Appendix F

Biological Resources Assessment
Technical Memorandum
(EDAW 2009)

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Technical Memorandum

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Subject:	Laguna Creek Watershed Protection Program, Biological Assessment Findings
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1 INTRODUCTION

This technical memorandum summarizes biological assessments conducted as part of the Laguna Creek Watershed Protection Program. The primary goals of the biological assessments were to characterize the current conditions of existing riparian and aquatic resources and to identify opportunities for management. The characterization of current conditions provides a baseline against which future monitoring can be measured. Adequate, accurate monitoring and assessment are the cornerstones to preserving, enhancing, and restoring watershed function and values. The information gathered from monitoring activities is critical to the effort to protect the beneficial uses of water, protect sensitive resources, and determine the effects of watershed development and protection, restoration, and enhancement programs.

The federal Clean Water Act (CWA) gives states and territories the primary responsibility for implementing programs to protect and restore water quality. CWA Section 106(e)(1) requires the U.S. Environmental Protection Agency (EPA) to determine that a state is monitoring the quality of navigable waters and compiling and analyzing data on water quality. To meet those CWA requirements and provide comprehensive information on the status of beneficial uses of California's surface waters, the State Water Resources Control Board and the regional water quality control boards introduced the Surface Water Ambient Monitoring Program (SWAMP) in 2001. The SWAMP provides the impetus to implement a better-organized, standardized program of biological assessment and monitoring throughout the state.

Biological assessments of aquatic communities, also referred to as bioassessments, are rapidly becoming a preferred tool for water quality monitoring. Bioassessments are gaining popularity among scientists, resource managers, and decision makers alike and have been adopted as a primary assessment method as part of the SWAMP. Standardized bioassessment procedures, combined with a rapid vegetation assessment developed by the California Native Plant Society (CNPS), were employed as primary assessment methods to characterize current conditions of existing riparian and aquatic resources in the Laguna Creek Watershed.

1.1 BACKGROUND ON BIOASSESSMENT

Aquatic invertebrates are common inhabitants of the stream bottom environment. Insects are the main types present, and commonly include mayflies, stoneflies, caddisflies, and true flies. Non-insect invertebrates include snails, leeches, worms, and scuds. Aquatic insects and other invertebrates are central to the proper ecological functioning of streams and surrounding terrestrial environments. These invertebrates consume decomposing organic matter (e.g., detritus, wood and leaf debris) and attached algae, and in turn become an important food resource to fish and birds. In addition to their role in the food web, aquatic invertebrates have varying degrees of ability to withstand environmental degradation; thus they may be used as indicators of water quality and habitat condition. For example, sediments from erosion and/or pollutants from runoff may decrease the variety of insects and other invertebrates that are able to survive, which may indicate a degradation of biological health.

Use of the stream invertebrate fauna to gauge the biological health of a stream is known as bioassessment. Bottom-dwelling (or benthic) organisms are collected to detect changes in stream health based on the number of different types present (diversity) and their level of tolerance of environmental impacts and pollution (sensitivity). Monitoring stream invertebrates in comparison to reference sites (areas having little or no impact but a similar physical setting) and/or over time at targeted sites provides a method to estimate the amount of degradation of aquatic systems or level of recovery in response to changing land uses. Bioassessment may be used together with other, more traditional methods of stream channel and riparian monitoring to measure the response of stream life to habitat changes. When pollution does not originate from a single point, it can be difficult to accurately characterize the source using chemical methods alone, because this type of pollution usually does not occur continuously and therefore may not be detected in a given water sample. Contamination may also exist upstream of a location and not be reflected in the channel or riparian conditions at that site. The advantage of using stream invertebrates is that because they live in the stream, they incorporate and embody changes in water quality that occur in both local and upstream areas of the watershed. Another advantage of bioassessment is that once baseline conditions (over a period of years and locations) have been established, repeated sampling can be done with less frequency to document future changes.

To fully understand the concept of bioassessments, it is important not only to know what they are, but also to understand the rationale for conducting them and how they can be used as a decision-making tool. The following text describes the rationale for conducting bioassessments, including the role of bioassessment in water quality determination and the utility of bioassessment as a decision-making tool.

1.1.1 THE ROLE OF BIOASSESSMENT IN WATER QUALITY DETERMINATION

State and tribal water resource agencies in the United States have developed bioassessment protocols that have added an important dimension of ecological understanding to their overburdened and underfunded monitoring programs (Barbour 1997). The central purpose of assessing the biological condition of aquatic communities is to determine how well a water body supports aquatic life (Barbour et al. 1996). Biological communities integrate the effects of different pollutant stressors such as excess nutrients, toxic chemicals, increased temperature, and excessive sediment loading; thus they provide an overall measure of the aggregate impact of the stressors. The use of information about ambient biological communities, assemblages, and populations to protect, manage, and exploit water resources has been progressing for the past 150 years (Davis 1995). Despite this long history, it has only been in the last decade that a widely accepted technical framework has evolved for using biological assemblage data for assessment of the water resource (Barbour et al. 1996).

1.1.2 Utility of Bioassessment as a Decision-making Tool

Bioassessment provides important planning information for managing watersheds. Bioassessment serves four primary functions or uses for watershed assessments and developing management plans, all of which are relevant to the Laguna Creek Watershed Protection Program:

1. Initial assessment of conditions
2. Characterizing the magnitude of impairment
3. Assisting in the diagnosis of causes to impairment (e.g., sedimentation, contaminants)
4. Monitoring of temporal trends to evaluate improvements or further degradation

2 METHODS

This section provides a discussion on the methodology used to conduct bioassessments and rapid vegetation assessments in the Laguna Creek Watershed.

2.1 SITE SELECTION

Site selection was based on three primary criteria: (1) access (e.g., physical accessibility and land ownership); (2) characterization of distinct portions of the watershed based on surrounding watershed conditions; and (3) relationship to Sacramento County Stormwater Quality Program sites located along Laguna Creek (between Excelsior Road and Sheldon Road). Based on these criteria, four sites were selected (see Exhibit 1):

1. Upper Laguna Creek (LC-1)—150-meter (m) reach beginning approximately 800 m downstream of Blodgett Reservoir where the human-made channel returns to the original Laguna Creek stream alignment. The watershed condition above this sample site can be characterized as rural grassland with limited development.

2. Middle Laguna Creek (LC-2)—150-m reach within the Sacramento Valley conservation easement along Laguna Creek immediately upstream of the Excelsior Road bridge. The watershed condition above this sample site can be characterized as semirural grassland with some residential development.

3. Lower Laguna Creek (LC-3)—150-m reach immediately downstream of the West Stockton Road/State Route 99 bridges, along the "Laguna Falls" bypass weir. The watershed condition above this sample site can be characterized as urbanized/suburbanized with residential and commercial development.

4. Elk Grove Creek (EG-1)—150-m reach along Elk Grove Creek (tributary to Laguna Creek) immediately downstream of the Emerald Vista Road bridge. The watershed condition above this sample site can be characterized as urbanized/suburbanized with residential and commercial development.

2.2 BIOASSESSMENT SAMPLING

Biologists and ecologists trained in conducting bioassessments performed the bioassessment sampling. This monitoring includes collection of benthic macroinvertebrates (BMIs), assessment of physical habitat characteristics, and general water quality measurements. Additional rapid vegetation assessments were also performed to provide more detailed information on the adjacent plant communities (described separately below).

2.2.1 BENTHIC MACROINVERTEBRATE SAMPLING

Field sampling for the Laguna Creek Watershed Protection Program followed the Standard Operating Procedure of the California Stream Bioassessment Procedure (CSBP) for multihabitat sampling of low-gradient streams developed by the California Department of Fish and Game's (DFG's) Aquatic Bioassessment Laboratory (ABL).

The multihabitat method calls for the identification of a stream reach of 150 m. For each reach, 11 cross-stream transects along the reach were identified at 15-m intervals. Starting at the most downstream transect, benthic samples were collected from either the left, center, or right end of the transect using a standard D-frame kick net with 0.5 millimeter (mm) mesh. Organisms were dislodged from the benthic substrate to a depth of 4–6 inches from within a 1-square-foot area of the benthic habitat (e.g., riffle, pool/glide, woody debris, vegetated banks, or submerged macrophytes) immediately upstream of the net. For each sample, the material retained in the net was immediately transferred into appropriately labeled 500-milliliter (mL) plastic wide-mouth jars containing 95% ethanol to preserve any organisms. A consistent amount of time was allocated to sampling each habitat type so as to not bias the BMI data generated during the study. Upon completion of the sample collection from a given transect, the next transect sample was collected in a similar fashion, and the collected material was placed into the same jar containing the material(s) from the previous transect(s). This sampling approach continued until all 11 transects were sampled.

The preserved samples were transported, under chain of custody, to the ABL where they were stored at room temperature until sorting and organism identification was performed.

2.2.2 Physical Habitat Assessment

A physical habitat assessment was performed for each reach sampled. The physical habitat assessment methods included a reachwide scoring evaluation, and measurements and observations for transects and intertransects.

The reachwide evaluation included three physical habitat metrics: epifaunal substrate cover, sediment deposition, and channel alteration. Each metric was given a maximum score of 20, with greater values representing a better habitat for BMI; the combined habitat metric score for any site could not be greater than 60. Each metric was assigned to one of four categories of physical condition: optimal (20–16), suboptimal (15–11), marginal (10–6), and poor (5–0). Where possible, discharge was also measured for each reach. U.S. Geological Survey (USGS) gauge data were recorded where available.

Transect measurements and observations included the following attributes: photographs at select transects, wetted width, bankfull width, bankfull height, transect substrates (i.e., size class, depth, and embeddedness), bank stability, human influence, riparian vegetation, instream habitat complexity, and canopy cover. Intertransect attributes included wetted width, flow habitats, and substrates. Photographs were taken at the first transect (upstream [one photo]), the middle transect (upstream and downstream [two photos]), and at the last transect (downstream [one photo]).

A GARMIN Geko 201 global positioning system (GPS) was used to record latitude and longitude coordinates for each sampling site. Reach and transect length were measured using a tape measure. Wetted and bankfull widths and substrate depths were measured using a stadia rod. Canopy was measured using a spherical densiometer. Flow rate was estimated (where possible) based on measuring the water velocity (with a flow meter) and wetted channel area at the sampling station. Copies of the field forms are attached in Appendix A.

2.2.3 Water Quality Sampling

The following water quality parameters were measured once upon arrival at each stream reach: temperature, pH, alkalinity, dissolved oxygen (DO), electrical conductivity (EC), and total dissolved solids (TDS). The following equipment was used to measure these water quality parameters:

- Temperature and DO were measured using a YSI Model 55 multi-meter.
- pH, EC, and TDS were measured using a Hanna Combo Model HI 98129 multi-meter.
- Alkalinity was measured using a LaMotte Model WAT-DR field test kit.

2.3 Benthic Macroinvertebrate Laboratory Procedures

The DFG ABL was contracted to perform all BMI laboratory procedures. A discussion of these procedures is provided below.

2.3.1 Sample Sorting

All sample sorting was performed at the ABL laboratory. Following the removal of alcohol from the 500-mL plastic wide-mouth jars, each sample was placed into a 0.5-mm mesh sieve and rinsed using deionized water. Each item was examined carefully for the presence of BMIs, then large debris (e.g., twigs, rocks) was removed from the sample. The remaining material was then evenly spread across a gridded tray. Following the random selection of a grid (using a random number generator), the materials from within the selected grid were transferred into a petri dish. Using a dissecting microscope, BMIs were removed from the dish during a systematic sorting of the sample. The BMIs were counted and then placed into 50-mL vials containing 70% ethanol/glycerin. This process was repeated grid by grid until 500 BMIs were collected.

Once 500 BMIs were collected, the remaining materials in the last grid being sorted were placed into an additional 50-mL vial labeled with the appropriate sample code. The remaining materials from all of the previously sorted grids were collected into a 500-mL plastic wide-mouth jar containing 70% ethanol/glycerin, and labeled with the sample code and identified as “sorted”; as a quality control measure, sorted materials from 20% of the samples were resorted by a different scientist, with the target of finding no more than 25 uncollected BMIs (5% of the overall number removed for identification). The remaining unsorted materials in the gridded tray were placed back into the original 500-mL plastic wide-mouth jar containing 70% ethanol/glycerin and the original sample label. This process was repeated for all of the samples collected.

2.3.2 Taxonomic Identification

A CSBP Level II taxonomic effort was approved for this study, whereby most organisms were taxonomically identified to family, with Chironomidae being identified to genus. This was achieved by removing the BMIs from the 50-mL vials, transferring them to a Petri dish, and identifying each organism using standard taxonomic keys (Harrington and Born 2000, Merritt and Cummins 1996). A 10-mL vial with 70% ethanol/glycerin and a specimen label containing the sample identification number and family name was prepared for each taxonomic group, and each identified organism was transferred into the appropriate vial. Once an organism was identified, and before the scientist proceeded to another specimen, the Petri dish was searched for additional organisms of the same family, which were added to the vial for that family. A push-button counter was used to maintain an accurate count of the various organisms; the data from the push-button counter were then transferred to a Level 2 Taxonomic Effort Worksheet. This process continued until all organisms were identified.

2.4 Data Analysis/Management

2.4.1 Data Analysis

The data from the identification of the sorted BMIs for each sample were used to generate biological metrics that allow for an assessment of the biological condition of the reach at each sampling location. These biological metrics define a characteristic of the BMI assemblage that may change in some predictable way with increased human disturbance and/or ecological restoration. The biological metrics are classified into four categories: richness measures, composition measures, tolerance/intolerance measures, and trophic measures. Those specified in the CSBP are listed below.

Richness Measures

- Taxa Richness
- EPT Taxa (families: Ephemeroptera, Plecoptera, and Trichoptera)
- Plecoptera Taxa
- Trichoptera Taxa
- Ephemeroptera Taxa

Composition Measures

- EPT Index
- Sensitive EPT Index
- Percent Hydropsychidae
- Percent Baetidae

Tolerance/Intolerance Measures

- Tolerance Value
- Percent Dominant Taxa
- Percent Tolerant Organisms
- Percent Intolerant Organisms

Trophic Measures

- Percent Collectors
- Percent Filterers
- Percent Scrapers
- Percent Predators
- Percent Shredders

Richness Measures

Measures of richness reflect the diversity of the aquatic assemblage, where increasing diversity correlates with increasing health of the assemblage; decreasing richness correlates with increasing disturbance. The richness measures used in this study were taxa richness (the total number of individual taxa) and EPT taxa (number of families in the Ephemeroptera [mayfly], Plecoptera [stonefly], and Trichoptera [caddisfly] insect orders).

Composition Measures

Measures of composition reflect the relative contribution of the population of individual taxa to the total fauna and are based on the ecological patterns and environmental requirements of certain organism groups, such as those taxa considered to be environmentally sensitive, or alternatively, those considered to be a nuisance species. The composition measures used in this study were EPT index (percent composition of mayfly, stonefly, and caddisfly larvae); sensitive EPT index (percent composition of EPTs with low tolerance values); percent Hydropsychidae (percent of caddisflies in the more tolerant family Hydropsychidae); and percent Baetidae (a composition measure for a tolerant family of mayflies).

Tolerance/Intolerance Measures

Tolerance/intolerance measures are metrics that reflect the relative sensitivity of the community to aquatic disturbances. Although the taxa used are usually “pollutant tolerant” or “intolerant,” they are not specific to the type of stressor. For example, these metric values typically also vary with increasing fine particulate organic matter and sedimentation. The tolerance/intolerance measures used in this study were tolerance value [values between 0 and 10 weighted for abundance of individuals that are pollutant tolerant (higher values) and intolerant (lower values)]; percent intolerant organisms (percent of organisms that are considered highly intolerant to impairment as indicated by tolerance values of 0, 1, or 2); percent tolerant organisms (percent of organisms that are considered highly tolerant to impairment as indicated by tolerance values of 8, 9, or 10); and percent dominant taxa (percent composition of the single most abundant taxa).

Trophic Measures

Trophic measures are metrics that provide information on the balance of feeding strategies in the aquatic assemblage. An imbalance of the functional feeding groups reflects unstable food dynamics and indicates stressed conditions. The trophic measures included in this assessment were percent collector-filterers (percent of BMIs that collect, gather, and filter fine particulate matter); percent scrapers (percent of BMIs that graze upon periphyton); percent predators (percent of BMIs that feed on other organisms); and percent shredders (percent of BMIs that shred coarse particulate organic matter).

Abundance

Abundance is one additional metric that provides information on the total number of organisms in a given sampling area. Abundance is calculated by dividing the total number of organisms collected by the number of grids used for the subsampling and multiplied by the number of possible sampling grids. The abundance data represent the total number of organisms sampled per unit of measure.

These metrics were quantified for each site to characterize the parameter ranges for each portion of the watershed. General trends in biological metrics associated with disturbance are presented in Table 1. For the purposes of this technical memorandum, the BMI data and physical habitat data are presented and compared qualitatively, with overall watershed characteristics noted.

Composite Metric Score

The composite metric score (CMS) approach to evaluating BMIs can be used to compare BMI metrics from one site to BMI metrics at other sites. Water quality and stream health as a function of BMI metrics can be identified by the distribution of CMS relative to each other and as they orient above, on, or below the normalized mean line. Since the quality of BMI metrics increase with improved water quality and stream health, CMS can be used to assess relative site water quality and stream health in the context of a biotic component.

In order to calculate a comparative CMS, the differences between sample metric values are normalized and summed in order to determine the grand mean of the metric values for multiple metrics. This value (or score) is then compared between the various sampling sites within a given watershed or to sites within a comparative watershed. The output of the CMS analysis is shown as a plot, which is composed of four parts: 1) sites are shown on the x-axis; 2) the range of normalized composite metric score values is shown on the y-axis, different datasets are depicted by different geometric symbols; 3) where multiple samples were collected from the same site intra-site scores are depicted by unique geometric symbols, where their vertical position on the plot corresponds to their individual composite metric score; and 4) a dashed, horizontal line crossing through “0” on the y-axis represents the grand mean of the normalized scores. For reference, if there was no variation in composite metric scores for samples collected from a group of sites, then the composite metric score plot would show points (samples) plotted on the mean line (sample metric values identical to grand mean metric value); as inter-site variation in composite metric scores increase, sites will score consistently above and below the mean line (sample metric values deviate from grand mean metric value). Sites with high intra-site variability will show samples ranging above and below the mean line.

