crangonyx sp.	Crangonyctidae	1	0.02	99.75
Stictotarsus sp.	Dytiscidae	1	0.02	99.77
Scatella sp.	Ephydridae	1	0.02	99.79
Peltodytes sp.	Haliplidae	1	0.02	99.81
Helophorus sp.	Helophoridae	1	0.02	99.83
Heptageniidae	Heptageniidae	1	0.02	99.85
Nixe sp.	Heptageniidae	1	0.02	99.87
Tropisternus lateralis	Hydrophilidae	1	0.02	99.89
Tropisternus sp.	Hydrophilidae	1	0.02	99.91
Hygrobates sp.	Hygrobatidae	1	0.02	99.92
Lymnaeidae	Lymnaeidae	1	0.02	99.94
Wormaldia sp.	Philopotamidae	1	0.02	99.96
Euparyphus sp.	Stratiomyidae	1	0.02	99.98
Molophilus sp.	Tipulidae	1	0.02	100.00
	Total	5301		

Table 13. Benthic metrics by site for the 10 Orestimba Creek sites.

	ORE 1	ORE 2	ORE 3	ORE 4	ORE 5	ORE 6	ORE 7	ORE 8	ORE 9	ORE 10
Taxonomic Richness	20	24	15	33	41	47	34	30	39	44
Percent Dominant Taxon	65	67	66	25	25	25	27	26	23	16
Number Plecoptera Taxa	0	0	0	0	0	0	0	0	0	0
Number Trichoptera Taxa	0	0	0	3	2	3	2	2	0	1
EPT Taxa	0	0	0	4	3	4	3	3	0	9
EPT Index (%)	0	0	0	8	6	2	2	3	0	20
Sensitive EPT Index (%)	0	0	0	1	0	0	0	0	0	5
Shannon Diversity	1.3	1.3	1.4	2.7	2.8	2.7	2.8	2.5	2.7	3.0
Tolerance Value	9.7	9.7	9.6	7.4	7.6	7.7	7.2	6.3	8.1	5.6
Percent Intolerant Taxa (0-2)	0	0	0	0	0	0	0	0	0	7
Percent Tolerant Taxa (8-10)	53	50	70	46	47	47	53	54	45	27
Percent Baetidae	0	0	0	1	2	1	1	1	0	19
Percent Chironomidae	9	10	3	15	19	35	58	48	43	34
Percent Hydropsychidae	0	0	0	7	4	1	1	2	0	0
Percent Collectors Gatherers	87	87	93	46	74	83	74	53	55	47
Percent Collector-Filterers	2	1	5	36	8	6	16	40	19	25
Percent Scrapers	0	1	0	2	6	3	3	1	22	1
Percent Predators	11	11	1	15	10	6	7	6	4	24
Percent Shredders	0	0	0	1	0	0	0	1	0	0
Total Abundance (#/sample)	1459	2142	273	164	456	479	455	400	1962	4238

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

Lowest Taxa	Higher Taxa	Total N	Total Percent	Cumulative %
Dero digitata	Naididae	352	13.86	13.86
Tubificidae unid.imm.	Tubificidae	327	12.88	26.74
Ferrissia sp.	Ancylidae	216	8.51	35.25
Cricotopus bicinctus group	Chironomidae	209	8.23	43.48
Tubificidae w/hair	Tubificidae	194	7.64	51.12
Cricotopus sp.	Chironomidae	121	4.77	55.89
Eudistylia vancouveri	Sabellidae	81	3.19	59.08
Slavina appendiculata	Naididae	75	2.95	62.03
Coenagrionidae	Coenagrionidae	68	2.68	64.71
Nais communis/ variabilis	Naididae	68	2.68	67.39
Corixidae	Corixidae	51	2.01	69.40
Dicrotendipes sp.	Chironomidae	49	1.93	71.33
Polypedilum sp.	Chironomidae	46	1.81	73.14
Dero borellii	Naididae	42	1.65	74.79
Limnodrilus hoffmeisteri	Tubificidae	39	1.54	76.33
Corbicula sp.	Corbiculidae	37	1.46	77.79
Parachironomus sp.	Chironomidae	36	1.42	79.20
Chironomus sp.	Chironomidae	35	1.38	80.58
Physa sp.	Physidae	33	1.30	81.88
Paratanytarsus sp.	Chironomidae	32	1.26	83.14
Goeldichironomus sp.	Chironomidae	29	1.14	84.29
Hyalella sp.	Hyalellidae	26	1.02	85.31
Manayunkia speciosa	Sabellidae	26	1.02	86.33
Psectrocladius sp.	Chironomidae	24	0.95	87.28
Tanypus sp.	Chironomidae	24	0.95	88.22
Branchiura sowerbyi	Tubificidae	23	0.91	89.13
Tanytarsus sp.	Chironomidae	21	0.83	89.96
Cambaridae	Cambaridae	17	0.67	90.63
Americorophium sp.	Corophiidae	15	0.59	91.22
Procladiini	Chironomidae	14	0.55	91.77
Enallagma sp.	Coenagrionidae	14	0.55	92.32
Callibaetis sp.	Baetidae	13	0.51	92.83
Cyprididae	Cyprididae	13	0.51	93.34
Nanocladius sp.	Chironomidae	12	0.47	93.82
Procladius sp.	Chironomidae	12	0.47	94.29
Gammarus sp.	Gammaridae	12	0.47	94.76
Glyptotendipes sp.	Chironomidae	10	0.39	95.16
Hydroptila sp.	Hydroptilidae	10	0.39	95.55
Dugesia tigrina	Planariidae	9	0.35	95.90
Microchironomus sp.	Chironomidae	7	0.28	96.18

Table 14. continued.

Lowest Taxa	Higher Taxa	Total N	Total Percent	Cumulative %
Prostoma sp.	Tertastemmatidae	7	0.28	96.46
Cladotanytarsus sp.	Chironomidae	6	0.24	96.69
Palaemonidae	Palaemonidae	6	0.24	96.93
Quistadrilus multisetosus	Tubificidae	5	0.20	97.12
Bezzia/ Palpomyia	Ceratopogonidae	4	0.16	97.28
Culicoides sp.	Ceratopogonidae	4	0.16	97.44
Cryptochironomus sp.	Chironomidae	4	0.16	97.60
Chironomini	Chironomidae	3	0.12	97.72
Phaenopsectra sp.	Chironomidae	3	0.12	97.83
Ischnura sp.	Coenagrionidae	3	0.12	97.95
Ephydridae	Ephydridae	3	0.12	98.07
Hydropsyche californica	Hydropsychidae	3	0.12	98.19
Muscidae	Muscidae	3	0.12	98.31
Ophidonais serpentina	Naididae	3	0.12	98.42
Paranais litoralis	Naididae	3	0.12	98.54
Aeshnidae	Aeshnidae	2	0.08	98.62
Procambarus clarkii	Cambaridae	2	0.08	98.70
Ablabesmyia sp.	Chironomidae	2	0.08	98.78
Endotribelos sp.	Chironomidae	2	0.08	98.86
Micropsectra sp.	Chironomidae	2	0.08	98.94
Dytiscidae	Dytiscidae	2	0.08	99.02
Lumbricina	Glossiphoniidae	2	0.08	99.09
Exopalaemon modestus	Palaemonidae	2	0.08	99.17
Menetus opercularis	Planorbidae	2	0.08	99.25
Ceratopogon sp.	Ceratopogonidae	1	0.04	99.29
Dasyhelea sp.	Ceratopogonidae	1	0.04	99.33
Hydrobaenus sp.	Chironomidae	1	0.04	99.37
Orthocladiinae	Chironomidae	1	0.04	99.41
Paracladopelma sp.	Chironomidae	1	0.04	99.45
Corisella decolor	Corixidae	1	0.04	99.49
Palmacorixa sp.	Corixidae	1	0.04	99.53
Crangonyx sp.	Crangonyctidae	1	0.04	99.57
Erpobdella sp.	Erpobdellidae	1	0.04	99.61
Glossiphoniidae	Glossiphoniidae	1	0.04	99.65
Helobdella triserialis	Glossiphoniidae	1	0.04	99.68
Ochthebius sp.	Hydraenidae	1	0.04	99.72
Hydra sp.	Hydridae	1	0.04	99.76
Hydropsychidae	Hydropsychidae	1	0.04	99.80
Fossaria sp.	Lymnaeidae	1	0.04	99.84
Mesovelia mulsanti	Mesoveliidae	1	0.04	99.88
Pristina leidyi	Naididae	1	0.04	99.92
Palaemonetes sp.	Palaemonidae	1	0.04	99.96
Simulium sp.	Simuliidae	1	0.04	100.00
	Total	2539		

Table 15. Benthic metrics by site for the five Salt Slough sites.

	SSL 1	SSL 2	SSL 3	SSL 4	SSL 5
Taxonomic Richness	34	37	33	43	40
Percent Dominant Taxon	26	24	27	21	39
Number Plecoptera Taxa	0	0	0	0	0
Number Trichoptera Taxa	2	0	1	1	0
EPT Taxa	2	1	1	2	1
EPT Index (%)	3	1	0	0	1
Sensitive EPT Index (%)	0	0	0	0	0
Shannon Diversity	2.5	2.6	2.6	3.1	2.5
Tolerance Value	7.3	7.4	7.0	7.5	8.2
Percent Intolerant Taxa (0-2)	0	0	0	0	0
Percent Tolerant Taxa (8-10)	32	46	57	62	61
Percent Baetidae	0	1	0	0	1
Percent Chironomidae	66	23	33	26	14
Percent Hydropsychidae	1	0	0	0	0
Percent Collectors Gatherers	91	63	75	76	68
Percent Collector-Filterers	4	11	13	6	1
Percent Scrapers	0	26	0	3	13
Percent Predators	3	1	10	14	16
Percent Shredders	0	0	0	0	1
Total Abundance (#/sample)	857	685	279	458	6901

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

Factor	Eigen Value	Proportion Variance Explained	Cumulative Variance Explained
Factor 1	7.3042	0.43	0.43
Factor 2	2.7594	0.16	0.59
Factor 3	2.4165	0.14	0.73
Factor 4	1.6614	0.10	0.83
Factor 5	0.9620	0.06	0.89
Factor 6	0.7003	0.04	0.93
Factor 7	0.5030	0.03	0.96
Factor 8	0.2482	0.01	0.97
Factor 9	0.2030	0.01	0.99
Factor 10	0.1414	0.01	0.99
Factor 11	0.0521	0.00	1.00
Factor 12	0.0240	0.00	1.00
Factor 13	0.0131	0.00	1.00
Factor 14	0.0085	0.00	1.00
Factor 15	0.0021	0.00	1.00
Factor 16	0.0009	0.00	1.00
Factor 17	0.0000	0.00	1.00

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

Benthic Metric	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1				
EPT Taxa	0.33	0.21	-0.09	-0.10
Number Ephemeroptera Taxa	0.32	0.20	0.18	0.03
Tolerance Value	-0.32	0.18	0.10	0.07
Sensitive EPT Index (%)	0.29	0.28	0.16	0.13
Percent Intolerant Taxa (0-2)	0.29	0.28	0.23	0.05
Percent Tolerant Taxa (8-10)	-0.25	-0.00	-0.14	0.18
EPT Index (%)	0.23	0.18	0.04	-0.17
Factor 2				
Percent Scrapers	0.01	-0.50	0.31	0.11
Percent Dominant Taxon	-0.28	0.34	0.12	0.15
Shannon Diversity	0.27	-0.27	-0.16	-0.16
Taxonomic Richness	0.26	-0.27	0.05	-0.26
Factor 3				
Abundance	0.10	-0.15	0.52	0.09
Number Trichoptera Taxa	0.15	0.09	-0.50	-0.27
Factor 4				
Percent Shredders	0.04	-0.05	-0.34	0.52
Percent Collectors Gatherers	-0.24	0.26	-0.00	-0.45
Percent Collector-Filterers	0.21	-0.10	-0.28	0.38
Percent Predators	0.18	0.28	0.04	0.30

Number Plecoptera Taxa omitted

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

Benthic Metric	Del Puerto	Orestimba	Salt Slough
Abundance	0.60	0.28	0.50
	0.2848	0.4250	0.3910
EPT Index (%)	0.10	0.48	-0.53
	0.8729	0.1573	0.3615
EPT Taxa	0.22	0.51	-0.29
	0.7177	0.1334	0.6376
Number Ephemeroptera Taxa	0.71	0.60	0.58
	0.1817	0.0650	0.3081
Number Trichoptera Taxa	0.22	0.25	-0.53
	0.7177	0.4784	0.3615
Percent Collector-Filterers	0.72	0.73 *	-0.30
	0.1718	0.0158	0.6238
Percent Collectors Gatherers	-0.21	-0.67 *	-0.30
	0.7406	0.0338	0.6238
Percent Dominant Taxon	-0.36	-0.77 *	0.30
	0.5528	0.0096	0.6238
Percent Intolerant Taxa (0-2)	0.71	0.52	.
	0.1817	0.1215	.
Percent Predators	-0.90 *	-0.11	0.90 *
	0.0374	0.7628	0.0374
Percent Scrapers	0.22	0.49	0.31
	0.7177	0.1468	0.6144
Percent Shredders	.	0.09	0.71
	.	0.8110	0.1817
Percent Tolerant Taxa (8-10)	-1.00 *	-0.48	0.90 *
	0.0000	0.1647	0.0374
Sensitive EPT Index (%)	0.71	0.31	.
	0.1817	0.3811	.
Shannon Diversity	0.67	0.73 *	0.16
	0.2189	0.0169	0.7995
Taxonomic Richness	0.89 *	0.67 *	0.60
	0.0405	0.0330	0.2848
Tolerance Value	-0.70	-0.77 *	0.70
	0.1881	0.0098	0.1881

Number Plecoptera Taxa omitted
* Significant trends

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.

Benthic Metric	Del Puerto	Orestimba	Salt Slough	Kruskal-Wallis p-value	DO	DS	OS
Abundance	738.00	530.10	507.80	0.2347			
EPT Index (%)	12.00	4.10	1.00	0.4874			
EPT Taxa	2.20	2.60	1.40	0.8682			
Number Ephemeroptera Taxa	1.60	1.30	0.60	0.3183			
Number Trichoptera Taxa	0.60	1.30	0.80	0.5253			
Percent Collector-Filterers	16.60	15.80	7.00	0.1218			
Percent Collectors Gatherers	62.00	69.90	74.60	0.3637			
Percent Dominant Taxon	28.80	36.50	27.40	0.8227			
Percent Intolerant Taxa (0-2)	0.40	0.70	0.00	1.0000			
Percent Predators	7.60	9.50	8.80	0.9417			
Percent Scrapers	12.40	3.90	8.40	0.4264			
Percent Shredders	0.00	0.20	0.20	0.7807			
Percent Tolerant Taxa (8-10)	47.00	49.20	51.60	0.5679			
Sensitive EPT Index (%)	0.20	0.60	0.00	0.7807			
Shannon Diversity	2.40	2.32	2.66	0.5244			
Taxonomic Richness	37.00	32.70	37.40	0.7181			
Tolerance Value	7.14	7.89	7.48	0.3495			

Number Plecoptera Taxa omitted

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

Benthic Metric	Epi Sub	Embedd	Vel Dpth	Sed Dep	Chan Flow	Chan Alt	Ben Riff	Bank Stab	Bank Veg	Rip Buff	Total
Abundance	0.05 0.8487	-0.01 0.9689	-0.15 0.5301	0.25 0.2803	0.00 0.9934	0.14 0.5563	-0.16 0.5003	0.11 0.6383	-0.25 0.2870	-0.08 0.7510	0.00 0.9950
EPT Index (%)	0.62 * 0.0033	0.73 * 0.0002	0.63 * 0.0028	0.72 * 0.0003	0.13 0.5848	0.29 0.2193	0.49 * 0.0290	0.57 * 0.0084	0.32 0.1628	0.43 0.0596	0.77 * 0.0001
EPT Taxa	0.78 * 0.0001	0.82 * 0.0000	0.66 * 0.0017	0.76 * 0.0001	0.21 0.3828	0.33 0.1564	0.50 * 0.0253	0.66 * 0.0015	0.28 0.2284	0.40 0.0847	0.80 * 0.0000
Number Ephemeroptera Taxa	0.71 * 0.0004	0.76 * 0.0001	0.61 * 0.0043	0.86 * 0.0000	0.05 0.8377	0.25 0.2945	0.37 0.1118	0.64 * 0.0022	0.15 0.5284	0.24 0.3028	0.72 * 0.0004
Number Trichoptera Taxa	0.65 * 0.0018	0.61 * 0.0042	0.57 * 0.0094	0.44 0.0502	0.33 0.1520	0.19 0.4108	0.36 0.1146	0.43 0.0590	0.26 0.2601	0.30 0.1981	0.60 * 0.0055
Percent Collector-Filterers	0.20 0.3988	0.49 * 0.0277	0.55 * 0.0111	0.59 * 0.0066	-0.30 0.1947	-0.14 0.5567	0.23 0.3263	0.52 * 0.0175	0.29 0.2214	-0.04 0.8714	0.48 * 0.0326
Percent Collectors Gatherers	-0.19 0.4194	-0.35 0.1255	-0.34 0.1412	-0.57 * 0.0093	0.19 0.4188	0.18 0.4553	0.02 0.9294	-0.48 * 0.0341	-0.21 0.3830	0.22 0.3559	-0.33 0.1598
Percent Dominant Taxon	-0.23 0.3287	-0.36 0.1234	-0.10 0.6741	-0.50 * 0.0250	0.17 0.4812	-0.21 0.3768	-0.18 0.4475	-0.47 * 0.0360	-0.07 0.7641	-0.10 0.6690	-0.30 0.1968
Percent Intolerant Taxa (0-2)	0.27 0.2570	0.44 0.0525	0.24 0.3185	0.52 * 0.0175	-0.17 0.4756	0.51 * 0.0207	0.52 * 0.0183	0.51 * 0.0214	0.01 0.9514	0.52 * 0.0179	0.52 * 0.0185

Table 20. continued.

