SACRAMENTO MUNICIPAL UTILITY DISTRICT
UPPER AMERICAN RIVER PROJECT
(FERC Project No. 2101)

and

PACIFIC GAS AND ELECTRIC COMPANY
CHILI BAR PROJECT
(FERC Project No. 2155)

AQUATIC BIOASSESSMENT
TECHNICAL REPORT

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3.1 Aquatic Bioassessment Study Plan

This study is designed to provide information regarding overall water quality and the biological integrity of the stream ecosystem using the California Stream Bioassessment Procedure, or CSBP, downstream of Sacramento Municipal Utility District's (SMUD) Upper American River Project (UARP) and Pacific Gas and Electric Company's Chili Bar Project. The overall approach is to collect information regarding benthic macroinvertebrate habitat and assemblages on all affected stream reaches and agreed-upon reference sites in 2002, 2003 and 2004, calculate CSBP indices, and assess the overall quality of the macroinvertebrate habitat and populations using the indices and data from the reference sites. Sampling may be eliminated or modified in 2003 and 2004 based on the results of the 2002 data or if the water year types are such that additional data collection would not provide additional valuable information.

3.1.1 Pertinent Issue Questions

The Aquatic Bioassessment Study Plan will be used, in part, to address the following Aquatics/Water Issue Question:

54. What is the health of existing macroinvertebrate communities in diverted reaches as an indicator of water quality?

This study, in concert with the Water Quality (direct measurements of water quality parameters), Water Temperature (direct measurements of water temperature), Channel Morphology (assessment of sediment in stream channels) and Project Sources of Sediment (assessment of project sources of sediment that may enter the river and reservoirs) will be used to assess the condition of water quality in the area of the projects.

3.1.2 Background

Since hydro projects affect stream flow, there is a potential influence on water quality. The CSBP (Harrington 1999), developed by the Department of Fish and Game (CDFG), is a preferred water quality monitoring tool used by the CDFG and the State Water Resources Control Board (SWRCB) to evaluate effects of pollutant discharge and to monitor the affects of various alterations to natural stream flow regimes. It is a rapid bioassessment procedure that utilizes measures of stream benthic macroinvertebrate community and physical/habitat characteristics to evaluate the biological integrity of stream ecosystems. This water quality assessment tool is used in concert with fishery, water chemistry, water temperature and other studies to evaluate the chemical, physical and biological health of a specified water body.

Historic information regarding benthic macroinvertebrates is available in the Project area from upstream of Robbs Peak Reservoir, upstream of Union Valley Reservoir, upstream of Ice House Reservoir, and the Ice House Dam Reach. This information is summarized in SMUD's Initial Information Package (SMUD 2001) and repeated below for reference.

- South Fork Rubicon River Upstream of Robbs Peak Reservoir - As part of the South Fork Rubicon Diversion application for a UARP license amendment (SMUD 1981), a benthic macroinvertebrate study was conducted on three reaches within the unregulated part of the South Fork Rubicon River upstream of Robbs Peak Reservoir. Presence of chironomids, Ephemeroptera, Plecoptera, and Trichoptera were documented. The study concluded that, overall, benthic macroinvertebrate abundance was generally lower in the reaches studied than in some comparable mountain streams (EA 1982a). More recently, the South Fork Rubicon River was sampled as part of a comprehensive study that investigated numerous streams within and around the Project area in fall 1999 (USDA 2001). The study produced basic information on overall abundance and taxonomic richness as well as indices of species diversity and evenness. In addition, biotic indices were calculated and an analysis of functional feeding groups was performed. No conclusions were drawn from the study. (SMUD 2001, Page E3-26 and 27.)
- South Fork Silver Creek in Ice House Dam Reach - As part of the Jones Fork Hydroelectric Development Final EIR (EA 1982b), a benthic macroinvertebrate study was conducted at two sites of SFSC between Ice House Reservoir and Junction Reservoir. The site closer to Ice House Reservoir differed strikingly from

the reach further downstream with respect to chironomids. Chironomidae larvae were very abundant in the upstream study area (177.33/ft^2). The sites were similar in abundance of most other taxa. However, the upper site had relatively higher numbers of Ephemeroptera, primarily *Baetis* spp., and oligochaete worms. The lower site was characterized by higher numbers of Trichoptera. (SMUD 2001, Page E3-27.)

- South Fork Silver Creek Upstream of Ice House Reservoir - South Fork Silver Creek and Big Hill Canyon Creek were sampled as part of a comprehensive study that investigated numerous streams within and around the Project area in Fall 1999 (USDA 2001). The study produced basic information on overall abundance and taxonomic richness as well as indices of species diversity and evenness. In addition, biotic indices were calculated and an analysis of functional feeding groups was performed. No conclusions were drawn from the study. (SMUD 2001, Page E3-28.)
- Jones Fork Silver Creek, Big Silver Creek, and Wench Creek Upstream of Union Valley Reservoir – These three streams were sampled as part of a comprehensive study that investigated numerous streams within and around the Project area in Fall 1999 (USDA 2001). The study produced basic information on overall abundance and taxonomic richness as well as indices of species diversity and evenness. In addition, biotic indices were calculated and an analysis of functional feeding groups was performed. No conclusions were drawn from the study. (SMUD 2001, Page E3-28.)

3.1.3 Study Objectives

The study objective is to use the CSBP as a bioassessment monitoring tool to evaluate the biological integrity of the stream reaches affected by the projects, and to provide insight into the general water quality in the area of the projects.

3.1.4 Study Area and Sampling Locations

The study area includes all Project affected stream reaches and reference sites described below. Project reservoirs are not included in the study area since the CSBP method is specifically developed for wadeable stream reaches, not reservoirs. Table 1 presents an estimate of locations and samples that would be collected. It is understood that an additional 3-5 sites may be established below the UARP facilities and an additional 2-3 sites may be established below the Chili Bar Project facilities based on the recommendation of the technical specialist and changes in geomorphology and tributary inputs, as needed. It is expected that the reference reaches will reflect different elevation bands (geographic regions: e.g., Rubicon River above Rubicon Reservoir for high elevations, South Fork Silver Creek above Ice House Reservoir for mid-elevation, and a lower elevation site to be recommended by a technical specialist and reviewed by the TWG). It is understood that 1 to 2 additional reference reaches (to bring total number to 6-10) may be added, and reference sites may include those in development for the EID Project. In general, in the longer reaches (more than 3 miles long) sampling locations will be at either end of the reach and one in the middle of the reach. In shorter reaches (less than 3 miles) sampling locations will be at either end of the reach. As described later in this study plan, one composite sample (3 subsamples) will be collected from one transect in the upper one-third of each of three randomly selected riffles located within each identified stream reach. Interested Aquatic TWG and Plenary Group Participants will be invited into the field to confirm the location of the sampling locations and transects before samples are collected. Site locations will be based on 1) availability and accessibility of riffle habitat, 2) safety considerations, and 3) a goal of optimizing spatial variability.

Table 1. Estimated number of CSBP samples and transects per reach for the relicensing of The Sacramento Municipal Utility District's Upper American River Project and Pacific Gas and Electric Company's Chili Bar Project.

Reach	Length (miles)	Locations/Reach	Transects/Location	Total No. of Composite Samples
Rubicon Dam	4.1	3	3	9
Fox Lake	---	1	3	3
Rockbound Dam	0.4	1	3	3
Buck Island Dam	2.8	2	3	6
Loon Lake Dam	8.9	3	3	9
Gerle Creek Dam	1.1	2	3	6
Robbs Peak Dam	5.6	2	3	6
Ice House Dam	11.5	4	3	12

Table 1. (Continued)				
Reach	**Length (miles)**	**Locations/Reach**	**Transects/Location**	**Total No. of Composite Samples**
Junction Dam	8.3	3	3	9
Camino Dam	6.0	3	3	9
S.F. American River [1]		0	0	0
Brush Creek Dam	2.1	2	3	6
Slab Creek Dam	8.0	3	3	9
Reach Downstream of Chili Bar Dam	20.0	5 [2]	3	15
Rubicon Reference Site [3]		1	3	3
S.F Silver Creek Reference Site		1	3	3
Low Elevation Reference Site		1	3	3
Additional Sites including reference reaches		6-10 [4]	3	18-30
Total (excluding additional sites)	---	---	---	111

1. Data from El Dorado Irrigation District's (EID) macroinvertebrate survey on the South Fork American may be used for this section of river and as reference data.
2. Two of the five sites will be located within 3 miles of Chili Bar Dam. The total number of samples at a given site may increase to accommodate sampling in the inundation zone.
3. Data from EID's macroinvertebrate survey within the high elevation project area (e.g., outflow from Alpine, Caples of Echo lakes) may be used a reference data.
4. Of these additional sites, it is understood that 4-7 may be applied to the reaches above Chili Bar and 2-3 to the Reach Downstream of Chili Bar.

3.1.5 Information Needed From Other Studies

Information needed from other studies includes: 1) Rosgen mapping from the Channel Morphology Study to assist in selecting sampling locations; 2) habitat mapping from the Instream Flow Study to identify riffle sampling sites; and 3) results from the Water Quality Study to corroborate the conclusions of the Aquatic Bioassessment Study regarding water quality. Data from the Aquatic Bioassessment Study may be useful in the Water Quality Study to determine overall compliance with portions of the Basin Plan.

3.1.6 Study Methods And Schedule

A CDFG scientific collecting permit will be obtained prior to collecting any macroinvertebrate specimens.

Sampling methods will conform with non-point source and spot sampling protocols of the CSBP for documenting and describing benthic macroinvertebrate assemblages and physical habitat, except where sampling sites contain scarce low gradient riffles, relatively large substrate or non-wadeable conditions within the thalweg. At those sites, a modification of the CSBP will be used. The modification will consist of delineating a high gradient riffle or high gradient riffle series into a low, middle, and upper section, and "spot sampling" each of the sections. Each site will be located using a GPS unit and the site elevation will be recorded, and water temperature, dissolved oxygen concentration, pH, and conductivity will be measured *in situ* in mid-channel. Also, each site will be characterized for macroinvertebrate habitat quality using the site-scale parameters for high gradient streams from the USEPA's Rapid Bioassessment Protocols (Barbour et al. 1999) shown in Table 2. Photographs will be taken at all selected transects. Flow data from the reach downstream of Chili Bar Dam will be recorded every 15 minutes utilizing the CDEC A49 gauge.

Specific sampling locations at each site will be randomized by identifying at least five areas (riffle habitat if low gradient riffles dominated the site) of potential sampling locations within each section of the site and then randomly selecting three of the five areas for sampling. Riffle length will be determined and a transect will be randomly established within the upper third of the riffle. Each transect will be characterized using the transect-scale parameters described in the CSBP for characterizing habitat at the specific sampling locations (Table 2).

Three macroinvertebrate subsamples, one near the bank, one at intermediate depth, and a third near the thalweg, will be collected along each transect. Subsamples will be collected by rubbing cobble and boulder substrates and disturbing finer substrates within a 2-square foot area upstream of a D-frame kicknet fitted with a 0.02-inch diameter (0.5 mm) mesh net. The three subsamples along the transect will be combined in a jar, preserved with 95 percent ethanol, and labeled to form a single composite sample for that transect.

Table 2. Habitat quality and transect scale parameters to be recorded during CSBP sampling for relicensing of the Sacramento Municipal Utility District's Upper American River Project.

Habitat Quality Site Scale		Transect Scale	
Parameter	**Units**	**Parameter**	**Units**
Epifaunal Substrate/Available Cover	Rank (0–20)	Average Wetted Width	Feet
Embeddedness	Rank (0–20)	Average Depth	Feet
Velocity/Depth Regime	Rank (0–20)	Average Velocity	Feet per Second
Sediment Deposition	Rank (0–20)	Average Canopy Cover	Percent over Transect
Channel Flow Status	Rank (0–20)	Substrate Complexity	Rank (0–20)
Channel Alteration	Rank (0–20)	Embeddedness	Rank (0–20)
Frequency of Riffles (or bends)	Rank (0–20)	Fines	Percent of Transect
Bank Stability	Rank (0–20)	Gravel	Percent of Transect
Vegetative Protection	Rank (0–20)	Cobble	Percent of Transect
Riparian Vegetative Zone Width	Rank (0–20)	Boulder	Percent of Transect
-	-	Bedrock	Percent
-	-	Substrate Consolidation	Loose, moderate, compact
-	-	Gradient	Percent

At a laboratory, each composite sample will be rinsed in a standard #35 sieve (0.5 mm) and transferred to a tray with multiple grids for subsampling. Subsamples will be transferred from randomly selected grids to petri dishes where the macroinvertebrates will be removed indiscriminately with the aid of a stereomicroscope and placed in vials containing 70 percent ethanol and 2 percent glycerol. The debris from the processed grids will be placed in a remnant jar and preserved in 70% ethanol for later quality control testing. Subsamples will be processed until 300 macroinvertebrates are obtained representing one composite sample. Subsampled benthic macroinvertebrates will be identified using standard macroinvertebrate identification keys and other appropriate references. A standard level of taxonomic effort will be used as specified in the draft California Aquatic Macroinvertebrate Laboratory Network short list of taxonomic effort. Exceptions may be made for some early instar taxonomic groups, such as capniids, leuctrids, and some dipterans, which may only be identified to family and for blackflies, which may only be identified as "*Simulium/Prosimulium.*"

For quality control, twenty percent of the processed composite samples will be randomly selected and submitted to CDFG for independent verification of the identification and number of benthic macroinvertebrates. Following CSBP protocol, the contents of the remnant jar will be examined for organisms that may have been overlooked during subsampling. Since the Licensee has no control over how long it takes CDFG to conduct its independent verification, the results from the study will be presented in a timely fashion and amended when CDFG's verification is complete, if needed.

In 2002, it is expected that the sampling sites and transect locations will be selected in July or August, depending on weather. Interested Aquatic TWG Participants will be invited to confirm/modify the sampling sites and transects in August. Sampling will occur in late September/early October, data analysis will occur in October and November, and the results of the study will be presented to the Aquatic TWG in December 2002. Sampling may be eliminated or modified in 2003 and/or 2004 if the 2002 data demonstrate that macroinvertebrate habitat and populations are not impaired as described above and/or if the water year types are such that additional data collection would not provide additional valuable information. This study plan will be amended to include the additional sampling.

3.1.7 Analysis

Habitat quality scores for each of the sites will be calculated as described in Barbour et al. (1999). The total number of macroinvertebrates and taxa per composite sample will be calculated. Each of the samples as well as the overall site will be given a relative ranking score based on a set of macroinvertebrate assemblage metric values using the ranking method developed by the CDFG Aquatic Bioassessment Laboratory (Table 3). Nine of these 10 metrics used for the ranking score were found to be reliable responders to disturbance by Karr and Chu (1999). The Shannon-Weaver Diversity index, although not identified by Karr and Chu, will be incorporated into the suite of metrics because it integrates richness and evenness (Shannon and Weaver 1963; Magurran 1988). The coefficient of variation value for each of the metrics will be calculated. The matrices will be provided in both a multi-metric and multivariate format.

Table 3. Biological metrics used to describe characteristics of benthic macroinvertebrate assemblages for relicensing of the Sacramento Municipal Utility District's Upper American River Project.

BMI Metric	Description	Response to Impairment
Richness Measures		
Taxonomic Richness	Total number of individual taxa	Decrease
Ephemeroptera Taxa	Number of mayfly taxa	Decrease
Plecoptera Taxa	Number of stonefly taxa	Decrease
Trichoptera Taxa	Number of caddisfly taxa	Decrease
Composition Measures		
Shannon Diversity Index	General measure of sample diversity that incorporates richness and evenness (Shannon and Weaver 1963)	Decrease
Tolerance/Intolerance Measures		
Tolerance Value	Tolerance values between 0–10 weighted for abundance of individuals designated as pollution tolerant (higher values) and intolerant (lower values).	Increase
Percent Intolerant Organisms	Percentage of organisms that are highly intolerant to water and/ or habitat quality impairment as indicated by tolerance values of 0, 1 or 2.	Decrease
Percent Tolerant Organisms	Percentage of organisms that are highly tolerant to water and/ or habitat quality impairment as indicated by tolerance values of 8, 9, or 10.	Increase
Percent Dominant Taxon	The highest percentage of organisms represented by one taxon.	Increase
Feeding Functional Group		
Percent Predators	Percent of macroinvertebrates that prey on living organisms	Decrease

Differences between sites will be examined using t-tests for differences in macroinvertebrate abundance, and cluster analysis (a multivariate procedure for detecting natural groupings in data) for differences in macroinvertebrate assemblages. If substantial differences are found, additional analysis (e.g., canonical correspondence analysis) or studies may occur to identify the reason for the differences as determined by the TWG.

3.1.8 Study Output

A status presentation on the study will be made to the Aquatics TWG and the Plenary Group in December 2002 and thereafter as appropriate. However, the ultimate study output will be a written report that includes the issues addressed, objectives, study area including sampling locations, methods, analysis, results, discussion and conclusions. The report will be prepared in a format so that it can easily be incorporated into the Licensee's draft environmental assessment that will be submitted to FERC with the Licensee's application for a new license. When the study is finalized, the data will be provided in electronic format to the DFG for incorporation into its State-wide CSBP database.

3.1.9 Preliminary Estimated Study Cost

A preliminary cost estimate for this study will be developed after approval by the Plenary Group.

3.1.10 Plenary Group Endorsement

The Aquatics TWG approved this plan on February 28, 2002. The participants at the meeting who said they could "live with" this study plan were BLM, City of Sacramento, CSPA, SWRCB, USFS and SMUD. None of the participants at the meeting said they could not "live with" this study plan. On April 11, the Plenary Group sent the plan back to the TWG to include Chili Bar. The plan was discussed at the Aquatic TWG meeting on April 25 and PG&E was requested to amend the plan for consideration by the TWG at its May 16 meeting. PG&E amended the plan and the Aquatics TWG approved the plan at the May 16, 2002 meeting. The participants at the meeting who said they could "live with" the study plan were USBLM, CSPA, SWRCB, ENF, CDFG, NMFS, PCWA, ARRA/Camp Lotus, PG&E and SMUD. None of the participants at the meeting said they could not "live with" this study plan. The Plenary Group approved the plan on June 5, 2002. The participants a the meeting who said they could "live with" this study plan were PCWA, El Dorado County, BLM, BOR, USFS, CSPA, SMUD, FOR, PG&E. None of the participants at the meeting said they could not "live with" this study plan. The Plenary Group also approved the plan on September 9, 2003. The participants a the meeting who said they could "live with" this study plan were USFS, SWRCB, NPS, CDFG, El Dorado County, Taxpayers Association of El Dorado County, Teichert

Materials, ARRA/Camp Lotus, El Dorado Irrigation District, SMUD, PCWA, City of Sacramento, FOR, and PG&E. None of the participants at the meeting said they could not "live with" this study plan.

3.1.11 Literature Cited

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AQUATICS TWG NOTE:

1. *This study area will be revisited once SMUD and the USFS reach agreement regarding responsibility for and potential Project actions in "Defense and Threat" zones as defined in the Forest Service Plan Amendment EIS and Record of Decision*

AQUATIC BIOASSESSMENT TECHNICAL REPORT

SUMMARY

This technical report provides information regarding overall water quality and the biological integrity of the stream ecosystem using the California Stream Bioassessment Procedure (CSBP) for the Sacramento Municipal Utility District Upper American River Project (UARP) and the Pacific Gas and Electric Company Chili Bar Project. The overall approach was to collect information regarding benthic macroinvertebrate (BMI) assemblages and habitat in all project reaches, including the Reach Downstream of Chili Bar, and compare with reference sites.

The study results presented here reflect a data collection effort at over 30 sites in 13 reaches of the UARP during the fall season of 2002 and 2003 and 6 sites in the Reach Downstream of Chili Bar in 2003 and 2004. Data collections included BMI, site- and transect-scale habitat, and point measurements of water quality constituents as described in the CSBP. With one exception (site below Rockbound Dam), sampling sites were established at both ends of each Project reach and a mid-reach site was established in reaches over three miles in length. Two reference sites were established in 2002 and a third was added in 2003 for the UARP; two reference sites were established in 2004 for the Reach Downstream of Chili Bar. The reference sites lie within and adjacent to the study area. Benthic sample processing was performed as outlined in the CSBP. Biological metrics suggested by the California Department of Fish and Game were calculated and 10 of the metrics considered reliable responders to habitat and/ or water quality impairment were integrated into a composite metric score for sites grouped within the ecological subregions of the project area. This composite metric score provides a relative measure of water and/or habitat quality between sites, as well as a means to compare project reaches with reference streams.

UARP benthic sample processing yielded a total of 176 BMI taxa, 20 mayfly taxa, 29 stonefly taxa and 34 caddisfly taxa. A comparison of metrics by year indicated fairly consistent trends for the UARP: 152 taxa in year 2002 and 159 taxa in year 2003. Several taxa unique to the reference site on the Silver Fork American River established in 2003 contributed to the increase in taxa in 2003. Composite metric scores indicated consistency between years with a few exceptions, while annual similarity of BMI composition was inconsistent (primarily in the middle region of the UARP area as depicted by cluster analysis). Several sites exhibited differences in taxonomic composition as shown by cluster analysis but composite metric scores of these same sites were consistent for both years, suggesting that although taxonomic composition of BMIs changed between years, the contribution of this difference to the composite metric score was less significant. For example, more tolerant taxa were replaced by other more tolerant taxa, and the data suggest consistency in water quality for both years.

Sites with higher water/habitat quality as defined by the composite metric scores and by comparisons with reference sites included: the two upstream Rubicon Dam Reach sites; the downstream Loon Lake Dam Reach site; the upstream Robbs Peak Dam Reach site; both Brush Creek Reach sites; and the Slab Creek Dam Reach site furthest upstream in the reach. Sites with relatively poorer water/habitat quality as defined by the composite metric scores and comparisons with reference sites included: the downstream Rubicon Dam Reach site; the upstream Loon Lake Dam Reach site; the upstream Gerle Creek Dam Reach site; the upstream Ice House Dam Reach site; the upstream Junction Dam Reach site; the downstream Camino Dam Reach site; and the two downstream Slab Creek Reach sites. Water/habitat quality of other UARP sites was variable when compared to reference sites. Some notable trends include: (a) increase in overall composite metric score moving downstream from the largest project dams (Ice House, Loon Lake, and Junction reservoirs), suggesting potential impairment immediately downstream of dams but recovery further along the reach; (b) decrease in overall composite metric score moving downstream in Camino Dam and Slab Creek Dam reaches, suggesting potential impairment at lower ends of reaches, and (c) lack or reductions of elmid beetle populations below the major reservoirs to recovery of elmid populations further downstream.

Benthic sample processing in the Reach Downstream of Chili Bar and associated reference sites yielded a total of 96 taxa, 13 mayfly taxa, 12 stonefly taxa and 14 caddisfly taxa. The water/habitat quality of sites within the Reach Downstream of Chili Bar were consistently lower than the water/habitat quality of reference sites as defined by BMI assemblage quality. A generally larger substrate composition (boulder and bedrock) contributed partially to the

lower BMI assemblage quality in the upper section of the reach. Oligochaetes were particularly abundant at sites within the reach but were especially abundant in the upper reach when compared to oligochaete abundance at the reference sites. EPT and Coleoptera Richness were consistently lower in the Reach Downstream of Chili Bar but stonefly (Plecoptera) richness was similar when compared to the reference sites. Although natural history information is incomplete for many BMI taxa, especially oligochaetes, the generally longer and more complex life cycles of EPT and Coleoptera taxa may have contributed to their more limited occurrence in the Reach Downstream of Chili Bar when compared to the reference sites. The burrowing behavior of oligochaetes may be favored in habitats with frequent fluctuating flow conditions and altered temperature regimes, the latter of which is known to limit BMI taxa that need temperature cues and thermal accumulation to complete their life cycles.

UARP site habitat quality scores for both years combined ranged from 114 to 185 with a median value of 159. The median value, 159, corresponds to an "optimal" score and the sites ranged from "suboptimal" to "optimal." No sites fell within the "poor" or "marginal" categories. UARP water quality constituents fell within ranges typical of the region. Habitat scores in the Reach Downstream of Chili Bar fell within the range of "suboptimal" (one site), "optimal" (three sites) and "optimal" and "suboptimal" depending on year (two sites). Habitat scores for the reference sites fell within the "optimal" range. Results of instantaneous water quality measurements in the Reach Downstream of Chili Bar were within ranges typical for the region.