The metric values are normalized (standardized) to the same measurement scale by dividing the difference between the sample mean metric value and the grand mean metric value by the standard error of the mean. The grand mean is the mean metric value calculated from all sample results being used in the comparative analysis. The formula for computing the CMS for these samples from the same ecological subregion is as follows:

Composite Metric Score =

$$\sum \pm(\mathbf{x}_i - x_i)/sem_i$$

where:

$\mathbf{x}_i$ = sample value for the i-th metric within an ecological subregion;

x_i = grand mean of the samples organized by collection season within an ecological subregion, for the i-th metric;

sem_i = standard error of the mean for the i-th metric; ± = a plus sign denotes a metric that decreases with response to impairment (e.g., Taxonomic Richness) while a minus sign denotes a metric that increases with response to impairment (e.g., Tolerance Value).

In order to apply the Laguna Creek Watershed bioassessment results to a comparative CMS, existing BMI data collected by the DFG ABL for streams throughout the Sacramento Valley were utilized. This data includes BMI samples in 30 candidate reference streams in the Sacramento Valley below 250 feet elevation. From these 30 samples, the ABL identified 14 BMI metrics that are most able to discriminate between highly-stressed sites from less-stressed sites (see p. 10 of the Sac. Valley Reference Stream report for more details on how these discriminators were determined).

Table 1
Trends in Biological Metrics Associated with Disturbance

Biological Metrics	Response to Disturbance
Richness Measures	
Taxa Richness	Decrease
EPT Taxa	Decrease
Composition Measures	
EPT Index	Decrease
Sensitive EPT Index	Decrease
Percent Hydropsychidae	Increase
Percent Baetidae	Increase
Tolerance/Intolerance Measures	
Tolerance Value	Increase
Percent Intolerant Organisms	Decrease
Percent Tolerant Organisms	Increase
Percent Dominant Taxa	Increase
Trophic Measures	
Percent Collectors	Increase
Percent Filterers	Increase
Percent Scrapers	Increase
Percent Predators	Increase
Percent Shredders	Decrease

2.5 RAPID VEGETATION ASSESSMENT

Vegetation community composition and dominance was sampled at each site using the CNPS Rapid Assessment protocol (CNPS 2005). Only those protocol components related to the assessment of plant community composition and structure were completed (the protocol also allows for the assessment of physical habitat parameters, much of which was redundant with data collected for other components of this study). The vegetation parameters collected at each site included the name of the sampled vegetation alliance, the size of the sample plot, the number and approximate diameter at breast height (dbh) of any trees within the sample plot, the height and approximate ground cover of trees, shrubs, and forbs within each plot, and the 15–20 most common vascular plants as well as the percent absolute ground cover for each plant within the sampled plot. In an effort to facilitate the repeatability of subsequent monitoring efforts, absolute ground cover for each plant was assigned one of seven standard cover classes rather than a specific ground cover value. A copy of the field form is attached in Appendix B.

For analysis purposes, vegetation communities were described in terms of the number and absolute cover of native, nonnative, and invasive plants commonly found at each sample point; the number, size, and species of trees found at each sample point; and, the percent ground cover of trees, shrubs, and herbs at each sample point. Rapid vegetation assessment data will be provided in a separate database.

3 RESULTS AND DISCUSSION

This section provides a discussion on the results of bioassessments and rapid vegetation assessments conducted in the Laguna Creek Watershed. Assessments were conducted on the following days and times for each reach:

- LC-1: April 27, 2006—1 p.m.
- LC-2: June 8, 2006—11:30 a.m., December 6, 2006—11:00 a.m.
- LC-3: June 15, 2006—1:30 p.m., December 6, 2006—1:45 p.m.
- EG-1: June 15, 2006—10 a.m., December 6, 2006—12:30 p.m.

As noted above, all sites were sampled during spring 2006. Sites LC-2, LC-3, LC-4, and EG-1 were also sampled during fall 2006; however, intermittent flows at the LC-1 site prevented sampling at this site during this time period. Bioassessments, including full stream habitat characterization, and rapid vegetation assessments were done during the spring sampling, but only water quality data and BMI samples were collected in the fall.

3.1 BIOASSESSMENT

3.1.1 PHYSICAL HABITAT ASSESSMENT

Photo documentation of the study sites is presented in Exhibits 2a through 5b. Several trends in the habitat condition were recorded during the physical habitat assessment of the study sites (Tables 2 and 3 and Exhibits 6–15). The Laguna and Elk Grove Creek sites ranked from suboptimal to poor for physical habitat quality moving from the upstream reaches (LC-1 and LC-2) to the downstream reaches (LC-3 and EG-1) in the reachwide scoring component of the CSBP. The physical habitat scores for lower Laguna Creek and Elk Grove Creek (19 and 7, respectively) were driven by the limited (to absent) epifaunal substrate/cover, high amounts of sediment deposition, a high-level channel alteration, and by the limited habitat variability.

Transect and intertransect measures of physical habitat parameters indicated that the four reaches surveyed in the watershed can be characterized by varying conditions. Common characteristics of all of the reaches surveyed included low riparian canopy cover and low gradient; all other parameters varied substantially.

Substrate class sizes recorded at LC-1 included fines, sand, fine gravel, and coarse gravel, with fines being the most dominant class recorded (44%). Substrates at LC-2 included a range of more coarse material (fines to cobble), with coarse gravel being the dominant size class (45%). Both LC-3 and EG-1 reaches were dominated by fines. Embeddedness was recorded for all substrates in the fine gravel class or larger. Embeddedness ranged from 45% to 56% between sites LC-1, LC-2, and LC-3. No fine gravel or larger class sizes were recorded at EG-1; therefore, embeddedness was not recorded.

The amount and type of human influence on each reach varied dramatically. Pasture/rangeland was the sole human influence recorded at both LC-1 and LC-2. Cattle were present at both reaches during the times of the surveys at these more rural locations within the watershed. LC-3 exhibited more urban/suburban influences, with pavement/cleared lot throughout the length of the reach. EG-1 exhibited a variety of human influences; buildings, pavement/cleared lot, roads, and park/lawn were the dominant class types.

Bank stability varied substantially between the four reaches and was influenced by other parameters (see additional discussion below). LC-1 banks were dominated by the "vulnerable" classification (86%); the remaining banks were classified as "eroded." The bank stability at LC-1 appeared to be affected most by cattle grazing at this reach. LC-2 banks were observed to be in the most "stable" condition, and the entire reach was recorded under this classification. LC-3 was characterized as having vulnerable to stable banks. EG-1 was characterized as having primarily eroded banks (77%).

The dominant form of instream habitat complexity at both LC-1 and LC-2 was filamentous algae; aquatic macrophytes were also present to a lesser degree. The extensive growth of filamentous algae at both LC-1 and LC-2 can perhaps be attributed to the presence of cattle (and associated feces) that can lead to nutrient loading in the creek. LC-3 also contained both algae and macrophytes, but filamentous algae was generally less dense. EG-1 was dominated by aquatic macrophytes (i.e., water primrose) and was nearly completely choked by this aquatic vegetation.

Flow habitats at LC-1 and LC-2 consisted of riffles, runs, glides, and pools; glides dominated both reaches (55% and 70%, respectively). Both LC-3 and EG-1 were 100% glides.

Table 2
Physical Habitat Characteristics of the Laguna Creek Watershed (Reachwide Scores)

Physical Habitat Parameters	Sampling Sites			
	Laguna Creek			Elk Grove Creek
	LC-1	LC-2	LC-3	EG-1
Epifaunal Substrate/Cover	13	14	3	3
Sediment Deposition	12	12	3	2
Channel Alteration	18	19	13	2
Total Habitat Score	**43**	**45**	**19**	**7**

Table 3
Physical Habitat Characteristics of the Laguna Creek Watershed

Physical Habitat Parameters	Sampling Sites			
	Laguna Creek			Elk Grove Creek
	LC-1	LC-2	LC-3	EG-1
Channel Dimensions				
Wetted Width (m)	2.52	3.73	8.07	7.54
Depth (cm)	10.8	7.7	53.4	22.9
Bankfull Width (m)	4.23	4.56	10.64	11.26
Bankfull Height (m)	0.33	0.20	1.36	2.18
Mean for all 11 transects				
Substrate Size Class (% of reach)				
Bedrock Smooth (>Car)	0	0	0	0
Bedrock Rough (> Car)	0	0	0	0
Concrete/Asphalt	0	0	0	0
Large Boulder (1–4 m)	0	0	0	0
Small Boulder (0.25 m–1 m)	0	0	0	0
Cobble (64–250 mm)	0	16	0	0
Coarse Gravel (16–64 mm)	13	45	9	0
Fine Gravel (2–16 mm)	24	24	2	0
Sand (0.25–2 mm)	20	11	0	0
Fines (<0.25 mm)	44	4	89	100
Hardpan (Consol. Fines)	0	0	0	0
Wood	0	0	0	0
Other	0	0	0	0

Table 3
Physical Habitat Characteristics of the Laguna Creek Watershed

Physical Habitat Parameters	Sampling Sites			
	Laguna Creek			Elk Grove Creek
	LC-1	LC-2	LC-3	EG-1
Bedrock Smooth (>Car)	0	0	0	0
Bedrock Rough (> Car)	0	0	0	0
Concrete/Asphalt	0	0	0	0
Mean for all 11 transects				
Embeddedness (% substrate class ≥ gravel)	56	45	50	NA
Mean for all 11 transects				
Bank Stability (% of reach)				
Eroded	14	0	14	77
Vulnerable	86	0	45	23
Stable	0	100	41	0
Average between transects for both banks (right and left)				
Human Influence (% of reach)				
Walls/Riprap/Dams	0	0	0	9
Buildings	0	0	0	100
Pavement/Cleared Lot	0	0	100	100
Road/Railroad	0	0	9	91
Pipes (Inlet/Outlet)	0	0	0	18
Landfill/Trash	0	0	18	36
Park/Lawn	0	0	0	100
Row Crops	0	0	0	0
Pasture/Rangeland	100	100	9	0
Logging Operations	0	0	0	0
Mining Activity	0	0	0	0
Average between transects				
Riparian Vegetation				
Upper Canopy (>5 m high)	0.45	0.00	0.00	0.05
Lower Canopy (<5 m high)	0.00	0.00	0.00	0.55
Ground Cover—Shrubs, Grasses	4.00	3.00	4.00	4.00
Ground Cover—Bare Soil	0.91	2.00	1.00	1.00
Mean for all 11 transects 0 = Absent (0%), 1 = Sparse (<10%), 2 = Moderate (10-40%), 3 = Heavy (40-75%), 4 = Very Heavy (>75%)				
Instream Habitat Complexity				
Filamentous Algae	3.18	3.00	1.18	0.36
Aquatic Macrophytes	1.55	0.45	1.09	3.55
Boulders	0.00	0.00	0.00	0.00
Large Woody Debris	0.09	0.00	0.00	0.00
Small Woody Debris	0.00	0.00	0.00	0.00
Undercut Banks	0.00	0.00	0.00	0.00
Overhanging Vegetation	0.27	0.00	0.00	0.27
Live Tree Roots	0.00	0.00	0.00	0.00
Artificial Structures	0.00	0.00	0.00	0.00
Mean for all 11 transects 0 = Absent (0%), 1 = Sparse (<10%), 2 = Moderate (10-40%), 3 = Heavy (40-75%), 4 = Very Heavy (>75%)				
Canopy Cover (% based on densitometer)	11	0	6	5
Mean for all readings				
Flow Habitats (% of reach)				
Riffle	2	19	0	0

Table 3 Physical Habitat Characteristics of the Laguna Creek Watershed				
Physical Habitat Parameters	Sampling Sites			
	Laguna Creek			Elk Grove Creek
	LC-1	LC-2	LC-3	EG-1
Rapid	0	0	0	0
Run	36.5	10	0	0
Glide	55	70	100	100
Pool	6	1	0	0
Cascade/ Fall	0.5	0	0	0
Dry	0	0	0	0
Mean for all transects				

3.1.2 Water Quality Assessment

Results of field water quality measurements are presented in Table 4. Discharge was measured to be 0.02 and 0.15 cubic feet per second (cfs) at sites LC-1 and LC-2, respectively. Field discharge measurements were not possible at LC-3 or EG-1 because of very low water velocity. A discharge measurement of 2 cfs was recorded from the USGS gauge station in the vicinity of LC-3 (USGS 11336585 LAGUNA C NR ELK GROVE CA); no gauge station data are available for EG-1. Temperatures were similar at all of the Laguna Creek sites (range from 25.6 to 27.2 degrees Celsius [^{o}C]) and slightly cooler at the Elk Grove Creek site (22.4^{o}C). DO and pH were measured to be high at the upper sites (i.e., LC-1 and LC-2) and within a more normal range at the LC-3 and EG-1 sites. EC, TDS, and alkalinity varied between the sites.

The temperature, DO, pH, and alkalinity readings at LC-1 and LC-2 were very similar during spring sampling. The direct relationship between the high DO concentrations (i.e., supersaturation), high pH readings, low alkalinity, and the extensive amounts of filamentous algae present in the channel at LC-1 and LC-2 can be explained by the same biochemical processes likely occurring at both sites. Alkalinity, measured as calcium carbonate ($CaCO_3$), represents buffering capacity in water against pH swings. In summer during midday (LC-1 surveyed at 1 p.m., LC-2 surveyed at 11:30 a.m.) when growth of aquatic vegetation (in this case filamentous algae) is at its peak, photosynthesis takes place at an extreme rate. Carbon dioxide (CO_2) is chemically removed out of $CaCO_3$ during photosynthesis. The buffer is then no longer chemically available, resulting in potentially dramatic shifts in pH during the day when the sunlight is strongest. During the evening, when the filamentous algae are respiring, CO_2 is generated and chemically replaced (in $CaCO_3$), resulting in increased buffer availability and pH shifts toward neutral. High rates of photosynthesis can also deliver high amounts of oxygen to the water column, resulting in daily shifts in DO. Extreme photosynthesis-induced diurnal swings in pH and DO can limit the aquatic fauna community relative to a more stable system.

Water quality results at LC-3 and EG-1 were both within a more typical range during spring sampling. EG-1 exhibited higher concentrations of EC and TDS, both proxies for salinity or salts in water. The higher concentration of EC and TDS is likely caused by urban and agricultural runoff entering Elk Grove Creek.

Fall sampling demonstrated much lower temperatures at all sample sites. At LC-2 (and potentially all sites) this could be due to lower seasonal ambient temperatures and lower surface runoff. With a greater proportion of flows sub-surface the water is able to remain cooler. Greater electrical conductivity and salinity measurements for LC-2 and LC-3 were likely due to a greater concentration of minerals in the water due to lower flows. Measurements at EG-1 showed a decrease in conductivity and salinity from spring to fall. This could be due to a decrease in agricultural or urban inputs into Elk Grove Creek. At LC-2 and LC-3 alkalinity increased from spring to fall while pH stayed relatively consistent. Again, an increase in alkalinity could be due to greater concentration of $CaCo_3$ due to less volume of water present. High alkalinity and pH values were likely due to high rates of photosynthesis in the stream and the same biochemical process described above. The drastic reduction in alkalinity in EG-1 may have been due to lower rates of photosynthesis within the stream.

Table 4
Water Quality Characteristics for Laguna Creek Watershed

Water Quality Parameters	Sampling Sites						
	Laguna Creek					Elk Grove Creek	
	LC-1	LC-2		LC-3		EG-1	
	4/27/06	6/8/06	12/6/06	6/15/06	12/6/06	6/15/06	12/6/06
Discharge (cfs)	0.02	0.15	--	np(2.0[1])	np	np	np
Temperature (°C)	26.8	25.6	11.8	27.2	10.6	22.4	8.3
Dissolved Oxygen (mg/L)	15.7	14.9	14.78	9.6	8.70	6.06	4.6
pH (standard pH units)	9.18	9.01	8.88	7.58	7.82	8.02	7.14
Electrical Conductivity (µs)	47	235	371	173	242	401	192
Salinity (PPM)	23	120	186	88	121	206	102
Alkalinity (mg/L as $CaCO_3$)	60	70	130	75	95	160	80

np = not possible (no detectable reading from flow meter)
[1] Reading from the USGS gauge located on Laguna Creek 50 feet downstream from bridge on Waterman Road at intersection with Bond Road (USGS 11336585 LAGUNA C NR ELK GROVE CA).

3.1.3 Benthic Macroinvertebrate Biological Metrics

Results of the biological metrics for BMIs collected in the Laguna Creek Watershed are provided in Table 5 and in Exhibits 16–22. A discussion of each of the metrics is provided below. The BMI taxa list is provided in Appendix C.

Richness Measures

Richness measures include taxa richness and EPT taxa. Taxa richness was similar for all four sites with EG-1 having the highest value. No EPT taxa were identified at LC-1, LC-3, or EG-1; a single EPT taxon was identified at LC-2 in the spring and at LC-3 in the fall (family Baetidae; see additional discussion below, see Exhibit 16).

As discussed above, richness measures reflect the diversity of the aquatic assemblage where increasing diversity correlates with increasing health of the assemblage and suggests that niche space, habitat, and food sources are adequate to support survival and propagation of particular species. The low richness values (i.e., limited ability to support sensitive EPT species) indicate that all of the reaches of stream are currently impaired to some extent.

Composition Measures

Composition measures include EPT index, sensitive EPT index, percent Hydropsychidae, and percent Baetidae. Because no EPT taxa were identified for sites LC-1and EG-1, values were zero for all composition measures at those sites. LC-2 had a value of 1.2 for the EPT index in the spring, based on identification of six individuals in the family Baetidae, and a value of zero in the fall. LC-3 had a value of zero in the spring, and 0.4 in the fall with 2 Baetidae individuals sampled (see Exhibit 17).

Composition metrics reflect the relative contribution of the population of individual taxa to the total fauna. Choice of a relevant taxon is based on knowledge of the individual taxa and their associated ecological patterns and environmental requirements, such as those that are environmentally sensitive or a nuisance species. Percent Hydropsychidae and Baetidae (two tolerant families) are regional metrics that have evolved to be particularly useful in California streams. The metric values usually increase as the effects of pollution in the form of fine particulate organic matter and sedimentation increase. Low composition values indicate that all of the reaches of stream are currently limited in their ability to support sensitive EPT species.

Tolerance/Intolerance Measures

Tolerance/intolerance measures include tolerance value, percent intolerant organisms, percent tolerant organisms, and percent dominant taxa. All four reaches had no intolerant (i.e., sensitive) organisms and relatively high percent of tolerant organisms (LC-1 is an exception, see Exhibit 18).

Tolerance/intolerance measures reflect the relative sensitivity of the community to aquatic disturbances. The taxa used are usually pollution tolerant and intolerant, but are generally nonspecific to the type of pollution or stressors. The lack of sensitive taxa in the samples indicates disturbance to the streams to where sensitive taxa are not able to survive.