Benthic Metric	Epi Sub	Embedd	Vel Dpth	Sed Dep	Chan Flow	Chan Alt	Ben Riff	Bank Stab	Bank Veg	Rip Buff	Total
Percent Predators	0.30 0.1968	0.28 0.2265	0.05 0.8284	0.17 0.4671	0.17 0.4791	0.10 0.6822	-0.02 0.9280	0.09 0.7168	-0.07 0.7559	0.05 0.8263	0.16 0.4967
Percent Scrapers	0.12 0.6055	0.09 0.7192	0.00 0.9975	0.32 0.1661	-0.01 0.9532	-0.13 0.5757	-0.31 0.1842	0.23 0.3381	0.03 0.8926	-0.28 0.2243	0.04 0.8734
Percent Shredders	0.32 0.1707	-0.04 0.8747	0.16 0.5053	0.02 0.9184	0.24 0.3081	-0.36 0.1233	-0.23 0.3257	-0.02 0.9185	-0.15 0.5362	-0.39 0.0880	-0.06 0.7993
Percent Tolerant Taxa (8-10)	0.10 0.6743	-0.29 0.2191	-0.02 0.9495	-0.43 0.0578	0.21 0.3724	-0.37 0.1126	-0.23 0.3205	-0.40 0.0804	-0.19 0.4349	-0.29 0.2157	-0.32 0.1702
Sensitive EPT Index (%)	0.25 0.2926	0.46 * 0.0394	0.32 0.1626	0.56 * 0.0109	-0.08 0.7483	0.41 0.0748	0.48 * 0.0309	0.54 * 0.0131	0.13 0.5722	0.30 0.1998	0.55 * 0.0116
Shannon Diversity	0.56 * 0.0109	0.54 * 0.0145	0.26 0.2737	0.50 * 0.0253	0.12 0.6013	0.26 0.2670	0.24 0.3048	0.59 * 0.0066	0.34 0.1478	0.24 0.3080	0.52 * 0.0184
Taxonomic Richness	0.53 * 0.0165	0.47 * 0.0384	0.17 0.4665	0.57 * 0.0090	0.04 0.8515	0.24 0.2997	0.18 0.4451	0.48 * 0.0333	-0.03 0.8999	0.09 0.7083	0.40 0.0840
Tolerance Value	-0.38 0.0979	-0.42 0.0659	-0.49 * 0.0299	-0.71 * 0.0004	-0.12 0.6084	-0.26 0.2704	-0.40 0.0767	-0.77 * 0.0001	-0.40 0.0819	-0.22 0.3533	-0.61 * 0.0047

* $p < 0.05$

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	Stream Width	Stream Depth	Mean Flow	Percent Canopy	Fines	Gravel	Cobble
Abundance	-0.41 0.1139	-0.54 * 0.0315	-0.13 0.6444	-0.59 * 0.0057	-0.08 0.7287	-0.00 0.9870	0.19 0.4214
EPT Index (%)	0.04 0.8729	-0.13 0.6343	0.51 * 0.0444	0.12 0.6046	-0.77 * 0.0001	0.73 * 0.0003	0.45 * 0.0471
EPT Taxa	0.24 0.3767	-0.04 0.8727	0.55 * 0.0274	0.07 0.7741	-0.77 * 0.0001	0.60 * 0.0053	0.64 * 0.0022
Number Ephemeroptera Taxa	-0.02 0.9549	-0.27 0.3094	0.42 0.1052	-0.13 0.5918	-0.73 * 0.0002	0.65 * 0.0019	0.52 * 0.0178
Number Trichoptera Taxa	0.29 0.2796	0.26 0.3348	0.65 * 0.0069	0.28 0.2398	-0.57 * 0.0089	0.38 0.0999	0.51 * 0.0225
Percent Collector-Filterers	-0.38 0.1502	-0.43 0.0939	0.13 0.6282	-0.16 0.4994	-0.62 * 0.0034	0.71 * 0.0004	0.19 0.4167
Percent Collectors Gatherers	0.30 0.2575	0.33 0.2057	-0.04 0.8708	0.29 0.2153	0.46 * 0.0406	-0.65 * 0.0019	0.01 0.9659
Percent Dominant Taxon	0.14 0.6123	0.39 0.1407	0.17 0.5206	0.44 0.0511	0.36 0.1210	-0.31 0.1852	-0.25 0.2834
Percent Intolerant Taxa (0-2)	0.10 0.6988	-0.49 0.0521	-0.06 0.8213	-0.28 0.2241	-0.54 * 0.0141	0.34 0.1461	0.62 * 0.0039
Percent Predators	0.23 0.3926	0.10 0.7193	-0.01 0.9740	0.06 0.8087	-0.17 0.4657	0.28 0.2334	-0.01 0.9586
Percent Scrapers	-0.38 0.1483	-0.12 0.6453	0.03 0.9238	-0.29 0.2120	-0.15 0.5408	0.16 0.5015	0.02 0.9491
Percent Shredders	0.04 0.8800	0.25 0.3585	0.35 0.1856	0.01 0.9556	0.01 0.9579	0.13 0.5964	-0.21 0.3779
Percent Tolerant Taxa (8-10)	0.08 0.7729	0.46 0.0734	0.23 0.3965	0.20 0.3980	0.44 * 0.0498	-0.37 0.1055	-0.31 0.1839
Sensitive EPT Index (%)	0.17 0.5401	-0.29 0.2843	0.02 0.9430	-0.01 0.9823	-0.58 * 0.0070	0.48 * 0.0306	0.46 * 0.0405
Shannon Diversity	0.21 0.4330	0.04 0.8782	0.30 0.2563	-0.07 0.7545	-0.47 * 0.0350	0.29 0.2115	0.49 * 0.0269
Taxonomic Richness	-0.11 0.6803	-0.37 0.1553	0.14 0.6172	-0.43 0.0596	-0.47 * 0.0375	0.24 0.2993	0.52 * 0.0178
Tolerance Value	0.07 0.8029	0.21 0.4436	-0.31 0.2434	0.53 * 0.0171	0.45 * 0.0450	-0.43 0.0591	-0.34 0.1415

* $p < 0.05$

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

	Temperature (C)							Specific Conductance (µS)						
Site	2006	2005	2004	2003	2002	2001	2000	2006	2005	2004	2003	2002	2001	2000
DLP1	27.5	15.0	23.2	22.9	15.6	20.2	n/a	1025	396.7	1179	1199	704	910	n/a
DLP2	19.9	17.3	25.6	25.6	20.6	23.7	n/a	525	426.4	1165	1336	709	900	n/a
DLP3	22.1	18.8	25.3	24.1	22.2	30.5	n/a	541	446.5	1254	1143	742	1086	n/a
DLP4	26.4	26.3	23.2	31.4	28.3	18.2	n/a	836	489	649	564	520	628	n/a
DLP5	27.7	22.9	20.6	18.7	22.7	22.1	n/a	988	940	1738	1287	1689	992	n/a
ORE1	25.7	18.9	17.0	18.7	18.1	18.8	21.5	628	560	761	659	663	648	754
ORE2	25.7	20.6	17.0	20.3	19.9	20.3	22.5	547	550	717	644	605	662	744
ORE3	27.6	18.7	21.9	22.7	21.1	20.3	23.0	472	510	824	672	653	675	739
ORE4	20.0	18.8	20.9	22.1	21.0	21.4	21.4	167	485	806	653	640	334	683
ORE5	20.2	18.8	17.0	20.4	18.8	22.8	22.0	173	510	712	596	656	636	654
ORE6	21.7	18.3	18.7	21.8	18.7	24.7	22.9	157	810	689	681	696	584	644
ORE7	22.1	19.5	18.2	24.4	20.1	19.5	29.5	153	830	892	745	711	663	620
ORE8	23.2	20.6	26.9	25.0	22.6	21.6	22.9	155	780	901	755	763	695	840
ORE9	27.1	-	20.1	28.5	23.1	30.3	27.7	156	-	937	933	697	1000	857
ORE10	24.5	21.4	21.6	21.9	18.1	27.1	27.4	647	670	798	780	825	1044	878
SSL1	26.6	19.2	24.6	28.6	18.5	22.1	n/a	869	1270	1606	1957	1885	989	n/a
SSL2	26.1	20.4	21.9	26.1	19.3	22.1	n/a	856	1190	1450	1844	1339	1011	n/a
SSL3	26.6	21.8	23.2	27.4	20.8	24.5	n/a	878	1160	1435	1616	1256	495	n/a
SSL4	27.6	21.9	18.9	24.6	23.5	20.6	n/a	723	990	951	1139	1073	542	n/a
SSL5	28.1	26.4	15.9	22.6	18.0	23.2	n/a	683	2490	2148	956	1473	552	n/a

Table 22. continued.

	pH							Dissolved Oxygen (mg/L)						
Site	2006	2005	2004	2003	2002	2001	2000	2006	2005	2004	2003	2002	2001	2000
DLP1	8.27	7.46	8.44	8.62	8.06	8.17	n/a	7.01	9.81	8.28	9.19	9.5	9	n/a
DLP2	8.29	7.74	8.53	8.82	8.58	-	n/a	8.85	9.48	7.93	9.19	8.8	5.9	n/a
DLP3	8.51	8.58	8.53	8.12	8.34	8.51	n/a	9.86	10.47	7.43	8.06	9.1	4.7	n/a
DLP4	8.86	9.29	8.47	8.50	7.55	8.05	n/a	13.48	14.9	9.91	6.35	5.4	4.5	n/a
DLP5	8.87	8.65	8.10	8.30	8.51	8.32	n/a	10.02	9.10	10.06	8.24	12.2	4.0	n/a
ORE1	7.37	7.80	7.86	7.28	7.80	7.96	8.01	4.88	8.81	7.33	6.92	7.6	8.4	6.7
ORE2	7.54	7.91	7.92	8.01	8.01	8.12	8.23	6.21	8.55	7.91	7.90	7.8	5.0	8.2
ORE3	7.83	7.89	7.93	8.10	8.12	7.86	8.18	6.43	9.17	6.97	7.70	8.1	4.9	7.5
ORE4	7.68	7.91	7.96	7.98	8.09	8.17	8.01	9.70	9.09	7.48	7.72	8.3	4.2	7.8
ORE5	7.72	7.92	7.81	7.15	8.06	8.08	8.1	8.31	8.54	7.48	6.86	7.6	4.3	8.1
ORE6	7.71	8.05	7.80	7.01	8.21	7.8	8.25	8.67	8.19	7.58	7.14	8.1	4.0	8.9
ORE7	7.68	8.02	7.62	7.73	8.14	8.04	8.48	8.54	8.52	7.24	7.99	8.4	4.2	8.9
ORE8	7.67	8.01	7.79	7.89	8.08	7.87	8.21	8.41	8.28	6.46	7.07	7.9	3.3	8.2
ORE9	9.18	-	8.22	7.91	8.13	8.59	8.4	7.41	-	8.18	5.78	8.0	4.0	7.8
ORE10	8.56	8.41	7.76	7.88	8.25	8.37	8.37	9.47	10.0	6.52	7.18	3.2	4.8	13.0
SSL1	7.59	7.64	7.73	7.68	7.69	7.62	n/a	5.43	7.12	7.26	5.37	6.4	2.8	n/a
SSL2	7.41	7.51	7.60	7.37	7.43	7.73	n/a	4.79	6.62	7.07	5.12	6.0	3.2	n/a
SSL3	7.42	7.56	7.56	7.51	7.56	7.74	n/a	5.19	7.17	7.88	5.25	6.7	2.8	n/a
SSL4	7.48	7.59	7.59	7.35	7.75	7.30	n/a	5.47	7.57	6.81	5.44	7.4	2.9	n/a
SSL5	7.34	8.04	7.39	6.96	7.37	7.37	n/a	4.20	10.41	6.08	4.06	4.8	2.7	n/a

Table 22. continued.

	Salinity ppt							Turbidity (NTU)						
Site	2006	2005	2004	2003	2002	2001	2000	2006	2005	2004	2003	2002	2001	2000
DLP1	0.5	0.2	0.6	-	0.4	0.4	-	82.6	116	81.3	3.33	84	103	n/a
DLP2	0.3	0.2	0.6	-	0.4	0.5	-	35.9	109	135	1.70	130	59	n/a
DLP3	0.3	0.2	0.6	-	0.4	0.5	-	50.1	80.5	64.5	1.93	112	25	n/a
DLP4	0.4	0.3	0.3	-	0.2	0.4	-	6.53	70.2	13.5	6.5	20	56	n/a
DLP5	0.5	0.2	0.9	-	0.9	0.5	-	1.13	0.56	1.13	1.53	1.1	0.64	n/a
ORE1	0.3	0.2	0.4	-	0.4	0.4	-	143	45.4	213	109.7	376	142	115
ORE2	0.2	0.2	0.4	-	0.3	0.4	-	228	85.6	249	102.8	207	126	158
ORE3	0.2	0.1	0.4	-	0.3	0.4	-	372	134	215	119	153	142	156
ORE4	0.1	0.1	0.4	-	0.3	0.2	-	117	137	267	135.6	226	104	107
ORE5	0.1	0.1	0.4	-	0.4	0.3	-	118	123	254	130	201	110	107
ORE6	0.1	0.4	0.4	-	0.4	0.3	-	182	152	270	99.7	178	128	131
ORE7	0.1	0.5	0.5	-	0.4	0.4	-	252	116	384	71.2	166	136	153
ORE8	0.1	0.3	0.4	-	0.4	0.4	-	162	110	656	116	150	92	80
ORE9	0	-	0.5	-	0.4	0.4	-	168	-	18.6	144	236	108	213
ORE10	0.2	0.2	0.2	-	0.1	0.5	-	22.8	0.44	0.26	0.07	0.88	0.82	0.51
SSL1	0.4	0.9	0.8	-	0.9	0.5	-	113	68.4	36.3	43.1	46	61	n/a
SSL2	0.4	0.9	0.8	-	0.8	0.5	-	84.5	74.3	49.7	80.1	41	78	n/a
SSL3	0.4	0.4	0.7	-	0.7	0.3	-	84.1	90.2	58.4	66.4	52	68	n/a
SSL4	0.3	0.2	0.5	-	0.6	0.3	-	132	70.3	56.1	60.3	52	65	n/a
SSL5	0.3	1.3	1.3	-	0.7	0.3	-	91.5	48.5	13.1	78.6	37	80	n/a

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

	Epifaunal Substrate							Embeddedness						
	2006	2005	2004	2003	2002	2001	2000	2006	2005	2004	2003	2002	2001	2000
DLP1	8	12	15	13	10	9	n/a	11	10	13	12	8	7	n/a
DLP2	8	11	11	13	11	7	n/a	8	11	10	12	7	7	n/a
DLP3	7	11	10	12	10	6	n/a	7	13	9	6	4	5	n/a
DLP4	6	1	11	10	9	2	n/a	6	0	7	8	4	10	n/a
DLP5	12	12	6	13	3	10	n/a	11	16	5	13	16	11	n/a
ORE1	3	11	6	15	9	13	6	0	1	2	1	0	6	4
ORE2	2	13	11	7	10	14	10	0	3	4	10	13	11	13
ORE3	3	11	11	10	11	15	14	0	6	13	13	15	16	14
ORE4	8	10	12	11	8	12	15	10	8	13	8	14	16	14
ORE5	13	10	10	10	10	16	17	14	10	9	8	7	15	13
ORE6	11	11	12	6	7	13	10	13	10	12	8	9	16	11
ORE7	11	13	13	12	8	10	8	12	10	12	8	10	16	13
ORE8	11	8	11	9	9	11	13	7	8	9	7	7	15	11
ORE9	0	-	2	10	11	10	14	0	-	13	6	9	12	14
ORE10	8	12	6	10	8	7	10	17	13	8	10	14	6	7
SSL1	6	7	6	5	2	8	n/a	0	0	0	0	0	1	n/a
SSL2	6	5	6	6	1	5	n/a	0	0	1	0	0	1	n/a
SSL3	7	3	7	6	1	2	n/a	0	0	0	0	0	1	n/a
SSL4	10	4	7	8	6	6	n/a	1	0	1	0	0	0	n/a
SSL5	11	2	7	2	6	2	n/a	0	0	0	0	0	0	n/a

Table 23. continued.

	Velocity Depth Diversity							Sediment Deposition						
	2006	2005	2004	2003	2002	2001	2000	2006	2005	2004	2003	2002	2001	2000
DLP1	11	11	11	16	17	16	n/a	5	10	14	15	12	14	n/a
DLP2	10	15	15	15	10	14	n/a	15	15	10	14	12	16	n/a
DLP3	15	15	10	9	10	7	n/a	15	13	10	11	12	7	n/a
DLP4	5	0	5	10	10	5	n/a	6	5	11	10	6	6	n/a
DLP5	15	10	5	9	3	13	n/a	16	15	11	11	13	11	n/a
ORE1	3	6	14	6	6	13	7	0	6	1	5	1	6	4
ORE2	3	6	13	10	9	16	10	0	5	3	9	14	10	5
ORE3	6	15	10	9	10	18	10	0	8	10	10	10	16	15
ORE4	12	9	10	10	10	19	17	10	10	14	13	16	15	16
ORE5	11	10	10	8	17	19	19	10	12	13	12	14	9	15
ORE6	14	10	10	9	5	16	13	10	13	13	11	16	13	10
ORE7	10	10	10	10	10	18	12	8	12	13	15	17	16	14
ORE8	16	10	10	14	16	15	10	6	10	12	12	16	15	14
ORE9	0	-	10	6	10	14	10	0	-	16	8	16	5	14
ORE10	9	10	4	10	3	7	13	18	14	11	13	8	5	12
SSL1	2	11	16	9	11	11	n/a	1	5	2	1	2	4	n/a
SSL2	4	11	6	6	13	12	n/a	4	4	2	6	2	5	n/a
SSL3	5	13	9	9	9	11	n/a	1	3	3	4	2	4	n/a
SSL4	6	14	6	7	6	12	n/a	3	1	1	5	3	2	n/a
SSL5	1	0	0	1	0	2	n/a	1	0	0	1	3	1	n/a

Table 23. continued.

	Channel Flow Status							Channel Alteration						
	2006	2005	2004	2003	2002	2001	2000	2006	2005	2004	2003	2002	2001	2000
DLP1	19	20	15	16	14	19	n/a	13	14	15	15	14	15	15
DLP2	20	19	15	16	15	16	n/a	14	11	13	10	8	12	12
DLP3	20	18	15	14	16	15	n/a	15	11	11	14	14	13	13
DLP4	11	4	11	6	8	8	n/a	6	0	11	6	11	2	2
DLP5	20	20	8	14	7	9	n/a	19	20	16	17	16	17	17
ORE1	20	19	8	14	14	17	16	17	14	15	16	14	16	16
ORE2	20	19	16	14	16	20	15	15	15	13	13	15	15	15
ORE3	19	13	16	16	14	20	19	13	9	13	7	8	15	15
ORE4	20	9	10	16	10	20	15	14	11	13	16	14	14	14
ORE5	20	9	16	16	15	15	15	14	13	14	14	14	15	15
ORE6	20	15	13	16	19	15	15	15	15	12	11	13	14	14
ORE7	20	14	16	16	18	20	11	14	15	15	15	14	15	15
ORE8	20	14	15	13	19	20	10	13	14	15	13	14	13	13
ORE9	5	-	6	9	9	20	15	5	-	11	13	15	15	15
ORE10	19	17	7	14	6	6	9	20	16	12	12	13	15	15
SSL1	20	20	16	14	13	20	n/a	17	17	16	16	14	15	15
SSL2	20	20	18	19	14	19	n/a	19	18	16	16	15	16	16
SSL3	20	20	16	15	11	19	n/a	14	14	14	15	14	14	14
SSL4	20	18	16	19	13	20	n/a	16	15	12	13	13	15	15
SSL5	20	16	16	15	9	18	n/a	7	6	2	2	0	6	6

Table 23. continued.

	Frequency Riffles & Bends							Left Bank Stability						
	2006	2005	2004	2003	2002	2001	2000	2006	2005	2004	2003	2002	2001	2000
DLP1	12	11	13	15	15	18	n/a	3	7	6	5	5	7	n/a
DLP2	6	11	7	10	12	7	n/a	6	7	6	4	3	2	n/a
DLP3	15	13	10	11	14	7	n/a	8	6	6	8	7	6	n/a
DLP4	5	0	8	6	8	2	n/a	2	0	7	5	6	5	n/a
DLP5	16	10	11	11	9	15	n/a	7	7	6	8	7	7	n/a
ORE1	9	6	7	5	4	15	5	2	5	5	5	6	8	1
ORE2	4	0	10	8	11	12	17	3	3	5	6	6	5	1
ORE3	12	11	7	6	7	15	18	1	3	5	3	3	3	7
ORE4	11	12	9	10	6	11	10	7	6	6	6	4	4	5
ORE5	5	11	15	11	16	16	18	5	6	6	6	7	6	7
ORE6	12	13	11	9	15	15	8	6	4	7	8	8	8	8
ORE7	8	14	13	12	7	16	10	8	8	8	7	7	8	4
ORE8	9	10	11	13	11	10	15	3	5	2	5	4	8	7
ORE9	3	-	4	10	9	15	10	3	-	6	3	7	8	9
ORE10	16	16	8	12	11	13	16	9	4	4	3	4	5	7
SSL1	13	5	7	4	7	15	n/a	4	5	2	3	5	7	n/a
SSL2	10	4	4	5	1	7	n/a	8	9	7	10	8	9	n/a
SSL3	9	4	2	5	2	8	n/a	7	8	6	6	6	8	n/a
SSL4	13	2	2	6	5	11	n/a	3	2	1	0	2	5	n/a
SSL5	2	0	0	0	0	6	n/a	3	0	1	0	0	1	n/a

Table 23. continued.

	Right Bank Stability							Left Bank Vegetative Protection						
	2006	2005	2004	2003	2002	2001	2000	2006	2005	2004	2003	2002	2001	2000
DLP1	4	7	7	6	5	8	n/a	5	7	8	5	3	7	n/a
DLP2	7	0	4	2	3	2	n/a	8	6	7	4	3	2	n/a
DLP3	8	6	6	6	7	4	n/a	8	6	5	5	7	6	n/a
DLP4	4	1	7	4	7	3	n/a	3	1	6	3	4	5	n/a
DLP5	9	7	4	8	7	9	n/a	5	4	3	5	5	7	n/a
ORE1	1	1	2	4	3	2	1	8	5	6	6	6	9	2
ORE2	3	3	5	6	6	6	1	2	5	6	6	6	9	2
ORE3	1	2	5	3	7	6	7	6	5	7	3	4	6	6
ORE4	7	4	4	3	2	2	5	7	6	6	4	3	5	4
ORE5	3	5	5	6	7	5	6	6	7	6	6	7	8	9
ORE6	8	7	7	7	8	8	8	7	4	6	6	6	6	9
ORE7	5	7	6	6	6	6	5	6	6	3	6	7	6	6
ORE8	7	5	5	7	6	8	9	6	6	5	5	7	6	7
ORE9	3	-	6	3	8	8	9	5	-	4	3	7	7	8
ORE10	9	4	4	2	4	6	7	7	4	2	1	4	4	3
SSL1	4	6	6	3	3	6	n/a	7	7	3	3	6	8	n/a
SSL2	7	8	7	6	8	9	n/a	9	8	8	8	7	7	n/a
SSL3	7	7	6	7	6	8	n/a	7	7	7	6	7	6	n/a
SSL4	6	6	6	6	7	6	n/a	3	6	3	3	4	4	n/a
SSL5	3	0	1	0	0	1	n/a	2	0	1	0	0	1	n/a

Table 23. continued.