1.0 INTRODUCTION

This technical report is one in a series of reports prepared by Devine Tarbell and Associates, Inc., (DTA) and Stillwater Sciences for the Sacramento Municipal Utility District (SMUD) and Pacific Gas and Electric Company to support the relicensing of SMUD's Upper American River Project (UARP) and Pacific Gas and Electric Company's Chili Bar Project. The report addresses aquatic ecosystem condition (as evaluated from benthic macroinvertebrate [BMI] data) in reaches associated with the projects and includes the following sections:

- BACKGROUND – Includes when the applicable study plan was approved by the UARP Relicensing Plenary Group; a brief description of the issue questions addressed, in part, by the study plan; the objectives of the study plan; and the study area. In addition, requests by resource agencies for additions to and modifications of this technical report are described in this section.
- METHODS – A description of the methods used in the study, including a listing of study sites.
- RESULTS – A description of the most important data results. Raw data, where copious and detailed model results are provided by request in a separate compact disc (CD) for additional data analysis and review by interested parties.
- SUMMARY – A brief discussion of the results.
- LITERATURE CITED – A listing of all literature cited in the report.

This technical report does not include a detailed description of the UARP Alternative Licensing Process (ALP) or the project, which can be found in the following sections of the Licensee's application for a new license: The UARP Relicensing Process, Exhibit A (Project Description), Exhibit B (Project Operations), and Exhibit C (Construction). Nor does this technical report include a detailed discussion of Pacific Gas and Electric Company's Chili Bar Project license application.

In addition, this technical report does not include a discussion regarding the effects of the project on water quality, ecological resources including benthic macroinvertebrates or their habitat, nor does the report include a discussion of appropriate protection, mitigation and enhancement (PME) measures. An impacts discussion regarding the UARP is included in the applicant-prepared preliminary draft environmental assessment (PDEA) document, which is part of the Licensee's application for a new license. Similarly, an impacts discussion regarding the Chili Bar Project will be included in the Pacific Gas and Electric's license application, Development of PME measures will occur in settlement discussions, which are ongoing, and will be reported in the UARP PDEA and the Chili Bar license application.

2.0 BACKGROUND

2.1 Aquatic Bioassessment Study Plan

On June 5, 2002, the UARP Relicensing Plenary Group approved an Aquatic Bioassessment Study Plan that was developed and approved by the UARP Relicensing Aquatic Technical Working Group (TWG) on February 28, 2002. The study plan was designed to address, in part, the following issue question developed by the Plenary Group:

Issue Question 54. What is the health of existing macroinvertebrate communities in diverted reaches as an indicator of water quality?

Specifically, the objectives of the study plan were:

- Use the California Stream Bioassessment Procedure (CSBP) as a bioassessment monitoring tool to evaluate the biological integrity of the stream reaches affected by the projects, and to provide insight into the general water quality in the area of the projects.

Preliminary results from aquatic bioassessment field work in 2002 were presented to the Aquatic TWG on May 13, 2003. Data from this first year of study was made available on CD-ROM. At that time, the Aquatic TWG made several requests of the Licensee for additional analysis, including: (a) evaluating BMI (benthic macroinvertebrate) data from the Silver Fork American River as a possible reference stream, (b) re-evaluating site-scale habitat assessment scores for sites that ranked in the suboptimal category, (c) examining BMI taxa identified for the UARP and Chili Bar Project that may be particularly sensitive to flow or temperature regimes, and (d) comparing other hydroelectric project BMI data sets with an emphasis on overall project metrics with the UARP and Chili Bar Project data sets. The Licensee's response to requests for further analysis were reported in a brief technical memorandum distributed at the Aquatic TWG meeting on July 14, 2003, provided in Appendix H. At the August 26, 2003 Aquatic TWG meeting, the Licensee agreed to a second year of sampling in the UARP. At the August 25, 2004 Aquatic TWG meeting, the Licensee agreed to sample two reference sites to supplement information for the Reach Downstream of Chili Bar. The reference sites included one on the North Fork American River at Ponderosa Way and one reference site on the Cosumnes River within the elevation range of the Reach Downstream of Chili Bar.

2.2 Water Year Types

The information in this subsection is provided for informational purposes, as requested by resource agencies. The derivation of water year types is described in the *Water Quality Technical Report*. Table 2.2-1 presents water year types for the period when aquatic bioassessment field work was conducted (October 2002 and 2003). Additional information for surrounding years is provided for reference.

Table 2.2-1. Water year types applied to individual months of years 2001-2004.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2001	AN	D	D	D	D	D	D	D	D	D	D	D
2002	D	BN	BN	BN	BN	BN	BN	BN	BN	BN	BN	BN
2003	BN	BN	BN	D	BN	BN	BN	BN	BN	BN	BN	BN
2004	BN	BN	BN	BN	BN	BN	BN	BN	BN	D	D	D

*CD=Critically Dry; D=Dry; BN=Below Normal; AN=Above Normal; W=Wet

2.3 Agency Requested Information

In a letter dated December 17, 2003 to the Licensee, the agencies requested that the Licensee provide the following information with regard to the Aquatic Bioassessment Study:

- Site map with GPS coordinates
- Report that compiles 2002 and 2003 data sets and methodology.
- Taxa list and metrics that are standard for the CSBP methods.
  - Habitat ranking criteria used for the UARP
  - Taxonomic list
  - Taxonomic lists of benthic macroinvertebrates grouped by ecological subregion
  - Biological metric values by sample
  - Site statistic metric values including mean, standard error (SE) and cumulative site total (CST)
  - Transect scale habitat documented at benthic sampling locations
  - Biological metrics used to describe characteristics of benthic macroinvertebrate assemblages
  - Site scale habitat scores measured during benthic macroinvertebrate surveys
  - Water quality values measured during benthic macroinvertebrate surveys
- Explanation and inclusion of the composite metric calculations and cluster analysis that were presented in the prior PowerPoint presentation

3.0 METHODS

3.1 Site Selection

The study area included all UARP Reaches, the Reach Downstream of Chili Bar, and reference sites (Tables 3.1-1, 3.1-2, and Appendix F). Project reservoirs were not included in the study area since the CSBP method is specifically developed for wadable stream reaches, not reservoirs. Table 3.1-1 presents sampling sites and corresponding number of samples that were collected. A site constituted an altering sequence of five riffles and five pools. Three reference sites were selected: Big Silver Creek, SF American River at Ice House Road, and Silver Fork American River upstream of Highway 50. Additionally in 2004, two additional sites were selected for comparison with the Reach Downstream of Chili Bar: the North Fork American River at Ponderosa Way and a site on the Cosumnes River.

As stipulated in the approved study plan, in reaches more than three miles long, sampling sites were at either end of the reach and included one site in the middle of the reach. In reaches less than three miles long, sampling sites were at either end of the reach. In some longer UARP reaches, a fourth site was added in the middle of the reach. In the Reach Downstream of Chili Bar, a total of 6 sites were sampled. At each study site one composite sample, consisting of three sub-samples, was collected from each of three of the five riffles in the riffle/pool sequence; thus, three composite samples were collected along three transects at each study site. For example, six composite samples were collected from a shorter reach with only two study sites, and twelve composite samples were collected for a longer reach with four study sites (Table 3.1-1). The sampled riffles were selected randomly from the original five riffles in the sequence that constituted the site. Once the riffles were selected, their length was measured and divided into thirds; the largest number of invertebrates with the greatest diversity has been shown to occur in the top (farthest upstream) third of most riffles (Harrington 1999). Therefore, the composite sample was collected from a lateral transect (determined from a randomly selected point) within the top third of the riffle. A detailed description of collection procedure and figure illustrating sampling design is located in Section 3.2. Sampling sites were located serially downstream of project dam faces with the uppermost site within each reach denoted as I1 ("Invertebrate site 1").

Actual site locations were based on: 1) the availability and accessibility of riffle habitat, 2) safety considerations, and 3) a goal of optimizing spatial variability. The uppermost site within a reach was generally located in view of the upstream dam, and the lowermost site within a reach was located above the influence of the downstream reservoir. A total of seven sites were initially selected for the Reach Downstream of Chili Bar. After reconnaissance, it was determined that substrate conditions at site CB-I6 were not suitable for sampling using the CSBP and water depths and velocities were much greater than would allow for safe wading. After consulting with the TWG, this site was eliminated from further study.

Table 3.1-1. CSBP samples and transects per reach for the UARP area and the Reach Downstream of Chili Bar. [1]

Reach	Length (miles)	Locations / Reach	Transects / Location	Total No. of Composite Samples
Rubicon Dam	4.1	3	3	9
Rockbound Dam	0.4	1	3	3
Buck Island Dam	2.8	2	3	6
Loon Lake Dam	8.9	3	3	9
Gerle Creek Dam	1.1	2	3	6
Robbs Peak Dam	5.6	2	3	6
Ice House Dam	11.5	4	3	12
Junction Dam	8.3	3	3	9
Camino Dam	6.0	3	3	9
S.F. American River[2]		0	0	0

Table 3.1-1. CSBP samples and transects per reach for the UARP area and the Reach Downstream of Chili Bar. [1]

Reach	Length (miles)	Locations / Reach	Transects / Location	Total No. of Composite Samples
Brush Creek Dam	2.1	2	3	6
Slab Creek Dam	8.0	3	3	9
Downstream of Chili Bar[3]	20.0	6	3	18
Big Silver Creek Reference		1	3	3
South Fork American River Reference		1	3	3
Silver Fork American River Reference[4]		1	3	3
North Fork American River Reference[5]		1	3	3
Cosumnes River Reference[5]		1	3	3
Total	---	39	51	111

[1] Adapted from Table 1 of the Plenary-approved Study Plan
[2] It was determined during Plenary and Aquatic TWG review of the study plan that sites in this reach would not be sampled.
[3] Two of the six sites were located within 3 miles of Chili Bar Dam, as stipulated in the approved study plan (see Appendix I). These six sites were sampled in 2003 and 2004.
[4] This reference site was added in 2003.
[5] This reference site was added in 2004.

Table 3.1-2. Location descriptions and year of sampling event for sites within the UARP and Reach Downstream of Chili Bar, El Dorado County.

Stream Name	Site Code	Year/s of Sampling	Elevation (ft)	Easting[#]	Northing[#]	Ecological Subregion*
Rubicon R	RR-I1	02/03	6200	740437.3	4320441	GBVF
Rubicon R	RR-I2	02/03	6070	739577.8	4321336	GBVF
Rubicon R	RR-I3	02/03	6040	738229.3	4322608	GBVF
Highland Cr	RLD-I1	02	6470	738547.1	4320318	GBVF
Little Rubicon R	BI-I1	02/03	6390	737462.3	4321149	GBVF
Little Rubicon R	BI-I2	02/03	6160	737131.6	4322564	GBVF
Gerle Cr	LL-I1	02/03	6310	732691.1	4320601	BVF
Gerle Cr	LL-I2	02/03	5920	730158.1	4321564	BVF
Gerle Cr	LL-I3	02/03	5420	727256.4	4318833	BVF
Gerle Cr	GC-I1	02/03	5180	725802.6	4316154	UFMB
Gerle Cr	GC-I2	02/03	5040	725735.2	4315013	UFMB
SF Rubicon R	RPD-I1	02/03	5120	725716.8	4314307	UFMB
SF Rubicon R	RPD-I2	02/03	4910	724343.1	4314532	UFMB
SF Silver Cr	IH-I1	02/03	5260	728754.7	4299824	BVF
SF Silver Cr	IH-I2	02/03	5190	727986	4299755	BVF
SF Silver Cr	IH-I3	02/03	4790	722286.9	4298798	BVF
SF Silver Cr	IH-I4	02/03	4480	721476.4	4303455	UFMB
Sliver Cr	JD-I1	02/03	4290	720377.3	4303377	UFMB
Silver Cr	JD-I2	02/03	4160	719143.4	4302718	UFMB
Silver Cr	JD-I3	02/03	3130	713729	4302012	UFMB
Silver Cr	CD-I1	02/03	2780	713541.1	4300069	UFMB
Silver Cr	CD-I2	02/03	2420	710243.5	4298661	UFMB

Table 3.1-2. Location descriptions and year of sampling event for sites within the UARP and Reach Downstream of Chili Bar, El Dorado County.

Stream Name	Site Code	Year/s of Sampling	Elevation (ft)	Easting#	Northing#	Ecological Subregion*
Silver Cr	CD-I3	02/03	2090	709354.4	4296229	UFMB
Brush Cr	BC-I1	02/03	2780	706305.8	4298473	UFMB
Brush Cr	BC-I2	02/03	2020	704166.8	4297015	UFMB
SF American R	SC-I1	02/03	1620	699544.8	4293944	UFMB
SF American R	SC-I2	02/03	1350	695381.2	4294156	UFMB
SF American R	SC-I3	02/03	980	692765.4	4292931	UFMB
SF American R	CB-I1	03/04	960	689011.2	4293154	UFMB
SF American R	CB-I2	03/04	860	687273.8	4293531	LFMB
SF American R	CB-I3	03/04	730	683109.3	4296925	LFMB
SF American R	CB-I4	03/04	700	680830.1	4297380	LFMB
SF American R	CB-I5	03/04	620	676774.3	4298522	LFMB
SF American R	CB-I7	03/04	470	673041.4	4292331	LFMB
Reference Sites						
Big Silver Cr	BSC	02/03	4900	729816.3	4306846	BVF
Silver Fork	SILV	03	4850	737643	4292693	BVF
SF American R	SFAR	02/03	3230	721194.5	4294529	BVF
NF American R	NF-PON	04	830	678254	4318760	LFMB
Cosumnes R	COS-2	04	780	687576	4269427	LFMB

#Using NAD27 Datum
*GBVF: Glaciated Batholith and Volcanic Flows
*BVF: Batholith and Volcanic Flows
*UFMB: Upper Foothills Metamorphic Belt
*LFMB: Lower Foothills Metamorphic Belt

3.2 Benthic Sampling and Habitat Assessment

Benthic samples were collected from the UARP from October 7–29, 2002 and October 5–23, 2003 and from the Reach Downstream of Chili Bar from October 6-27, 2003 and October 19-22, 2004 using procedures outlined in the CSBP (Harrington 1999). The non-point source method outlined in the CSBP was used in conjunction with the spot sampling modification (Harrington 1999). The spot sampling modification was applied because not all stream reaches contained suitable riffles for sampling.

A modification of the CSBP was applied wherever high gradient and/or narrow channels precluded the establishment of transects (i.e., water velocities and depths exceeded levels that were conducive to wading such as in the Reach Downstream of Chili Bar). This modification was also applied when substrate conditions were not ideal for sampling benthic macroinvertebrates (i.e., substrate was comprised of mostly bedrock and boulder, with only small patches of moveable cobbles and gravels). The modification of the CSBP consisted of delineating a high gradient riffle or high gradient riffle series into a low, middle, and upper section and "spot sampling" each of the sections. Sampling was randomized by identifying at least five areas of potential sampling locations within each section and randomly selecting three for sampling. When lower gradient riffles predominated, the standard sampling approach was taken. As specified in the CSBP, five riffle habitat units were identified within the site and three were randomly chosen for sampling. Riffle length was determined and a transect was randomly established within the upper third of the riffle. Three collections, one near the bank, a second at intermediate depth, and a third near the thalweg were gathered with a D-frame kicknet along the transect; these collections were combined as a single composite sample for the transect.

Benthic collections were taken by rubbing cobble and boulder substrates by hand and disturbing finer substrates within a 2 ft^2 (0.18 m^2) area upstream of a D-frame kicknet fitted with a 0.0196 in. (0.5 mm) mesh net. The total area sampled per transect was 6 sq. ft. (0.54 m^2). Each composite sample was transferred to a plastic jar, preserved with 95 percent ethanol and labeled. Composite samples were collected in this manner at 30 sites in 2002, 36 sites in 2003 and 8 sites in 2004 (Table 3.1-2).

At each site, physical characteristics of the riparian zone were documented using the U.S. EPA's Rapid Bioassessment Protocols for high gradient streams (Barbour et al. 1999). Criteria for scoring the habitat parameters are shown in Appendix A. Ten habitat parameters, such as available cover, embeddedness, channel flow status, and riparian and bank conditions are ranked on a scale of 0 to 20, for a total possible score of 200. For reference, habitat scores of 0 to 50 are considered "poor;" habitat scores of greater than 50 to 100 are considered "marginal;" habitat scores of greater than 100 to 150 are considered "suboptimal;" and scores of greater than 150 to 200 are considered "optimal" (Barbour et al. 1999). These habitat characterizations (i.e., poor, marginal, etc.) are based on the written criteria shown in Appendix A. Optimal habitats contain a high diversity of habitats, low levels of embeddedness and sediment deposition, stable banks, and a well-developed riparian zone. Poor habitats are channelized with little diversity of habitats, high sediment loads filling interstitial spaces, high erosion, and narrow or no riparian corridors.

In addition, sites were photographed and water quality measurements recorded. Specific conductance, pH, temperature, and dissolved oxygen were measured using a YSI 600XL portable water quality meter, which was re-calibrated when sites differed by greater than 2,000 ft (610 m) elevation or at the beginning of each week of sampling.

3.2.1 Sample Processing

At the laboratory, each composite sample was rinsed in a standard No. 35 sieve (0.0196 in; 0.5 mm) and transferred to a tray with twenty, 4 in^2 (25 cm^2) grids for subsampling. Benthic material in the subsampling tray was transferred from randomly selected grids to petri dishes where the BMIs were removed systematically with the aid of a stereomicroscope and placed in vials containing 70 percent ethanol, 28 percent water and 2 percent glycerol. In cases where BMI abundance exceeded 100 organisms per grid, half grids were delineated to assure that a minimum of three discreet areas within the tray of benthic material were subsampled. At least 300 BMIs were subsampled from a minimum of three grids, or three half grids. If there were more BMIs remaining in the last grid after 300 were archived, then the remaining BMIs were tallied and archived in a separate vial. This was done to assure a reasonably accurate estimate of BMI abundance based on the portion of benthos in the tray that was subsampled. These "extra" BMIs were not included in the taxonomic lists and metric calculations.

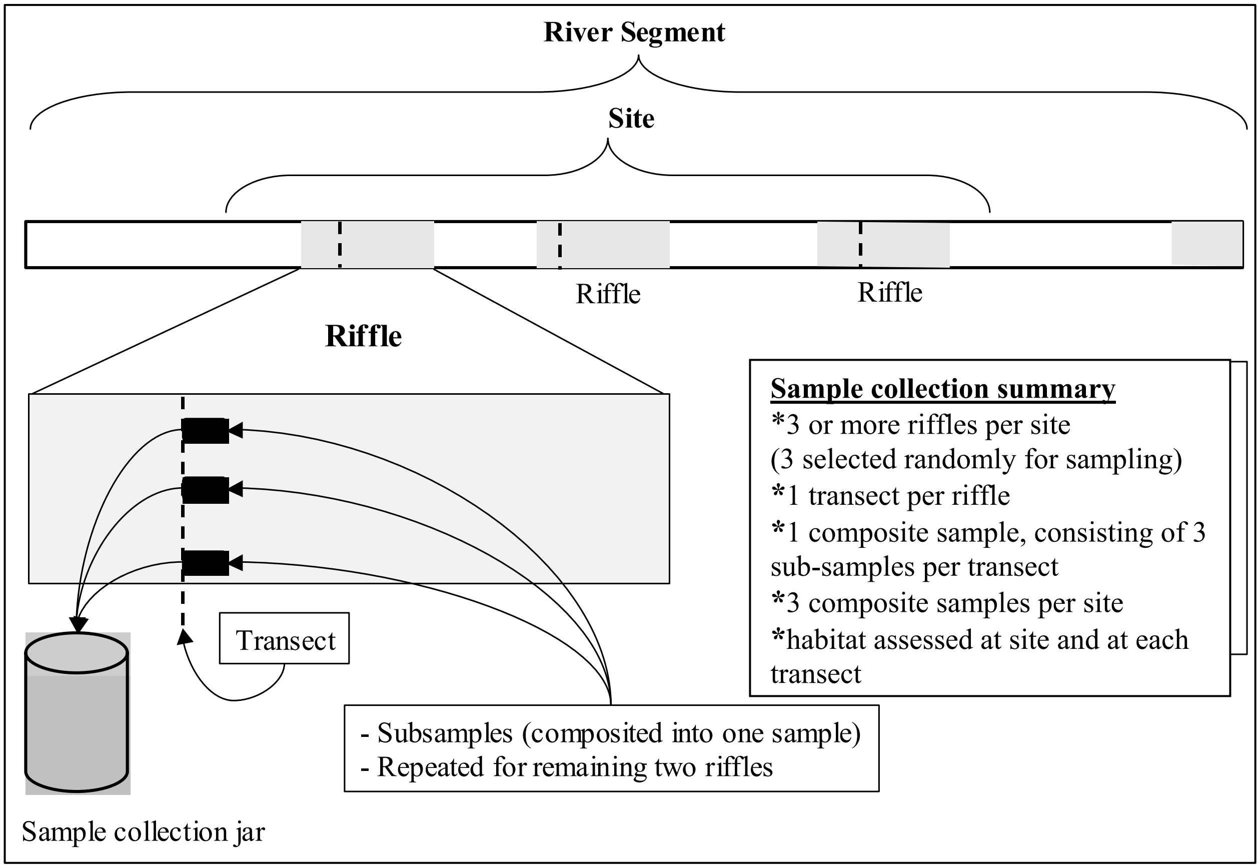


Figure 3.2-1. Diagrammatic representation of benthic sample collection.

Subsampled BMIs were identified using taxonomic keys including Kathman and Brinkhurst (1998), Merritt and Cummins (1996), Stewart and Stark (1993), Thorp and Covich (2001), Wiggins (1996), and unpublished references. A standard level of taxonomic effort was used as specified in the California Aquatic Macroinvertebrate Laboratory Network (CAMLnet) taxonomic effort (January 2003). The CAMLnet August 2002 list of taxonomic effort was used for midge subfamily/tribe identifications and family level identification of oligochaetes. Exceptions to this standard included less precise identification of some immature larvae and pupae.

3.2.2 Data Processing and Analysis

Site scale and transect scale habitat data and BMI taxa including the number of individuals comprising each taxon were entered into a Microsoft Access® database. Database queries were used to produce taxonomic lists, which were transferred to Microsoft Excel® where biological metrics (numerical attributes of biotic assemblages) were generated. The biological metrics calculated were those suggested in the CSBP (Harrington 1999) (Table 3.2-1). California Tolerance Values (CTV) and functional feeding group designations were obtained from the most recent list of the CAMLnet taxonomic effort (January 2003). Family level tolerance values for oligochaetes were obtained from the previous revision of the CAMLnet taxonomic effort (August 2002, unpublished) and from Barbour et al. (1999). Metric values were tabulated by composite sample and summarized by site using mean, standard error and cumulative site totals. Cumulative site totals were determined by pooling the BMIs from the replicate composite samples collected at each site.

Sites were grouped into four categories based on ecological subregions of California, as described by Goudey and Smith (1994). The ecological subregions include (by increasing elevation): lower foothills metamorphic belt (LFMB); upper foothills metamorphic belt (UFMB); batholith and volcanic flows (BVF); and glaciated batholith and volcanic flows (GBVF). Ecological regions and subregions are classified and mapped based on associations of those biotic and environmental factors that directly affect or indirectly express energy, moisture, and nutrient gradients that regulate the structure and function of ecosystems (Goudey and Smith 1994, Omernik and Bailey 1997). With limited resources to perform comprehensive site assessments, these ecological regions provide a framework for grouping monitoring sites that have a high likelihood of sharing similar ecological attributes. In addition, for the Reach Downstream of Chili Bar (because it is such a long reach), sites were selected to encompass the three identified fluvial geomorphological subreaches within the reach, to also provide a basis for comparison.

3.2.3 Composite Metric Scores

To assess the biological integrity of a given site, regional Indices of Biotic Integrity (IBI) are being developed by the CDFG (P. Ode, CDFG, pers. comm., 2004). While a regional IBI does not yet exist for streams draining the central Sierra Nevada range, an intermediate step for characterizing sites based on multiple biological metrics is the formulation of composite metric scores for sites within similar ecological regions.

For the UARP, samples collected at transects or "spots" within each of the three ecological subregions were given a relative composite metric score based on a set of BMI assemblage metric values. The metrics used for the scores were Taxonomic Richness, Ephemeroptera Taxa, Plecoptera Taxa, Trichoptera Taxa, Shannon Diversity, Tolerance Value, Percent Intolerant Organisms, Percent Tolerant Organisms, Percent Dominant Taxon and Predator Richness. Nine of the 10 metrics used for the composite metric scores were found to be reliable responders to disturbance by Karr and Chu (1999). Karr and Chu (1999) identified human activities contributing to disturbance of aquatic ecosystems, which include land use, effluent discharge, water withdrawal, discharge from reservoirs, sport and commercial fisheries and introduction of alien species. These factors subsequently influence flow regime, physical habitat structure, water quality, energy source and biological interactions. Shannon Diversity, although not identified by Karr and Chu, was incorporated into the suite of metrics because it integrates richness and evenness (Shannon and Weaver 1963; Magurran 1988). For the Reach Downstream of Chili Bar, the same group of metrics was used for the generation of composite metric scores except Coleoptera Richness was added and EPT Richness replaced the individual **E**phemeroptera, **P**lecoptera and **T**richoptera orders.