Trophic Measures

Trophic measures include percent collectors-filterers, percent scrapers, percent predators, and percent shredders. In the spring LC-1 was dominated by collector-gatherers (54%) and collectors-filters (42%), with 3% scrapers. LC-2, LC-3, and EG-1 samples were composed mostly of collector-gatherers (82%, 78%, and 60% respectively), with predators (15%, 11%, 24% respectively) being the second most-abundant feeding group, followed by scrapers (2%, 6%, 14% respectively). The proportion of certain different feeding groups within each reach changed from spring to fall with a substantial increase in predators in both LC-2 and EG-1(see Exhibit 19). This was compensated by a decrease in collector-gatherers in LC-2 and scrapers in EG-1. Changes in LC-3 were not very drastic but can be characterized by a decrease in predators with increases in scrapers and collector-filterers.

Trophic measures (i.e., functional feeding group measures) provide information on the balance of feeding strategies in the aquatic assemblage. The composition of the functional feeding group is a surrogate for complex processes of trophic interaction, production, and availability of food sources. An imbalance of the functional feeding groups can reflect unstable food dynamics and can indicate a stressed condition.

Abundance

Abundance provides a measure of density of individuals collected over a fixed area. Because the abundance of individuals can be dominated by a single taxon and/or tolerant taxa, this measure does not necessarily reflect ecological health, function, or value. Nevertheless, abundance is a useful measure to document increases and/or decreases in the aquatic population over a given area.

In the spring LC-2 (743) had the highest abundance per square foot, followed by LC-1(111), EG-1 (59), and LC-3 (58), respectively (see Exhibit 20). The relatively high abundance at LC-2 can likely be attributed to more diverse and favorable substrate conditions, including higher concentrations of gravel and cobble. Abundance values in the fall were drastically lower; with LC-2 and LC-3 both having values of 44 and EG-1 with only 17 individuals per square foot. This reduction in abundance observed between spring and fall sampling could be the result of many different causes. One is that it could simply be due to a natural cycle in invertebrate population within the watershed. In LC-2 the reduction in abundance could be attributed to extremely low flow and the difficulty of collecting samples from the dried out stream bed. In LC-3 the difficulty of obtaining quality kicknet samples was due to water depth (±3 ft), the composition of the substrate (fines, clay), and the lack of current. Lack of substrate class diversity may reduce the richness and abundance of BMIs. Also, current is essential in delivering materials into the net once organisms have been dislodged from the substrate. In EG-1 it was difficult to access the substrate to take a kick-net sample through the dense layer of aquatic vegetation. The abundance of water primrose and the lack of current flowing through the channel made it nearly impossible to take a benthic sample; therefore the majority of the samples came from the vegetation and mid to upper water column.

Table 5
Biological Metrics for BMIs Collected in the Laguna Creek Watershed

Biological Metric	Sampling Sites						
	Laguna Creek					Elk Grove Creek	
	LC-1	LC-2		LC-3		EG-1	
	4/27/06	6/8/06	12/6/06	6/15/06	12/6/06	6/15/06	12/6/06
Richness Measures							
Taxa Richness	16	13	13	24	25	23	15
EPT Taxa	0	1	0	0	1	0	0
Composition Measures							
EPT Index	0	1.2	0	0	0	0	0
Sensitive EPT Index	0	0	0	0	0	0	0
Percent Hydropsychidae	0	0	0	0	0	0	0
Percent Baetidae	0	1.2	0	0	0.4	0	0
Tolerance/ Intolerance Measures							
Tolerance Value	5.7	6.9	6.9	7.7	6.8	6.9	7.6
Percent Intolerant Organisms	0	0	0	0	0	0	0
Percent Tolerant Organisms	4.3	61.2	72	76.7	46	45.3	72
Percent Dominant Taxa	44.3	35.8	52	52.1	36	45.5	33
Trophic Measures							
Percent Collectors-Filterers	42.1	0.6	0	3.9	9	2.1	1
Percent Scrapers	2.7	2.2	5	6.3	10	13.8	7
Percent Predators	0.2	14.8	26	11.0	6	24.3	33
Percent Shredders	0	0	0	0	0	0	0
Abundance (per square foot)	111	743	44	58	44	59	17

Discussion

EPT taxa are a common group to focus on in bioassessments due to their sensitivity and intolerance of poor stream conditions. The lack of EPT taxa indicates disturbed stream conditions in all reaches sampled. However, the presence or absence of other taxa may provide further information about stream health. LC-2 was dominated by turbellarians (flatworms) in both spring and fall sampling. Turbellarians are detrivores that tend to be associated with mesotrophic and eutrophic water bodies where detritus and decaying animal matter is abundant (SWCSMH 2006). During fall sampling, cow excrement was observed in and around the stream channel, providing excessive nutrient input directly into the stream. Pouch snails of the family Physidae generally indicate nutrient enriched conditions and poor water quality. Pouch snails were found in samples of all sites in spring and fall except for LC-2 in the spring sample. The presence of freshwater leeches of the phylum Annelida, class Hirudinea are generally considered to be indicators of very poor water quality, especially in running waters (EPA 2007). Helobdella stagnalis of the class Hirudinea were found in LC-3 in low numbers in the spring and were found in LC-2, LC-3, and EG-1 in larger numbers in the fall. An overall increase in the number and proportion of non-insect taxa was observed in all the sites sampled (see Exhibit 21).

The main change noted in the sampled BMI community from spring to fall sampling was an increase in non-insect taxa in the fall. This was observed in all reaches sampled along with a decrease in diptera taxa. Certain families of Diptera are relatively intolerant, and the decrease in Dipterans would indicate a negative change in stream conditions from spring to fall. However, many taxa that were sampled in relatively high numbers in the spring are indicators of poor water quality. Most of these same taxa were sampled in the fall, but with less abundance. The decrease in abundance of dipterans may be caused by the same seasonal reduction in overall abundance observed in all reaches or by a specific change in stream health.

Composite Metric Score

Exhibits 22 and 23 plots Laguna Creek BMI CMS relative to other Sacramento County and Sacramento valley stream BMI scores, respectively. Relative to other Sacramento County and valley streams, Laguna Creek Watershed streams exhibit intermediate to poor quality conditions as measures using CMS analysis with the 14 metrics that were determined to be most discriminate.

3.2 RAPID VEGETATION ASSESSMENT

As shown below, the vegetation at all four sample sites is dominated primarily by nonnative and invasive plants, with native plants constituting a relatively small portion of total community composition. However the assessed plant communities are dominated by perennial grasses and other grass-like plants (with the exception of the LC-1 reach). A well-developed riparian overstory is absent along all stream reaches sampled; and few signs of woody plant regeneration and/or colonization were noted, except at sample site LC-3 where small valley oaks are commonly found. A few larger cottonwoods and black willows are found at site LC-1. Results from vegetation assessments are summarized in Table 6.

Table 6
Vegetation Community Characteristics of the Laguna Creek Watershed

Vegetation Community Parameters	Sampling Sites			
	Laguna Creek			Elk Grove Creek
	LC-1	LC-2	LC-3	EG-1
Vegetation Alliance	CA Annual Grassland	Introduced Perennial Grassland	Bulrush	Introduced Perennial Grassland
Trees				
Pct. Ground Cover	10	0	0	2
Count	3	0	0	24
Average Height Class (m)	10–15	-	-	1–2
Average dbh (in)	21	-	-	1

Table 6
Vegetation Community Characteristics of the Laguna Creek Watershed

Vegetation Community Parameters	Sampling Sites			
	Laguna Creek			Elk Grove Creek
	LC-1	LC-2	LC-3	EG-1
Shrubs				
Pct. Ground Cover	0	0	0	1
Average Height Class (m)	-	-	-	<0.5
Shrub Maturity				
Pct. Seedling	-	-	-	0
Pct. Young	-	-	-	100
Pct. Mature	-	-	-	0
Pct. Decadent	-	-	-	0
Herbs				
Average Height Class (m)	<0.5	<0.5	1–2	0.5–1
Pct. <4”	0	70	0	0
Pct. 4”–8”	0	30	10	0
Pct. 8”–12”	0	0	70	0
Pct. >12”	100	0	20	100
Pct. Ground Cover	90	70	95	95
Native Plants (Major Species)	7	7	9	7
Pct. of Major Species	39	50	50	37
Average Pct. Ground Cover	2	3	9	3
Nonnative Plants (Major Species)	4	4	3	7
Pct. of Major Species	22	29	17	37
Average Pct. Ground Cover	28	17	8	9
Invasive Plants[1] (Major Species)	7	3	6	5
Pct. of Major Species	39	21	33	26
Average Pct. Ground Cover	14	5	1	24

[1] Invasive plants include those species listed on the most recent version of the California Invasive Plant Inventory (Cal-IPC 2006).

4 PRELIMINARY CONCLUSIONS AND RECOMENDATIONS

This section provides a brief discussion on the conclusions and recommendations based on the results of bioassessments and rapid vegetation assessments conducted in the Laguna Creek Watershed.

4.1 PRELIMINARY CONCLUSIONS

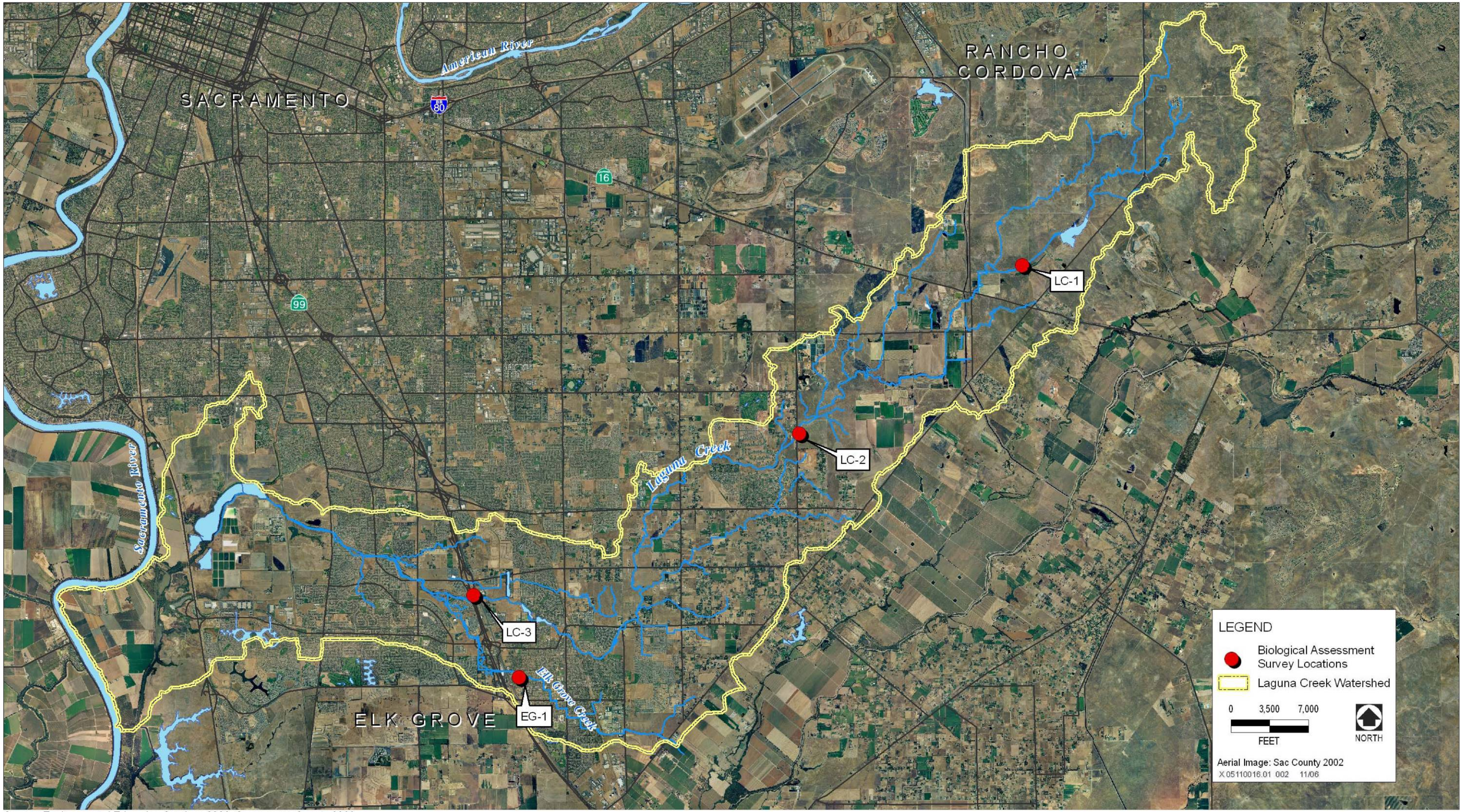
The following preliminary conclusions can be made based on biological assessments conducted in the Laguna Creek Watershed:

- The Laguna and Elk Grove Creek sites ranked from suboptimal to poor for physical habitat quality moving from the upstream reaches (LC-1 and LC-2) to the downstream reaches (LC-3 and EG-1) in the reachwide scoring component of the CSBP. The physical habitat scores for lower Laguna Creek and Elk Grove Creek (19 and 7, respectively) were driven by the limited (to absent) epifaunal substrate/ cover, high amounts of sediment deposition, a high-level channel alteration, and by the limited habitat variability.
- In the spring temperatures were similar at all of the Laguna Creek sites (ranging from 25.6^{o}C to 27.2^{o}C) and slightly cooler at the Elk Grove Creek site (22.4^{o}C). Fall temperatures were much lower but were also similar among LC-2 and LC-3 (11.8 and 10.6°C respectively) with EG-1 having the coolest temperature of 8.3°C. DO and pH were measured to be high at the upper sites (i.e., LC-1 and LC-2) and within a more normal range at the LC-3 and EG-1 sites. EC, TDS, and alkalinity varied between the sites. Measurements for DO, pH, and alkalinity appear to be induced by photosynthesis-related processes. Although flow data is lacking for some reaches, it was very obvious that flows were much lower during fall sampling.
- The benthic macroinvertebrate community sampled in all reaches is indicative of poor water quality and stream health and generally compares poorly to other Sacramento Valley floor streams. Nutrient loading is indicated by the taxa sampled and conditions seemed to deteriorate through the summer and fall. An overall decrease in the abundance of macroinvertebrates was observed from spring to fall in all reaches sampled, along with a reduction in dipterans and an overall increase in non-insect taxa.
- Vegetation at all four survey sites is dominated primarily by nonnative plants and invasive plants, with native plants constituting a relatively smaller portion of total community composition. With the exception of sample site LC-1, plant communities are dominated by perennial grasses and grass-like plants.
- A well-developed riparian overstory is absent along all stream reaches sampled; few signs of woody plant regeneration and/or colonization were noted, except at sample site LC-3 where small valley oaks are commonly found. A few larger cottonwoods and black willows are also found at site LC-1.

4.2 RECOMMENDATIONS

The following recommendations have been made based on biological assessments conducted in the Laguna Creek Watershed:

- The data generated as part of the bioassessments represent a baseline from which future data could be compared against. Additional data collection during spring periods is recommended in order to confirm preliminary conclusions noted above and identify potential trends over time as new developments take place in the watershed and stewardship actions are implemented.



Source: Environmental Education Services 2006, Sacramento County 2003

Map of Laguna Creek Watershed Biological Assessment Survey Sites **Exhibit 1**

Laguna Creek: LC-1, Transect A (upstream) (4/27/06)

Laguna Creek: LC-1, Transect F (upstream)

Photodocumentation of Laguna Creek (Reach LC-1) (4/27/06) **Exhibit 2a**

Laguna Creek: LC-1, Transect F (downstream)

Laguna Creek: LC-1, Transect K (downstream)

Photodocumentation of Laguna Creek (Reach LC-1) (4/27/06) **Exhibit 2b**

Laguna Creek: LC-2, Transect A (upstream)

Laguna Creek: LC-2, Transect F (upstream)

Photodocumentation of Laguna Creek (Reach LC-2) (6/08/06) **Exhibit 3a**

Laguna Creek: LC-2, Transect F (downstream)

Laguna Creek: LC-2, Transect K (downstream)

Photodocumentation of Laguna Creek (Reach LC-2) (6/08/06) **Exhibit 3b**

Laguna Creek: LC-3, Transect A (upstream)

Laguna Creek: LC-3, Transect F (upstream)

Photodocumentation of Laguna Creek (Reach LC-3) (6/15/06) **Exhibit 4a**

Laguna Creek: LC-3, Transect F (downstream)

Laguna Creek: LC-3, Transect K (downstream)

Photodocumentation of Laguna Creek (Reach LC-3) (6/15/06) **Exhibit 4b**

Elk Grove Creek: EG-1, Transect A (upstream)

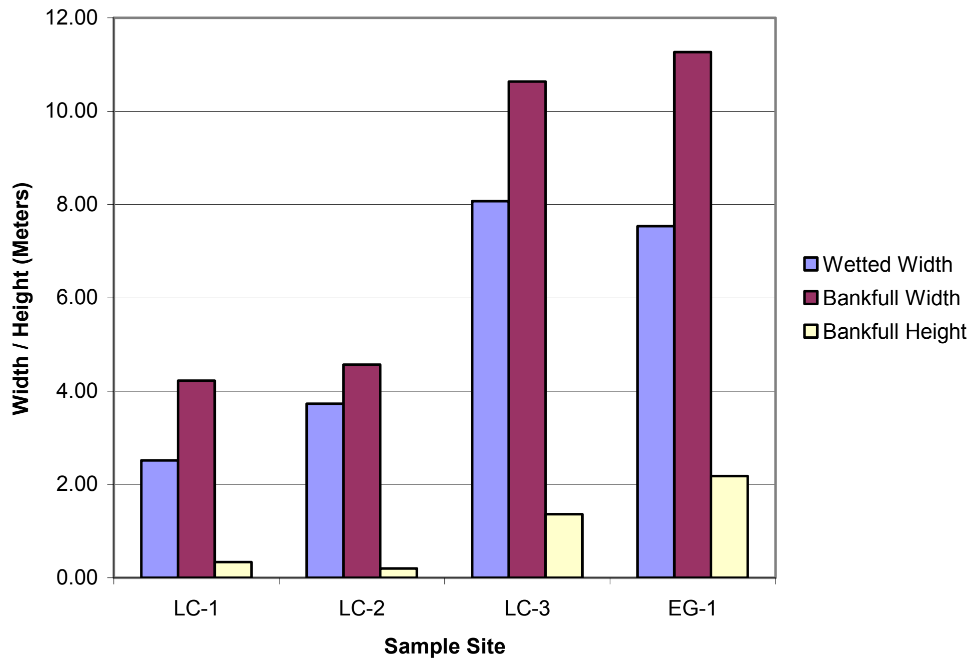
Elk Grove Creek: EG-1, Transect F (upstream)

