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Characterization of Benthic Communities and Physical Habitat in Agricultural Streams in California's San Joaquin Valley in 2002

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ABSTRACT

The primary goal of this study was to characterize physical habitat and benthic communities (macroinvertebrates) in three representative agricultural streams in California's San Joaquin Valley in 2002. These streams have been listed as impaired water bodies (303d list) by the State of California due to the presence of the organophosphate (OP) insecticides chlorpyrifos and diazinon. A secondary goal of this study was to compare the presence of OP-sensitive benthic species in these streams with available OP toxicity and exposure data to determine if these benthic species are present. Habitat requirements and to a lesser degree sampling gear limitations were considered in this comparison.

Based on 10 instream and riparian physical habitat metrics, total physical habitat scores in Del Puerto Creek ranged from 79 to 116 (maximum possible total score is 200). Most habitat metrics were highly variable among Del Puerto Creek sites. The velocity/depth/diversity metric decreased significantly from downstream to upstream sites. Orestimba Creek physical habitat scores ranged from 77 to 128. The lowest total habitat score was reported for the most downstream site. However, there were no significant spatial trends (upstream to downstream) for any of the physical habitat metrics. Salt Slough physical habitat scores ranged from 18 to 92. The habitat at the upstream site was extremely poor. Salt Slough appears to have the strongest gradient of declining habitat from downstream to upstream..

Approximately 3,800 individual macroinvertebrates were picked and identified from 95 taxa in five Del Puerto Creek sites. Chironomids, oligochaetes and hirundinea were the three most dominant taxa. Chironomids can be either sensitive or tolerant to environmental stressors depending on the species; oligochaetes are generally found in stressful environments. Hirundinea (leeches) are

a highly tolerant taxa. Pollution sensitive species such as Ephemeroptera (mayflies), Plecoptera (stoneflies) and Tricoptera (caddisflies) - EPT taxa - were generally found in low numbers at most of the sites. Total taxa richness in Del Puerto Creek ranged from 24 at one upstream site to 57 at the most upstream site. The number of individuals collected at each site did not show a consistent pattern from upstream to downstream, although the greatest number of individuals were collected from the upstream site. Most of the benthic metrics were consistent at the five Del Puerto Creek sites. The exceptions were greater EPT taxa (sensitive taxa) at the upstream site and higher percent of collectors (a feeding guild typically dominant in stressed environments) at two sites.

Approximately 6,600 individual macroinvertebrates from 107 taxa were picked and identified from 10 sites in Orestimba Creek. Oligochaetes and chironomids were the two most dominant taxa collected. As discussed above, oligochaetes are generally found in stressful environments while chironomids can be either sensitive or tolerant to environmental stressors depending on the species. Two non-insect taxa - pelecypoda and cladocera - also comprised approximately 14% of the individuals collected at this stream. Pelecypoda (clams such as *Corbicula*) and cladocerans (water fleas) are generally considered tolerant of most environmental stressors. However, cladocerans are considered particularly sensitive to OP insecticides (chlorpyrifos and diazinon) commonly used in the Orestimba Creek area. Pollution-sensitive species (EPT taxa) were generally collected in low numbers in this creek with the highest numbers collected at the upstream site. Total taxa richness ranged from 28 to 45. Benthic abundance was generally greater at the upstream sites and lower at the downstream sites. EPT taxa were primarily found at the upstream site. The percent tolerant taxa were highly variable among sites. The % chironomidae were higher at the downstream Orestimba Creek site. Collectors, a feeding guild that dominates in stressed environments, were the dominant feeding group for the various benthic taxa collected in three of the Orestimba Creek sites.

Approximately 3,900 individual macroinvertebrates from 81 taxa were picked and identified from five Salt Slough sites. The most dominant species (*Corophium spinicorne*) collected in this stream is an amphipod. Amphipods are generally considered sensitive to various stressors, particularly OP insecticides. Chironomids - a taxonomic assemblage that is either tolerant or sensitive to environmental degradation - were also dominant in Salt Slough. Daphnids - a highly sensitive taxa to OP insecticides - were the 8^{th} most dominant taxa found in this stream. Total taxa richness in Salt Slough ranged from 34 to 43. Benthic abundance generally increased from downstream to upstream. The % chironomidae and % collectors (taxa generally associated with stressed environments) generally increased from downstream to upstream. The percent shredders (taxa associated with non-stressed environments) was higher at one of the upstream sites. At the three downstream sites, the percent filterers (taxa associated with stressed environments) was higher.

Channel flow, riparian buffer, and velocity/depth/diversity were the most important physical habitat metrics influencing the various benthic metrics for these three streams. For the non-traditional habitat metrics, velocity had the highest number of significant relationships with the various benthic metrics.

A qualitative comparison of OP-sensitive benthic species in the three agricultural streams based on single species toxicity data was limited due to lack of data. The most dominant macroinvertebrate species collected in Salt Slough (the amphipod, *Corophium spinicorne*) is a member of a taxa considered sensitive to OPs. Daphnids, another OP-sensitive taxa of benthic invertebrates, were the 6^{th} most dominant species in Orestimba Creek and the 8^{th} most dominant species in Salt Slough. *Chironomus sp* and *Gammarus lacustris,* other benthic species particularly sensitive to chlorpyrifos, were also found in all three streams. These data suggest that selected OP sensitive benthic species have not been eliminated from agricultural streams classified as impaired due to the presence of OPs.

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

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

INTRODUCTION

Abundant water and long growing seasons are critical factors responsible for the highly productive agricultural economy in California's San Joaquin Valley. Approximately 10.2% of the total value of agricultural production in the United States came 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. The following factors may have contributed to the decline of aquatic resources in California's Central Valley: water diversion, changes in basin hydrology, loss of habitat, introduction of exotic species and contaminants (e. g. organophosphate insecticides) (Foe, 1995). Activities such as diking, dredging, filling of wetlands and significant diversion of freshwater flows for irrigated agriculture and urban use have also altered fish habitat and resulted in adverse impacts on fish populations (Moyle et al., 1992).

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

screening or initial assessment of conditions; (2) characterization of impairment and diagnosis; and (3) trend monitoring to evaluate improvements from mitigation practices or further degradation.

The primary goal of this study was to characterize physical habitat and benthic communities in three representative agricultural streams in California's San Joaquin Valley. 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, 13 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). 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) and 2001 (Hall and Killen, 2002). Initial site visits were conducted for all streams in April of 2002. Exact sample stations were determined in each stream and landowner contacts were made to access the sample sites for the late spring/early summer sampling.

Physical Habitat Assessments

Physical habitat was evaluated at each site concurrently with benthic collections and water quality evaluations. The physical habitat evaluation methods followed protocols described in

Harrington (1999) and Harrington and Born (2000). The physical habitat metrics used for this study are based on nationally standardized protocols described in Barbour et al. (1999). A total of 10 continuous metrics scored on a 0-20 scale were evaluated (Appendix A). Other non-continuous metrics including percent canopy, % gradient, and substrate composition that were also measured are described in Appendix A.

Benthic Macroinvertebrate Sampling

Benthic macroinvertebrates were collected in the late spring of 2002 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 (1999) and 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 then taken using a standard D-net with 0.5 mm mesh starting with the most downstream portion of the riffle. A 1x2 foot section of the riffle immediately upstream of the net was disturbed to a depth of 4-6 inches to dislodge and collect the benthic macroinvertebrates. Large rocks and woody debris were scrubbed and leaves were examined to dislodge organisms clinging to these substrates. Within each of the randomly chosen transects, three replicate samples were collected to reflect the structure and complexity of the habitat within the transect. If habitat complexity was lacking, samples were taken near the side margins and thalweg of the transect and the procedures described above were followed. All samples were preserved with 95% ethanol.

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

Taxonomy of Benthic Macroinvertebrates

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

The benthic macroinvertebrate subsampling (resulting in a maximum of 300 individuals) and identifications were supervised by Angie Montalvo of California's Department of Fish and Game (CDFG) in Rancho Cordova, California. The benthic macroinvertebrate samples were subsampled and sorted by personnel at the CDFG Laboratory located at Chico State University campus. Level 3 identifications (species level identifications) followed protocols outlined in Harrington and Born (2000). Mr. Dan Pickard of CDFG conducted the taxonomic identifications. Slide preparations and mounting for species such as midges and oligochaetes followed protocols from the United States Geological Survey National Quality Control Laboratory described in Moulton et al. 2000.

Water Quality Measurements

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

Statistical Analysis

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

RESULTS

Physical Habitat

Del Puerto Creek

The total physical habitat scores in Del Puerto Creek ranged from 79 to 116 for the ten metrics that were scored on a 0 to 20 scale (Table 2). Most of the metrics were highly variable across the five stations within Del Puerto Creek indicating diverse physical habitat conditions in this waterbody. For example, velocity/depth/diversity ranged from 3 to 17, embeddedness ranged from 4 to 16, and frequency of bend/riffles ranged from 8 to 15. The site with the lowest total physical habitat score (DLP4) had particularly low scores for embeddedness, sediment deposition, frequency of bends/riffles, and riparian zone. In contrast, the site with the highest physical habitat score (DLP3) had higher scores for all of these metrics except embeddedness.

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 to 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 0.13 m/s upstream to 0.58 m/s downstream. The mean value across all five sites was 0.42 m/s. The percent canopy for the five Del Puerto Creek sites ranged from 0% at DLP2, DLP4 and DLP5 to 86% at downstream site DLP1. Gradient was consistent at all sites (1%). The percent fines for substrate percentages ranged from 20% DLP5 (upstream site) to 55% at DLP1.

Orestimba Creek

Orestimba Creek total physical habitat scores for the 10 metrics that were scored on a 0 to 20 scale ranged from 77 to 128 (Table 2). The lowest total habitat score (77) was reported for the downstream site ORE1 (Figure 3). This site had particularly low scores for embeddedness, sediment deposition, and frequency of bends/riffles. The highest total habitat score (128) was reported at ORE5. The following metrics were reasonably high at this site: velocity/depth/diversity, sediment deposition, channel flow status and frequency of bends/riffles. Other descriptive habitat metrics for the 10 Orestimba Creek sites in Table 3 showed that mean site flow ranged from 0.01 to 0.59 m/s (mean stream value of 0.33 m/s), % canopy ranged from 0 to 81%, % gradient was consistently 1%, and % fines ranged from 20% to 100%.

Salt Slough

The total physical habitat scores in Salt Slough ranged from 18 to 92 for the 10 metrics that were scored on a 0 to 20 scale (Table 2). The lowest total physical habitat score (18) was reported at the most upstream site (SSL5). This site had particularly low scores for embeddedness, velocity /depth/diversity, channel alteration, frequency of bends/riffles, bank stability, vegetative protection, and riparian vegetation. The highest total physical habitat score (92) was reported at the downstream site (SSL2). Velocity/depth/diversity, channel flow status, and channel alteration were optimal (a high rating) at this site. The embeddedness metric, which is an rough measure of sediment loading, was particularly low at all sites in this stream when compared with either Del Puerto Creek or Orestimba Creek.

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

Summary Statistical Analysis for All Creeks

Principal Components Analysis (PCA) was used to determine the relationship among habitat metrics and identify metrics that covary (ie. 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 79% of the variance in the data set. The metrics important to each factor are presented in Table 5. Bank stability, bank vegetation, and channel alteration were heavily loaded on the first factor. Bank stability and bank vegetation are related as both are riparian metrics. Metric loading on factor two included: epifaunal substrate, riparian buffer, and sediment deposition. Epifaunal substrate and sediment deposition are related to sediment. Factor three had loading for velocity/depth/diversity, channel flow and embeddedness. All three of these metrics are "instream" characteristics related to water movement processes.

Correlations among raw physical habitat metrics grouped by factors identified by PCA showed correlations are high among the three metrics supporting factor 1 (Table 6). In factor 2, epifaunal substrate is strongly correlated with riparian buffer and sediment deposition; riparian buffer is strongly correlated with epifaunal substrate but not sediment deposition. Sediment depositon is strongly correlated with epifaunal substrate but not riparian buffer. In factor 3, velocity/depth/diversity is significantly correlated with channel flow but not embeddedness; channel flow is significantly correlated with velocity/depth/diversity but not embeddedness; and embeddedness is not correlated with either velocity/depth/diversity or channel flow. Riparian buffer was the only habitat metric that had a relatively low correlation (0.28) with total habitat score

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

The Spearman rank test for trends was conducted for each physical habitat metric in each stream to examine trends that might be associated with changing morphology of the stream between upstream and downstream (Table 8). Salt Slough appears to have the strongest gradient from upstream to downstream in physical habitat metrics as the ranks of the total habitat score align very well with the upstream-downstream position. Most of the metrics show a negative correlation with site indicating a decrease in value moving upstream. Although only the individual metrics of velocity/depth/diversity and riparian buffer have significant trends in Salt Slough, the lack of significance for other metrics may be due to small sample size. In Orestimba Creek, there were no significant metrics based on an "upstream to downstream analysis". There also appears to be no significant spatial trends in habitat metrics in Del Puerto Creek, with the exception of velocity/depth/diversity, which decreased from downstream to upstream.

More than half of the mean habitat metrics were greater in Orestimba Creek when compared with the other two agricultural streams (Table 9). Significant differences were reported for four metrics among the three streams. Pairwise regression showed that epifaunal substrate, sediment deposition and embeddedness were significantly lower in Salt Slough when compared with either Del Puerto Creek or Orestimba Creek. Bend/riffle frequency was lower in Salt Slough when compared with Del Puerto Creek. The total habitat score in Salt Slough was also was significantly lower than in Orestimba Creek. However, there was no statistical difference in total habitat score between Orestimba Creek and Del Puerto Creek.

Benthic Macroinvertebrates

Del Puerto Creek

Approximately 3,800 individual macroinvertebrates were picked and identified from 95 taxa collected from five Del Puerto Creek sites (Table 10; Appendix B). The five most abundant taxa - *Slavina appendiculata,* undetermined Tubificadae, *Cricotopus sp*, *Helobdella stagnalis*, and *Nais communis/variabilis*, - comprised over 50% of the total individuals collected (Table 10). Chironomids, oligochaetes and hirundinea were generally the three most dominant taxa. Chironomids can be either sensitive or tolerant to environmental stressors depending on the species (Stribling et al., 1998) while oligochaetes are generally found in stressful environments (Harrington and Born, 2000). Hirundinea (leeches) are a highly tolerant taxa (Harrington and Born, 2000). Pollution sensitive species such as Ephemeroptera (mayflies), Plecoptera (stoneflies) and Tricoptera (caddisflies), i.e. EPT taxa, were generally found in low numbers at most of the sites.

Total taxa richness ranged from 24 at upstream site (DLP4) to 57 at the most upstream site (DLP5) (Figure 5). The most upstream site (DLP5) was above the agricultural activity in this stream. Taxa richness was reasonably consistent among the three transects at each site but the number of individuals per site was more variable (Figure 6). The number of individuals collected at each site did not show a consistent pattern from upstream to downstream; although the greatest number of individuals were collected at the upstream site..

Most of the benthic metrics summarized in Table 11 were generally consistent among sites with only a few exceptions. EPT taxa and percent Baetidae (mayflies) were more dominant at the upstream site (DLP5). The mean % Chironomidae were higher at DLP4 when compared with the other sites. Percent collectors - a feeding guild typically dominant in a stressed environment (Harrington and Born, 2000) - were dominant at DLP1 and DLP4. Percent shredders (macrobenthos that shred coarse material) were dominant at DLP3. Shredders are typically found in non-stressed environments (Harrington and Born, 2000).

Orestimba Creek

Approximately 6,600 individual macroinvertebrates were picked and identified from 107 taxa collected from 10 sites in Orestimba Creek (Table 12; Appendix C). The following taxa comprised over 50% of the total number of individuals collected: *Ophidonais serpentina*, *Simulium sp.*, *Orthocladius complex*, *Corbicula sp.*, *Cricotpus sp.*, and *Daphnidae*. Oligochaetes and chironomids were the two most dominant taxa collected. As discussed above, oligochaetes are generally found in stressful environments while chironomids can be either sensitive or tolerant depending on the species. Two non-insect taxa - Pelecypoda (9%) and Cladocera (5%) - also comprised approximately 14% of the individuals collected at this stream. Pelecypoda (clams such as *Corbicula*) and Cladocera (water fleas) are generally considered tolerant of most environmental stressors (Harrington and Born, 2000). However, water fleas are considered particularly sensitive to OP insecticides such as chlorpyrifos (Giesy et al., 1999) and diazinon (Giddings et al., 2000). These are two commonly used insecticides in the Orestimba Creek area. Pollution-sensitive species (EPT taxa) were generally collected in low numbers in this creek with the highest numbers collected at the upstream site (ORE10).

Total taxa richness ranged from 28 at ORE8 to 45 at the most upstream site ORE 10 (Figure 7). Richness was variable among the transects at most of the sites. The number of individuals per transect at each site was also somewhat variable for most of the sites (Figure 8). Benthic abundance was generally greater at the upstream sites (ORE8 and ORE10) with the lowest abundance reported downstream (ORE1 and ORE2).

Various benthic metrics for the Orestimba Creek sites summarized in Table 13 showed the following: (1) % dominant taxa were lower at ORE1, ORE7, and ORE9; (2) EPT taxa (taxa associated with non-stressed environments) were primarily found at ORE10; (3) % tolerant taxa were highly variable among sites; and (4) % chironomidae were higher at downstream site ORE1. The % collectors (generally associated with stressed environments) were higher at ORE1, ORE8 and ORE10. The % shredders - taxa associated with non-stressed environments - were low (< 27%) at all locations.

Salt Slough

Approximately 3,900 individual macroinvertebrates were picked and identified from 81 taxa in five Salt Slough sites (Table 14, Appendix D). *Corophium spinicorne, Chironomus sp., Physa/Physella,* and *Cricotopus bicinctus* group comprised over half of the individuals collected. The most dominant species (*C. spinicorne*) is an amphipod. Amphipods are generally considered sensitive to OP insecticides (Giesy et al., 1999; Giddings et al., 2000) as well as other stressors (Harrington and Born, 2000). Chironomids were also a dominant taxa collected in this stream. Chironomids can be either tolerant or sensitive to environmental degradation depending upon the species (Stribling et al., 1998). Daphnids - which are highly sensitive to OP insecticides (Giesy et al., 1999 ; Giddings et al. 2000) - were the 8th most dominant taxa found in this stream. The lower flow conditions (lentic-like habitat) in Salt Slough may have influenced the higher abundance of daphnids. Poletika et al. (2002) have reported a similar finding for daphnids in lentic environments.

Total taxa richness ranged from 34 at SSL5 (the most upstream site) to 43 at SSL3 (Figure 9). Richness was variable by site among the transects. The number of individuals per transect at each site was also variable (Figure 10). Benthic abundance generally increased from downstream to upstream.

The % chironomidae and % collectors (generally associated with stressed environments) generally increased from downstream to upstream (Table 15). The percent shredders (associated with non-stressed environments) were generally higher at upstream SSL4 and lower at downstream site SSL1. The percent filterers (taxa associated with stressed environments) were higher at the three downstream sites (SSL1, SSL2 and SSL3).

Summary Statistical Analysis for all Creeks

PCA was used to determine the relationship among the benthic metrics and identify metrics that covary (Table 16). Seven Eigenvalues exceeded 1 indicating that there were seven important factors in these data. Sensitive EPT Index (%), percent intolerant taxa, cumulative EPT taxa, Ephemoroptera taxa, EPT taxa, % Baetidae, and taxonomic richness were heavily loaded on factor 1 (Table 17). Factor 2 was composed of Trichoptera taxa. Tolerance value and % tolerant taxa were significant for Factor 3. Factor 4 was composed of abundance, Shannon Diversity, and % dominant taxa. Percent shredders, % collectors, and cumulative taxa were heavily loaded on Factor 5. Percent Hydropsychidae, % filterers and EPT Index were significant for Factor 6. Percent predators, % Chironomidae and % grazers were heavily loaded on Factor 7 (Table 17).

Spearmans Rank Correlation Analysis showed a significant ($p<0.05$) spatial trend - a significant decrease from downstream to upstream - for percent dominant taxa in Del Puerto Creek (Table 18). For Orestimba Creek, there was a significant increase downstream to upstream for abundance, cumulative EPT taxa, and percent filterers. There was also a significant increase downstream to upstream for percent collectors, percent shredders, and Trichoptera taxa in Salt Slough. In contrast, a significant decease in percent predators was reported from downstream to upstream in Salt Slough (Table 18).

A comparison among benthic metrics in Del Puerto Creek, Orestimba Creek and Salt Slough in Table 19 showed that none of the metrics were significantly different among streams at the 0.05 significance level. However, % filterers and % grazers were lower ($p < 0.06$) in Orestimba Creek when compared with either Del Puerto Creek or Salt Slough.

Relationship of Physical Habitat and Benthos

Spearman's Rank Correlation Analysis showed that channel flow, riparian buffer, and velocity/depth/diversity were the most important physical habitat metrics influencing the various benthic metrics (Table 20). Channel flow was negatively correlated with cumulative taxa, % Baetidae, % grazers, % intolerant taxa, and sensitive EPT Index. Riparian buffer was positively correlated with cumulative EPT taxa, EPT index, EPT taxa, and Trichoptera taxa. Velocity/depth/diversity was negatively correlated with Ephemeroptera taxa, % Chironomidae, and Shannnon diversity. A positive correlation was reported between velocity/depth/diversity and percent dominant taxa. The total physical habitat index score was negatively correlated with % tolerant taxa and tolerance value.

The correlation matrix in Table 21 for habitat metrics not scored on a 0-20 scale shows that velocity has the highest number of significant relationships with the various benthic metrics. Velocity was significant but negatively correlated with cumulative taxa, Shannon Diversity, and tolerance value. Velocity was positively correlated with % dominant taxa. The other significant relationships were: (1) width was positively correlated with % filterers; (2) depth was positively correlated with cumulative taxa and tolerance value; and (3) canopy was negatively correlated with abundance and % predators.

Water Quality

Del Puerto Creek

Various water quality conditions such as pH and salinity were reasonably consistent at all five sample sites in Del Puerto Creek (Table 1). Parameters such as temperature (15.6 to 28.3 C), conductivity (520 to 1,686 umhos/L), dissolved oxygen (5.4 to 12.2 mg/L) and turbidity (1.1 to 130 NTU) were variable across the various study sites. Spatial patterns showed that dissolved oxygen and conductivity were higher at the upstream site (DLP5) when compared with the downstream sites. Turbidity was significantly lower at the upstream site (DPL5) when compared with the other sites. This upstream site is located above agricultural activities where eroded soil may increase turbidity in the stream.

A comparison of water quality measurements in Table 22 for the five Del Puerto Creek sites sampled in 2001 (Hall and Killen, 2002) and 2002 showed the following: (1) temperature was lower at the three downstream sites in 2002; (2) conductivity was lower at all sites except DLP5 in 2002; (3) pH was fairly consistent at all sites between the two years; (4) dissolved oxygen was higher at all sites in 2002; (5) salinity was fairly consistent at all sites between the two years; and (6) turbidity showed no consistent spatial pattern between years except the upstream site had significantly lower turbidity for both years.

Orestimba Creek

Salinity and pH were fairly consistent among all 10 sites in Orestimba Creek (Table 1). Temperature ranged from 18.1 to 23.1 C with no clear spatial pattern. Conductivity ranged from 605 to 825 umhos/L. Dissolved oxygen varied from 3.2 mg/L at the most upstream site (ORE10) to 8.4 mg/L at a downstream site (ORE7). Only one dissolved oxygen value (ORE10) was below 5.0 mg/L in Orestimba Creek - a concentration likely to be stressful to aquatic life (Lee and Jones-Lee, 2000). Turbidity was much lower at the upstream site (ORE10) when compared with the nine downstream sites. The lower turbidity at this upstream site likely occurs because there is no suspended sediment coming from eroded soil in irrigated agricultural fields (sites ORE 1-9).

A comparison of water quality data in Table 22 for the 10 Orestimba Creek sites sampled in 2000 (Hall and Killen, 2001), 2001 (Hall and Killen, 2002) and 2002 showed the following: (1) temperature was lower at six of the sites in 2002; (2) specific conductance was lower for half of the sites in 2002; (3) pH was consistent among all sites for the three years; (4) dissolved oxygen was significantly less at all sites in 2001 except ORE1; (5) salinity was consistent among all sites for 2002 and 2001; and (6) turbidity was higher at nine of the ten sites in 2002.

Salt Slough

Most of the water quality conditions were consistent in all five Salt Slough sites with the exception of conductivity which ranged from 1,073 to 1,885 umhos/L (Table 1). Specifically, the following ranges of water quality conditions were reported: temperature (18 to 23.5 C), pH (7.3 to 7.8), dissolved oxygen (4.8 to 7.4 mg/L), salinity (0.6 to 0.9 ppt) and turbidity (37 to 52 NTU). There was no apparent spatial trend of these water quality conditions.

A comparison of water quality data in Table 22 for the five Salt Slough sites sampled in 2001 (Hall and Killen, 2002) and 2002 showed the following: (1) temperature was lower for four sites in 2002; (2) conductivity was higher at all sites in 2002; (3) pH was consistent among sites for both years; (4) dissolved oxygen was lower at all sites in 2001; (5) salinity was consistently higher at all sites in 2002; and (6) turbidity was lower at all sites in 2002.

DISCUSSION

Physical Habitat

The three major stressors to aquatic life in California streams are water augmentation, sediment loading and impaired physical habitat (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 (Karr et al., 1986). Identifying degraded physical habitat in streams is critical for bioassessments as failure to do so can sometimes hinder investigations on the effects of toxic chemicals or other water quality related stressors. There is a small but still significant risk of reporting a water quality related impact when one does not exist (false positive) when habitat assessments are insufficient or absent (Rankin, 1995). Physical habitat evaluations are not intended to replace biological assessments but rather to add an additional line of evidence about the status of lotic systems when conducted in concert with biological assessments. Evaluation of physical habitat in agricultural streams in California's Central Valley is particularly important due to the intensive development and landscape modifications in these areas.

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

An exact extensive historical comparison of total physical habitat scores (maximum of 200) for Del Puerto Creek (79 to 116), Orestimba Creek (77 to 128) and Salt Slough (19 to 92) 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 2002 can be cautiously compared with the same type of assessments conducted in 2000 (Hall and Killen, 2001) and 2001 (Hall and Killen, 2002) with the caveat that these are only three temporally limited evaluations (Table 23). Total physical habitat scores across the three years were variable for five sites (ORE1, ORE2, ORE3, ORE4, and ORE7) and similar for two sites (ORE6 and ORE8). Mean scores for channel flow, stream width, and stream depth were significantly different ($p<0.05$) between 2000 and 2001 (Table 24a). The increase in both stream width and stream depth between the two years implies that available aquatic habitat for benthic species increased between the two years. Although the mean total physical habitat score across all sites was similar between 2000 (122) and 2001 (131), the most significant changes in habitat by site occurred at both the downstream (ORE1) and upstream (ORE10) site (Table 23). A significant improvement occurred in physical habitat at ORE1 between 2000 and 2001 (an increase in total score from 74 to 128). Improved epifaunal substrate, velocity/depth/diversity, bank stability and vegetative protection were critical metrics that improved over the one year period. In contrast to the improved habitat at the downstream site, the total physical score at the most upstream site (ORE10) declined from 2000 to 2001 (112 to 83). Qualitative observations by the field crew during the 2001 sampling noted the presence of wading cows in this stream site. We therefore speculate that the presence of cows (which were not observed in 2000) may have contributed to impaired physical habitat. Waste contamination from cows may have also increased nutrient concentrations in this stream.

In contrast to the differences in various mean physical habitat metrics between 2000 and 2001, mean habitat metrics were similar in Orestimba Creek between 2000 and 2002 (Table 24a). The exception was a significant decrease in channel alteration between 2000 and 2002.

The highest number of significant annual differences between mean metrics in Orestimba Creek occurred between 2001 and 2002 (Table 24a). The following habitat metrics were significantly higher in 2001: velocity/depth/diversity, bend/riffle frequency, width, depth, and velocity. The increase in stream width and depth suggests that the volume of available habitat was greater in 2001 when compared with 2002. The increase in available habitat in 2001 also corresponds with a significantly higher total habitat score in 2001 when compared with 2002.

A comparison of physical habitat metrics in Table 23, Table 24 b and Table 24c between the five Del Puerto Creek and Salt Slough sites sampled in 2001 (Hall and Killen, 2002) and 2002 is possible with the caveat that these are only two temporally limited evaluations. The final habitat scores in Del Puerto Creek site DLP2 are consistent among years but the final habitat scores for the other sites are somewhat variable (Table 23). However, there were no significant differences for the various mean habitat metrics in Del Puerto Creek between 2001 and 2002 (Table 24b).

A comparison of total physical habitat scores among the five Salt Slough sites in 2001 and 2002 shows consistently lower values for all sites in 2002 (Table 23). There was no significant difference at the 0.05 level but the mean total habitat score was higher in 2001 at a slightly higher significance level of $p < 0.07$ (Table 24c). Other mean physical habitat metrics that were significantly higher ($p < 0.07$) in Salt Slough in 2001 were bank stability, bend/riffle frequency, and channel flow.