	Right Bank Vegetative Protection							Left Bank Riparian Zone						
	2006	2005	2004	2003	2002	2001	2000	2006	2005	2004	2003	2002	2001	2000
DLP1	6	7	8	5	4	8	n/a	6	4	5	2	1	5	n/a
DLP2	5	0	3	1	3	2	n/a	4	3	3	3	1	1	n/a
DLP3	8	6	5	3	7	6	n/a	4	3	2	3	4	3	n/a
DLP4	3	1	6	3	4	3	n/a	0	1	1	2	1	4	n/a
DLP5	5	4	3	4	5	7	n/a	8	5	7	6	6	8	n/a
ORE1	5	4	4	6	6	7	2	6	5	6	6	4	8	5
ORE2	2	5	6	6	6	9	2	6	4	6	5	5	8	5
ORE3	6	3	6	6	7	4	6	3	3	5	2	1	3	3
ORE4	7	6	6	4	3	3	4	3	5	6	3	2	3	4
ORE5	8	8	6	6	7	8	8	5	5	5	6	4	5	8
ORE6	6	6	6	6	6	5	8	6	3	5	5	5	3	6
ORE7	9	8	4	8	7	9	9	3	5	3	4	4	3	3
ORE8	6	6	5	6	7	6	7	3	3	2	2	4	3	6
ORE9	5	-	4	3	7	7	8	3	-	4	3	3	5	7
ORE10	7	4	2	1	4	3	3	8	5	3	3	6	3	3
SSL1	6	7	6	3	6	6	n/a	7	8	6	6	8	9	n/a
SSL2	6	6	4	6	7	7	n/a	9	8	8	10	8	9	n/a
SSL3	7	6	7	6	7	6	n/a	4	3	2	3	4	8	n/a
SSL4	6	7	4	7	6	4	n/a	5	3	1	1	4	3	n/a
SSL5	2	0	1	0	0	1	n/a	2	0	1	1	0	0	n/a

Table 23. continued.

	Right Bank Riparian Zone							Total Score						
	2006	2005	2004	2003	2002	2001	2000	2006	2005	2004	2003	2002	2001	2000
DLP1	6	4	5	3	3	7	n/a	109	124	136	128	111	140	n/a
DLP2	3	0	3	3	1	1	n/a	114	109	105	107	89	89	n/a
DLP3	4	3	2	4	4	4	n/a	134	124	101	106	116	89	n/a
DLP4	0	1	1	2	1	4	n/a	57	15	91	75	79	59	n/a
DLP5	8	5	7	5	6	8	n/a	151	135	90	124	103	132	n/a
ORE1	4	4	6	3	4	8	3	78	87	80	92	77	128	74
ORE2	6	3	6	3	3	6	5	66	84	101	103	120	141	104
ORE3	3	3	5	4	4	3	3	73	92	113	92	101	140	137
ORE4	3	3	6	5	2	3	5	119	99	114	109	94	127	129
ORE5	4	4	5	5	3	5	8	118	110	119	114	128	142	158
ORE6	3	3	5	3	4	2	4	131	114	119	105	121	134	124
ORE7	9	6	3	5	4	6	6	123	128	119	124	119	149	116
ORE8	6	3	2	4	5	3	6	113	102	105	110	125	133	128
ORE9	3	-	4	3	5	5	8	35	-	90	80	116	131	141
ORE10	8	5	3	3	6	3	3	155	124	74	94	91	83	112
SSL1	7	7	6	3	8	9	n/a	94	105	93	70	85	119	n/a
SSL2	6	8	8	8	8	9	n/a	108	109	93	106	92	115	n/a
SSL3	5	5	2	5	5	5	n/a	93	93	84	87	74	100	n/a
SSL4	6	5	1	6	4	3	n/a	98	83	64	81	73	91	n/a
SSL5	2	0	1	1	0	0	n/a	56	24	31	23	18	39	n/a

Table 24a. Trends over years for physical habitat metrics from Del Puerto Creek.

Metric	2001	2002	2003	2004	2005	2006	trend	trend p-value
Epifaunal Substrate	6.80	8.60	12.20	10.60	9.40	8.20	0.07	0.7828
Embeddedness	8.00	7.80	10.20	8.80	10.00	8.60	0.18	0.6112
Velocity depth	11.00	10.00	11.80	9.20	10.20	11.20	-0.23	0.5042
Sediment deposition	10.80	11.00	12.20	11.20	11.60	11.40	0.03	0.9290
Channel flow	13.40	12.00	13.20	12.80	16.20	18.00	0.59	0.0852
Channel alteration	11.80	12.60	12.40	13.20	11.20	13.40	0.11	0.7977
Riffles and bends	9.80	11.60	10.60	9.80	9.00	10.80	-0.19	0.6125
Bank stability	10.60	11.40	11.20	11.80	9.60	11.60	0.07	0.8579
Vegetative protection	10.60	9.00	7.60	10.80	8.40	11.20	0.07	0.8164
Riparian vegetative zone	9.00	5.60	6.60	6.40	5.80	8.60	0.04	0.9161
Total score	101.80	99.60	108.00	104.60	101.40	113.00	0.74	0.7840

Table 24b. Trends over sites for physical habitat metrics from Del Puerto Creek.

Metric	site 1	site 2	site 3	site 4	site 5	trend	trend p-value
Epifaunal Substrate	11.17	10.17	9.33	6.50	9.33	-0.73	0.0701
Embeddedness	10.17	9.17	7.33	5.83	12.00	0.03	0.9486
Velocity depth	13.67	13.17	11.00	5.83	9.17	-1.63	0.0043*
Sediment deposition	11.67	13.67	11.33	7.33	12.83	-0.40	0.4112
Channel flow	17.17	16.83	16.33	8.00	13.00	-1.72	0.0022*
Channel alteration	14.33	11.33	13.00	6.00	17.50	0.10	0.8779
Riffles and bends	14.00	8.83	11.67	4.83	12.00	-0.80	0.1711
Bank stability	11.67	7.67	13.00	8.50	14.33	0.62	0.2738
Vegetative protection	12.17	7.33	12.00	7.00	9.50	-0.57	0.2513
Riparian vegetative zone	8.67	4.00	6.67	2.83	12.83	0.72	0.2303
Total score	124.67	102.17	111.67	62.67	122.50	-4.38	0.2856

* $p < 0.05$

Table 24c. Trends over years for physical habitat metrics from Orestimba Creek.

Metric	2000	2001	2002	2003	2004	2005	2006	trend	trend p-value
Epifaunal Substrate	11.70	12.10	9.10	10.00	9.40	11.00	7.00	-0.26	0.1699
Embeddedness	11.40	12.90	9.80	7.90	9.50	7.67	7.30	-0.60	0.0234*
Velocity depth	12.10	15.50	9.60	9.20	10.10	9.56	8.40	-0.68	0.0040*
Sediment deposition	11.90	11.00	12.80	10.80	10.60	10.00	6.20	-0.14	0.5772
Channel flow	14.00	17.30	14.00	14.40	12.30	14.33	18.30	-0.42	0.0672
Channel alteration	15.70	14.70	13.40	13.00	13.30	13.56	14.00	-0.36	0.0156*
Riffles and bends	12.70	13.80	9.70	9.60	9.50	10.33	8.90	-0.48	0.0340*
Bank stability	11.40	12.00	11.30	9.90	10.30	9.11	9.40	-0.29	0.2078
Vegetative protection	11.30	12.70	11.70	9.80	10.00	10.89	12.10	-0.32	0.1484
Riparian vegetative zone	10.10	8.80	7.80	7.70	9.00	8.00	9.50	-0.24	0.1800
Total score	122.30	130.80	109.20	102.30	104.00	104.44	101.10	-3.78	0.0053*

* $p < 0.05$

Table 24d. Trends over sites for physical habitat metrics from Orestimba Creek.

Metric	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9	site 10	trend p-value
Epifaunal Substrate	9.00	9.57	10.71	10.86	12.29	10.00	10.71	10.29	7.83	8.71	-0.10 .4283
Embeddedness	2.00	7.71	11.00	11.86	10.86	11.29	11.57	9.14	9.00	10.71	0.47 .0090*
Velocity depth	7.86	9.57	11.14	12.43	13.43	11.00	11.43	13.00	8.33	8.00	-0.01 .9266
Sediment deposition	3.29	6.57	9.86	13.43	12.14	12.29	13.57	12.14	9.83	11.57	0.68 .0002*
Channel flow	15.43	17.14	16.71	14.29	15.14	16.14	16.43	15.86	10.67	11.14	-0.48 .0029*
Channel alteration	15.71	14.86	11.43	13.86	14.14	13.43	14.71	13.57	12.33	15.29	-0.05 .6247
Riffles and bends	7.29	8.86	10.86	9.86	13.14	11.86	11.43	11.29	8.50	13.14	0.36 .0210*
Bank stability	6.57	8.43	8.00	9.29	11.43	14.57	13.00	11.57	12.17	10.29	0.55 .0007*
Vegetative protection	10.86	10.29	10.71	9.71	14.29	12.43	13.43	12.14	11.33	7.00	-0.07 .6391
Riparian vegetative zone	10.29	10.14	6.43	7.57	10.29	8.14	9.14	7.43	8.83	8.86	-0.09 .4296
Total score	88.29	103.14	106.86	113.14	127.14	121.14	125.43	116.43	98.83	104.71	1.25 .1651

* $p < 0.05$

Table 24e. Trends over years for physical habitat metrics from Salt Slough Creek.

Metric	2001	2002	2003	2004	2005	2006	trend	trend p-value
Epifaunal Substrate	4.60	3.20	5.40	6.60	4.20	8.00	0.49	0.0166*
Embeddedness	0.60	0.00	0.00	0.40	0.00	0.20	-0.03	0.3198
Velocity depth	9.60	7.80	6.40	7.40	9.80	3.60	-0.67	0.0376*
Sediment deposition	3.20	2.40	3.40	1.60	2.60	2.00	-0.23	0.0949
Channel flow	19.20	12.00	16.40	16.40	18.80	20.00	0.53	0.0003*
Channel alteration	13.20	11.20	12.40	12.00	14.00	14.60	0.05	0.8614
Riffles and bends	9.40	3.00	4.00	3.00	3.00	9.40	-0.17	0.4042
Bank stability	12.00	9.00	8.20	8.60	10.20	10.40	-0.31	0.4365
Vegetative protection	10.00	10.00	8.40	8.80	10.80	11.00	-0.08	0.8004
Riparian vegetative zone	11.00	9.80	8.80	8.20	9.40	10.60	-0.46	0.0836
Total score	92.80	68.40	73.40	73.00	82.80	89.80	-0.88	0.5729

* $p < 0.05$

Table 24f. Trends over sites for physical habitat metrics from Salt Slough Creek.

Metric	site 1	site 2	site 3	site 4	site 5	trend	trend p-value
Epifaunal Substrate	5.67	4.83	4.33	6.83	5.00	0.07	0.8162
Embeddedness	0.17	0.33	0.17	0.33	0.00	-0.03	0.4912
Velocity depth	10.00	8.67	9.33	8.50	0.67	-1.88	0.0004*
Sediment deposition	2.50	3.83	2.83	2.50	1.00	-0.43	0.0362*
Channel flow	17.17	18.33	16.83	17.67	15.67	-0.37	0.0663
Channel alteration	15.83	16.67	14.17	14.00	3.83	-2.67	0.0000*
Riffles and bends	8.50	5.17	5.00	6.50	1.33	-1.30	0.0004*
Bank stability	9.00	16.00	13.67	8.33	1.67	-2.23	0.0010*
Vegetative protection	11.33	13.83	13.17	9.50	1.33	-2.43	0.0000*
Riparian vegetative zone	14.17	16.17	9.00	7.50	1.33	-3.43	0.0000*
Total score	94.33	103.83	88.50	81.67	31.83	-14.72	0.0000*

* $p < 0.05$

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)
Caenis sp.	ORE 10	1	>3.0[A]
Chironomus sp.	DLP 2	4	0.07[B]
Chironomus sp.	ORE 2	1	0.07[B]
Chironomus sp.	ORE 5	2	0.07[B]
Chironomus sp.	ORE 6	1	0.07[B]
Chironomus sp.	ORE 9	57	0.07[B]
Chironomus sp.	SSL 1	3	0.07[B]
Chironomus sp.	SSL 2	4	0.07[B]
Chironomus sp.	SSL 3	1	0.07[B]
Chironomus sp.	SSL 4	14	0.07[B]
Chironomus sp.	SSL 5	13	0.07[B]
Cricotopus sp.	DLP 2	55	3.5-90
Cricotopus sp.	DLP 3	94	3.5-90
Cricotopus sp.	DLP 4	174	3.5-90
Cricotopus sp.	DLP 5	17	3.5-90
Cricotopus sp.	ORE 3	5	3.5-90
Cricotopus sp.	ORE 5	6	3.5-90
Cricotopus sp.	ORE 6	12	3.5-90
Cricotopus sp.	ORE 7	59	3.5-90
Cricotopus sp.	ORE 8	50	3.5-90
Cricotopus sp.	ORE 9	37	3.5-90
Cricotopus sp.	ORE 10	16	3.5-90
Cricotopus sp.	SSL 1	100	3.5-90
Cricotopus sp.	SSL 2	2	3.5-90
Cricotopus sp.	SSL 3	10	3.5-90
Cricotopus sp.	SSL 4	9	3.5-90

Table 26. continued.

Culicoides sp.	ORE 4	2	0.5-1[C]
Culicoides sp.	SSL 5	4	0.5-1[C]
Dicrotendipes sp.	DLP 2	15	7-40[D]
Dicrotendipes sp.	DLP 3	16	7-40[D]
Dicrotendipes sp.	DLP 4	39	7-40[D]
Dicrotendipes sp.	ORE 4	1	7-40[D]
Dicrotendipes sp.	ORE 8	15	7-40[D]
Dicrotendipes sp.	ORE 9	31	7-40[D]
Dicrotendipes sp.	ORE 10	11	7-40[D]
Dicrotendipes sp.	SSL 1	10	7-40[D]
Dicrotendipes sp.	SSL 2	2	7-40[D]
Dicrotendipes sp.	SSL 3	6	7-40[D]
Dicrotendipes sp.	SSL 4	13	7-40[D]
Dicrotendipes sp.	SSL 5	17	7-40[D]
Dugesia tigrina	DLP 1	1	2.0-4.3[E]
Dugesia tigrina	DLP 2	7	2.0-4.3[E]
Dugesia tigrina	DLP 3	9	2.0-4.3[E]
Dugesia tigrina	DLP 5	3	2.0-4.3[E]
Dugesia tigrina	ORE 7	6	2.0-4.3[E]
Dugesia tigrina	ORE 9	1	2.0-4.3[E]
Dugesia tigrina	ORE 10	10	2.0-4.3[E]
Dugesia tigrina	SSL 5	9	2.0-4.3[E]
Enallagma sp.	SSL 3	3	11.4[F]
Enallagma sp.	SSL 5	11	11.4[F]
Gammarus sp.	DLP 1	2	0.11[G]
Gammarus sp.	DLP 3	2	0.11[G]
Gammarus sp.	ORE 7	1	0.11[G]
Gammarus sp.	ORE 8	2	0.11[G]

Table 26. continued.

Gammarus sp.	ORE 8	2	0.11[G]
Gammarus sp.	SSL 2	3	0.11[G]
Gammarus sp.	SSL 3	9	0.11[G]
Hyalella sp.	DLP 5	13	1.3
Hyalella sp.	ORE 4	1	1.3
Hyalella sp.	ORE 6	18	1.3
Hyalella sp.	ORE 7	18	1.3
Hyalella sp.	SSL 4	2	1.3
Hyalella sp.	SSL 5	24	1.3
Hydropsyche californica	DLP 1	1	30.6[H]
Hydropsyche californica	ORE 4	10	30.6[H]
Hydropsyche californica	ORE 5	15	30.6[H]
Hydropsyche californica	ORE 6	1	30.6[H]
Hydropsyche californica	ORE 7	4	30.6[H]
Hydropsyche californica	ORE 8	7	30.6[H]
Hydropsyche californica	SSL 1	2	30.6[H]
Hydropsyche californica	SSL 4	1	30.6[H]
Ischnura sp.	ORE 4	1	11.4[F]
Ischnura sp.	SSL 3	2	11.4[F]
Ischnura sp.	SSL 4	1	11.4[F]
Limnodrilus hoffmeisteri	DLP 1	8	>36
Limnodrilus hoffmeisteri	ORE 1	96	>36
Limnodrilus hoffmeisteri	ORE 2	66	>36
Limnodrilus hoffmeisteri	ORE 3	19	>36
Limnodrilus hoffmeisteri	ORE 5	1	>36
Limnodrilus hoffmeisteri	ORE 6	3	>36
Limnodrilus hoffmeisteri	SSL 1	5	>36
Limnodrilus hoffmeisteri	SSL 2	10	>36

Table 26. continued.

Limnodrilus hoffmeisteri	SSL 3	9	>36
Limnodrilus hoffmeisteri	SSL 4	4	>36
Limnodrilus hoffmeisteri	SSL 5	11	>36
Paratanytarsus sp.	DLP 2	8	<1.6
Paratanytarsus sp.	DLP 3	2	<1.6
Paratanytarsus sp.	DLP 4	131	<1.6
Paratanytarsus sp.	DLP 5	18	<1.6
Paratanytarsus sp.	ORE 2	1	<1.6
Paratanytarsus sp.	ORE 6	2	<1.6
Paratanytarsus sp.	ORE 7	13	<1.6
Paratanytarsus sp.	ORE 9	56	<1.6
Paratanytarsus sp.	ORE 10	9	<1.6
Paratanytarsus sp.	SSL 1	2	<1.6
Paratanytarsus sp.	SSL 2	2	<1.6
Paratanytarsus sp.	SSL 3	4	<1.6
Paratanytarsus sp.	SSL 4	13	<1.6
Paratanytarsus sp.	SSL 5	11	<1.6
Peltodytes sp.	DLP 4	3	0.8
Peltodytes sp.	DLP 5	10	0.8
Peltodytes sp.	ORE 10	1	0.8
Simulium sp.	DLP 1	3	27[I]
Simulium sp.	DLP 2	9	27[I]
Simulium sp.	DLP 3	140	27[I]
Simulium sp.	DLP 5	71	27[I]
Simulium sp.	ORE 4	1	27[I]
Simulium sp.	ORE 5	1	27[I]
Simulium sp.	ORE 6	5	27[I]
Simulium sp.	ORE 7	8	27[I]

Table 26. continued.

Simulium sp.	ORE 8	43	27[I]
Simulium sp.	ORE 9	1	27[I]
Simulium sp.	ORE 10	56	27[I]
Simulium sp.	SSL 1	1	27[I]
Tanypus sp.	DLP 4	1	1.5[J]
Tanypus sp.	ORE 9	1	1.5[J]
Tanypus sp.	SSL 1	3	1.5[J]
Tanypus sp.	SSL 2	2	1.5[J]
Tanypus sp.	SSL 3	14	1.5[J]
Tanypus sp.	SSL 5	5	1.5[J]

[A] Listed toxicity value was for *Caenis horaria.*
[B] Listed toxicity value was for *Chironomus tentans.*
[C] Listed toxicity value was for *Culicoides variipennis.*
[D] Listed toxicity value was for *Dicrotendipes californicus.*
[E] Listed toxicity value was for *Dugesia dorotocephala.*
[F] Listed toxicity value was for *Enallagma/Ischnura sp.*
[G] Listed toxicity value was for *Gammarus lacustris*. 2 values listed for this species. Used conservative value, other value = 0.76 μg/L.
[H] Listed toxicity value was for *Hydropsyche/Cheumatopsyche sp.*
[I] Listed toxicity value was for *Simulium vitattum.*
[J] 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	19	24[A]
Baetis sp.	ORE 10	34	24[A]
Baetis tricaudatus	DLP 5	205	24[A]
Baetis tricaudatus	ORE 4	1	24[A]
Gammarus sp.	DLP 1	2	184[B]
Gammarus sp.	DLP 3	2	184[B]
Gammarus sp.	ORE 7	1	184[B]
Gammarus sp.	ORE 8	2	184[B]
Gammarus sp.	ORE 9	2	184[B]
Gammarus sp.	SSL 2	3	184[B]
Gammarus sp.	SSL 3	9	184[B]
Hyalella sp.	DLP 5	13	22[C]
Hyalella sp.	ORE 4	1	22[C]
Hyalella sp.	ORE 6	18	22[C]
Hyalella sp.	ORE 7	18	22[C]
Hyalella sp.	SSL 4	2	22[C]
Hyalella sp.	SSL 5	24	22[C]
Physa sp.	DLP 1	1	48[D]
Physa sp.	DLP 2	101	48[D]
Physa sp.	DLP 3	94	48[D]
Physa sp.	DLP 4	102	48[D]
Physa sp.	DLP 5	13	48[D]
Physa sp.	ORE 2	2	48[D]
Physa sp.	ORE 4	1	48[D]
Physa sp.	ORE 5	13	48[D]
Physa sp.	ORE 6	8	48[D]
Physa sp.	ORE 7	1	48[D]
Physa sp.	ORE 8	2	48[D]
Physa sp.	ORE 9	166	48[D]

Table 27. continued.