Photodocumentation of Elk Grove Creek (Reach EG-1) (6/15/06) **Exhibit 5a**

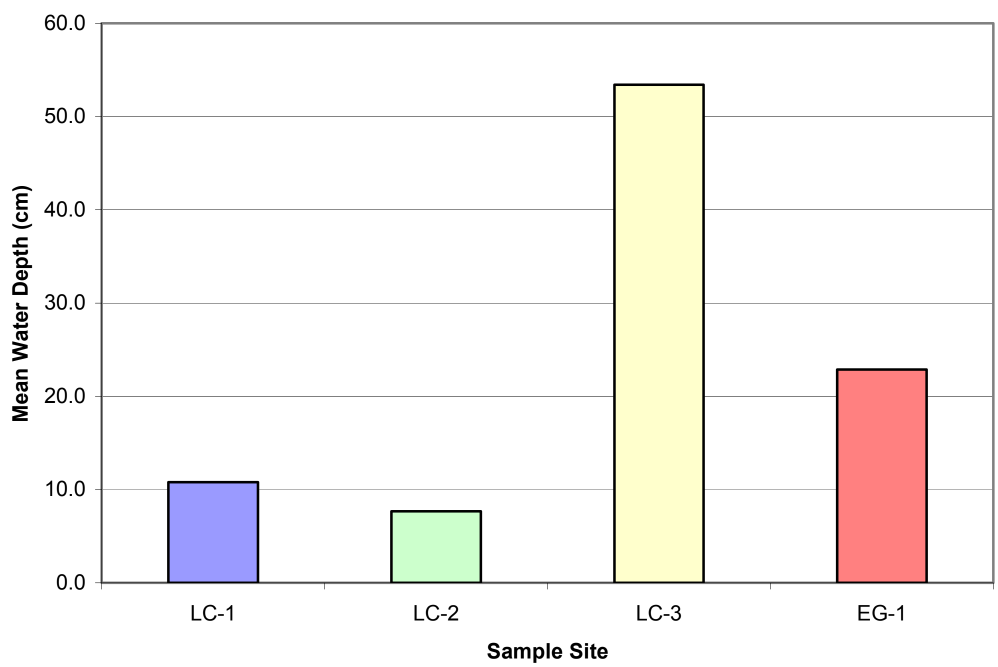
Elk Grove Creek: EG-1, Transect F (downstream)

Elk Grove Creek: EG-1, Transect K (downstream)

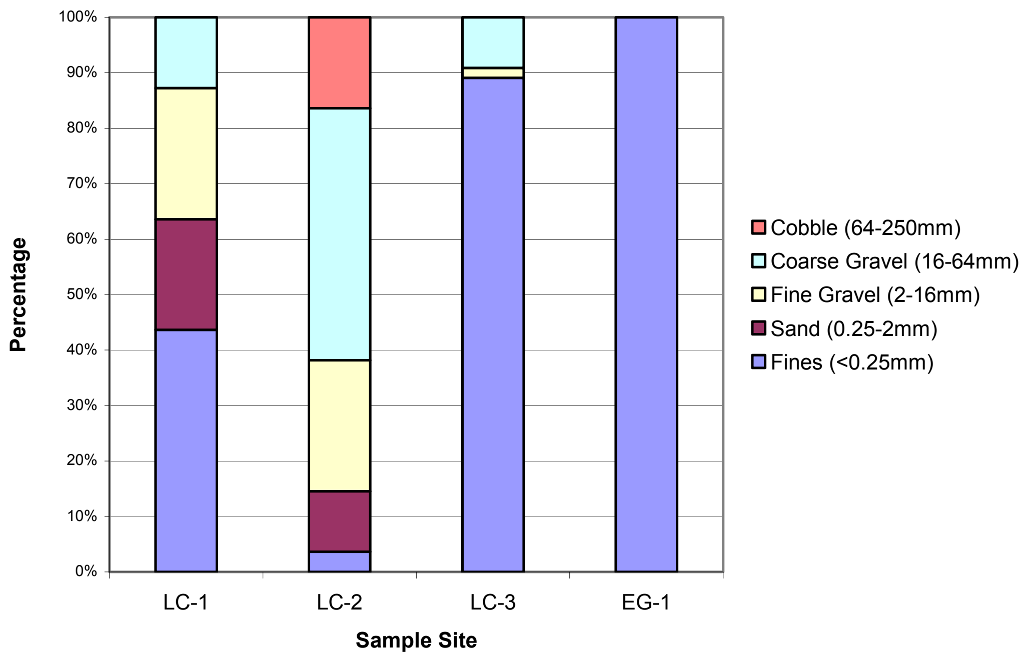
Photodocumentation of Elk Grove Creek (Reach EG-1) (6/15/06) **Exhibit 5b**



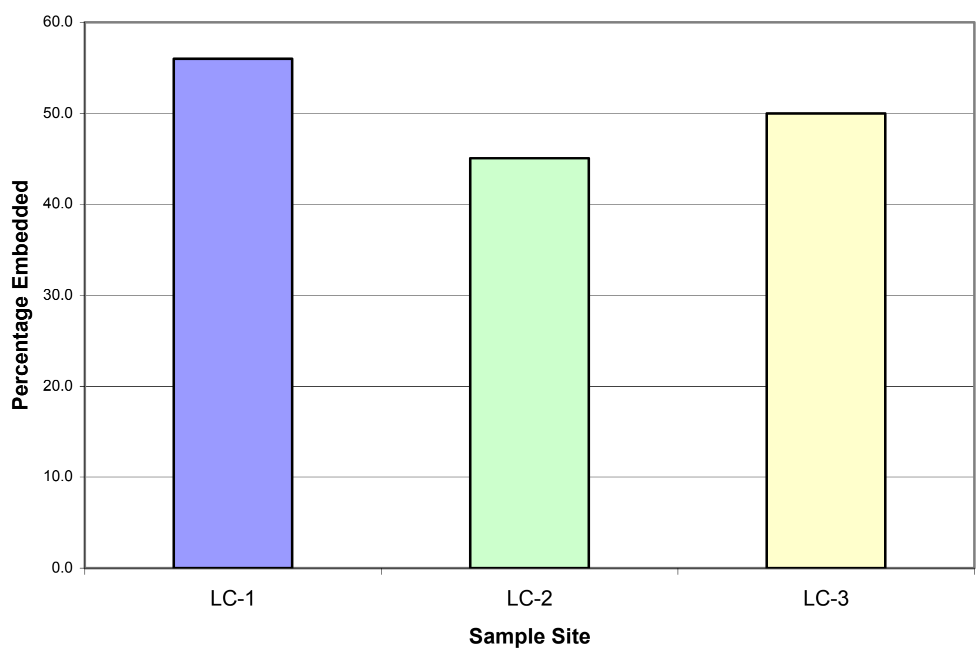
Mean Channel Dimensions by Reach **Exhibit 6**



Mean Water Depth by Reach **Exhibit 7**

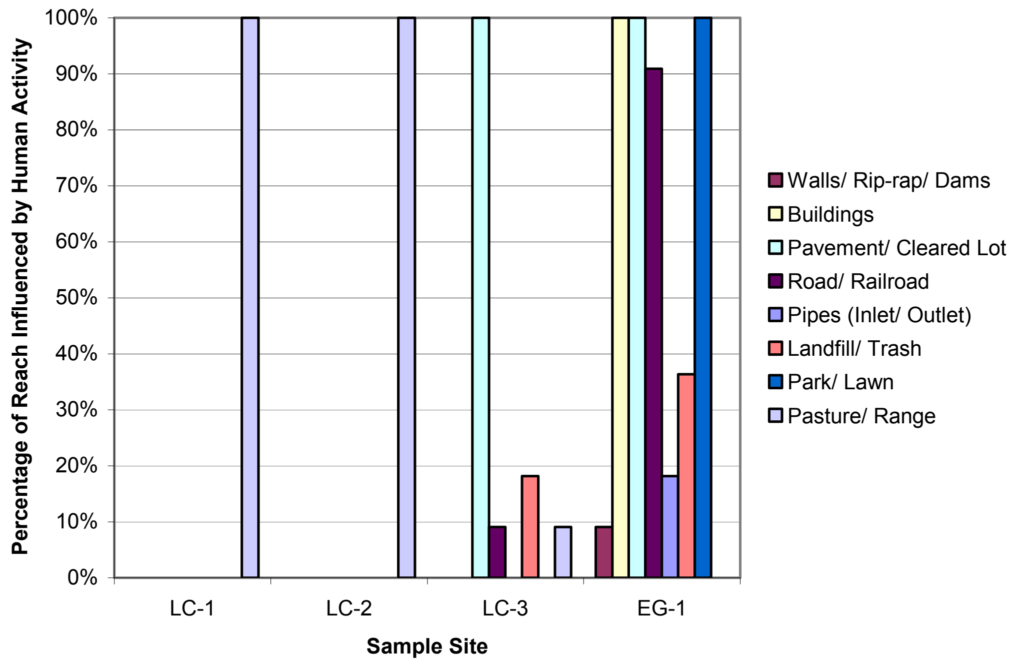


Substrate Size Class Abundance by Reach **Exhibit 8**

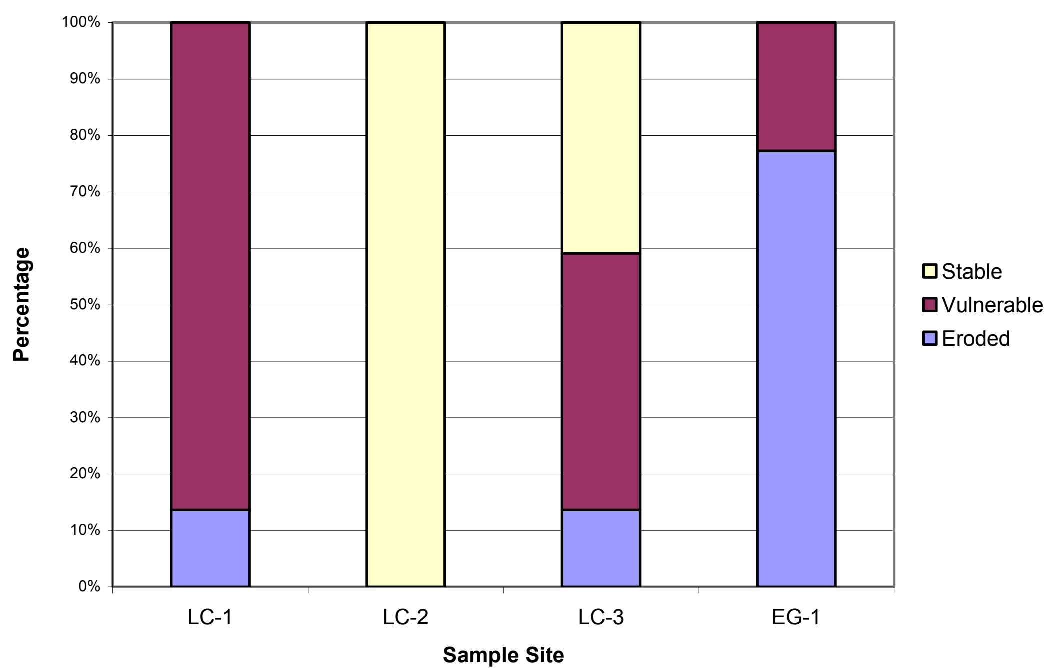


Note: Cobble in LC-3 was documented to be artificial construction material; no cobble was documented in EG-1.

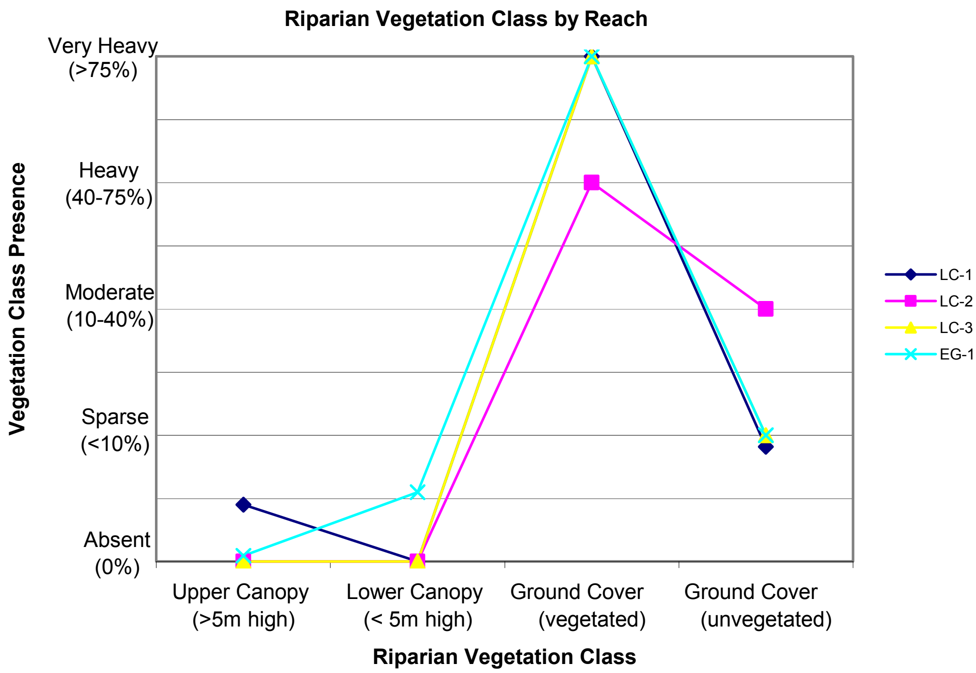
Cobble Embeddedness by Reach **Exhibit 9**



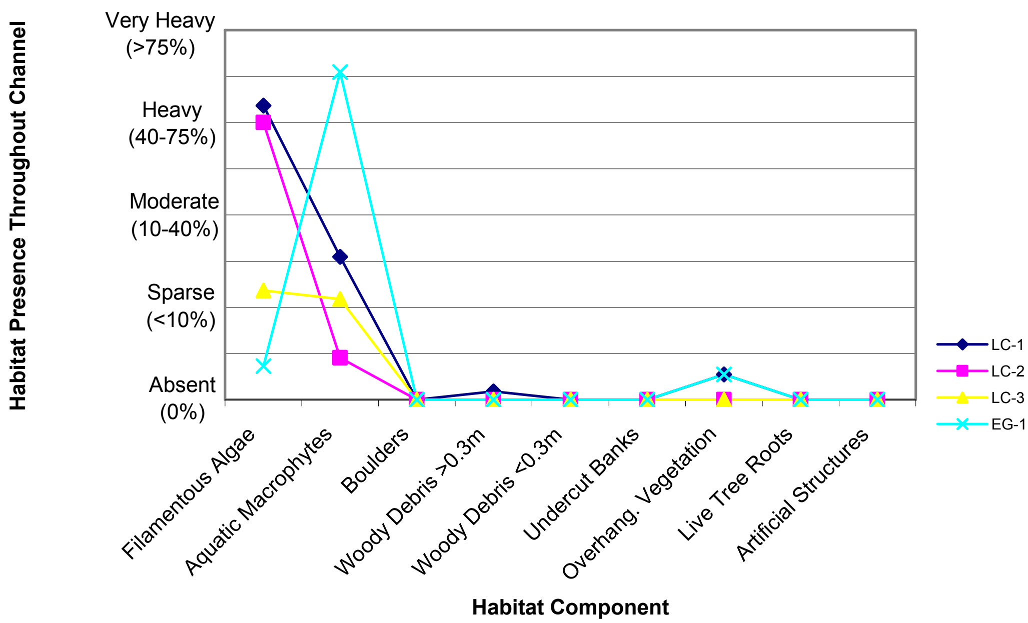
Human Influence by Reach **Exhibit 10**



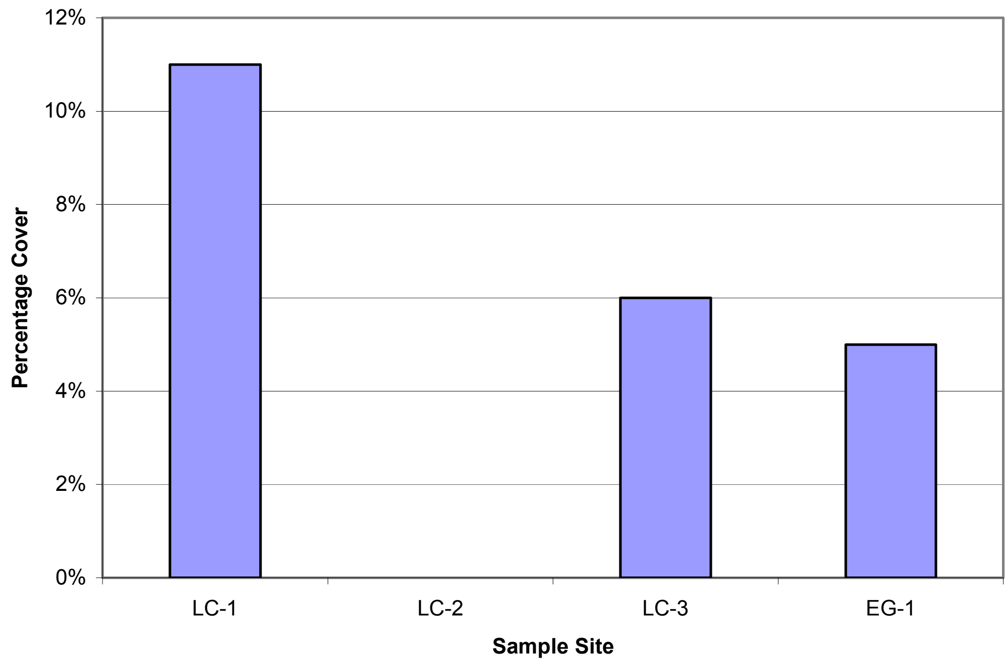
Bank Stability by Reach **Exhibit 11**



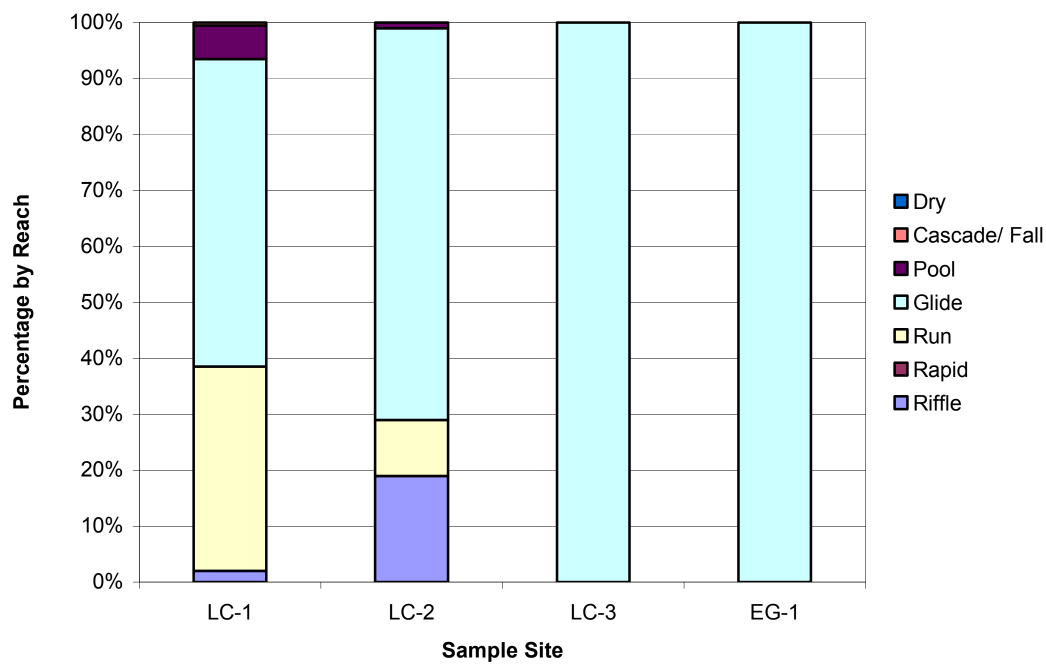
Riparian Vegetation Class by Reach **Exhibit 12**