Presence of OP-Sensitive Species

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

Chlorpyrifos acute toxicity data were available for 15 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 lacustris* (LC50 = 110 ng/L), Daphnidae (LC50 = 210 ng/L), *Peltodytes sp.* (LC50 = 800 ng/L), *Hyalella azteca* (LC50 = 1,300 ng/L), *Paratanytarsus sp.* (LC50 < 1,600 ng/L), and *Dugesia tigrina* (LC50 = 2,000 - 4,300 ng/L). The species most sensitive to chlorpyrifos (*Chironomus sp.)* was found in all three streams but was clearly less abundant in Del Puerto Creek. *Gammarus lacustris* are also predicted to be sensitive to chlorpyrifos based on single species toxicity tests and the effect concentrations are enviromentally realistic. This scud was found in all three streams but was more abundant in Orestimba Creek and Del Puerto Creek.

Daphniidae (cladocerans) were collected in all three streams with higher numbers in upstream sites of Orestimba Creek and Salt Slough (Table 26). Collecting high numbers of cladocerans in the upstream sites of these two streams may be related to their habitat preference as daphnids prefer lentic environments such as ponds and lakes rather than lotic environments such as streams and creeks (Pennack, 1989). Upstream sites for both of these streams were lentic type habitats (i.e. pool type habitat in Orestimba Creek) that may have contributed to higher numbers of cladocerans. The sampling gear used for collection of benthic macroinvertebrates in lotic habitats (D net with 0.5 mm mesh) is also somewhat inefficient for daphnids which may have influenced the numbers collected at all sites.

The Coleoptera, *Peltodytes sp.* was only collected at upstream sites in Del Puerto Creek and Orestimba Creek. The amphipod, *Hyalella azteca*, was collected in low numbers Orestimba Creek and Salt Slough. The chironomid, *Paratanytarsus sp.*, was collected in all three streams but was clearly more dominant in Salt Slough. The flatworm, *Dugesia tigrina* was found at most sites in both Del Puerto and Orestimba Creeks.

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: daphniids (LC50 = 780 to 1,020 ng/L);

Hyalella azteca (LC50 = 22,000 ng/L); and *Baetis tricaudatus* (LC50 = 24,000 ng/L). Daphniids (cladocerans) were collected in all streams but were more dominant in upstream sites in Orestimba Creek (6^{th} most dominant species) and Salt Slough (8^{th} most dominant species). Unsuitable habitat for this lentic species was likely a factor contributing to the low number collected collected at other sites and to a lesser degree the use of stream bioassessment sampling gear may have also been a factor. The amphipod, *Hyalella azteca,* was only collected in low numbers in both Orestimba Creek and Salt Slough. The mayfly *B. tricaudatus* - a species potentially sensitive to maximum reported environmental concentrations of diazinon - was collected in low numbers in both Del Puerto Creek and Orestimba Creek. Of the remaining three taxa in Table 27, *Physa/Physella* (gastropod), *Gammarus lacustris* (scud), and undetermined tubificidae were found in all three streams.

Historical Comparisons of Benthic Assemblages

Historical comparisons of our data with other benthic data from these three streams were limited. In 1993, the U. S Geological Survey collected benthic macroinvertebrates at one site in Orestimba Creek that was approximately half way between our stations ORE 2 and ORE 3 (Larry Brown, personal communication). Dominant taxa reported by these investigators were mayflies, oligochaetes and gastropods. The dominant taxa we reported in Orestimba Creek (particularly at ORE 2 and 3) were oligochaetes and chironomids. Mayflies were not collected during our 2002 sampling at these two sites but gastropods were collected in moderate numbers. Due to the nine year time period between the two sampling events, it is difficult to explain possible factors contributing to the differences in dominant taxa.

Benthic community assessments conducted during the present study at the 10 Orestimba Creek sites can be compared with similar studies conducted at the same sites in 2000 (Hall and

Killen, 2001) and 2001 (Hall and Killen, 2002). A comparison of mean benthic metrics across all 10 sites for 2000, 2001 and 2002 showed that percent collectors were higher in 2000 than in 2001 and 2002 (Table 28a). Percent collectors were also higher in 2001 than in 2002. The percent filterers were higher in 2001 than in 2000 and were also higher in 2002 than in 2000. There were no other significant differences among benthic metrics at the three sites using a significance level of $p < 0.05$. However, using a cutpoint of $p < 0.07$ percent chironomidae taxa were higher in 2002 than 2001 and percent dominant taxa were higher in 2000 than 2001. Using the same cutpoint ($p < 0.07$), percent tolerant taxa were lower in 2002 than 2000 or 2001. Shannon Diversity Index was lower in 2000 than in 2001 and 2002 ($p<0.07$). In general, the mean scores for most benthic metrics were fairly consistent for Orestimba Creek sites for 2000, 2001 and 2002.

A comparison of mean benthic metrics in Del Puerto Creek for 2001 and 2002 showed no significant differences ($p<0.05$) for any metric (Table 28b). However by using a slightly higher statistical cutpoint ($p<0.07$), a higher percent grazers and a higher tolerance value was reported in 2002. The mean scores for the various benthic metrics were fairly consistent between 2001 and 2002 in Del Puerto Creek.

Mean benthic metrics reported for the five Salt Slough sites in 2001 and 2002 showed no significant differences ($p<0.05$) for any metric between years (Table 28c). However with a slightly higher statistical cutpoint ($p<0.07$), abundance and percent shredders were higher in 2002 while percent collectors and percent tolerant taxa were higher in 2001. In general, the various mean benthic metrics were consistent between 2001 and 2002 in Salt Slough.

Regulatory and Ecological Implications

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

Benthic communities in all three agricultural streams were generally comprised of tolerant species such as oligochaetes and chironomids with the exception of Salt Slough where amphipods (an OP sensitive species) were dominant. Dominance by tolerant species is expected in these streams due to fluctuating flow conditions and stressful water quality conditions such elevated temperature and low dissolved oxygen. Historical data from permanent gaging stations near ORE 10 (USGS) and ORE 8 (CA DWR) show 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). Daphnids (cladocerans) with a moderate tolerance rating to general environmental stressors, but highly sensitive to chlorpyrifos and diazinon based on laboratory toxicity tests, were the 6^{th} most dominant species in Orestimba Creek. Two other OP sensitive species - the amphipod, *Corophium spinicorne* (most dominant species), and Daphnids (8^{th} most dominant species) - were also abundant in Salt Slough. The presence of these OP sensitive benthic species in these water bodies suggest that the laboratory toxicity data used to generate the "effects benchmarks" for OPs may not accurately predict the status of resident biota.

Critical issues to address with the benthic community data from these streams are: (1) What are the biological (benthic) expectations for these agricultural streams? and (2) Do these streams meet these biological expectations and are they impaired based on the status of resident benthic communities? Unfortunately, an agricultural reference stream is not available for this watersheds to compare benthic communities for each stream. Therefore, the traditional approach often used to interpret the status of benthic communities is not feasible. The presence of 95 taxa in Del Puerto Creek, 107 taxa in Orestimba Creek, and 81 taxa in Salt Slough implies that the benthic communities in these streams are fairly diverse, considering their ephemeral environments, but without a clear definition of benthic community expectations it is unknown if these water bodies are actually impaired. Extensive spatial and temporal assessments of benthic communities in concert with physical habitat assessments are needed in agricultural streams of California's Central Valley in order to identify the range of benthic community taxa assemblages by stream orders and identify potential reference sites.

REFERENCES

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

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

Dubrovsky, N. M., C. R. Kratzer, L. R. Brown, J. M. Gronberg, and K. R. Burow. 1998. Water quality in the San 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, Sacramento, 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.

Harrington, J.. 1999. California's stream bioassessment procedure. Report. California Department of Fish and Game, Rancho Cordova, CA.

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

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

Kazyak, P. F. 1997. Maryland Biological Stream Survey Sampling Manuel. 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.

Pennack, R. W. 1989. *Freshwater Invertebrates of the United States*. John Wiley and Sons, Inc. New York, NY.

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 AgroSciences LLC, Indianapolis, IN.

Poletika, N. N., K. B. Woodburn, and K. S. Henry. 2002. A ecological risk assessment for chlorpyrifos in an agriculturally dominanted 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 Incorported, Owings, MD.

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

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

TABLES AND FIGURES

Table 1. Sample site names, coordinates and water quality parameters measured during late spring 2002 in Del Puerto Creek, Orestimba Creek and Salt Slough.

Site	Latitude	Longitude	Water Temperature (C)	Specific Conductivity µmhos/L	pH	Dissolved Oxygen mg/L	Salinity ppt	Turbidity NTU
DLP1	37 32 25	121 07 07	15.6	704	8.06	9.5	0.4	84
DLP2	37 32 03	121 07 46	20.6	709	8.58	8.8	0.4	130
DLP3	37 31 20	121 08 54	22.2	742	8.34	9.1	0.4	112
DLP4	37 30 43	121 09 38	28.3	520	7.55	5.4	0.2	20
DLP5	37 28 59	121 12 41	22.7	1689	8.51	12.2	0.9	1.1
ORE1	37 25 10	121 00 09	18.1	663	7.80	7.6	0.4	376
ORE2	37 25 12	121 00 21	19.9	605	8.01	7.8	0.3	207
ORE3	37 24 47	121 00 59	21.1	653	8.12	8.1	0.3	153
ORE4	37 24 19	121 01 28	21.0	640	8.09	8.3	0.3	226
ORE5	37 23 54	121 02 02	18.8	656	8.06	7.6	0.4	201
ORE6	37 23 21	121 02 34	18.7	696	8.21	8.1	0.4	178
ORE7	37 22 59	121 03 00	20.1	711	8.14	8.4	0.4	166
ORE8	37 22 37	121 03 31	22.6	763	8.08	7.9	0.4	150
ORE9	37 21 53	121 03 45	23.1	697	8.13	8.0	0.4	236
ORE10	37 19 08	121 07 18	18.1	825	8.25	3.2	0.1	0.88
SSL1	37 14 54	120 51 12	18.5	1885	7.69	6.4	0.9	46
SSL2	37 11 59	120 49 33	19.3	1339	7.43	6.0	0.8	41
SSL3	37 09 33	120 48 44	20.8	1256	7.56	6.7	0.7	52
SSL4	37 08 21	120 46 04	23.5	1073	7.75	7.4	0.6	52
SSL5	37 07 45	120 42 28	18.0	1473	7.37	4.8	0.7	37

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

Site	Epi Subs	Embedd	Veloc Depth Divers	Sedim Depos	Chan Flow Status	Chan Alt	Freq Bends Riffles	Left Bank Stab	Right Bank Stab	L Bank Veget. Protect	R Bank Veget. Protect	L Bank Ripar Zone	R Bank Ripar Zone	Total
DPL1	10	8	17	12	14	14	15	5	5	3	4	1	3	111
DPL2	11	7	10	12	15	8	12	3	3	3	3	1	1	88
DPL3	10	4	10	12	16	14	14	7	7	7	7	4	4	116
DPL4	9	4	10	6	8	11	8	6	7	4	4	1	1	79
DPL5	3	16	3	13	7	16	9	7	7	5	5	6	6	103
ORE1	9	0	6	1	14	14	4	6	3	6	6	4	4	77
ORE2	10	13	9	14	16	15	11	6	6	6	6	5	3	120
ORE3	11	15	10	10	14	8	7	3	7	4	7	1	4	101
ORE4	8	14	10	16	19	14	6	4	2	3	3	2	2	94
ORE5	10	7	17	14	15	14	16	7	7	7	7	4	3	128
ORE6	7	9	5	16	19	13	15	8	8	6	6	5	4	121
ORE7	8	10	10	17	18	14	7	7	6	7	7	4	4	119
ORE8	9	7	16	16	19	14	11	4	6	7	7	4	5	125
ORE9	11	9	10	16	9	15	9	7	8	7	7	3	5	116
ORE10	8	14	3	8	6	13	11	4	4	4	4	6	6	91
SSL1	2	0	11	2	13	14	7	5	3	6	6	8	8	85
SSL2	1	0	13	2	14	15	1	8	8	7	7	8	8	92
SSL3	1	0	9	2	11	14	2	6	8	7	7	4	5	76
SSL4	6	0	6	3	13	13	5	2	7	4	6	4	4	73
SSL5	6	0	0	3	9	0	0	0	0	0	0	0	0	18

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

Site	Mean Flow m/s	Canopy Cover %	Gradient %	Fines %	Gravel %	Cobble %	Boulder %	Bedrock %
DLP 1	0.58	86	1	55	40	5	0	0
DLP 2	0.54	0	1	50	40	10	0	0
DLP 3	0.54	39	1	50	40	10	0	0
DLP 4	0.32	0	1	50	40	10	0	0
DLP 5	0.13	0	1	20	60	20	0	0
ORE 1	0.03	44	1	100	0	0	0	0
ORE 2	0.50	47	1	30	70	0	0	0
ORE 3	0.23	81	1	25	55	5	15	0
ORE 4	0.59	61	1	20	70	10	0	0
ORE 5	0.28	91	1	40	40	20	0	0
ORE 6*	0.46	0	1	40	60	0	0	0
ORE 7	0.41	44	1	25	50	25	0	0
ORE 8	0.52	0	1	40	40	20	0	0
ORE 9	0.26	67	1	30	55	15	0	0
ORE 10**	0.01	66	1	40	35	25	0	0
SSL 1	0.22	0	1	100	0	0	0	0
SSL 2	0.29	0	1	100	0	0	0	0
SSL 3	0.34	0	1	100	0	0	0	0
SSL 4	0.18	0	1	100	0	0	0	0
SSL 5	0	0	1	100	0	0	0	0

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

** Original sample segment was dry. Sample taken ~ 25 meters downstream at first watered section of stream.

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

	Eigenvalue	Proportion	Cumulative
Factor 1	3.725927*	0.3726	0.3726
Factor 2	2.814490*	0.2814	0.6540
Factor 3	1.363214*	0.1363	0.7904
Factor 4	0.589924	0.0590	0.8494
Factor 5	0.466544	0.0467	0.8960
Factor 6	0.400886	0.0401	0.9361
Factor 7	0.287227	0.0287	0.9648
Factor 8	0.188804	0.0189	0.9837
Factor 9	0.106813	0.0107	0.9944
Factor 10	0.056172	0.0056	1.0000

* eigenvalue > 1.0

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

Metric	Factor 1	Factor 2	Factor 3
BANKSTAB	0.413*	-0.186	0.116
BANKVEG	0.412*	-0.282	-0.098
CHAN ALT	0.403*	-0.236	0.217
BENRIFF	0.342+	0.318+	0.022
EPI SUB	0.128	0.502*	-0.148
RIPBUFF	0.208	-0.461*	0.235
SED DEP	0.324+	0.385*	0.187
VEL DPTH	0.320+	0.034	-0.444*
CH FLOW	0.281	0.048	-0.551*
EMBEDDED	0.185	0.337+	0.563*

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

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

	BANK STAB	BANK VEG	CHAN ALT	BEN RIFF	EPI SUB	RIP BUFF	SED DEP	VEL DPTH	CH FLOW	EMBEDD	TOTAL
BANKSTAB	1.0000	0.7941	0.7028	0.3473	-0.0617	0.4677	0.3031	0.3361	0.2640	0.1406	0.6987
		0.0001	0.0005	0.1335	0.7960	0.0376	0.1940	0.1474	0.2608	0.5544	0.0006
BANK VEG	0.7941	1.0000	0.7302	0.1900	-0.0967	0.6264	0.1663	0.4433	0.4704	-0.0473	0.6715
	0.0001		0.0003	0.4224	0.6851	0.0031	0.4835	0.0503	0.0363	0.8430	0.0012
CHAN_ALT	0.7028	0.7302	1.0000	0.3071	-0.1464	0.6452	0.2562	0.3960	0.1580	0.1843	0.6899
	0.0005	0.0003		0.1878	0.5380	0.0021	0.2756	0.0839	0.5058	0.4368	0.0008
BEN RIFF	0.3473	0.1900	0.3071	1.0000	0.5779	-0.0702	0.6772	0.3873	0.3491	0.4604	0.7424
	0.1335	0.4224	0.1878		0.0076	0.7686	0.0010	0.0916	0.1314	0.0411	0.0002
EPI SUB	-0.0617	-0.0967	-0.1464	0.5779	1.0000	-0.6023	0.5638	0.2400	0.2307	0.4136	0.3844
	0.7960	0.6851	0.5380	0.0076		0.0049	0.0096	0.3081	0.3279	0.0699	0.0942
RIP BUFF	0.4677	0.6264	0.6452	-0.0702	-0.6023	1.0000	-0.1920	0.0474	0.0614	-0.0786	0.2856
	0.0376	0.0031	0.0021	0.7686	0.0049		0.4173	0.8427	0.7971	0.7418	0.2223
SED DEP	0.3031	0.1663	0.2562	0.6772	0.5638	-0.1920	1.0000	0.2878	0.3306	0.7400	0.7578
	0.1940	0.4835	0.2756	0.0010	0.0096	0.4173		0.2186	0.1545	0.0002	0.0001
VEL DPTH	0.3361	0.4433	0.3960	0.3873	0.2400	0.0474	0.2878	1.0000	0.4706	-0.0375	0.5837
	0.1474	0.0503	0.0839	0.0916	0.3081	0.8427	0.2186		0.0363	0.8754	0.0069
CH FLOW	0.2640	0.4704	0.1580	0.3491	0.2307	0.0614	0.3306	0.4706	1.0000	-0.1062	0.5178
	0.2608	0.0363	0.5058	0.1314	0.3279	0.7971	0.1545	0.0363		0.6558	0.0194
EMBEDD	0.1406	-0.0473	0.1843	0.4604	0.4136	-0.0786	0.7400	-0.0375	-0.1062	1.0000	0.5276
	0.5544	0.8430	0.4368	0.0411	0.0699	0.7418	0.0002	0.8754	0.6558		0.0168
TOTAL	0.6987	0.6715	0.6899	0.7424	0.3844	0.2856	0.7578	0.5837	0.5178	0.5276	1.0000
	0.0006	0.0012	0.0008	0.0002	0.0942	0.2223	0.0001	0.0069	0.0194	0.0168	

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

Metric	width	depth	velocity	canopy
BANKSTAB	-0.0171 0.9447	-0.6330* 0.0036	0.1524 0.5334	0.1167 0.6342
BANKVEG	0.1764 0.4700	-0.4306 0.0657	0.1593 0.5148	0.1330 0.5874
CHAN ALT	0.0571 0.8164	-0.5747* 0.0101	0.2988 0.2141	0.1696 0.4876
BENRIFF	-0.6418* 0.0031	-0.5898* 0.0079	0.5636* 0.0120	0.3821 0.1064
EPI SUB	-0.8380* 0.0001	-0.2712 0.2614	0.3507 0.1410	0.6176* 0.0048
RIPBUFF	0.5875* 0.0082	-0.0890 0.7171	-0.1081 0.6596	-0.2491 0.3037
SED DEP	-0.7369* 0.0003	-0.6824* 0.0013	0.6243* 0.0043	0.4259 0.0690
VEL DPTH	-0.0182 0.9411	-0.4991* 0.0296	0.5942* 0.0073	0.4552 0.0502
CH FLOW	-0.0786 0.7491	-0.2619 0.2788	0.5307* 0.0194	0.0959 0.6962
EMBEDDED	-0.6361* 0.0034	-0.6041* 0.0062	0.3361 0.1595	0.4574* 0.0489
TOTAL	-0.4112 0.0803	-0.7934* 0.0001	0.5989* 0.0067	0.4497 0.0534

Number of observations = 19
* p-value < 0.05

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

	Del Puerto	Orestimba	Salt Slough
VEL DPTH	-0.8944*	0.0250	-0.9000*
	0.0405	0.9453	0.0374
EPI SUB	-0.8208	-0.2168	0.6325
	0.0886	0.5475	0.2522
BENRIFF	-0.8000	0.3754	-0.6000
	0.1041	0.2850	0.2848
CHAN ALT	0.4104	-0.0651	-0.8208
	0.4925	0.8582	0.0886
BANKVEG	0.6000	0.2788	-0.6669
	0.2848	0.4354	0.2189
RIPBUFF	0.4104	0.5772	-0.9747*
	0.4925	0.0806	0.0048
SED DEP	0.2236	0.3952	0.8660
	0.7177	0.2583	0.0577
EMBEDDED	0.0513	0.0428	-
	0.9347	0.9065	-
BANKSTAB	0.7182	0.1945	-0.4000
	0.1718	0.5902	0.5046
CH FLOW	-0.6000	-0.1403	-0.6669
	0.2848	0.6992	0.2189
TOTAL	-0.3000	0.1636	-0.9000*
	0.6238	0.6515	0.0374
Sample Size	5	10	5

* P-value < 0.05

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

	Mean for each Creek			Kruskal Wallis	Pairwise Comparisons		
Metric	Del Puerto	Orestimba	Salt Slough	P-value	DO	DS	OS
VEL DPTH	10.0	9.6	7.8	0.7237			
EPI SUB	8.6	9.1	3.2	0.0005		*	*
BENRIFF	11.6	9.7	3.0	0.0023		*	
CHAN ALT	12.6	13.4	11.2	0.5676			
BANKVEG	9.0	11.7	10	0.4138			
RIPBUFF	5.6	7.8	9.8	0.3063			
SED DEP	11.0	12.8	2.4	0.0006		*	*
EMBEDDED	7.8	9.8	0	0.0015		*	*
BANKSTAB	11.4	11.3	9.0	0.5507			
CH FLOW	12.0	14.0	12.0	0.5351			
TOTAL	99.6	109.2	68.4	0.0069			*

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

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

Lowest Taxa	Higher Taxa	Total N	Total %	Cumulative %
Slavina appendiculata	Oligochaeta	454	12.078	12.078
Undetermined Tubificidae	Oligochaeta	411	10.934	23.011
Cricotopus sp.	Chironomidae	401	10.668	33.679
Helobdella stagnalis	Hirundinea	388	10.322	44.001
Nais communis/ variabilis	Oligochaeta	384	10.215	54.217
Physa/ Physella	Gastropoda	290	7.715	61.931
Cyprididae	Ostracoda	140	3.724	65.656
Pentaneura sp.	Chironomidae	106	2.82	68.476
Lumbricina	Oligochaeta	103	2.74	71.216
Simulium sp.	Chironomidae	91	2.421	73.637
Gyraulus parvus	Gastropoda	84	2.235	75.871
Cricotopus bicinctus group	Chironomidae	83	2.208	78.079
Dugesia tigrina	Platyhelminthes	83	2.208	80.287
Dicrotendipes sp.	Chironomidae	62	1.649	81.937
Prostoma sp.	Enopla	60	1.596	83.533
Parachironomus sp.	Chironomidae	59	1.57	85.102
Gammarus lacustris	Amphipoda	48	1.277	86.379
Peltodytes sp.	Coleoptera	48	1.277	87.656
Rheotanytarsus sp.	Chironomidae	36	0.958	88.614
Bezzia/ Palpomyia	Diptera	33	0.878	89.492
Undetermined Gastropoda	Gastropoda	29	0.771	90.263
Rheocricotopus sp.	Chironomidae	28	0.745	91.008
Tanytarsus sp.	Chironomidae	25	0.665	91.673
Orthocladius complex	Chironomidae	17	0.452	92.126
Mooreobdella microstoma	Hirundinea	16	0.426	92.551
Oxyethira sp.	Trichoptera	16	0.426	92.977
Undetermined Enchytraeidae	Oligochaeta	15	0.399	93.376
Hydra sp.	Hydrozoa	15	0.399	93.775
Sperchon sp.	Arachnida	14	0.372	94.147
Nanocladius sp.	Chironomidae	13	0.346	94.493
Cricotopus trifascia group	Chironomidae	11	0.293	94.786
Planorbella sp.	Gastropoda	10	0.266	95.052
Dasyhelea sp.	Diptera	9	0.239	95.291
Undetermined Erpobdellidae	Hirundinea	9	0.239	95.531
Fallceon quilleri	Ephemeroptera	9	0.239	95.77
Limnodrilus hoffmeisteri	Oligochaeta	9	0.239	96.01
Limnophyes sp.	Chironomidae	9	0.239	96.249
Baetis adonis	Ephemeroptera	8	0.213	96.462
Eukiefferiella sp.	Chironomidae	7	0.186	96.648
Laccobius sp.	Coleoptera	7	0.186	96.834
Baetis tricaudatus	Ephemeroptera	6	0.16	96.994
Berosus sp.	Coleoptera	6	0.16	97.153
Pisidium sp.	Pelecypoda	6	0.16	97.313
Chironomini	Chironomidae	5	0.133	97.446
Corbicula sp.	Pelecypoda	5	0.133	97.579
Oreodytes sp.	Coleoptera	5	0.133	97.712

Table 10. - continued

Lowest Taxa	Higher Taxa	Total N	Total %	Cumulative %
Paratanytarsus sp.	Chironomidae	5	0.133	97.845
Baetis sp.	Ephemeroptera	4	0.106	97.952
Corisella inscripta	Hemiptera	4	0.106	98.058
Undetermined Corixidae	Hemiptera	4	0.106	98.164
Daphniidae	Cladocera	4	0.106	98.271
Micropsectra sp.	Chironomidae	3	0.08	98.351
Parametriocnemus sp.	Chironomidae	3	0.08	98.43
Stictotarsus sp.	Coleoptera	3	0.08	98.51
Tricorythodes sp.	Ephemeroptera	3	0.08	98.59
Apedilum sp.	Chironomidae	2	0.053	98.643
Chironomus sp.	Chironomidae	2	0.053	98.696
Coenagrionidae	Odonata	2	0.053	98.75
Enochrus sp.	Coleoptera	2	0.053	98.803
Hydrobaenus sp.	Chironomidae	2	0.053	98.856
Menetus opercularis	Gastropoda	2	0.053	98.909
Microtendipes pedellus group	Chironomidae	2	0.053	98.962
Mooreobdella tetragon	Hirundinea	2	0.053	99.016
Undetermined Nematoda	Nematoda	2	0.053	99.069
Ophidonais serpentina	Oligochaeta	2	0.053	99.122
Ormosia sp.	Chironomidae	2	0.053	99.175
Polypedilum sp.	Chironomidae	2	0.053	99.229
Pomatiopsis sp.	Gastropoda	2	0.053	99.282
Arrenurus sp.	Arachnida	1	0.027	99.308
Caloparyphus/ Euparyphus	Chironomidae	1	0.027	99.335
Centroptilum sp.	Ephemeroptera	1	0.027	99.362
Ceratopogonidae	Diptera	1	0.027	99.388
Chaetogaster diaphanus	Oligochaeta	1	0.027	99.415
Cladotanytarsus sp.	Chironomidae	1	0.027	99.441
Corisella decolor	Hemiptera	1	0.027	99.468
Cyclopidae	Copepoda	1	0.027	99.495
Dolichopodidae	Chironomidae	1	0.027	99.521
Undetermined Glossiphoniidae	Hirudnea	1	0.027	99.548
Hemerodromia sp.	Chironomidae	1	0.027	99.574
Hydrellia sp.	Chironomidae	1	0.027	99.601
Hydroptila sp.	Trichoptera	1	0.027	99.628
Hygrobates sp.	Arachnida	1	0.027	99.654
Lebertia sp.	Arachnida	1	0.027	99.681
Microtendipes pedellus	Chironomidae	1	0.027	99.707
Muscidae	Chironomidae	1	0.027	99.734
Nemotelus sp.	Chironomidae	1	0.027	99.761
Undetermined Orthocladiinae	Chironomidae	1	0.027	99.787
Paraphaenocladius sp.	Chironomidae	1	0.027	99.814
Undetermined Pelecypoda	Pelecypoda	1	0.027	99.84
Pristinella jenkinae	Oligochaeta	1	0.027	99.867
Tabanus/ Atylotus	Chironomidae	1	0.027	99.894
Tanytarsini	Chironomidae	1	0.027	99.92
Thienemanniella sp.	Chironomidae	1	0.027	99.947
Thienemannimyia group	Chironomidae	1	0.027	99.973
Tropisternus sp.	Chironomidae	1	0.027	100
		3759		