Physa sp.	SSL 3	1	48[D]
Physa sp.	SSL 4	3	48[D]
Physa sp.	SSL 5	29	48[D]
Undetermined Tubificidae	DLP 1	98	3160[E]
Undetermined Tubificidae	DLP 2	3	3160[E]
Undetermined Tubificidae	DLP 3	1	3160[E]
Undetermined Tubificidae	DLP 4	6	3160[E]
Undetermined Tubificidae	DLP 5	1	3160[E]
Undetermined Tubificidae	ORE 1	467	3160[E]
Undetermined Tubificidae	ORE 2	3	3160[E]
Undetermined Tubificidae	ORE 3	462	3160[E]
Undetermined Tubificidae	ORE 4	177	3160[E]
Undetermined Tubificidae	ORE 5	22	3160[E]
Undetermined Tubificidae	ORE 6	58	3160[E]
Undetermined Tubificidae	ORE 7	67	3160[E]
Undetermined Tubificidae	ORE 8	27	3160[E]
Undetermined Tubificidae	ORE 9	5	3160[E]
Undetermined Tubificidae	ORE 10	188	3160[E]
Undetermined Tubificidae	SSL 1	45	3160[E]
Undetermined Tubificidae	SSL 2	108	3160[E]
Undetermined Tubificidae	SSL 3	37	3160[E]
Undetermined Tubificidae	SSL 4	57	3160[E]
Undetermined Tubificidae	SSL 5	80	3160[E]
Tubificidae with hair	DLP 1	3	3160[E]
Tubificidae with hair	ORE 1	9	3160[E]
Tubificidae with hair	ORE 2	3	3160[E]
Tubificidae with hair	ORE 3	11	3160[E]
Tubificidae with hair	ORE 5	7	3160[E]
Tubificidae with hair	ORE 9	1	3160[E]
Tubificidae with hair	ORE 10	2	3160[E]
Tubificidae with hair	SSL 1	3	3160[E]

Table 27. continued.

Tubificidae with hair	SSL 2	22	3160[E]
Tubificidae with hair	SSL 3	74	3160[E]
Tubificidae with hair	SSL 4	95	3160[E]

[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 *Tubifex* species.

Table 28a. Trends over years for biological metrics from Del Puerto Creek.

Metric	2001	2002	2003	2004	2005	2006	trend	trend p-value
Abundance	866.33	1361.27	2691.93	1494.80	2566.07	738.00	79.68	0.4876
EPT Index (%)	0.06	0.01	0.02	0.01	0.04	12.00	1.41	0.0494*
EPT Taxa	1.07	0.73	1.40	1.00	1.20	2.20	0.21	0.1051
Number Ephemeroptera Taxa	0.80	0.47	0.93	1.00	1.00	1.60	0.17	0.0489*
Number Plecoptera Taxa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.
Number Trichoptera Taxa	0.27	0.27	0.47	0.00	0.20	0.60	0.04	0.4427
Percent Collector-Filterers	0.15	0.05	0.30	0.27	0.20	16.60	1.78	0.0000*
Percent Collectors-Gatherers	0.25	0.61	0.51	0.44	0.56	62.00	6.61	0.0000*
Percent Dominant Taxon	0.30	0.38	0.44	0.54	0.34	28.80	2.98	0.0000*
Percent Intolerant Taxa (0-2)	0.00	0.00	0.00	0.00	0.01	0.40	0.05	0.1098
Percent Predators	0.17	0.11	0.05	0.07	0.06	7.60	0.77	0.0000*
Percent Scrapers	0.04	0.11	0.07	0.21	0.15	12.40	1.35	0.0004*
Percent Shredders	0.03	0.00	0.00	0.00	0.00	0.00	-0.00	0.0030*
Percent Tolerant Taxa (8-10)	0.51	0.43	0.46	0.50	0.50	47.00	4.93	0.0000*
Sensitive EPT Index (%)	0.00	0.00	0.00	0.00	0.00	0.20	0.03	0.1143
Shannon Diversity	2.19	2.04	1.81	1.64	2.15	2.40	0.02	0.5639
Taxonomic Richness	21.00	20.13	18.80	18.13	22.67	37.00	1.96	0.0020*
Tolerance Value	7.00	7.07	6.89	7.19	7.35	7.14	0.04	0.4925

* $p < 0.05$

Table 28b. Trends over sites for biological metrics from Del Puerto Creek.

Metric	site 1	site 2	site 3	site 4	site 5	trend	trend p-value
Abundance	968.50	993.56	1911.89	839.94	3384.78	467.89	0.0115*
EPT Index (%)	1.84	0.17	0.34	0.00	7.77	1.17	0.2642
EPT Taxa	0.67	0.72	0.50	0.22	4.22	0.66	0.0019*
Number Ephemeroptera Taxa	0.50	0.72	0.50	0.22	2.89	0.43	0.0023*
Number Plecoptera Taxa	0.00	0.00	0.00	0.00	0.00	0.00	.
Number Trichoptera Taxa	0.17	0.00	0.00	0.00	1.33	0.23	0.0053*
Percent Collector-Filterers	2.85	2.60	3.24	2.87	3.09	0.07	0.4257
Percent Collectors-Gatherers	12.30	9.90	9.38	10.10	11.96	-0.05	0.9079
Percent Dominant Taxon	7.79	4.18	5.04	4.32	4.34	-0.68	0.1705
Percent Intolerant Taxa (0-2)	0.00	0.00	0.00	0.00	0.35	0.07	0.1452
Percent Predators	2.10	1.45	1.22	0.87	1.08	-0.26	0.0647
Percent Scrapers	0.04	3.23	3.22	3.36	0.96	0.20	0.6936
Percent Shredders	0.01	0.00	0.01	0.00	0.00	-0.00	0.3564
Percent Tolerant Taxa (8-10)	9.22	8.92	8.30	7.58	7.14	-0.55	0.0375*
Sensitive EPT Index (%)	0.00	0.00	0.00	0.00	0.17	0.03	0.1450
Shannon Diversity	2.17	2.06	1.95	1.86	2.15	-0.02	0.6683
Taxonomic Richness	22.28	23.56	21.44	18.28	29.22	0.86	0.3210
Tolerance Value	7.30	6.68	7.38	7.42	6.75	-0.04	0.6992

* $p < 0.05$

Table 28c. Trends over years for biological metrics from Orestimba Creek.

Metric	2000	2001	2002	2003	2004	2005	2006	trend	trend p-value
Abundance	454.10	590.13	1359.93	1365.97	1208.00	1027.15	530.10	165.13	0.0244*
EPT Index (%)	0.02	0.04	0.01	0.03	0.08	0.21	4.10	0.06	0.6777
EPT Taxa	0.80	1.00	0.87	1.27	1.13	1.44	2.60	0.16	0.0800
Number Ephemeroptera Taxa	0.47	0.57	0.40	0.63	0.23	0.70	1.30	0.06	0.4169
Number Plecoptera Taxa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.
Number Trichoptera Taxa	0.33	0.43	0.47	0.63	0.90	0.74	1.30	0.10	0.0254*
Percent Collector-Filterers	0.07	0.23	0.24	0.10	0.16	0.27	15.80	0.10	0.7523
Percent Collectors-Gatherers	0.76	0.58	0.57	0.71	0.54	0.55	69.90	-0.17	0.6857
Percent Dominant Taxon	0.44	0.31	0.35	0.25	0.33	0.36	36.50	-0.21	0.6527
Percent Intolerant Taxa (0-2)	0.00	0.01	0.01	0.01	0.01	0.01	0.70	0.01	0.7830
Percent Predators	0.12	0.14	0.10	0.04	0.14	0.11	9.50	0.01	0.9319
Percent Scrapers	0.03	0.04	0.07	0.11	0.13	0.04	3.90	0.04	0.7735
Percent Shredders	0.00	0.00	0.00	0.00	0.00	0.00	0.20	-0.00	0.9973
Percent Tolerant Taxa (8-10)	0.54	0.47	0.47	0.46	0.44	0.47	49.20	-0.08	0.7392
Sensitive EPT Index (%)	0.00	0.01	0.00	0.01	0.00	0.02	0.60	0.01	0.7659
Shannon Diversity	1.84	2.28	2.17	2.39	2.31	2.12	2.32	0.04	0.1373
Taxonomic Richness	16.73	22.27	20.30	22.90	23.00	20.67	32.70	0.73	0.0550
Tolerance Value	8.10	7.18	7.15	7.22	6.85	6.48	7.89	-0.23	0.0004*

* $p < 0.05$

Table 28d. Trends over sites for biological metrics from Orestimba Creek.

Metric	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9	site 10	trend p-value
Abundance	281.43	211.29	205.38	628.67	468.24	675.57	848.38	1529.90	1975.94	2647.00	249.41 .0000*
EPT Index (%)	0.02	0.00	0.06	1.30	0.94	0.32	0.33	0.44	0.00	2.98	0.16 .1195
EPT Taxa	0.33	0.00	0.62	1.38	1.14	1.71	1.57	1.29	0.06	4.71	0.28 .0000*
Number Ephemeroptera Taxa	0.19	0.00	0.05	0.52	0.19	0.52	0.33	0.24	0.00	4.00	0.22 .0001*
Number Plecoptera Taxa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00 .
Number Trichoptera Taxa	0.14	0.00	0.57	0.86	0.95	1.19	1.24	1.05	0.06	0.71	0.06 .0375*
Percent Collector-Filterers	0.37	0.28	0.95	5.52	1.43	0.96	2.40	5.80	3.21	3.62	0.38 .0914
Percent Collectors-Gatherers	13.08	13.04	13.78	6.91	11.00	12.44	11.13	8.16	9.62	7.26	-0.62 .0319*
Percent Dominant Taxon	9.54	9.83	9.69	3.93	3.87	3.83	4.13	3.97	4.26	2.56	-0.83 .0108*
Percent Intolerant Taxa (0-2)	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.06	0.06 .0985
Percent Predators	1.65	1.62	0.20	2.22	1.51	0.97	1.14	0.98	0.72	3.58	0.07 .5311
Percent Scrapers	0.04	0.18	0.04	0.30	0.90	0.45	0.45	0.19	3.94	0.23	0.15 .1485
Percent Shredders	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.14	0.00	0.00	0.00 .8160
Percent Tolerant Taxa (8-10)	8.02	7.59	10.44	6.96	7.14	7.12	7.96	8.11	7.96	4.14	-0.30 .0769
Sensitive EPT Index (%)	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.77	0.04 .1114
Shannon Diversity	2.14	2.15	2.16	2.09	2.32	2.31	2.25	2.23	1.84	2.51	0.01 .4763
Taxonomic Richness	20.48	20.19	18.24	22.86	25.48	24.81	21.19	21.76	20.67	30.86	0.67 .0101*
Tolerance Value	8.16	7.99	7.74	6.68	7.38	7.21	6.39	6.87	8.17	6.35	-0.14 .0016*

* $p < 0.05$

Table 28e. Trends over years for biological metrics from Salt Slough Creek.

Metric	2001	2002	2003	2004	2005	2006	trend	trend p-value
Abundance	402.13	1228.07	763.67	965.47	1061.87	507.80	15.54	0.8164
EPT Index (%)	0.03	0.02	0.03	0.04	0.01	1.00	0.09	0.0366*
EPT Taxa	0.93	0.67	0.93	0.87	0.53	1.40	0.02	0.6739
Number Ephemeroptera Taxa	0.07	0.20	0.00	0.20	0.07	0.60	0.06	0.0171*
Number Plecoptera Taxa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.
Number Trichoptera Taxa	0.87	0.47	0.93	0.67	0.47	0.80	-0.05	0.2573
Percent Collector-Filterers	0.28	0.38	0.46	0.38	0.45	7.00	0.69	0.0006*
Percent Collectors-Gatherers	0.28	0.42	0.30	0.32	0.33	74.60	7.90	0.0000*
Percent Dominant Taxon	0.33	0.42	0.53	0.41	0.41	27.40	2.93	0.0000*
Percent Intolerant Taxa (0-2)	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.7809
Percent Predators	0.12	0.11	0.04	0.15	0.07	8.80	1.00	0.0001*
Percent Scrapers	0.11	0.08	0.19	0.15	0.14	8.40	0.90	0.0343*
Percent Shredders	0.02	0.00	0.00	0.00	0.00	0.20	0.02	0.1527
Percent Tolerant Taxa (8-10)	0.58	0.47	0.48	0.48	0.55	51.60	5.61	0.0000*
Sensitive EPT Index (%)	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.2264
Shannon Diversity	2.19	1.94	1.58	2.06	1.94	2.66	0.08	0.0042*
Taxonomic Richness	20.80	19.87	16.07	19.33	20.73	37.40	2.04	0.0000*
Tolerance Value	7.41	6.34	6.17	6.76	6.52	7.48	0.09	0.2676

* $p < 0.05$

Table 28f. Trends over sites for biological metrics from Salt Slough Creek.

Metric	site 1	site 2	site 3	site 4	site 5	trend	trend p-value
Abundance	974.78	736.11	450.78	376.50	1569.33	82.95	0.4144
EPT Index (%)	0.53	0.19	0.05	0.00	0.17	-0.09	0.1631
EPT Taxa	1.28	0.94	1.17	0.50	0.56	-0.19	0.0065*
Number Ephemeroptera Taxa	0.06	0.17	0.00	0.22	0.50	0.09	0.0208*
Number Plecoptera Taxa	0.00	0.00	0.00	0.00	0.00	0.00	.
Number Trichoptera Taxa	1.22	0.78	1.17	0.28	0.06	-0.28	0.0001*
Percent Collector-Filterers	1.05	2.36	2.68	1.11	0.26	-0.28	0.2916
Percent Collectors-Gatherers	15.35	10.74	12.74	13.02	11.68	-0.51	0.3753
Percent Dominant Taxon	4.70	4.42	4.91	3.75	6.80	0.35	0.3406
Percent Intolerant Taxa (0-2)	0.00	0.00	0.00	0.00	0.00	-0.00	0.5425
Percent Predators	0.64	0.21	1.72	2.43	2.75	0.64	0.0627
Percent Scrapers	0.12	4.36	0.03	0.72	2.34	0.08	0.8950
Percent Shredders	0.01	0.00	0.00	0.00	0.18	0.03	0.1460
Percent Tolerant Taxa (8-10)	5.75	8.02	9.86	10.81	10.69	1.27	0.0556
Sensitive EPT Index (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.4912
Shannon Diversity	1.94	1.88	1.98	2.44	2.07	0.08	0.0336*
Taxonomic Richness	20.39	20.78	23.11	25.94	21.61	0.76	0.0993
Tolerance Value	6.59	5.97	5.69	7.64	8.01	0.45	0.0010*