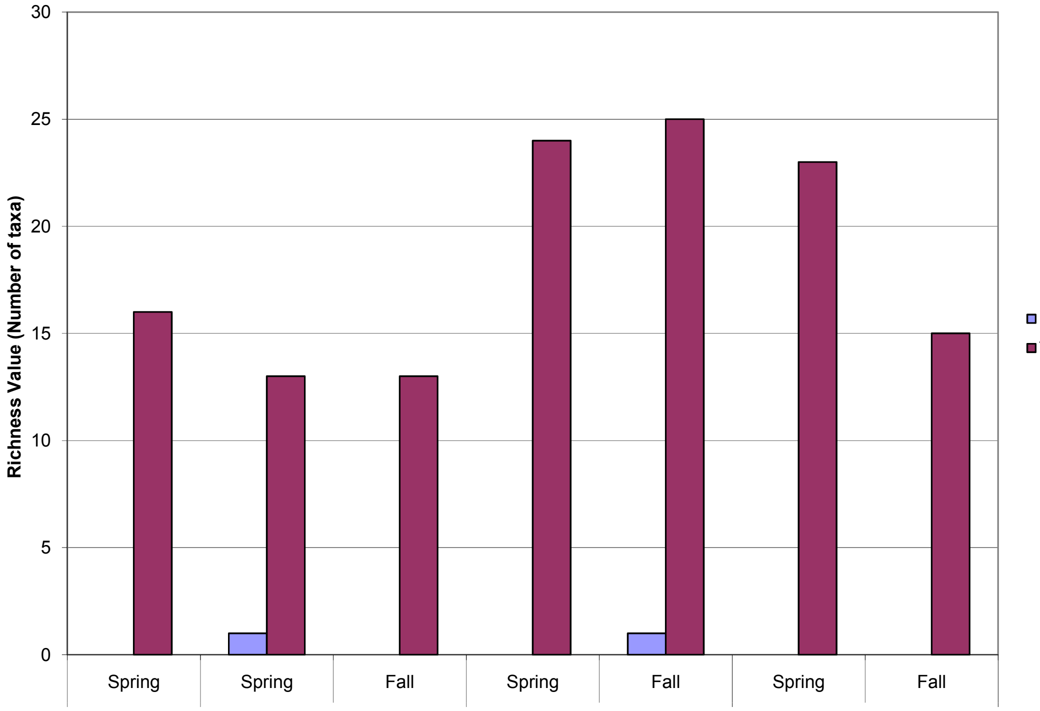
Instream Habitat Complexity by Reach **Exhibit 13**



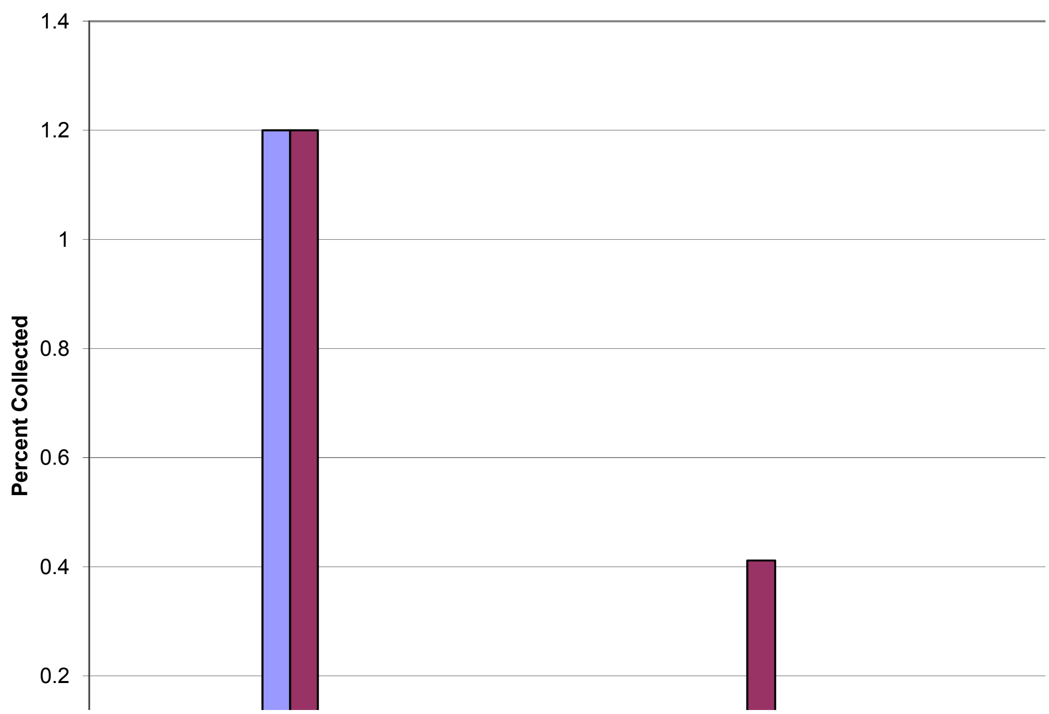
Riparian Canopy Cover by Reach **Exhibit 14**



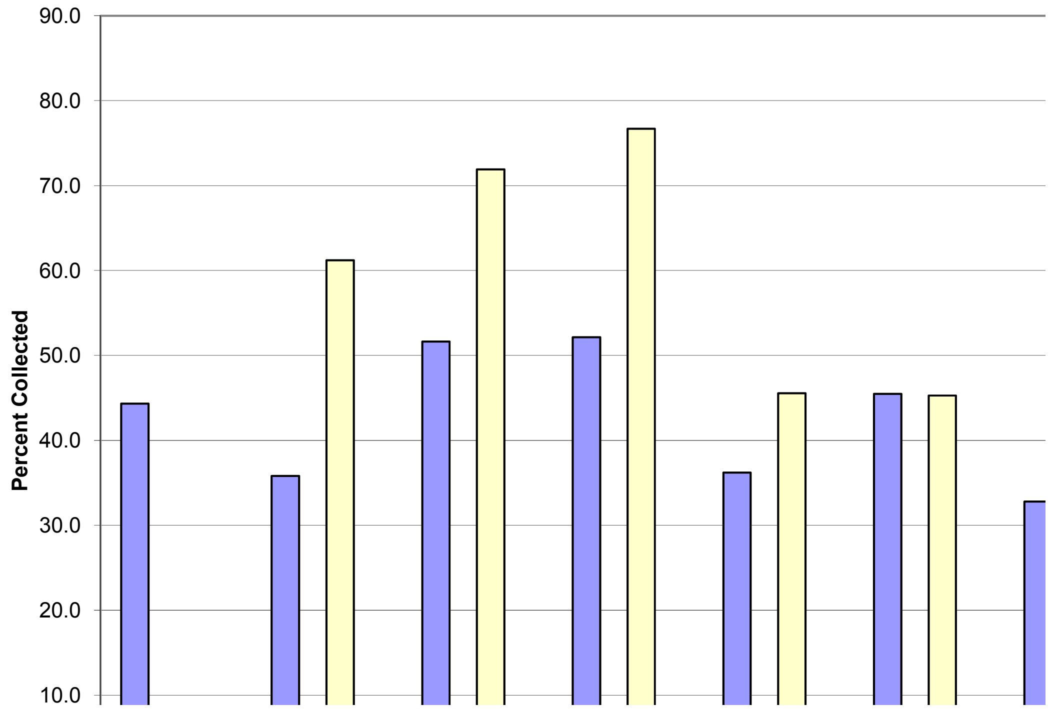
Flow Habitats by Reach **Exhibit 15**



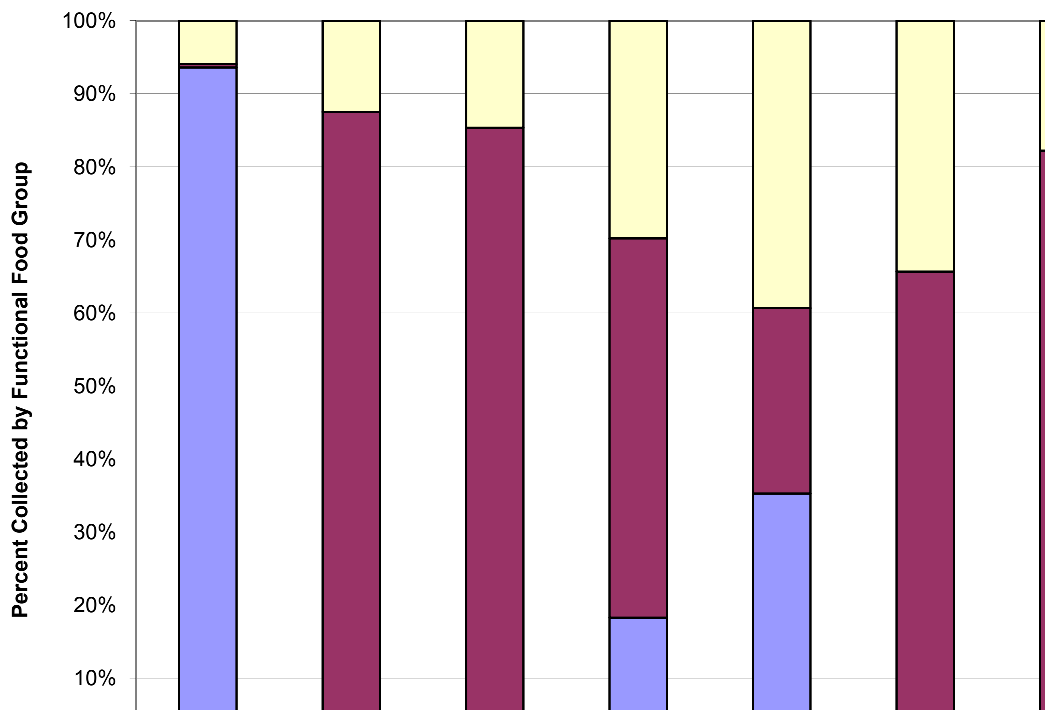
BMI Richness Measures by Reach **Exhibit 16**



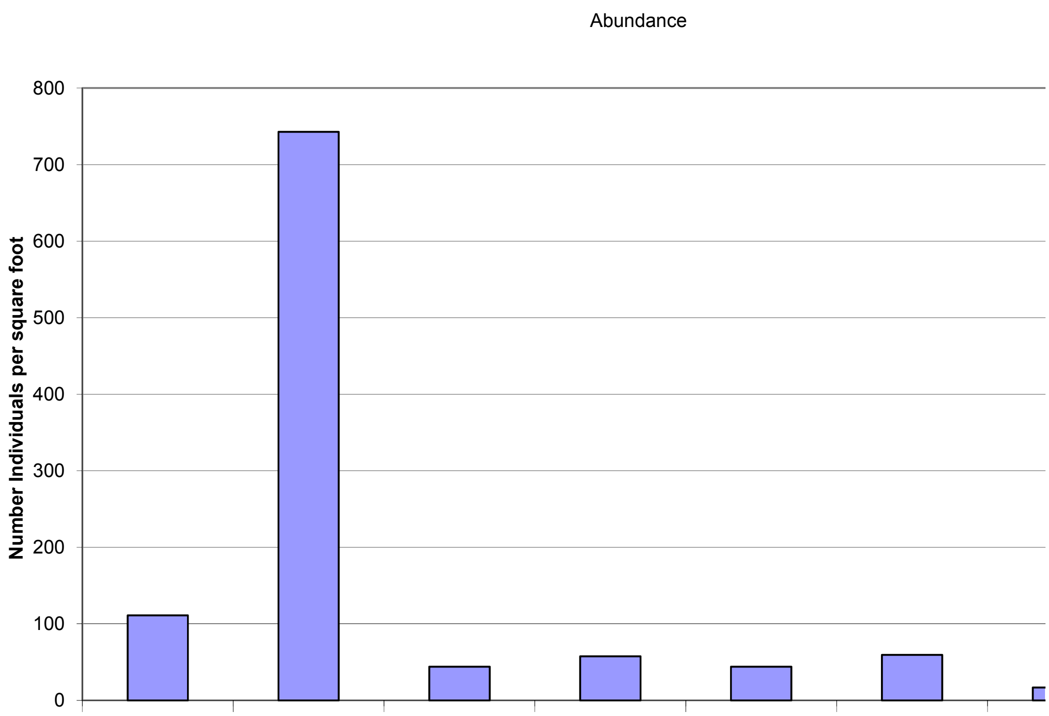
BMI Composition Measures by Reach **Exhibit 17**



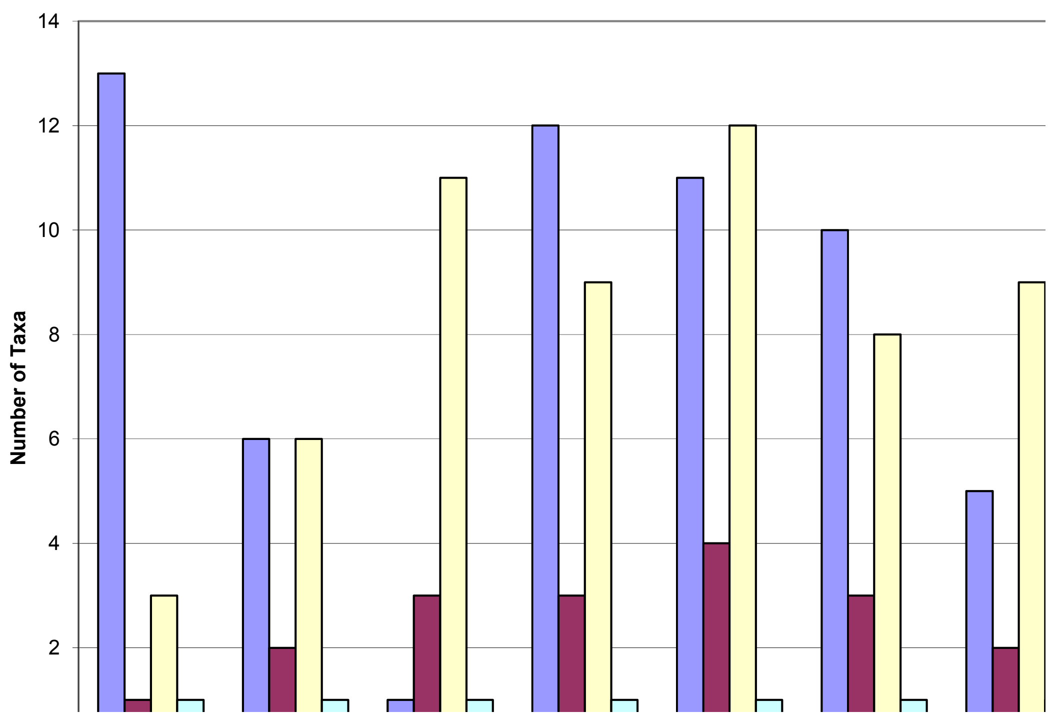
BMI Tolerance/Intolerance Measures by Reach **Exhibit 18**



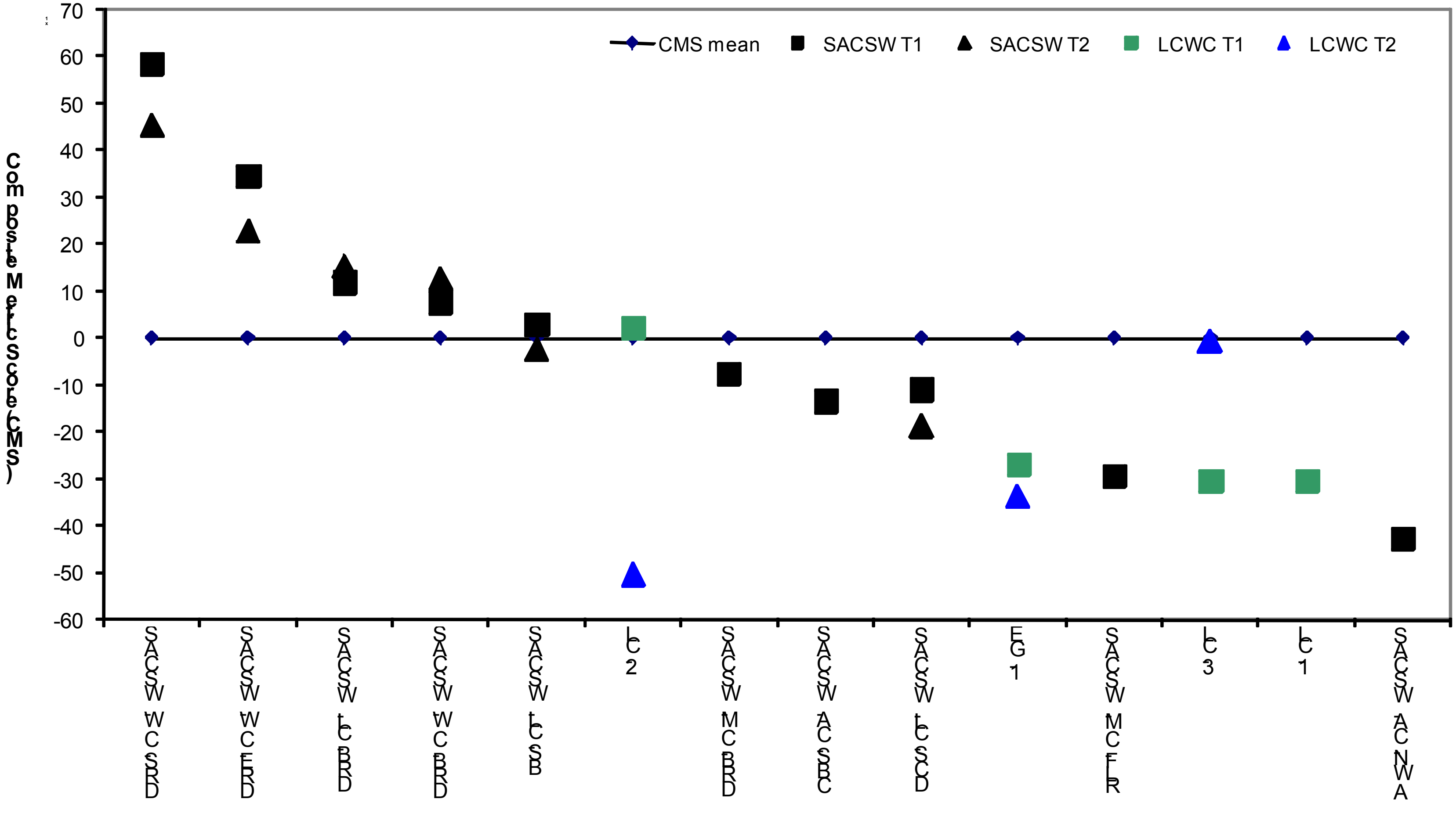
BMI Trophic Measures by Reach **Exhibit 19**