The composite metric score approach to evaluating BMI metric-based data is to normalize and sum the differences between sample metric values and the grand mean of the metric values for the ten metrics (see formula below), then compare the resulting score between the various sampling sites. The output of the composite metric score 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; 3) each of the three locations (transects) where samples were collected at each site 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, as represented by the three samples, 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.

Trends in site quality as a function of BMI assemblage quality can then be identified by the distribution of composite metric scores relative to each other and as they orient above, on, or below the mean line. Since the quality of BMI assemblages increase with increasing water and habitat quality, composite metric scores can be used to assess relative site water and habitat quality in the context of a biotic component.

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 the samples comprising each ecological subregion.

The formula for computing the composite metric scores for each ecological subregion is as follows:

$$\text{Composite Metric Score} = \sum \pm(\mathbf{x}_i - \mathrm{x}_i)/\mathrm{sem}_i$$

where:

$\mathbf{x}_i$ = sample value for the i-th metric within an ecological subregion
x_i = grand mean of the samples 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).

3.2.4 Cluster Analysis

Cluster analysis is a multivariate procedure for detecting natural groupings in data (McCune and Mefford 1999). PC-ORD® (version 4) software was used for performing cluster analysis on BMI cumulative site totals for the three ecological subregions within the UARP. Cumulative site totals were determined by pooling the BMIs from the three replicate samples collected at each site. Pooling BMIs from the three replicate samples collected at each site was necessary to keep the number of site/sample units under 30. Dendrograms showing more than 30 sites or samples are difficult to interpret (Magurran 1988). For the Reach Downstream of Chili Bar, cluster analysis was performed on all samples and sites within the reach. The cluster distance measure used was Sorenson (Bray Curtis), which is considered to be a more accurate representation of community structure than Euclidian distance (McCune and Grace 2002). The Group Average method was used for group linking because it is compatible with the Sorenson distance and is frequently used in ecological studies where the objective is exploring patterns in taxonomic composition (Magurran 1988). PC-ORD® dendrograms are scaled by the percentage of information remaining, which is based on information loss as agglomeration (linking of groups) proceeds during the analysis. When the program begins clustering, all information is present but is gradually lost as the fusing of groups commences until all groups are complete and no more information remains. The output of the cluster analysis is a tree-like dendrogram, which shows relative site or sample similarity based on the composition of BMIs.

To evaluate trends identified by composite metric scores, cluster analyses were also applied to habitat variables and the same BMI metrics used to generate composite metric scores, which were discussed in Section 3.2.3. The habitat variables selected were those that are known to influence BMI assemblage composition and included visual estimates of the percentage of substrate size classes where benthic samples were collected, percent gradient and percent canopy cover of the riffles where samples were collected. Transient habitat variables (e.g. velocity and depth) were avoided because they change within relatively short temporal scales. Because of the different measurement scales of the habitat variables and biological metrics used in the analyses, Ward's method was used for group linking (Davis 1986) and Euclidian distance was used because it is compatible with Ward's method (McCune and Mefford 1999). The objective of these cluster analyses was to provide further insight into the grouping of sites based on habitat variables when compared to the grouping of sites based on metric values. Cluster analyses were confined to groups of sites within ecological subregions and were performed at the transect scale (as opposed to site scale) to provide the most information. Transects that cluster with their respective sites for metrics and habitat would indicate habitat influence on the metrics. Transects that do not cluster with their respective sites for habitat but do form clusters based on metrics would indicate that other factors, not included in the analysis, were influencing BMI assemblages. These other factors could include habitat variables not assessed or habitat variables that were assessed with low precision. Other factors known to influence BMI assemblages would include annual flow and temperature regimes and water quality.

WinSTAT® was used to perform cluster analyses on habitat variables and metrics, and produces a somewhat different dendrogram format compared to the dendrogram produced by PC-ORD®. However, the interpretation of both dendrogram formats is similar. As site and transect dissimilarity increases, clusters form with increasing Euclidian distance, denoted as "Distance" on the y-axis for WinSTAT® dendrograms.

Table 3.2-1. Biological metrics used to describe characteristics of benthic macroinvertebrate assemblages.

BMI Metric	Description	Response to Impairment[#]
Richness Measures		
1. Taxonomic Richness*	Total number of individual taxa.	Decrease
2. EPT Taxa	Number of taxa in the orders Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly)	Decrease
3. Ephemeroptera (mayfly) Taxa*	Number of mayfly taxa	Decrease
4. Plecoptera (stonefly) Taxa*	Number of stonefly taxa	Decrease
5. Trichoptera (caddisfly) Taxa*	Number of caddisfly taxa	Decrease
6. Coleoptera (beetle) Taxa*	Number of aquatic beetle taxa	Decrease
Composition Measures		
7. EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae	Decrease
8. Sensitive EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae with Tolerance Values less than 3.	Decrease
9. Shannon Diversity Index*	General measure of sample diversity that incorporates richness and evenness (Shannon and Weaver 1963).	Decrease
Tolerance Measures		
10. California Tolerance Value (CTV)*	CTVs between 0 and 10 weighted for abundance of individuals designated as pollution tolerant (higher values) and intolerant (lower values).	Increase
11. Percent Intolerant Organisms*	Percentage of organisms that are highly intolerant to water and/ or habitat quality impairment as indicated by CTVs of 0, 1 or 2.	Decrease
12. Percent Tolerant Organisms*	Percentage of organisms that are highly tolerant to water and/ or habitat quality impairment as indicated by CTVs of 8, 9 or 10.	Increase
13. Percent Dominant Taxon*	The highest percentage of organisms represented by one taxon.	Increase
Functional Feeding Groups (FFG)		
14. % Collector-Gatherers	Percent of macroinvertebrates that collect or gather material	Increase
15. % Collector-Filterers	Percent of macroinvertebrates that filter suspended material from the water column	Increase
16. % Scrapers	Percent of macroinvertebrates that graze upon periphyton	Variable
17. % Predators**	Percent of macroinvertebrates that prey on living organisms	Decrease
18. % Shredders	Percent of macroinvertebrates that shred leaf litter	Decrease
19. % Others		
Other		
20. Abundance	Estimate of the number of BMIs in a sample based on the proportion of BMIs subsampled.	Variable

[#]These responses to impairment are based on water quality pollution not necessarily on flow related changes in water quality.
*Metrics identified with an asterisk were used for the composite metric scores; Coleoptera taxa metric was used for the Reach Downstream of Chili Bar only.
**The Percent Predator metric value was converted to Predator Richness for composite metric scores.

3.2.5 Quality Control

Twenty percent of processed BMI samples collected during years 2002 through 2004 for the UARP and Reach Downstream of Chili Bar were submitted to CDFG for assessment of taxonomic and enumeration accuracy and conformance to standard taxonomic level. Results of CDFG's quality control for years 2002 and 2003 were summarized in letters, which are included in Appendix E. Quality control results for 2004 data are pending.

4.0 RESULTS

4.1 Benthic Macroinvertebrates

4.1.1 Upper American River Project

From the 180 samples collected for years 2002 and 2003, 53,270 BMIs were processed comprising 176 distinct taxa, 83 EPT taxa, 20 mayfly taxa, 29 stonefly taxa and 34 caddisfly taxa (Table 4.1-1). Mean tolerance for the project reaches was 4.4 and overall Shannon Diversity was 3.5. Yearly totals and site statistics including median, minimum and maximum values are also shown in Table 4.1-1. An area-wide taxa list for the study area indicating California Tolerance Values (CTV) and Functional Feeding Group designations is shown in Appendix B. Also included in Appendix B are taxonomic lists (cumulative site totals) by ecological subregion. Biological metric values are presented by sample and summarized by site in Appendix C. Appendix H (item 4) shows results of commonly reported metrics for other hydroelectric projects in the central Sierra Nevada. Note that Appendix H (item 4) shows metrics calculated by **sample** median values, while Table 4.1-1 reports metric values as **site** median values. Reporting the metrics using cumulative site totals is consistent with the more recent version of the CSBP (December 2003), which places more of an emphasis on site totals.

Three taxa were unique to the Silver Fork American River Reference site, which contributed to the higher total Taxa Richness value in year 2003 when compared to year 2002.

Table 4.1-1. UARP metric summaries for benthic macroinvertebrate assemblages, fall 2002 and 2003.

Metric	Cumulative Project Totals (Years 2002/2003)	Year 2002		Year 2003	
		Total	Site Median (range)	Total	Site Median (range)
Taxa Richness	176	152	42 (21 – 56)	159	47 (26 – 68)
EPT Taxa	83	73	22 (12 – 31)	76	23 (13 – 33)
Ephemeroptera	20	19	8 (5 – 11)	20	9 (5 – 11)
Plecoptera	29	24	5 (2 – 13)	25	6 (1 – 13)
Trichoptera	34	30	8 (2 – 12)	31	9 (2 – 13)
Tolerance Value	4.4	4.5	4.2 (2.9 – 6.4)	4.4	4.5 (3.2 – 6.1)
Shannon Diversity	3.5	3.6	2.7 (1.6 – 3.1)	3.5	2.9 (1.8 – 3.3)

4.1.2 Reach Downstream of Chili Bar

From the 45 samples collected within the Reach Downstream of Chili Bar and reference site samples, 12,600 BMIs were processed comprising 96 distinct taxa, which included 39 EPT taxa, 13 mayfly taxa, 12 stonefly taxa and 14 caddisfly taxa (Table 4.1-2). Mean tolerance for the project was 5.4 and overall Shannon Diversity was 3.0. Site median and range values (Table 4.1-2) indicate a wide range of variation, which will be explored for trends across sites and for relationships with habitat variables in Section 5.0. A taxa list indicating California Tolerance Values (CTV) and Functional Feeding Group designations is shown in Appendix D; biological metric values are presented by sample and summarized by site in Appendix D.

Table 4.1-2. Metric summaries for benthic macroinvertebrate assemblages from the Reach Downstream of Chili Bar (years 2003 and 2004) and reference sites (year 2004).

Metric	Cumulative Project Totals (Years 2003/2004)	Year 2003		Year 2004*	
		Total	Site Median (range)	Total	Site Median (range)
Taxa Richness	96	61	35 (19 - 41)	93	38 (23 – 57)
EPT Taxa	39	23	13 (8 – 16)	38	16 (6 – 24)
Ephemeroptera	13	7	5 (4 – 7)	13	5 (3 – 9)
Plecoptera	12	10	4 (2 – 5)	10	5 (2 – 7)
Trichoptera	14	6	4 (2 – 5)	15	5 (1 – 11)
Tolerance Value	5.4	5.7	5.7 (4.4 – 7.0)	5.2	4.9 (3.3 – 6.7)
Shannon Diversity	3.0	2.6	2.4 (1.5 – 2.6)	3.1	2.6 (1.7 – 3.1)

* Includes reference site data from year 2004.

4.1.3 Quality Control/ Taxonomic Notes

For years 2002 and 2003, CDFG concluded that taxonomic procedures were conducted in accordance with their protocols and that the identification of BMIs was accurate. A few problems were noted: In year 2002, diamesin midges were not consistently differentiated from orthoclad midges; in year 2003 there were instances of misidentifications of Acari (water mites) and elmid beetles.

In year 2003, the Licensee is confident that diamesin midges were consistently differentiated, but both midge taxa were combined into one taxon (Orthocladiinae/Diamesinae) for metric calculations so annual comparisons would be consistent. In addition, early instar stoneflies identified as *Taenionema* were changed to the less precise family, Taeniopterygidae, as suggested by CDFG. All hydroptilid caddisflies incorrectly identified as *Stactobiella* were changed to the newly described species *Nothotrichia shasta*. Bivalves were changed from superfamily Corbiculacea to family Sphaeriidae. While CDFG indicated that the bivalve specimens they examined belonged to the genus, *Pisidium*, the Licensee was not certain that all bivalve specimens in the project reaches were *Pisidium* so they were identified to the less precise family, Sphaeriidae. This less precise identification was warranted because many of the bivalves were in early developmental stages and many were in poor condition: shells damaged or separated from viscera. All elmids originally identified as *Heterelmis* were re-examined and changed to *Microcylloepus*.

4.2 Habitat Assessment

A physical habitat assessment is conducted at each site as part of the CSBP. Ten habitat parameters are scored on a scale of 0 to 20 and totaled for the site (for a total possible score of 200). Channel flow status and velocity/depth regimes are assessed for conditions during the sampling period, and do not reflect fluctuating flows. Impacts to habitat and potential impacts to the benthic macroinvertebrate community as a result of fluctuating flows for the Reach Downstream of Chili Bar are addressed in a separate *Flow and Fluctuation Technical Report*.

4.2.1 Upper American River Project

Site-scale habitat data are presented in Tables 4.2-1 and 4.2-2. Transect-scale data are presented in Appendix F. Photos from study sites are presented in Appendix G. For both assessment years, habitat scores were greater than 100 for all sites, which places them in the suboptimal and optimal ranges. For reference, habitat scores of 0 to 50 are considered "poor;" habitat scores of greater than 50 to 100 are considered "marginal;" habitat scores of greater than 100 to 150 are considered "suboptimal"; and scores of greater than 150 to 200 are considered "optimal" (Barbour et al. 1999).

The median site habitat value for the two assessment years was 159 and values ranged from 114 to 185 (Table 4.2-1). Habitat scores were generally lower in year 2002 (median 147) than habitat scores determined for year 2003 (median value 169). Much of the difference in habitat scores between the two years was attributed to the inherent variability in interpreting the criteria for primarily two habitat parameters: channel flow status and riparian zones in bedrock dominated channels (see also Appendix H, item 2).

Results of water quality measurements for the entire study area and by year are shown in Table 4.2-1. Water temperature ranged from 4.3 to 16 ˚C, pH ranged from 6.8 to 8.5, specific conductance ranged from 9.0 to 60 µS/cm, and dissolved oxygen ranged from 5.5 to 12 mg/l. Dissolved oxygen was not reported for year 2003 due to a meter malfunction.

Table 4.2-1. Site scale habitat and water quality value summaries for the UARP, years 2002 and 2003.

Assessment Parameter	Project Median (range)		
	Years 2002/2003	Year 2002	Year 2003
Site Habitat Score (rank: 0 – 200)	159 (114 – 185)	147 (114 – 185)	169 (135 – 182)
Temperature (˚C)	11 (4.3 – 16)	10 (4.3 – 14)	11 (7.4 – 16)
pH	7.5 (6.8 – 8.5)	7.3 (6.8 – 7.9)	7.6 (6.9 – 8.5)
Specific Conductance (µS/cm@25˚C)	15 (9.0 – 60)	15 (9.0 – 53)	14 (9.3 – 60)
Dissolved Oxygen (mg/l)*	7.8 (5.5 – 12)	7.8 (5.5 – 12)	---

*Values for year 2002 only

4.2.2 Reach Downstream of Chili Bar

Site-scale habitat and water quality data are presented in Table 4.2-3; transect scale habitat values reported for the Reach Downstream of Chili Bar are shown in Appendix F.

Table 4.2-2. UARP site scale habitat values, years 2002 and 2003.

Date	Stream Name	Site Code	Epifaunal Sub./ Available Cover	Embeddedness	Velocity/Depth Regime	Sediment Deposition	Channel Flow Status	Channel Alteration	Riffle Frequency	Left Bank Stability	Right Bank Stability	Left Bank Veg Protection	Right Bank Veg Protection	Left Bank Riparian Veg	Right Bank Riparian Veg	Total
10/16/02	Rubicon R	RR-I1	14	14	8	14	9	20	17	7	8	8	8	9	9	145
10/22/03	Rubicon R	RR-I1	20	16	15	15	11	20	20	7	6	10	10	10	10	170
10/17/02	Rubicon R	RR-I2	13	17	7	18	8	20	17	9	8	2	5	6	6	136
10/22/03	Rubicon R	RR-I2	18	15	10	18	10	20	19	10	9	5	10	6	6	156
10/16/02	Rubicon R	RR-I3	11	16	14	19	8	19	16	10	10	1	4	1	5	134
10/22/03	Rubicon R	RR-I3	11	20	14	20	9	19	17	10	10	4	9	4	7	154
10/15/02	Not named	RLD-I1	10	16	7	19	5	20	10	9	9	2	2	9	9	127
10/15/02	Little Rubicon R	BI-I1	11	15	14	18	8	20	9	9	9	3	3	8	8	135
10/21/03	Little Rubicon R	BI-I1	17	11	14	18	8	17	18	9	9	8	8	8	8	153
10/15/02	Little Rubicon R	BI-I2	8	19	15	19	9	19	11	10	10	1	1	6	6	134
10/21/03	Little Rubicon R	BI-I2	15	17	18	18	10	20	16	10	10	9	9	6	6	164
10/10/02	Gerle Cr	LL-I1	13	16	9	14	17	20	18	8	9	9	9	10	7	159
10/16/03	Gerle Cr	LL-I1	18	10	19	9	10	19	17	8	8	10	10	9	8	155
10/9/02	Gerle Cr	LL-I2	18	16	15	17	17	20	18	9	9	9	9	9	9	175
10/15/03	Gerle Cr	LL-I2	19	18	13	18	10	19	19	8	8	10	10	10	10	172
10/10/02	Gerle Cr	LL-I3	14	20	14	18	9	20	17	9	9	8	9	10	10	167
10/15/03	Gerle Cr	LL-I3	19	19	15	18	9	20	19	9	9	9	9	10	10	175
10/9/02	Gerle Cr	GC-I1	10	20	15	20	9	20	18	10	10	5	5	8	10	160
10/16/03	Gerle Cr	GC-I1	17	16	16	19	10	13	19	8	8	7	9	7	9	158
10/8/02	Gerle Cr	GC-I2	16	19	18	19	10	20	16	9	9	6	6	10	10	168
10/15/03	Gerle Cr	GC-I2	15	13	19	18	15	15	17	10	10	10	10	10	9	171
10/8/02	SF Rubicon R	RPD-I1	15	20	14	18	10	20	10	8	9	9	9	9	9	160
10/15/03	SF Rubicon R	RPD-I1	13	12	19	18	10	16	15	9	10	10	10	10	9	161
10/29/02	SF Rubicon R	RPD-I2	6	19	14	16	10	20	16	9	7	2	2	9	10	140
10/15/03	SF Rubicon R	RPD-I2	11	20	19	20	10	19	16	10	10	9	9	9	9	171

Table 4.2-2. UARP site scale habitat values, years 2002 and 2003.

Date	Stream Name	Site Code	Epifaunal Sub./ Available Cover	Embeddedness	Velocity/Depth Regime	Sediment Deposition	Channel Flow Status	Channel Alteration	Riffle Frequency	Left Bank Stability	Right Bank Stability	Left Bank Veg Protection	Right Bank Veg Protection	Left Bank Riparian Veg	Right Bank Riparian Veg	Total
10/7/02	SF Silver Cr	IH-I1	14	19	16	18	12	20	14	10	8	9	9	10	8	167
10/8/03	SF Silver Cr	IH-I1	16	19	15	19	12	19	19	9	9	8	8	10	10	173
10/7/02	SF Silver Cr	IH-I2	15	13	16	9	7	20	17	8	10	7	9	7	10	148
10/18/03	SF Silver Cr	IH-I2	13	15	18	11	14	20	11	10	10	10	10	10	10	162
10/11/02	SF Silver Cr	IH-I3	12	15	10	16	10	20	16	9	9	6	6	2	2	133
10/9/03	SF Silver Cr	IH-I3	18	19	20	20	18	19	17	9	9	8	9	8	8	182
10/11/02	SF Silver Cr	IH-I4	16	18	15	14	10	20	17	8	8	5	5	10	9	155
10/8/03	SF Silver Cr	IH-I4	16	14	20	17	17	19	19	10	9	9	9	6	6	171
10/18/02	Sliver Cr	JD-I1	8	19	16	19	9	12	16	9	9	5	6	2	2	132
10/8/03	Silver Cr	JD-I1	16	19	18	20	18	16	19	6	10	6	6	2	6	162
10/18/02	Silver Cr	JD-I2	11	20	18	18	15	20	10	9	8	5	5	9	9	157
10/23/03	Silver Cr	JD-I2	15	20	17	20	16	20	17	9	9	8	8	9	9	177
10/28/02	Silver Cr	JD-I3	11	19	16	18	10	20	15	9	9	2	2	9	9	149
10/17/03	Silver Cr	JD-I3	11	19	20	19	15	19	9	9	10	8	6	8	6	159
10/22/02	Silver Cr	CD-I1	18	19	18	19	16	19	18	10	10	9	9	10	10	185
10/17/03	Silver Cr	CD-I1	12	19	19	19	16	13	11	9	10	6	6	6	6	152
10/23/02	Silver Cr	CD-I2	12	18	18	19	18	20	15	10	10	10	10	10	10	180
10/16/03	Silver Cr	CD-I2	14	18	20	20	11	19	17	10	10	8	8	9	9	173
10/18/02	Silver Cr	CD-I3	13	17	13	19	9	20	17	9	9	4	5	9	9	153
10/23/03	Silver Cr	CD-I3	17	19	20	19	18	20	18	8	9	9	9	8	8	182
10/23/02	Brush Cr	BC-I1	18	16	10	18	17	19	18	9	8	9	9	9	8	168
10/9/03	Brush Cr	BC-I1	19	18	19	17	11	15	16	9	9	10	10	10	10	173
10/28/02	Brush Cr	BC-I2	15	16	6	18	11	20	17	2	2	6	6	9	9	137
10/3/03	Brush Cr	BC-I2	14	16	9	15	15	20	17	10	9	5	3	5	5	143
10/18/02	SFAR	SC-I1	14	18	16	15	10	12	15	9	9	2	2	2	2	126

Table 4.2-2. UARP site scale habitat values, years 2002 and 2003.

Date	Stream Name	Site Code	Epifaunal Sub./ Available Cover	Embeddedness	Velocity/Depth Regime	Sediment Deposition	Channel Flow Status	Channel Alteration	Riffle Frequency	Left Bank Stability	Right Bank Stability	Left Bank Veg Protection	Right Bank Veg Protection	Left Bank Riparian Veg	Right Bank Riparian Veg	Total
10/10/03	SFAR	SC-I1	13	18	19	19	18	13	13	10	10	8	8	9	10	168
10/14/02	SFAR	SC-I2	11	19	20	17	11	20	9	9	9	3	3	6	5	142
10/9/03	SFAR	SC-I2	12	19	20	19	18	19	14	10	10	3	3	6	6	159
10/23/02	SFAR	SC-I3	12	19	15	9	9	12	12	9	7	8	8	6	5	131
10/10/03	SFAR	SC-I3	16	19	16	19	11	20	17	8	8	9	9	10	10	172
10/29/02	Big Silver Cr	BSC	12	8	7	8	6	19	19	6	6	5	5	8	5	114
10/8/03	Big Silver Cr	BSC	15	5	15	12	8	19	13	8	8	8	8	8	8	135
10/15/03	Silver Fork	SILV	15	17	19	13	14	19	18	10	9	10	9	10	8	171
10/11/02	SFAR	SFAR	15	12	12	16	9	20	17	7	7	8	8	4	8	143
10/6/03	SFAR	SFAR	17	16	19	16	14	16	19	10	10	10	10	9	10	176

Table 4.2-3. Site scale habitat and water quality constituents for the Reach Downstream of Chili Bar and reference sites, years 2003 and 2004.

Site Code:	CB-I1		CB-I2		CB-I3		CB-I4		CB-I5		CB-I7		NF-PON	COS-2
Habitat Parameters	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2004	2004
Epifaunal Substrate Available Cover	9	10	13	8	13	12	14	16	16	16	11	14	15	15
Embeddedness	19	19	19	18	14	14	15	13	17	19	14	18	18	16
Velocity/Depth Regime	14	15	20	15	18	14	17	19	19	19	20	19	16	15
Sediment Deposition	12	19	19	18	16	11	11	18	18	18	17	18	19	17
Channel Flow Status	10	15	13	10	12	10	11	15	11	15	11	15	18	20
Channel Alteration	12	13	20	19	14	16	19	19	19	20	19	19	20	20
Riffle Frequency	13	13	17	14	18	16	18	19	18	17	18	12	19	18
Left Bank Stability	4	8	10	10	8	8	10	9	10	10	10	10	10	10

Table 4.2-3. Site scale habitat and water quality constituents for the Reach Downstream of Chili Bar and reference sites, years 2003 and 2004.