* $p < 0.05$

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

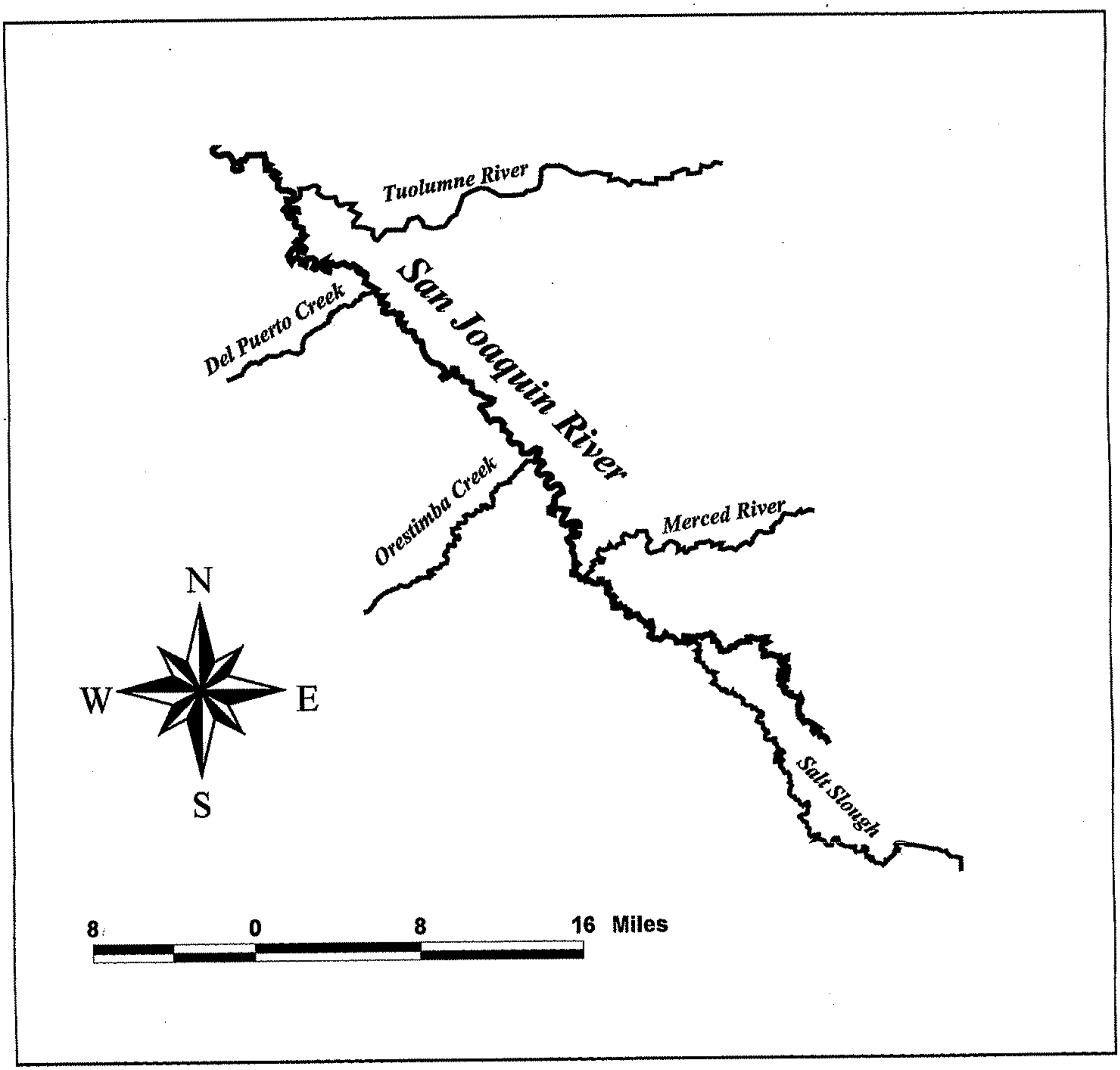
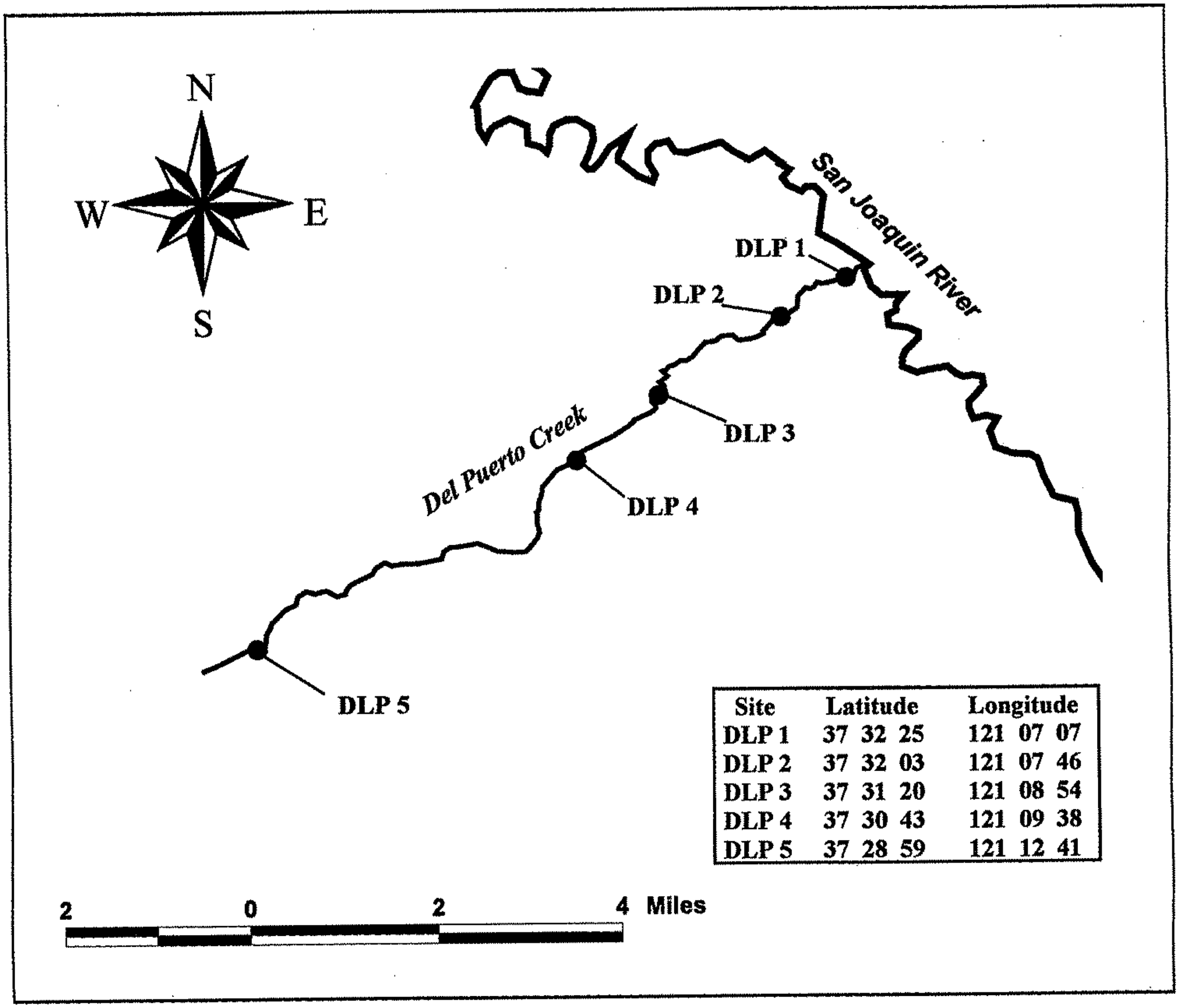
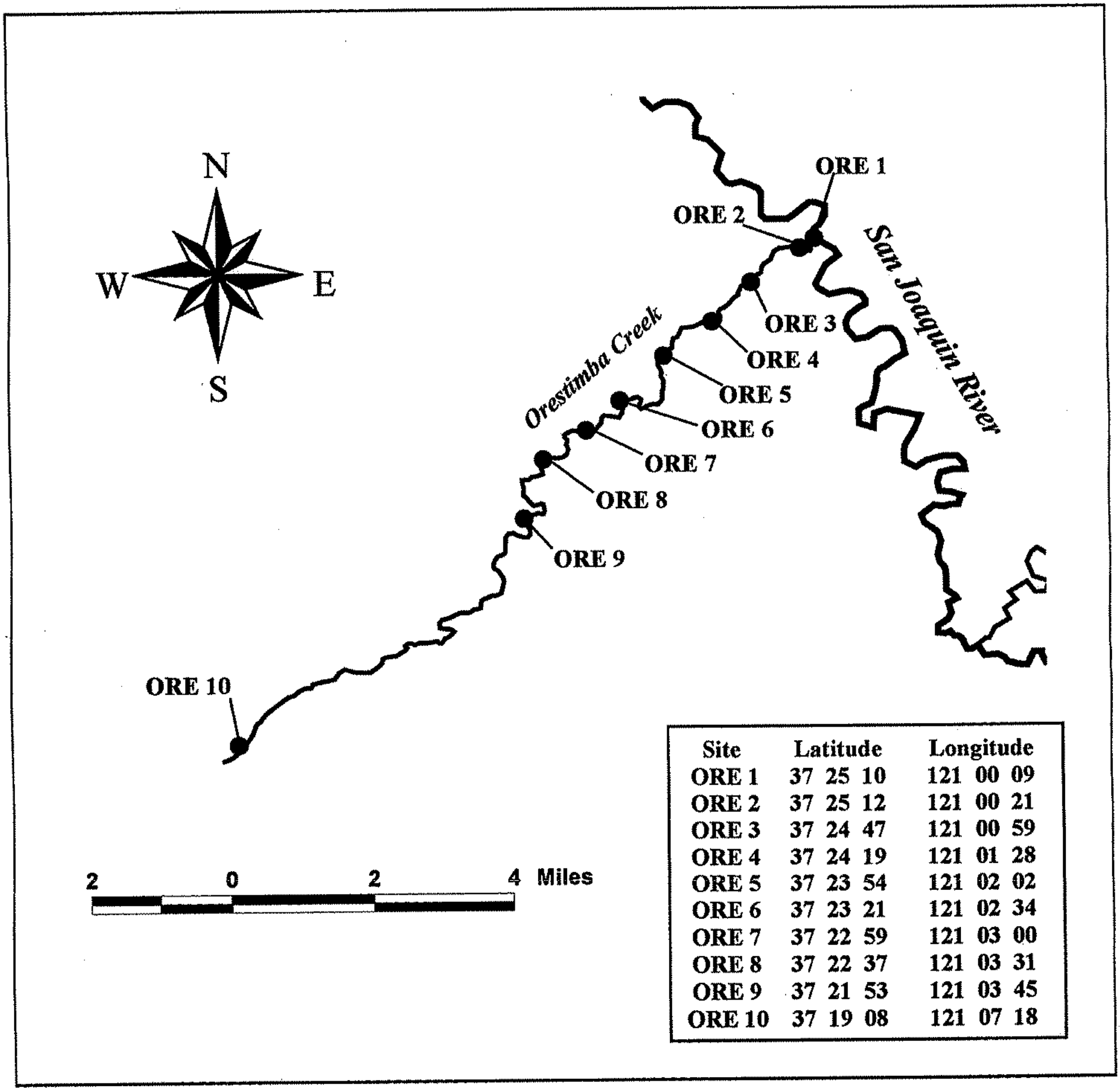


Figure 2. Del Puerto Creek sample sites.



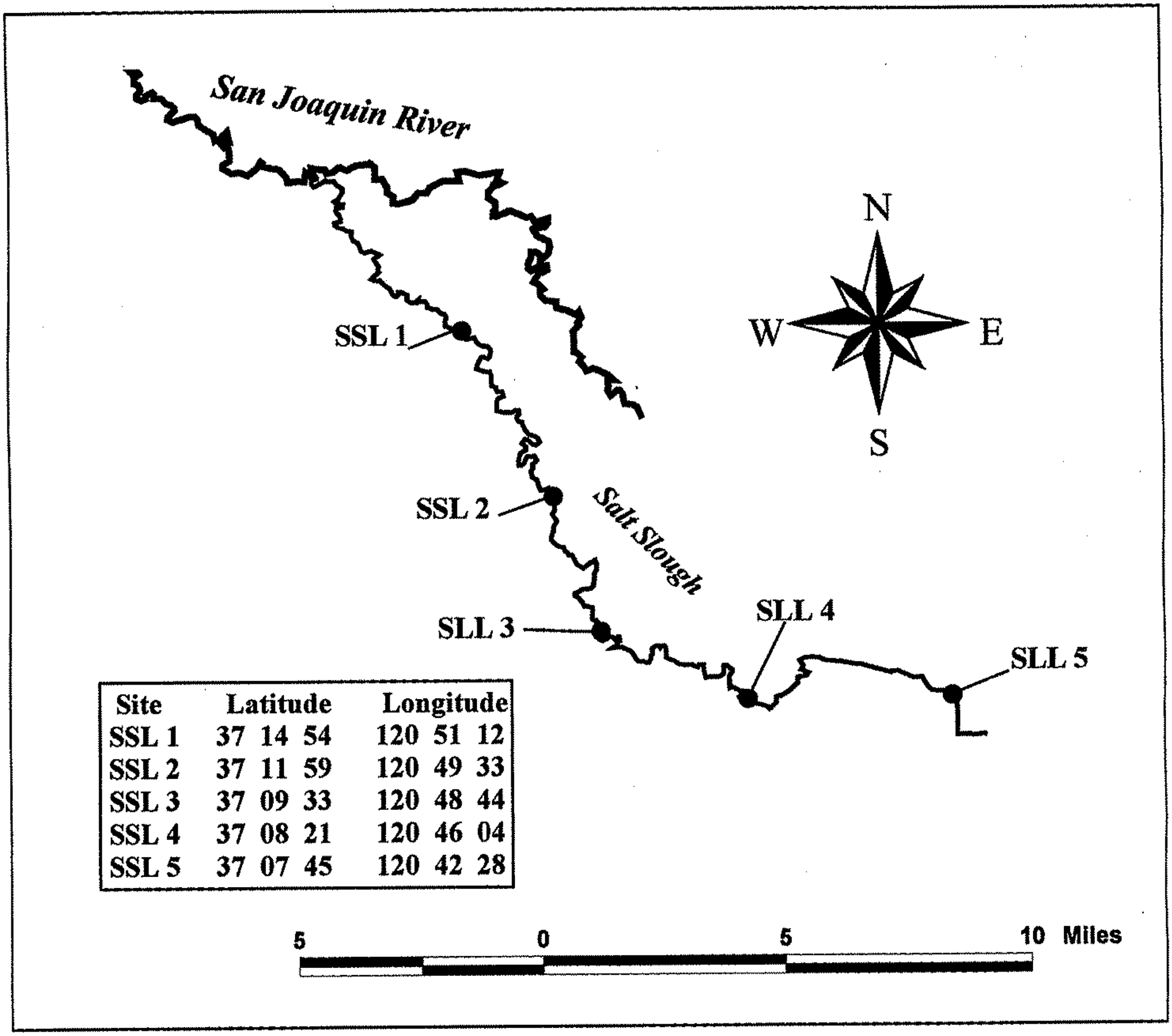
Site	Latitude	Longitude
DLP 1	37 32 25	121 07 07
DLP 2	37 32 03	121 07 46
DLP 3	37 31 20	121 08 54
DLP 4	37 30 43	121 09 38
DLP 5	37 28 59	121 12 41

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

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 Creek 1

Taxon	T1
Tubificidae unid.imm.	27
Corbicula sp.	16
Prostoma sp.	10
Fallceon quilleri	7
Simulium sp.	3
Orthocladius complex	2
Corixidae	2
Eudistylia vancouveri	2
Cladotanytarsus sp.	1
Procladius sp.	1
Hydropsyche californica	1
Procambarus clarkii	1
Erpobdella sp.	1
Tubificidae w/hair	1
Dugesia tigrina	1
	76

Taxon	T2
Fallceon quilleri	13
Corbicula sp.	6
Prostoma sp.	4
Cricotopus bicinctus group	3
Cladotanytarsus sp.	2
Nereis limnicola	2
Eudistylia vancouveri	2
Gammarus sp.	1
Erpobdella sp.	1
	34

Taxon	T3
Tubificidae unid.imm.	71
Limnodrilus hoffmeisteri	8
Corbicula sp.	8
Branchiura sowerbyi	4
Lumbricina	3
Prostoma sp.	3
Fallceon quilleri	2
Corixidae	2
Tubificidae w/hair	2
Parachironomus sp.	1
Gammarus sp.	1
Slavina appendiculata	1
Physa sp.	1
	107

	Tol Val	FFG	Total
Tubificidae unid.imm.	10	CG	98
Corbicula sp.	8	CF	30
Fallceon quilleri	4	CG	22
Prostoma sp.	8	P	17
Limnodrilus hoffmeisteri	--	CG	8
Eudistylia vancouveri	--	--	4
Corixidae	10	P	4
Branchiura sowerbyi	10	CG	4
Tubificidae w/hair	5	CG	3
Simulium sp.	6	CF	3
Lumbricina	--	CG	3
Cricotopus bicinctus group	7	CG	3
Cladotanytarsus sp.	7	CG	3
Orthocladius complex	6	CG	2
Nereis limnicola	--	--	2
Gammarus sp.	6	CG	2
Erpobdella sp.	8	P	2
Slavina appendiculata	--	CG	1
Procladius sp.	9	P	1
Procambarus clarkii	8	SH	1
Physa sp.	8	SC	1
Parachironomus sp.	10	P	1
Hydropsyche californica	4	CF	1
Dugesia tigrina	4	P	1
			217

Del Puerto Creek 2

Taxon	T1
Nais communis/ variabilis	65
Cricotopus bicinctus group	60
Physa sp.	43
Tanytarsus sp.	28
Prostoma sp.	17
Cricotopus sp.	12
Gyraulus sp.	11
Menetus opercularis	9
Cricotopus sp.	8
Simulium sp.	7
Corbicula sp.	6
Lumbricina	5
Dicrotendipes sp.	4
Eukiefferiella sp.	3
Fallceon quilleri	3
Cladotanytarsus sp.	2
Hydra sp.	2
Ceratopogonidae	1
Chironomini	1
Apedilum sp.	1
Paratanytarsus sp.	1
Eukiefferiella sp.	1
Hydrellia sp.	1
Ormosia sp.	1
Corixidae	1
Sperchon sp.	1
Tubificidae unid.imm.	1
Dugesia tigrina	1
	296

Taxon	T2
Cricotopus bicinctus group	83
Nais communis/ variabilis	70
Tanytarsus sp.	39
Prostoma sp.	17
Physa sp.	14
Menetus opercularis	9
Slavina appendiculata	7
Dicrotendipes sp.	6
Gyraulus sp.	6
Cladotanytarsus sp.	4
Paratanytarsus sp.	4
Hydra sp.	4
Dugesia tigrina	4
Chironomus sp.	3
Tanytarsus sp.	3
Corbicula sp.	3
Parachironomus sp.	2
Chironomini	2
Apedilum sp.	1
Eukiefferiella sp.	1
Eukiefferiella sp.	1
Tanypodinae	1
Psychoda sp.	1
Corixidae	1
Tubificidae unid.imm.	1
	287

Taxon	T3
Nais communis/ variabilis	56
Cricotopus bicinctus group	54
Physa sp.	44
Cricotopus sp.	26
Tanytarsus sp.	20
Gyraulus sp.	20
Prostoma sp.	13
Cricotopus sp.	9
Menetus opercularis	7
Dicrotendipes sp.	5
Corbicula sp.	4
Paratanytarsus sp.	3
Simulium sp.	2
Fallceon quilleri	2
Sperchon sp.	2
Lumbricina	2
Enchytraeidae	2
Planorbella sp.	2
Dugesia tigrina	2
Apedilum sp.	1
Chironomus sp.	1
Parachironomus sp.	1
Cladotanytarsus sp.	1
Micropsectra sp.	1
Rheotanytarsus sp.	1
Eukiefferiella sp.	1
Psectrocladius sp.	1
Cyprididae	1
Erpobdellidae	1
Tubificidae unid.imm.	1
	286

Taxon	TolVal	FFG	Total
Cricotopus bicinctus group	7	CG	197
Nais communis/ variabilis	--	CG	191
Physa sp.	8	SC	101
Tanytarsus sp.	6	CF	87
Prostoma sp.	8	P	47
Cricotopus sp.	7	CG	38
Gyraulus sp.	8	SC	37
Menetus opercularis	6	SC	25
Cricotopus sp.	--	--	17
Dicrotendipes sp.	8	CG	15
Corbicula sp.	8	CF	13
Simulium sp.	6	CF	9
Paratanytarsus sp.	6	CF	8
Cladotanytarsus sp.	7	CG	7
Dugesia tigrina	4	P	7
Lumbricina	--	CG	7
Slavina appendiculata	--	CG	7
Hydra sp.	5	P	6
Eukiefferiella sp.	8	OM	5
Fallceon quilleri	4	CG	5
Chironomus sp.	10	CG	4
Apedilum sp.	6	CG	3
Chironomini	6	CG	3
Parachironomus sp.	10	P	3
Sperchon sp.	8	P	3
Tanytarsus sp.	--	--	3
Tubificidae unid.imm.	10	CG	3
Corixidae	10	P	2
Enchytraeidae	10	CG	2
Eukiefferiella sp.	--	--	2
Planorbella sp.	6	SC	2

Del Puerto Creek 2 continued.

Taxon	T1	Taxon	T2	Taxon	T3

Taxon	TolVal	FFG	Total
Ceratopogonidae	--	--	1
Cyprididae	8	CG	1
Erpobdellidae	8	P	1
Hydrellia sp.	6	SH	1
Micropsectra sp.	7	CG	1
Ormosia sp.	3	CG	1
Psectrocladius sp.	8	CG	1
Psychoda sp.	10	CG	1
Rheotanytarsus sp.	6	CF	1
Tanypodinae	--	--	1
			869

Del Puerto Creek 3

Taxon	T1
Nais communis/ variabilis	57
Physa sp.	55
Cricotopus bicinctus group	38
Simulium sp.	36
Gyraulus sp.	18
Cricotopus sp.	17
Slavina appendiculata	8
Prostoma sp.	8
Fallceon quilleri	7
Eukiefferiella sp.	6
Menetus opercularis	6
Hydra sp.	5
Dicrotendipes sp.	4
Tanytarsus sp.	4
Corixidae	3
Parachironomus sp.	2
Ephydridae	2
Ochthebius sp.	1
Paratanytarsus sp.	1
Psectrocladius sp.	1
Cyprididae	1
Sperchon sp.	1
Stylaria lacustris	1
Tubificidae unid.imm.	1
Corbicula sp.	1
Dugesia tigrina	1
	285

Taxon	T2
Simulium sp.	77
Nais communis/ variabilis	66
Cricotopus sp.	51
Prostoma sp.	16
Physa sp.	12
Eukiefferiella sp.	11
Dicrotendipes sp.	9
Cricotopus bicinctus group	8
Gyraulus sp.	8
Dugesia tigrina	8
Fallceon quilleri	7
Menetus opercularis	4
Tanytarsus sp.	3
Ophidonais serpentina	2
Corbicula sp.	2
Paratanytarsus sp.	1
Cricotopus trifascia group	1
Corixidae	1
Coenagrionidae	1
Gammarus sp.	1
Lumbricina	1
Planorbella sp.	1
	291

Taxon	T3
Nais communis/ variabilis	122
Simulium sp.	27
Physa sp.	27
Cricotopus sp.	21
Gyraulus sp.	17
Cricotopus bicinctus group	15
Slavina appendiculata	9
Menetus opercularis	8
Cricotopus sp.	5
Fallceon quilleri	5
Prostoma sp.	4
Planariidae	4
Dicrotendipes sp.	3
Tanytarsus sp.	3
Eukiefferiella sp.	3
Enchytraeidae	3
Planorbella sp.	3
Corixidae	2
Lumbricina	2
Hydra sp.	2
Liodessus obscurellus	1
Eukiefferiella sp.	1
Corynoneura sp.	1
Thienemannimyia group	1
Gammarus sp.	1
Cyprididae	1
Lebertia sp.	1
	292

Taxon	Tol Val	FFG	Total
Nais communis/ variabilis	--	CG	245
Simulium sp.	6	CF	140
Physa sp.	8	SC	94
Cricotopus sp.	7	CG	89
Cricotopus bicinctus group	7	CG	61
Gyraulus sp.	8	SC	43
Prostoma sp.	8	P	28
Eukiefferiella sp.	8	OM	20
Fallceon quilleri	4	CG	19
Menetus opercularis	6	SC	18
Slavina appendiculata	--	CG	17
Dicrotendipes sp.	8	CG	16
Tanytarsus sp.	6	CF	10
Dugesia tigrina	4	P	9
Hydra sp.	5	P	7
Corixidae	10	P	6
Cricotopus sp.	--	--	5
Planorbella sp.	6	SC	4
Planariidae	4	P	4
Lumbricina	--	CG	3
Enchytraeidae	10	CG	3
Corbicula sp.	8	CF	3
Paratanytarsus sp.	6	CF	2
Parachironomus sp.	10	P	2
Ophidonais serpentina	--	--	2
Gammarus sp.	6	CG	2
Ephydridae	--	--	2
Cyprididae	8	CG	2

Del Puerto Creek 3 continued.