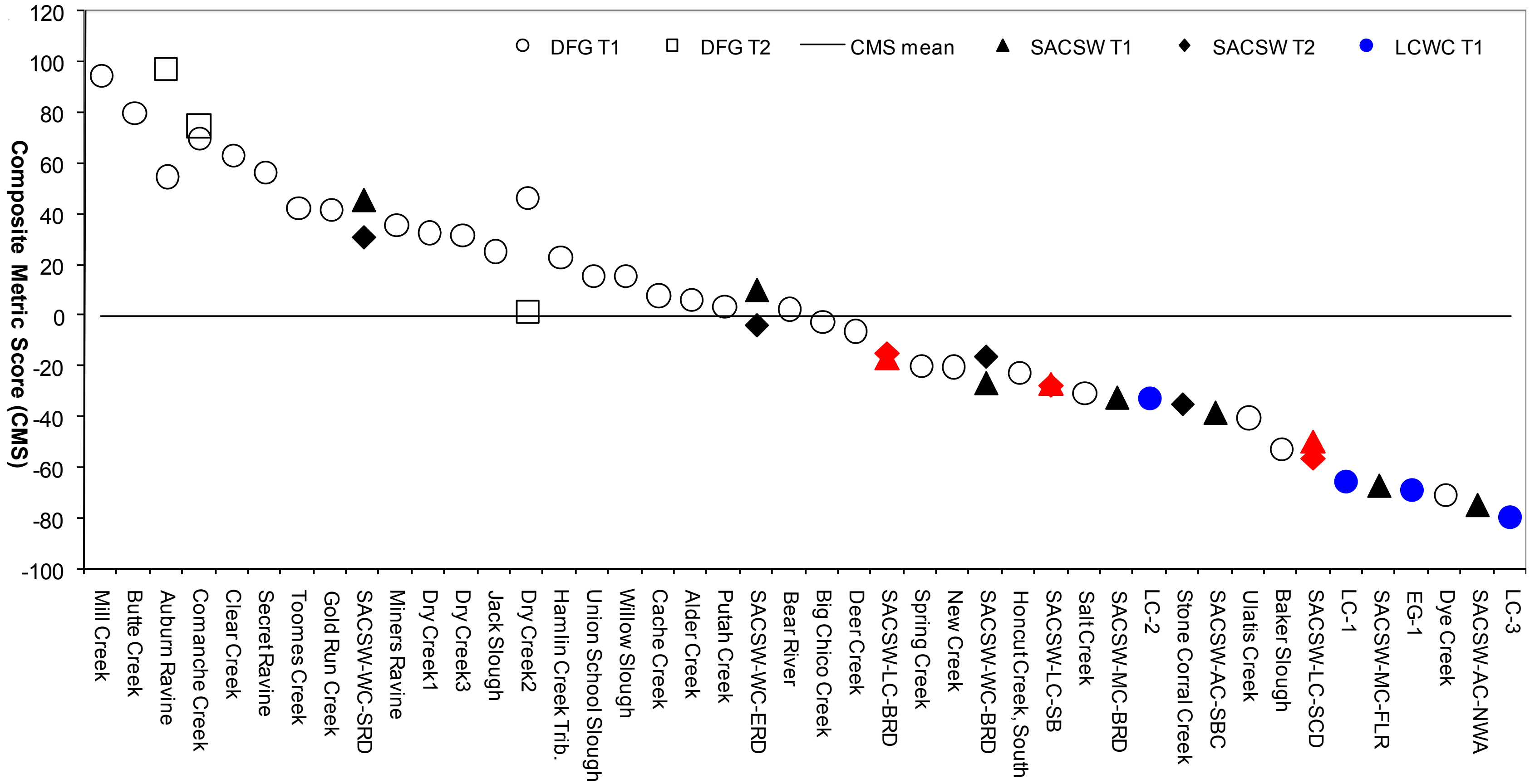
BMI Abundance by Reach **Exhibit 20**



Composition by Taxa **Exhibit 21**



Ranked CMS Plot for Sacramento County Stream BMI Bioassessment Sites **Exhibit 22**



Ranked CMS Plot for Sacramento Valley Stream BMI Bioassessment Sites **Exhibit 23**

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APPENDIX A

Bioassessment Forms

Aquatic Bioassessment Laboratory
Water Pollution Control Laboratory
California Department of Fish and Game

ABL Stream Habitat Characterization Form

FULL VERSION *Revision date: March 17, 2006*

REACH DOCUMENTATION Standard Reach Length = 150 m Distance between transects = 15 m		
Project Name:	Date:	Time:
Stream Name:	Site Name:	
Site Code:	Crew Members:	
Latitude: °N	datum: NAD27 NAD83	
Longitude: °W		

AMBIENT WATER QUALITY MEASUREMENTS							
Temperature (°C)		pH		Alkalinity (mg/L)		Turbidity (optional)	
Dissolved O_2 (mg/L)		Specific Cond. (µs)		Salinity (ppt)		Silica (optional)	

REACH LENGTH			
150 m		Other	
Actual Length (m)			
Explanation:			

PHOTOGRAPHS:	A (up): ☐	F (up): ☐	F (down): ☐	K (down): ☐
Additional Photographs (optional):				

DISCHARGE MEASUREMENTS (first measurement = left bank**)** **check if measurement not possible** ☐

VELOCITY AREA METHOD (preferred)				Transect Width:			
	Distance from Bank (cm)	Depth (cm)	Velocity (m/sec)		Distance from Bank (cm)	Depth (cm)	Velocity (m/sec)
1				11			
2				12			
3				13			
4				14			
5				15			
6				16			
7				17			
8				18			
9				19			
10				20			

BOUYANT OBJECT METHOD			
	Float 1	Float 2	Float 3
Distance			
Float Time			

Float Reach Cross Section			
width (m) depth (cm)	Upper Section	Middle Section	Lower Section
Width			
Depth 1			
Depth 2			
Depth 3			
Depth 4			
Depth 5			

NOTABLE FIELD CONDITIONS (check one box per topic)						
Evidence of recent rainfall (enough to increase surface runoff)	NO		minimal		>10% flow increase	
Evidence of fires in reach or immediately upstream (<500 m)	NO		< 1 year		< 5 years	
Dominant landuse/ landcover in area surrounding reach	Agriculture		Forest		Rangeland	
	Urban/ Indus		Suburb/Town		Other	

Site Code:	Date: __ __ / __ __ / 2005	FULL FORM

SLOPE and BEARING FORM (transect based- for Full PHAB only)

	Main Segment			Supplemental Segment 1			Supplemental Segment 2		
Transect	Slope (degrees)	Bearing (0º-359º)	Proportion (%)	Slope (degrees)	Bearing (0º-359º)	Proportion (%)	Slope (degrees)	Bearing (0º-359º)	Proportion (%)
K-J									
J-I									
I-H									
H-G									
G-F									
F-E									
E-D									
D-C									
C-B									
B-A									

SLOPE MEASUREMENTS (use the fewest segments necessary, record as percent slope not degrees slope) BASIC ONLY

Segment Number	Segment Length	Percent Slope	Segment Number	Segment Length	Percent Slope	Segment Number	Segment Length	Percent Slope	Segment Number	Segment Length	Percent Slope
1			4			7			10		
2			5			8			11		
3			6			9			12		

Segment

ADDITIONAL HABITAT CHARACTERIZATION

Parameter	Optimal	Suboptimal	Marginal	Poor
Epifaunal Substrate/ Cover	Greater than 70% of substrate favorable for epifaunal colonization	40-70% mix of stable habitat; well-suited for colonization	20-40% mix of stable habitat; substrate frequently disturbed	Less than 20% stable habitat; lack of habitat is obvious
Score:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected	Moderate deposition of new gravel, sand or fine sediment on bars; 30-50% of the bottom affected	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently
Score:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, (e.g. bridge abutments; recent channelization not present.	Channelization or shoring structures present on both banks; 40 to 80% of stream reach disrupted	Over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed
Score:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Site Code:	Date: __ __ / __ __ / 2006	Take PHOTOGRAPH Upstream
Wetted Width (m):	Bankfull Width (m):	Bankfull Height:

Transect: A

TRANSECT SUBSTRATES				Cobble Embed (%)
Position	mm or Size Class	Depth (cm)	CPOM	
L Bank			P A	
LeftCtr			P A	
Center			P A	
RightCtr			P A	
R Bank			P A	

HUMAN INFLUENCE	0 = Not Present CH - Within Channel B = On Bank C = Within 10m of Channel P = >10m and <50m of Channel		
	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	0 B C P	CH	0 B C P
Buildings	0 B C P	CH	0 B C P
Pavement/ Cleared Lot	0 B C P		0 B C P
Road/ Railroad	0 B C P	CH	0 B C P
Pipes (Inlet/ Outlet)	0 B C P	CH	0 B C P
Landfill/ Trash	0 B C P	CH	0 B C P
Park/ Lawn	0 B C P		0 B C P
Row Crops	0 B C P		0 B C P
Pasture/ Range	0 B C P		0 B C P
Logging Operations	0 B C P		0 B C P
Mining Activity	0 B C P	CH	0 B C P

BANK STABILITY 5m up and 5m downstream of transect and from bankfull to wetted width

Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

RIPARIAN VEGETATION (downstream)

0 = Absent (0%) 3 = Heavy (40-75%)
1 = Sparse (<10%) 4 = Very Heavy>75%)
2 = Moderate (10-40%) **circle one**

Riparian estimates are made 5m above and 5m below the transect and 10m to the side starting at the bank.

Vegetation Class	Left Bank	Right Bank
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m to 5m high)		
Shrubs and saplings 0.5m to 5m high	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Shrubs and saplings, herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY	0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)
Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3m	0 1 2 3 4
Woody Debris <0.3m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17) *count covered dots*	
Left Bank	
Center Upstream	
Center Downstream	
Right Bank	

Inter-transect: A-B Wetted Width (m):

FLOW HABITATS (% between transects, T=100%)

Channel Type	%
Riffle	
Rapid	
Run	
Glide	
Pool	
Cascade/ Fall	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)

Position (%)	mm or Size Class	Depth (cm)	CPOM
L Bank			P A
LeftCtr			P A
Center			P A
RightCtr			P A
R Bank			P A

Note: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of the size classes listed to right

SUBSTRATE SIZE CLASS CODES

RS = bedrock smooth (>car)
RR = bedrock rough (> car)
RC = concrete/asphalt
XB = large boulder (1-4m)
SB = sm blder (.25 m to 1m)
CB = cobble (64-250mm)
GC = coarse gravel (16-64)
GF = fine gravel (2-16 mm)
SA = sand (0.25-2mm)
FN = fines (<0.25mm)
HP = hardpan (consol. fines)
WD = wood
OT = other

CPOM/ COBBLE EMBEDDEDNESS

CPOM: Record presence (P)/ absence (A) of coarse particulate organic matter (>1.0 mm) within 1 cm of each particle.

Cobble Embeddedness: visually estimate % embedded by fine particles (record to nearest 5%)

Site Code:	Date: __ __ / __ __ / 2006	
Wetted Width (m):	Bankfull Width (m):	Bankfull Height:

Transect: B

TRANSECT SUBSTRATES				Cobble Embed (%)
Position	mm or Size Class	Depth (cm)	CPOM	
L Bank			P A	
LeftCtr			P A	
Center			P A	
RightCtr			P A	
R Bank			P A	

BANK STABILITY 5m up and 5m downstream of transect and from bankfull to wetted width

Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE

0 = Not Present CH - Within Channel B = On Bank
C = Within 10m of Channel P = >10m and <50m of Channel

	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	0 B C P	CH	0 B C P
Buildings	0 B C P	CH	0 B C P
Pavement/ Cleared Lot	0 B C P		0 B C P
Road/ Railroad	0 B C P	CH	0 B C P
Pipes (Inlet/ Outlet)	0 B C P	CH	0 B C P
Landfill/ Trash	0 B C P	CH	0 B C P
Park/ Lawn	0 B C P		0 B C P
Row Crops	0 B C P		0 B C P
Pasture/ Range	0 B C P		0 B C P
Logging Operations	0 B C P		0 B C P
Mining Activity	0 B C P	CH	0 B C P

RIPARIAN VEGETATION (downstream)

0 = Absent (0%) 3 = Heavy (40-75%)
1 = Sparse (<10%) 4 = Very Heavy>75%)
2 = Moderate (10-40%) **circle one**

Riparian estimates are made 5m above and 5m below the transect and 10m to the side starting at the bank.

Vegetation Class	Left Bank	Right Bank
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m to 5m high)		
Shrubs and saplings 0.5m to 5m high	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Shrubs and saplings, herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY

0 = Absent (0%)
1 = Sparse (<10%)
2 = Moderate (10-40%)
3 = Heavy (40-75%)
4 = Very Heavy (>75%)

Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3m	0 1 2 3 4
Woody Debris <0.3m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17)
count covered dots

Left Bank	
Center Upstream	
Center Downstream	
Right Bank	

Inter-transect: B-C Wetted Width (m):

FLOW HABITATS (% between transects, T=100%)

Channel Type	%
Riffle	
Rapid	
Run	
Glide	
Pool	
Cascade/ Fall	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)

Position (%)	mm or Size Class	Depth (cm)	CPOM
L Bank			P A
LeftCtr			P A
Center			P A
RightCtr			P A
R Bank			P A

Note: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of the size classes listed to right

SUBSTRATE SIZE CLASS CODES

RS = bedrock smooth (>car)
RR = bedrock rough (> car)
RC = concrete/asphalt
XB = large boulder (1-4m)
SB = sm blder (.25 m to 1m)
CB = cobble (64-250mm)
GC = coarse gravel (16-64)
GF = fine gravel (2-16 mm)
SA = sand (0.25-2mm)
FN = fines (<0.25mm)
HP = hardpan (consol. fines)
WD = wood
OT = other

CPOM/ COBBLE EMBEDDEDNESS

CPOM: Record presence (P)/ absence (A) of coarse particulate organic matter (>1.0 mm) within 1 cm of each particle.

Cobble Embeddedness: visually estimate % embedded by fine particles (record to nearest 5%)

Site Code:	Date: __ __ / __ __ / 2006	
Wetted Width (m):	Bankfull Width (m):	Bankfull Height:

Transect: C

TRANSECT SUBSTRATES				Cobble Embed (%)
Position	mm or Size Class	Depth (cm)	CPOM	
L Bank			P A	
LeftCtr			P A	
Center			P A	
RightCtr			P A	
R Bank			P A	

BANK STABILITY 5m up and 5m downstream of transect and from bankfull to wetted width			
Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE	0 = Not Present CH - Within Channel B = On Bank C = Within 10m of Channel P = >10m and <50m of Channel								
	Left Bank				Channel	Right Bank			
Walls/ Rip-rap/ Dams	0	B	C	P	CH	0	B	C	P
Buildings	0	B	C	P	CH	0	B	C	P
Pavement/ Cleared Lot	0	B	C	P		0	B	C	P
Road/ Railroad	0	B	C	P	CH	0	B	C	P
Pipes (Inlet/ Outlet)	0	B	C	P	CH	0	B	C	P
Landfill/ Trash	0	B	C	P	CH	0	B	C	P
Park/ Lawn	0	B	C	P		0	B	C	P
Row Crops	0	B	C	P		0	B	C	P
Pasture/ Range	0	B	C	P		0	B	C	P
Logging Operations	0	B	C	P		0	B	C	P
Mining Activity	0	B	C	P	CH	0	B	C	P

RIPARIAN VEGETATION (downstream)	0 = Absent (0%) 3 = Heavy (40-75%) 1 = Sparse (<10%) 4 = Very Heavy>75%) 2 = Moderate (10-40%) **circle one**									
Riparian estimates are made 5m above and 5m below the transect and 10m to the side starting at the bank.										
Vegetation Class	Left Bank					Right Bank				
Upper Canopy (>5 m high)										
Trees and saplings >5 m high	0	1	2	3	4	0	1	2	3	4
Lower Canopy (0.5 m to 5m high)										
Shrubs and saplings 0.5m to 5m high	0	1	2	3	4	0	1	2	3	4
Ground Cover (<0.5 m high)										
Shrubs and saplings, herbs/ grasses	0	1	2	3	4	0	1	2	3	4
Barren, bare soil/ duff	0	1	2	3	4	0	1	2	3	4

INSTREAM HABITAT COMPLEXITY	0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)				
Filamentous Algae	0	1	2	3	4
Aquatic Macrophytes	0	1	2	3	4
Boulders	0	1	2	3	4
Woody Debris >0.3m	0	1	2	3	4
Woody Debris <0.3m	0	1	2	3	4
Undercut Banks	0	1	2	3	4
Overhang. Vegetation	0	1	2	3	4
Live Tree Roots	0	1	2	3	4
Artificial Structures	0	1	2	3	4

DENSIOMETER READINGS (0-17) *count covered dots*	
Left Bank	
Center Upstream	
Center Downstream	
Right Bank	

Inter-transect: C-D Wetted Width (m):

FLOW HABITATS (% between transects, T=100%)	
Channel Type	%
Riffle	
Rapid	
Run	
Glide	
Pool	
Cascade/ Fall	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)			
Position (%)	mm or Size Class	Depth (cm)	CPOM
L Bank			P A
LeftCtr			P A
Center			P A
RightCtr			P A
R Bank			P A

Note: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of the size classes listed to right

SUBSTRATE SIZE CLASS CODES

RS = bedrock smooth (>car)
RR = bedrock rough (> car)
RC = concrete/asphalt
XB = large boulder (1-4m)
SB = sm blder (.25 m to 1m)
CB = cobble (64-250mm)
GC = coarse gravel (16-64)
GF = fine gravel (2-16 mm)
SA = sand (0.25-2mm)
FN = fines (<0.25mm)
HP = hardpan (consol. fines)
WD = wood
OT = other

CPOM/ COBBLE EMBEDDEDNESS

CPOM: Record presence (P)/ absence (A) of coarse particulate organic matter (>1.0 mm) within 1 cm of each particle.