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

	DLP 1					DLP 2					DLP 3					DLP 4					DLP 5				
Transect Number	**T1**	**T2**	**T3**	**Mean**	**CV**	**T1**	**T2**	**T3**	**Mean**	**CV**	**T1**	**T2**	**T3**	**Mean**	**CV**	**T1**	**T2**	**T3**	**Mean**	**CV**	**T1**	**T2**	**T3**	**Mean**	**CV**
Taxonomic Richness	17	25	19	20	20	25	22	25	24	7	18	13	21	17	23	12	12	16	13	17	35	35	28	33	12
Cumulative Taxa				31					34					28					25					57	
Percent Dominant Taxon	37	49	49	45	15	58	43	45	48	17	29	40	55	41	31	34	46	33	37	19	18	15	21	18	17
Ephemeroptera Taxa	0	0	0	0		0	1	0	0		0	0	0	0		0	0	0			2	4	1		
Plecoptera Taxa	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0			0	0	0		
Trichoptera Taxa	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0			2	1	1		
EPT Taxa	0	0	0	0	-	0	1	0	0	173	0	0	0	0	-	0	0	0	0	-	4	5	2	4	42
EPT Index (%)	0	0	0	0	-	0	1	0	0	173	0	0	0	0	-	0	0	0	0	-	3	8	4	5	57
Sensitive EPT Index (%)	0	0	0	0	-	0	0	0	0.0	-	0	0	0	0	-	0	0	0	0	-	0	2	4	2	90
Cumulative EPT Taxa				0					1.0					0					0					8	
Shannon Diversity	1.8	1.9	1.7	1.8	4	1.8	2.0	2.2	2.0	10	2.1	1.7	1.7	1.8	12	1.8	1.7	2.1	1.8	10	2.8	2.9	2.5	2.7	7
Tolerance Value	7.0	6.8	7.0	7.0	2	9.2	8.8	8.7	8.9	3	6.8	6.9	7.0	6.9	1	6.8	5.9	6.7	6.5	8	6.6	6.5	6.9	6.7	3
Percent Intolerant Taxa (0-2)	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	1	0	173
Percent Tolerant Taxa (8-10)	27	26	34	29	16	86	86	75	82	8	24	3	31	19	76	65	33	47	48	33	38	41	62	47	28
Percent Baetidae	0	0	0	-	-	0	1	0	-	-	0	0	0	-	-	0	0	0	-	-	2	6	0	-	-
Percent Chironomidae	20	19	20	19	3	15	8	20	14	43	33	37	22	31	27	14	27	67	36	77	37	29	9	25	57
Percent Hydropsychidae	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-
Percent Collectors	62	71	71	68	7	8	5	13	9	45	16	15	10	14	25	56	86	65	69	22	29	34	39	34	15
Percent Filterers	9	9	5	7	32	3	7	6	5	38	4	0	25	10	140	2	9	16	9	75	13	4	2	6	90
Percent Grazers	7	5	6	6	14	6	25	7	13	84	20	25	29	25	19	31	1	4	12	137	16	20	37	24	45
Percent Predators	2	3	6	4	44	81	59	67	69	16	14	4	6	8	63	10	1	1	4	128	36	35	12	27	50
Percent Shredders	20	12	12	15	32	2	4	7	4	66	46	55	30	44	29	0	2	13	5	136	6	7	11	8	31
Abundance (#/ sample)	2280	823	1505	1536	-	1275	204	1822	1100	-	2544	1585	724	1618	-	134	900	106	380	-	1878	3350	1289	2173	-

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

Lowest Taxa	Higher Taxa	Total N	Total %	Cumulative %
Ophidonais serpentina	Oligochaeta	685	10.417	10.417
Simulium sp.	Chironomidae	661	10.052	20.468
Orthocladius complex	Chironomidae	614	9.337	29.805
Corbicula sp.	Pelecypoda	594	9.033	38.838
Cricotopus sp.	Chironomidae	588	8.942	47.78
Daphniidae	Cladocera	305	4.638	52.418
Cricotopus bicinctus group	Chironomidae	294	4.471	56.889
Physa/ Physella	Gastropoda	277	4.212	61.101
Dugesia tigrina	Platyhelminthes	244	3.71	64.811
Slavina appendiculata	Oligochaeta	223	3.391	68.203
Undetermined Enchytraeidae	Oligochaeta	213	3.239	71.442
Nais communis/ variabilis	Oligochaeta	157	2.387	73.829
Dicrotendipes sp.	Chironomidae	132	2.007	75.836
Undetermined Corixidae	Hemiptera	122	1.855	77.692
Chironomus sp.	Chironomidae	115	1.749	79.44
Eudistylia vancouveri	Polychaeta	91	1.384	80.824
Lumbricina	Oligochaeta	82	1.247	82.071
Undetermined Nematoda	Nematoda	81	1.232	83.303
Undetermined Tubificidae	Oligochaeta	69	1.049	84.352
Cricotopus trifascia group	Chironomidae	67	1.019	85.371
Gammarus lacustris	Amphipoda	60	0.912	86.283
Eukiefferiella sp.	Chironomidae	57	0.867	87.15
Prostoma sp.	Enopla	56	0.852	88.002
Sperchon sp.	Arachnida	53	0.806	88.808
Fossaria sp.	Gastropoda	49	0.745	89.553
Hydropsyche californica	Trichoptera	41	0.623	90.176
Tanytarsus sp.	Chironomidae	41	0.623	90.8
Microchironomus nigrovittatus	Chironomidae	39	0.593	91.393
Planorbella sp.	Gastropoda	37	0.563	91.956
Cyclopidae	Copepoda	33	0.502	92.457
Rheocricotopus sp.	Chironomidae	32	0.487	92.944
Procladius sp.	Chironomidae	27	0.411	93.355
Caenis sp.	Ephemeroptera	26	0.395	93.75
Gyraulus parvus	Gastropoda	26	0.395	94.145
Ophidonais sp.	Oligochaeta	24	0.365	94.51
Ormosia sp.	Chironomidae	24	0.365	94.875
Cyprididae	Ostracoda	21	0.319	95.195
Pseudosmittia sp.	Chironomidae	19	0.289	95.484
Micropsectra sp.	Chironimidae	18	0.274	95.757
Limnophyes sp.	Chironimidae	15	0.228	95.985
Chaetogaster diaphanus	Oligochaeta	14	0.213	96.198
Callibaetis sp.	Ephemeroptera	13	0.198	96.396
Hydroptila sp.	Trichoptera	13	0.198	96.594
Peltodytes sp.	Coleoptera	13	0.198	96.791
Cladotanytarsus sp.	Chironomidae	12	0.182	96.974
Nanocladius sp.	Chironomidae	12	0.182	97.156
Oxyethira sp.	Trichoptera	11	0.167	97.324

Table 12. - continued

Lowest Taxa	Higher Taxa	Total N	Total %	Cumulative %
Paranais litoralis	Oligochaeta	11	0.167	97.491
Corisella inscripta	Hemiptera	10	0.152	97.643
Chironomini	Chironomidae	8	0.122	97.765
Hyalella sp.	Amphipoda	8	0.122	97.886
Phaenopsectra sp.	Chironomidae	8	0.122	98.008
Limnodrilus hoffmeisteri	Oligochaeta	7	0.106	98.114
Manayunkia speciosa	Polychaeta	7	0.106	98.221
Orthocladiinae	Chironomidae	7	0.106	98.327
Polypedilum sp.	Chironomidae	7	0.106	98.434
Branchiura sowerbyi	Oligochaeta	5	0.076	98.51
Caecidotea occidentalis	Isopoda	5	0.076	98.586
Nais barbata	Oligochaeta	5	0.076	98.662
Scatella sp.	Chironomidae	5	0.076	98.738
Fallceon quilleri	Ephemeroptera	4	0.061	98.799
Limonia sp.	Chironomidae	4	0.061	98.859
Menetus opercularis	Gastropoda	4	0.061	98.92
Mooreobdella tetragon	Hirundinea	4	0.061	98.981
Centroptilum sp.	Ephemeroptera	3	0.046	99.027
Corisella decolor	Hemiptera	3	0.046	99.072
Corynoneura sp.	Chironomidae	3	0.046	99.118
Hexatoma sp.	Chironomidae	3	0.046	99.164
Parachironomus sp.	Chironomidae	3	0.046	99.209
Paracladopelma sp.	Chironomidae	3	0.046	99.255
Paraphaenocladius sp.	Chironomidae	3	0.046	99.3
Paratanytarsus sp.	Chironomidae	3	0.046	99.346
Berosus sp.	Coleoptera	2	0.03	99.377
Bezzia/ Palpomyia	Diptera	2	0.03	99.407
Ephydridae	Chironomidae	2	0.03	99.437
Erpobdellidae	Hirundinea	2	0.03	99.468
Ferrissia rivularis	Gastropoda	2	0.03	99.498
Undetermined Hydropsychidae	Trichoptera	2	0.03	99.529
Psectrocladius sp.	Chironomidae	2	0.03	99.559
Rheotanytarsus sp.	Chironomidae	2	0.03	99.589
Apedilum sp.	Chironomidae	1	0.015	99.605
Aturus sp.	Arachnida	1	0.015	99.62
Baetis tricaudatus	Ephemeroptera	1	0.015	99.635
Ceratopogonidae	Diptera	1	0.015	99.65
Coenagrionidae	Odonata	1	0.015	99.665
Corisella sp.	Hemiptera	1	0.015	99.681
Cryptochironomus sp.	Chironomidae	1	0.015	99.696
Haplotaxis sp.	Oligochaeta	1	0.015	99.711
Helobdella sp.	Hirundinea	1	0.015	99.726
Helobdella triserialis	Hirundinea	1	0.015	99.741
Ischnura sp.	Odonata	1	0.015	99.757
Lebertia sp.	Arachnida	1	0.015	99.772
Mideopsis sp.	Arachnida	1	0.015	99.787
Neoplasta sp.	Chironomidae	1	0.015	99.802
Parachaetocladius sp.	Chironomidae	1	0.015	99.818

Table 12. - continued

Lowest Taxa	Higher Taxa	Total N	Total %	Cumulative %
Pisidium sp.	Pelecypoda	1	0.015	99.833
Pomatiopsis sp.	Gastropoda	1	0.015	99.848
Pristina aequiseta	Oligochaeta	1	0.015	99.863
Psychoda sp.	Chironomidae	1	0.015	99.878
Stygobromus sp.	Amphipoda	1	0.015	99.894
Sublettea sp.	Chironomidae	1	0.015	99.909
Tanypodinae	Chironomidae	1	0.015	99.924
Tanytarsini	Chironomidae	1	0.015	99.939
Temoridae	Copepoda	1	0.015	99.954
Tipulidae	Chironomidae	1	0.015	99.97
Torrenticola sp.	Arachnida	1	0.015	99.985
Tribelos sp.	Chironomidae	1	0.015	100
		6576		

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

	ORE 1					ORE 2					ORE 3					ORE 4					ORE 5				
Transect Number	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV
Taxonomic Richness	24	18	22	21	14	26	12	19	19	37	16	9	23	16	44	20	21	21	21	3	26	30	20	25	20
Cumulative Taxa				33					34					34					31					36	
Percent Dominant Taxon	13	20	34	22	49	30	57	20	36	53	40	46	33	40	17	32	32	58	41	37	37	57	45	47	22
Ephemeroptera Taxa	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	1	1	0	-	-	0	0	0	-	-
Plecoptera Taxa	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-
Trichoptera Taxa	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	1	2	1	-	-
EPT Taxa	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	1	1	0	1	87	1	2	1	1	43
EPT Index (%)	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	1	1	0	0	87	1	1	1	1	11
Sensitive EPT Index (%)	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-
Cumulative EPT Taxa				0					0					0					1					2	
Shannon Diversity	2.8	2.5	2.3	2.5	10	2.5	1.6	2.5	2.2	24	2.1	1.7	2.1	2.0	11	2.0	1.9	1.7	1.9	6	2.1	1.8	2.0	2.0	9
Tolerance Value	8.2	7.9	8.7	8.3	5	6.8	6.3	6.3	6.5	5	6.8	6.7	7.8	7.1	9	6.3	6.2	6.2	6.2	1	6.2	6.0	5.7	6.0	4
Percent Intolerant Taxa (0-2)	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0.0	-	0	0	0	0	-
Percent Tolerant Taxa (8-10)	67	53	71	64	15	15	5	14	11	48	32	9	44	28	62	7	5	4	5.0	20	4	5	6	5	14
Percent Baetidae	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	1	1	0.00	-	-	0	0	0	-	-
Percent Chironomidae	65	76	67	69	9	61	21	37	39	51	18	56	36	37	53	30	30	24	28	12	19	12	10	13	33
Percent Hydropsychidae	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0.00	-	-	1	1	1	-	-
Percent Collectors	43	40	60	48	23	24	18	48	30	53	29	17	55	33	57	8	9	10	9	9	19	13	33	22	46
Percent Filterers	11	30	12	18	61	36	69	28	44	49	64	20	16	33	80	75	71	80	75	6	71	81	65	72	11
Percent Grazers	11	3	7	7	54	3	2	2	3	31	4	11	0	5	117	1	0	0	0	173	0	1	2	1	119
Percent Predators	24	23	15	21	23	5	0	2	2	109	4	0	1	1	131	3	3	2	3	35	4	4	0	3	88
Percent Shredders	12	3	5	7	65	31	11	20	21	48	0	51	28	27	97	13	17	8	13	35	7	1	0	3	139
Abundance (#/ sample)	94	55	141	97	-	176	98	70	115	-	78	51	563	230	-	218	583	845	549	-	256	368	172	265	-

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

	ORE 6					ORE 7					ORE 8					ORE 9					ORE 10				
Transect Number	**T1**	**T2**	**T3**	**Mean**	**CV**	**T1**	**T2**	**T3**	**Mean**	**CV**	**T1**	**T2**	**T3**	**Mean**	**CV**	**T1**	**T2**	**T3**	**Mean**	**CV**	**T1**	**T2**	**T3**	**Mean**	**CV**
Taxonomic Richness	20	19	21	20	5	27	25	27	26	4	15	25	15	18	31	25	22	22	23	8	30	24	33	29	16
Cumulative Taxa				26					31					28					34					45	
Percent Dominant Taxon	29	31	41	34	19	23	14	42	26	56	55	30	44	43	29	19	28	33	27	27	39	52	19	37	45
Ephemeroptera Taxa	0	0	1	-	-	0	1	0	-	-	0	0	0	-	-	0	0	0	-	-	3	3	2		
Plecoptera Taxa	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0		
Trichoptera Taxa	0	0	0	-	-	2	2	2	-	-	1	2	1	-	-	0	0	0	-	-	1	0	1		
EPT Taxa	0	0	1	0	173	2	3	2	2	25	1	2	1	1	43	0	0	0	0	-	4	3	3	3	17
EPT Index (%)	0	0	0	0	173	6	3	3	4	40	2	3	1	2	56	0	0	0	0	-	7	3	8	6	43
Sensitive EPT Index (%)	0	0	0	0	-	0	0	0	0	12	0	0	0	0	-	0	0	0	0	-	2	1	2	2	50
Cumulative EPT Taxa				1					3					2					0					4	
Shannon Diversity	2.1	2.2	2.0	2.1	5	2.6	2.7	2.1	2.5	12	1.7	2.3	1.6	1.9	22	2.5	2.3	2.2	2.3	5	2.4	1.9	2.9	2.4	21
Tolerance Value	6.0	5.8	6.0	5.9	2	5.0	5.7	4.9	5.2	8	5.7	6.3	7.0	6.3	11	7.2	8.1	8.0	7.8	7	7.9	8.2	7.8	7.9	3
Percent Intolerant Taxa (0-2)	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	173	0	1	0	0	101
Percent Tolerant Taxa (8-10)	36	7	17	20	73	11	9	9	10	16	18	31	21	23	29	48	73	70	63	22	78	88	69	78	12
Percent Baetidae	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	2	2	1	-	-
Percent Chironomidae	52	59	62	58.00	9	42	35	56	44	24	21	31	38	30	28	10	11	7	9	21	12	8	26	15	61
Percent Hydropsychidae	0	0	0	-	-	4	1	2	-	-	2	3	1	-	-	0	0	0	-	-	0	0	0	-	-
Percent Collectors	42	25	35	34	25	37	35	36	36	2	45	31	68	48	39	33	44	37	38	15	58	67	44	56	20
Percent Filterers	8	15	50	24	91	19	17	15	17	14	8	17	5	10	66	14	6	12	10	38	5	3	4	4	20
Percent Grazers	0	0	0	0	-	5	3	3	3	35	0	21	2	7	156	27	33	44	35	24	16	12	30	20	49
Percent Predators	40	32	15	29	43	37	25	46	36	29	27	17	0	15	93	22	13	2	12	78	17	16	14	16	10
Percent Shredders	10	28	0	12	113	2	20	0	7	150	19	14	26	20	30	5	5	4	5	8	3	2	8	4	64
Abundance (#/ sample)	1907	1776	1228	1637	-	1038	1306	1268	1204	-	1564	8193	2834	4197	-	409	242	293	315	-	2468	9453	3050	4990	-

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

Lowest Taxa	Higher Taxa	Total N	Total %	Cumulative %
Corophium spinicorne	Amphipoda	1117	28.693	28.693
Cricotopus sp.	Chironomidae	565	14.513	43.206
Physa/ Physella	Gastropoda	264	6.781	49.987
Cricotopus bicinctus group	Chironomidae	222	5.703	55.69
Paratanytarsus sp.	Chironomidae	210	5.394	61.084
Nais communis/ variabilis	Oligochaeta	152	3.904	64.988
Undetermined Corixidae	Hemiptera	130	3.339	68.328
Daphniidae	Cladocera	124	3.185	71.513
Eudistylia vancouveri	Polychaeta	112	2.877	74.39
Ophidonais serpentina	Oligochaeta	101	2.594	76.984
Hydropsyche californica	Trichoptera	99	2.543	79.527
Trichocorixa calva	Hemiptera	78	2.004	81.531
Slavina appendiculata	Oligochaeta	77	1.978	83.509
Chironomus sp.	Chironomidae	45	1.156	84.665
Apedilum sp.	Chironomidae	44	1.13	85.795
Undetermined Coenagrionidae	Odonata	44	1.13	86.925
Corisella inscripta	Hemiptera	43	1.105	88.03
Undetermined Tubificidae	Oligochaeta	40	1.027	89.057
Parachironomus sp.	Chironomidae	30	0.771	89.828
Cyclopidae	Copepoda	29	0.745	90.573
Fossaria sp.	Gastropoda	28	0.719	91.292
Dicrotendipes sp.	Chironomidae	26	0.668	91.96
Simulium sp.	Chironomidae	22	0.565	92.525
Prostoma sp.	Enopla	20	0.514	93.039
Tanytarsini	Chironomidae	20	0.514	93.553
Corbicula sp.	Pelecypoda	19	0.488	94.041
Liodessus obscurellus	Coleoptera	19	0.488	94.529
Limnophyes sp.	Chironomidae	17	0.437	94.965
Undetermined Nematoda	Nematoda	15	0.385	95.351
Ischnura sp.	Odonata	14	0.36	95.71
Nanocladius sp.	Chironomidae	14	0.36	96.07
Glyptotendipes sp.	Chironomidae	11	0.283	96.352
Cladotanytarsus sp.	Chironomidae	10	0.257	96.609
Ferrissia rivularis	Gastropoda	10	0.257	96.866
Paranais litoralis	Oligochaeta	10	0.257	97.123
Limnodrilus hoffmeisteri	Oligochaeta	8	0.205	97.329
Chironomini	Chironomidae	7	0.18	97.508
Procladius sp.	Chironimidae	7	0.18	97.688
Corisella decolor	Hemiptera	6	0.154	97.842
Microchironomus nigrovittatus	Chironomidae	6	0.154	97.996
Hyalella sp.	Amphipoda	5	0.128	98.125
Orthocladiinae	Chironomidae	5	0.128	98.253
Polypedilum sp.	Chironomidae	5	0.128	98.382
Cambaridae	Decapoda	4	0.103	98.484
Lumbricina	Oligochaeta	4	0.103	98.587
Branchiura sowerbyi	Oligochaeta	3	0.077	98.664
Callibaetis sp.	Ephemeroptera	3	0.077	98.741

Table 14. - continued

Lowest Taxa	Higher Taxa	Total N	Total %	Cumulative %
Corynoneura sp.	Chironomidae	3	0.077	98.818
Gammarus lacustris	Amphipoda	3	0.077	98.895
Hydra sp.	Hydrozoa	3	0.077	98.973
Orthocladius complex	Chironomidae	3	0.077	99.05
Pseudosmittia sp.	Chironomidae	3	0.077	99.127
Berosus sp.	Coleoptera	2	0.051	99.178
Endotribelos sp.	Chironomidae	2	0.051	99.229
Harnischia sp.	Chironomidae	2	0.051	99.281
Hydrellia sp.	Chironomidae	2	0.051	99.332
Tanypus sp.	Chironomidae	2	0.051	99.384
Ceratopogonidae	Diptera	1	0.026	99.409
Cryptochironomus sp.	Chironomidae	1	0.026	99.435
Cryptotendipes sp.	Chironomidae	1	0.026	99.461
Enchytraeidae	Oligochaeta	1	0.026	99.486
Ephydridae	Chironomidae	1	0.026	99.512
Glossiphoniidae	Hirundinea	1	0.026	99.538
Limonia sp.	Chironomidae	1	0.026	99.563
Macrothricidae	Cladocera	1	0.026	99.589
Muscidae	Chironomidae	1	0.026	99.615
Notonecta sp.	Hemiptera	1	0.026	99.64
Ochthebius sp.	Coleoptera	1	0.026	99.666
Ormosia sp.	Chironomidae	1	0.026	99.692
Pacifastacus sp.	Decapoda	1	0.026	99.717
Pentaneura sp.	Chironomidae	1	0.026	99.743
Pericoma/ Telmatoscopus	Chironomidae	1	0.026	99.769
Pristinella sp.	Oligochaeta	1	0.026	99.795
Psychodidae	Chironomidae	1	0.026	99.82
Sciomyzidae	Chironomidae	1	0.026	99.846
Sigara vallis	Hemiptera	1	0.026	99.872
Sphaeromias sp.	Diptera	1	0.026	99.897
Thermonectus sp.	Coleoptera	1	0.026	99.923
Thienemanniella sp.	Chironomidae	1	0.026	99.949
Thienemannimyia group	Chironomidae	1	0.026	99.974
Tropisternus sp.	Coleoptera	1	0.026	100
		3893		

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

	SSL 1					SSL 2					SSL 3					SSL 4					SSL 5				
Transect Number	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV	T1	T2	T3	Mean	CV
Taxonomic Richness	10	29	25	21	47	31	9	15	18	62	22	28	23	24	13	22	22	28	24	14	19	21	19	20	6
Cumulative Taxa				42					40					43					42					34	
Percent Dominant Taxon	86	23	24	44	82	33	45	86	55	51	55	29	61	49	35	36	24	27	29	22	25	51	29	35	40
Ephemeroptera Taxa	0	1	0	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	1	0	1	-	-
Plecoptera Taxa	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-
Trichoptera Taxa	1	1	1	-	-	1	1	0	-	-	1	1	0	-	-	0	0	0	-	-	0	0	0	-	-
EPT Taxa	1	2	1	1	43	1	1	0	1	87	1	1	0	1	87	0	0	0	0	-	1	0	1	1	87
EPT Index (%)	4	2	9	5	69	0	3	0	1	144	13	6	0	6	105	0	0	0	0	-	0	0	0	0	87
Sensitive EPT Index (%)	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-
Cumulative EPT Taxa				2					1					1					0					1	
Shannon Diversity	0.6	2.4	2.6	1.9	58	2.2	1.6	0.7	1.5	48	1.7	2.6	1.5	1.9	29	2.2	2.1	2.7	2.3	14	2.2	1.9	2.1	2.1	8
Tolerance Value	5.5	8.8	8.4	7.6	24	6.5	6.6	8.1	7.1	13	7.1	7.0	7.8	7.3	6	7.6	7.6	7.2	7.5	3	7.4	7.6	7.5	7.5	1
Percent Intolerant Taxa (0-2)	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-
Percent Tolerant Taxa (8-10)	17	75	66	53	60	28	14	54	32	63	38	48	61	49	24	42	34	37	38	10	54	32	56	47	28
Percent Baetidae	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-	0	0	0	-	-
Percent Chironomidae	6	28	23	19	61	45	34	6	28	70	20	17	10	16	34	65	35	52	51	29	48	73	38	53	34
Percent Hydropsychidae	4	2	9	-	-	0	3	0	-	-	13	6	0	-	-	0	0	0	-	-	0	0	0	-	-
Percent Collectors	6	10	16	11	46	12	13	4	10	51	8	25	23	19	52	8	33	16	19	65	40	13	32	28	50
Percent Filterers	71	8	30	36	89	57	50	36	48	23	52	33	6	30	75	2	1	3	2	39	20	10	6	12	61
Percent Grazers	6	9	10	8	27	19	0	4	8	131	9	20	34	21	61	30	7	31	23	59	9	8	23	13	64
Percent Predators	18	57	31	35	57	6	13	48	22	101	12	8	17	12	36	13	12	9	11	20	6	12	5	8	50
Percent Shredders	0	16	13	10	88	5	25	8	13	87	20	13	19	18	22	46	47	41	45	7	25	58	34	39	43
Abundance (#/ sample)	1100	819	803	907	-	1585	57	797	813	-	695	868	661	741	-	259	930	107	432	-	5228	2152	2360	3247	-

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

	Eigenvalue	Proportion	Cumulative
Factor 1	8.7960	0.3998	0.3998
Factor 2	3.3685	0.1531	0.5529
Factor 3	2.6425	0.1201	0.6730
Factor 4	1.6598	0.0754	0.7485
Factor 5	1.4876	0.0676	0.8161
Factor 6	1.3281	0.0604	0.8765
Factor 7	1.0244	0.0466	0.9230
Factor 8	0.6605	0.0300	0.9531
Factor 9	0.3355	0.0153	0.9683
Factor 10	0.2622	0.0119	0.9802
Factor 11	0.1890	0.0086	0.9888
Factor 12	0.0796	0.0036	0.9924
Factor 13	0.0636	0.0029	0.9953
Factor 14	0.0411	0.0019	0.9972
Factor 15	0.0327	0.0015	0.9987
Factor 16	0.0182	0.0008	0.9995
Factor 17	0.0090	0.0004	0.9999
Factor 18	0.0014	0.0001	1.0000
Factor 19	0.0002	0.0000	1.0000

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

Metric	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
Factor 1							
Sensitive EPT Index (%)	0.3175	-0.0648	-0.0758	-0.1458	0.1052	-0.0875	-0.0086
Percent Intolerant Taxa	0.3160	-0.0692	-0.0653	-0.1787	0.0870	-0.0835	-0.0008
Cumulative EPT Taxa	0.3080	0.1409	-0.1065	0.0322	0.0134	-0.0116	0.1050
Ephemeroptera Taxa	0.3077	-0.0499	-0.0669	-0.1725	0.0772	-0.1153	0.1591
EPT Taxa	0.3067	0.1748	-0.1002	-0.0427	-0.0605	0.0577	0.1071
Percent Baetidae	0.3049	-0.0374	-0.0780	-0.0976	0.1633	-0.2010	0.0343
Taxonomic Richness	0.2846	0.0633	0.0303	0.2463	0.0669	-0.0578	-0.0511
Factor 2							
Trichoptera Taxa	0.1692	0.3665	-0.0955	0.1318	-0.1987	0.2395	-0.0029
Factor 3							
Tolerance Value	0.0419	-0.2979	0.4568	0.0187	0.0194	-0.1415	0.0767
Percent Tolerant Taxa	0.1392	-0.2862	0.3984	0.0109	-0.2193	-0.0792	-0.0263
Factor 4							
Abundance (#/ sample)	0.1909	-0.0536	-0.0241	-0.4298	-0.1421	0.2796	0.3710
Shannon Diversity	0.2124	-0.2144	-0.2014	0.3981	-0.0416	0.0082	-0.1369
Percent Dominant	-0.1381	0.2721	0.3169	-0.3826	0.0128	-0.0648	0.1739
Factor 5							
Percent Shredders	-0.1129	-0.1610	-0.0394	-0.0341	0.4933	0.4922	0.2952
Percent Collectors	0.0462	-0.2108	-0.2447	-0.3008	-0.4673	0.0958	-0.3691
Cumulative Taxa	0.2589	0.0563	0.1589	0.1322	0.3329	-0.0124	-0.0996
Factor 6							
Percent Hydropsychidae	0.0168	0.3425	0.2723	0.1570	-0.1088	0.4068	-0.1641
Percent Filterers	-0.1052	0.3786	-0.0865	0.0145	0.2603	-0.3859	-0.0779
EPT Index (%)	0.2481	0.2455	0.1436	0.0181	-0.0746	0.2649	-0.0959
Factor 7							
Percent Predators	0.1007	0.0221	0.2717	0.3379	-0.3411	-0.1547	0.4873
Percent Chironomidae	-0.0958	-0.2060	-0.3303	0.2959	-0.0487	0.1470	0.3626
Percent Grazers	0.1313	-0.2597	0.2593	0.0249	0.2323	0.2778	-0.3326

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 (#/ sample)	0.3000	0.8424	0.0000
	0.6238	0.0022	1.0000
Cumulative EPT Taxa	0.4472	0.6357	-0.6708
	0.4502	0.0482	0.2152
Cumulative Taxa	0.1000	0.0739	-0.3591
	0.8729	0.8393	0.5528
EPT Index (%)	0.4472	0.6013	-0.6669
	0.4502	0.0660	0.2189
EPT Taxa	0.4472	0.6211	-0.6708
	0.4502	0.0553	0.2152
Ephemeroptera Taxa	0.4472	0.3976	0.2236
	0.4502	0.2553	0.7177
Percent Baetidae	0.4472	0.3114	-
	0.4502	0.3811	-
Percent Chironomidae	0.6000	-0.5515	0.7000
	0.2848	0.0984	0.1881
Percent Collectors	0.2000	0.5394	0.9000
	0.7471	0.1076	0.0374
Percent Dominant Taxon	-0.9000	0.1030	-0.6000
	0.0374	0.7770	0.2848
Percent Filterers	0.1000	-0.7091	-0.8000
	0.8729	0.0217	0.1041
Percent Grazers	0.5000	0.4667	0.6000
	0.3910	0.1739	0.2848
Percent	-	0.2908	-0.6669
	-	0.4150	0.2189
Percent Intolerant Taxa	0.7071	0.5222	-
	0.1817	0.1215	-

Table 18. - continued.