Taxon	T1	Taxon	T2	Taxon	T3

Taxon	TolVal	FFG	Total
Tubificidae unid.imm.	10	CG	1
Thienemannimyia group	6	P	1
Stylaria lacustris	--	CG	1
Sperchon sp.	8	P	1
Psectrocladius sp.	8	CG	1
Ochthebius sp.	5	SC	1
Liodessus obscurellus	5	P	1
Lebertia sp.	8	P	1
Eukiefferiella sp.	--	--	1
Cricotopus trifascia group	7	CG	1
Corynoneura sp.	7	CG	1
Coenagrionidae	--	P	1
			868

Del Puerto Creek 4

Taxon	T1
Paratanytarsus sp.	83
Cricotopus sp.	63
Nais communis/ variabilis	46
Physa sp.	32
Gyraulus sp.	17
Cyprididae	11
Dicrotendipes sp.	10
Tanytarsus sp.	3
Procladius sp.	3
Lebertia sp.	3
Peltodytes sp.	2
Apedilum sp.	2
Libellula sp.	2
Laccobius sp.	1
Tanypus sp.	1
Tubificidae unid.imm.	1
	280

Taxon	T2
Nais communis/ variabilis	100
Cricotopus sp.	50
Physa sp.	31
Paratanytarsus sp.	28
Gyraulus sp.	18
Dicrotendipes sp.	15
Cyprididae	14
Tanytarsus sp.	8
Cricotopus bicinctus group	7
Lebertia sp.	6
Apedilum sp.	3
Libellulidae	3
Nilothauma sp.	2
Cladotanytarsus sp.	2
Fossaria sp.	2
Prostoma sp.	2
Laccophilus sp.	1
Bezzia/ Palpomyia	1
Ceratopogon sp.	1
Cricotopus trifascia group	1
Procladius sp.	1
Muscidae	1
Corixidae	1
Corisella sp.	1
Tubificidae unid.imm.	1
	300

Taxon	T3
Nais communis/ variabilis	64
Cricotopus sp.	61
Physa sp.	39
Gyraulus sp.	26
Paratanytarsus sp.	20
Cyprididae	18
Dicrotendipes sp.	14
Tanytarsus sp.	8
Cladotanytarsus sp.	7
Lebertia sp.	4
Tubificidae unid.imm.	4
Thienemannimyia group	2
Procladius sp.	2
Coenagrionidae	2
Peltodytes sp.	1
Tropisternus lateralis	1
Ceratopogonidae	1
Psectrocladius sp.	1
Cricotopus bicinctus group	1
Larsia sp.	1
Tricorythodes sp.	1
Corixidae	1
Corisella sp.	1
Libellulidae	1
Mideopsis sp.	1
Erpobdellidae	1
Slavina appendiculata	1
Prostoma sp.	1
	285

Taxon	Tol Val	FFG	Total
Nais communis/ variabilis	--	CG	210
Cricotopus sp.	7	CG	174
Paratanytarsus sp.	6	CF	131
Physa sp.	8	SC	102
Gyraulus sp.	8	SC	61
Cyprididae	8	CG	43
Dicrotendipes sp.	8	CG	39
Tanytarsus sp.	6	CF	19
Lebertia sp.	8	P	13
Cladotanytarsus sp.	7	CG	9
Cricotopus bicinctus group	7	CG	8
Tubificidae unid.imm.	10	CG	6
Procladius sp.	9	P	6
Apedilum sp.	6	CG	5
Libellulidae	9	P	4
Prostoma sp.	8	P	3
Peltodytes sp.	5	MH	3
Thienemannimyia group	6	P	2
Nilothauma sp.	6	CG	2
Libellula sp.	9	P	2
Fossaria sp.	8	SC	2
Corixidae	10	P	2
Corisella sp.	8	P	2
Coenagrionidae	--	P	2
Tropisternus lateralis	5	CG	1
Tricorythodes sp.	4	CG	1
Tanypus sp.	--	--	1
Slavina appendiculata	--	CG	1
Psectrocladius sp.	8	CG	1

Del Puerto Creek 4 continued.

Taxon	T1	Taxon	T2	Taxon	T3

Taxon	TolVal	FFG	Total
Muscidae	6	P	1
Mideopsis sp.	5	P	1
Larsia sp.	6	P	1
Laccophilus sp.	5	P	1
Laccobius sp.	5	MH	1
Erpobdellidae	8	P	1
Cricotopus trifascia group	7	CG	1
Ceratopogonidae	6	P	1
Ceratopogon sp.	6	P	1
Bezzia/ Palpomyia	6	P	1
			865

Del Puerto Creek 5

Taxon	T1	Taxon	T2	Taxon	T3	Taxon	Tol Val	FFG	Total
Tricorythodes sp.	54	Baetis tricaudatus	63	Baetis tricaudatus	128	Baetis tricaudatus	6	CG	205
Cyprididae	53	Fallceon quilleri	40	Simulium sp.	68	Fallceon quilleri	4	CG	99
Rheotanytarsus sp.	35	Nais communis/ variabilis	36	Fallceon quilleri	29	Tricorythodes sp.	4	CG	86
Fallceon quilleri	30	Tricorythodes sp.	27	Rheotanytarsus sp.	12	Cyprididae	8	CG	74
Nais communis/ variabilis	19	Cyprididae	20	Hydrobiidae	8	Simulium sp.	6	CF	71
Baetis tricaudatus	14	Rheotanytarsus sp.	14	Paratanytarsus sp.	7	Nais communis/ variabilis	--	CG	62
Cricotopus sp.	9	Hydrobiidae	11	Nais communis/ variabilis	7	Rheotanytarsus sp.	6	CF	61
Hyalella sp.	9	Cricotopus bicinctus group	9	Tricorythodes sp.	5	Hydrobiidae	8	SC	24
Lebertia sp.	8	Physa sp.	7	Cricotopus sp.	4	Paratanytarsus sp.	6	CF	18
Paratanytarsus sp.	7	Corynoneura sp.	6	Sperchon sp.	4	Lebertia sp.	8	P	16
Cricotopus bicinctus group	6	Peltodytes sp.	5	Lebertia sp.	3	Cricotopus sp.	7	CG	16
Physa sp.	6	Lebertia sp.	5	Ambrysus sp.	2	Cricotopus bicinctus group	7	CG	16
Centroptilum sp.	5	Paratanytarsus sp.	4	Hydropsyche sp.	2	Physa sp.	8	SC	13
Hydrobiidae	5	Centroptilum sp.	4	Erpobdellidae	2	Hyalella sp.	8	CG	13
Corynoneura sp.	3	Hyalella sp.	4	Helochares sp.	1	Sperchon sp.	8	P	11
Coenagrionidae	3	Sperchon sp.	4	Laccobius sp.	1	Peltodytes sp.	5	MH	10
Sperchon sp.	3	Peltodytes sp.	3	Cladotanytarsus sp.	1	Corynoneura sp.	7	CG	9
Peltodytes sp.	2	Orthocladius complex	3	Tanytarsus sp.	1	Centroptilum sp.	2	CG	9
Phaenopsectra sp.	2	Cricotopus sp.	3	Eukiefferiella sp.	1	Erpobdellidae	8	P	5
Erpobdellidae	2	Simulium sp.	3	Cricotopus bicinctus group	1	Tanytarsus sp.	6	CF	4
Haliplus sp.	1	Cladotanytarsus sp.	2	Thienemannimyia group	1	Coenagrionidae	--	P	4
Laccobius sp.	1	Tanytarsus sp.	2	Coenagrionidae	1	Cladotanytarsus sp.	7	CG	4
Tanytarsini	1	Thienemannimyia group	2	Cyprididae	1	Thienemannimyia group	6	P	3
Cladotanytarsus sp.	1	Dugesia tigrina	2	Atractides sp.	1	Phaenopsectra sp.	7	SC	3
Tanytarsus sp.	1	Berosus sp.	1	Dugesia tigrina	1	Orthocladius complex	6	CG	3
Cricotopus sp.	1	Phaenopsectra sp.	1		292	Dugesia tigrina	4	P	3
Thienemanniella sp.	1	Eukiefferiella sp.	1			Laccobius sp.	5	MH	2

Del Puerto Creek 5 continued.

Taxon	T1	Taxon	T2	Taxon	T3
Tanypodinae	1	Caloparyphus/ Euparyphus	1		
Procladius sp.	1	Stratiomyidae	1		
Caloparyphus/ Euparyphus	1	Corixidae	1		
Libellula sp.	1	Hygrobates sp.	1		
Hydroptila sp.	1	Erpobdellidae	1		
Mooreobdella microstoma	1	Enchytraeidae	1		
Gyraulus sp.	1	Ophidonais serpentina	1		
	289	Tubificidae unid.imm.	1		
			290		

Taxon	TolVal	FFG	Total
Hydropsyche sp.	4	CF	2
Eukiefferiella sp.	8	OM	2
Caloparyphus/ Euparyphus	8	CG	2
Ambrysus sp.	5	P	2
Tubificidae unid.imm.	10	CG	1
Thienemanniella sp.	6	CG	1
Tanytarsini	6	CG	1
Tanypodinae	7	P	1
Stratiomyidae	--	--	1
Procladius sp.	9	P	1
Ophidonais serpentina	--	--	1
Mooreobdella microstoma	8	P	1
Libellula sp.	9	P	1
Hygrobates sp.	8	P	1
Hydroptila sp.	6	PH	1
Helochares sp.	5	P	1
Haliplus sp.	5	MH	1
Gyraulus sp.	8	SC	1
Enchytraeidae	10	CG	1
Cricotopus sp.	--	--	1
Corixidae	10	P	1
Berosus sp.	5	P	1
Atractides sp.	8	P	1
			871

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 Creek 1

Taxon	T1
Tubificidae unid.imm.	223
Limnodrilus hoffmeisteri	25
Branchiura sowerbyi	23
Procladius sp.	15
Nais communis/ variabilis	5
Bezzia/ Palpomyia	4
Quistadrilus multisetosus	4
Cricotopus bicinctus group	3
Prostoma sp.	2
Microchironomus sp.	1
Coenagrionidae	1
Cyprididae	1
Dero borellii	1
Dero digitata	1
Ferrissia sp.	1
Menetus opercularis	1
	311

Taxon	T2
Tubificidae unid.imm.	200
Limnodrilus hoffmeisteri	52
Procladius sp.	18
Branchiura sowerbyi	16
Corbicula sp.	13
Tubificidae w/hair	9
Ceratopogon sp.	8
Slavina appendiculata	3
	319

Taxon	T3
Tubificidae unid.imm.	44
Procladius sp.	27
Limnodrilus hoffmeisteri	19
Ceratopogon sp.	2
Branchiura sowerbyi	1
	93

Taxon	Tol Val	FFG	Total
Tubificidae unid.imm.	10	CG	467
Limnodrilus hoffmeisteri	--	CG	96
Procladius sp.	9	P	60
Branchiura sowerbyi	10	CG	40
Corbicula sp.	8	CF	13
Ceratopogon sp.	6	P	10
Tubificidae w/hair	5	CG	9
Nais communis/ variabilis	--	CG	5
Quistadrilus multisetosus	10	CG	4
Bezzia/ Palpomyia	6	P	4
Slavina appendiculata	--	CG	3
Cricotopus bicinctus group	7	CG	3
Prostoma sp.	8	P	2
Microchironomus sp.	6	CG	1
Menetus opercularis	6	SC	1
Ferrissia sp.	6	SC	1
Dero digitata	--	CG	1
Dero borellii	10	CG	1
Cyprididae	8	CG	1
Coenagrionidae	--	P	1
			723

Orestimba Creek 2

Taxon	T1
Tubificidae unid.imm.	220
Limnodrilus hoffmeisteri	34
Branchiura sowerbyi	27
Procladius sp.	17
Corbicula sp.	4
Bezzia/ Palpomyia	2
Chironomus sp.	1
Microchironomus sp.	1
Coenagrionidae	1
Lumbricina	1
Physa sp.	1
	309

Taxon	T2
Procladius sp.	39
Tubificidae unid.imm.	31
Limnodrilus hoffmeisteri	8
Branchiura sowerbyi	3
Nais communis/ variabilis	2
Paratanytarsus sp.	1
Cricotopus bicinctus group	1
Belostomatidae	1
Menetus opercularis	1
	87

Taxon	T3
Tubificidae unid.imm.	211
Limnodrilus hoffmeisteri	24
Branchiura sowerbyi	14
Tubificidae w/hair	11
Procladius sp.	10
Dero digitata	10
Ceratopogon sp.	2
Corbicula sp.	2
Lymnaea sp.	2
Glyptotendipes sp.	1
Cricotopus bicinctus group	1
Slavina appendiculata	1
Ferrissia sp.	1
Physa sp.	1
Prostoma sp.	1
	292

Taxon	Tol Val	FFG	Total
Tubificidae unid.imm.	10	CG	462
Procladius sp.	9	P	66
Limnodrilus hoffmeisteri	--	CG	66
Branchiura sowerbyi	10	CG	44
Tubificidae w/hair	5	CG	11
Dero digitata	--	CG	10
Corbicula sp.	8	CF	6
Physa sp.	8	SC	2
Nais communis/ variabilis	--	CG	2
Lymnaea sp.	7	SC	2
Ceratopogon sp.	6	P	2
Bezzia/ Palpomyia	6	P	2
Slavina appendiculata	--	CG	1
Prostoma sp.	8	P	1
Paratanytarsus sp.	6	CF	1
Microchironomus sp.	6	CG	1
Menetus opercularis	6	SC	1
Lumbricina	--	CG	1
Glyptotendipes sp.	10	SH	1
Ferrissia sp.	6	SC	1
Cricotopus bicinctus group	--	--	1
Cricotopus bicinctus group	7	CG	1
Coenagrionidae	--	P	1
Chironomus sp.	10	CG	1
Belostomatidae	8	P	1
			688

Orestimba Creek 3

Taxon	T1
Tubificidae unid.imm.	43
Limnodrilus hoffmeisteri	17
Branchiura sowerbyi	7
Nereis limnicola	5
Corbicula sp.	5
Lumbricina	3
Tubificidae w/hair	3
Rheocricotopus sp.	1
Cricotopus sp.	1
	85

Taxon	T2
Tubificidae unid.imm.	84
Branchiura sowerbyi	14
Lumbricina	4
Tubificidae w/hair	4
Corbicula sp.	4
Eudistylia vancouveri	2
Limnodrilus hoffmeisteri	2
Parachironomus sp.	1
Cricotopus sp.	1
Nais communis/ variabilis	1
Fossaria sp.	1
Prostoma sp.	1
	119

Taxon	T3
Tubificidae unid.imm.	50
Branchiura sowerbyi	7
Cricotopus sp.	3
Corbicula sp.	3
Rheocricotopus sp.	1
Erpobdellidae	1
Lumbricina	1
	66

Taxon	Tol Val	FFG	Total
Tubificidae unid.imm.	10	CG	177
Branchiura sowerbyi	10	CG	28
Limnodrilus hoffmeisteri	--	CG	19
Corbicula sp.	8	CF	12
Lumbricina	--	CG	8
Tubificidae w/hair	5	CG	7
Nereis limnicola	--	--	5
Cricotopus sp.	--	--	5
Rheocricotopus sp.	6	OM	2
Eudistylia vancouveri	--	--	2
Prostoma sp.	8	P	1
Parachironomus sp.	10	P	1
Nais communis/ variabilis	--	CG	1
Fossaria sp.	8	SC	1
Erpobdellidae	8	P	1
			270

Orestimba Creek 4

Taxon	T1	Taxon	T2	Taxon	T3	Taxon	Tol Val	FFG	Total
Tubificidae unid.imm.	9	Corbicula sp.	14	Corbicula sp.	18	Corbicula sp.	8	CF	41
Corbicula sp.	9	Tubificidae unid.imm.	9	Hydropsyche californica	7	Tubificidae unid.imm.	10	CG	22
Polypedilum sp.	8	Sperchon sp.	5	Lumbricina	7	Sperchon sp.	8	P	12
Ormosia sp.	3	Lumbricina	3	Cladotanytarsus sp.	5	Lumbricina	--	CG	12
Culicoides sp.	2	Hydropsyche californica	2	Sperchon sp.	5	Polypedilum sp.	6	CG	10
Dolichopodidae	2	Slavina appendiculata	2	Nereis limnicola	4	Hydropsyche californica	4	CF	10
Sperchon sp.	2	Prostoma sp.	2	Nais communis/ variabilis	4	Cladotanytarsus sp.	7	CG	7
Lumbricina	2	Cladotanytarsus sp.	1	Tubificidae unid.imm.	4	Slavina appendiculata	--	CG	5
Cladotanytarsus sp.	1	Micropsectra sp.	1	Slavina appendiculata	3	Prostoma sp.	8	P	5
Ischnura sp.	1	Eukiefferiella sp.	1	Prostoma sp.	3	Ormosia sp.	3	CG	4
Hydropsyche californica	1	Orthocladiinae	1	Polypedilum sp.	2	Nereis limnicola	--	--	4
Wormaldia sp.	1	Scatella sp.	1	Tanytarsus sp.	2	Nais communis/ variabilis	--	CG	4
Procambarus clarkii	1	Ormosia sp.	1	Dicrotendipes sp.	1	Tanytarsus sp.	6	CF	2
Lebertia sp.	1	Baetis tricaudatus	1	Phaenopsectra sp.	1	Dolichopodidae	4	P	2
Physa sp.	1	Corixidae	1	Simulium sp.	1	Culicoides sp.	6	P	2
	44	Cambaridae	1	Hydropsyche sp.	1	Wormaldia sp.	3	CF	1
		Menetus opercularis	1	Hyalella sp.	1	Simulium sp.	6	CF	1
			47	Ophidonais serpentina	1	Scatella sp.	6	CG	1
					70	Procambarus clarkii	8	SH	1
						Physa sp.	8	SC	1
						Phaenopsectra sp.	7	SC	1
						Orthocladiinae	--	--	1
						Ophidonais serpentina	--	--	1
						Micropsectra sp.	7	CG	1
						Menetus opercularis	6	SC	1
						Lebertia sp.	8	P	1

Orestimba Creek 4 continued.

Taxon	T1	Taxon	T2	Taxon	T3	Taxon	Tol Val	FFG	Total
						Ischnura sp.	9	P	1
						Hydropsyche sp.	4	CF	1
						Hyalella sp.	8	CG	1
						Eukiefferiella sp.	8	OM	1
						Dicrotendipes sp.	8	CG	1
						Corixidae	10	P	1
						Cambaridae	8	CG	1
						Baetis tricaudatus	6	CG	1
									161

Orestimba Creek 5

Taxon	T1
Slavina appendiculata	52
Lumbricina	18
Tubificidae unid.imm.	15
Nais communis/ variabilis	10
Pristina leidyi	9
Micropsectra sp.	8
Physa sp.	7
Cricotopus bicinctus group	6
Rheocricotopus sp.	5
Sperchon sp.	5
Thienemanniella sp.	4
Corbicula sp.	4
Menetus opercularis	4
Tanytarsini	2
Nereis limnicola	2
Ophidonais serpentina	2
Prostoma sp.	2
Phaenopsectra sp.	1
Ablabesmyia sp.	1
Simulium sp.	1
Fallceon quilleri	1
Hydropsyche californica	1
Cyprididae	1
Lebertia sp.	1
	162

Taxon	T2
Corbicula sp.	4
Sperchon sp.	3
Chironominae	1
Tanypodinae	1
Procambarus clarkii	1
	10

Taxon	T3
Slavina appendiculata	59
Tubificidae unid.imm.	43
Sperchon sp.	25
Micropsectra sp.	19
Nais communis/ variabilis	18
Hydropsyche californica	14
Fallceon quilleri	10
Corbicula sp.	10
Cricotopus bicinctus group	8
Pristina leidyi	8
Lumbricina	7
Polypedilum sp.	6
Cricotopus sp.	6
Rheocricotopus sp.	6
Physa sp.	6
Menetus opercularis	6
Ophidonais serpentina	5
Chironomini	4
Chironomus sp.	2
Psectrocladius sp.	2
Procladius sp.	2
Nereis limnicola	2
Prostoma sp.	2
Cladotanytarsus sp.	1
Eukiefferiella sp.	1
Corynoneura sp.	1
Ablabesmyia sp.	1
Psychoda sp.	1

Taxon	Tol Val	FFG	Total
Slavina appendiculata	--	CG	111
Tubificidae unid.imm.	10	CG	58
Sperchon sp.	8	P	33
Nais communis/ variabilis	--	CG	28
Micropsectra sp.	7	CG	27
Lumbricina	--	CG	25
Corbicula sp.	8	CF	18
Pristina leidyi	--	CG	17
Hydropsyche californica	4	CF	15
Cricotopus bicinctus group	7	CG	14
Physa sp.	8	SC	13
Rheocricotopus sp.	6	OM	11
Fallceon quilleri	4	CG	11
Menetus opercularis	6	SC	10
Ophidonais serpentina	--	--	7
Polypedilum sp.	6	CG	6
Cricotopus sp.	7	CG	6
Thienemanniella sp.	6	CG	4
Prostoma sp.	8	P	4
Nereis limnicola	--	--	4
Chironomini	6	CG	4
Tanytarsini	6	CG	2
Psectrocladius sp.	8	CG	2
Procladius sp.	9	P	2
Chironomus sp.	10	CG	2
Ablabesmyia sp.	8	CG	2
Tubificidae w/hair	5	CG	1
Tanypodinae	7	P	1

Orestimba Creek 5 continued.