Cobble Embeddedness: visually estimate % embedded by fine particles (record to nearest 5%)

Site Code:	Date: __ __ / __ __ / 2006	
Wetted Width (m):	Bankfull Width (m):	Bankfull Height:

Transect: D

TRANSECT SUBSTRATES				Cobble Embed (%)
Position	mm or Size Class	Depth (cm)	CPOM	
L Bank			P A	
LeftCtr			P A	
Center			P A	
RightCtr			P A	
R Bank			P A	

BANK STABILITY 5m up and 5m downstream of transect and from bankfull to wetted width			
Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE	0 = Not Present CH - Within Channel B = On Bank C = Within 10m of Channel P = >10m and <50m of Channel								
	Left Bank				Channel	Right Bank			
Walls/ Rip-rap/ Dams	0	B	C	P	CH	0	B	C	P
Buildings	0	B	C	P	CH	0	B	C	P
Pavement/ Cleared Lot	0	B	C	P		0	B	C	P
Road/ Railroad	0	B	C	P	CH	0	B	C	P
Pipes (Inlet/ Outlet)	0	B	C	P	CH	0	B	C	P
Landfill/ Trash	0	B	C	P	CH	0	B	C	P
Park/ Lawn	0	B	C	P		0	B	C	P
Row Crops	0	B	C	P		0	B	C	P
Pasture/ Range	0	B	C	P		0	B	C	P
Logging Operations	0	B	C	P		0	B	C	P
Mining Activity	0	B	C	P	CH	0	B	C	P

RIPARIAN VEGETATION (downstream)	0 = Absent (0%) 3 = Heavy (40-75%) 1 = Sparse (<10%) 4 = Very Heavy>75%) 2 = Moderate (10-40%) **circle one**									
Riparian estimates are made 5m above and 5m below the transect and 10m to the side starting at the bank.										
Vegetation Class	Left Bank					Right Bank				
Upper Canopy (>5 m high)										
Trees and saplings >5 m high	0	1	2	3	4	0	1	2	3	4
Lower Canopy (0.5 m to 5m high)										
Shrubs and saplings 0.5m to 5m high	0	1	2	3	4	0	1	2	3	4
Ground Cover (<0.5 m high)										
Shrubs and saplings, herbs/ grasses	0	1	2	3	4	0	1	2	3	4
Barren, bare soil/ duff	0	1	2	3	4	0	1	2	3	4

INSTREAM HABITAT COMPLEXITY	0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)				
Filamentous Algae	0	1	2	3	4
Aquatic Macrophytes	0	1	2	3	4
Boulders	0	1	2	3	4
Woody Debris >0.3m	0	1	2	3	4
Woody Debris <0.3m	0	1	2	3	4
Undercut Banks	0	1	2	3	4
Overhang. Vegetation	0	1	2	3	4
Live Tree Roots	0	1	2	3	4
Artificial Structures	0	1	2	3	4

DENSIOMETER READINGS (0-17) *count covered dots*	
Left Bank	
Center Upstream	
Center Downstream	
Right Bank	

Inter-transect: D-E

Wetted Width (m):

FLOW HABITATS (% between transects, T=100%)	
Channel Type	%
Riffle	
Rapid	
Run	
Glide	
Pool	
Cascade/ Fall	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)			
Position (%)	mm or Size Class	Depth (cm)	CPOM
L Bank			P A
LeftCtr			P A
Center			P A
RightCtr			P A
R Bank			P A

Note: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of the size classes listed to right

SUBSTRATE SIZE CLASS CODES

RS = bedrock smooth (>car)
RR = bedrock rough (> car)
RC = concrete/asphalt
XB = large boulder (1-4m)
SB = sm blder (.25 m to 1m)
CB = cobble (64-250mm)
GC = coarse gravel (16-64)
GF = fine gravel (2-16 mm)
SA = sand (0.25-2mm)
FN = fines (<0.25mm)
HP = hardpan (consol. fines)
WD = wood
OT = other

CPOM/ COBBLE EMBEDDEDNESS

CPOM: Record presence (P)/ absence (A) of coarse particulate organic matter (>1.0 mm) within 1 cm of each particle.

Cobble Embeddedness: visually estimate % embedded by fine particles (record to nearest 5%)

Site Code:	Date: __ __ / __ __ / 2006	
Wetted Width (m):	Bankfull Width (m):	Bankfull Height:	**Transect: E**

TRANSECT SUBSTRATES				Cobble Embed (%)
Position	mm or Size Class	Depth (cm)	CPOM	
L Bank			P A	
LeftCtr			P A	
Center			P A	
RightCtr			P A	
R Bank			P A	

BANK STABILITY 5m up and 5m downstream of transect and from bankfull to wetted width			
Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE	0 = Not Present CH - Within Channel B = On Bank C = Within 10m of Channel P = >10m and <50m of Channel		
	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	0 B C P	CH	0 B C P
Buildings	0 B C P	CH	0 B C P
Pavement/ Cleared Lot	0 B C P		0 B C P
Road/ Railroad	0 B C P	CH	0 B C P
Pipes (Inlet/ Outlet)	0 B C P	CH	0 B C P
Landfill/ Trash	0 B C P	CH	0 B C P
Park/ Lawn	0 B C P		0 B C P
Row Crops	0 B C P		0 B C P
Pasture/ Range	0 B C P		0 B C P
Logging Operations	0 B C P		0 B C P
Mining Activity	0 B C P	CH	0 B C P

RIPARIAN VEGETATION (downstream)	0 = Absent (0%) 3 = Heavy (40-75%) 1 = Sparse (<10%) 4 = Very Heavy>75%) 2 = Moderate (10-40%) **circle one**	
Riparian estimates are made 5m above and 5m below the transect and 10m to the side starting at the bank.		
Vegetation Class	Left Bank	Right Bank
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m to 5m high)		
Shrubs and saplings 0.5m to 5m high	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Shrubs and saplings, herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY	0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)
Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3m	0 1 2 3 4
Woody Debris <0.3m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17) *count covered dots*	
Left Bank	
Center Upstream	
Center Downstream	
Right Bank	

Inter-transect: E-F Wetted Width (m):

FLOW HABITATS (% between transects, T=100%)	
Channel Type	%
Riffle	
Rapid	
Run	
Glide	
Pool	
Cascade/ Fall	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)			
Position (%)	mm or Size Class	Depth (cm)	CPOM
L Bank			P A
LeftCtr			P A
Center			P A
RightCtr			P A
R Bank			P A

Note: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of the size classes listed to right

SUBSTRATE SIZE CLASS CODES

RS = bedrock smooth (>car)
RR = bedrock rough (> car)
RC = concrete/asphalt
XB = large boulder (1-4m)
SB = sm blder (.25 m to 1m)
CB = cobble (64-250mm)
GC = coarse gravel (16-64)
GF = fine gravel (2-16 mm)
SA = sand (0.25-2mm)
FN = fines (<0.25mm)
HP = hardpan (consol. fines)
WD = wood
OT = other

CPOM/ COBBLE EMBEDDEDNESS

CPOM: Record presence (P)/ absence (A) of coarse particulate organic matter (>1.0 mm) within 1 cm of each particle.

Cobble Embeddedness: visually estimate % embedded by fine particles (record to nearest 5%)

Site Code:	Date: __ __ / __ __ / 2006	Photos UPSTREAM and DOWNSTREAM
Wetted Width (m):	Bankfull Width (m):	Bankfull Height:

Transect: F

TRANSECT SUBSTRATES				Cobble Embed (%)
Position	mm or Size Class	Depth (cm)	CPOM	
L Bank			P A	
LeftCtr			P A	
Center			P A	
RightCtr			P A	
R Bank			P A	

BANK STABILITY 5m up and 5m downstream of transect and from bankfull to wetted width			
Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE	0 = Not Present CH - Within Channel B = On Bank C = Within 10m of Channel P = >10m and <50m of Channel		
	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	0 B C P	CH	0 B C P
Buildings	0 B C P	CH	0 B C P
Pavement/ Cleared Lot	0 B C P		0 B C P
Road/ Railroad	0 B C P	CH	0 B C P
Pipes (Inlet/ Outlet)	0 B C P	CH	0 B C P
Landfill/ Trash	0 B C P	CH	0 B C P
Park/ Lawn	0 B C P		0 B C P
Row Crops	0 B C P		0 B C P
Pasture/ Range	0 B C P		0 B C P
Logging Operations	0 B C P		0 B C P
Mining Activity	0 B C P	CH	0 B C P

RIPARIAN VEGETATION (downstream)	0 = Absent (0%) 3 = Heavy (40-75%) 1 = Sparse (<10%) 4 = Very Heavy>75%) 2 = Moderate (10-40%) **circle one**	
Riparian estimates are made 5m above and 5m below the transect and 10m to the side starting at the bank.		
Vegetation Class	**Left Bank**	**Right Bank**
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m to 5m high)		
Shrubs and saplings 0.5m to 5m high	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Shrubs and saplings, herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY	0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)
Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3m	0 1 2 3 4
Woody Debris <0.3m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17) *count covered dots*	
Left Bank	
Center Upstream	
Center Downstream	
Right Bank	

Inter-transect: F-G Wetted Width (m):

FLOW HABITATS (% between transects, T=100%)	
Channel Type	**%**
Riffle	
Rapid	
Run	
Glide	
Pool	
Cascade/ Fall	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)			
Position (%)	**mm or Size Class**	**Depth (cm)**	**CPOM**
L Bank			P A
LeftCtr			P A
Center			P A
RightCtr			P A
R Bank			P A

Note: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of the size classes listed to right

SUBSTRATE SIZE CLASS CODES

RS = bedrock smooth (>car)
RR = bedrock rough (> car)
RC = concrete/asphalt
XB = large boulder (1-4m)
SB = sm blder (.25 m to 1m)
CB = cobble (64-250mm)
GC = coarse gravel (16-64)
GF = fine gravel (2-16 mm)
SA = sand (0.25-2mm)
FN = fines (<0.25mm)
HP = hardpan (consol. fines)
WD = wood
OT = other

CPOM/ COBBLE EMBEDDEDNESS

CPOM: Record presence (P)/ absence (A) of coarse particulate organic matter (>1.0 mm) within 1 cm of each particle.

Cobble Embeddedness: visually estimate % embedded by fine particles (record to nearest 5%)

Site Code:	Date: __ __ / __ __ / 2006	
Wetted Width (m):	Bankfull Width (m):	Bankfull Height:

Transect: G

TRANSECT SUBSTRATES				Cobble Embed (%)
Position	mm or Size Class	Depth (cm)	CPOM	
L Bank			P A	
LeftCtr			P A	
Center			P A	
RightCtr			P A	
R Bank			P A	

BANK STABILITY 5m up and 5m downstream of transect and from bankfull to wetted width			
Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE	0 = Not Present CH - Within Channel B = On Bank C = Within 10m of Channel P = >10m and <50m of Channel								
	Left Bank				Channel	Right Bank			
Walls/ Rip-rap/ Dams	0	B	C	P	CH	0	B	C	P
Buildings	0	B	C	P	CH	0	B	C	P
Pavement/ Cleared Lot	0	B	C	P		0	B	C	P
Road/ Railroad	0	B	C	P	CH	0	B	C	P
Pipes (Inlet/ Outlet)	0	B	C	P	CH	0	B	C	P
Landfill/ Trash	0	B	C	P	CH	0	B	C	P
Park/ Lawn	0	B	C	P		0	B	C	P
Row Crops	0	B	C	P		0	B	C	P
Pasture/ Range	0	B	C	P		0	B	C	P
Logging Operations	0	B	C	P		0	B	C	P
Mining Activity	0	B	C	P	CH	0	B	C	P

RIPARIAN VEGETATION (downstream)

0 = Absent (0%) 3 = Heavy (40-75%)
1 = Sparse (<10%) 4 = Very Heavy>75%)
2 = Moderate (10-40%) **circle one**

Riparian estimates are made 5m above and 5m below the transect and 10m to the side starting at the bank.

Vegetation Class	Left Bank	Right Bank
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m to 5m high)		
Shrubs and saplings 0.5m to 5m high	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Shrubs and saplings, herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY	0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)
Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3m	0 1 2 3 4
Woody Debris <0.3m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17) *count covered dots*	
Left Bank	
Center Upstream	
Center Downstream	
Right Bank	

Inter-transect: G-H Wetted Width (m):

FLOW HABITATS (% between transects, T=100%)

Channel Type	%
Riffle	
Rapid	
Run	
Glide	
Pool	
Cascade/ Fall	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)

Position (%)	mm or Size Class	Depth (cm)	CPOM
L Bank			P A
LeftCtr			P A
Center			P A
RightCtr			P A
R Bank			P A

Note: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of the size classes listed to right

SUBSTRATE SIZE CLASS CODES

RS = bedrock smooth (>car)
RR = bedrock rough (> car)
RC = concrete/asphalt
XB = large boulder (1-4m)
SB = sm blder (.25 m to 1m)
CB = cobble (64-250mm)
GC = coarse gravel (16-64)
GF = fine gravel (2-16 mm)
SA = sand (0.25-2mm)
FN = fines (<0.25mm)
HP = hardpan (consol. fines)
WD = wood
OT = other

CPOM/ COBBLE EMBEDDEDNESS

CPOM: Record presence (P)/ absence (A) of coarse particulate organic matter (>1.0 mm) within 1 cm of each particle.

Cobble Embeddedness: visually estimate % embedded by fine particles (record to nearest 5%)

Site Code:	Date: __ __ / __ __ / 2006	
Wetted Width (m):	Bankfull Width (m):	Bankfull Height:

Transect: H

TRANSECT SUBSTRATES				Cobble Embed (%)
Position	mm or Size Class	Depth (cm)	CPOM	
L Bank			P A	
LeftCtr			P A	
Center			P A	
RightCtr			P A	
R Bank			P A	

BANK STABILITY 5m up and 5m downstream of transect and from bankfull to wetted width

Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE

0 = Not Present CH - Within Channel B = On Bank
C = Within 10m of Channel P = >10m and <50m of Channel

	Left Bank				Channel	Right Bank			
Walls/ Rip-rap/ Dams	0	B	C	P	CH	0	B	C	P
Buildings	0	B	C	P	CH	0	B	C	P
Pavement/ Cleared Lot	0	B	C	P		0	B	C	P
Road/ Railroad	0	B	C	P	CH	0	B	C	P
Pipes (Inlet/ Outlet)	0	B	C	P	CH	0	B	C	P
Landfill/ Trash	0	B	C	P	CH	0	B	C	P
Park/ Lawn	0	B	C	P		0	B	C	P
Row Crops	0	B	C	P		0	B	C	P
Pasture/ Range	0	B	C	P		0	B	C	P
Logging Operations	0	B	C	P		0	B	C	P
Mining Activity	0	B	C	P	CH	0	B	C	P

RIPARIAN VEGETATION (downstream)

0 = Absent (0%) 3 = Heavy (40-75%)
1 = Sparse (<10%) 4 = Very Heavy>75%)
2 = Moderate (10-40%) **circle one**

Riparian estimates are made 5m above and 5m below the transect and 10m to the side starting at the bank.

Vegetation Class	Left Bank					Right Bank				
Upper Canopy (>5 m high)										
Trees and saplings >5 m high	0	1	2	3	4	0	1	2	3	4
Lower Canopy (0.5 m to 5m high)										
Shrubs and saplings 0.5m to 5m high	0	1	2	3	4	0	1	2	3	4
Ground Cover (<0.5 m high)										
Shrubs and saplings, herbs/ grasses	0	1	2	3	4	0	1	2	3	4
Barren, bare soil/ duff	0	1	2	3	4	0	1	2	3	4

INSTREAM HABITAT COMPLEXITY

0 = Absent (0%)
1 = Sparse (<10%)
2 = Moderate (10-40%)
3 = Heavy (40-75%)
4 = Very Heavy (>75%)

Filamentous Algae	0	1	2	3	4
Aquatic Macrophytes	0	1	2	3	4
Boulders	0	1	2	3	4
Woody Debris >0.3m	0	1	2	3	4
Woody Debris <0.3m	0	1	2	3	4
Undercut Banks	0	1	2	3	4
Overhang. Vegetation	0	1	2	3	4
Live Tree Roots	0	1	2	3	4
Artificial Structures	0	1	2	3	4

DENSIOMETER READINGS (0-17)
count covered dots

Left Bank	
Center Upstream	
Center Downstream	
Right Bank	

Inter-transect: H-I

Wetted Width (m):

FLOW HABITATS (% between transects, T=100%)

Channel Type	%
Riffle	
Rapid	
Run	
Glide	
Pool	
Cascade/ Fall	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)

Position (%)	mm or Size Class	Depth (cm)	CPOM
L Bank			P A
LeftCtr			P A
Center			P A
RightCtr			P A
R Bank			P A

Note: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of the size classes listed to right

SUBSTRATE SIZE CLASS CODES

RS = bedrock smooth (>car)
RR = bedrock rough (> car)
RC = concrete/asphalt
XB = large boulder (1-4m)
SB = sm blder (.25 m to 1m)
CB = cobble (64-250mm)
GC = coarse gravel (16-64)
GF = fine gravel (2-16 mm)
SA = sand (0.25-2mm)
FN = fines (<0.25mm)
HP = hardpan (consol. fines)
WD = wood
OT = other

CPOM/ COBBLE EMBEDDEDNESS

CPOM: Record presence (P)/ absence (A) of coarse particulate organic matter (>1.0 mm) within 1 cm of each particle.