Benthic Metric	Del Puerto	Orestimba	Salt Slough
Percent Predators	0.3000	0.3769	-1.0000
	0.6238	0.2830	<.0001
Percent Shredders	-0.1000	-0.4195	0.9000
	0.8729	0.2276	0.0374
Percent Tolerant Taxa	0.1000	0.2857	-0.3000
	0.8729	0.4236	0.6238
Plecoptera	-	-	-
	-	-	-
Sensitive EPT Index (%)	0.7071	0.5222	-
	0.1817	0.1215	-
Shannon Diversity	0.7000	0.0183	0.8000
	0.1881	0.9600	0.1041
Taxonomic Richness	0.1000	0.4667	0.1000
	0.8729	0.1739	0.8729
Tolerance Value	-0.8000	-0.0909	0.0000
	0.1041	0.8028	1.0000
Trichoptera Taxa	0.7071	0.4867	-0.9487
	0.1817	0.1538	0.0138

Table 19. Mean scores for each benthic metric for each creek with the p-value for comparing the means among the three creeks based on the Kruskal-Wallis test.

	Mean for each Creek			Kruskal-Wallace
Metric	Del Puerto	Orestimba	Salt Slough	p-value
Abundance (#/ sample)	1361.27	1456.92	1228.07	0.5088
Cumulative EPT Taxa	1.80	1.30	1.00	0.7897
Cumulative Taxa	35.00	33.20	40.20	0.0937
EPT Index (%)	1.07	1.37	2.47	0.6156
EPT Taxa	0.80	0.93	0.67	0.6726
Ephemeroptera Taxa	0.53	0.40	0.20	0.9950
Percent Baetidae	0.60	0.23	0.00	0.3106
Percent Chironomidae	25.13	34.40	33.33	0.7087
Percent Collectors	38.67	35.43	17.27	0.1177
Percent Dominant Taxon	38.13	35.10	42.27	0.3386
Percent Filterers	7.60	0.90	5.67	0.0544
Percent Grazers	15.93	8.10	14.60	0.0584
Percent Hydropsychidae	0.00	0.53	2.47	0.1061
Percent Intolerant Taxa	0.07	0.03	0.00	0.5899
Percent Predators	22.47	13.77	17.80	0.7503
Percent Shredders	15.13	7411.77	24.67	0.2314
Percent Tolerant Taxa	45.20	30.87	43.73	0.3074
Plecoptera Taxa	0.00	0.00	0.00	1.0000
Sensitive EPT Index (%)	0.40	0.17	0.00	0.5583
Shannon Diversity	2.05	2.17	1.94	0.2637
Taxonomic Richness	21.53	21.90	21.53	0.9072
Tolerance Value	7.17	6.72	7.38	0.2955
Trichoptera Taxa	0.27	0.53	0.47	0.6917

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

Benthic Metric	BANK STAB	BANK VEG	BEN RIFF	CHAN ALT	CHAN FLOW	EMBE DDED	EPI SUB	RIP BUFF	SED DEP	VEL DPTH	TOTAL
Abundance (#/ sample)	-0.0438	-0.1681	0.2601	-0.1621	-0.0321	0.1870	-0.3405	0.2521	0.2825	-0.1207	0.1541
	0.8506	0.4665	0.2548	0.4827	0.8902	0.4169	0.1310	0.2702	0.2146	0.6022	0.5050
Cumulative EPT Taxa	-0.0266	0.0697	0.1050	0.0965	-0.0660	0.2570	-0.4754	0.4444	0.2751	-0.0242	0.2209
	0.9091	0.7640	0.6507	0.6774	0.7761	0.2608	0.0294	0.0435	0.2274	0.9172	0.3358
Cumulative Taxa	-0.1334	-0.0212	-0.2669	0.1972	-0.4927	-0.0378	-0.3927	0.4279	-0.3621	-0.2448	-0.3248
	0.5643	0.9274	0.2421	0.3915	0.0232	0.8708	0.0783	0.0530	0.1067	0.2848	0.1508
EPT Index (%)	-0.0353	0.2194	-0.0504	0.2504	-0.1727	0.1226	-0.5090	0.5632	0.0555	0.1154	0.0583
	0.8793	0.3392	0.8284	0.2736	0.4542	0.5966	0.0185	0.0079	0.8112	0.6184	0.8018
EPT Taxa	-0.0393	0.0838	0.0222	0.1361	-0.1237	0.2263	-0.5214	0.4476	0.2345	-0.0149	0.1796
	0.8657	0.7181	0.9240	0.5565	0.5931	0.3239	0.0153	0.0419	0.3063	0.9488	0.4360
Ephemeroptera Taxa	-0.3645	-0.5074	0.0056	-0.2014	-0.3365	0.3865	-0.3736	0.0972	0.2154	-0.4513	-0.0859
	0.1043	0.0189	0.9807	0.3815	0.1359	0.0835	0.0953	0.6750	0.3485	0.0400	0.7112
Percent Baetidae	-0.3067	-0.5134	0.1445	0.0070	-0.4345	0.5367	-0.0861	0.0600	0.1869	-0.3046	-0.0474
	0.1764	0.0173	0.5321	0.9758	0.0491	0.0121	0.7106	0.7962	0.4172	0.1794	0.8384
Percent Chironomidae	-0.0836	-0.0800	-0.3820	-0.2262	0.2895	-0.2441	-0.1515	-0.1075	-0.2256	-0.4504	-0.2262
	0.7186	0.7302	0.0875	0.3241	0.2031	0.2863	0.5120	0.6428	0.3254	0.0405	0.3242
Percent Collectors	0.1212	-0.0310	0.1904	-0.0242	-0.1065	0.1974	0.2290	-0.0289	0.0684	-0.1224	0.1320
	0.6007	0.8938	0.4084	0.9173	0.6460	0.3911	0.3180	0.9011	0.7684	0.5971	0.5685
Percent Dominant Taxon	-0.0248	0.0874	0.1923	-0.1000	0.1821	-0.1950	0.0321	-0.0418	-0.0680	0.6712	0.0910
	0.9150	0.7065	0.4036	0.6662	0.4296	0.3970	0.8900	0.8572	0.7696	0.0009	0.6948
Percent Filterers	0.1568	0.3528	-0.2223	0.2938	0.2495	-0.0418	-0.1128	0.0882	0.0209	0.2932	0.2151
	0.4974	0.1167	0.3328	0.1961	0.2754	0.8573	0.6263	0.7037	0.9283	0.1971	0.3490
Percent Grazers	-0.0101	0.0093	-0.1709	0.0390	-0.5238	-0.2521	-0.1378	0.1842	-0.2947	-0.2594	-0.4109
	0.9652	0.9680	0.4590	0.8668	0.0148	0.2702	0.5514	0.4242	0.1946	0.2561	0.0642

Table 20.- continued.

Benthic Metric	BANK STAB	BANK VEG	BEN RIFF	CHAN ALT	CHAN FLOW	EMBE DDED	EPI SUB	RIP BUFF	SED DEP	VEL DPTH	TOTAL
Percent Hydropsychidae	0.1667	0.6171	-0.1659	0.2590	0.2426	-0.2986	-0.4285	0.4588	-0.0185	0.4686	0.1312
	0.4703	0.0029	0.4723	0.2569	0.2893	0.1887	0.0526	0.0364	0.9367	0.0321	0.5708
Percent Intolerant Taxa	-0.0135	-0.2475	0.1479	0.1422	-0.5132	0.4787	-0.2435	0.4105	0.0270	-0.4650	0.0000
	0.9538	0.2793	0.5224	0.5386	0.0173	0.0281	0.2875	0.0646	0.9076	0.0337	1.0000
Percent Predators	0.0412	0.1612	-0.0832	0.0894	0.1271	-0.1912	-0.3820	0.5129	-0.0933	-0.1719	-0.1044
	0.8593	0.4852	0.7200	0.7000	0.5829	0.4065	0.0875	0.0174	0.6876	0.4562	0.6525
Percent Shreders	-0.0589	-0.0127	-0.2351	-0.0819	0.1971	-0.1405	-0.2037	-0.0086	-0.0603	-0.0907	-0.0912
	0.7999	0.9565	0.3050	0.7243	0.3918	0.5435	0.3758	0.9704	0.7952	0.6959	0.6944
Percent Tolerant Taxa	-0.3655	-0.2630	-0.2917	-0.1968	-0.5126	-0.3406	-0.0558	0.1116	-0.5971	-0.3552	-0.6513
	0.1033	0.2494	0.1995	0.3926	0.0175	0.1308	0.8101	0.6302	0.0043	0.1141	0.0014
Sensitive EPT Index (%)	0.0026	-0.2446	0.1445	0.1623	-0.5113	0.4814	-0.2496	0.4100	0.0334	-0.4645	0.0051
	0.9912	0.2852	0.5320	0.4820	0.0178	0.0271	0.2752	0.0649	0.8859	0.0339	0.9825
Shannon Diversity	-0.0895	-0.0666	-0.1332	0.0523	-0.1575	0.2048	-0.0066	0.1129	0.0069	-0.7088	-0.1295
	0.6996	0.7742	0.5649	0.8219	0.4954	0.3733	0.9774	0.6261	0.9763	0.0003	0.5758
Taxonomic Richness	-0.1060	0.0174	0.0353	0.1900	-0.2634	0.1448	-0.2303	0.2605	0.0701	-0.2717	-0.0749
	0.6475	0.9404	0.8794	0.4095	0.2487	0.5311	0.3152	0.2541	0.7627	0.2335	0.7470
Tolerance Value	-0.5064	-0.2558	-0.3574	-0.1932	-0.3980	-0.4130	0.0748	0.0063	-0.6827	-0.2936	-0.6795
	0.0192	0.2630	0.1118	0.4015	0.0740	0.0628	0.7473	0.9784	0.0006	0.1965	0.0007
Trichoptera Taxa	0.2279	0.4624	0.0509	0.3610	0.0647	0.1035	-0.4157	0.5682	0.1832	0.2497	0.3104
	0.3204	0.0348	0.8266	0.1079	0.7807	0.6551	0.0609	0.0072	0.4267	0.2750	0.1709

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

Benthic Metric	width	depth	velocity	canopy
Abundance (#/ sample)	-0.1685	-0.2393	0.3414	-0.5351
	0.4777	0.3095	0.1408	0.0151
Cumulative EPT Taxa	0.0970	-0.2989	0.0874	-0.3542
	0.6843	0.2006	0.7140	0.1255
Cumulative Taxa	0.4269	0.5136	-0.4995	-0.1535
	0.0605	0.0206	0.0250	0.5183
EPT Index (%)	0.1845	-0.2174	0.1393	-0.3227
	0.4361	0.3572	0.5580	0.1652
EPT Taxa	0.1563	-0.2719	0.0572	-0.3345
	0.5106	0.2461	0.8108	0.1494
Ephemeroptera Taxa	-0.0382	-0.2217	-0.0471	-0.3438
	0.8731	0.3476	0.8438	0.1377
Percent Baetidae	-0.4185	-0.3757	0.1634	-0.1422
	0.0663	0.1026	0.4912	0.5498
Percent Chironomidae	0.3234	0.0132	-0.3293	-0.1033
	0.1642	0.9558	0.1562	0.6647
Percent Collectors	-0.2792	-0.2769	-0.1073	0.2425
	0.2333	0.2373	0.6525	0.3029
Percent Dominant Taxon	0.1204	0.1614	0.5228	-0.0945
	0.6133	0.4965	0.0180	0.6920
Percent Filterers	0.4964	0.0828	0.0109	0.3180
	0.0260	0.7286	0.9636	0.1718
Percent Grazers	-0.2069	0.2753	-0.2843	-0.4275
	0.3814	0.2400	0.2245	0.0601
Percent Hydropsychidae	0.4424	0.0196	0.1253	-0.2191
	0.0508	0.9347	0.5986	0.3533

Table 21. - continued

Benthic Metric	width	depth	velocity	canopy
Percent Intolerant Taxa	-0.2586	-0.3400	-0.2588	-0.2126
	0.2709	0.1425	0.2706	0.3681
Percent Predators	0.0181	-0.1192	-0.1186	-0.5391
	0.9397	0.6167	0.6183	0.0142
Percent Shredders	0.3390	0.2965	0.1225	-0.1977
	0.1437	0.2043	0.6069	0.4035
Percent Tolerant Taxa	-0.0256	0.4277	-0.4928	-0.3067
	0.9147	0.0599	0.0273	0.1885
Sensitive EPT Index (%)	-0.2586	-0.3400	-0.2588	-0.2126
	0.2709	0.1425	0.2706	0.3681
Shannon Diversity	-0.0363	0.0015	-0.5690	0.0683
	0.8793	0.9949	0.0088	0.7750
Taxonomic Richness	0.0113	-0.0462	-0.2515	0.0387
	0.9623	0.8466	0.2848	0.8714
Tolerance Value	0.0828	0.6653	-0.5177	-0.0845
	0.7287	0.0014	0.0194	0.7233
Trichoptera Taxa	0.1725	-0.2770	0.0283	-0.1882
	0.4671	0.2371	0.9056	0.4270

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

	Temperature (C)			Specific Conductance (µmhos/L)			pH			Dissolved Oxygen (mg/L)			Salinity ppt			Turbidity (NTU)		
Site	2002	2001	2000	2002	2001	2000	2002	2001	2000	2002	2001	2000	2002	2001	2000*	2002	2001	2000
DLP1	15.6	20.2	n/a	704	910	n/a	8.06	8.17	n/a	9.5	9	n/a	0.4	0.4	n/a	84	103	n/a
DLP2	20.6	23.7	n/a	709	900	n/a	8.58	-	n/a	8.8	5.9	n/a	0.4	0.5	n/a	130	59	n/a
DLP3	22.2	30.5	n/a	742	1086	n/a	8.34	8.51	n/a	9.1	4.7	n/a	0.4	0.5	n/a	112	25	n/a
DLP4	28.3	18.2	n/a	520	628	n/a	7.55	8.05	n/a	5.4	4.5	n/a	0.2	0.4	n/a	20	56	n/a
DLP5	22.7	22.1	n/a	1689	992	n/a	8.51	8.32	n/a	12.2	4.0	n/a	0.9	0.5	n/a	1.1	0.64	n/a
ORE1	18.1	18.8	21.5	663	648	754	7.80	7.96	8.01	7.6	8.4	6.7	0.4	0.4	-	376	142	115
ORE2	19.9	20.3	22.5	605	662	744	8.01	8.12	8.23	7.8	5.0	8.2	0.3	0.4	-	207	126	158
ORE3	21.1	20.3	23.0	653	675	739	8.12	7.86	8.18	8.1	4.9	7.5	0.3	0.4	-	153	142	156
ORE4	21.0	21.4	21.4	640	334	683	8.09	8.17	8.01	8.3	4.2	7.8	0.3	0.2	-	226	104	107
ORE5	18.8	22.8	22.0	656	636	654	8.06	8.08	8.1	7.6	4.3	8.1	0.4	0.3	-	201	110	107
ORE6	18.7	24.7	22.9	696	584	644	8.21	7.8	8.25	8.1	4.0	8.9	0.4	0.3	-	178	128	131
ORE7	20.1	19.5	29.5	711	663	620	8.14	8.04	8.48	8.4	4.2	8.9	0.4	0.4	-	166	136	153
ORE8	22.6	21.6	22.9	763	695	840	8.08	7.87	8.21	7.9	3.3	8.2	0.4	0.4	-	150	92	80
ORE9	23.1	30.3	27.7	697	1000	857	8.13	8.59	8.4	8.0	4.0	7.8	0.4	0.4	-	236	108	213
ORE10	18.1	27.1	27.4	825	1044	878	8.25	8.37	8.37	3.2	4.8	13.0	0.1	0.5	-	0.88	0.82	0.51
SSL1	18.5	22.1	n/a	1885	989	n/a	7.69	7.62	n/a	6.4	2.8	n/a	0.9	0.5	n/a	46	61	n/a
SSL2	19.3	22.1	n/a	1339	1011	n/a	7.43	7.73	n/a	6.0	3.2	n/a	0.8	0.5	n/a	41	78	n/a
SSL3	20.8	24.5	n/a	1256	495	n/a	7.56	7.74	n/a	6.7	2.8	n/a	0.7	0.3	n/a	52	68	n/a
SSL4	23.5	20.6	n/a	1073	542	n/a	7.75	7.30	n/a	7.4	2.9	n/a	0.6	0.3	n/a	52	65	n/a
SSL5	18.0	23.2	n/a	1473	552	n/a	7.37	7.37	n/a	4.8	2.7	n/a	0.7	0.3	n/a	37	80	n/a

* Salinity not measured in 2000.

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

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

Table 23. Continued.

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

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

Habitat Metric	2000	2001	2002	Friedman p-value	2000 vs 2001	2000 vs 2002	2001 vs 2002
EPI SUB	11.700	12.100	9.100	0.0583			
EMBEDDED	11.400	12.900	9.800	0.0720			
VEL DPTH	12.100	15.500	9.600	0.0033			*
SED DEP	11.900	11.000	12.800	0.3872			
CH FLOW	14.000	17.300	14.000	0.0405	*		
CHAN ALT	15.700	14.700	13.400	0.0102		*	
BENRIFF	12.700	13.800	9.700	0.0203			*
BANKSTAB	11.400	12.000	11.300	0.7674			
BANKVEG	11.300	12.700	11.700	0.5580			
RIPBUFF	10.100	8.800	7.800	0.0458			
TOTAL	122.300	130.800	109.200	0.0450			*
WIDTH	3.860	6.170	4.580	0.0202	*		*
DEPTH	0.220	0.479	0.200	0.0231	*		*
VELOC	0.445	0.514	0.351	0.0449			*
CANOPY	32.900	28.900	50.100	0.2359			*

Table 24b. Mean scores for each physical habitat metric, total score, and stream measurement for years 2001 and 2002 for Del Puerto creek. The p-value is based on the Wilcoxon signed rank test.

Habitat Metric	2001	2002	p-value
BANKSTAB	10.60	11.40	0.8750
BANKVEG	10.60	9.00	0.6250
BENRIFF	9.80	11.60	0.5000
CANOPY	15.20	24.80	0.5000
CHAN ALT	11.80	12.60	1.0000
CH FLOW	13.40	12.00	0.3750
DEPTH	0.38	0.14	0.1250
EMBEDDED	8.00	7.80	1.0000
EPI SUB	6.80	8.60	0.5000
RIPBUFF	9.00	5.60	0.2500
SED DEP	10.80	11.00	1.0000
TOTAL	101.80	99.60	0.5000
VELOCITY	0.45	0.42	0.8125
VEL DPTH	11.00	10.00	1.0000
WIDTH	2.18	2.92	0.6250

Table 24c. Mean scores for each physical habitat metric, total score, and stream measurement for years 2001 and 2002 for Salt Slough creek. The p-value is based on the Wilcoxon signed rank test.

Benthic Metric	2001	2002	p-value
BANKSTAB	12.00	9.00	0.0625
BANKVEG	10.00	10.00	1.0000
BENRIFF	9.40	3.00	0.0625
CANOPY	0.20	0.00	1.0000
CHAN_ALT	13.20	11.20	0.1250
CH FLOW	19.20	12.00	0.0625
DEPTH	0.79	0.59	0.3125
EMBEDDED	0.60	0.00	0.2500
EPI SUB	4.60	3.20	0.5000
RIPBUFF	11.00	9.80	0.5000
SED DEP	3.20	2.40	0.5000
TOTAL	92.80	68.40	0.0625
VELOCITY	0.28	0.21	0.1250
VEL DPTH	9.60	7.80	0.2500
WIDTH	20.80	18.96	0.3125

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	Waterborne Environmental Inc., 2002
Chlorpyrifos	Orestimba Creek	0 - 2,282	1996/97	Poletika and Robb, 1998
Chlorpyrifos	Salt Slough	0 - 120	1991/93	Waterborne Environmental Inc., 2002
Diazinon	Del Puerto Creek	0 - 2,600	1991/93	Waterborne Environmental Inc., 2002
Diazinon	Orestimba Creek	0 - 29,371	1996/97	Poletika and Robb, 1998
Diazinon	Salt Slough	0 - 330	1991/93	Waterborne Environmental Inc., 2002

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.

Species	Collection Site	Abundance	EC or LC50 Values (µg/L)
Dugesia tigrina	DLP 2	42	2.0-4.3[A]
Dugesia tigrina	DLP 3	29	2.0-4.3[A]
Dugesia tigrina	DLP 4	11	2.0-4.3[A]
Dugesia tigrina	DLP 5	1	2.0-4.3[A]
Dugesia tigrina	ORE 2	1	2.0-4.3[A]
Dugesia tigrina	ORE 4	4	2.0-4.3[A]
Dugesia tigrina	ORE 5	5	2.0-4.3[A]
Dugesia tigrina	ORE 6	59	2.0-4.3[A]
Dugesia tigrina	ORE 7	130	2.0-4.3[A]
Dugesia tigrina	ORE 8	43	2.0-4.3[A]
Dugesia tigrina	ORE 9	1	2.0-4.3[A]
Dugesia tigrina	ORE 10	1	2.0-4.3[A]
Gammarus lacustris	DLP 1	2	0.11[B]
Gammarus lacustris	DLP 4	46	0.11[B]
Gammarus lacustris	ORE 4	1	0.11[B]
Gammarus lacustris	ORE 5	34	0.11[B]
Gammarus lacustris	ORE 7	22	0.11[B]
Gammarus lacustris	ORE 8	2	0.11[B]
Gammarus lacustris	ORE 9	1	0.11[B]
Gammarus lacustris	SSL 1	1	0.11[B]
Gammarus lacustris	SSL 2	2	0.11[B]
Daphniidae	DLP 3	1	0.21[C]
Daphniidae	DLP 4	3	0.21[C]
Daphniidae	ORE 1	1	0.21[C]
Daphniidae	ORE 10	304	0.21C
Daphniidae	SSL 1	1	0.21[C]
Daphniidae	SSL 3	1	0.21[C]

Table 26 continued.

Daphniidae	SSL 5	122	0.21[C]
Simulium sp.	DLP 1	29	27[D]
Simulium sp.	DLP 2	24	27[D]
Simulium sp.	DLP 3	26	27[D]
Simulium sp.	DLP 5	12	27[D]
Simulium sp.	ORE 3	43	27[D]
Simulium sp.	ORE 4	311	27[D]
Simulium sp.	ORE 5	244	27[D]
Simulium sp.	ORE 6	29	27[D]
Simulium sp.	ORE 7	24	27[D]
Simulium sp.	ORE 8	10	27[D]
Simulium sp.	SSL 3	21	27[D]
Simulium sp.	SSL 4	1	27[D]
Hydropsyche californica	SSL 1	44	30.6[E]
Hydropsyche californica	SSL 2	2	30.6[E]
Hydropsyche californica	SSL 3	53	30.6[E]
Hydropsyche californica	ORE 5	4	30.6[E]
Hydropsyche californica	ORE 7	21	30.6[E]
Hydropsyche californica	ORE 8	16	30.6[E]
Paratanytarsus sp.	DLP 4	4	<1.6
Paratanytarsus sp.	DLP 5	1	<1.6
Paratanytarsus sp.	ORE 1	1	<1.6
Paratanytarsus sp.	ORE 6	2	<1.6
Paratanytarsus sp.	SSL 1	7	<1.6
Paratanytarsus sp.	SSL 2	107	<1.6
Paratanytarsus sp.	SSL 3	1	<1.6
Paratanytarsus sp.	SSL 4	4	<1.6
Paratanytarsus sp.	SSL 5	91	<1.6
Caenis sp.	ORE 10	26	>3[F]

Table 26 continued.

Chironomus sp.	DLP 2	1	0.07[G]
Chironomus sp.	DLP 3	1	0.07[G]
Chironomus sp.	ORE 1	67	0.07[G]
Chironomus sp.	ORE 2	5	0.07[G]
Chironomus sp.	ORE 3	1	0.07[G]
Chironomus sp.	ORE 5	1	0.07[G]
Chironomus sp.	ORE 6	1	0.07[G]
Chironomus sp.	ORE 9	8	0.07[G]
Chironomus sp.	ORE 10	32	0.07[G]
Chironomus sp.	SSL 1	2	0.07[G]
Chironomus sp.	SSL 2	1	0.07[G]
Chironomus sp.	SSL 3	3	0.07[G]
Chironomus sp.	SSL 4	13	0.07[G]
Chironomus sp.	SSL 5	26	0.07[G]
Cricotopus sp.	DLP 1	109	3.5-90
Cricotopus sp.	DLP 2	47	3.5-90
Cricotopus sp.	DLP 3	249	3.5-90
Cricotopus sp.	DLP 4	19	3.5-90
Cricotopus sp.	DLP 5	71	3.5-90
Cricotopus sp.	ORE 1	22	3.5-90
Cricotopus sp.	ORE 2	77	3.5-90
Cricotopus sp.	ORE 3	108	3.5-90
Cricotopus sp.	ORE 4	142	3.5-90
Cricotopus sp.	ORE 5	36	3.5-90
Cricotopus sp.	ORE 6	154	3.5-90
Cricotopus sp.	ORE 7	130	3.5-90
Cricotopus sp.	ORE 8	219	3.5-90
Cricotopus sp.	ORE 9	34	3.5-90
Cricotopus sp.	ORE 10	27	3.5-90

Table 26 continued.

Cricotopus sp.	SSL 1	148	3.5-90
Cricotopus sp.	SSL 2	21	3.5-90
Cricotopus sp.	SSL 3	88	3.5-90
Cricotopus sp.	SSL 4	233	3.5-90
Cricotopus sp.	SSL 5	297	3.5-90
Dicrotendipes sp.	DLP 1	1	7-40[H]
Dicrotendipes sp.	DLP 2	10	7-40[H]
Dicrotendipes sp.	DLP 4	48	7-40[H]
Dicrotendipes sp.	DLP 5	3	7-40[H]
Dicrotendipes sp.	ORE 1	17	7-40[H]
Dicrotendipes sp.	ORE 2	4	7-40[H]
Dicrotendipes sp.	ORE 3	7	7-40[H]
Dicrotendipes sp.	ORE 4	4	7-40[H]
Dicrotendipes sp.	ORE 5	4	7-40[H]
Dicrotendipes sp.	ORE 6	34	7-40[H]
Dicrotendipes sp.	ORE 7	18	7-40[H]
Dicrotendipes sp.	ORE 8	17	7-40[H]
Dicrotendipes sp.	ORE 9	7	7-40[H]
Dicrotendipes sp.	ORE 10	20	7-40[H]
Dicrotendipes sp.	SSL 1	2	7-40[H]
Dicrotendipes sp.	SSL 2	1	7-40[H]
Dicrotendipes sp.	SSL 4	21	7-40[H]
Dicrotendipes sp.	SSL 5	2	7-40[H]
Limnodrilus hoffmeisteri	DLP 2	9	>36
Limnodrilus hoffmeisteri	ORE 1	4	>36
Limnodrilus hoffmeisteri	ORE 2	1	>36
Limnodrilus hoffmeisteri	ORE 8	1	>36
Limnodrilus hoffmeisteri	ORE 9	1	>36
Limnodrilus hoffmeisteri	SSL 3	7	>36

Table 26 continued.

Limnodrilus hoffmeisteri	SSL 4	1	>36
Hyalella azteca	ORE 1	3	1.3[I]
Hyalella azteca	ORE 2	1	1.3[I]
Hyalella azteca	ORE 6	1	1.3[I]
Hyalella azteca	ORE 8	3	1.3[I]
Hyalella azteca	SSL 1	3	1.3[I]
Hyalella azteca	SSL 2	1	1.3[I]
Hyalella azteca	SSL 3	1	1.3[I]
Peltodytes sp.	DLP 5	48	0.8
Peltodytes sp.	ORE 10	13	0.8
Ischnura sp.	ORE 3	1	11.4[J]
Ischnura sp.	SSL 3	1	11.4[J]
Tanypus sp.	SSL 1	2	1.5[K]

[A] Listed toxicity value was for *Dugesia dorotocephala.*
[B] Two values listed for this species, used conservative value, other value = 0.76 µg/L.
[C] Several genera listed, toxicity value used was for *Daphnia pulex.*
[D] Listed toxicity value was for *Simulium vitattum.*
[E] Listed toxicity value was for *Hydropsyche/Cheumatopsyche sp.*
[F] Listed toxicity value was for *Caenis horaria.*
[G] Listed toxicity value was for *Chironomus tentans.*
[H] Listed toxicity value was for *Dicrotendipes californicus.*
[I] Listed toxicity value was for *Hyalella sp.*
[J] Listed toxicity value was for *Enallagma/Ischnura sp.*
[K] 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
Gammarus lacustris	DLP 1	2	184
Gammarus lacustris	DLP 4	46	184
Gammarus lacustris	ORE 4	1	184
Gammarus lacustris	ORE 5	34	184
Gammarus lacustris	ORE 7	22	184
Gammarus lacustris	ORE 8	2	184
Gammarus lacustris	ORE 9	1	184
Gammarus lacustris	SSL 1	1	184
Gammarus lacustris	SSL 2	2	184
Daphniidae	DLP 3	1	0.78[A]
Daphniidae	DLP 4	3	0.78[A]
Daphniidae	ORE 1	1	0.78[A]
Daphniidae	ORE 10	304	0.78[A]
Daphniidae	SSL 1	1	0.78[A]
Daphniidae	SSL 3	1	0.78[A]
Daphniidae	SSL 5	122	0.78[A]
Daphniidae	DLP 3	1	1.02[B]
Daphniidae	DLP 4	3	1.02[B]
Daphniidae	ORE 1	1	1.02[B]
Daphniidae	ORE 10	304	1.02[B]
Daphniidae	SSL 1	1	1.02[B]
Daphniidae	SSL 3	1	1.02[B]
Daphniidae	SSL 5	122	1.02[B]
Hyalella azteca	ORE 1	3	22
Hyalella azteca	ORE 2	1	22
Hyalella azteca	ORE 6	1	22

Table 27 continued.