Site Code:	CB-I1		CB-I2		CB-I3		CB-I4		CB-I5		CB-I7		NF-PON	COS-2
Habitat Parameters	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2004	2004
Right Bank Stability	9	9	10	10	9	9	7	9	8	10	10	10	9	7
Left Bank Veg Protection	4	7	9	5	8	9	10	8	10	10	9	10	8	10
Right Bank Veg Protection	5	9	6	5	9	5	9	9	10	10	10	9	8	9
Left Bank Riparian Zone	4	6	9	8	7	5	10	8	9	8	9	6	9	7
Right Bank Riparian Zone	5	6	5	8	9	9	8	9	9	8	10	7	8	8
Total Habitat Score:	120	149	170	148	155	138	159	171	174	180	168	167	177	172
Water Quality Constituents														
Water Temperature (°C)	14	13	14	13	16	13	16	14	14	14	15	13	9.9	9.6
pH	7.3	ND	8.4	ND	7.1	6.2	8.0	5.7	7.5	ND	7.7	6.9	6.0	ND
Specific Conductance (µS/cm)	25	25	20	34	20	25	20	29	33	28	130	50	125	43
Dissolved Oxygen (mg/l)	ND	9.5	9.0	12	9.3	9.5	9.6	9.8	ND	12	9.0	10	11	14

ND: Not Determined

Four of the sites scored within the optimal range for both years' assessments; only one site (CB-I1) scored in the suboptimal range for both years (Table 4.2-3). The remaining sites varied by year between suboptimal and optimal. Water temperature ranged from 9.6 to 16 ˚C, pH ranged from 5.7 to 8.4, specific conductance ranged from 20 to 130 µS/cm and dissolved oxygen ranged from 9.0 to 14 mg/l.

5.0 ANALYSIS

5.1 Upper American River Project

5.1.1 Upper Project Area (GBVF subregion)

Composite metric scores are shown in Figure 5.1-1 for sites within the upper project area and allow for comparisons with other project sites and reference sites. A group of sites with no variation in composite metric values 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 increases, sites, as represented by the three samples, 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 (see Section 3.2.2 for a more detailed description on the interpretation of composite metric scores).

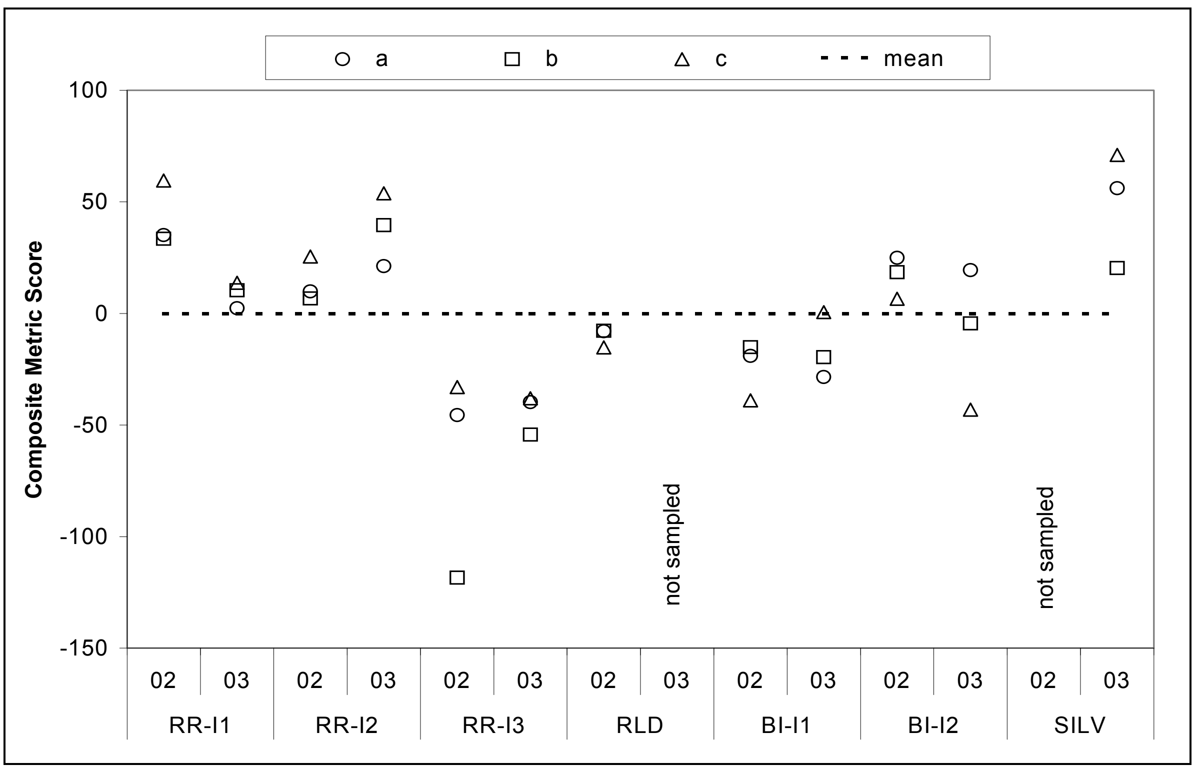


Figure 5.1-1. Composite metric scores for benthic macroinvertebrate samples (a, b, and c) collected from sites within the upper ecological subregion of the UARP, years 2002 and 2003. Site RLD was not sampled in 2003 because it was dry. Site SILV was not sampled in 2002 because it had not been identified as a potential reference site until 2003.

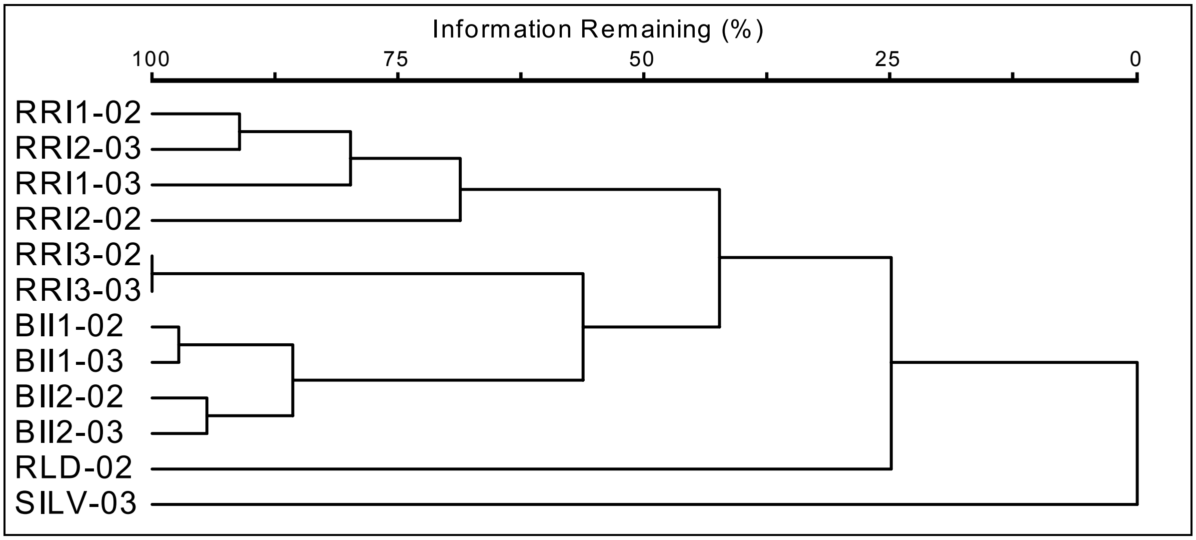


Figure 5.1-2. Dendrogram showing relative site (cumulative site totals) similarity based on the composition of benthic macroinvertebrates sampled from sites within the upper ecological subregion of the UARP, years 2002 (02) and 2003 (03).

Site SILV was included in the composite metric score analysis even though it does not fall within the boundaries of the GBVF subregion. Site SILV, however, was the highest elevation reference site in the project area and there were no reference sites established in the upper project area. A potential reference site was identified in year 2002 upstream of Rubicon Reservoir, but it was dry in the fall of 2002 and 2003. Several other potential reference sites were considered (e.g., upstream of Ice House Reservoir, Ellis Creek), but all were dry or nearly dry during sampling. The SILV reference site was established in response to Aquatic TWG concerns for the lack of reference data following 2002 studies (Appendix H, item 1).

Composite metric scores for sites RR-I1, RR-I2, and BI-I2 (year 2002) were consistently above average and similar to the SILV site. In contrast, sites RR-I3, RLD and BI-I1 were consistently average or below average and below the range exhibited by the SILV reference site. Metric scores for site BI-I2 (year 2003) ranged above and below average. The consistently low score for site RR-I3 was due to the high percentage of oligochaetes (mostly naidids; Appendix B), which contributed to low richness, low diversity and high tolerance relative to the other sites (Appendix C).

A cluster dendrogram showing relative similarity of BMI composition for sites within the upper project area is shown in Figure 5.1-2. Annual BMI composition was similar for most sites, which supports results shown in the composite metric score plot (Figure 5.1-1). For example, BMI composition of site RR-I3 for both years was highly similar and BMI composition for sites RR-I1 and RR-I2 for both years formed a distinct cluster, which supports the grouping of these sites as shown by the composite metric score plot (Figure 5.1-1). BMI composition of the SILV reference site (year 2003) was relatively dissimilar when compared to the other sites except site RLD.

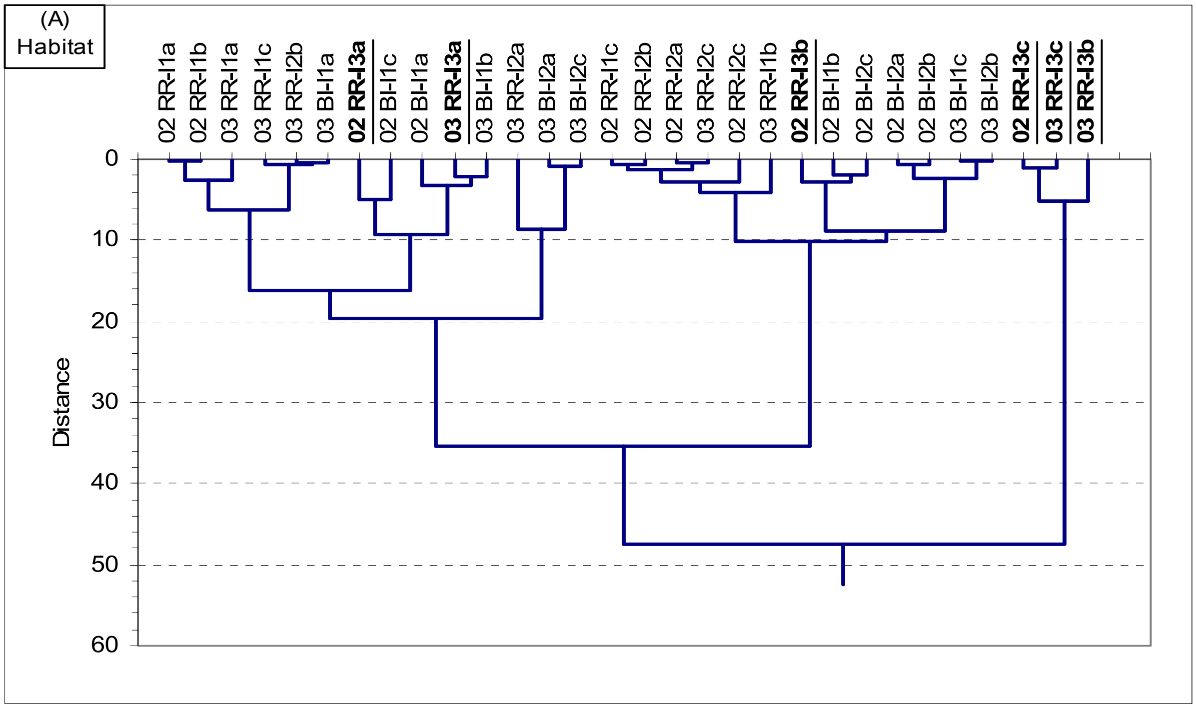
To evaluate factors contributing to site RR-I3's relatively low composite metric score, supplemental cluster dendrograms were prepared depicting relative site/transect similarity as a function of habitat (substrate, gradient, and canopy) and metrics (Figure 5.1-3). Buck Island Reach transects were included in the analysis for perspective. The analysis suggests that while composite metric scores are relatively similar for any given site and across years, habitat (substrate, gradient, and canopy) does not explain the similarity; another factor is driving the lower composite metric scores at RR-I3.

There was a more random grouping of transects comprising site RR-I3 for habitat variables when compared to metrics, which suggests factors other than substrate composition, gradient and canopy cover were contributing to relatively low composite metric scores for site RR-I3. The grouping of three RR-I3 transects was probably due to the dominance of bedrock documented along the transects. Other RR-I3 transects, however, with gravel and cobble dominated substrate had similarly low composite metric scores when compared to the transects with dominant bedrock substrate. Due to a lack of suitable riffle and cobble habitats for sampling, the "spot" method was used instead of sampling along transects at this site. Sampling efforts were, therefore, focused on the few patches of gravel and cobble within the predominantly bedrock channel. This may also have influenced the metric scores.

One possible explanation for the consistently low composite metric scores for site RR-I3 is the site's location immediately downstream of a meadow. The Rubicon River traverses through this low gradient meadow for approximately one mile just upstream of site RR-I3. This low gradient meadow habitat likely harbors a more lentic type of BMI assemblage, including populations of segmented worms and clams, which were documented from the RR-I3 transects and contributed to the site's low metric scores.

5.1.2 Middle Project Area (BVF subregion)

Composite metric scores are shown in Figure 5.1-4 for sites within the middle project area. The composite metric scores suggest fairly consistent trends: samples collected from sites immediately downstream of Loon Lake Reservoir and Ice House Reservoir were below average and scores increased with distance downstream of the reservoirs. There were, however, notable exceptions to the trends. The low composite metric score for sample LL-I2c in year 2003 was due to a locally abundant population of sphaeriid clams. While BMI composition was highly similar for site LL-I2 for both years as depicted in the dendrogram (Figure 5.1-5; Appendix B), the higher abundance of sphaeriid clams in sample "c" contributed to the composite metric score indicated in Figure 5.1-4. The relatively low score for sample LL-I3a in year 2003 was due an abundance of midge larvae (*Tanytarsini*), which comprised over half of the BMIs in the sample. The generally high metric score variability for site IH-I4 was due to low richness in sample "a" for both years.



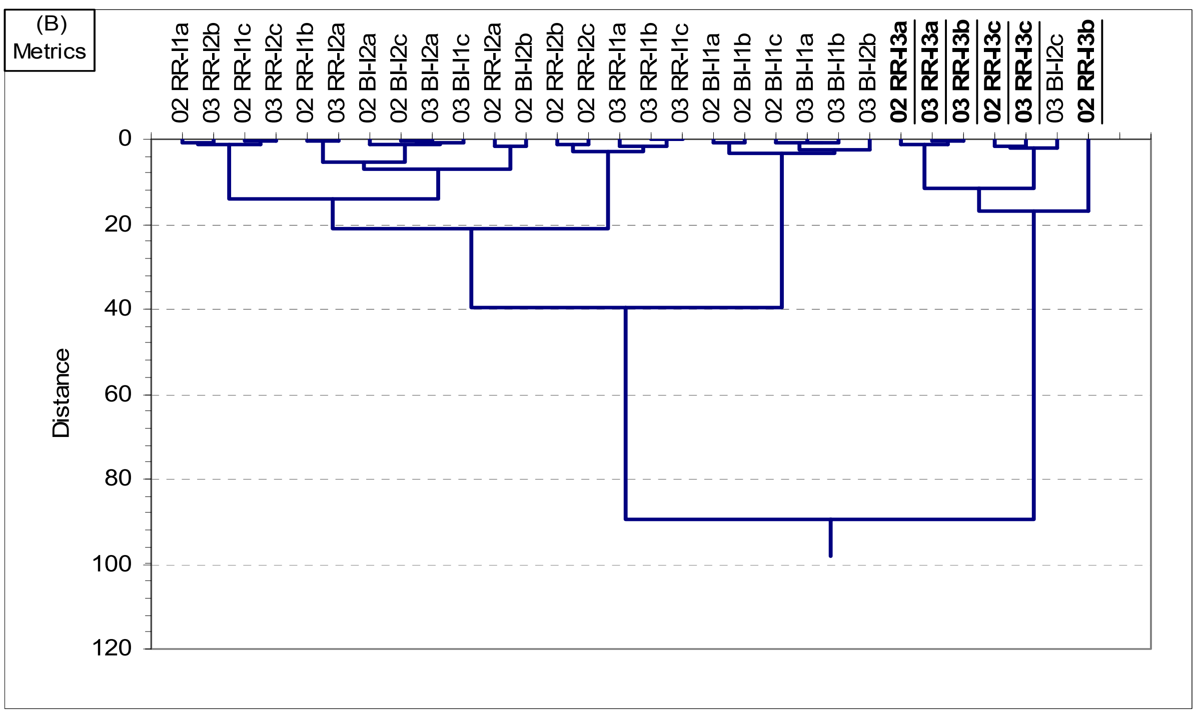


Figure 5.1-3 (A and B). Dendrograms showing relative site and transect (denoted as a, b and c) similarity based on habitat (dendrogram A) and metrics (dendrogram B) for the Rubicon Reservoir (RR) and Buck Island (BI) Reaches for years 2002 (02) and 2003 (03). Site RR-I3 transects are identified in bold and underlined for reference.

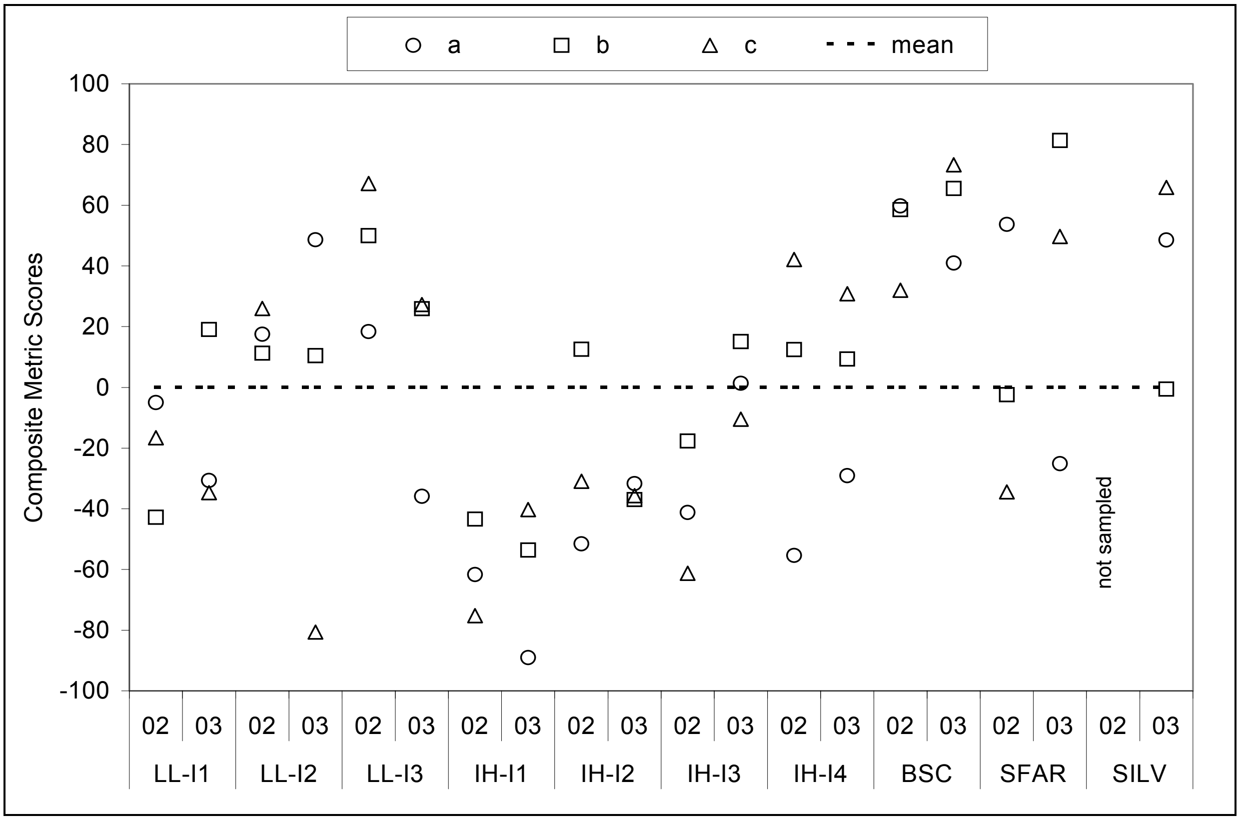


Figure 5.1-4. Composite metric scores for benthic macroinvertebrate samples (a, b, and c) collected from sites within the middle ecological subregion of the UARP, years 2002 and 2003.

Locally abundant black fly larvae in year 2002 contributed to the variability of metric scores for site IH-I2. Thirteen of the 15 samples collected from the reference sites (BSC, SFAR and SILV) ranked average and above. Locally abundant populations of hydropsychid caddisflies contributed to below average scores for two samples collected from site SFAR and their "patchy" distribution contributed to the relatively high variability in scores for both years. The riparian zone and upslope areas of two of the lower sites within the Ice House Dam Reach (IH-I3 and IH-I4) were affected by the Cleveland fire in 1992.

A cluster dendrogram showing relative similarity of BMI composition for sites within the middle project area is shown in Figure 5.1-5. Relatively high annual similarity in BMI composition was evident for sites with the exception of the Big Silver Creek (BSC) reference site. Annual variation in BMI composition of the BSC reference site was relatively high as depicted in the dendrogram where it clustered more closely to the BMI composition of the Loon Lake Dam Reach sites for year 2003. Annual variation in composite metric scores for site BSC, however, was low (Figure 5.1-4). This suggests that the composite metric scores are relatively insensitive to variation in BMI composition as long as the BMI taxa that contribute to variation share common attributes such as tolerance, numerical composition and trophic structure (i.e., Predator Richness).

Annual variation in taxonomic composition at site IH-I2 was due to localized, high populations of black fly larvae in year 2002. It is noteworthy that the elmid, *Heterlimnius*, was unique to site IH-I2 where it was collected during both sampling events in years 2002 and 2003 (Appendix B).

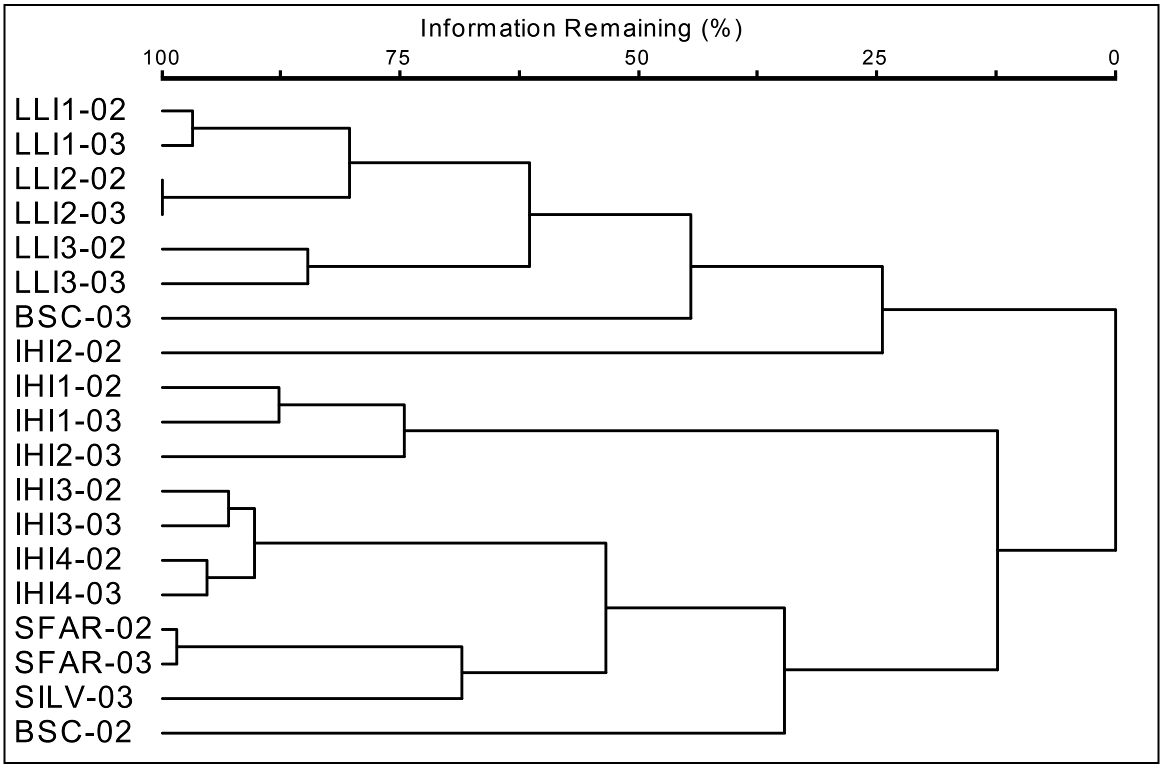


Figure 5.1-5. Dendrogram showing relative site (cumulative site totals) similarity based on the composition of benthic macroinvertebrates sampled from sites within the middle ecological subregion of the UARP, year 2002 (02) and 2003 (03).

To evaluate factors contributing to the trend of increasing composite metrics scores with distance downstream of Loon Lake Dam, supplemental cluster dendrograms were prepared depicting relative site/transect similarity as a function of habitat variables (substrate, gradient and canopy) and metrics (Figure 5.1-6). The BSC reference site was included in the analysis for perspective.