Taxon	T1	Taxon	T2	Taxon	T3	Taxon	Tol Val	FFG	Total
				Belostoma flumineum	1	Simulium sp.	6	CF	1
				Corisella inscripta	1	Psychoda sp.	10	CG	1
				Hydropsyche sp.	1	Procambarus clarkii	8	SH	1
				Tubificidae w/hair	1	Phaenopsectra sp.	7	SC	1
				Limnodrilus hoffmeisteri	1	Lymnaeidae	6	SC	1
				Lymnaeidae	1	Limnodrilus hoffmeisteri	--	CG	1
					281	Lebertia sp.	8	P	1
						Hydropsyche sp.	4	CF	1
						Eukiefferiella sp.	8	OM	1
						Cyprididae	8	CG	1
						Corynoneura sp.	7	CG	1
						Corisella inscripta	10	P	1
						Cladotanytarsus sp.	7	CG	1
						Chironominae	6	CG	1
						Belostoma flumineum	8	P	1
									453

Orestimba Creek 6

Taxon	T1	Taxon	T2	Taxon	T3	Taxon	Tol Val	FFG	Total
Cricotopus bicinctus group	54	Tubificidae unid.imm.	22	Slavina appendiculata	75	Slavina appendiculata	--	CG	119
Slavina appendiculata	33	Cricotopus bicinctus group	19	Cricotopus bicinctus group	33	Cricotopus bicinctus group	7	CG	106
Tubificidae unid.imm.	13	Hyalella sp.	18	Tubificidae unid.imm.	32	Tubificidae unid.imm.	10	CG	67
Corbicula sp.	11	Slavina appendiculata	11	Lumbricina	10	Hyalella sp.	8	CG	18
Thienemanniella sp.	7	Physa sp.	8	Eukiefferiella sp.	9	Corbicula sp.	8	CF	16
Cricotopus sp.	5	Nanocladius sp.	7	Cricotopus sp.	6	Lumbricina	--	CG	13
Simulium sp.	5	Polypedilum sp.	5	Corbicula sp.	5	Cricotopus sp.	7	CG	12
Corixidae	4	Coenagrionidae	3	Prostoma sp.	4	Thienemanniella sp.	6	CG	9
Psectrocladius sp.	3	Phaenopsectra sp.	2	Tanytarsini	3	Eukiefferiella sp.	8	OM	9
Lumbricina	3	Cladotanytarsus sp.	2	Fallceon quilleri	3	Physa sp.	8	SC	8
Psychoda sp.	2	Corixidae	2	Hydropsyche sp.	3	Nanocladius sp.	3	CG	7
Sigara omani	2	Branchiura sowerbyi	2	Nais communis/ variabilis	3	Corixidae	10	P	7
Ophidonais serpentina	2	Helophorus sp.	1	Ophidonais serpentina	3	Ophidonais serpentina	--	--	6
Tanytarsini	1	Cricotopus sp.	1	Cladotanytarsus sp.	2	Simulium sp.	6	CF	5
Paratanytarsus sp.	1	Procladius sp.	1	Thienemanniella sp.	2	Prostoma sp.	8	P	5
Muscidae	1	Fallceon quilleri	1	Enchytraeidae	2	Polypedilum sp.	6	CG	5
Fallceon quilleri	1	Corisella sp.	1	Limnodrilus hoffmeisteri	2	Fallceon quilleri	4	CG	5
Hydropsyche sp.	1	Trichocorixa calva	1	Planariidae	2	Tanytarsini	6	CG	4
Hydropsyche californica	1	Americorophium sp.	1	Tropisternus lateralis	1	Psectrocladius sp.	8	CG	4
Hydroptila sp.	1	Eudistylia vancouveri	1	Atrichopogon sp.	1	Hydropsyche sp.	4	CF	4
Eudistylia vancouveri	1	Ophidonais serpentina	1	Chironomus sp.	1	Cladotanytarsus sp.	7	CG	4
Erpobdellidae	1	Limnodrilus hoffmeisteri	1	Paratanytarsus sp.	1	Sigara omani	8	P	3
Menetus opercularis	1	Fossaria sp.	1	Psectrocladius sp.	1	Nais communis/ variabilis	--	CG	3
	154	Prostoma sp.	1	Rheocricotopus sp.	1	Limnodrilus hoffmeisteri	--	CG	3
			113	Muscidae	1	Coenagrionidae	--	P	3
				Corixidae	1	Branchiura sowerbyi	10	CG	3
				Sigara omani	1	Psychoda sp.	10	CG	2
				Sperchon sp.	1	Planariidae	4	P	2

Orestimba Creek 6 continued.

Taxon	T1	Taxon	T2	Taxon	T3
				Paranais litoralis	1
				Branchiura sowerbyi	1
				Fossaria sp.	1
					212

Taxon	Tol Val	FFG	Total
Phaenopsectra sp.	7	SC	2
Paratanytarsus sp.	6	CF	2
Muscidae	6	P	2
Fossaria sp.	8	SC	2
Eudistylia vancouveri	--	--	2
Enchytraeidae	10	CG	2
Tropisternus lateralis	5	CG	1
Trichocorixa calva	8	P	1
Sperchon sp.	8	P	1
Rheocricotopus sp.	6	OM	1
Procladius sp.	9	P	1
Paranais litoralis	--	CG	1
Menetus opercularis	6	SC	1
Hydroptila sp.	6	PH	1
Hydropsyche californica	4	CF	1
Helophorus sp.	--	SH	1
Erpobdellidae	8	P	1
Corisella sp.	8	P	1
Chironomus sp.	10	CG	1
Atrichopogon sp.	6	CG	1
Americorophium sp.	4	CF	1
			479

Orestimba Creek 7

Taxon	T1
Cricotopus bicinctus group	70
Slavina appendiculata	26
Psectrocladius sp.	21
Hyalella sp.	15
Cricotopus sp.	14
Cricotopus sp.	14
Psectrocladius sp.	13
Orthocladiinae	12
Prostoma sp.	12
Tubificidae unid.imm.	11
Paratanytarsus sp.	9
Ophidonais serpentina	7
Eudistylia vancouveri	6
Simulium sp.	5
Corbicula sp.	5
Menetus opercularis	5
Dugesia tigrina	5
Polypedilum sp.	2
Eukiefferiella sp.	2
Thienemanniella sp.	2
Paratanytarsus sp.	1
Cricotopus trifascia group	1
Thienemannimyia group	1
Fallceon quilleri	1
Corixidae	1
Hydropsyche sp.	1
Gammarus sp.	1
Erpobdellidae	1
Enchytraeidae	1
	265

Taxon	T2
Cricotopus bicinctus group	45
Corbicula sp.	27
Tubificidae unid.imm.	15
Cricotopus sp.	13
Cricotopus sp.	7
Psectrocladius sp.	4
Paratanytarsus sp.	3
Simulium sp.	3
Americorophium sp.	3
Prostoma sp.	3
Thienemanniella sp.	1
Corixidae	1
Cyprididae	1
Hygrobates sp.	1
Erpobdella sp.	1
Ophidonais serpentina	1
Slavina appendiculata	1
Physa sp.	1
Dugesia tigrina	1
	132

Taxon	T3
Cricotopus sp.	10
Menetus opercularis	6
Cricotopus bicinctus group	5
Hydropsyche californica	4
Hyalella sp.	3
Tanytarsus sp.	2
Fallceon quilleri	2
Americorophium sp.	2
Eudistylia vancouveri	2
Corbicula sp.	2
Prostoma sp.	2
Cricotopus sp.	1
Eukiefferiella sp.	1
Psectrocladius sp.	1
Eukiefferiella sp.	1
Thienemanniella sp.	1
Sperchon sp.	1
Lumbricina	1
Slavina appendiculata	1
Tubificidae unid.imm.	1
	49

Taxon	Tol Val	FFG	Total
Cricotopus bicinctus group	7	CG	120
Cricotopus sp.	--	--	37
Corbicula sp.	8	CF	34
Slavina appendiculata	--	CG	28
Tubificidae unid.imm.	10	CG	27
Psectrocladius sp.	8	CG	26
Cricotopus sp.	7	CG	22
Hyalella sp.	8	CG	18
Prostoma sp.	8	P	17
Psectrocladius sp.	--	--	13
Paratanytarsus sp.	6	CF	12
Orthocladiinae	5	CG	12
Menetus opercularis	6	SC	11
Simulium sp.	6	CF	8
Ophidonais serpentina	--	--	8
Eudistylia vancouveri	--	--	8
Dugesia tigrina	4	P	6
Americorophium sp.	4	CF	5
Thienemanniella sp.	6	CG	4
Hydropsyche californica	4	CF	4
Fallceon quilleri	4	CG	3
Eukiefferiella sp.	8	OM	3
Tanytarsus sp.	6	CF	2
Polypedilum sp.	6	CG	2
Corixidae	10	P	2
Thienemannimyia group	6	P	1
Sperchon sp.	8	P	1
Physa sp.	8	SC	1
Paratanytarsus sp.	--	--	1
Lumbricina	--	CG	1

Orestimba Creek 7 continued.

Taxon	T1	Taxon	T2	Taxon	T3

Taxon	Tol Val	FFG	Total
Hygrobates sp.	8	P	1
Hydropsyche sp.	4	CF	1
Gammarus sp.	6	CG	1
Eukiefferiella sp.	--	--	1
Erpobdellidae	8	P	1
Erpobdella sp.	8	P	1
Enchytraeidae	10	CG	1
Cyprididae	8	CG	1
Cricotopus trifascia group	7	CG	1
			446

Orestimba Creek 8

Taxon	T1
Cricotopus bicinctus group	74
Simulium sp.	19
Cricotopus bicinctus group	13
Cricotopus sp.	8
Corbicula sp.	8
Americorophium sp.	5
Slavina appendiculata	4
Cladotanytarsus sp.	2
Dicrotendipes sp.	1
Glyptotendipes sp.	1
Molophilus sp.	1
Fallceon quilleri	1
Hydropsyche californica	1
Hydroptila sp.	1
Crangonyx sp.	1
Sperchon sp.	1
Lumbricina	1
Ophidonais serpentina	1
Tubificidae unid.imm.	1
Prostoma sp.	1
	145

Taxon	T2
Americorophium sp.	44
Cricotopus bicinctus group	23
Cricotopus sp.	16
Corbicula sp.	9
Simulium sp.	8
Dicrotendipes sp.	6
Prostoma sp.	6
Slavina appendiculata	5
Lebertia sp.	4
Tubificidae unid.imm.	3
Hydropsyche californica	2
Gammarus sp.	2
Eudistylia vancouveri	2
Physa sp.	2
Cryptochironomus sp.	1
Cladotanytarsus sp.	1
Eukiefferiella sp.	1
Eukiefferiella sp.	1
Fallceon quilleri	1
Hydroptila sp.	1
Erpobdella sp.	1
Dero digitata	1
	140

Taxon	T3
Americorophium sp.	36
Cricotopus sp.	26
Simulium sp.	16
Dicrotendipes sp.	8
Cricotopus bicinctus group	5
Rheotanytarsus sp.	4
Hydropsyche californica	4
Lebertia sp.	3
Prostoma sp.	3
Sperchon sp.	2
Nais communis/ variabilis	2
Slavina appendiculata	2
Polypedilum sp.	1
Tubificidae unid.imm.	1
Corbicula sp.	1
	114

Taxon	Tol Val	FFG	Total
Cricotopus bicinctus group	7	CG	102
Americorophium sp.	4	CF	85
Simulium sp.	6	CF	43
Cricotopus sp.	7	CG	34
Corbicula sp.	8	CF	18
Cricotopus sp.	--	--	16
Dicrotendipes sp.	8	CG	15
Cricotopus bicinctus group	--	--	13
Slavina appendiculata	--	CG	11
Prostoma sp.	8	P	10
Lebertia sp.	8	P	7
Hydropsyche californica	4	CF	7
Tubificidae unid.imm.	10	CG	5
Rheotanytarsus sp.	6	CF	4
Sperchon sp.	8	P	3
Cladotanytarsus sp.	7	CG	3
Physa sp.	8	SC	2
Nais communis/ variabilis	--	CG	2
Hydroptila sp.	6	PH	2
Gammarus sp.	6	CG	2
Fallceon quilleri	4	CG	2
Eudistylia vancouveri	--	--	2
Polypedilum sp.	6	CG	1
Ophidonais serpentina	--	--	1
Molophilus sp.	4	SH	1
Lumbricina	--	CG	1
Glyptotendipes sp.	10	SH	1
Eukiefferiella sp.	8	OM	1

Orestimba Creek 8 continued.

Taxon	T1	Taxon	T2	Taxon	T3

Taxon	Tol Val	FFG	Total
Eukiefferiella sp.	--	--	1
Erpobdella sp.	8	P	1
Dero digitata	--	CG	1
Cryptochironomus sp.	8	P	1
Crangonyx sp.	4	CG	1
			399

Orestimba Creek 9

Taxon	T1	Taxon	T2	Taxon	T3	Taxon	Tol Val	FFG	Total
Physa sp.	69	Physa sp.	64	Tubificidae unid.imm.	101	Tubificidae unid.imm.	10	CG	188
Tubificidae unid.imm.	64	Cricotopus bicinctus group	39	Rheotanytarsus sp.	59	Physa sp.	8	SC	166
Paratanytarsus sp.	54	Tanytarsus sp.	31	Physa sp.	33	Rheotanytarsus sp.	6	CF	59
Chironomus sp.	13	Enchytraeidae	25	Chironomus sp.	31	Chironomus sp.	10	CG	57
Cricotopus sp.	13	Tubificidae unid.imm.	23	Cladotanytarsus sp.	8	Paratanytarsus sp.	6	CF	56
Dicrotendipes sp.	10	Cricotopus sp.	21	Polypedilum sp.	6	Cricotopus bicinctus group	7	CG	45
Procladius sp.	6	Dicrotendipes sp.	16	Cricotopus bicinctus group	6	Cricotopus sp.	7	CG	36
Enchytraeidae	5	Chironomus sp.	13	Dicrotendipes sp.	5	Enchytraeidae	10	CG	34
Slavina appendiculata	5	Nais communis/ variabilis	6	Enchytraeidae	4	Tanytarsus sp.	6	CF	31
Hydra sp.	5	Corbicula sp.	6	Dero digitata	3	Dicrotendipes sp.	8	CG	31
Planariidae	5	Planorbella sp.	5	Corbicula sp.	3	Corbicula sp.	8	CF	11
Cyprididae	4	Cladotanytarsus sp.	4	Cricotopus sp.	2	Procladius sp.	9	P	9
Fossaria sp.	3	Lumbricina	4	Procladius sp.	2	Nais communis/ variabilis	--	CG	8
Prostoma sp.	3	Menetus opercularis	4	Cyprididae	2	Cladotanytarsus sp.	--	--	8
Mooreobdella microstoma	2	Apedilum sp.	2	Prostoma sp.	2	Prostoma sp.	8	P	7
Nais communis/ variabilis	2	Paratanytarsus sp.	2	Microchironomus sp.	1	Cyprididae	8	CG	7
Tubificidae w/hair	2	Cricotopus bicinctus group	2	Chironomini	1	Slavina appendiculata	--	CG	6
Corbicula sp.	2	Prostoma sp.	2	Cladotanytarsus sp.	1	Polypedilum sp.	6	CG	6
Simulium sp.	1	Tropisternus sp.	1	Tanypus sp.	1	Hydra sp.	5	P	6
Lumbricina	1	Chironomini	1	Gammarus sp.	1	Planorbella sp.	6	SC	5
Dero borellii	1	Cricotopus sp.	1	Paranais litoralis	1	Planariidae	4	P	5
Gyraulus sp.	1	Procladius sp.	1	Slavina appendiculata	1	Lumbricina	--	CG	5
	271	Coenagrionidae	1	Fossaria sp.	1	Fossaria sp.	8	SC	5
		Gammarus sp.	1	Dugesia tigrina	1	Cladotanytarsus sp.	7	CG	5
		Cyprididae	1		276	Menetus opercularis	6	SC	4
		Branchiura sowerbyi	1			Dero digitata	--	CG	3

Orestimba Creek 9 continued.

Taxon	T1	Taxon	T2	Taxon	T3
		Hydra sp.	1		
		Fossaria sp.	1		
			279		

Taxon	Tol Val	FFG	Total
Tubificidae w/hair	5	CG	2
Mooreobdella microstoma	8	P	2
Gammarus sp.	6	CG	2
Cricotopus bicinctus group	--	--	2
Chironomini	--	--	2
Apedilum sp.	6	CG	2
Tropisternus sp.	5	P	1
Tanypus sp.	10	P	1
Simulium sp.	6	CF	1
Paranais litoralis	--	CG	1
Microchironomus sp.	6	CG	1
Gyraulus sp.	8	SC	1
Dugesia tigrina	4	P	1
Dero borellii	10	CG	1
Cricotopus sp.	--	--	1
Coenagrionidae	--	P	1
Branchiura sowerbyi	10	CG	1
			826

Orestimba Creek 10

Taxon	T1	Taxon	T2	Taxon	T3	Taxon	Tol Val	FFG	Total
Simulium sp.	48	Torrenticola sp.	60	Torrenticola sp.	72	Torrenticola sp.	5	P	140
Tanytarsus sp.	47	Tanytarsus sp.	30	Tanytarsus sp.	36	Tanytarsus sp.	6	CF	113
Fallceon quilleri	40	Odontomyia/ Hedriodiscus	22	Centroptilum sp.	29	Fallceon quilleri	4	CG	66
Baetis sp.	34	Rheocricotopus sp.	19	Cyprididae	23	Simulium sp.	6	CF	56
Rheotanytarsus sp.	29	Baetis adonis	19	Corynoneura sp.	18	Caloparyphus/ Euparyphus	8	CG	48
Hexatoma sp.	20	Caloparyphus/ Euparyphus	16	Caloparyphus/ Euparyphus	15	Centroptilum sp.	2	CG	43
Caloparyphus/ Euparyphus	17	Cricotopus sp.	14	Cricotopus bicinctus group	13	Cricotopus bicinctus group	7	CG	35
Cricotopus bicinctus group	12	Fallceon quilleri	14	Fallceon quilleri	12	Rheotanytarsus sp.	6	CF	34
Corynoneura sp.	9	Cricotopus bicinctus group	10	Bezzia/ Palpomyia	8	Baetis sp.	5	CG	34
Torrenticola sp.	8	Centroptilum sp.	10	Hexatoma sp.	7	Cyprididae	8	CG	33
Cyprididae	6	Dicrotendipes sp.	8	Paratanytarsus sp.	5	Hexatoma sp.	2	P	30
Pristina leidyi	6	Simulium sp.	7	Rheotanytarsus sp.	5	Corynoneura sp.	7	CG	27
Centroptilum sp.	4	Bezzia/ Palpomyia	5	Pristina leidyi	5	Odontomyia/ Hedriodiscus	8	CG	22
Bezzia/ Palpomyia	3	Pseudochironomus sp.	5	Dugesia tigrina	5	Rheocricotopus sp.	6	OM	19
Pseudochironomus sp.	3	Orthocladiinae	4	Chaetogaster diaphanus	4	Baetis adonis	5	CG	19
Paratanytarsus sp.	3	Cyprididae	4	Pseudochironomus sp.	3	Cricotopus sp.	7	CG	16
Rheotanytarsus sp.	3	Dugesia tigrina	4	Tubificidae unid.imm.	3	Bezzia/ Palpomyia	6	P	16
Thienemanniella sp.	2	Hexatoma sp.	3	Gyraulus sp.	3	Pristina leidyi	--	CG	12
Lebertia sp.	2	Atractides sp.	3	Dicrotendipes sp.	2	Pseudochironomus sp.	5	CG	11
Sperchon sp.	2	Nais communis/ variabilis	3	Paraleptophlebia sp.	2	Dicrotendipes sp.	8	CG	11
Peltodytes sp.	1	Tubificidae w/hair	3	Hydroptila sp.	2	Dugesia tigrina	4	P	10
Dicrotendipes sp.	1	Micropsectra sp.	2	Stictotarsus sp.	1	Paratanytarsus sp.	6	CF	9
Polypedilum sp.	1	Paracladopelma sp.	1	Stilobezzia sp.	1	Orthocladiinae	5	CG	4
Tanytarsus sp.	1	Paratanytarsus sp.	1	Cricotopus sp.	1	Nais communis/ variabilis	--	CG	4
Cricotopus sp.	1	Paraleptophlebia sp.	1	Simulium sp.	1	Chaetogaster diaphanus	--	--	4

Orestimba Creek 10 continued.