Hyalella azteca	ORE 8	3	22
Hyalella azteca	SSL 1	3	22
Hyalella azteca	SSL 2	1	22
Hyalella azteca	SSL 3	1	22
Baetis sp.	DLP 5	4	24[C]
Baetis adonis	DLP 5	8	24[C]
Baetis tricaudatus	DLP 5	6	24[C]
Baetis tricaudatus	ORE 7	1	24[C]
Physa/ Physella	DLP 1	36	48[D]
Physa/ Physella	DLP 2	59	48[D]
Physa/ Physella	DLP 3	48	48[D]
Physa/ Physella	DLP 4	45	48[D]
Physa/ Physella	DLP 5	102	48[D]
Physa/ Physella	ORE 1	6	48[D]
Physa/ Physella	ORE 3	2	48[D]
Physa/ Physella	ORE 4	1	48[D]
Physa/ Physella	ORE 5	3	48[D]
Physa/ Physella	ORE 7	1	48[D]
Physa/ Physella	ORE 8	20	48[D]
Physa/ Physella	ORE 9	146	48[D]
Physa/ Physella	ORE 10	98	48[D]
Physa/ Physella	SSL 1	29	48[D]
Physa/ Physella	SSL 2	26	48[D]
Physa/ Physella	SSL 3	38	48[D]
Physa/ Physella	SSL 4	69	48[D]
Physa/ Physella	SSL 5	102	48[D]
Physa/ Physella	DLP 1	36	4800[E]
Physa/ Physella	DLP 2	59	4800[E]

Table 27 continued.

Physa/ Physella	DLP 3	48	4800[E]
Physa/ Physella	DLP 4	45	4800[E]
Physa/ Physella	DLP 5	102	4800[E]
Physa/ Physella	ORE 1	6	4800[E]
Physa/ Physella	ORE 3	2	4800[E]
Physa/ Physella	ORE 4	1	4800[E]
Physa/ Physella	ORE 5	3	4800[E]
Physa/ Physella	ORE 7	1	4800[E]
Physa/ Physella	ORE 8	20	4800[E]
Physa/ Physella	ORE 9	146	4800[E]
Physa/ Physella	ORE 10	98	4800[E]
Physa/ Physella	SSL 1	29	4800[E]
Physa/ Physella	SSL 2	26	4800[E]
Physa/ Physella	SSL 3	38	4800[E]
Physa/ Physella	SSL 4	69	4800[E]
Physa/ Physella	SSL 5	102	4800[E]
Undetermined Tubificidae	DLP 1	6	3160[F]
Undetermined Tubificidae	DLP 2	40	3160[F]
Undetermined Tubificidae	DLP 3	360	3160[F]
Undetermined Tubificidae	DLP 5	5	3160[F]
Undetermined Tubificidae	ORE 1	17	3160[F]
Undetermined Tubificidae	ORE 2	3	3160[F]
Undetermined Tubificidae	ORE 3	1	3160[F]
Undetermined Tubificidae	ORE 4	2	3160[F]
Undetermined Tubificidae	ORE 5	3	3160[F]
Undetermined Tubificidae	ORE 6	9	3160[F]
Undetermined Tubificidae	ORE 7	5	3160[F]
Undetermined Tubificidae	ORE 8	1	3160[F]

Table 27 continued.

Undetermined Tubificidae	ORE 9	28	3160[F]
Undetermined Tubificidae	SSL 1	8	3160[F]
Undetermined Tubificidae	SSL 2	1	3160[F]
Undetermined Tubificidae	SSL 3	18	3160[F]
Undetermined Tubificidae	SSL 4	9	3160[F]
Undetermined Tubificidae	SSL 5	4	3160[F]

[A] Listed toxicity value was for *Daphnia pulex.*
[B] Listed toxicity value was for *Daphnia magna.*
[C] Listed toxicity value was for *Baetis intermedius.*
[D] Listed toxicity value was for *Physa gyrina.*
[E] Listed toxicity value was for *Physa acuta.*
[F] Listed toxicity value was for *Tubifex* species.

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

Benthic Metric	2000	2001	2002	p-value+	2000 vs 2001	2000 vs 2002	2001 vs 2002
Abundance (#/ sample)	1012.00	588.03	1456.92	0.2725			
Cumulative EPT Taxa	-	1.90	1.30	0.4609			
Cumulative Taxa	-	35.30	33.20	0.5234			
Dipteran Taxa	-	1.53	-	-			
EPT Index (%)	2.03	4.23	1.37	0.7855			
EPT Taxa	0.93	1.00	0.93	0.9017			
Ephemeroptera Taxa	0.60	0.57	0.40	0.5045			
Non-Insect Taxa	-	11.63	-	-			
Percent Baetidae	-	2.33	0.23	0.5000			
Percent Chironomidae	-	18.37	34.40	0.0578			
Percent Collectors	75.83	56.57	35.43	0.0007	*	*	*
Percent Diptera	-	9.07	-	-			
Percent Dominant	44.20	32.13	35.10	0.0450			
Percent Filterers	7.07	16.43	30.90	0.0055	*	*	
Percent Grazers	3.73	3.37	8.10	0.4516			
Percent Hydropsychidae	-	0.13	0.53	0.2500			
Percent Intolerant Taxa	0.30	0.23	0.03	0.3679			
Percent Non-Insect Taxa	-	64.60	-	-			
Percent Predators	7.10	10.40	13.77	1.0000			
Percent Shredders	6.07	6.73	11.77	0.2231			
Percent Tolerant Taxa	52.57	52.67	30.87	0.0608			
Plecoptera Taxa	0.00	0.00	0.00				
Sensitive EPT Index (%)	0.43	0.00	0.17	0.3679			
Shannon Diversity	1.84	2.25	2.17	0.0608			
Taxonomic Richness	17.33	22.37	21.90	0.2847			
Tolerance Value	6.82	6.80	6.72	0.3872			
Trichoptera Taxa	0.33	0.43	0.53	0.8777			

+ Friedman test if three years, Wilcoxon signed rank test if two years.

* $p < 0.05$ by Wilcoxon signed rank test.

Table 28b. Mean scores for each benthic metric by year for Del Puerto creek with p-value based on Wilcoxon signed rank test.

Benthic Metric	2001	2002	p-value
Abundance (#/ sample)	864.867	1361.267	0.3125
Cumulative EPT Taxa	1.400	1.800	1.0000
Cumulative Taxa	34.600	35.000	1.0000
Dipteran Taxa	1.267	-	-
EPT Index (%)	6.267	1.067	0.5000
EPT Taxa	1.067	0.800	0.5000
Ephemeroptera Taxa	0.800	0.533	0.5000
Non-Insect Taxa	9.933	-	
Percent Baetidae	5.000	0.600	0.5000
Percent Chironomidae	36.267	25.133	0.1875
Percent Collectors	38.533	38.667	1.0000
Percent Diptera	12.600	-	-
Percent Dominant Taxon	29.867	38.133	0.1875
Percent Filterers	16.600	7.600	0.1250
Percent Grazers	3.667	15.933	0.0625
Percent Hydropsychidae	1.067	0.000	1.0000
Percent Intolerant Taxa	0.000	0.067	1.0000
Percent Non-Insect Taxa	42.133	-	-
Percent Predators	14.800	22.467	1.0000
Percent Shredders	16.067	15.133	0.6250
Percent Tolerant Taxa	41.667	45.200	1.0000
Plecoptera Taxa	0.000	0.000	-
Sensitive EPT Index (%)	0.000	0.400	1.0000
Shannon Diversity	2.193	2.047	0.8750
Taxonomic Richness	21.800	21.533	1.0000
Tolerance Value	6.473	7.173	0.0625
Trichoptera Taxa	0.267	0.267	-

Table 28c. Mean scores for each benthic metric by year for Salt Slough with p-value based on Wilcoxon signed rank test.

Benthic Metric	2001	2002	p-value
Abundance (#/ sample)	399.533	1228.067	0.0625
Cumulative EPT Taxa	2.000	1.000	0.2500
Cumulative Taxa	35.600	40.200	0.1250
Dipteran Taxa	0.800	-	-
EPT Index (%)	2.867	2.467	0.7500
EPT Taxa	1.000	0.667	0.2500
Ephemeroptera Taxa	0.067	0.200	0.7500
Non-Insect Taxa	8.333	-	-
Percent Baetidae	0.000	0.000	-
Percent Chironomidae	35.133	33.333	0.8125
Percent Collectors	48.400	17.267	0.0625
Percent Diptera	1.133	-	-
Percent Dominant Taxon	33.400	42.267	0.1250
Percent Filterers	12.067	25.667	0.3125
Percent Grazers	8.800	14.600	0.3125
Percent Hydropsychidae	2.733	2.467	0.7500
Percent Intolerant Taxa	0.000	0.000	-
Percent Non-Insect Taxa	46.267	-	-
Percent Predators	17.133	17.800	1.0000
Percent Shredders	10.800	24.667	0.0625
Percent Tolerant Taxa	71.867	43.733	0.0625
Plecoptera Taxa	0.000	0.000	-
Sensitive EPT Index (%)	0.000	0.000	-
Shannon Diversity	2.173	1.940	0.3125
Taxonomic Richness	22.133	21.533	0.8125
Tolerance Value	7.833	7.380	0.4375
Trichoptera Taxa	0.933	0.467	0.1250

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

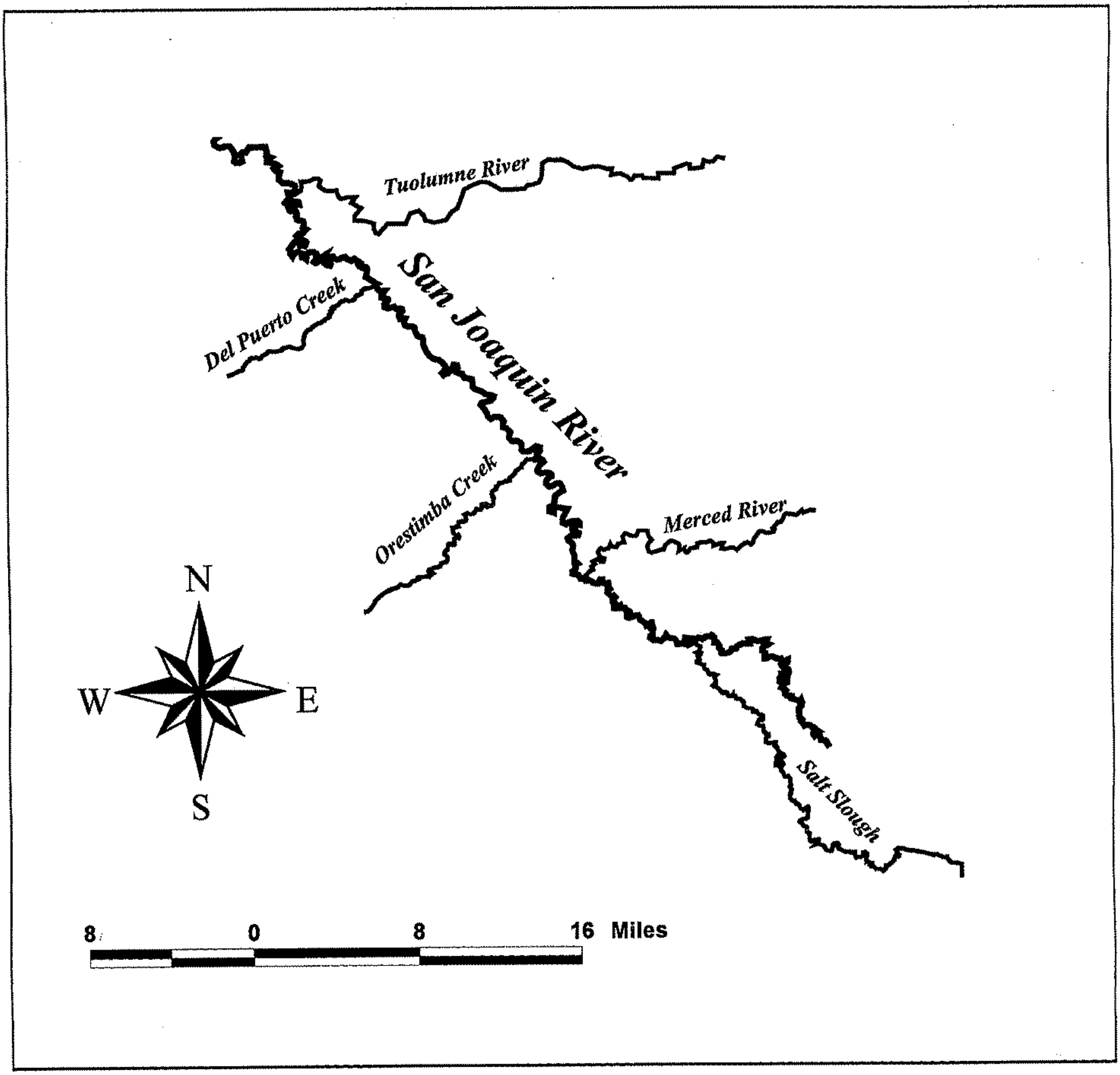


Figure 2. Del Puerto Creek sample sites.

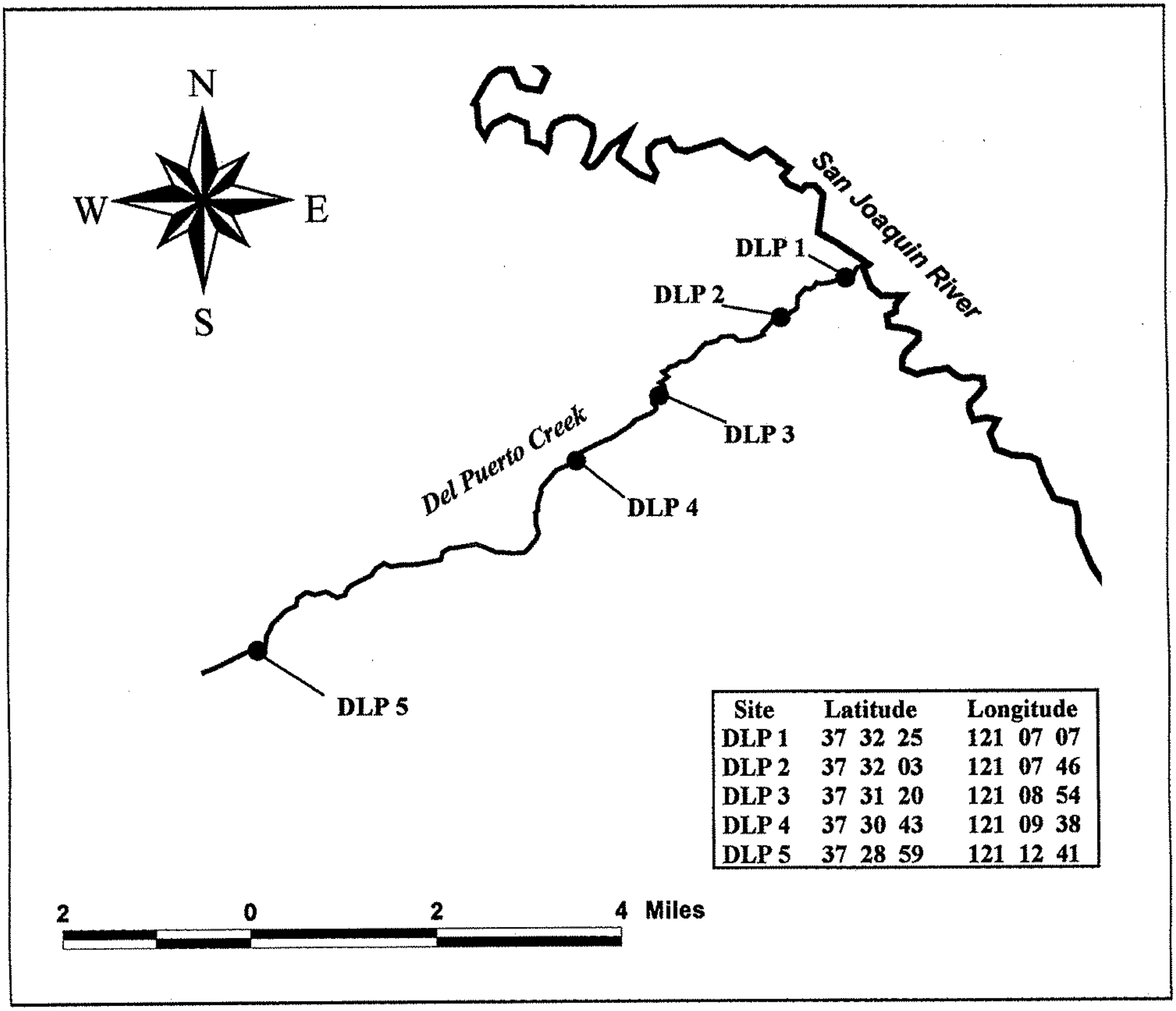
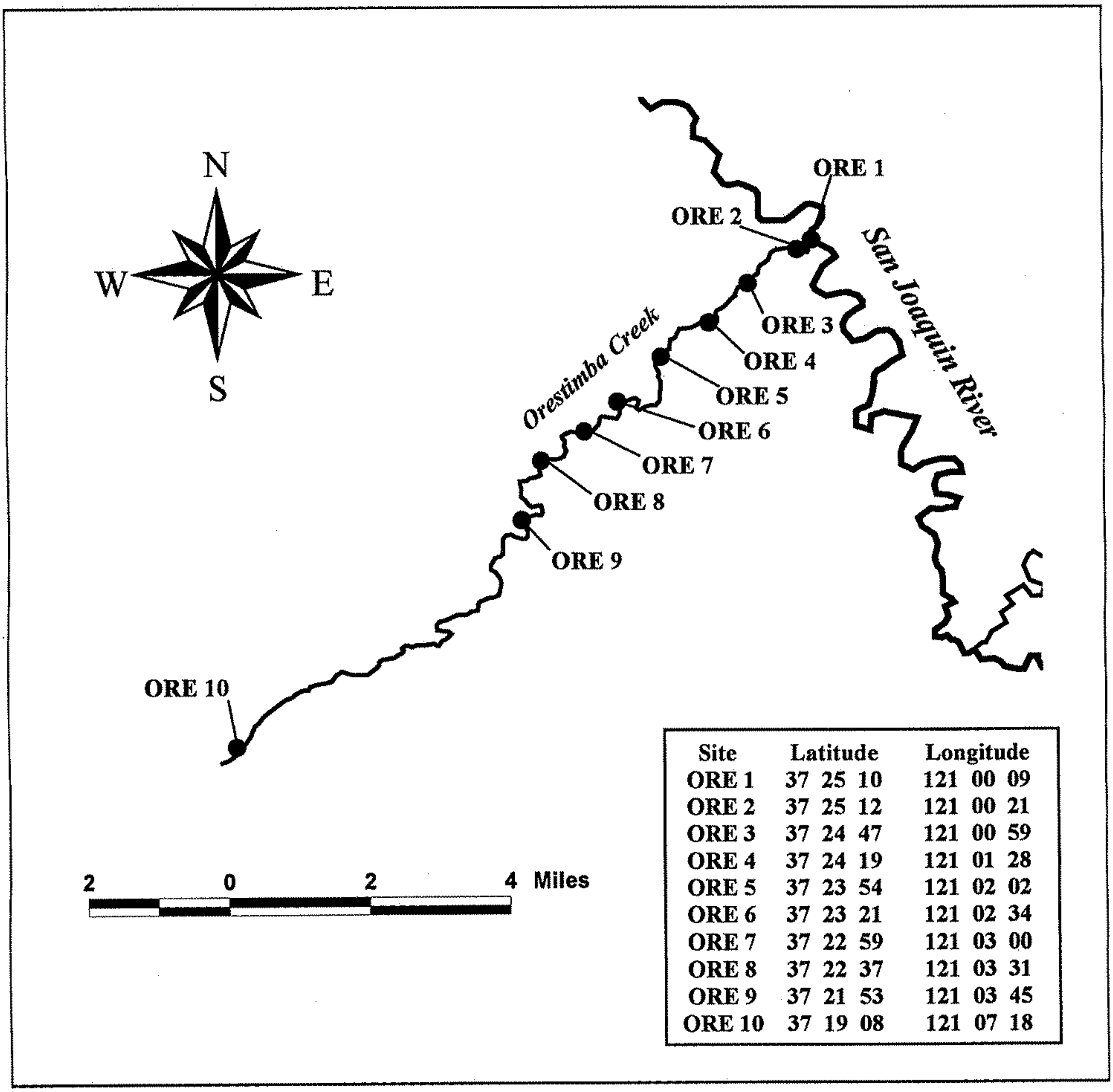
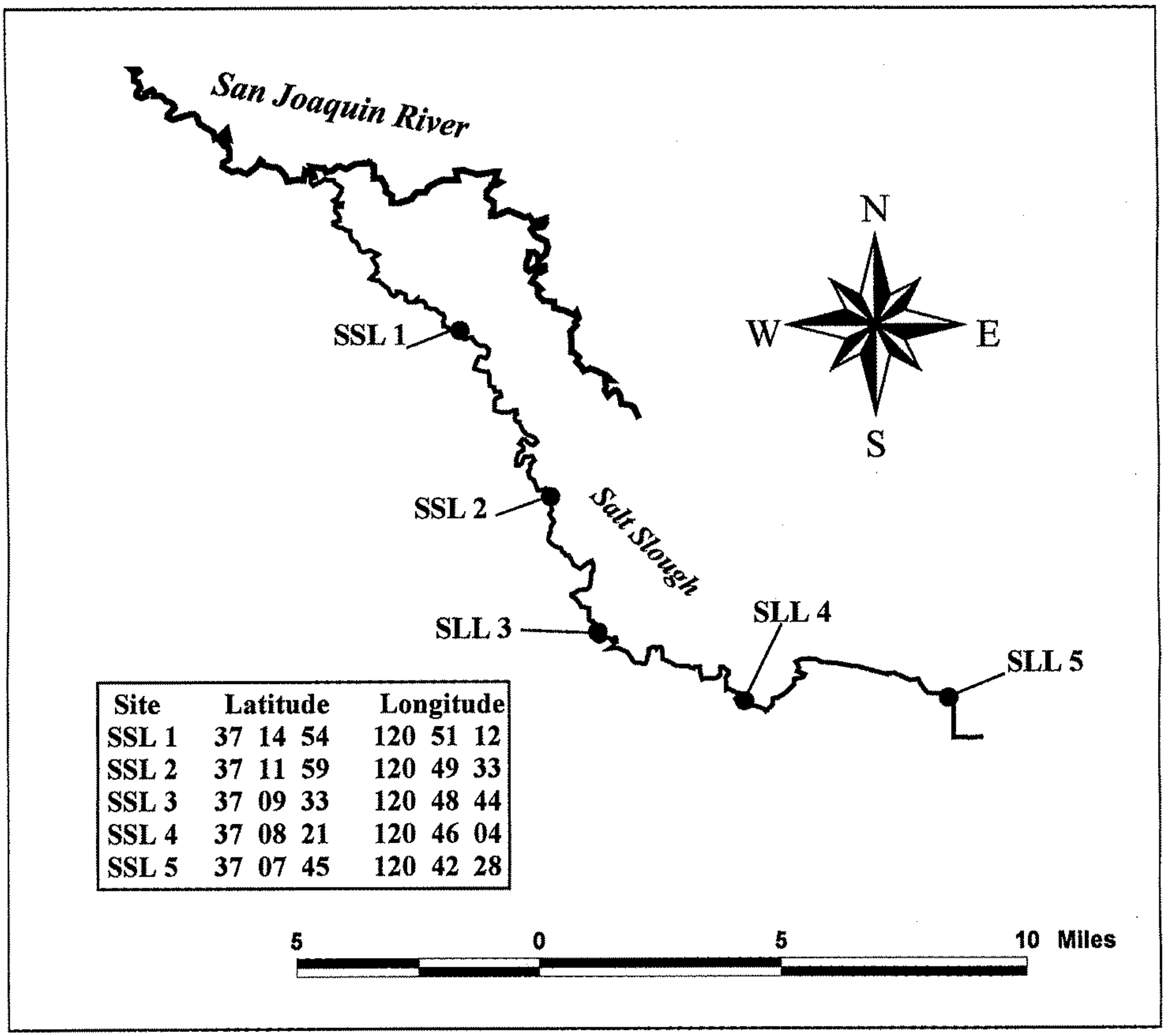


Figure 3. Orestimba Creek sample sites.



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

Figure 4. Salt Slough sample sites.



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

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

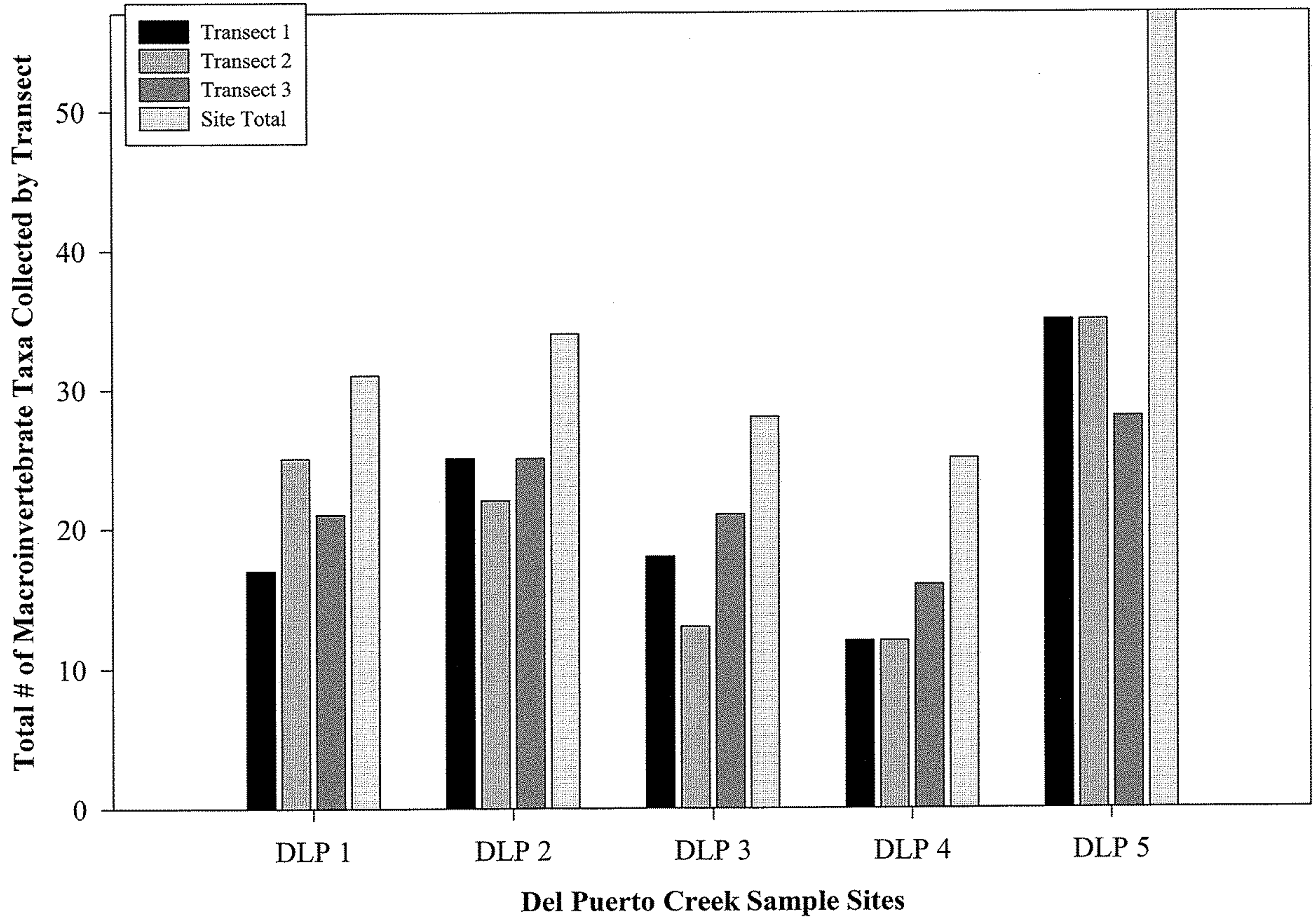


Figure 6. Macroinvertebrate abundance for each transect and site total for the five Del Puerto Creek sites.