There was a more random grouping of transects comprising the Loon Lake Dam Reach sites for habitat variables when compared to metrics, which suggests factors other than substrate composition, gradient and canopy were more important influences on metrics. The habitat dendrogram shows several LL-I1 transects grouping closely with several BSC reference site transects, indicating relatively similar habitat. The metric dendrogram shows one LL-I1 transect grouping closely with several BSC reference site transects, indicating that the sample collected from this transect was similar to the BSC reference site samples in terms of metrics, which is supported by the composite metric score plot (Figure 5.1-4).

To evaluate factors contributing to the trend of increasing composite metrics scores with distance downstream of Ice House Dam, supplemental cluster dendrograms were prepared depicting relative site/transect similarity as a function of habitat variables (substrate, gradient, and canopy) and metrics (Figure 5.1-7). The BSC reference site was included in the analysis for perspective.

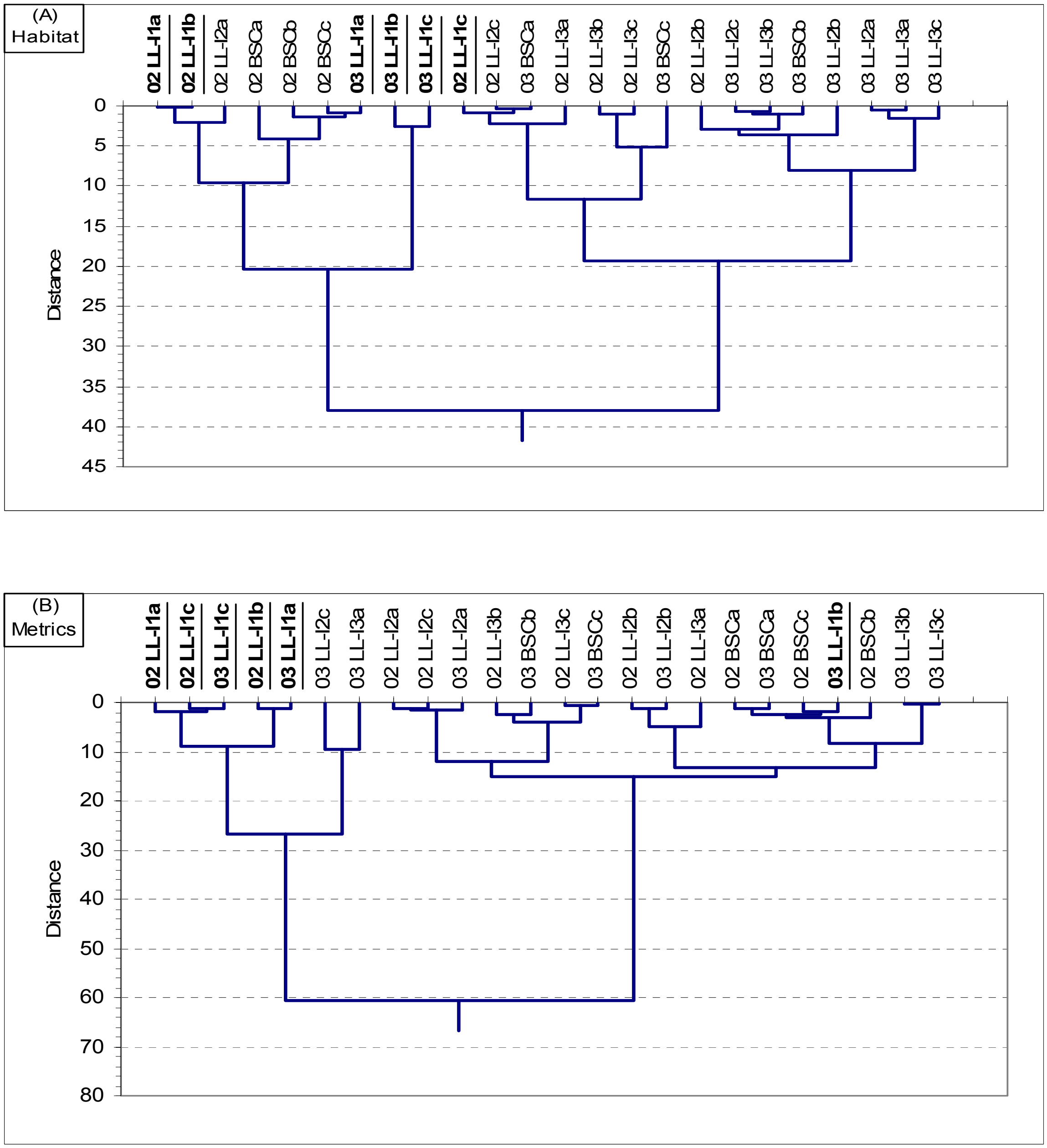


Figure 5.1-6 (A and B). Dendrograms showing relative site and transect (denoted as a, b and c) similarity based on habitat (dendrogram A) and metrics (dendrogram B) for the Loon Lake (LL) Reach and BSC reference, years 2002 (02) and 2003 (03). Site LL-I1 transects are identified in bold and underlined for reference.

There was a more random grouping of transects comprising the Ice House Reach sites for habitat variables when compared to metrics, which suggests factors other than substrate composition, gradient and canopy were more important influences on metrics. Only one of the IH-I1 transects grouped more closely with transects from other sites based on metrics, but these transects also had relatively low metric scores as shown in Figure 5.1-4. The BSC reference site transects formed two distinct habitat clusters by year but formed one distinct metric cluster.

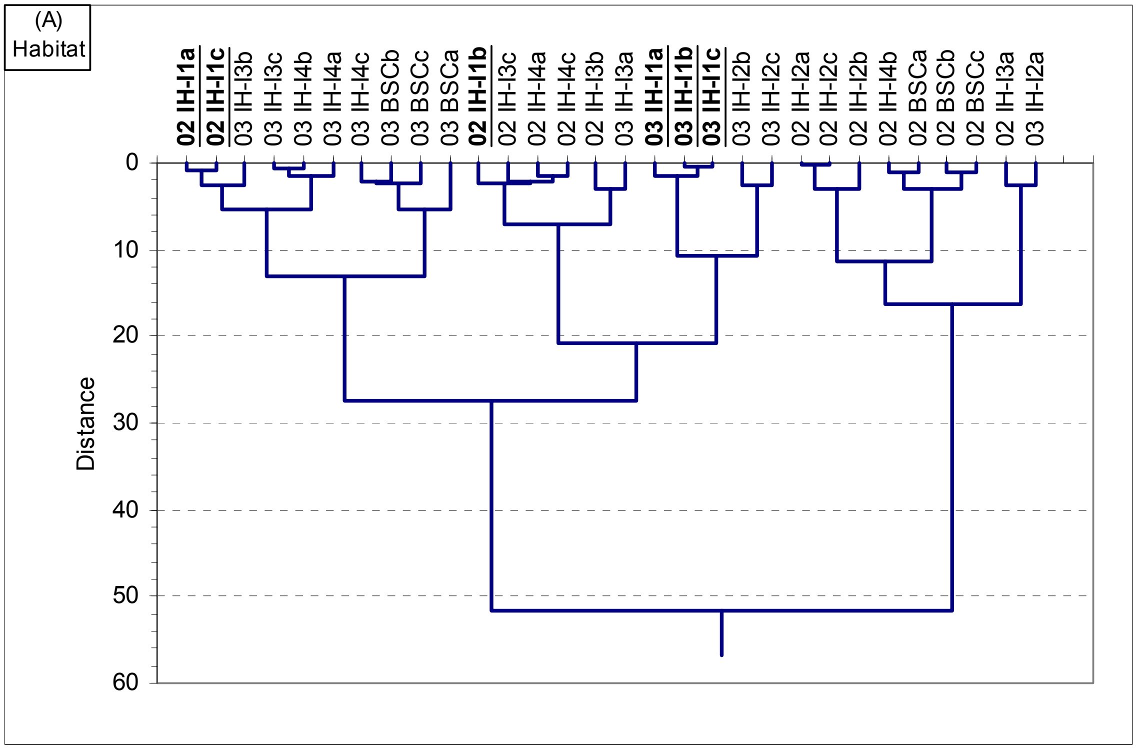
5.1.3 Lower Project Area (UFMB subregion)

Composite metric scores are shown in Figure 5.1-8 for sites that lie within the lower project area. Sites that scored consistently above average included RPD-I1, both Brush Creek sites and site SC-I1. On the other hand, sites GC-I1, JD-I1, and CD-I3 generally scored below average. Composite metric scores for sites GC-I2 and JD-I2 exhibited considerable annual variation: scores for both sites were consistently higher in year 2003. For both the Camino Dam and Slab Creek reaches there appeared to be a trend of decreasing composite metric scores with distance downstream from the dams. This pattern was especially evident for the Slab Creek sites where site SC-I1 ranked consistently above average for both years and site SC-I3 ranked consistently below average for both years.

A cluster dendrogram showing relative similarity of BMI composition of sites within the lower project area is shown in Figure 5.1-9. With the exception of the Brush Creek and Slab Creek sites, most sites within their respective reaches did not consistently group together. For example, BMI composition of site RPD-I1 in year 2002 was more closely associated with the BMI composition of site GC-I1 in year 2002 than it was to BMI composition of the other RPD sites. Also, while the BMI composition of site CD-I2 was highly similar in years 2002 and 2003, BMI composition of site CD-I1 was more closely associated with BMI composition of the Junction Dam sites. The annual taxonomic dissimilarity of the GC-I1 site was due to locally abundant sphaeriid clams, which accounted for nearly half the BMIs in the year 2003 samples.

While site JD-I1 scored similarly for both years, there was a notable difference in taxonomic composition (Figure 5.1-9; Appendix B). In year 2002, naidid worms accounted for 50 percent of the BMIs in samples from site JD-I1, while in year 2003 naidid worms accounted for less than 20 percent of the BMIs at site JD-I1; however, the high numerical abundance of midge larvae (nearly 60 percent of the BMIs) contributed to its low composite metric score in 2003. As was discussed for the annual variation of the BSC site (Section 5.1.2), the taxonomic composition of site JD-I1 varied by year but composite metric scores were consistent for both years.

To evaluate factors contributing to the trend of increasing composite metric scores with distance downstream of Junction Dam, supplemental cluster dendrograms were prepared depicting relative site/transect similarity as a function of habitat variables (substrate, gradient, and canopy) and metrics (Figure 5.1-10). The SFAR reference site was included in the analysis for perspective.



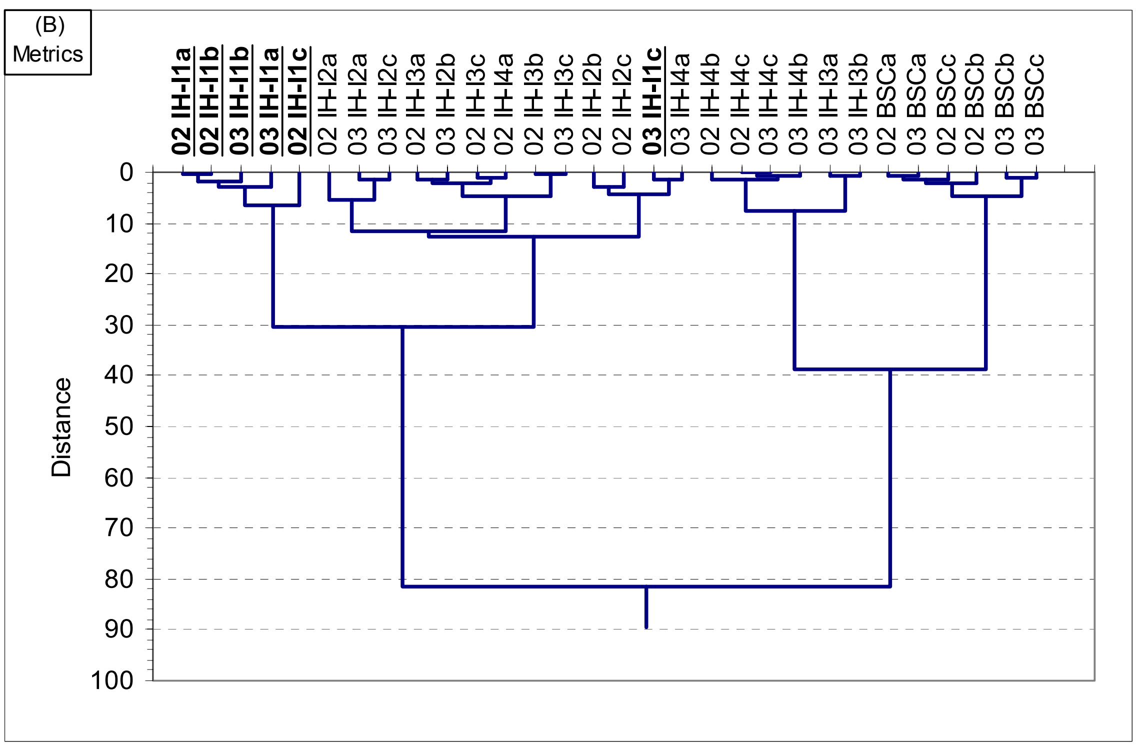


Figure 5.1-7 (A and B). Dendrograms showing relative site and transect (denoted as a, b and c) similarity based on habitat (dendrogram A) and metrics (dendrogram B) for the Ice House (IH) Reach and BSC reference site, years 2002 (02) and 2003 (03). Site IH-I1 transects are identified in bold and underlined for reference.

There was a more random grouping of transects comprising the Junction Dam Reach sites for habitat variables when compared to metrics, which suggests factors other than substrate composition, gradient, and canopy cover were contributing to relatively low metrics scores for site JD-I1 (Figure 5.1-10). Note that all JD-I1 transects and two JD-I2 transects form a metric group distinct from all other transects in the reach, including the SFAR reference site. While reference site transects do not group with JD-I1 transects for habitat, two JD-I3 transects group at a distance of seven from the JD-I1 transects based on habitat.

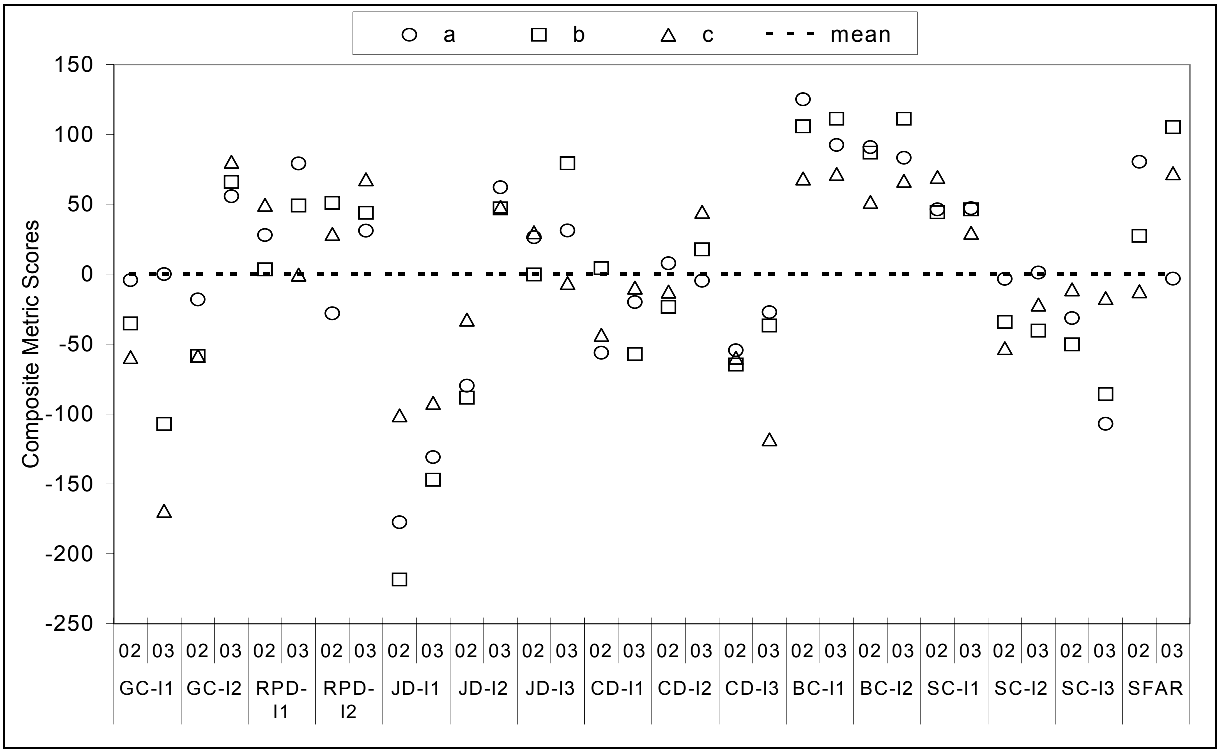


Figure 5.1-8. Composite metric scores for benthic macroinvertebrate samples (a, b, and c) collected from sites within the lower ecological subregion of the UARP, years 2002 and 2003.

To evaluate factors contributing to the trend of decreasing composite metrics scores with distance downstream of Slab Creek Dam, supplemental cluster dendrograms were prepared depicting relative site/transect similarity as a function of habitat variables (substrate, gradient and canopy) and metrics (Figure 5.1-11). The SFAR reference site was included in the analysis for perspective.

There was a more random grouping of transects comprising the Slab Creek Dam Reach sites for habitat variables when compared to metrics, which suggests factors other than substrate composition, gradient and canopy cover were contributing to relatively low metric scores for site SC-I3 (Figure 5.1-11). Transects comprising SC-I1 form a distinct cluster with respect to metrics but these same transects group with other transects for the other sites with respect to habitat. Two of the SC-I3 transects with low metric scores grouped closely with several SC-I1 and SC-I2 transects for habitat.

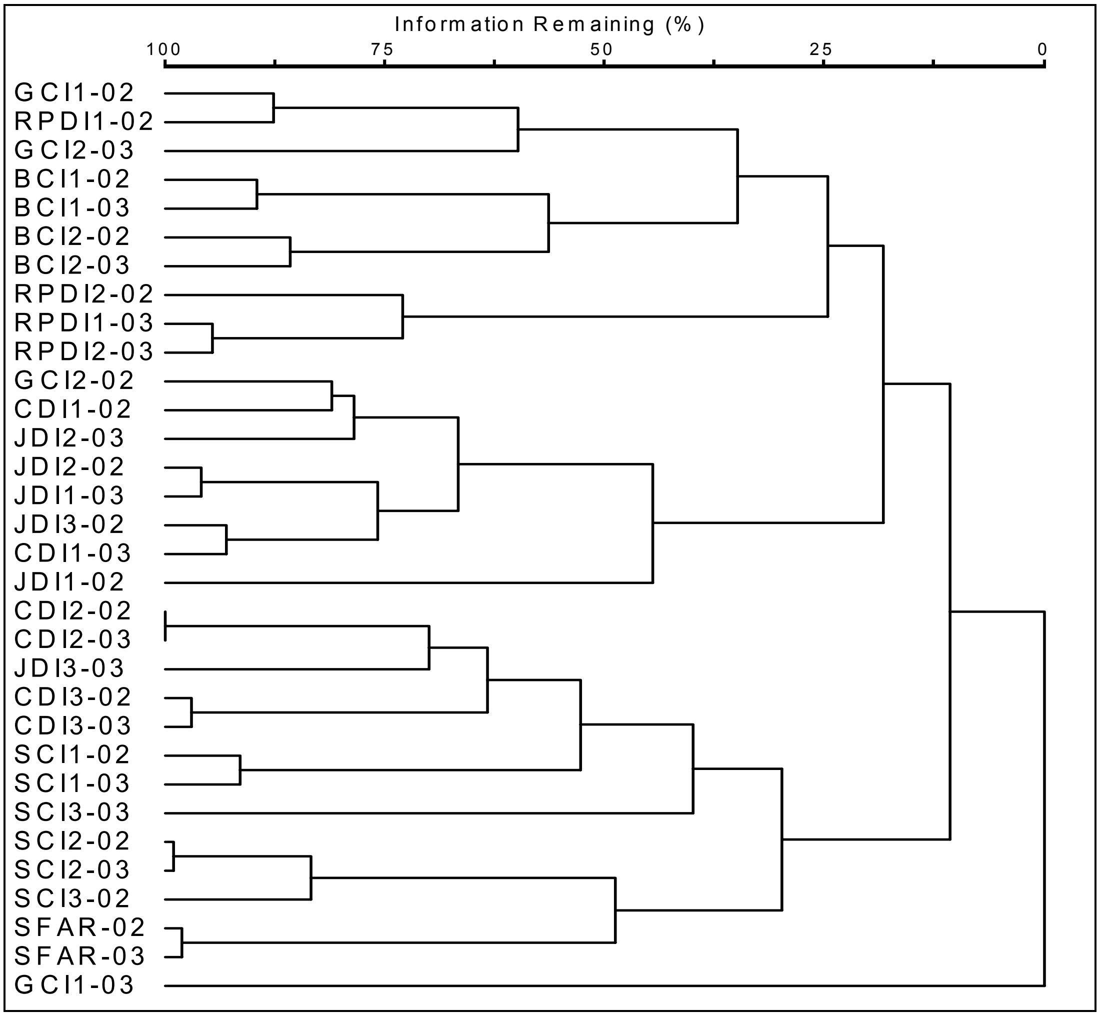
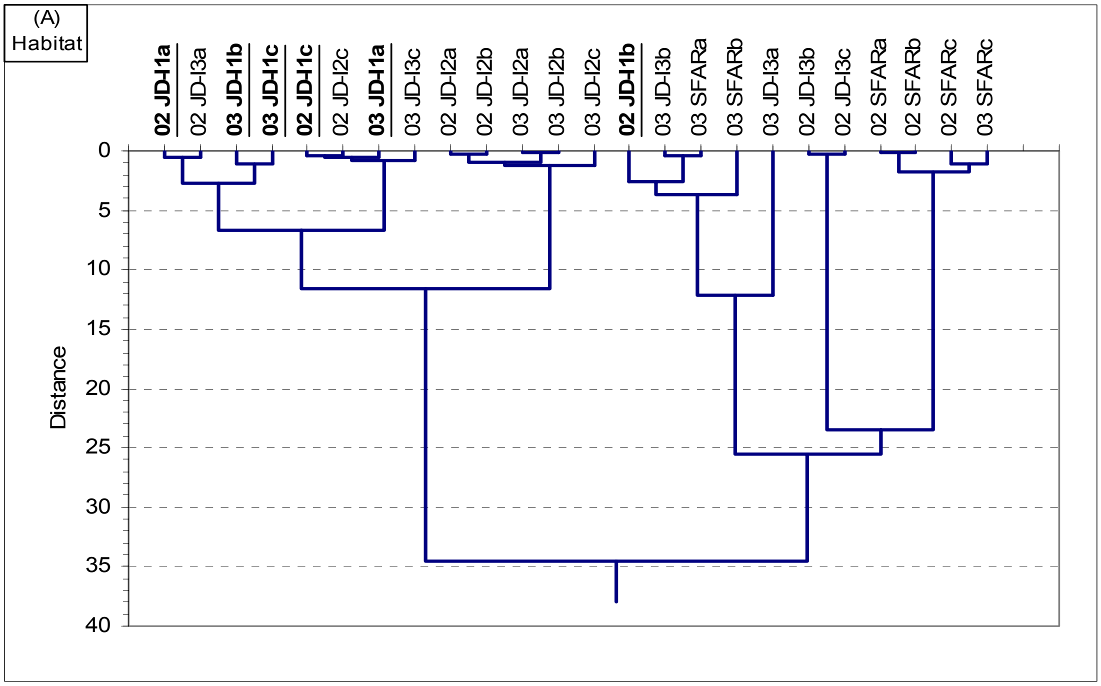


Figure 5.1-9. Dendrogram showing relative site (cumulative site totals) similarity based on the composition of benthic macroinvertebrate samples from sites within the lower ecological subregion of the UARP, years 2002 (02) and year 2003 (03).