Cobble Embeddedness: visually estimate % embedded by fine particles (record to nearest 5%)

Site Code:	Date: __ __ / __ __ / 2006	
Wetted Width (m):	Bankfull Width (m):	Bankfull Height: **Transect: I**

TRANSECT SUBSTRATES				Cobble Embed (%)
Position	mm or Size Class	Depth (cm)	CPOM	
L Bank			P A	
LeftCtr			P A	
Center			P A	
RightCtr			P A	
R Bank			P A	

BANK STABILITY 5m up and 5m downstream of transect and from bankfull to wetted width			
Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE	0 = Not Present CH - Within Channel B = On Bank C = Within 10m of Channel P = >10m and <50m of Channel		
	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	0 B C P	CH	0 B C P
Buildings	0 B C P	CH	0 B C P
Pavement/ Cleared Lot	0 B C P		0 B C P
Road/ Railroad	0 B C P	CH	0 B C P
Pipes (Inlet/ Outlet)	0 B C P	CH	0 B C P
Landfill/ Trash	0 B C P	CH	0 B C P
Park/ Lawn	0 B C P		0 B C P
Row Crops	0 B C P		0 B C P
Pasture/ Range	0 B C P		0 B C P
Logging Operations	0 B C P		0 B C P
Mining Activity	0 B C P	CH	0 B C P

RIPARIAN VEGETATION (downstream)	0 = Absent (0%) 3 = Heavy (40-75%) 1 = Sparse (<10%) 4 = Very Heavy>75%) 2 = Moderate (10-40%) **circle one**	
Riparian estimates are made 5m above and 5m below the transect and 10m to the side starting at the bank.		
Vegetation Class	Left Bank	Right Bank
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m to 5m high)		
Shrubs and saplings 0.5m to 5m high	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Shrubs and saplings, herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY	0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)
Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3m	0 1 2 3 4
Woody Debris <0.3m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17) *count covered dots*	
Left Bank	
Center Upstream	
Center Downstream	
Right Bank	

Inter-transect: I-J Wetted Width (m):

FLOW HABITATS (% between transects, T=100%)	
Channel Type	%
Riffle	
Rapid	
Run	
Glide	
Pool	
Cascade/ Fall	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)			
Position (%)	mm or Size Class	Depth (cm)	CPOM
L Bank			P A
LeftCtr			P A
Center			P A
RightCtr			P A
R Bank			P A

Note: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of the size classes listed to right

SUBSTRATE SIZE CLASS CODES

RS = bedrock smooth (>car)
RR = bedrock rough (> car)
RC = concrete/asphalt
XB = large boulder (1-4m)
SB = sm blder (.25 m to 1m)
CB = cobble (64-250mm)
GC = coarse gravel (16-64)
GF = fine gravel (2-16 mm)
SA = sand (0.25-2mm)
FN = fines (<0.25mm)
HP = hardpan (consol. fines)
WD = wood
OT = other

CPOM/ COBBLE EMBEDDEDNESS

CPOM: Record presence (P)/ absence (A) of coarse particulate organic matter (>1.0 mm) within 1 cm of each particle.

Cobble Embeddedness: visually estimate % embedded by fine particles (record to nearest 5%)

Site Code:	Date: __ __ / __ __ / 2006	
Wetted Width (m):	Bankfull Width (m):	Bankfull Height:

Transect: J

TRANSECT SUBSTRATES				Cobble Embed (%)
Position	mm or Size Class	Depth (cm)	CPOM	
L Bank			P A	
LeftCtr			P A	
Center			P A	
RightCtr			P A	
R Bank			P A	

BANK STABILITY 5m up and 5m downstream of transect and from bankfull to wetted width

Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE

0 = Not Present CH - Within Channel B = On Bank
C = Within 10m of Channel P = >10m and <50m of Channel

	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	0 B C P	CH	0 B C P
Buildings	0 B C P	CH	0 B C P
Pavement/ Cleared Lot	0 B C P		0 B C P
Road/ Railroad	0 B C P	CH	0 B C P
Pipes (Inlet/ Outlet)	0 B C P	CH	0 B C P
Landfill/ Trash	0 B C P	CH	0 B C P
Park/ Lawn	0 B C P		0 B C P
Row Crops	0 B C P		0 B C P
Pasture/ Range	0 B C P		0 B C P
Logging Operations	0 B C P		0 B C P
Mining Activity	0 B C P	CH	0 B C P

RIPARIAN VEGETATION (downstream)

0 = Absent (0%) 3 = Heavy (40-75%)
1 = Sparse (<10%) 4 = Very Heavy>75%)
2 = Moderate (10-40%) **circle one**

Riparian estimates are made 5m above and 5m below the transect and 10m to the side starting at the bank.

Vegetation Class	Left Bank	Right Bank
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m to 5m high)		
Shrubs and saplings 0.5m to 5m high	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Shrubs and saplings, herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY

0 = Absent (0%)
1 = Sparse (<10%)
2 = Moderate (10-40%)
3 = Heavy (40-75%)
4 = Very Heavy (>75%)

Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3m	0 1 2 3 4
Woody Debris <0.3m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17)
count covered dots

Left Bank	
Center Upstream	
Center Downstream	
Right Bank	

Inter-transect: J-K

Wetted Width (m):

FLOW HABITATS (% between transects, T=100%)

Channel Type	%
Riffle	
Rapid	
Run	
Glide	
Pool	
Cascade/ Fall	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)

Position (%)	mm or Size Class	Depth (cm)	CPOM
L Bank			P A
LeftCtr			P A
Center			P A
RightCtr			P A
R Bank			P A

Note: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of the size classes listed to right

SUBSTRATE SIZE CLASS CODES

RS = bedrock smooth (>car)
RR = bedrock rough (> car)
RC = concrete/asphalt
XB = large boulder (1-4m)
SB = sm blder (.25 m to 1m)
CB = cobble (64-250mm)
GC = coarse gravel (16-64)
GF = fine gravel (2-16 mm)
SA = sand (0.25-2mm)
FN = fines (<0.25mm)
HP = hardpan (consol. fines)
WD = wood
OT = other

CPOM/ COBBLE EMBEDDEDNESS

CPOM: Record presence (P)/ absence (A) of coarse particulate organic matter (>1.0 mm) within 1 cm of each particle.

Cobble Embeddedness: visually estimate % embedded by fine particles (record to nearest 5%)

Site Code:	Date: __ __ / __ __ / 2006	Take Photograph DOWNSTREAM
Wetted Width (m):	Bankfull Width (m):	Bankfull Height:
		Transect: K

TRANSECT SUBSTRATES				Cobble Embed (%)
Position	mm or Size Class	Depth (cm)	CPOM	
L Bank			P A	
LeftCtr			P A	
Center			P A	
RightCtr			P A	
R Bank			P A	

BANK STABILITY 5m up and 5m downstream of transect and from bankfull to wetted width			
Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE	0 = Not Present CH - Within Channel B = On Bank C = Within 10m of Channel P = >10m and <50m of Channel								
	Left Bank				Channel	Right Bank			
Walls/ Rip-rap/ Dams	0	B	C	P	CH	0	B	C	P
Buildings	0	B	C	P	CH	0	B	C	P
Pavement/ Cleared Lot	0	B	C	P		0	B	C	P
Road/ Railroad	0	B	C	P	CH	0	B	C	P
Pipes (Inlet/ Outlet)	0	B	C	P	CH	0	B	C	P
Landfill/ Trash	0	B	C	P	CH	0	B	C	P
Park/ Lawn	0	B	C	P		0	B	C	P
Row Crops	0	B	C	P		0	B	C	P
Pasture/ Range	0	B	C	P		0	B	C	P
Logging Operations	0	B	C	P		0	B	C	P
Mining Activity	0	B	C	P	CH	0	B	C	P

RIPARIAN VEGETATION (downstream)	0 = Absent (0%) 3 = Heavy (40-75%) 1 = Sparse (<10%) 4 = Very Heavy>75%) 2 = Moderate (10-40%) **circle one**									
Riparian estimates are made 5m above and 5m below the transect and 10m to the side starting at the bank.										
Vegetation Class	Left Bank					Right Bank				
Upper Canopy (>5 m high)										
Trees and saplings >5 m high	0	1	2	3	4	0	1	2	3	4
Lower Canopy (0.5 m to 5m high)										
Shrubs and saplings 0.5m to 5m high	0	1	2	3	4	0	1	2	3	4
Ground Cover (<0.5 m high)										
Shrubs and saplings, herbs/ grasses	0	1	2	3	4	0	1	2	3	4
Barren, bare soil/ duff	0	1	2	3	4	0	1	2	3	4

INSTREAM HABITAT COMPLEXITY	0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)				
Filamentous Algae	0	1	2	3	4
Aquatic Macrophytes	0	1	2	3	4
Boulders	0	1	2	3	4
Woody Debris >0.3m	0	1	2	3	4
Woody Debris <0.3m	0	1	2	3	4
Undercut Banks	0	1	2	3	4
Overhang. Vegetation	0	1	2	3	4
Live Tree Roots	0	1	2	3	4
Artificial Structures	0	1	2	3	4

DENSIOMETER READINGS (0-17) *count covered dots*	
Left Bank	
Center Upstream	
Center Downstream	
Right Bank	

Additional Comments/ Field Notes:

Site Code:	Date: __ __ / __ __ / **2006**	FULL FORM

Site Map:

Field Notes/ Comments:

APPENDIX B

Rapid Vegetation Assessment Field Forms

CALIFORNIA NATIVE PLANT SOCIETY - VEGETATION RAPID ASSESSMENT FIELD FORM

(Revised Nov 21, 2005)

For Office Use:	**Final database #:**	**Final vegetation type name:**	**Alliance**_______________________________ **Association**_______________________________

I. LOCATIONAL/ENVIRONMENTAL DESCRIPTION

Polygon/Stand #:	**Air photo #:**	**Date:**	**Name(s) of surveyors:**
_______________	_______________	______________	____

GPS waypoint #: __________ **GPS name:** ______________ **GPS datum: (e.g. NAD 83)** ________ **Is GPS within stand?** __**Yes / No**__

If No, cite from GPS point to stand, the distance _______(in meters) and bearing _______(in degrees) GPS Error: ±______ **ft / m**

UTM field reading: UTME ___ ___ ___ ___ ___ ___ **UTMN** ___ ___ ___ ___ ___ ___ ___ **UTM zone:** ______________

Elevation: __________ **ft / m Photograph #'s**: ____

Topography: convex____ flat____ concave____ undulating____ | top____ upper____ mid____ lower____ bottom____

Geology: _______ Soil Texture: _______ Rock: %Large____ %Small ____ %Bare/Fine: ____ %Litter: ____ %BA Stems: ____

Slope exposure (circle one and/or enter actual °): **NE_______ NW_______ SE_______ SW_______ Flat__ Variable__**

Slope steepness (circle one and enter actual °): **0°__ 1-5° _____ 5-25°_____ > 25°_____ Upland** or **Wetland/Riparian** (circle one)

Site history, stand age, and comments: ____

____

____

Type/ Level of disturbance (*use codes*): _____/____ _____/____ _____/____ _____/____ _____/____ _____/____ _____/____ _____/____

II. VEGETATION DESCRIPTION

Field-assessed vegetation alliance name: ____

Field-assessed association name (optional): ____

Size of stand: <1 acre___ 1-5 acres___ >5 acres___ Plot: __**Yes / No**__ **If Yes, denote size: 100m² __ 400 m²__ 1000 m²__ Other ____**

Adj alliances:________________________________ ________ / ________________________________ _________

Tree DBH (enter counts or denote **)**:	**T1 (<1" dbh)**	**T2 (1-6" dbh)**	**T3 (6-11" dbh)**	**T4 (11-24" dbh)**	**T5 (24-48" dbh)**	**T6 (>48" dbh)**

If Tree, list 1-3 dominant overstory spp.: ____

Shrub (mark one or enter %)**: S1** (seedling <3 yr old) ___ **S2** (young <1% dead) ___ **S3** (mature 1-25% dead) ___ **S4** (decadent >25% dead) ___

Herb (mark one or enter %'s)**: H1** (<4" height) ___ **H2** (4 -<8" ht) ___ **H3** (8 -<12" ht) ___ **H4** (≥12" ht.) ___ **% Total Veg Cover:** _____

% Cover- Overstory Tree Conifer/Hardwood: _____/_____ **Low Tree-Tall Shrub:** _____ **Lo-Mid Shrub:** _____ **Herbaceous:** _____

Height Class - Overstory Conifer/Hardwood: _____/_____ **Low Tree-Tall Shrub:** _____ **Lo-Mid Shrub:** _____ **Herbaceous:** _____

Height classes: 01=<1/2m 02=1/2-1m 03=1-2m 04=2-5m 05=5-10m 06=10-15m 07=15-20m 08=20-35m 09=35-50m 10=>50m

Species (List up to 20 major species), Stratum, and Approximate % cover: (Jepson Manual nomenclature please)

Stratum categories: T=tall, M=medium, L=low; *% cover intervals for reference*: <1%, 1-5%, >5-15%, >15-25%, >25-50%, >50-75%, >75%

Strata	Species	% cover		Strata	Species	% cover

Unusual species: ____

III. PROBLEMS WITH INTERPRETATION

Confidence in alliance identification: (L, M, H) ______ **Explain** ____

Other identification problems (describe)**:** ____

Polygon is more than one type: (Yes, No) ________ (Note: type with greatest coverage in polygon should be entered in above section)

Other types: ______________________________ ______________________________ ______________________________

Has the vegetation changed since air photo taken? __**Yes / No**__ **If Yes, What has changed?** _______________________________

APPENDIX C

BMI Taxa List

Appendix C – Benthic Macroinvertebrate Taxa List for Laguna and Elk Grove Creeks

Benthic Macroinvertebrate Taxa List for Laguna and Elk Grove Creeks								**Laguna Creek**					**Elk Grove Creek**	
								LC-1	**LC-2**		**LC-3**		**EG-1**	
								4/27/2006	**6/8/2006**	**12/6/2006**	**6/15/2006**	**12/6/2006**	**6/15/2006**	**12/6/2006**
Phylum	**Subphylum**	**Class**	**Order**	**Family**	**Subfamily**	**Tribe**	**Taxon**							
Arthropoda														
	Hexapoda													
		Insecta												
			Coleoptera											
				Dytiscidae										
							Liodessus sp.	--	--	--	--	--	1	--
				Hydraenidae										
							Ochthebius sp.	--	--	--	--	--	1	--
			Diptera											
				Ceratopogonidae										
							Bezzia/ Palpomyia	--	2	--	5	--	--	--
							Culicoides sp.	1	--	--	--	--	--	--
							Dasyhelea sp.	--	--	1	--	--	--	9
				Ceratopogonidae				--	--	--	--	--	1	--
				Chironomidae										
					Chironominae									
						Chironomini								
							Apedilum sp.	--	--	--	--	--	1	--
							Chironomus sp.	--	--	--	6	--	4	5
							Cryptochironomus sp.	--	--	--	3	--	1	--
							Cryptotendipes sp.	--	--	--	2	51	2	--
							Dicrotendipes sp.	--	35	--	5	3	--	--
							Endotribelos sp.	--	--	--	--	8	--	--
							Parachironomus sp.	--	--	--	2	5	--	--
							Paracladopelma sp.	1	--	--	--	--	--	--

							Phaenopsectra sp.	7	--	--	--	3	--	--
							Polypedilum sp.	--	--	--	1	--	--	--
						Tanytarsini								
							Paratanytarsus sp.	16	--	--	17	42	10	--
							Rheotanytarsus sp.	7	--	--	--	--	--	--
							Tanytarsus sp.	46	2	--	2	1	--	1
					Orthocladiinae									
							Cricotopus sp.	--	41	--	52	16	24	1
							Eukiefferiella sp.	3	--	--	--	--	--	--
							Nanocladius sp.	1	2	--	--	--	--	--
							Cricotopus bicinctus group	27	--	--	--	--	--	--
						Corynoneurini								
							Corynoneura sp.	2	--	--	--	6	1	--
							Thienemanniella sp.	6	--	--	--	--	--	--
					Tanypodinae									
						Pentaneurini								
							Ablabesmyia sp.	1	--	--	--	--	--	--
						Procladiini								
							Procladius sp.	--	--	--	5	3	1	--
						Tanypodini								
							Tanypus sp.	--	--	--	2	--	85	--
				Ephydridae					--	--	--	--	--	6
				Psychodidae										
					Psychoda sp.				--	--	--	1	--	--
				Simuliidae										
							Simulium sp.	135	1	--	--	--	--	--
			Ephemeroptera											
				Baetidae										
							Claibaetis sp.		--	--	--	2	--	--
							Fallceon quilleri	--	6	--	--	--	--	--
			Hemiptera											

				Corixidae				--	--	--	--	--	1	--
				Corixidae				--	--	--	17	--	--	--
							Corisella sp.	--	--	--	2	--	--	--
							Trichocorixa sp.	--	--	--	2	--	--	--
			Odonata											
				Aeshnidae				--	--	--	--	--	1	--
				Coenagrionidae										
							Ischnura sp.	--	--	--	12	10	23	55
				Libellulidae										
							Erthemis sp.	--	--	1	--	--	--	--
	Crustacea													
		Malacostraca												
			Amphipoda											
				Hyalellidae										
							Hyalella sp.	--	88	252	255	176	23	61
			Decopoda											
				Cambaridae				--	--	--	--	2	--	--
		Ostracoda						11	179	77	35	2	15	4
	Chelicerata													
		Arachnida												
			Trombidiformes											
				Arrenuridae										
							Arrenurus sp.	--	--	--	1	--	--	--
				Unionicolidae				--	--	--	--	--	--	--
							Koenikea sp.	--	--	4	--	3	--	1
Annelida														
	Clitellata													
		Hirudinea												
			Arhynchobdellida											
				Erpobdellidae						3				
			Rhynchobdellida											
				Glossiphoniidae				--	--	3	--		2	3
							Helobdella stagnalis	--	--		3	8	--	1

		Oligochaeta						215	61	4	26	86	221	25
Mollusca														
		Gastropoda												
			Basommatophora											
				Ancylidae										
							Ferrissia sp.	--	--		2	25	--	
				Lymnaeidae										
							Fossaria sp.	--	--		--		6	
							Lymnaea sp.					4		
				Physidae										
							Physa sp.	6	--	1	14	7	59	5
				Planorbidae										
							Gyraulus sp.	--	4	10	15	9	--	
							Helisoma sp.		11					8
							Planorbella sp.	--	7		--		1	
Nemertea														
		Enopla												
				Hoplonemertea										
					Tertastemmatidae									
							Prostoma sp.	--	--	1	--	--	--	--
Platyhelminthes														
		Turbellaria						--	72	120	3	8	2	1
							Total Organisms Recovered	**485**	**500**	**488**	**489**	**486**	**486**	**186**
							Extra Organisms	**2**	**30**	**0**	**4**	**3**	**4**	**0**
							QC Organisms	**5**	**3**	**4**	**8**	**3**	**1**	**0**
							Total Picked (includes extras + QC)	**492**	**533**	**492**	**501**	**492**	**491**	**186**
							Grids Processed	**2**	**0.375**	**0.5**	**10**	**7.25**	**6.25**	**6**
							Total Grids Possible	**5**	**6**	**12**	**12**	**7.25**	**8**	**6**
							Abundance (#/ sample)	**1222**	**8169**	**11808**	**634**	**1086**	**654**	**186**