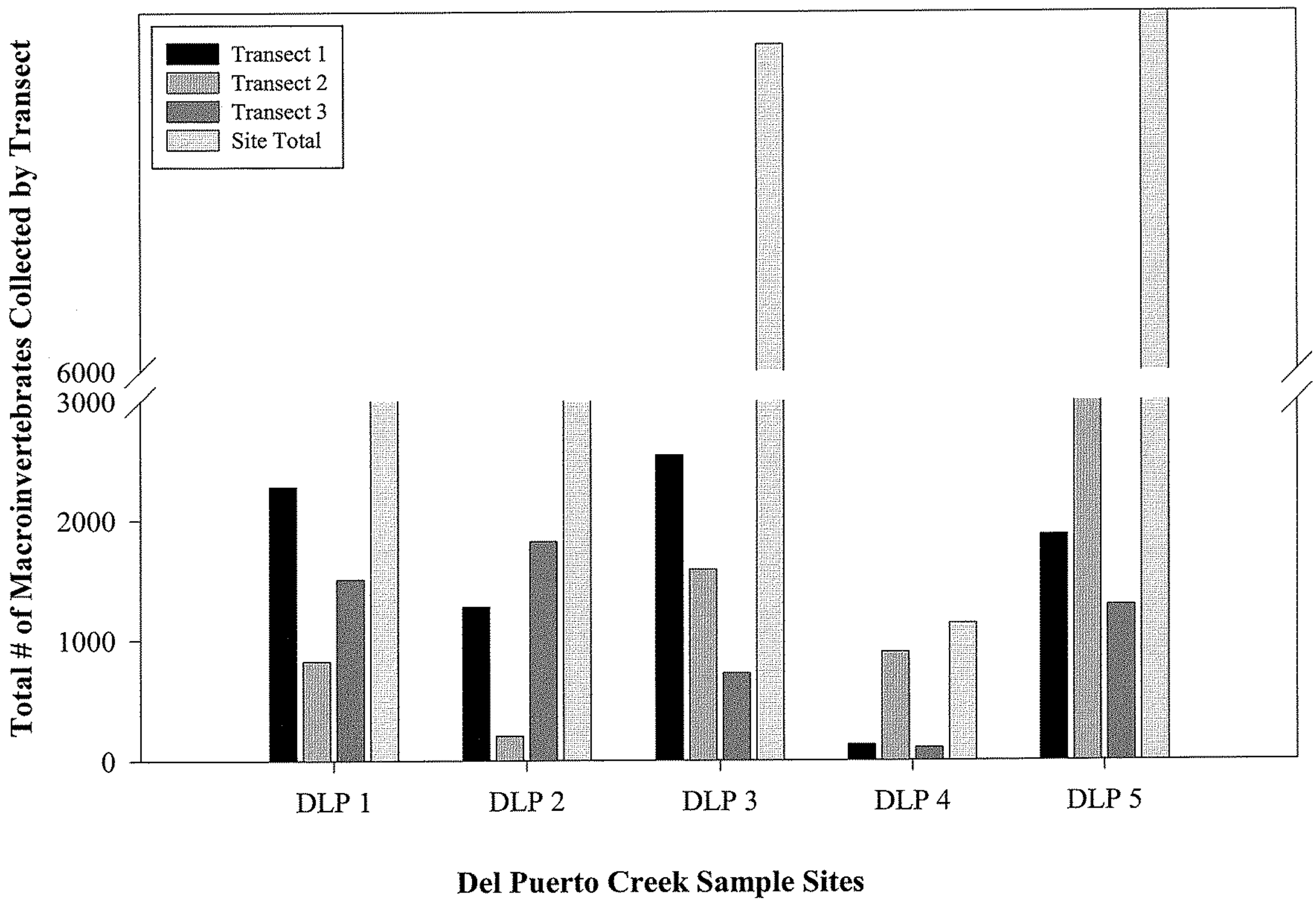


Figure 7. Macroinvertebrate richness for each transect and site total for the ten Orestimba Creek sites.

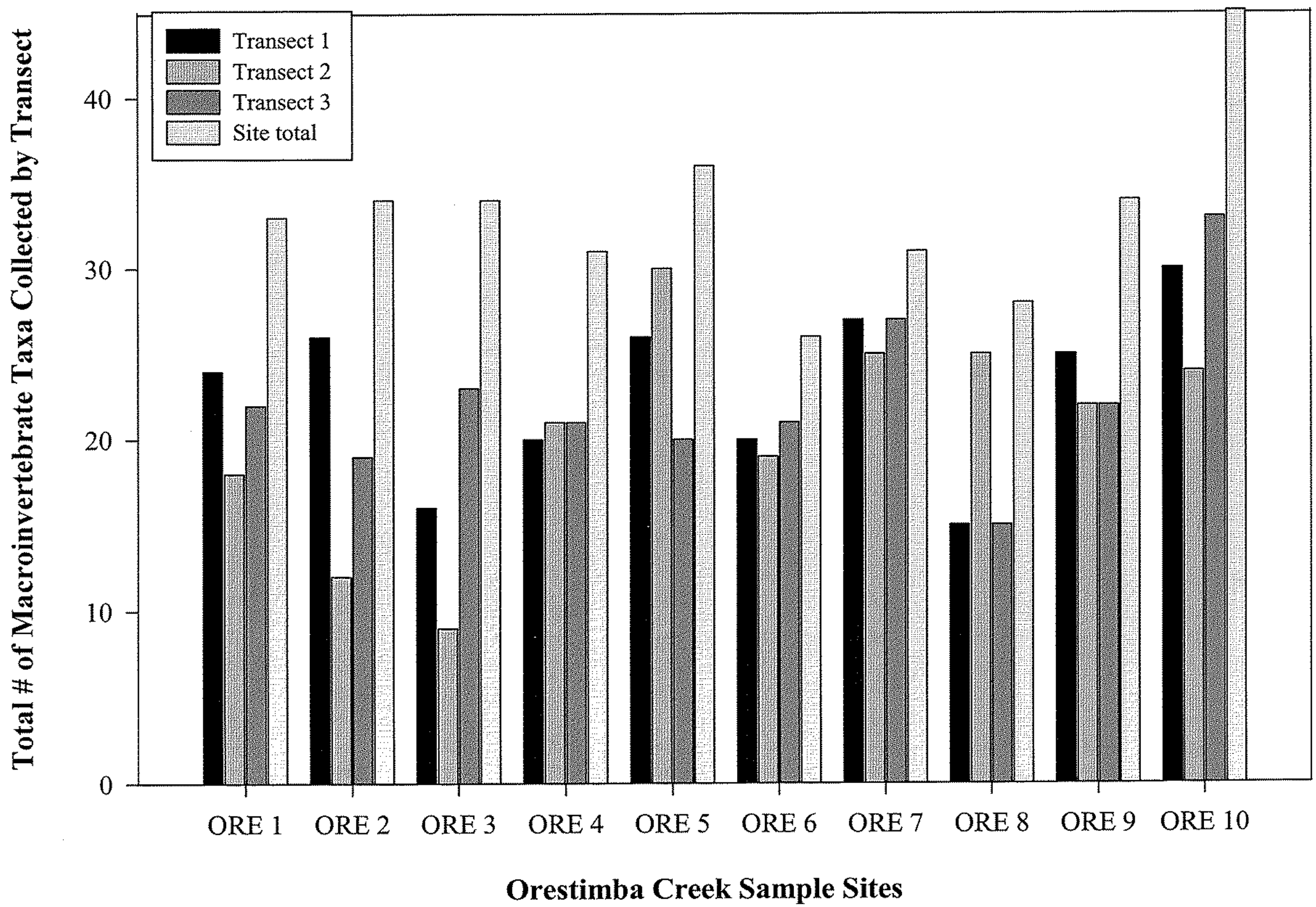


Figure 8. Macroinvertebrate abundance for each transect and site total for the ten Orestimba Creek sites.

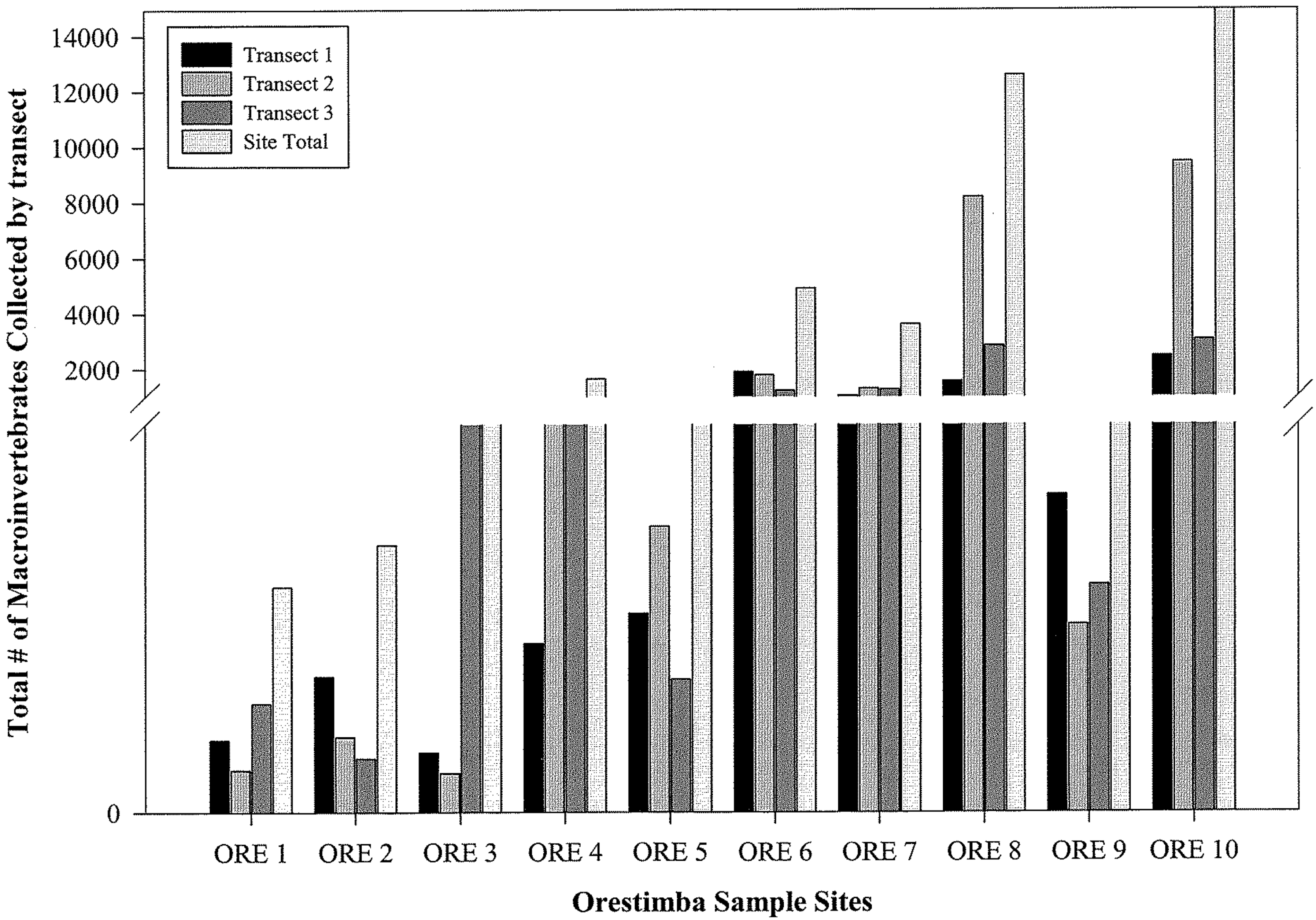


Figure 9. Macroinvertebrate richness for each transect and site total for the five Salt Slough sites.

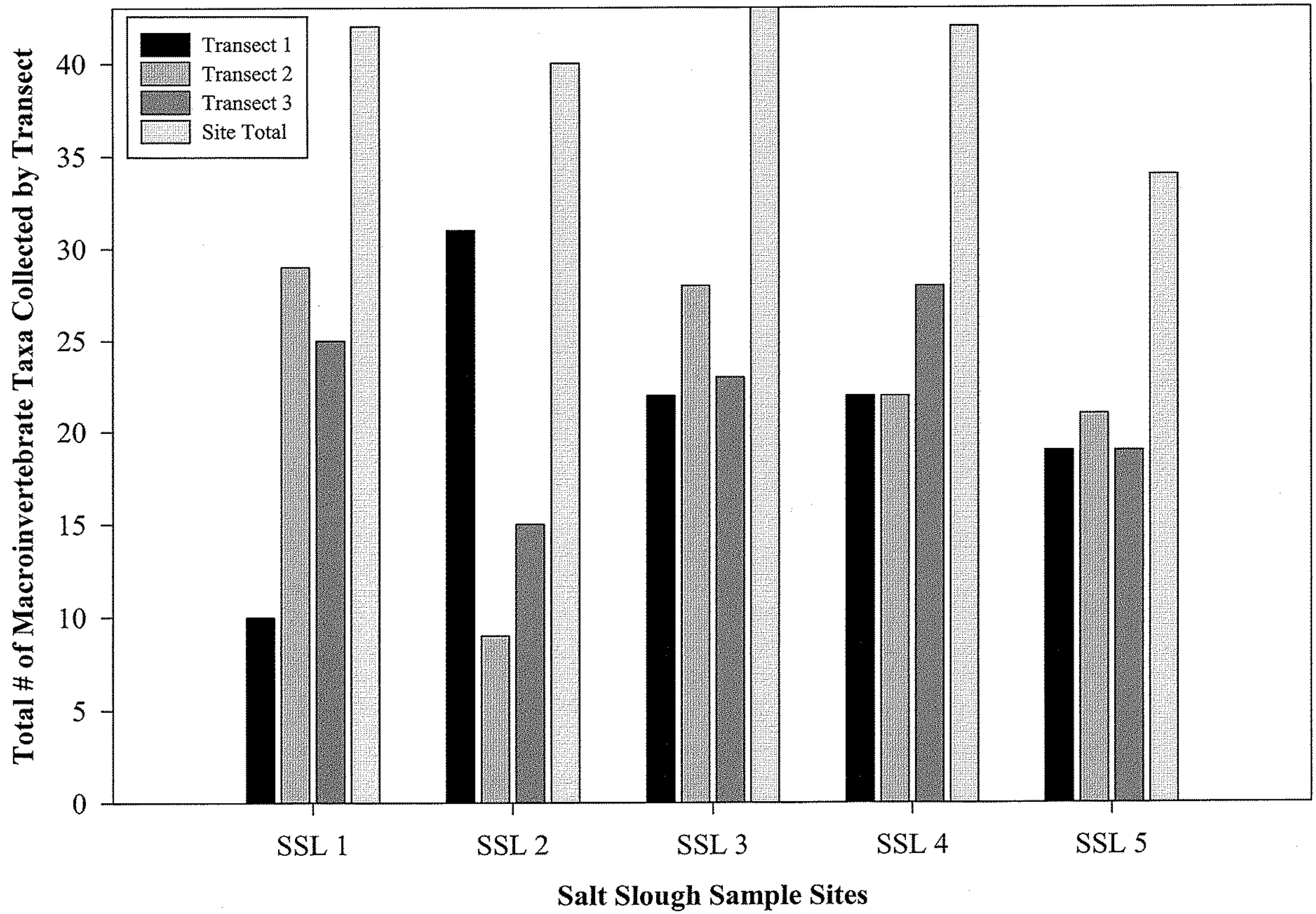
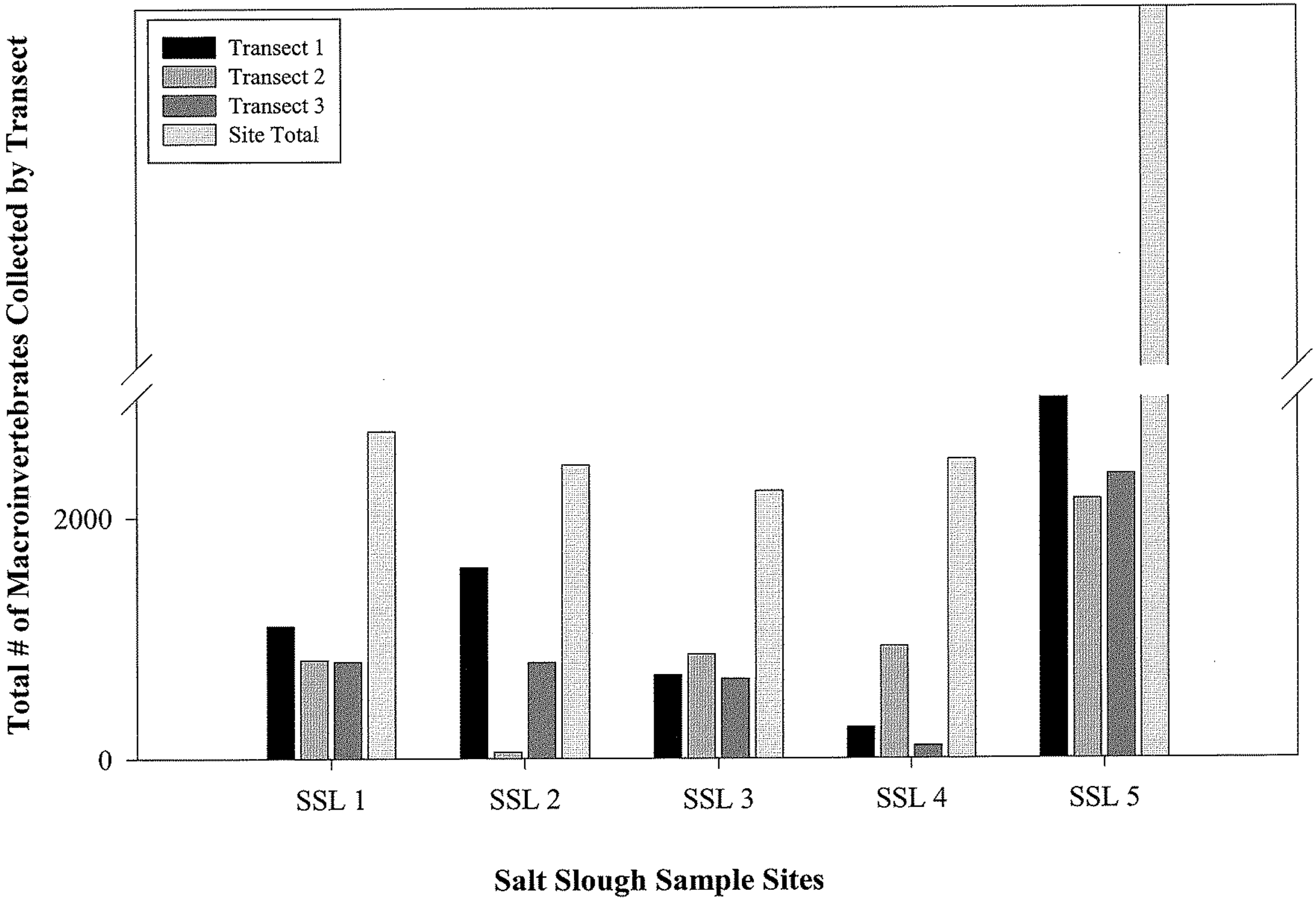


Figure 10. Macroinvertebrate abundance for each transect and site total for the five Salt Slough sites.



Appendix A

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

CALIFORNIA BIOASSESSMENT WORKSHEET

WATERSHED/ STREAM: ______________________
DATE/ TIME: ______________________
COMPANY/ AGENCY: ______________________
SAMPLE ID #: ______________________
SITE DESCRIPTION: ______________________

SAMPLING CREW

____
____
____

SITE INFORMATION

GPS Coordinates
Latitude: ____________
Longitude: ____________
Elevation: ____________
Ecoregion: ____________
COMMENTS:

____
____
____
____
____

CHEMICAL CHARACTERISTICS

Water Temperature: ________
Specific Conductance: ________
pH: ________
Dissolved Oxygen: ________

Bioassessment Laboratory Information:

____
____
____
____
____

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

RIFFLE/ REACH CHARACTERISTICS

Point Source Sampling Design

Riffle Length: ____
Transect 1: ____
Transect 2: ____
Transect 3: ____

(record Physical/ Habitat Characteristcs 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 not new fall and not 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: c = collector; f = filterer; g = grazer; p = producer and s = shredder.

Del Puerto 1

Lowest Taxa	T1
Parachironomus sp.	3
Orthocladius complex	2
Cricotopus sp.	33
Eukiefferiella sp.	1
Nanocladius sp.	2
Parametriocnemus sp.	3
Rheocricotopus sp.	8
Cricotopus bicinctus group	1
Cricotopus sp.	7
Simulium sp.	15
Erpobdellidae	1
Enchytraeidae	5
Nais communis/ variabilis	113
Ophidonais serpentina	2
Slavina appendiculata	92
Tubificidae	4
Physa/ Physella	12
	304

Lowest Taxa	T2
Parachironomus sp.	5
Rheotanytarsus sp.	1
Orthocladius complex	1
Cricotopus sp.	24
Nanocladius sp.	3
Rheocricotopus sp.	9
Cricotopus bicinctus group	6
Cricotopus sp.	6
Nanocladius sp.	1
Simulium sp.	13
Corisella inscripta	2
Gammarus lacustris	1
Helobdella stagnalis	1
Lumbricina	1
Enchytraeidae	1
Nais communis/ variabilis	52
Chaetogaster diaphanus	1
Pristinella jenkinae	1
Slavina appendiculata	148
Tubificidae	2
Hydra sp.	5
Corbicula sp.	2
Physa/ Physella	11
Gyraulus parvus	1
Prostoma sp.	2
	300

Lowest Taxa	TV	FFG	T3
Dicrotendipes sp.	8	c	1
Parachironomus sp.	10	p	7
Cladotanytarsus sp.	6	f	1
Orthocladius complex			1
Cricotopus sp.	7	s	23
Nanocladius sp.	3	s	3
Rheocricotopus sp.	6	c	10
Cricotopus bicinctus group			7
Cricotopus sp.			2
Rheocricotopus sp.			1
Hemerodromia sp.	6	p	1
Simulium sp.	6	f	1
Gammarus lacustris	4	c	1
Mooreobdella microstoma			1
Helobdella stagnalis	10	p	4
Nais communis/ variabilis			61
Slavina appendiculata		c	141
Hydra sp.	5	f	8
Physa/ Physella	8	g	13
			287

Lowest Taxa	TV	FFG	TOTAL
Chaetogaster diaphanus			1
Cladotanytarsus sp.	6	f	1
Corbicula sp.	6	f	2
Corisella inscripta	10	p	2
Cricotopus bicinctus group			14
Cricotopus sp.	7	s	80
Cricotopus sp.			15
Dicrotendipes sp.	8	c	1
Enchytraeidae	10	c	6
Erpobdellidae	8	p	1
Eukiefferiella sp.	8	c	1
Gammarus lacustris	4	c	2
Gyraulus parvus		g	1
Helobdella stagnalis	10	p	5
Hemerodromia sp.	6	p	1
Hydra sp.	5	f	13
Lumbricina		c	1
Mooreobdella microstoma			1
Nais communis/ variabilis			226
Nanocladius sp.			1
Nanocladius sp.	3	s	8
Ophidonais serpentina			2
Orthocladius complex			4
Parachironomus sp.	10	p	15
Parametriocnemus sp.	5	c	3
Physa/ Physella	8	g	36
Pristinella jenkinae		c	1
Prostoma sp.		c	2
Rheocricotopus sp.	6	c	27
Rheocricotopus sp.			1
Rheotanytarsus sp.	6	f	1
Simulium sp.	6	f	29
Slavina appendiculata		c	381
Tubificidae			6
			891

Del Puerto 2

Lowest Taxa	T1
Chironomus sp.	1
Dicrotendipes sp.	3
Parachironomus sp.	25
Chironomini	3
Rheotanytarsus sp.	1
Tanytarsus sp.	1
Orthocladius complex	1
Cricotopus sp.	5
Cricotopus bicinctus group	2
Cricotopus sp.	4
Thienemannimyia group	1
Simulium sp.	4
Mooreobdella microstoma	6
Helobdella stagnalis	176
Nais communis/ variabilis	11
Slavina appendiculata	3
Tubificidae	6
Limnodrilus hoffmeisteri	5
Hydra sp.	1
Pisidium sp.	2
Physa/ Physella	10
Planorbella sp.	5
Gyraulus parvus	1
Prostoma sp.	10
Dugesia tigrina	18
	305

Lowest Taxa	T2
Ceratopogonidae	1
Dicrotendipes sp.	1
Parachironomus sp.	7
Polypedilum sp.	1
Cricotopus sp.	3
Nanocladius sp.	2
Cricotopus bicinctus group	1
Simulium sp.	11
Fallceon quilleri	1
Corixidae	1
Erpobdellidae	3
Mooreobdella microstoma	7
Helobdella stagnalis	83
Nais communis/ variabilis	1
Tubificidae	23
Limnodrilus hoffmeisteri	3
Corbicula sp.	1
Physa/ Physella	36
Planorbella sp.	1
Gyraulus parvus	3
Prostoma sp.	3
Dugesia tigrina	2
	195

Lowest Taxa	T3
Dicrotendipes sp.	4
Parachironomus sp.	8
Chironomini	2
Dicrotendipes sp.	2
Rheotanytarsus sp.	1
Orthocladius complex	4
Cricotopus sp.	16
Nanocladius sp.	1
Cricotopus bicinctus group	3
Cricotopus sp.	13
Simulium sp.	9
Mooreobdella tetragon	2
Helobdella stagnalis	122
Lumbricina	3
Enchytraeidae	4
Nais communis/ variabilis	6
Slavina appendiculata	11
Tubificidae	11
Limnodrilus hoffmeisteri	1
Pisidium sp.	3
Physa/ Physella	13
Planorbella sp.	2
Gyraulus parvus	1
Prostoma sp.	6
Dugesia tigrina	22
	270

Lowest Taxa	TV	FFG	TOTAL
Ceratopogonidae			1
Chironomini			5
Chironomus sp.	10	c	1
Corbicula sp.	6	f	1
Corixidae	10	p	1
Cricotopus bicinctus group			6
Cricotopus sp.	7	s	24
Cricotopus sp.			17
Dicrotendipes sp.	8	c	8
Dicrotendipes sp.			2
Dugesia tigrina	4	p	42
Enchytraeidae	10	c	4
Erpobdellidae	8	p	3
Fallceon quilleri	4	c	1
Gyraulus parvus		g	5
Helobdella stagnalis	10	p	381
Hydra sp.	5	f	1
Limnodrilus hoffmeisteri		c	9
Lumbricina		c	3
Mooreobdella microstoma			13
Mooreobdella tetragon		p	2
Nais communis/ variabilis			18
Nanocladius sp.	3	s	3
Orthocladius complex			5
Parachironomus sp.	10	p	40
Physa/ Physella	8	g	59
Pisidium sp.	8	f	5
Planorbella sp.	7	g	8
Polypedilum sp.	6	s	1
Prostoma sp.		c	19
Rheotanytarsus sp.	6	f	2
Simulium sp.	6	f	24
Slavina appendiculata		c	14
Tanytarsus sp.	6	f	1
Thienemannimyia group			1
Tubificidae			40
			770

Del Puerto 3

Lowest Taxa	T1
Chironomus sp.	1
Parachironomus sp.	3
Orthocladius complex	7
Cricotopus sp.	83
Cricotopus bicinctus group	4
Cricotopus sp.	6
Simulium sp.	5
Helobdella stagnalis	1
Lumbricina	1
Nais communis/ variabilis	25
Slavina appendiculata	16
Tubificidae	93
Hydra sp.	1
Pisidium sp.	1
Physa/ Physella	29
Gyraulus parvus	7
Prostoma sp.	11
Dugesia tigrina	22
	316

Lowest Taxa	T2
Cricotopus sp.	63
Eukiefferiella sp.	1
Cricotopus sp.	34
Eukiefferiella sp.	2
Enchytraeidae	1
Nais communis/ variabilis	10
Slavina appendiculata	12
Tubificidae	107
Pelecypoda	1
Gastropoda	29
Nematoda	1
Prostoma sp.	3
Dugesia tigrina	4
	268

Lowest Taxa	T3
Parachironomus sp.	1
Cricotopus sp.	28
Eukiefferiella sp.	2
Cricotopus sp.	31
Eukiefferiella sp.	1
Simulium sp.	21
Corixidae	1
Daphniidae	1
Mooreobdella microstoma	1
Helobdella stagnalis	1
Lumbricina	2
Nais communis/ variabilis	4
Slavina appendiculata	3
Tubificidae	160
Corbicula sp.	2
Physa/ Physella	19
Planorbella sp.	2
Gyraulus parvus	6
Menetus opercularis	2
Prostoma sp.	1
Dugesia tigrina	3
	292

Lowest Taxa	TV	FFG	TOTAL
Chironomus sp.	10	c	1
Corbicula sp.	6	f	2
Corixidae	10	p	1
Cricotopus bicinctus group			4
Cricotopus sp.	7	s	174
Cricotopus sp.			71
Daphniidae	8	c	1
Dugesia tigrina	4	p	29
Enchytraeidae	10	c	1
Eukiefferiella sp.	8	c	3
Eukiefferiella sp.			3
Gastropoda		g	29
Gyraulus parvus		g	13
Helobdella stagnalis	10	p	2
Hydra sp.	5	f	1
Lumbricina		c	3
Menetus opercularis			2
Mooreobdella microstoma			1
Nais communis/ variabilis			39
Nematoda	5	p	1
Orthocladius complex			7
Parachironomus sp.	10	p	4
Pelecypoda			1
Physa/ Physella	8	g	48
Pisidium sp.	8	f	1
Planorbella sp.	7	g	2
Prostoma sp.		c	15
Simulium sp.	6	f	26
Slavina appendiculata		c	31
Tubificidae			360
			876