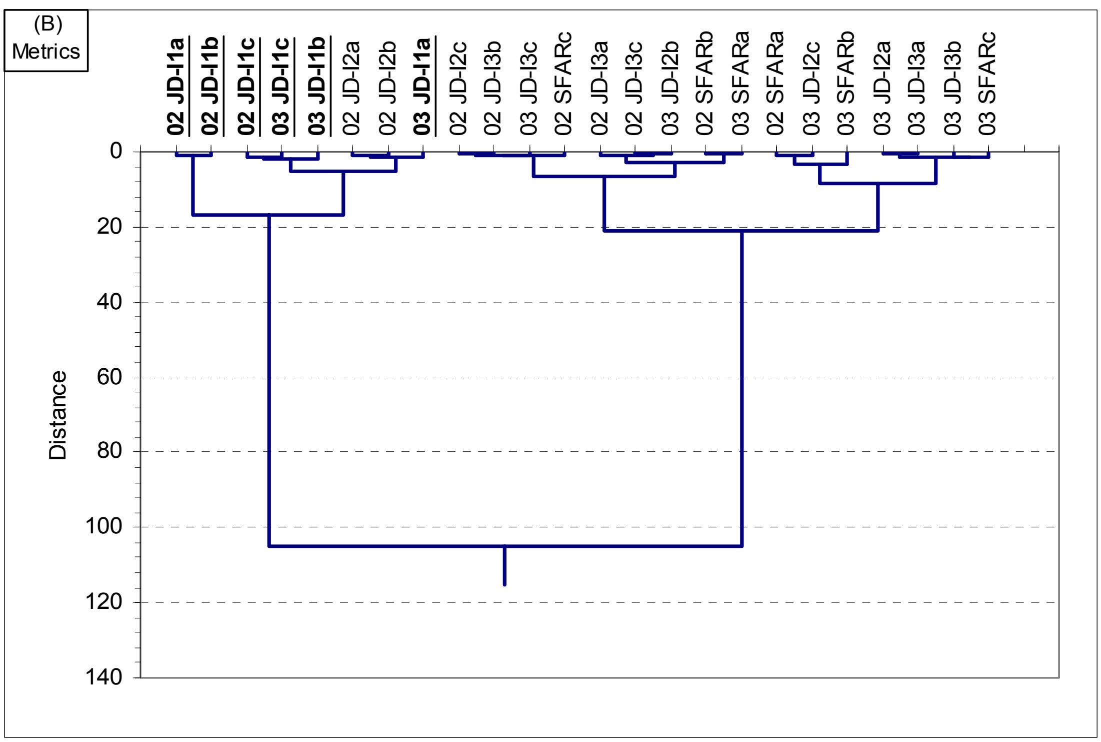
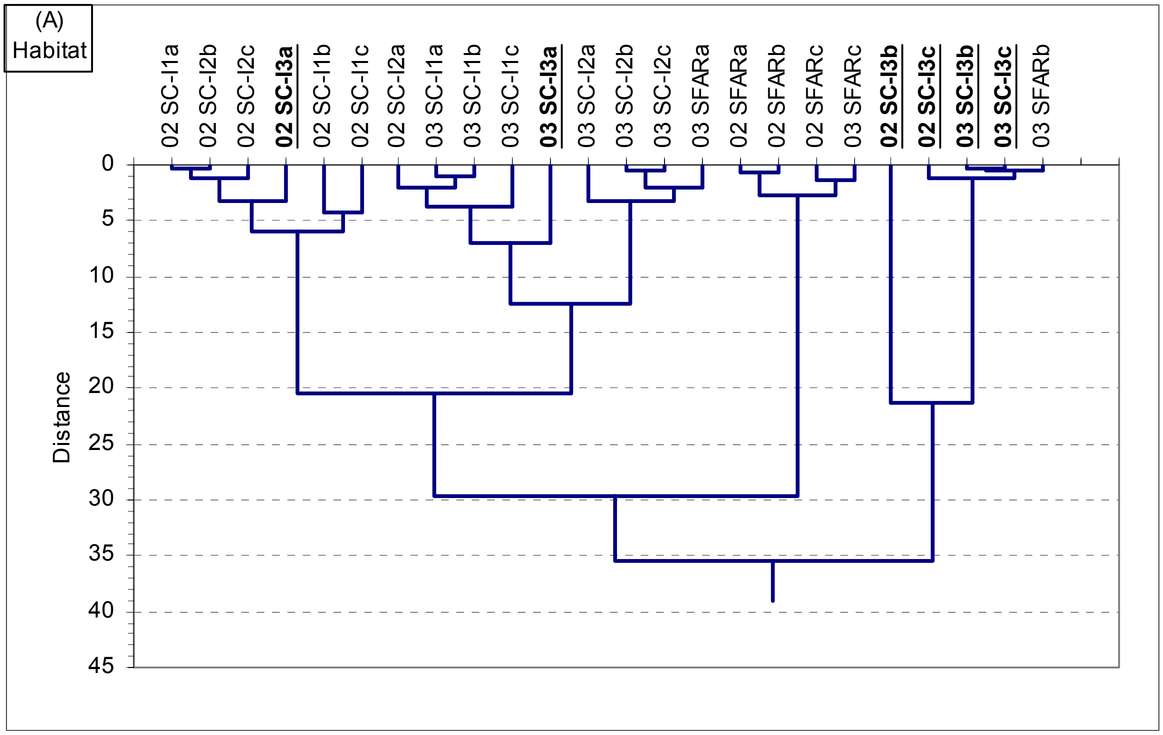


Figure 5.1-10 (A and B). Dendrograms showing relative site and transect (denoted as a, b and c) similarity based on habitat (Dendrogram A) and metrics (Dendrogram B) for the Junction Dam (JD) Reach and SFAR reference site for years 2002 (02) and 2003 (03). Site JD-I1 transects are identified in bold and underlined for reference.



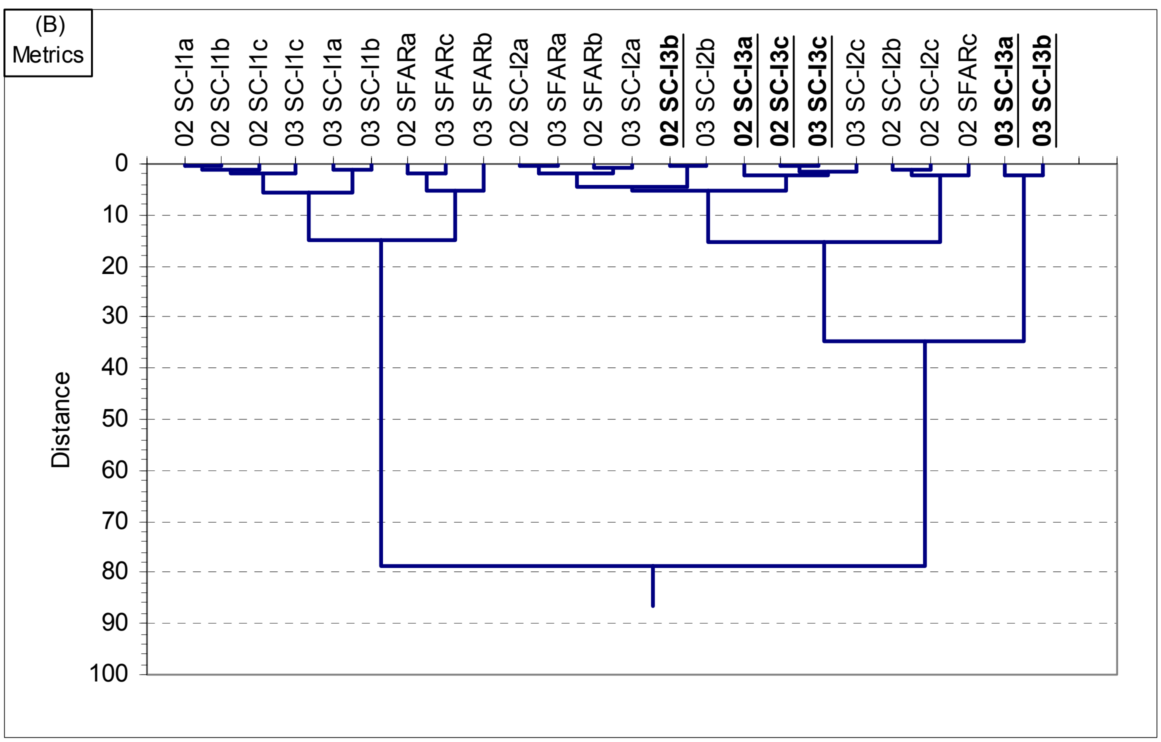


Figure 5.1-11 (A and B). Dendrograms showing relative site and transect (denoted as a, b and c) similarity based on habitat (Dendrogram A) and metrics (Dendrogram B) for the Slab Creek Dam (SC) Reach and SFAR reference site for years 2002 (02) and 2003 (03). Site SC-I3 transects are identified in bold and underlined for reference.

5.1.4 Overall Trends in the UARP

Annual Trends – Trends in annual variation of water/habitat quality as represented by composite metric scores were consistent for several sites within the UARP area. Sites with relatively high water/habitat quality for both years included RR-I1, RR-12, RPD-I1, BSC, BC-I1, BC-I2, SC-I1 and SC-I2. Sites with relatively lower water/habitat quality for both years included RR-I3, IH-I1, JD-I1, CD-I3 and SC-I3. Two sites, GC-I2 and JD-I2, exhibited high annual variability in water/habitat quality: in year 2002 both sites were characterized as relatively poor water/habitat quality and in year 2003 both sites were characterized as having relatively high water/habitat quality. Annual trends in water/habitat quality for the other sites fell within a more moderate range. The remaining sites were characterized as having a wide range of intra-site variation, where distinct trends in water/habitat quality were not evident. As one indication of annual consistency, normally distributed EPT Taxa metric values for years 2002 and 2003 showed no significant difference between years (paired t-test; $p>0.05$).

Reference Sites – Sites with higher water/habitat quality as defined by the composite metric scores and by comparisons with reference sites included: the two upstream Rubicon Dam Reach sites; the downstream Loon Lake Dam Reach site; the upstream Robbs Peak Dam Reach site; both Brush Creek Reach sites; and the Slab Creek Dam Reach site furthest upstream in the reach. Sites with relatively poorer water/habitat quality as defined by the composite metric scores and comparisons with reference sites included: the downstream Rubicon Dam Reach site; the upstream Loon Lake Dam Reach site; the upstream Gerle Creek Dam Reach site; the upstream Ice House Dam Reach site; the upstream Junction Dam Reach site; the downstream Camino Dam Reach site; and the two downstream Slab Creek Reach sites. Water/habitat quality of other UARP sites was variable when compared to reference sites.

Other Trends – Other notable trends include: (a) increase in overall composite metric score moving downstream from the largest project dams (Ice House, Loon Lake, and Junction reservoirs), suggesting potential impairment downstream of dams but recovery further along the reach; (b) decrease in overall composite metric score moving downstream in Camino Dam and Slab Creek Dam reaches, suggesting potential impairment at lower ends of reaches, and (c) lack or reductions of elmid beetle populations below the major reservoirs to recovery of elmid populations further downstream. Local habitat conditions including substrate composition, riffle gradient and canopy cover did not appear to influence these trends to a degree that precludes other factors from being more influential. These other factors could include water temperature and flow regime, which have been shown by others to be primary factors affecting benthic assemblages in unpolluted stream systems (Ward and Stanford 1979, Extence et al. 1999). Data presented in the draft Water Temperature Monitoring report would suggest strongly that low water temperature and water temperature constancy documented immediately downstream of the largest project dams contributed to the trends identified for the Loon Lake Dam, Ice House Dam and Junction Dam Reaches. Furthermore, this potential water temperature effect was limited to sites closest to project dam faces, which would explain the increasing trend of BMI assemblage quality with increasing distance downstream of these dams.

5.2 Reach Downstream of Chili Bar

5.2.1 Composite Metric Scores and Taxonomic Composition

Composite metric scores are shown in Figure 5.2-1 for sites within the Reach Downstream of Chili Bar (2003/2004) and reference sites, which were sampled in year 2004. For additional reference, 1995 Cosumnes River data (CDFG, unpublished data) from site COS-2 were included in the composite metric score analysis. The addition of the 1995 COS-2 data helped clarify questionable 2004 COS-2 sample integrity indicated by very low BMI abundance (130 to 680 BMIs; Appendix D). Low abundance for the 2004 COS-2 samples would be expected if subsamples were collected from a recently wetted benthos where BMIs had not yet colonized. An October storm event resulted in an increase in flow (measured at Michigan Bar) from 7 cfs to 200 cfs (http://cdec.water.ca.gov) on the day of COS-2 sampling. An examination of 1995 COS-2 abundance data revealed a more typical range of abundance values (1,900 to 2,200 BMIs; Appendix D). Sampling in the recently wetted area of the benthos likely contributed to the low score for sample "b" (Figure 5.2-1), which was also the sample with the lowest abundance. It is rare for samples to contain fewer than 300 BMIs from six sq. ft. of benthos.

The site immediately downstream of Chili Bar Dam (site CB-I1) scored consistently below average (Figure 5.2-1) while the reference sites and sites CB-I5 (year 2003) and CB-I7 (year 2004) scored consistently above average. Five of the six samples from site CB-I2 scored below average. The other sites within the Reach Downstream of Chili Bar ranked within an intermediate range with respect to the other sites.

Oligochaetes, primarily within the families Naididae and Enchytraeidae, were numerically dominant in most of the samples collected within the upper four sites of the Reach Downstream of Chili Bar (Figure 5.2-2; Appendix D). High oligochaete abundance and generally low richness and diversity contributed to the sites' low scores. Figure 5.2-2 also shows two metrics, cumulative site total EPT and Coleoptera Richness, which contributed to the scoring of sites shown in Figure 5.2-1.

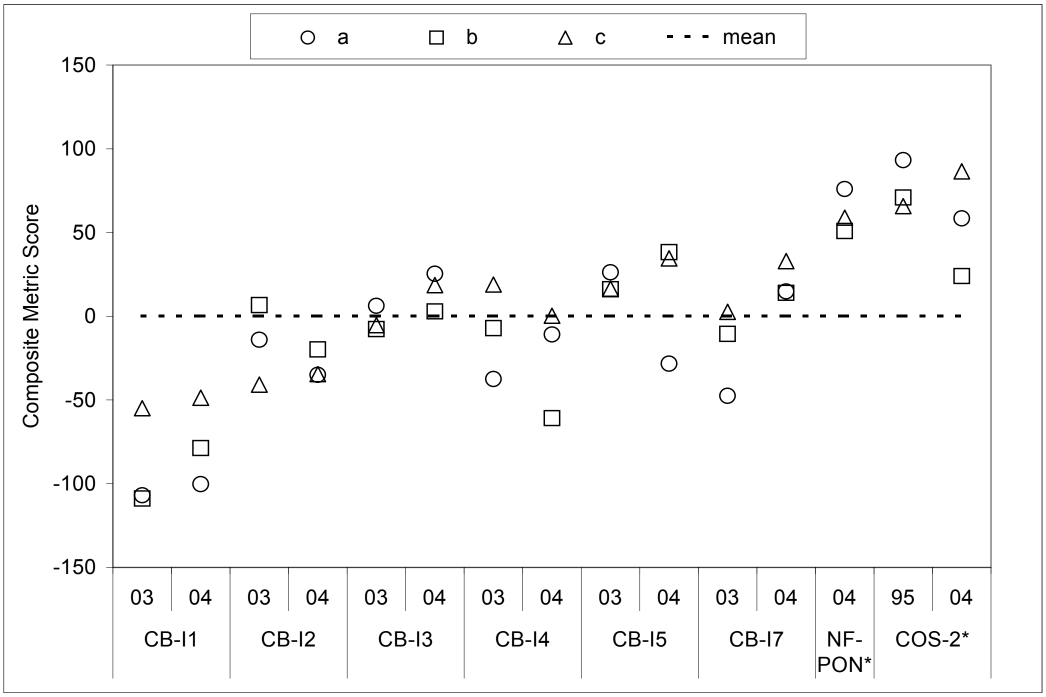


Figure 5.2-1. Composite metric scores for benthic macroinvertebrate samples (a, b, and c) collected from sites in the Reach Downstream of Chili Bar and reference sites (identified with asterisks), fall 2003 and 2004. Year 1995 COS-2 data were obtained from CDFG.

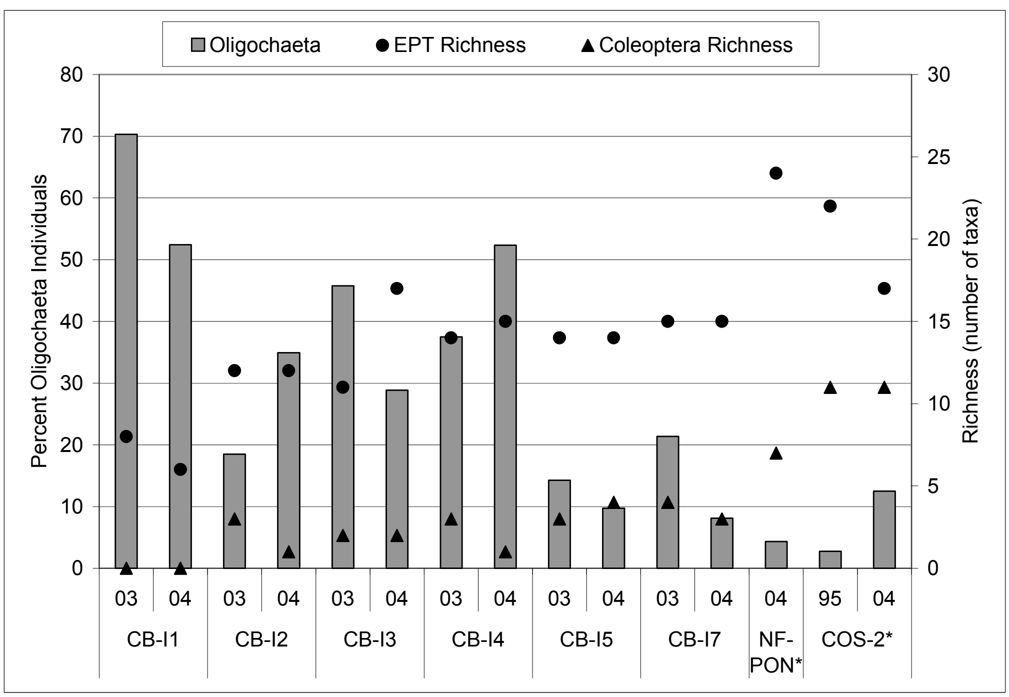


Figure 5.2-2. Plot of cumulative site total oligochaete individuals and EPT/Coleoptera Richness for the Reach Downstream of Chili Bar and reference sites (identified with asterisks). Year 1995 COS-2 data were obtained from CDFG.

A cluster dendrogram for sites within the Reach Downstream of Chili Bar and for reference sites shows relative site similarity based on BMI composition (Figure 5.2-3). At the highest level of grouping (1), BMI composition separated all sites within the Reach Downstream of Chili Bar from the reference sites. At the second highest level of grouping (2), BMI composition separated the two reference sites. There did not appear to be a meaningful grouping of sites by year of sampling, suggesting low annual variation in BMI composition (see also Appendix D). The distribution of oligochaete individuals and Coleoptera taxa shown in Figure 5.2-2 were major factors contributing to the partitioning of sites shown in the cluster dendrogram (Figure 5.2-3; Appendix D).

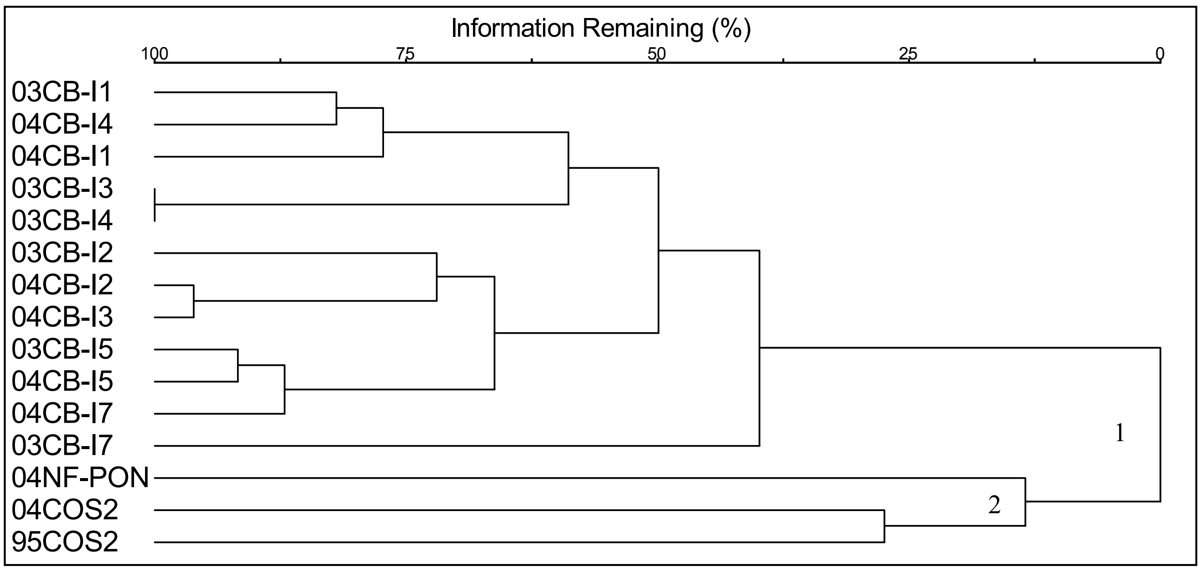


Figure 5.2-3. Dendrogram showing relative site similarity based on the composition of benthic macroinvertebrates sampled from the Reach Downstream of Chili Bar (CB) for years 2003 and 2004 and reference sites (NF-PON and COS2) for 2004. Year 1995 (95) COS-2 data were obtained from CDFG.

5.2.2 Abundance

Figure 5.2-4 shows high variability of BMI abundance for sample units for the Reach Downstream of Chili Bar and reference sites. The highest abundance values were documented at CB-I1 in year 2004. As described previously, abundance was especially low at site COS-2 in 2004 where one sample contained 230 BMI/m^2 as a result of sampling on the ascending limb of the hydrograph after a storm event. BMI abundance is inherently variable due to heterogeneous distributions of organisms in riffles (Allan 1995) and laboratory fixed-count subsampling. Additional reference sample data would be needed to conduct more definitive abundance analyses and a measure of biomass such as biovolume should typically be included in abundance studies.

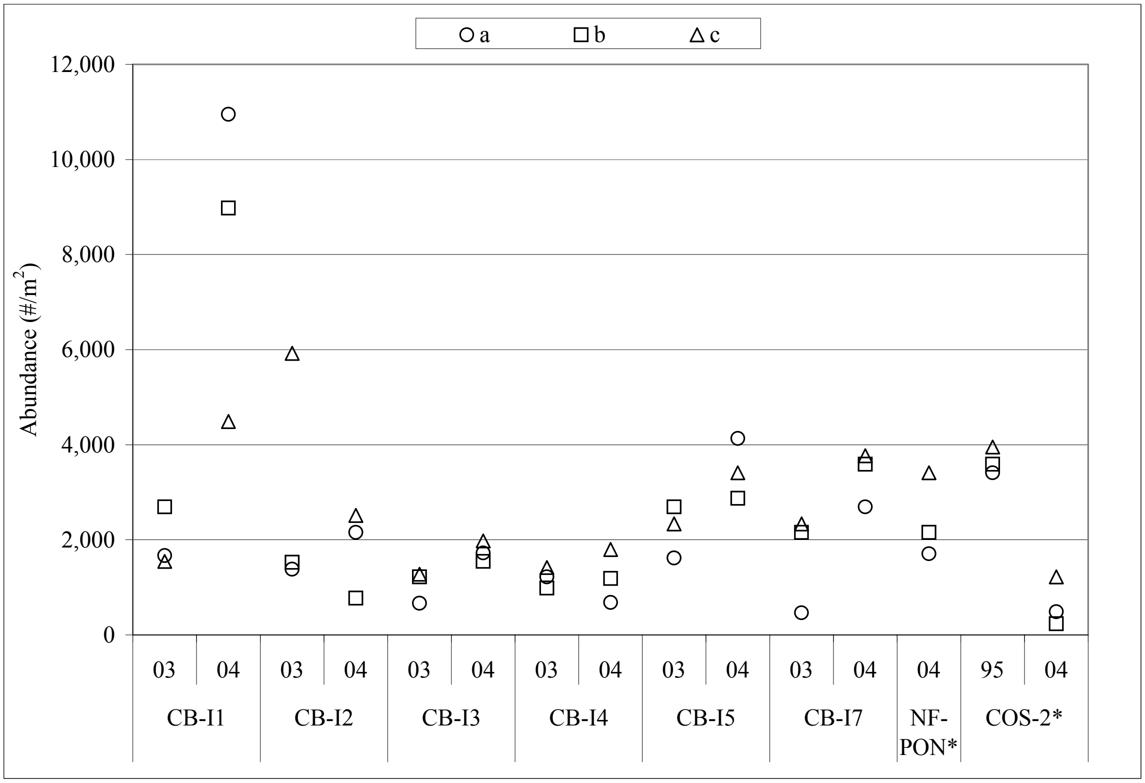


Figure 5.2-4. **Benthic macroinvertebrate abundance for sample units (denoted as a, b and c) within the Reach Downstream of Chili Bar and reference sites (identified with asterisks), years 2003 and 2004. Year 1995 COS-2 data were obtained from CDFG.**

5.2.3 Habitat Influences

To evaluate factors contributing to composite metric score variation, supplemental cluster dendrograms were prepared depicting relative site/transect similarity as a function of habitat variables (substrate, gradient, and canopy) and biological metrics (Figure 5.2-5). The reference sites for years 1995 and 2004 were included in the analysis for comparison.