Taxon	T1
Nixe sp.	1
Hydroptila sp.	1
Nais communis/ variabilis	1
Dugesia tigrina	1
	307

Taxon	T2
Corixidae	1
Pristina leidyi	1
	270

Taxon	T3
Euparyphus sp.	1
Caenis sp.	1
Heptageniidae	1
	279

Taxon	Tol Val	FFG	Total
Tubificidae w/hair	5	CG	3
Tubificidae unid.imm.	10	CG	3
Rheotanytarsus sp.	--	--	3
Paraleptophlebia sp.	4	CG	3
Hydroptila sp.	6	PH	3
Gyraulus sp.	8	SC	3
Atractides sp.	8	P	3
Thienemanniella sp.	6	CG	2
Sperchon sp.	8	P	2
Micropsectra sp.	7	CG	2
Lebertia sp.	8	P	2
Tanytarsus sp.	--	--	1
Stilobezzia sp.	6	P	1
Stictotarsus sp.	5	P	1
Polypedilum sp.	6	CG	1
Peltodytes sp.	5	MH	1
Paracladopelma sp.	7	--	1
Nixe sp.	2	SC	1
Heptageniidae	4	SC	1
Euparyphus sp.	8	CG	1
Corixidae	10	P	1
Caenis sp.	7	CG	1
			856

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

Taxon	T1
Cricotopus sp.	92
Cricotopus bicinctus group	71
Nais communis/ variabilis	34
Polypedilum sp.	20
Tubificidae unid.imm.	13
Dicrotendipes sp.	9
Hydroptila sp.	9
Tanytarsus sp.	8
Branchiura sowerbyi	5
Nanocladius sp.	4
Eudistylia vancouveri	4
Limnodrilus hoffmeisteri	4
Chironomus sp.	3
Cladotanytarsus sp.	2
Paratanytarsus sp.	2
Hydropsyche californica	2
Dasyhelea sp.	1
Tanypus sp.	1
Coenagrionidae	1
Crangonyx sp.	1
Cyprididae	1
Hydra sp.	1
	288

Taxon	T2
Procladiini	14
Eudistylia vancouveri	9
Cricotopus bicinctus group	4
Bezzia/ Palpomyia	3
Micropsectra sp.	2
Dicrotendipes sp.	1
Paracladopelma sp.	1
Psectrocladius sp.	1
Tubificidae w/hair	1
	36

Taxon	T3
Tubificidae unid.imm.	32
Cricotopus sp.	8
Cricotopus bicinctus group	5
Tanypus sp.	2
Nais communis/ variabilis	2
Paranais litoralis	2
Tubificidae w/hair	2
Ceratopogon sp.	1
Endotribelos sp.	1
Tanytarsus sp.	1
Hydrobaenus sp.	1
Nanocladius sp.	1
Cricotopus bicinctus group	1
Simulium sp.	1
Hydroptila sp.	1
Eudistylia vancouveri	1
Limnodrilus hoffmeisteri	1
Corbicula sp.	1
	64

Taxon	Tol Val	FFG	Total
Cricotopus sp.	7	CG	100
Cricotopus bicinctus group	7	CG	80
Tubificidae unid.imm.	10	CG	45
Nais communis/ variabilis	--	CG	36
Polypedilum sp.	6	CG	20
Procladiini	--	--	14
Eudistylia vancouveri	--	--	14
Hydroptila sp.	6	PH	10
Dicrotendipes sp.	8	CG	10
Tanytarsus sp.	6	CF	9
Nanocladius sp.	3	CG	5
Limnodrilus hoffmeisteri	--	CG	5
Branchiura sowerbyi	10	CG	5
Tubificidae w/hair	5	CG	3
Tanypus sp.	10	P	3
Chironomus sp.	10	CG	3
Bezzia/ Palpomyia	6	P	3
Paratanytarsus sp.	6	CF	2
Paranais litoralis	--	CG	2
Micropsectra sp.	7	CG	2
Hydropsyche californica	4	CF	2
Cladotanytarsus sp.	7	CG	2
Simulium sp.	6	CF	1
Psectrocladius sp.	8	CG	1
Paracladopelma sp.	7	--	1
Hydrobaenus sp.	8	CG	1
Hydra sp.	5	P	1
Endotribelos sp.	6	CG	1
Dasyhelea sp.	6	CG	1

Salt Slough 1 continued.

Taxon	T1	Taxon	T2	Taxon	T3	Taxon	Tol Val	FFG	Total
						Cyprididae	8	CG	1
						Cricotopus bicinctus group	--	--	1
						Crangonyx sp.	4	CG	1
						Corbicula sp.	8	CF	1
						Coenagrionidae	--	P	1
						Ceratopogon sp.	6	P	1
									388

Salt Slough 2

Taxon	T1
Corbicula sp.	31
Tubificidae w/hair	17
Eudistylia vancouveri	13
Callibaetis sp.	7
Chironomus sp.	3
Psectrocladius sp.	3
Palaemonidae	3
Polypedilum sp.	2
Cricotopus bicinctus group	2
Microchironomus sp.	1
Paratanytarsus sp.	1
Exopalaemon modestus	1
	84

Taxon	T2
Ferrissia sp.	123
Cricotopus bicinctus group	57
Tubificidae unid.imm.	33
Polypedilum sp.	15
Nais communis/ variabilis	12
Slavina appendiculata	9
Cricotopus bicinctus group	6
Americorophium sp.	5
Tubificidae w/hair	5
Limnodrilus hoffmeisteri	5
Nanocladius sp.	4
Cyprididae	3
Tanytarsus sp.	2
Cricotopus sp.	2
Tanypus sp.	2
Dicrotendipes sp.	1
Goeldichironomus sp.	1
Microchironomus sp.	1
Endotribelos sp.	1
Polypedilum sp.	1
Paratanytarsus sp.	1
Cladotanytarsus sp.	1
Nanocladius sp.	1
Ephydridae	1
Palmacorixa sp.	1

Taxon	T3
Tubificidae unid.imm.	75
Eudistylia vancouveri	18
Americorophium sp.	7
Branchiura sowerbyi	7
Limnodrilus hoffmeisteri	5
Nais communis/ variabilis	4
Psectrocladius sp.	3
Procladius sp.	3
Gammarus sp.	3
Palaemonidae	3
Quistadrilus multisetosus	3
Corbicula sp.	2
Chironomus sp.	1
Dicrotendipes sp.	1
Parachironomus sp.	1
Polypedilum sp.	1
Cricotopus bicinctus group	1
Exopalaemon modestus	1
Cyprididae	1
Dero borellii	1
Paranais litoralis	1
	142

Taxon	Tol Val	FFG	Total
Ferrissia sp.	6	SC	123
Tubificidae unid.imm.	10	CG	108
Cricotopus bicinctus group	7	CG	60
Corbicula sp.	8	CF	34
Eudistylia vancouveri	--	--	31
Tubificidae w/hair	5	CG	22
Polypedilum sp.	6	CG	18
Nais communis/ variabilis	--	CG	16
Americorophium sp.	4	CF	12
Limnodrilus hoffmeisteri	--	CG	10
Slavina appendiculata	--	CG	9
Callibaetis sp.	9	CG	7
Branchiura sowerbyi	10	CG	7
Psectrocladius sp.	8	CG	6
Palaemonidae	--	--	6
Cricotopus bicinctus group	--	--	6
Nanocladius sp.	3	CG	4
Cyprididae	8	CG	4
Chironomus sp.	10	CG	4
Quistadrilus multisetosus	10	CG	3
Procladius sp.	9	P	3
Gammarus sp.	6	CG	3
Tanytarsus sp.	6	CF	2
Tanypus sp.	10	P	2
Microchironomus sp.	6	CG	2

Salt Slough 2 continued.

Taxon	T1

Taxon	T2
Manayunkia speciosa	1
Dero digitata	1
Corbicula sp.	1
	296

Taxon	T3

Taxon	Tol Val	FFG	Total
Exopalaemon modestus	--	--	2
Dicrotendipes sp.	8	CG	2
Cricotopus sp.	7	CG	2
Polypedilum sp.	--	--	1
Paratanytarsus sp.	--	--	1
Paratanytarsus sp.	6	CF	1
Paranais litoralis	--	CG	1
Parachironomus sp.	10	P	1
Palmacorixa sp.	--	--	1
Nanocladius sp.	--	--	1
Manayunkia speciosa	--	CF	1
Goeldichironomus sp.	6	CG	1
Ephydridae	6	--	1
Endotribelos sp.	--	--	1
Dero digitata	--	CG	1
Dero borellii	10	CG	1
Cladotanytarsus sp.	--	--	1
			522

Salt Slough 3

Taxon	T1
Tubificidae w/hair	74
Cricotopus bicinctus group	37
Cricotopus sp.	9
Gammarus sp.	9
Eudistylia vancouveri	8
Dicrotendipes sp.	2
Cladotanytarsus sp.	2
Tanytarsus sp.	2
Psectrocladius sp.	2
Americorophium sp.	2
Cricotopus sp.	1
Psectrocladius sp.	1
Hydropsychidae	1
Procambarus clarkii	1
Corbicula sp.	1
	152

Taxon	T2
Manayunkia speciosa	14
Tubificidae unid.imm.	10
Tanypus sp.	8
Paratanytarsus sp.	4
Coenagrionidae	4
Dicrotendipes sp.	3
Enallagma sp.	3
Cricotopus bicinctus group	2
Nanocladius sp.	2
Muscidae	2
Ischnura sp.	2
Chironomus sp.	1
Goeldichironomus sp.	1
Microchironomus sp.	1
Polypedilum sp.	1
Dicrotendipes sp.	1
Cladotanytarsus sp.	1
Cricotopus bicinctus group	1
Ephydridae	1
Palaemonetes sp.	1
Limnodrilus hoffmeisteri	1
Quistadrilus multisetosus	1
	65

Taxon	T3
Tubificidae unid.imm.	27
Manayunkia speciosa	11
Limnodrilus hoffmeisteri	8
Tanypus sp.	6
Procladius sp.	3
Dicrotendipes sp.	1
Cyprididae	1
Branchiura sowerbyi	1
Physa sp.	1
	59

Taxon	Tol Val	FFG	Total
Tubificidae w/hair	5	CG	74
Cricotopus bicinctus group	7	CG	39
Tubificidae unid.imm.	10	CG	37
Manayunkia speciosa	--	CF	25
Tanypus sp.	10	P	14
Limnodrilus hoffmeisteri	--	CG	9
Gammarus sp.	6	CG	9
Cricotopus sp.	--	--	9
Eudistylia vancouveri	--	--	8
Dicrotendipes sp.	8	CG	6
Paratanytarsus sp.	6	CF	4
Coenagrionidae	--	P	4
Procladius sp.	9	P	3
Enallagma sp.	9	P	3
Tanytarsus sp.	6	CF	2
Psectrocladius sp.	--	--	2
Nanocladius sp.	--	--	2
Muscidae	--	--	2
Ischnura sp.	9	P	2
Cladotanytarsus sp.	7	CG	2
Americorophium sp.	4	CF	2
Quistadrilus multisetosus	10	CG	1
Psectrocladius sp.	8	CG	1
Procambarus clarkii	8	SH	1
Polypedilum sp.	6	CG	1
Physa sp.	8	SC	1
Palaemonetes sp.	8	OM	1
Microchironomus sp.	6	CG	1
Hydropsychidae	4	CF	1

Salt Slough 3 continued.

Taxon	T1	Taxon	T2	Taxon	T3

Taxon	Tol Val	FFG	Total
Goeldichironomus sp.	6	CG	1
Ephydridae	6	--	1
Dicrotendipes sp.	--	--	1
Cyprididae	8	CG	1
Cricotopus sp.	7	CG	1
Cricotopus bicinctus group	--	--	1
Corbicula sp.	8	CF	1
Cladotanytarsus sp.	--	--	1
Chironomus sp.	10	CG	1
Branchiura sowerbyi	10	CG	1
			276

Salt Slough 4

Taxon	T1
Tubificidae unid.imm.	56
Dero borellii	21
Slavina appendiculata	21
Nais communis/ variabilis	16
Eudistylia vancouveri	13
Coenagrionidae	5
Branchiura sowerbyi	5
Psectrocladius sp.	4
Dicrotendipes sp.	3
Cricotopus bicinctus group	3
Microchironomus sp.	2
Limnodrilus hoffmeisteri	2
Cryptochironomus sp.	1
Parachironomus sp.	1
Polypedilum sp.	1
Corixidae	1
Ischnura sp.	1
Cyprididae	1
Ferrissia sp.	1
Physa sp.	1
	159

Taxon	T2
Tubificidae w/hair	95
Corixidae	18
Cambaridae	17
Cricotopus bicinctus group	16
Paratanytarsus sp.	13
Chironomus sp.	12
Coenagrionidae	11
Dicrotendipes sp.	10
Psectrocladius sp.	10
Eudistylia vancouveri	9
Tanytarsus sp.	8
Prostoma sp.	7
Parachironomus sp.	6
Cricotopus sp.	6
Ferrissia sp.	4
Polypedilum sp.	3
Cricotopus sp.	3
Chironomini	2
Hyalella sp.	2
Physa sp.	2
Menetus opercularis	2
Dytiscidae	1
Ochthebius sp.	1
Cryptochironomus sp.	1
Phaenopsectra sp.	1
Orthocladiinae	1
Ablabesmyia sp.	1
Callibaetis sp.	1

Taxon	T3
Coenagrionidae	4
Cricotopus bicinctus group	3
Eudistylia vancouveri	3
Chironomus sp.	2
Lumbricina	2
Limnodrilus hoffmeisteri	2
Dytiscidae	1
Cryptochironomus sp.	1
Glyptotendipes sp.	1
Microchironomus sp.	1
Polypedilum sp.	1
Americorophium sp.	1
Procambarus clarkii	1
Erpobdella sp.	1
Glossiphoniidae	1
Slavina appendiculata	1
Tubificidae unid.imm.	1
Ferrissia sp.	1
Fossaria sp.	1
	29

Taxon	Tol Val	FFG	Total
Tubificidae w/hair	5	CG	95
Tubificidae unid.imm.	10	CG	57
Eudistylia vancouveri	--	--	25
Slavina appendiculata	--	CG	22
Cricotopus bicinctus group	7	CG	22
Dero borellii	10	CG	21
Coenagrionidae	--	P	20
Corixidae	10	P	19
Cambaridae	8	CG	17
Nais communis/ variabilis	--	CG	16
Psectrocladius sp.	8	CG	14
Chironomus sp.	10	CG	14
Paratanytarsus sp.	6	CF	13
Dicrotendipes sp.	8	CG	13
Tanytarsus sp.	6	CF	8
Prostoma sp.	8	P	7
Parachironomus sp.	10	P	7
Ferrissia sp.	6	SC	6
Cricotopus sp.	--	--	6
Polypedilum sp.	6	CG	5
Branchiura sowerbyi	10	CG	5
Limnodrilus hoffmeisteri	--	CG	4
Physa sp.	8	SC	3
Microchironomus sp.	6	CG	3
Cryptochironomus sp.	8	P	3
Cricotopus sp.	7	CG	3
Menetus opercularis	6	SC	2
Lumbricina	--	CG	2

Salt Slough 4 continued.

Taxon	T1	Taxon	T2	Taxon	T3
		Hydropsyche californica	1		
		Cyprididae	1		
		Corbicula sp.	1		
			266		

Taxon	Tol Val	FFG	Total
Hyalella sp.	8	CG	2
Dytiscidae	5	P	2
Cyprididae	8	CG	2
Chironomini	6	CG	2
Procambarus clarkii	8	SH	1
Phaenopsectra sp.	7	SC	1
Orthocladiinae	5	CG	1
Ochthebius sp.	5	SC	1
Ischnura sp.	9	P	1
Hydropsyche californica	4	CF	1
Glyptotendipes sp.	10	SH	1
Glossiphoniidae	8	P	1
Fossaria sp.	8	SC	1
Erpobdella sp.	8	P	1
Corbicula sp.	8	CF	1
Callibaetis sp.	9	CG	1
Americorophium sp.	4	CF	1
Ablabesmyia sp.	8	CG	1
			454

Salt Slough 5

Taxon	T1	Taxon	T2	Taxon	T3	Taxon	Tol Val	FFG	Total
Dero digitata	155	Dero digitata	102	Dero digitata	94	Dero digitata	--	CG	351
Slavina appendiculata	36	Ferrissia sp.	68	Tubificidae unid.imm.	71	Ferrissia sp.	6	SC	87
Coenagrionidae	18	Goeldichironomus sp.	26	Corixidae	29	Tubificidae unid.imm.	10	CG	80
Ferrissia sp.	16	Parachironomus sp.	24	Dero borellii	18	Slavina appendiculata	--	CG	44
Hyalella sp.	15	Coenagrionidae	16	Limnodrilus hoffmeisteri	10	Coenagrionidae	--	P	43
Dicrotendipes sp.	12	Physa sp.	15	Coenagrionidae	9	Corixidae	10	P	32
Tubificidae unid.imm.	9	Enallagma sp.	11	Chironomus sp.	8	Physa sp.	8	SC	29
Physa sp.	8	Glyptotendipes sp.	9	Slavina appendiculata	7	Parachironomus sp.	10	P	28
Dugesia tigrina	7	Paratanytarsus sp.	9	Procladius sp.	6	Goeldichironomus sp.	6	CG	26
Cyprididae	4	Hyalella sp.	9	Physa sp.	6	Hyalella sp.	8	CG	24
Chironomus sp.	3	Tanypus sp.	5	Branchiura sowerbyi	5	Dero borellii	10	CG	20
Corixidae	3	Chironomus sp.	2	Culicoides sp.	4	Dicrotendipes sp.	8	CG	17
Phaenopsectra sp.	2	Ophidonais serpentina	2	Dicrotendipes sp.	4	Chironomus sp.	10	CG	13
Dero borellii	2	Dugesia tigrina	2	Callibaetis sp.	4	Paratanytarsus sp.	6	CF	11
Chironomini	1	Dicrotendipes sp.	1	Parachironomus sp.	3	Limnodrilus hoffmeisteri	--	CG	11
Parachironomus sp.	1	Goeldichironomus sp.	1	Eudistylia vancouveri	3	Enallagma sp.	9	P	11
Callibaetis sp.	1	Ablabesmyia sp.	1	Ferrissia sp.	3	Glyptotendipes sp.	10	SH	9
Aeshnidae	1	Ephydridae	1	Paratanytarsus sp.	2	Dugesia tigrina	4	P	9
Ophidonais serpentina	1	Muscidae	1	Bezzia/ Palpomyia	1	Procladius sp.	9	P	6
Limnodrilus hoffmeisteri	1	Mesovelia mulsanti	1	Cryptochironomus sp.	1	Tanypus sp.	10	P	5
	296	Helobdella triserialis	1	Microchironomus sp.	1	Cyprididae	8	CG	5
		Pristina leidyi	1	Polypedilum sp.	1	Callibaetis sp.	9	CG	5
		Slavina appendiculata	1	Corisella decolor	1	Branchiura sowerbyi	10	CG	5
			309	Aeshnidae	1	Culicoides sp.	6	P	4
				Cyprididae	1	Ophidonais serpentina	--	--	3
				Quistadrilus multisetosus	1	Eudistylia vancouveri	--	--	3
					294	Phaenopsectra sp.	7	SC	2

Salt Slough 5 continued.

Taxon	T1	Taxon	T2	Taxon	T3

Taxon	Tol Val	FFG	Total
Aeshnidae	5	P	2
Quistadrilus multisetosus	10	CG	1
Pristina leidyi	--	CG	1
Polypedilum sp.	6	CG	1
Muscidae	6	P	1
Microchironomus sp.	6	CG	1
Mesovelia mulsanti	--	P	1
Helobdella triserialis	--	PA	1
Goeldichironomus sp.	--	--	1
Ephydridae	6	--	1
Cryptochironomus sp.	8	P	1
Corisella decolor	--	--	1
Chironomini	6	CG	1
Bezzia/ Palpomyia	6	P	1
Ablabesmyia sp.	8	CG	1
			899