Del Puerto 4

Lowest Taxa	T1
Tropisternus sp.	1
Dicrotendipes sp.	4
Microtendipes pedellus	1
Micropsectra sp.	2
Rheotanytarsus sp.	2
Limnophyes sp.	8
Orthocladiinae	1
Corisella inscripta	2
Gammarus lacustris	13
Lumbricina	43
Physa/ Physella	40
Dugesia tigrina	11
	128

Lowest Taxa	T2
Apedilum sp.	1
Dicrotendipes sp.	10
Paratanytarsus sp.	3
Tanytarsus sp.	5
Cricotopus sp.	2
Cricotopus bicinctus group	3
Dolichopodidae	1
Daphniidae	3
Gammarus lacustris	19
Lumbricina	41
Enchytraeidae	1
Physa/ Physella	1
	90

Lowest Taxa	T3
Apedilum sp.	1
Dicrotendipes sp.	34
Microtendipes pedellus group	2
Micropsectra sp.	1
Paratanytarsus sp.	1
Tanytarsus sp.	15
Tanytarsini	1
Cricotopus sp.	13
Limnophyes sp.	1
Cricotopus bicinctus group	1
Ormosia sp.	2
Corixidae	1
Corisella decolor	1
Gammarus lacustris	14
Lumbricina	12
Physa/ Physella	4
	104

Lowest Taxa	TV	FFG	TOTAL
Apedilum sp.			2
Corisella decolor			1
Corisella inscripta	10	p	2
Corixidae	10	p	1
Cricotopus bicinctus group			4
Cricotopus sp.	7	s	15
Daphniidae	8	c	3
Dicrotendipes sp.	8	c	48
Dolichopodidae	4	p	1
Dugesia tigrina	4	p	11
Enchytraeidae	10	c	1
Gammarus lacustris	4	c	46
Limnophyes sp.	8	c	9
Lumbricina		c	96
Micropsectra sp.	7	c	3
Microtendipes pedellus		f	1
Microtendipes pedellus group			2
Ormosia sp.	3	c	2
Orthocladiinae			1
Paratanytarsus sp.	6	f	4
Physa/ Physella	8	g	45
Rheotanytarsus sp.	6	f	2
Tanytarsini			1
Tanytarsus sp.	6	f	20
Tropisternus sp.	5	c	1
			322

Del Puerto 5

Transect Number	T1	Transect Number	T2	Lowest Taxa	T3
Stictotarsus sp.	1	*Oreodytes sp.*	5	*Stictotarsus sp.*	2
Peltodytes sp.	12	*Peltodytes sp.*	14	*Peltodytes sp.*	22
Berosus sp.	5	*Laccobius sp.*	4	*Berosus sp.*	1
Enochrus sp.	2	*Bezzia/ Palpomyia*	11	*Laccobius sp.*	1
Laccobius sp.	2	*Dasyhelea sp.*	5	*Bezzia/ Palpomyia*	3
Bezzia/ Palpomyia	19	*Dicrotendipes sp.*	1	*Dasyhelea sp.*	4
Polypedilum sp.	1	*Paratanytarsus sp.*	1	*Dicrotendipes sp.*	2
Rheotanytarsus sp.	21	*Rheotanytarsus sp.*	6	*Rheotanytarsus sp.*	4
Tanytarsus sp.	2	*Tanytarsus sp.*	1	*Tanytarsus sp.*	1
Orthocladius complex	1	*Cricotopus sp.*	3	*Cricotopus sp.*	2
Hydrobaenus sp.	2	*Nanocladius sp.*	1	*Cricotopus bicinctus group*	10
Paraphaenocladius sp.	1	*Cricotopus bicinctus group*	30	*Pentaneura sp.*	9
Cricotopus bicinctus group	15	*Cricotopus trifascia group*	1	*Centroptilum sp.*	1
Cricotopus trifascia group	10	*Pentaneura sp.*	47	Coenagrionidae	2
Thienemanniella sp.	1	*Simulium sp.*	2	*Oxyethira sp.*	10
Pentaneura sp.	50	*Tabanus/ Atylotus*	1	Cyprididae	43
Hydrellia sp.	1	*Baetis sp.*	4	*Arrenurus sp.*	1
Muscidae	1	*Baetis adonis*	8	*Hygrobates sp.*	1
Simulium sp.	10	*Fallceon quilleri*	8	Erpobdellidae	3
Caloparyphus/ Euparyphus	1	*Tricorythodes sp.*	2	*Mooreobdella microstoma*	1
Nemotelus sp.	1	Corixidae	1	Enchytraeidae	2
Baetis tricaudatus	6	*Oxyethira sp.*	5	*Nais communis/ variabilis*	63
Tricorythodes sp.	1	Cyclopidae	1	*Slavina appendiculata*	12
Hydroptila sp.	1	Cyprididae	47	Tubificidae	1
Oxyethira sp.	1	*Lebertia sp.*	1	*Physa/ Physella*	44
Cyprididae	50	*Sperchon sp.*	9	*Gyraulus parvus*	38
Sperchon sp.	5	Erpobdellidae	1	*Prostoma sp.*	17
Erpobdellidae	1	Glossiphoniidae	1	*Dugesia tigrina*	1
Nais communis/ variabilis	10	Enchytraeidae	1		301
Slavina appendiculata	5	*Nais communis/ variabilis*	28		
Physa/ Physella	28	*Slavina appendiculata*	11		
Gyraulus parvus	8	Tubificidae	4		
Pomatiopsis sp.	2	*Physa/ Physella*	30		
Nematoda	1	*Gyraulus parvus*	19		
Prostoma sp.	3	*Prostoma sp.*	4		
	281		318		

Lowest Taxa	TV	FFG	TOTAL
Arrenurus sp.	5	p	1
Baetis adonis			8
Baetis sp.	5	c	4
Baetis tricaudatus	5	c	6
Berosus sp.	5	p	6
Bezzia/ Palpomyia	6	p	33
Caloparyphus/ Euparyphus			1
Centroptilum sp.	2	c	1
Coenagrionidae	9	p	2
Corixidae	10	p	1
Cricotopus bicinctus group			55
Cricotopus sp.	7	s	5
Cricotopus trifascia group			11
Cyclopidae	8	c	1
Cyprididae	8	c	140
Dasyhelea sp.	6	p	9
Dicrotendipes sp.	8	c	3
Dugesia tigrina	4	p	1
Enchytraeidae	10	c	3
Enochrus sp.	5	p	2
Erpobdellidae	8	p	5
Fallceon quilleri	4	c	8
Glossiphoniidae	8	p	1
Gyraulus parvus		g	65
Hydrellia sp.	6	s	1
Hydrobaenus sp.	8	g	2
Hydroptila sp.	6	g	1
Hygrobates sp.		p	1
Laccobius sp.	5	p	7
Lebertia sp.		p	1
Mooreobdella microstoma			1
Muscidae	6	p	1
Nais communis/ variabilis			101
Nanocladius sp.	3	s	1
Nematoda	5	p	1
Nemotelus sp.	8	c	1
Oreodytes sp.	5	p	5
Orthocladius complex			1
Oxyethira sp.	3	c	16
Paraphaenocladius sp.	5	c	1
Paratanytarsus sp.	6	f	1
Peltodytes sp.	5	s	48
Pentaneura sp.	6	p	106
Physa/ Physella	8	g	102
Polypedilum sp.	6	s	1
Pomatiopsis sp.			2
Prostoma sp.		c	24
Rheotanytarsus sp.	6	f	31
Simulium sp.	6	f	12
Slavina appendiculata		c	28
Sperchon sp.		p	14
Stictotarsus sp.			3
Tabanus/ Atylotus	5	p	1
Tanytarsus sp.			2
Tanytarsus sp.	6	f	2
Thienemanniella sp.	6	c	1
Tricorythodes sp.	5	c	3
Tubificidae			5
			900

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: c = collector; f = filterer; g = grazer; p = producer and s = shredder.

Orestimba 1

Lowest Taxa	T1
Apedilum sp.	1
Chironomus sp.	11
Dicrotendipes sp.	11
Phaenopsectra sp.	1
Microchironomus nigrovittatus	7
Chironomini	4
Cladotanytarsus sp.	2
Paratanytarsus sp.	1
Orthocladiinae	1
Cricotopus sp.	9
Limnophyes sp.	1
Paraphaenocladius sp.	2
Cricotopus bicinctus group	4
Orthocladiinae	1
Procladius sp.	5
Corixidae	12
Corisella sp.	1
Daphniidae	1
Hyalella sp.	2
Tubificidae	2
Limnodrilus hoffmeisteri	3
Corbicula sp.	5
Fossaria sp.	1
Physa/ Physella	6
	94

Lowest Taxa	T2
Chironomus sp.	8
Cryptochironomus sp.	1
Dicrotendipes sp.	1
Paracladopelma sp.	2
Microchironomus nigrovittatus	11
Chironomini	2
Dicrotendipes sp.	3
Microchironomus nigrovittatus	1
Cladotanytarsus sp.	1
Cricotopus sp.	1
Cricotopus bicinctus group	2
Cricotopus sp.	3
Procladius sp.	6
Hyalella sp.	1
Eudistylia vancouveri	1
Tubificidae	2
Corbicula sp.	8
Fossaria sp.	1
	55

Lowest Taxa	T3
Chironomus sp.	48
Dicrotendipes sp.	2
Paracladopelma sp.	1
Phaenopsectra sp.	5
Polypedilum sp.	2
Microchironomus nigrovittatus	20
Cladotanytarsus sp.	2
Orthocladiinae	1
Cricotopus sp.	3
Procladius sp.	10
Corixidae	1
Corisella decolor	1
Coenagrionidae	1
Temoridae	1
Cyclopidae	1
Eudistylia vancouveri	10
Ophidonais serpentina	6
Tubificidae	13
Limnodrilus hoffmeisteri	1
Corbicula sp.	9
Fossaria sp.	1
Nematoda	2
	141

Lowest Taxa	TV	FFG	TOTAL
Apedilum sp.			1
Chironomini			6
Chironomus sp.	10	c	67
Cladotanytarsus sp.	6	f	5
Coenagrionidae	9	p	1
Corbicula sp.	6	f	22
Corisella decolor			1
Corisella sp.	10	p	1
Corixidae	10	p	13
Cricotopus bicinctus group			6
Cricotopus sp.	7	s	13
Cricotopus sp.			3
Cryptochironomus sp.	8	p	1
Cyclopidae	8	c	1
Daphniidae	8	c	1
Dicrotendipes sp.	8	c	14
Dicrotendipes sp.			3
Eudistylia vancouveri			11
Fossaria sp.	6	g	3
Hyalella sp.	6	c	3
Limnodrilus hoffmeisteri		c	4
Limnophyes sp.	8	c	1
Microchironomus nigrovittatus			39
Nematoda	5	p	2
Ophidonais serpentina			6
Orthocladiinae	5	c	3
Paracladopelma sp.	7	c	3
Paraphaenocladius sp.	5	c	2
Paratanytarsus sp.	6	f	1
Phaenopsectra sp.	7	g	6
Physa/ Physella	8	g	6
Polypedilum sp.	6	s	2
Procladius sp.	9	p	21
Temoridae	8	c	1
Tubificidae			17
			290

Orestimba 2

Lowest Taxa	T1
Chironomus sp.	2
Phaenopsectra sp.	1
Polypedilum sp.	2
Cladotanytarsus sp.	2
Tanytarsus sp.	1
Orthocladius complex	3
Cricotopus sp.	16
Rheocricotopus sp.	1
Cricotopus bicinctus group	36
Cricotopus trifascia group	2
Cricotopus sp.	5
Limnophyes sp.	1
Ormosia sp.	1
Corixidae	2
Eudistylia vancouveri	3
Manayunkia speciosa	1
Enchytraeidae	2
Nais communis/ variabilis	2
Ophidonais serpentina	5
Slavina appendiculata	4
Tubificidae	3
Branchiura sowerbyi	2
Limnodrilus hoffmeisteri	1
Corbicula sp.	19
Fossaria sp.	1
Dugesia tigrina	1
	119

Lowest Taxa	T2
Chironomus sp.	1
Dicrotendipes sp.	1
Phaenopsectra sp.	1
Cladotanytarsus sp.	1
Orthocladius complex	1
Cricotopus sp.	5
Cricotopus sp.	1
Eudistylia vancouveri	6
Manayunkia speciosa	2
Lumbricina	2
Slavina appendiculata	2
Corbicula sp.	30
	53

Lowest Taxa	T3
Chironomus sp.	2
Dicrotendipes sp.	3
Orthocladius complex	6
Cricotopus sp.	10
Paraphaenocladius sp.	1
Pseudosmittia sp.	1
Cricotopus bicinctus group	2
Orthocladiinae	1
Ephydridae	1
Ormosia sp.	4
Tipulidae	1
Hyalella sp.	1
Eudistylia vancouveri	5
Lumbricina	9
Ophidonais serpentina	4
Slavina appendiculata	3
Corbicula sp.	14
Fossaria sp.	1
Nematoda	1
	70

Lowest Taxa	TV	FFG	TOTAL
Chironomus sp.	10	c	5
Cladotanytarsus sp.	6	f	3
Corbicula sp.	6	f	63
Corixidae	10	p	2
Cricotopus bicinctus group			38
Cricotopus sp.	7	s	31
Cricotopus sp.			6
Cricotopus trifascia group			2
Dicrotendipes sp.	8	c	4
Dugesia tigrina	4	p	1
Enchytraeidae	10	c	2
Ephydridae			1
Eudistylia vancouveri			14
Fossaria sp.	6	g	2
Hyalella sp.	6	c	1
Limnodrilus hoffmeisteri		c	1
Limnophyes sp.			1
Lumbricina		c	11
Manayunkia speciosa		c	3
Nais communis/ variabilis			2
Nematoda	5	p	1
Ophidonais serpentina			9
Ormosia sp.	3	c	5
Orthocladiinae			1
Orthocladius complex			10
Paraphaenocladius sp.	5	c	1
Phaenopsectra sp.	7	g	2
Polypedilum sp.	6	s	2
Pseudosmittia sp.		c	1
Rheocricotopus sp.	6	c	1
Slavina appendiculata		c	9
Tanytarsus sp.			1
Tipulidae			1
Tubificidae			3
			240

Orestimba 3

Lowest Taxa	T1
Chironomus sp.	1
Dicrotendipes sp.	2
Orthocladius complex	1
Limnophyes sp.	1
Orthocladiinae	1
Cricotopus sp.	1
Simulium sp.	2
Ormosia sp.	1
Ischnura sp.	1
Cyclopidae	1
Eudistylia vancouveri	8
Enchytraeidae	1
Branchiura sowerbyi	1
Corbicula sp.	16
Physa/ Physella	1
Menetus opercularis	1
	40

Lowest Taxa	T2
Dicrotendipes sp.	2
Cricotopus sp.	18
Cricotopus bicinctus group	2
Scatella sp.	2
Eudistylia vancouveri	2
Lumbricina	2
Corbicula sp.	7
Fossaria sp.	3
Physa/ Physella	1
	39

Lowest Taxa	T3
Dicrotendipes sp.	3
Parachironomus sp.	1
Tanytarsus sp.	1
Cricotopus sp.	72
Pseudosmittia sp.	17
Cricotopus bicinctus group	14
Cricotopus trifascia group	1
Nanocladius sp.	3
Scatella sp.	3
Ephydridae	1
Simulium sp.	41
Limonia sp.	4
Ormosia sp.	14
Sperchon sp.	1
Eudistylia vancouveri	7
Enchytraeidae	102
Nais communis/ variabilis	14
Nais barbata	2
Ophidonais serpentina	1
Slavina appendiculata	5
Tubificidae	1
Corbicula sp.	1
Prostoma sp.	2
	311

Lowest Taxa	TV	FFG	TOTAL
Branchiura sowerbyi	10	c	1
Chironomus sp.	10	c	1
Corbicula sp.	6	f	24
Cricotopus bicinctus group			16
Cricotopus sp.			91
Cricotopus trifascia group			1
Cyclopidae	8	c	1
Dicrotendipes sp.	8	c	7
Enchytraeidae	10	c	103
Ephydridae			1
Eudistylia vancouveri			17
Fossaria sp.	6	g	3
Ischnura sp.	9	p	1
Limnophyes sp.	8	c	1
Limonia sp.	3	s	4
Lumbricina		c	2
Menetus opercularis			1
Nais barbata			2
Nais communis/ variabilis			14
Nanocladius sp.			3
Ophidonais serpentina			1
Ormosia sp.	3	c	15
Orthocladiinae			1
Orthocladius complex			1
Parachironomus sp.	10	p	1
Physa/ Physella	8	g	2
Prostoma sp.		c	2
Pseudosmittia sp.		c	17
Scatella sp.	6	c	5
Simulium sp.	6	f	43
Slavina appendiculata		c	5
Sperchon sp.		p	1
Tanytarsus sp.	6	f	1
Tubificidae			1
			390

Orestimba 4

Lowest Taxa	T1
Dicrotendipes sp.	2
Chironomini	2
Orthocladius complex	3
Cricotopus sp.	18
Eukiefferiella sp.	3
Limnophyes sp.	1
Rheocricotopus sp.	1
Cricotopus bicinctus group	3
Cricotopus trifascia group	7
Cricotopus sp.	11
Eukiefferiella sp.	1
Simulium sp.	55
Fallceon quilleri	1
Cyclopidae	1
Sperchon sp.	5
Eudistylia vancouveri	1
Lumbricina	2
Enchytraeidae	1
Corbicula sp.	53
Physa/ Physella	1
	172

Lowest Taxa	T2
Dicrotendipes sp.	1
Micropsectra sp.	3
Rheotanytarsus sp.	2
Sublettea sp.	1
Cricotopus sp.	46
Eukiefferiella sp.	13
Rheocricotopus sp.	1
Cricotopus sp.	20
Eukiefferiella sp.	3
Simulium sp.	91
Ormosia sp.	1
Fallceon quilleri	2
Gammarus lacustris	1
Sperchon sp.	4
Eudistylia vancouveri	2
Haplotaxis sp.	1
Lumbricina	3
Nais communis/ variabilis	4
Corbicula sp.	95
Nematoda	1
Dugesia tigrina	3
	298

Lowest Taxa	T3
Dicrotendipes sp.	1
Micropsectra sp.	3
Orthocladius complex	13
Cricotopus sp.	20
Eukiefferiella sp.	7
Limnophyes sp.	2
Pseudosmittia sp.	1
Rheocricotopus sp.	2
Cricotopus trifascia group	8
Cricotopus sp.	9
Eukiefferiella sp.	3
Rheocricotopus sp.	1
Simulium sp.	165
Sperchon sp.	3
Manayunkia speciosa	1
Lumbricina	7
Nais communis/ variabilis	5
Ophidonais serpentina	4
Tubificidae	2
Corbicula sp.	28
Dugesia tigrina	1
	286

Lowest Taxa	TV	FFG	TOTAL
Chironomini			2
Corbicula sp.	6	f	176
Cricotopus bicinctus group			3
Cricotopus sp.	7	s	84
Cricotopus sp.			40
Cricotopus trifascia group			15
Cyclopidae	8	c	1
Dicrotendipes sp.	8	c	4
Dugesia tigrina	4	p	4
Enchytraeidae	10	c	1
Eudistylia vancouveri			3
Eukiefferiella sp.	8	c	23
Eukiefferiella sp.			7
Fallceon quilleri	4	c	3
Gammarus lacustris	4	c	1
Haplotaxis sp.			1
Limnophyes sp.	8	c	3
Lumbricina		c	12
Manayunkia speciosa		c	1
Micropsectra sp.	7	c	6
Nais communis/ variabilis			9
Nematoda	5	p	1
Ophidonais serpentina			4
Ormosia sp.	3	c	1
Orthocladius complex			16
Physa/ Physella	8	g	1
Pseudosmittia sp.		c	1
Rheocricotopus sp.	6	c	4
Rheocricotopus sp.			1
Rheotanytarsus sp.	6	f	2
Simulium sp.	6	f	311
Sperchon sp.		p	12
Sublettea sp.		f	1
Tubificidae			2
			756

Orestimba 5

Lowest Taxa	T1
Chironomus sp.	1
Cladotanytarsus sp.	1
Micropsectra sp.	4
Tanytarsus sp.	2
Orthocladius complex	9
Cricotopus sp.	15
Eukiefferiella sp.	3
Limnophyes sp.	1
Rheocricotopus sp.	2
Cricotopus bicinctus group	3
Cricotopus trifascia group	1
Cricotopus sp.	4
Neoplasta sp.	1
Simulium sp.	59
Hydropsyche californica	2
Gammarus lacustris	5
Sperchon sp.	6
Manayunkia speciosa	1
Lumbricina	22
Enchytraeidae	1
Nais communis/ variabilis	1
Ophidonais serpentina	7
Tubificidae	1
Branchiura sowerbyi	2
Corbicula sp.	92
Nematoda	2
	248

Lowest Taxa	T2
Dicrotendipes sp.	1
Micropsectra sp.	2
Orthocladiinae	1
Orthocladius complex	6
Cricotopus sp.	3
Eukiefferiella sp.	3
Limnophyes sp.	7
Rheocricotopus sp.	5
Cricotopus bicinctus group	1
Cricotopus trifascia group	1
Cricotopus sp.	3
Eukiefferiella sp.	2
Simulium sp.	173
Ormosia sp.	3
Hydropsyche californica	1
Hydropsychidae	1
Gammarus lacustris	7
Sperchon sp.	7
Eudistylia vancouveri	3
Lumbricina	2
Enchytraeidae	2
Nais communis/ variabilis	5
Ophidonais serpentina	1
Slavina appendiculata	2
Corbicula sp.	49
Fossaria sp.	1
Physa/ Physella	1
Menetus opercularis	2
Prostoma sp.	1
Dugesia tigrina	5
	301

Lowest Taxa	T3
Dicrotendipes sp.	3
Orthocladius complex	5
Limnophyes sp.	1
Rheocricotopus sp.	1
Cricotopus bicinctus group	4
Cricotopus sp.	1
Simulium sp.	12
Hydropsyche californica	1
Gammarus lacustris	22
Eudistylia vancouveri	9
Manayunkia speciosa	2
Lumbricina	8
Nais communis/ variabilis	3
Slavina appendiculata	1
Tubificidae	2
Corbicula sp.	67
Fossaria sp.	1
Physa/ Physella	2
Menetus opercularis	1
Prostoma sp.	2
	148

Lowest Taxa	TV	FFG	TOTAL
Branchiura sowerbyi	10	c	2
Chironomus sp.	10	c	1
Cladotanytarsus sp.	6	f	1
Corbicula sp.	6	f	208
Cricotopus bicinctus group			8
Cricotopus sp.	7	s	18
Cricotopus sp.			8
Cricotopus trifascia group			2
Dicrotendipes sp.	8	c	4
Dugesia tigrina	4	p	5
Enchytraeidae	10	c	3
Eudistylia vancouveri			12
Eukiefferiella sp.	8	c	8
Fossaria sp.	6	g	2
Gammarus lacustris	4	c	34
Hydropsyche californica		f	4
Hydropsychidae			1
Limnophyes sp.	8	c	9
Lumbricina		c	32
Manayunkia speciosa		c	3
Menetus opercularis			3
Micropsectra sp.	7	c	6
Nais communis/ variabilis			9
Nematoda	5	p	2
Neoplasta sp.			1
Ophidonais serpentina			8
Ormosia sp.	3	c	3
Orthocladiinae	5	c	1
Orthocladius complex			20
Physa/ Physella	8	g	3
Prostoma sp.		c	3
Rheocricotopus sp.	6	c	8
Simulium sp.	6	f	244
Slavina appendiculata		c	3
Sperchon sp.		p	13
Tanytarsus sp.	6	f	2
Tubificidae			3
			697

Orestimba 6

Lowest Taxa	T1
Dicrotendipes sp.	29
Orthocladiinae	1
Orthocladius complex	87
Cricotopus sp.	8
Rheocricotopus sp.	2
Cricotopus bicinctus group	19
Cricotopus trifascia group	5
Cricotopus sp.	5
Simulium sp.	4
Hyalella sp.	1
Eudistylia vancouveri	5
Lumbricina	1
Nais communis/ variabilis	7
Chaetogaster diaphanus	3
Ophidonais serpentina	82
Tubificidae	5
Corbicula sp.	3
Nematoda	2
Prostoma sp.	1
Dugesia tigrina	31
	301

Lowest Taxa	T2
Dicrotendipes sp.	3
Orthocladius complex	92
Cricotopus sp.	23
Eukiefferiella sp.	2
Nanocladius sp.	1
Rheocricotopus sp.	6
Cricotopus bicinctus group	18
Cricotopus trifascia group	15
Cricotopus sp.	13
Simulium sp.	10
Sperchon sp.	6
Eudistylia vancouveri	2
Lumbricina	3
Nais communis/ variabilis	2
Ophidonais serpentina	66
Slavina appendiculata	7
Corbicula sp.	3
Prostoma sp.	1
Dugesia tigrina	22
	295

Lowest Taxa	T3
Chironomus sp.	1
Dicrotendipes sp.	2
Paratanytarsus sp.	2
Orthocladius complex	125
Eukiefferiella sp.	4
Rheocricotopus sp.	4
Cricotopus bicinctus group	12
Cricotopus trifascia group	16
Cricotopus sp.	20
Eukiefferiella sp.	2
Simulium sp.	15
Fallceon quilleri	1
Eudistylia vancouveri	1
Lumbricina	2
Nais communis/ variabilis	10
Ophidonais serpentina	67
Slavina appendiculata	2
Tubificidae	4
Corbicula sp.	6
Nematoda	1
Dugesia tigrina	6
	303

Lowest Taxa	TV	FFG	TOTAL
Chaetogaster diaphanus			3
Chironomus sp.	10	c	1
Corbicula sp.	6	f	12
Cricotopus bicinctus group			49
Cricotopus sp.			38
Cricotopus sp.	7	s	31
Cricotopus trifascia group			36
Dicrotendipes sp.	8	c	34
Dugesia tigrina	4	p	59
Eudistylia vancouveri			8
Eukiefferiella sp.	8	c	8
Fallceon quilleri	4	c	1
Hyalella sp.	6	c	1
Lumbricina		c	6
Nais communis/ variabilis			19
Nanocladius sp.	3	s	1
Nematoda	5	p	3
Ophidonais serpentina			215
Orthocladiinae	5	c	1
Orthocladius complex			304
Paratanytarsus sp.	6	f	2
Prostoma sp.		c	2
Rheocricotopus sp.	6	c	12
Simulium sp.	6	f	29
Slavina appendiculata		c	9
Sperchon sp.		p	6
Tubificidae			9
			899

Orestimba 7

Lowest Taxa	T1
Dicrotendipes sp.	9
Cladotanytarsus sp.	1
Orthocladius complex	69
Cricotopus sp.	1
Eukiefferiella sp.	1
Nanocladius sp.	2
Rheocricotopus sp.	3
Cricotopus bicinctus group	1
Cricotopus trifascia group	1
Cricotopus sp.	34
Eukiefferiella sp.	1
Nanocladius sp.	4
Simulium sp.	3
Hydropsyche californica	11
Hydroptila sp.	6
Gammarus lacustris	10
Sperchon sp.	9
Eudistylia vancouveri	16
Erpobdellidae	1
Lumbricina	2
Nais communis/ variabilis	15
Ophidonais serpentina	15
Slavina appendiculata	28
Corbicula sp.	14
Ferrissia rivularis	1
Prostoma sp.	2
Dugesia tigrina	45
	305

Lowest Taxa	T2
Dicrotendipes sp.	6
Cladotanytarsus sp.	1
Micropsectra sp.	1
Orthocladius complex	36
Cricotopus sp.	38
Eukiefferiella sp.	5
Rheocricotopus sp.	1
Cricotopus bicinctus group	2
Cricotopus trifascia group	4
Cricotopus sp.	16
Simulium sp.	14
Baetis tricaudatus	1
Hydropsyche californica	4
Hydroptila sp.	4
Gammarus lacustris	11
Sperchon sp.	6
Lumbricina	3
Nais communis/ variabilis	25
Ophidonais serpentina	33
Slavina appendiculata	38
Tubificidae	4
Corbicula sp.	14
Physa/ Physella	1
Prostoma sp.	2
Dugesia tigrina	43
	313

Lowest Taxa	T3
Dicrotendipes sp.	3
Cladotanytarsus sp.	1
Micropsectra sp.	1
Orthocladius complex	127
Eukiefferiella sp.	2
Rheocricotopus sp.	1
Cricotopus bicinctus group	2
Cricotopus trifascia group	6
Cricotopus sp.	25
Eukiefferiella sp.	1
Simulium sp.	7
Hydropsyche californica	6
Hydroptila sp.	3
Gammarus lacustris	1
Sperchon sp.	6
Eudistylia vancouveri	2
Erpobdellidae	1
Lumbricina	1
Ophidonais sp.	23
Nais communis/ variabilis	5
Slavina appendiculata	25
Tubificidae	1
Corbicula sp.	2
Pomatiopsis sp.	1
Nematoda	1
Prostoma sp.	5
Dugesia tigrina	42
	301