There was a similar grouping of sites and transects for both habitat and biological metrics, which suggests that habitat contributed to the grouping of sites as a function of BMI assemblage quality. In particular, bedrock was a dominant substrate class at site CB-I1 and two of the CB-I2 transects, which contributed to the transects grouping by habitat and likely contributed to their grouping by metrics. Scatterplots were examined of composite metric scores versus individual habitat variables including mean substratum size (phi values), substrate complexity, gradient and canopy to further explore effects of habitat on BMI assemblage quality.

Mean substrate size and substrate complexity influenced BMI assemblage quality as shown in Figure 5.2-6 where substrate size and complexity explained approximately half of the variation in composite metric scores. Gradient did not influence composite metric scores and canopy data were highly skewed: canopy ranged from zero to 10 percent for 41 of the transects (Reach

Downstream of Chili Bar and NF-PON reference site) while canopy cover for the remaining three transects from year 2004 COS-2 ranged from 65 to 100 percent (Appendix F).

One would expect limited oligochaete colonization at sites with boulder and bedrock dominated substrates, but we found oligochaetes associated with attached algae, which is consistent with other field observations regarding naidid worms (Thorp and Covich 2001). Naidids and enchytraeids may also have been especially concentrated in small pockets of finer substrates present with the boulder and bedrock.

Frequent flow fluctuation may favor BMIs that are active swimmers or those that burrow into either fine substrates or attached algae, while alteration in water temperature regime is known to limit taxa that require temperature cues to complete their life cycles (Allan 1995, Ward and Stanford 1979, Armitage 1977). Also, temperature suppression reduces seasonal thermal accumulation required by many aquatic insect taxa to complete their life cycles. While natural history information is incomplete or lacking for aquatic enchytraeids (Healy and Fend 2000) and many naidid species, these diverse oligochaete families could be more tolerant of fluctuating flow because of their ability to burrow into damp substrate or attached algae. This premise is supported by the relatively high abundance of enchytraeid worms in samples collected for the Inundation Study conducted in 2003 at site CB-I3 within the Reach Downstream of Chili Bar, where it was the dominant taxon found in samples collected from a recently dewatered area of benthos.

Aquatic oligochaetes may not require the temperature cues and thermal accumulation that many insect taxa need to complete their life cycles; however, this premise is only suggested in the literature (Thorp and Covich 2001). Many enchytraeid species are found in cold environments with well-oxygenated waters or habitats where they have access to atmospheric oxygen (Healy and Bolger 1984).

In addition to the more adaptable and tolerant oligochaetes, intolerant taxa were also sampled from the Reach Downstream of Chili Bar. These taxa included the long-lived and relatively large shredder stonefly, *Pteronarcys*, and scraper mayflies, *Rhithrogena* and *Epeorus*. While EPT Richness was generally higher at the reference sites, stonefly richness within the middle and lower sections of the Reach Downstream of Chili Bar was similar to reference site stonefly richness (Appendix D).

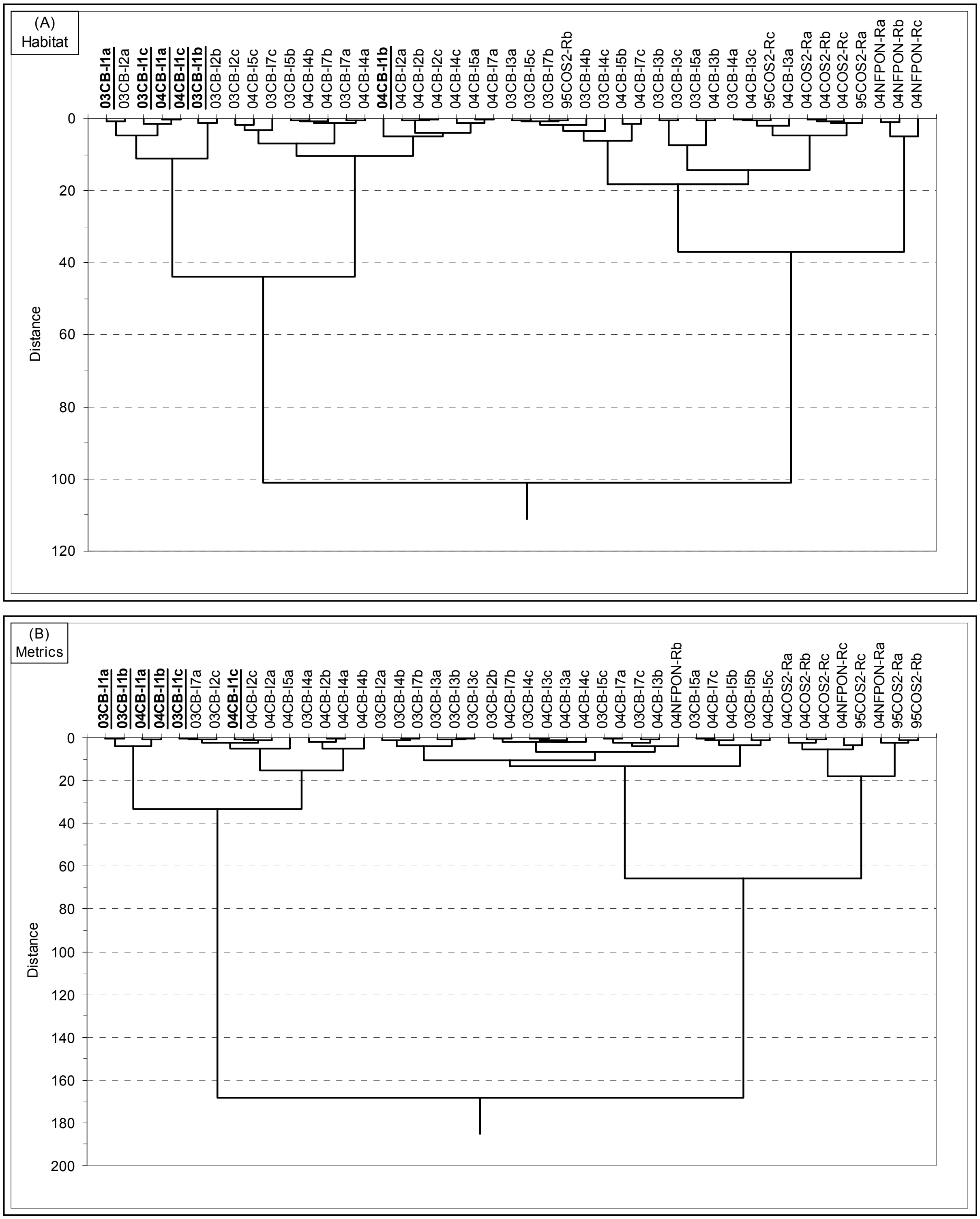


Figure 5.2-5 (A and B). Dendrograms showing relative site and transect (denoted as a, b and c) similarity based on habitat (Dendrogram A) and metrics (Dendrogram B) for the Reach Downstream of Chili Bar (CB) for years 2003 and 2004 and reference sites (R) for year 2004. Site CB-I1 transects are identified in bold and underlined for reference.

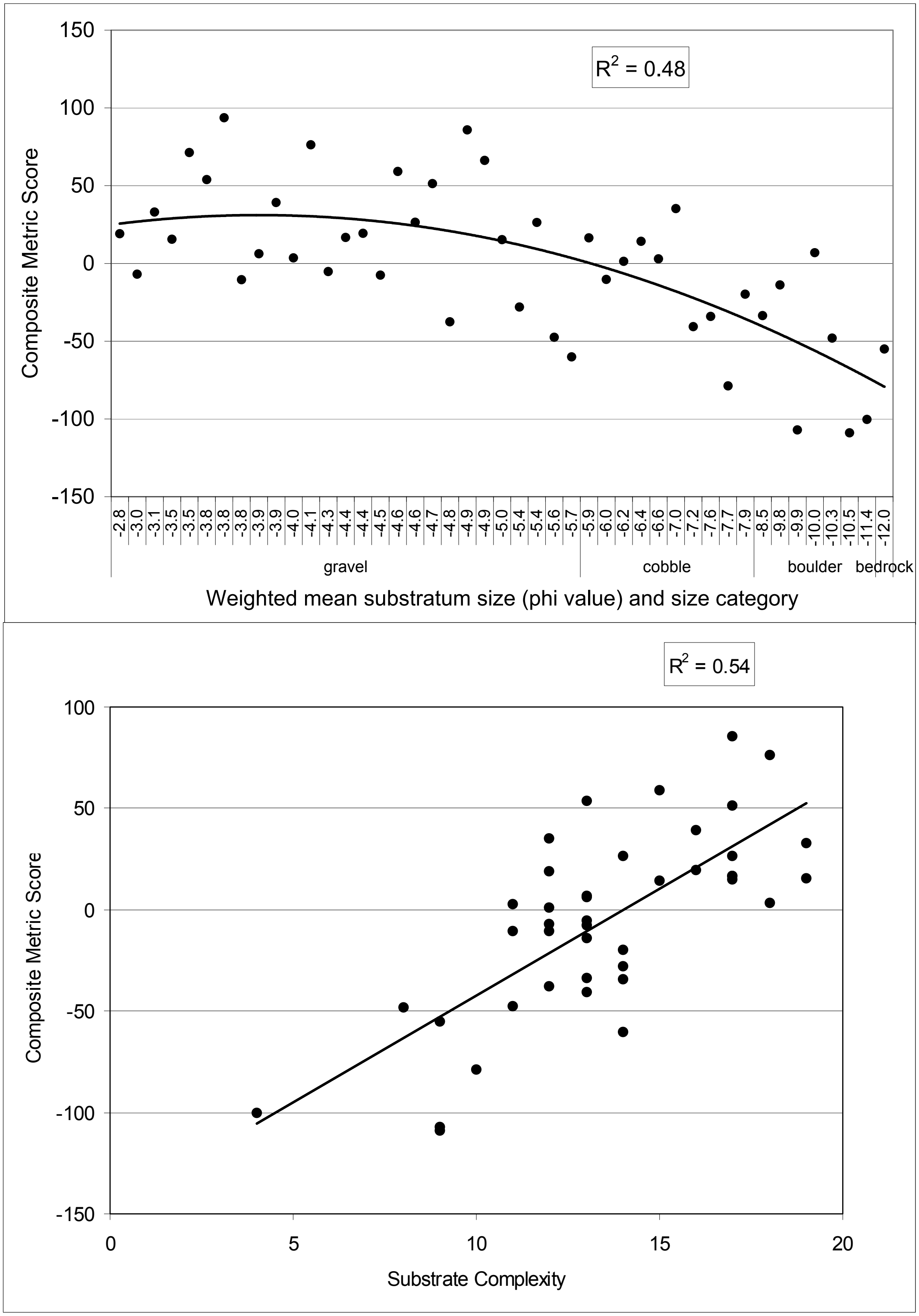


Figure 5.2-6 (A and B). Plots of mean substrate size (A) and substrate complexity (A) versus composite metric scores for the sample units established in the Reach Downstream of Chili Bar and reference sites.

5.2.4 Overall Trends in the Reach Downstream of Chili Bar

The water/habitat quality of sites within the Reach Downstream of Chili Bar were consistently lower than the water/habitat quality of reference sites as defined by BMI assemblage quality. However, a generally larger substrate composition (boulder and bedrock) contributed partially to the lower BMI assemblage quality in the upper section of the reach. Oligochaetes were particularly abundant at sites within the reach but were especially abundant in the upper reach when compared to oligochaete abundance at the reference sites. EPT and Coleoptera Richness were consistently lower in the Reach Downstream of Chili Bar, but stonefly richness was similar when compared to the reference sites. Although natural history information is incomplete for many BMI taxa, especially oligochaetes, the generally longer and more complex life cycles of EPT and Coleoptera taxa may have contributed to their more limited occurrence in the Reach Downstream of Chili Bar when compared to the reference sites. The burrowing behavior of oligochaetes may be favored in habitats with frequent fluctuating flow conditions and altered temperature regimes, the latter of which is known to limit BMI taxa that require temperature cues and thermal accumulation to complete their life cycles.

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APPENDIX A

HABITAT ASSESSMENT CRITERIA USED FOR THE UARP AND REACH DOWNSTREAM OF CHILI BAR

Table A1. Habitat assessment criteria used for the UARP and Reach Downstream of Chili Bar.

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

Table A1. Habitat assessment criteria used for the UARP and Reach Downstream of Chili Bar.

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Table A1. Habitat assessment criteria used for the UARP and Reach Downstream of Chili Bar.

10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.			Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.			Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.			Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.			
SCORE ___ (LB)	Left Bank	10	9	8	7	6	5	4	3	2	1	0	
SCORE ___ (RB)	Right Bank	10	9	8	7	6	5	4	3	2	1	0	

APPENDIX B

UARP TAXONOMIC LISTS OF BENTHIC MACROINVERTEBRATES BY YEAR AND BY ECOLOGICAL SUBREGION

Taxonomic list of benthic macroinveretebrates sampled from the UARP in years 2002 and 2003

	Final ID	CTV*	FFG**	2002	2003	Total
Arthropoda						
Insecta						
Coleoptera						
Dryopidae	Helichus (adult)	5	sh	1		1
Dytiscidae	Hydroporus (adult)	5	cg	1		1
	Liodessus obscurellus (adult)	5	p	1		1
	Nebrioporus/Stictotarus (adult)	5	p	1		1
	Oreodytes (adult)	5	p	1	1	2
Elmidae	Ampumixis dispar	4	cg	32	32	64
	Cleptelmis addenda	4	cg	120	162	282
	Cleptelmis addenda (adult)	4	sc	14	11	25
	Microcylloepus	4	cg	8	16	24
	Heterlimnius	4	cg	55	35	90
	Heterlimnius (adult)	4	cg		1	1
	Lara	4	sh	2	3	5
	Microcylloepus (adult)	4	sc		2	2
	Narpus	4	cg	4	6	10
	Optioservus	4	sc	464	274	738
	Optioservus (adult)	4	cg	32	82	114
	Ordobrevia nubifera	4	sc	20	51	71
	Ordobrevia nubifera (adullt)	4	cg	1	4	5
	Zaitzevia	4	sc	246	249	495
	Zaitzevia (adult)	4	cg	7	29	36
Hydraenidae	Hydraena (adult)	5	sc	1	3	4
	Ochthebius (adult)	5	sc		1	1
Psephenidae	Eubrianax edwardsii	4	sc	91	243	334
	Psephenus falli	4	sc	2	4	6
Ptilodactylidae	Stenocolus scutellaris	4	sh	1	1	2
Diptera						
Athericidae	Atherix pachypus	2	p	3	54	57
Blephariceridae	Blephariceridae	0	sc		5	5
Ceratopogonidae	Atrichopogon	6	cg	8	1	9
	Bezzia/ Palpomyia	6	p	29	62	91
	Dasyhelea	6	cg	6	8	14
	Forcipomyia	6	cg	2		2
Chironomidae	Chironomini	6	cg	462	261	723
	Orthocladiinae/Diamesinae	5	cg	3858	3270	7128
	Pseudochironomus	5	cg	1	2	3
	Tanypodinae	7	p	348	359	707
	Tanytarsini	6	cg	2039	3158	5197
Dixidae	Dixa	2	cg	8	5	13
	Dixidae	2	cg	2	1	3
	Meringodixa chalonensis	2	cg	1	1	2
Dolichopodidae	Dolichopodidae	4	p		9	9
Empididae	Chelifera/ Metachela	6	p	49	69	118
	Empididae	6	p	11	39	50
	Hemerodromia	6	p	69	69	138
	Trichoclinocera/Clinocera	6	p	2	11	13
	Wiedemannia	6	p	35	30	65

Taxonomic list of benthic macroinveretebrates sampled from the UARP in years 2002 and 2003

		Final ID	CTV*	FFG**	2002	2003	Total
	Muscidae	Muscidae	6	p	1		1
	Pelecorhynchidae	Glutops	3	p	2		2
	Psychodidae	Maruina lanceolata	2	sc	6	5	11
	Simuliidae	Prosimulium	3	cf	1	2	3
		Simulium	6	cf	1370	949	2319
	Stratiomyidae	Caloparyphus	7	cg		1	1
	Tabanidae	Tabanidae	8	p		1	1
	Tipulidae	Antocha	3	cg	91	135	226
		Cryptolabis	3	sh	87	90	177
		Dicranota	3	p	5	17	22
		Hexatoma	2	p	34	35	69
		Limnophila	4	p	1		1
		Limonia	6	sh	4	2	6
		Tipula	4	om	2	2	4
Ephemeroptera							
	Ameletidae	Ameletus	0	cg	40	72	112
	Baetidae	Acentrella	4	cg	5	5	10
		Baetis	5	cg	1750	1760	3510
		Camelobaetidius	4	cg		2	2
		Centroptilum	2	cg	3	4	7
		Diphetor hageni	5	cg	169	187	356
	Caenidae	Caenis	7	cg	3	1	4
	Ephemerellidae	Attenella	2	cg	5	11	16
		Caudatella	1	cg	25	55	80
		Drunella	0	cg	18	34	52
		Ephemerella	1	cg	1052	542	1594
		Ephemerellidae	1	cg		14	14
		Serratella	2	cg	3	50	53
	Heptageniidae	Cinygma	2	sc	147	138	285
		Cinygmula	4	sc	478	299	777
		Epeorus	0	sc	628	724	1352
		Heptageniidae	4	sc	3	4	7
		Ironodes	4	sc	794	840	1634
		Leucrocuta/Nixe	1	sc	1	3	4
		Rhithrogena	0	sc	173	198	371
	Leptohyphidae	Tricorythodes	4	cg	7	2	9
	Leptophlebiidae	Paraleptophlebia	4	cg	1425	1326	2751
Lepidoptera							
	Pyralidae	Petrophila	5	sc	16	12	28
Megaloptera							
	Corydalidae	Corydalidae	0	p	1		1
		Orohermes crepusculus	0	p	135	118	253
	Sialidae	Sialis	4	p	7	11	18
Odonata							
	Aeshnide	Aeshna	5	p	1		1
	Calopterygidae	Hetaerina americana	6	p	2		2
	Coenagrionidae	Argia	7	p	103	113	216
		Coenagrionidae	6	p		2	2
	Cordulegastridae	Cordulegaster dorsalis	3	p	1	1	2

Taxonomic list of benthic macroinveretebrates sampled from the UARP in years 2002 and 2003

	Final ID	CTV*	FFG**	2002	2003	Total
Gomphidae	Gomphidae	4	p	3	3	6
	Octogomphus specularis	4	p	10	10	20
Plecoptera						
Capniidae	Capniidae	1	sh	32	25	57
Chloroperlidae	Haploperla chilnualna	1	p	2	2	4
	Kathroperla	0	p	1		1
	Paraperla	0	p		2	2
	Suwallia	1	p		1	1
	Sweltsa	1	p	350	274	624
Leuctridae	Despaxia augusta	0	sh	10	6	16
	Leuctridae	0	sh	18	12	30
	Moselia infuscata	0	sh	31	3	34
	Paraleuctra	0	sh	2		2
Nemouridae	Malenka	2	sh	33	151	184
	Nemoura spinoloba	1	sh	10	2	12
	Soyedina	2	sh		11	11
	Visoka cataractae	0	sh		1	1
	Zapada	2	sh	2025	1176	3201
Peltoperlidae	Soliperla	1	sh		1	1
	Yoraperla	1	sh	257	186	443
Perlidae	Calineuria californica	1	p	417	486	903
	Doroneuria baumanni	1	p	8	6	14
	Hesperoperla	2	p	77	88	165
Perlodidae	Cultus	2	p	28	36	64
	Frisonia picticepes	2	p	1		1
	Isoperla	2	p	128	78	206
	Kogotus nomus	2	p	2	1	3
	Oroperla barbara	2	p	5	2	7
	Perlinodes aureus	2	p	10	1	11
	Perlodidae	2	p	7	13	20
	Skwala parallela	2	p	25	10	35
Pteronarcyidae	Pteronarcys	0	om	16	13	29
Taeniopterygidae	Taeniopterygidae	2	om	45		45
Trichoptera						
	Trichoptera	0		19	2	21
Apataniidae	Apatania	1	sc	14	8	22
	Pedomoecus sierra	0	sc		1	1
Brachycentridae	Amiocentrus aspilus	3	cg	25	84	109
	Micrasema	1	mh	216	306	522
Calamoceratidae	Heteroplectron californicum	1	sh	2	5	7
Glossosomatidae	Agapetus	0	sc		1	1
	Anagapetus	0	sc	10	21	31
	Glossosoma	1	sc	39	44	83
	Protoptila	1	sc	1		1
Helicopsychidae	Helicopsyche borealis	3	sc	15	4	19
Hydropsychidae	Arctopsyche	1	p	35	80	115
	Cheumatopsyche	5	cf	668	425	1093
	Hydropsyche	4	cf	1566	1179	2745
	Parapsyche	0	p	11	7	18

Taxonomic list of benthic macroinveretebrates sampled from the UARP in years 2002 and 2003

	Final ID	CTV*	FFG**	2002	2003	Total
Hydroptilidae	Hydroptila	6	ph	109	209	318
	Hydroptilidae	4	ph	6	4	10
	Leucotrichia pictipes	6	sc	11	1	12
	Nothotrichia shasta	4	ph	88	194	282
	Ochrotrichia	4	ph	3	2	5
Lepidostomatidae	Lepidostoma	1	sh	188	203	391
Leptoceridae	Mystacides	4	om	2	3	5
	Oecetis	8	p	4	2	6
Limnephilidae	Eocosmoecus	4	sh	2		2
	Limnephilidae	4	sh	3	1	4
Philopotamidae	Chimarra	4	cf	155	36	191
	Dolophilodes	2	cf	29	26	55
	Philopotamidae	3	cf	1	2	3
	Wormaldia	3	cf	62	16	78
Phryganeidae	Yphria californica	1	p	1		1
Polycentropodidae	Polycentropus	6	p	14	7	21
Psychomyiidae	Tinodes	2	sc		1	1
Rhyacophilidae	Rhyacophila	0	p	226	295	521
Sericostomatidae	Gumaga	3	sh	112	204	316
Uenoidae	Neophylax	3	sc		2	2
	Oligophlebodes	0	sc	11	40	51
Arachnoidea						
Acari						
Hydryphantidae	Partunia	5	p		2	2
	Protzia	8	p		11	11
Hygrobatidae	Hygrobates	8	p	13	48	61
Lebertiidae	Lebertia	8	p	74	189	263
Sperchontidae	Sperchon	8	p	66	131	197
	Sperchonopsis	8	p	14	24	38
Torrenticolidae	Torrenticola	5	p	52	290	342
Malacostraca						
Amphipoda						
Crangonyctidae	Crangonyx	4	cg	30	52	82
Hyalellidae	Hyalella	8	cg		2	2
Isopoda						
Asellidae						
	Caecidotea	8	cg	43	130	173
Ostracoda						
	Ostracoda	8	cg	8	19	27
Annelida						
Oligochaeta						
Lumbriculida						
Lumbriculidae	Lumbriculidae	8	cg	16	1	17
Tubificida						
Enchytraeidae	Enchytraeidae	8	cg	120	240	360
Naididae	Naididae/Tubificidae	8	cg	1521	1336	2857
Coelenterata						
Hydrozoa						
Hydroida						

Taxonomic list of benthic macroinveretebrates sampled from the UARP in years 2002 and 2003

	Final ID	CTV*	FFG**	2002	2003	Total
Hydridae	Hydra	5	p		28	28
Mollusca						
Gastropoda						
Prosobranchia						
	Prosobranchia	5	sc		1	1
Pleuroceridae	Juga	7	sc		17	17
Bivalvia						
Pelecypoda						
Sphaeriidae	Sphaeriidae	8	cf	645	1210	1855
Gastropoda						
Pulmonata						
Ancylidae	Ferrissia	6	sc	2	8	10
Physidae	Physa/ Physella	8	sc	11	147	158
Planorbidae	Gyraulus/Menetus	8	sc	2	1	3
	Planorbidae	6	sc		15	15
Nemertea						
Enopa						
Tertastemmatidae	Prostoma	8	p	30	38	68
Platyhelminthes						
Turbellaria						
Tricladida						
Planariidae	Planariidae	4	p	172	268	440
			Total macroinvertebrates subsampled:	34665	34626	5327 1

*CTV: California Tolerance Value
**Functional Feeding Group:
- cg: collector-gatherer
- cf: collector-filterer
- sc: scraper
- p: predator
- sh: shredder
- mh: macrophyte herbivore
- om: omnivore
- ph: piercer herbivore

Fall 2002 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP glaciated batholith and volcanic flow subregion.