Lowest Taxa	TV	FG	TOTAL
Baetis tricaudatus	5	c	1
Cladotanytarsus sp.	6	f	3
Corbicula sp.	6	f	30
Cricotopus bicinctus group			5
Cricotopus sp.			75
Cricotopus sp.	7	s	39
Cricotopus trifascia group			11
Dicrotendipes sp.	8	c	18
Dugesia tigrina	4	p	130
Erpobdellidae	8	p	2
Eudistylia vancouveri			18
Eukiefferiella sp.	8	c	8
Eukiefferiella sp.			2
Ferrissia rivularis		g	1
Gammarus lacustris	4	c	22
Hydropsyche californica		f	21
Hydroptila sp.	6	g	13
Lumbricina		c	6
Micropsectra sp.	7	c	2
Nais communis/ variabilis			45
Nanocladius sp.	3	s	2
Nanocladius sp.			4
Nematoda	5	p	1
Ophidonais serpentina			48
Ophidonais sp.			23
Orthocladius complex			232
Physa/ Physella	8	g	1
Pomatiopsis sp.			1
Prostoma sp.		c	9
Rheocricotopus sp.	6	c	5
Simulium sp.	6	f	24
Slavina appendiculata		c	91
Sperchon sp.		p	21
Tubificidae			5
			919

Orestimba 8

Lowest Taxa	T1
Dicrotendipes sp.	8
Orthocladius complex	9
Cricotopus sp.	14
Nanocladius sp.	1
Cricotopus bicinctus group	31
Cricotopus sp.	1
Hydropsyche californica	6
Eudistylia vancouveri	1
Lumbricina	1
Nais communis/ variabilis	18
Ophidonais serpentina	169
Slavina appendiculata	22
Limnodrilus hoffmeisteri	1
Prostoma sp.	3
Dugesia tigrina	21
	306

Lowest Taxa	T2
Dicrotendipes sp.	5
Polypedilum sp.	1
Orthocladius complex	9
Cricotopus sp.	18
Eukiefferiella sp.	1
Cricotopus bicinctus group	66
Cricotopus sp.	2
Simulium sp.	10
Hydropsyche californica	8
Hydropsychidae	1
Gammarus lacustris	1
Hyalella sp.	3
Eudistylia vancouveri	6
Lumbricina	1
Enchytraeidae	1
Nais communis/ variabilis	9
Ophidonais serpentina	99
Slavina appendiculata	25
Corbicula sp.	4
Pisidium sp.	1
Physa/ Physella	19
Gyraulus parvus	9
Nematoda	1
Prostoma sp.	4
Dugesia tigrina	22
	326

Lowest Taxa	T3
Dicrotendipes sp.	4
Tanytarsini	1
Orthocladius complex	12
Cricotopus sp.	17
Cricotopus bicinctus group	69
Cricotopus sp.	1
Hydropsyche californica	2
Gammarus lacustris	1
Eudistylia vancouveri	1
Lumbricina	1
Nais communis/ variabilis	6
Ophidonais serpentina	120
Slavina appendiculata	38
Tubificidae	1
Physa/ Physella	1
	275

Lowest Taxa	TV	FFG	TOTAL
Corbicula sp.	6	f	4
Cricotopus bicinctus group			166
Cricotopus sp.	7	s	49
Cricotopus sp.			4
Dicrotendipes sp.	8	c	17
Dugesia tigrina	4	p	43
Enchytraeidae	10	c	1
Eudistylia vancouveri			8
Eukiefferiella sp.	8	c	1
Gammarus lacustris	4	c	2
Gyraulus parvus		g	9
Hyalella sp.	6	c	3
Hydropsyche californica		f	16
Hydropsychidae			1
Limnodrilus hoffmeisteri		c	1
Lumbricina		c	3
Nais communis/ variabilis			33
Nanocladius sp.	3	s	1
Nematoda	5	p	1
Ophidonais serpentina			388
Orthocladius complex			30
Physa/ Physella	8	g	20
Pisidium sp.	8	f	1
Polypedilum sp.	6	s	1
Prostoma sp.		c	7
Simulium sp.	6	f	10
Slavina appendiculata		c	85
Tanytarsini	6	f	1
Tubificidae			1
			907

Orestimba 9

Lowest Taxa	T1
Chironomus sp.	2
Dicrotendipes sp.	4
Parachironomus sp.	1
Polypedilum sp.	1
Tanytarsus sp.	1
Cricotopus sp.	11
Parachaetocladius sp.	1
Cricotopus sp.	7
Cyprididae	2
Mooreobdella tetragon	1
Lumbricina	1
Enchytraeidae	39
Nais communis/ variabilis	3
Chaetogaster diaphanus	1
Ophidonais serpentina	3
Slavina appendiculata	9
Tubificidae	24
Corbicula sp.	33
Fossaria sp.	3
Physa/ Physella	54
Planorbella sp.	10
Gyraulus parvus	2
Nematoda	51
Prostoma sp.	24
Dugesia tigrina	1
	289

Lowest Taxa	T2
Ceratopogonidae	1
Chironomus sp.	4
Dicrotendipes sp.	2
Parachironomus sp.	1
Tanytarsus sp.	1
Cricotopus sp.	8
Cricotopus sp.	3
Procladius sp.	1
Psychoda sp.	1
Mooreobdella tetragon	1
Lumbricina	2
Enchytraeidae	41
Chaetogaster diaphanus	4
Ophidonais serpentina	3
Paranais litoralis	11
Slavina appendiculata	12
Tubificidae	3
Corbicula sp.	9
Physa/ Physella	51
Planorbella sp.	2
Gyraulus parvus	2
Nematoda	18
	181

Lowest Taxa	T3
Chironomus sp.	2
Dicrotendipes sp.	1
Tanytarsus sp.	1
Cricotopus sp.	5
Gammarus lacustris	1
Cyprididae	1
Mooreobdella tetragon	2
Helobdella sp.	1
Helobdella triserialis	1
Lumbricina	7
Enchytraeidae	23
Ophidonais sp.	1
Nais communis/ variabilis	1
Tubificidae	1
Limnodrilus hoffmeisteri	1
Corbicula sp.	13
Ferrissia rivularis	1
Fossaria sp.	1
Physa/ Physella	41
Planorbella sp.	9
Gyraulus parvus	1
Prostoma sp.	9
	124

Lowest Taxa	TV	FFG	TOTAL
Ceratopogonidae			1
Chaetogaster diaphanus			5
Chironomus sp.	10	c	8
Corbicula sp.	6	f	55
Cricotopus sp.	7	s	24
Cricotopus sp.			10
Cyprididae	8	c	3
Dicrotendipes sp.	8	c	7
Dugesia tigrina	4	p	1
Enchytraeidae	10	c	103
Ferrissia rivularis		g	1
Fossaria sp.	6	g	4
Gammarus lacustris	4	c	1
Gyraulus parvus		g	5
Helobdella sp.	10	p	1
Helobdella triserialis		PA	1
Limnodrilus hoffmeisteri		c	1
Lumbricina		c	10
Mooreobdella tetragon		p	4
Nais communis/ variabilis			4
Nematoda	5	p	69
Ophidonais serpentina			6
Ophidonais sp.			1
Parachaetocladius sp.	2	c	1
Parachironomus sp.	10	p	2
Paranais litoralis		c	11
Physa/ Physella	8	g	146
Planorbella sp.	7	g	21
Polypedilum sp.	6	s	1
Procladius sp.	9	p	1
Prostoma sp.		c	33
Psychoda sp.	10	c	1
Slavina appendiculata		c	21
Tanytarsus sp.	6	f	3
Tubificidae			28
			594

Orestimba 10

Lowest Taxa	T1
Peltodytes sp.	4
Chironomus sp.	4
Dicrotendipes sp.	5
Polypedilum sp.	1
Tribelos sp.	1
Tanytarsus sp.	14
Orthocladius complex	1
Cricotopus sp.	4
Psectrocladius sp.	2
Rheocricotopus sp.	1
Cricotopus bicinctus group	1
Procladius sp.	2
Hexatoma sp.	1
Callibaetis sp.	5
Centroptilum sp.	1
Caenis sp.	11
Corixidae	39
Corisella inscripta	8
Oxyethira sp.	5
Daphniidae	119
Cyclopidae	12
Stygobromus sp.	1
Caecidotea occidentalis	5
Cyprididae	1
Nais communis/ variabilis	11
Fossaria sp.	14
Physa/ Physella	25
Planorbella sp.	5
Gyraulus parvus	3
Nematoda	1
	307

Lowest Taxa	T2
Peltodytes sp.	3
Chironomus sp.	9
Micropsectra sp.	2
Tanytarsus sp.	9
Cricotopus sp.	2
Cricotopus sp.	1
Corynoneura sp.	1
Hexatoma sp.	1
Callibaetis sp.	5
Centroptilum sp.	2
Caenis sp.	2
Corixidae	42
Corisella inscripta	2
Daphniidae	153
Cyclopidae	10
Cyprididae	1
Aturus sp.	1
Nais communis/ variabilis	6
Chaetogaster diaphanus	6
Pristina aequiseta	1
Fossaria sp.	6
Physa/ Physella	19
Planorbella sp.	5
Gyraulus parvus	4
	293

Lowest Taxa	T3
Peltodytes sp.	6
Berosus sp.	2
Bezzia/ Palpomyia	2
Chironomus sp.	19
Dicrotendipes sp.	15
Micropsectra sp.	2
Tanytarsus sp.	11
Cricotopus sp.	12
Nanocladius sp.	1
Cricotopus bicinctus group	2
Cricotopus sp.	5
Corynoneura sp.	2
Tanypodinae	1
Procladius sp.	3
Hexatoma sp.	1
Callibaetis sp.	3
Caenis sp.	13
Corixidae	26
Corisella decolor	2
Oxyethira sp.	6
Daphniidae	32
Cyclopidae	8
Cyprididae	16
Lebertia sp.	1
Mideopsis sp.	1
Torrenticola sp.	1
Nais communis/ variabilis	5
Nais barbata	3
Fossaria sp.	15
Physa/ Physella	54
Planorbella sp.	6
Gyraulus parvus	5
Dugesia tigrina	1
	282

Lowest Taxa	TV	FFG	TOTAL
Aturus sp.			1
Berosus sp.	5	p	2
Bezzia/ Palpomyia	6	p	2
Caecidotea occidentalis			5
Caenis sp.	7	c	26
Callibaetis sp.	9	c	13
Centroptilum sp.	2	c	3
Chaetogaster diaphanus			6
Chironomus sp.	10	c	32
Corisella decolor			2
Corisella inscripta	10	p	10
Corixidae	10	p	107
Corynoneura sp.	7	c	3
Cricotopus bicinctus group			3
Cricotopus sp.	7	s	18
Cricotopus sp.			6
Cyclopidae	8	c	30
Cyprididae	8	c	18
Daphniidae	8	c	304
Dicrotendipes sp.	8	c	20
Dugesia tigrina	4	p	1
Fossaria sp.	6	g	35
Gyraulus parvus		g	12
Hexatoma sp.	3	s	3
Lebertia sp.		p	1
Micropsectra sp.	7	c	4
Mideopsis sp.		p	1
Nais barbata			3
Nais communis/ variabilis			22
Nanocladius sp.	3	s	1
Nematoda	5	p	1
Orthocladius complex			1
Oxyethira sp.	3	c	11
Peltodytes sp.	5	s	13
Physa/ Physella	8	g	98
Planorbella sp.	7	g	16
Polypedilum sp.	6	s	1
Pristina aequiseta		c	1
Procladius sp.	9	p	5
Psectrocladius sp.	8	c	2
Rheocricotopus sp.	6	c	1
Stygobromus sp.	4	c	1
Tanypodinae			1
Tanytarsus sp.	6	f	34
Torrenticola sp.		p	1
Tribelos sp.	5	c	1
			882

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: c = collector; f = filterer; g = grazer; p = producer and s = shredder.

Salt Slough 1

Lowest Taxa	T1
Berosus sp.	1
Cricotopus bicinctus group	16
Hydropsyche californica	11
Corophium spinicorne	234
Gammarus lacustris	1
Nais communis/ variabilis	1
Ophidonais serpentina	3
Corbicula sp.	1
Physa/ Physella	1
Nematoda	2
	271

Lowest Taxa	T2
Dicrotendipes sp.	2
Polypedilum sp.	1
Microchironomus nigrovittatus	1
Cladotanytarsus sp.	2
Paratanytarsus sp.	3
Cricotopus sp.	21
Cricotopus bicinctus group	55
Cricotopus sp.	1
Thienemanniella sp.	1
Pentaneura sp.	1
Hydrellia sp.	1
Callibaetis sp.	1
Corixidae	41
Corisella inscripta	26
Trichocorixa calva	32
Coenagrionidae	3
Ischnura sp.	11
Hydropsyche californica	6
Daphniidae	1
Cyclopidae	1
Corophium spinicorne	72
Hyalella sp.	3
Cambaridae	1
Pristinella sp.	1
Nais communis/ variabilis	2
Ophidonais serpentina	4
Paranais litoralis	3
Slavina appendiculata	2
Physa/ Physella	13
	312

Lowest Taxa	T3
Chironomus sp.	2
Cladotanytarsus sp.	4
Paratanytarsus sp.	4
Cricotopus sp.	19
Limnophyes sp.	1
Cricotopus bicinctus group	36
Orthocladiinae	1
Tanypus sp.	2
Corixidae	31
Corisella inscripta	10
Trichocorixa calva	20
Notonecta sp.	1
Ischnura sp.	2
Hydropsyche californica	27
Macrothricidae	1
Cyclopidae	3
Corophium spinicorne	72
Eudistylia vancouveri	11
Ophidonais serpentina	5
Slavina appendiculata	13
Tubificidae	8
Branchiura sowerbyi	2
Corbicula sp.	9
Physa/ Physella	15
Prostoma sp.	1
	300

Lowest Taxa	TV	FFG	TOTAL
Berosus sp.	5	p	1
Branchiura sowerbyi	10	c	2
Callibaetis sp.	9	c	1
Cambaridae	6	c	1
Chironomus sp.	10	c	2
Cladotanytarsus sp.	6	f	6
Coenagrionidae	9	p	3
Corbicula sp.	6	f	10
Corisella inscripta	10	p	36
Corixidae	10	p	72
Corophium spinicorne			378
Cricotopus bicinctus group			107
Cricotopus sp.	7	s	40
Cricotopus sp.			1
Cyclopidae	8	c	4
Daphniidae	8	c	1
Dicrotendipes sp.	8	c	2
Eudistylia vancouveri			11
Gammarus lacustris	4	c	1
Hyalella sp.	6	c	3
Hydrellia sp.	6	s	1
Hydropsyche californica		f	44
Ischnura sp.	9	p	13
Limnophyes sp.	8	c	1
Macrothricidae	8	c	1
Microchironomus nigrovittatus			1
Nais communis/ variabilis			3
Nematoda	5	p	2
Notonecta sp.	10	p	1
Ophidonais serpentina			12
Orthocladiinae			1
Paranais litoralis		c	3
Paratanytarsus sp.	6	f	7
Pentaneura sp.	6	p	1
Physa/ Physella	8	g	29
Polypedilum sp.	6	s	1
Pristinella sp.		c	1
Prostoma sp.		c	1
Slavina appendiculata		c	15
Tanypus sp.	10	p	2
Thienemanniella sp.			1
Trichocorixa calva			52
Tubificidae			8
			883

Salt Slough 2

Lowest Taxa	T1
Liodessus obscurellus	6
Ochthebius sp.	1
Ceratopogonidae	1
Chironomini	1
Endotribelos sp.	1
Parachironomus sp.	1
Polypedilum sp.	1
Paratanytarsus sp.	97
Tanytarsini	10
Orthocladius complex	1
Cricotopus sp.	3
Limnophyes sp.	9
Nanocladius sp.	3
Pseudosmittia sp.	1
Cricotopus bicinctus group	2
Orthocladiinae	1
Muscidae	1
Pericoma/ Telmatoscopus	1
Limonia sp.	1
Ormosia sp.	1
Coenagrionidae	9
Hydropsyche californica	1
Corophium spinicorne	78
Gammarus lacustris	2
Hyalella sp.	1
Nais communis/ variabilis	1
Ophidonais serpentina	22
Ferrissia rivularis	2
Fossaria sp.	4
Physa/ Physella	26
Prostoma sp.	4
	293

Lowest Taxa	T2
Cryptochironomus sp.	1
Paratanytarsus sp.	1
Cricotopus sp.	2
Cricotopus bicinctus group	9
Hydropsyche californica	1
Corophium spinicorne	4
Cambaridae	1
Eudistylia vancouveri	17
Corbicula sp.	2
	38

Lowest Taxa	TV	FFG	T3
Liodessus obscurellus			1
Chironomus sp.	10	c	1
Chironomini			1
Dicrotendipes sp.			1
Paratanytarsus sp.	6	f	9
Cricotopus sp.	7	s	2
Cricotopus bicinctus group			3
Nanocladius sp.			1
Corixidae	10	p	6
Corisella inscripta	10	p	2
Coenagrionidae	9	p	4
Corophium spinicorne			245
Eudistylia vancouveri			7
Tubificidae			1
Ferrissia rivularis		g	1
			285

Lowest Taxa	TV	FFG	TOTAL
Cambaridae	6	c	1
Ceratopogonidae			1
Chironomini	6	c	1
Chironomini			1
Chironomus sp.	10	c	1
Coenagrionidae	9	p	13
Corbicula sp.	6	f	2
Corisella inscripta	10	p	2
Corixidae	10	p	6
Corophium spinicorne			327
Cricotopus bicinctus group			14
Cricotopus sp.	7	s	7
Cryptochironomus sp.	8	p	1
Dicrotendipes sp.			1
Endotribelos sp.		c	1
Eudistylia vancouveri			24
Ferrissia rivularis		g	3
Fossaria sp.	6	g	4
Gammarus lacustris	4	c	2
Hyalella sp.	6	c	1
Hydropsyche californica		f	2
Limnophyes sp.	8	c	9
Limonia sp.	3	s	1
Liodessus obscurellus			7
Muscidae	6	p	1
Nais communis/ variabilis			1
Nanocladius sp.	3	s	3
Nanocladius sp.			1
Ochthebius sp.	5	g	1
Ophidonais serpentina			22
Ormosia sp.	3	c	1
Orthocladiinae			1
Orthocladius complex			1
Parachironomus sp.	10	p	1
Paratanytarsus sp.	6	f	107
Pericoma/ Telmatoscopus	4	c	1
Physa/ Physella	8	g	26
Polypedilum sp.	6	s	1
Prostoma sp.		c	4
Pseudosmittia sp.		c	1
Tanytarsini			10
Tubificidae			1
			616

Salt Slough 3

Lowest Taxa	T1
Liodessus obscurellus	10
Berosus sp.	1
Parachironomus sp.	4
Polypedilum sp.	1
Cladotanytarsus sp.	1
Paratanytarsus sp.	1
Orthocladiinae	1
Cricotopus sp.	14
Limnophyes sp.	3
Nanocladius sp.	4
Pseudosmittia sp.	1
Cricotopus bicinctus group	28
Sciomyzidae	1
Simulium sp.	9
Corixidae	4
Corisella inscripta	1
Hydropsyche californica	37
Corophium spinicorne	162
Hyalella sp.	1
Nais communis/ variabilis	1
Limnodrilus hoffmeisteri	1
Physa/ Physella	8
	294

Lowest Taxa	T2
Chironomus sp.	1
Endotribelos sp.	1
Microchironomus nigrovittatus	3
Cladotanytarsus sp.	1
Cricotopus sp.	7
Limnophyes sp.	2
Nanocladius sp.	6
Cricotopus bicinctus group	25
Procladius sp.	4
Simulium sp.	12
Corixidae	3
Corisella decolor	2
Trichocorixa calva	26
Ischnura sp.	1
Hydropsyche californica	16
Daphniidae	1
Corophium spinicorne	85
Eudistylia vancouveri	32
Nais communis/ variabilis	5
Paranais litoralis	6
Slavina appendiculata	5
Tubificidae	13
Branchiura sowerbyi	1
Limnodrilus hoffmeisteri	5
Corbicula sp.	4
Ferrissia rivularis	5
Physa/ Physella	15
Prostoma sp.	3
	290

Lowest Taxa	T3
Chironomus sp.	2
Harnischia sp.	2
Parachironomus sp.	1
Polypedilum sp.	1
Microchironomus nigrovittatus	2
Cladotanytarsus sp.	1
Orthocladius complex	1
Cricotopus sp.	8
Limnophyes sp.	1
Pseudosmittia sp.	1
Cricotopus bicinctus group	6
Corixidae	5
Coenagrionidae	1
Corophium spinicorne	165
Eudistylia vancouveri	44
Slavina appendiculata	1
Tubificidae	5
Limnodrilus hoffmeisteri	1
Corbicula sp.	2
Fossaria sp.	1
Physa/ Physella	15
Nematoda	1
Prostoma sp.	3
	270

Lowest Taxa	TV	FFG	TOTAL
Berosus sp.	5	p	1
Branchiura sowerbyi	10	c	1
Chironomus sp.	10	c	3
Cladotanytarsus sp.	6	f	3
Coenagrionidae	9	p	1
Corbicula sp.	6	f	6
Corisella decolor			2
Corisella inscripta	10	p	1
Corixidae	10	p	12
Corophium spinicorne			412
Cricotopus bicinctus group			59
Cricotopus sp.	7	s	29
Daphniidae	8	c	1
Endotribelos sp.		c	1
Eudistylia vancouveri			76
Ferrissia rivularis		g	5
Fossaria sp.	6	g	1
Harnischia sp.	6	c	2
Hyalella sp.	6	c	1
Hydropsyche californica		f	53
Ischnura sp.	9	p	1
Limnodrilus hoffmeisteri		c	7
Limnophyes sp.	8	c	6
Liodessus obscurellus			10
Microchironomus nigrovittatus			5
Nais communis/ variabilis			6
Nanocladius sp.	3	s	10
Nematoda	5	p	1
Orthocladiinae	5	c	1
Orthocladius complex			1
Parachironomus sp.	10	p	5
Paranais litoralis		c	6
Paratanytarsus sp.	6	f	1
Physa/ Physella	8	g	38
Polypedilum sp.	6	s	2
Procladius sp.	9	p	4
Prostoma sp.		c	6
Pseudosmittia sp.		c	2
Sciomyzidae		p	1
Simulium sp.	6	f	21
Slavina appendiculata		c	6
Trichocorixa calva			26
Tubificidae			18
			854

Salt Slough 4

Lowest Taxa	T1
Apedilum sp.	9
Chironomus sp.	8
Dicrotendipes sp.	7
Parachironomus sp.	9
Cladotanytarsus sp.	1
Paratanytarsus sp.	3
Tanytarsini	1
Cricotopus sp.	93
Cricotopus bicinctus group	34
Thienemannimyia group	1
Procladius sp.	2
Hydrellia sp.	1
Corixidae	8
Corisella inscripta	3
Sigara vallis	1
Coenagrionidae	2
Lumbricina	2
Nais communis/ variabilis	4
Tubificidae	6
Fossaria sp.	16
Physa/ Physella	45
Nematoda	3
	259

Lowest Taxa	T2
Chironomini	1
Apedilum sp.	2
Chironomus sp.	4
Dicrotendipes sp.	11
Parachironomus sp.	12
Polypedilum sp.	1
Cricotopus sp.	69
Cricotopus bicinctus group	4
Corixidae	4
Corisella decolor	2
Nais communis/ variabilis	69
Ophidonais serpentina	65
Slavina appendiculata	25
Tubificidae	1
Limnodrilus hoffmeisteri	1
Hydra sp.	1
Corbicula sp.	1
Ferrissia rivularis	1
Fossaria sp.	1
Physa/ Physella	9
Nematoda	2
Prostoma sp.	7
	293

Lowest Taxa	T3
Thermonectus sp.	1
Liodessus obscurellus	2
Sphaeromias sp.	1
Apedilum sp.	4
Chironomus sp.	1
Dicrotendipes sp.	3
Glyptotendipes sp.	2
Chironomini	3
Paratanytarsus sp.	1
Cricotopus sp.	26
Cricotopus bicinctus group	4
Orthocladiinae	2
Cricotopus sp.	3
Psychodidae	1
Simulium sp.	1
Corixidae	1
Eudistylia vancouveri	1
Lumbricina	2
Enchytraeidae	1
Nais communis/ variabilis	2
Ophidonais serpentina	1
Paranais litoralis	1
Slavina appendiculata	1
Tubificidae	2
Fossaria sp.	6
Physa/ Physella	15
Nematoda	5
Prostoma sp.	2
	95

Lowest Taxa	TV	FFG	TOTAL
Apedilum sp.			15
Chironomini	6	c	1
Chironomini			3
Chironomus sp.	10	c	13
Cladotanytarsus sp.	6	f	1
Coenagrionidae	9	p	2
Corbicula sp.	6	f	1
Corisella decolor			2
Corisella inscripta	10	p	3
Corixidae	10	p	13
Cricotopus bicinctus group			42
Cricotopus sp.	7	s	188
Cricotopus sp.			3
Dicrotendipes sp.	8	c	21
Enchytraeidae	10	c	1
Eudistylia vancouveri			1
Ferrissia rivularis		g	1
Fossaria sp.	6	g	23
Glyptotendipes sp.	10	s	2
Hydra sp.	5	f	1
Hydrellia sp.			1
Limnodrilus hoffmeisteri		c	1
Liodessus obscurellus			2
Lumbricina		c	4
Nais communis/ variabilis			75
Nematoda	5	p	10
Ophidonais serpentina			66
Orthocladiinae			2
Parachironomus sp.	10	p	21
Paranais litoralis		c	1
Paratanytarsus sp.	6	f	4
Physa/ Physella	8	g	69
Polypedilum sp.	6	s	1
Procladius sp.	9	p	2
Prostoma sp.		c	9
Psychodidae			1
Sigara vallis			1
Simulium sp.	6	f	1
Slavina appendiculata		c	26
Sphaeromias sp.			1
Tanytarsini			1
Thermonectus sp.			1
Thienemannimyia group			1
Tubificidae			9
			647

Salt Slough 5

Lowest Taxa	T1
Apedilum sp.	18
Chironomus sp.	3
Glyptotendipes sp.	3
Parachironomus sp.	3
Paratanytarsus sp.	50
Tanytarsini	7
Orthocladius complex	1
Cricotopus sp.	61
Callibaetis sp.	1
Corixidae	1
Coenagrionidae	11
Daphniidae	75
Cyclopidae	12
Cambaridae	2
Nais communis/ variabilis	21
Ophidonais serpentina	1
Slavina appendiculata	8
Hydra sp.	1
Physa/ Physella	23
	302

Lowest Taxa	T2
Chironomini	1
Apedilum sp.	4
Chironomus sp.	23
Cryptotendipes sp.	1
Glyptotendipes sp.	6
Paratanytarsus sp.	27
Tanytarsini	2
Cricotopus sp.	150
Corynoneura sp.	1
Procladius sp.	1
Ephydridae	1
Corixidae	24
Corisella decolor	2
Coenagrionidae	5
Cyclopidae	4
Glossiphoniidae	1
Nais communis/ variabilis	12
Slavina appendiculata	4
Tubificidae	4
Physa/ Physella	21
Nematoda	2
	296

Lowest Taxa	T3
Tropisternus sp.	1
Apedilum sp.	7
Dicrotendipes sp.	2
Paratanytarsus sp.	14
Cricotopus sp.	86
Limnophyes sp.	1
Corynoneura sp.	2
Callibaetis sp.	1
Corixidae	2
Corisella inscripta	1
Coenagrionidae	9
Daphniidae	47
Cyclopidae	9
Pacifastacus sp.	1
Nais communis/ variabilis	34
Slavina appendiculata	18
Hydra sp.	1
Ferrissia rivularis	1
Physa/ Physella	58
	295

Lowest Taxa	TV	FFG	TOTAL
Apedilum sp.			29
Callibaetis sp.	9	c	2
Cambaridae	6	c	2
Chironomini	6	c	1
Chironomus sp.	10	c	26
Coenagrionidae	9	p	25
Corisella decolor			2
Corisella inscripta	10	p	1
Corixidae	10	p	27
Corynoneura sp.	7	c	3
Cricotopus sp.	7	s	297
Cryptotendipes sp.	6	c	1
Cyclopidae	8	c	25
Daphniidae	8	c	122
Dicrotendipes sp.	8	c	2
Ephydridae			1
Ferrissia rivularis		g	1
Glossiphoniidae	8	p	1
Glyptotendipes sp.	10	s	9
Hydra sp.	5	f	2
Limnophyes sp.	8	c	1
Nais communis/ variabilis			67
Nematoda	5	p	2
Ophidonais serpentina			1
Orthocladius complex			1
Pacifastacus sp.		c	1
Parachironomus sp.	10	p	3
Paratanytarsus sp.	6	f	91
Physa/ Physella	8	g	102
Procladius sp.	9	p	1
Slavina appendiculata		c	30
Tanytarsini			9
Tropisternus sp.	5	p	1
Tubificidae			4
			893