Final ID	RR-I1	RR-I2	RR-I3	RLD-I1	BI-I1	BI-I2
Aeshna					1	
Ameletus	4	1	1			2
Amiocentrus aspilus	2	2		4		
Antocha	10	14	1			1
Apatania	2					
Atherix pachypus		3				
Atrichopogon	1			1		
Baetis	32	27	1	24	27	51
Bezzia/ Palpomyia	5		2	1	1	
Caenis	1		2			
Calineuria californica	9	13	1	23	3	14
Centroptilum				1		
Chelifera/ Metachela		3			1	
Chironomini	34	29	7	17	17	13
Cinygma					31	2
Cinygmula	27	34	2		1	
Cleptelmis addenda		6	9	6	16	59
Cleptelmis addenda (adult)		1		2		8
Corbiculacea	2		51	11	143	86
Cryptolabis	35					
Dasyhelea		3	1			
Diphetor hageni	22	8	2	2	1	2
Dixa				2		5
Dixidae	2					
Drunella	1					
Empididae			2			
Enchytraeidae	5	2	25	5	18	1
Epeorus	31	39	2			14
Ephemerella	25	13	1	429	120	135
Eubrianax edwardsii	26	4				3
Ferrissia			1			
Glossosoma	18					
Gomphidae		1				
Gumaga	36	3			5	1
Helicopsyche borealis	2	2				8
Hemerodromia	9	9	17	1	1	7
Heteroplectron californicum					1	
Hexatoma	3	1	1		2	4
Hydraena (adult)						1
Hydropsyche	30	15	4	6	74	38
Hydroptila		4	6	1		
Hygrobates	1		1	1		
Ironodes	11	6	1			5
Isoperla	6	1	2			

Fall 2002 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP glaciated batholith and volcanic flow subregion.

Final ID	RR-I1	RR-I2	RR-I3	RLD-I1	BI-I1	BI-I2
Lebertia	3	1	1			2
Lepidostoma	11			57	17	5
Leucotrichia pictipes						1
Malenka	1	1				
Meringodixa chalonensis						1
Micrasema	26	52	3			31
Mystacides					1	
Naididae	2	20	278	37	20	12
Nebrioporus/Stictotarus (adult)						1
Nothotrichia shasta	8	7			1	11
Ochrotrichia		1				
Optioservus	2	2	1	2		13
Optioservus (adult)	2			2		3
Ordobrevia nubifera	1		1	1		
Oreodytes (adult)				1		
Orohermes crepusculus	2		1			1
Orthocladiinae	109	313	112	99	62	59
Paraleptophlebia	66	45	142	7	86	86
Paraleuctra						1
Perlodidae		1				
Polycentropus				7	1	
Rhyacophila	2	7	1	13	8	4
Sialis					1	
Simulium	6		20	9	42	15
Skwala parallela						1
Sperchon	3	4	4	2	1	4
Sperchonopsis			1	3		
Sweltsa	5	1	1			1
Tanypodinae	5	29	23	25	36	12
Tanytarsini	207	73	142	55	86	123
Torrenticola	2	11	1			2
Wiedemannia				14		
Wormaldia		2				
Zaitzevia	3	2	12	8		7
Zaitzevia (adult)						1
Zapada	49	78	14	13	71	44
Total:	907	894	901	892	896	901

Fall 2002 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP batholith and volcanic flow subregion.

Final ID	IH-I1	IH-I2	IH-I3	LL-I1	LL-I2	LL-I3	BSC	SFAR
Acentrella								2
Ameletus		1		2		2	1	
Amiocentrus aspilus	1	2			3	2		
Antocha					3	4	3	2
Apatania	1	10						
Arctopsyche					4	15		
Argia			5					
Attenella		3						
Baetis	81	26	84	11	25	29	2	80
Bezzia/ Palpomyia		2		1	6	1		
Calineuria californica		9	25		12	6	47	4
Capniidae						1	28	
Caudatella	3							
Centroptilum		1						
Chelifera/ Metachela			5	7	1		2	
Cheumatopsyche			1					75
Chironomini		16	1		23	45	134	6
Cinygma	17			2	1		3	1
Cinygmula	5	94	1	1	57	41	3	
Cleptelmis addenda (adult)					2			
Corbiculacea		8	13	125	117	2		
Corydalidae	1							
Cryptolabis			16			3	1	
Cultus							2	
Dasyhelea								1
Diamesinae	5	14	1					
Dicranota		3					1	
Diphetor hageni		1	7	8	10	16	5	1
Dolophilodes					3	9		
Drunella	3	3				6	2	2
Enchytraeidae			10	3	2	2		
Eocosmoecus							2	
Epeorus	1		22		8	67	39	86
Ephemerella	4	6	1	2	15	12	127	45
Eubrianax edwardsii			8				4	10
Frisonia picticepes							1	
Glossosoma		2				11		1
Gomphidae						1		
Gumaga				2	9	13	1	
Helicopsyche borealis			1					2
Hemerodromia			4					5
Heptageniidae			3					
Hesperoperla				6	4	8		2
Heterlimnius		53						

Fall 2002 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP batholith and volcanic flow subregion.

Final ID	IH-I1	IH-I2	IH-I3	LL-I1	LL-I2	LL-I3	BSC	SFAR
Heteroplectron californicum						1		
Hexatoma		3			1	1	3	
Hydropsyche		23	39		88	40	192	259
Hydroptila			4		2			1
Hydroptilidae			6					
Hygrobates								2
Ironodes	6	5	2	22	51	48	6	
Isoperla					5	6		29
Lebertia	4	2	5	10	7	2	1	3
Lepidostoma			13	18	7	12	5	8
Leucotrichia pictipes				1				
Leuctridae	1	3						
Limnephilidae							3	
Limnophila		1						
Lumbriculidae	3						1	
Maruina lanceolata						6		
Micrasema	1		1	30	6	14	1	8
Muscidae							1	
Naididae	53	10	37	13	5	3	6	1
Narpus								2
Nemoura spinoloba	1							
Nothotrichia shasta	1	3	3	22	9	6		
Octogomphus specularis			1					
Oecetis			2					
Oligophlebodes						11		
Optioservus		4	161				5	77
Optioservus (adult)			7				2	2
Ordobrevia nubifera			1					1
Ordobrevia nubifera (adullt)								1
Orohermes crepusculus	2	1			3	2	3	
Oroperla barbara							4	
Orthocladiinae	211	29	169	56	15	55	76	60
Ostracoda	3	1				1		
Paraleptophlebia	4	27	54	25	37	7	44	1
Parapsyche	1			1				
Perlinodes aureus							8	1
Perlodidae							1	
Philopotamidae								1
Planariidae	2	1	4					2
Protoptila								1
Rhithrogena		3				3	10	23
Rhyacophila	7	9	3	7	8	4	3	3
Serratella								1
Simulium	71	253	21	12	79	43	6	23

Fall 2002 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP batholith and volcanic flow subregion.

Final ID	IH-I1	IH-I2	IH-I3	LL-I1	LL-I2	LL-I3	BSC	SFAR
Skwala parallela		4					2	4
Sperchon				2	2		7	1
Sperchonopsis				10				
Sweltsa	4	103	6	4	15	3	41	4
Taeniopterygidae		1			2		32	
Tanypodinae	4	1	6	17	5	2	3	1
Tanytarsini	29	32	63	146	121	213	33	1
Torrenticola				2	5	4		1
Trichoptera			1					
Tubificidae	1		8	1				
Wiedemannia	2		2	1			1	1
Wormaldia			3					19
Yoraperla				231	22			
Yphria californica				1				
Zaitzevia		9	35		2	10	1	28
Zaitzevia (adult)								4
Zapada	347	107	5	100	99	110	5	
Total:	880	889	870	902	901	903	914	899

Fall 2002 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP uppper foothills metamorphic belt subregion.

Final ID	GC-I1	GC-I2	RPD-I1	RPD-I2	IH-I4	JD-I1	JD-I2	JD-I3	CD-I1	CD-I2	CD-I3	BC-I1	BC-I2	SC-I1	SC-I2	SC-I3
Acentrella										1	2					
Ameletus	2		3	2				4	1			1	1	12		
Amiocentrus aspilus				5			2			1				1		
Ampumixis dispar		1	9	2								1	16	3		
Anagapetus												1	9			
Antocha	3		2	4	2		8		1	8	2			12	7	4
Apatania	1															
Arctopsyche		3		2	1							10				
Argia		8			2						61		2			25
Asellidae									1					18		
Atrichopogon												6				
Attenella									2							
Baetis	35	18	31	30	161	7	57	97	42	73	116	92	15	146	135	195
Bezzia/ Palpomyia			2							1		2	5			
Caecidotea														24		
Calineuria californica		13	4	83	42		4	13	1	23	1	5	43	15	3	1
Capniidae														2		1
Caudatella	1	3		1	1		2					14				
Centroptilum		1														
Chelifera/ Metachela		4		3	3	2	6		1			7	4			
Cheumatopsyche					2			3		189	87			19	211	81
Chimarra										1					32	122
Chironomini	8	25	10	29		1	7	12	16	1	1		6			3
Cinygma	32	1	12			7		1	19			16	2			
Cinygmula		13	24	61			5	12	5				92			
Cleptelmis addenda		2	15		5								1	1		
Cleptelmis addenda (adult)					1											
Clinocera							2									
Corbiculacea	11	17			5		4	2	3			12	33			
Cordulegaster dorsalis													1			
Crangonyx														5	2	23
Cryptolabis				24	5			1					2			
Cultus										5	4		10	6	1	
Dasyhelea										1						
Despaxia augusta												10				
Diamesinae		16	1	3												
Dicranota							1									
Diphetor hageni	4	2	36	5	2		9	6	14	1			3	2		
Dixa											1					
Dolophilodes					1			12		1		2	1			
Doroneuria baumanni												8				

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Fall 2002 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP uppper foothills metamorphic belt subregion.

Final ID	GC-I1	GC-I2	RPD-I1	RPD-I2	IH-I4	JD-I1	JD-I2	JD-I3	CD-I1	CD-I2	CD-I3	BC-I1	BC-I2	SC-I1	SC-I2	SC-I3
Drunella													1			
Empididae								2		4	1			2		
Enchytraeidae				10	5			4				13	15			
Epeorus	2		17	15	24		1	20	13	19	2		69	1	52	84
Ephemerella	1	3		25	9	5	2	16	3	3	2	7	8	32		1
Eubrianax edwardsii			6		10								11	9		
Ferrissia																1
Forcipomyia												1	1			
Glossosoma													5	1		1
Glutops												2				
Gomphidae													1			
Gumaga		15	10	14								3				
Gyraulus														2		
Haploperla chilnualna				2												
Helichus (adult)										1						
Hemerodromia					2			1	1	2	6					4
Hesperoperla	5	1	5						6	1	1	29	3	2	3	1
Hetaerina americana											1					1
Heterlimnius											2					
Hexatoma			4	6	2								3			
Hydroporus (adult)										1						
Hydropsyche	3	25	40	67	53		12	64	45	67	188	7	9	42	49	87
Hydroptila	1	2		1	4		27	4	2	5	10	2		33		
Hygrobates					1					5				2		
Ironodes	100	15	67	2	4	12	22	46	64	7	5	166	105	9	7	
Isoperla					2			7		1			9	9	27	24
Kathroperla												1				
Kogotus nomus						2										
Lara													2			
Lebertia		1			5	3	2	2	2	8	1	1	2	6		
Lepidostoma			2		4	5	1	1	2			3	3	14		
Leucotrichia pictipes			2				3									4
Leucrocuta/Nixe							1									
Leuctridae		1		10								3				
Limonia								1			1	1		1		
Liodessus obscurellus (adult)															1	
Lumbriculidae					1							2		1	3	5
Malenka	1					1		1		5	3	7		13		
Micrasema	9		1	3				2				10	16	2		
Microcylloepus																8
Moselia infuscata	4					1						26				

Fall 2002 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP uppper foothills metamorphic belt subregion.

Final ID	GC-I1	GC-I2	RPD-I1	RPD-I2	IH-I4	JD-I1	JD-I2	JD-I3	CD-I1	CD-I2	CD-I3	BC-I1	BC-I2	SC-I1	SC-I2	SC-I3
Mystacides											1					
Naididae		93		37	77	454	46	36	160	5	40	22	8	20	2	1
Narpus													2			
Nemoura spinoloba												8		1		
Nothotrichia shasta	3		1	7	2		2	1						1		
Ochrotrichia					1			1								
Octogomphus specularis			4		1					1		1	1	1		
Oecetis		2														
Optioservus			1	31	69			3		22	14		2	30	5	20
Optioservus (adult)					9					1				4		
Ordobrevia nubifera			1		2						1		3	1	7	
Orohermes crepusculus	58	4	14	5	6		4	2		1		22	4			
Oroperla barbara					1											
Orthocladiinae	65	231	65	79	103	189	511	281	180	143	140	60	123	136	33	54
Ostracoda		2										1				
Paraleptophlebia	10	36	100	112	62	13	14	85	19	100	11	55	110	49	17	1
Paraleuctra												1				
Parapsyche												9				
Perlinodes aureus					1											
Perlodidae							1	1	2		1					
Petrophila											9					7
Physa/ Physella																11
Planariidae			2		13	6		31	6	9	21	18	2	16	18	21
Polycentropus			3				2						1			
Prosimulium							1									
Prostoma										5	14				6	5
Psephenus falli																2
Pseudochironomus										1						
Pteronarcys												15			1	
Rhithrogena				5	1			6		5			10	10	78	19
Rhyacophila	21	6	5	3	6	5	9	4	4			65	16	2		1
Serratella							2									
Sialis				1								5				
Simulium	146	8	61		28	23	21	26	51	16	99	11	35	56	152	37
Skwala parallela								1		1					6	6
Sperchon			4	2	2			4		5	1		3	5	6	4
Stenocolus scutellaris					1											
Sweltsa		3	6	39	15	1	1	12		31		29	20	5		
Taenionema								5	2					3		
Tanypodinae	16	35	6	10	2	13	27	1	60	2	2		2	2		1
Tanytarsini	60	160	33	89	58	52	34	10	48	62	20	10	18	23	9	29

Fall 2002 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP uppper foothills metamorphic belt subregion.

Final ID	GC-I1	GC-I2	RPD-I1	RPD-I2	IH-I4	JD-I1	JD-I2	JD-I3	CD-I1	CD-I2	CD-I3	BC-I1	BC-I2	SC-I1	SC-I2	SC-I3
Tipula														2		
Torrenticola		13	2		6							1	2			
Trichoptera			18													
Tricorythodes											1					6
Tubificidae		12			1											
Wiedemannia					2			3	3		1	3	1	1		
Wormaldia		1			2			2	4	1	4	2		12	10	
Yoraperla		3												1		
Zaitzevia			10	16	41			9		37	3		1		4	8
Zaitzevia (adult)							1	1								
Zapada	273	66	242	25	14	57	25	24	119	1		66	8	60	3	
Total:	875	865	881	870	885	859	879	883	902	884	881	875	881	888	890	909

Fall 2003 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP glaciated batholith and volcanic flow subregion

Final ID	RR-I1	RR-I2	RR-I3	BI-I1	BI-I2
Ameletus	11	10	2		8
Amiocentrus aspilus	4	5			
Antocha	19	5			
Apatania	1				
Argia					20
Atherix pachypus		1			
Baetis	32	26	6	10	24
Bezzia/ Palpomyia	7	2	3		
Caenis			1		
Calineuria californica	15	29	2	1	12
Capniidae			1		
Centroptilum				1	
Chelifera/ Metachela			1	1	
Chironomini	20	17	14	39	32
Cinygma				26	4
Cinygmula	4	31	1	1	
Cleptelmis addenda		7	12	29	38
Cleptelmis addenda (adult)		2			
Coenagrionidae			2		
Cryptolabis	24				
Dasyhelea			1		1
Diamesinae		1	38	1	
Dicranota	1				
Diphetor hageni	26	35	1	2	3
Dixidae		1			
Enchytraeidae		9	11	26	17
Epeorus	8	18	2		15
Ephemerella	23	23	5	85	108
Eubrianax edwardsii	16	6	3		28
Glossosoma	1				
Gomphidae					1
Gumaga	37	8		7	
Helicopsyche borealis	1	1			2
Hemerodromia		5	7	3	6
Heptageniidae	3				
Heteroplectron californicum				1	
Hexatoma	7	2		2	3
Hydropsyche	12	13	6	32	19
Hydroptila	8	7	4		2
Hygrobates	1	2			
Ironodes	29	22			8
Isoperla			9		
Lebertia	3	2	2	1	2
Lepidostoma	4	2	1	4	2

Fall 2003 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP glaciated batholith and volcanic flow subregion

Final ID	RR-I1	RR-I2	RR-I3	BI-I1	BI-I2
Leucrocuta/Nixe	1				
Limnephilidae				1	
Malenka					1
Micrasema	12	50	5		14
Mystacides				1	
Naididae	1	4	340	23	24
Nothotrichia shasta	36	27		3	9
Octogomphus specularis				1	
Optioservus	1	1			3
Optioservus (adult)	2				
Ordobrevia nubifera	1	1			9
Orohermes crepusculus		4			
Orthocladiinae	19	69	98	108	34
Paraleptophlebia	37	96	87	101	86
Partunia	1				
Perlodidae	3				
Philopotamidae					1
Protzia	1				
Rhithrogena		2			
Rhyacophila	5	10	4	6	3
Sialis				1	5
Simulium		2	15	36	2
Skwala parallela			2	1	
Sperchon	6	8	11	2	
Sphaeriidae	4	5	8	124	110
Sweltsa	8	2	2	3	1
Tanypodinae	9	17	18	119	20
Tanytarsini	418	216	111	45	187
Tipula				2	
Torrenticola	4	21	1		6
Trichoptera				2	
Wiedemannia	1	6	1		
Wormaldia				1	
Zaitzevia		9	13		12
Zaitzevia (adult)	2		1		1
Zapada	10	33	19	26	19
Total:	899	875	871	878	902

Fall 2003 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP batholith and volcanic flow subregion.

Final ID	LL-I1	LL-I2	LL-I3	IH-I1	IH-I2	IH-I3	BSC	SFR	SFAR
Acentrella									2
Agapetus							1		
Ameletus	2	3	1			1	3	1	
Amiocentrus aspilus		3	5				36		
Anagapetus							2		
Antocha		4	1		8		4	7	
Apatania							7		
Arctopsyche		4	1			1		37	
Argia						5			
Atherix pachypus								48	1
Attenella					8			1	
Baetis	12	12	6	94	59	83	19	97	72
Bezzia/ Palpomyia	1	3	6		1		9		
Blephariceridae								3	
Calineuria californica	4	9	9		1	18	14	19	7
Capniidae					9		9	1	1
Caudatella			5	4		2	1	6	
Chelifera/ Metachela	16	2	2		5	4	1		
Cheumatopsyche						1			65
Chironomini		13	69		1	5	1		4
Cinygma	6	7		12	4				
Cinygmula	4	46	14	1	18		135	12	1
Cleptelmis addenda	1	1				5			
Cleptelmis addenda (adult)			1			1			
Cordulegaster dorsalis			1						
Cryptolabis			3			8	2		
Cultus								1	2
Diamesinae		1		12	5	3	1		
Dicranota	10		1	1	1			1	
Diphetor hageni	4	8	3		2	3	2		
Dixa						1	1		
Dolophilodes		2	6						
Drunella			2	2	3		5	8	7
Empididae				3	1				1
Enchytraeidae	7		2		2	5	6	30	
Epeorus	1	11	64			12	73	129	85
Ephemerella	4	4	7			10	33	15	28
Ephemerellidae			2		6			5	
Eubrianax edwardsii						11	100		16
Glossosoma			6		1			7	26
Gomphidae			1						
Gumaga	3	9	21			1	6		
Hemerodromia						8			4
Hesperoperla	3	3	3					1	2

Fall 2003 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP batholith and volcanic flow subregion.

Final ID	LL-I1	LL-I2	LL-I3	IH-I1	IH-I2	IH-I3	BSC	SFR	SFAR
Heterlimnius					35				
Heterlimnius (adult)					1				
Heteroplectron californicum		2					1		
Hexatoma			1		2		1		
Hydra				19	3				
Hydraena (adult)							2		
Hydropsyche		63	19		3	45	55	54	188
Hydroptila					17	6			
Hygrobates			1			1			5
Ironodes	43	56	24	28	7	11	9	7	1
Isoperla		5	2					4	13
Lebertia	6	5	4	10	26	7	5	2	6
Lepidostoma	9	16	14			26	22	4	19
Limonia							1		
Lumbriculidae									1
Malenka				17	2				
Maruina lanceolata							1	2	
Meringodixa chalonensis							1		
Micrasema	2	12	30		4	13	26	6	17
Microcllyoepus									1
Naididae	82	1	2	59	31	52	5	15	8
Narpus					1				1
Neophylax							1	1	
Nothotrichia shasta	1	20	3	4	3	8			
Ochrotrichia						1			
Oligophlebodes		1	15				22	2	
Optioservus						85		12	49
Optioservus (adult)		1				23	2	8	5
Ordobrevia nubifera		1				3		2	1
Oreodytes (adult)						1			
Orohermes crepusculus	4	9	2		3	1	3	2	
Oroperla barbara								2	
Orthocladiinae	38	17	31	276	238	82	21	40	25
Ostracoda				16	1				
Paraleptophlebia	57	24	21	1	11	37	26	5	2
Paraperla					1		1		
Parapsyche	1								
Partunia			1						
Pedomoecus sierra								1	
Perlinodes aureus									1
Perlodidae	1								4
Philopotamidae									1
Planariidae	2			47	2	8		1	3
Polycentropus	1	1					1		

Fall 2003 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP batholith and volcanic flow subregion.

Final ID	LL-I1	LL-I2	LL-I3	IH-I1	IH-I2	IH-I3	BSC	SFR	SFAR
Prosobranchia									1
Prostoma									7
Protzia							7		
Pteronarcys								1	2
Rhithrogena			1				1	63	64
Rhyacophila	39	6	5	15	15	9	13	11	2
Serratella				33	13				
Sialis					1				
Simulium	13	5	1	28	16	72	2	123	75
Skwala parallela									2
Sperchon	5		2	17	1	6	4	1	2
Sperchonopsis						1	1	1	
Sphaeriidae	116	202	9		15	56		1	
Stenocolus scutellaris									1
Sweltsa	10	12	8	15	54	5	31	1	8
Tanypodinae	9	8	5		15	3			
Tanytarsini	107	177	392	9	179	57	74	15	10
Torrenticola	1	7	10			19	28	1	1
Trichoclinocera/Clinocera				1					
Visoka cataractae			1						
Wiedemannia	1			1	3	2			
Wormaldia						7			1
Yoraperla	171	12							
Zaitzevia		4				23	5	19	41
Zaitzevia (adult)						5	3	2	2
Zapada	85	74	40	167	42	19	48	1	
Total:	882	886	886	892	880	882	894	839	894

Fall 2003 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP uppper foothills metamorphic belt subregion.

Final ID	GC-I1	GC-I2	RPD-I1	RPD-I2	IH-I4	JD-I1	JD-I2	JD-I3	CD-I1	CD-I2	CD-I3	BC-I1	BC-I2	SC-I1	SC-I2	SC-I3
Acentrella					2						1					
Ameletus	1		1	1				9	3	2	1		1	11		
Amiocentrus aspilus		3	2	14	1	1	2	2			1	2	3			
Ampumixis dispar			2	5				1				6	11	7		
Anagapetus								2				8	9			
Antocha		12	16	9		2	1	1	1	5	12	1	1	18	8	
Arctopsyche			9	1	1		25	1								
Argia			1	4						4	74					5
Atherix pachypus							4									
Atrichopogon														1		
Attenella									2							
Baetis		20	31	29	111	10	73	139	70	146	116	52	34	102	204	71
Bezzia/ Palpomyia	3	2	7	5	2			4				1	6			
Blephariceridae		1						1								
Caecidotea												2		128		
Calineuria californica	2	6	7	37	65	1	9	47	4	47		31	64	26		
Caloparyphus														1		
Camelobaetidius																2
Capniidae		1								1				2		
Caudatella		3	21	4			5	2				2				
Centroptilum																3
Chelifera/ Metachela	1	2	4	2	7	1	11	2			1	4	1			1
Cheumatopsyche				2	6			2		130	24	2		12	155	26
Chimarra															8	28
Chironomini		7	8	8	2	1	1		6	2	1	3	2	2		3
Cinygma	12	27	5	1		3	1		10			4	12	4		
Cinygmula		1	3	8			2	1	2			2	12			
Cleptelmis addenda	8	48	7	4	1					1						
Cleptelmis addenda (adult)	1	5			1											
Crangonyx														8	5	39
Cryptolabis		3	17	4	13			1				1	14			
Cultus				1	2		2	1	1	9	1	3	8	4	1	

Fall 2003 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP uppper foothills metamorphic belt subregion.

Final ID	GC-I1	GC-I2	RPD-I1	RPD-I2	IH-I4	JD-I1	JD-I2	JD-I3	CD-I1	CD-I2	CD-I3	BC-I1	BC-I2	SC-I1	SC-I2	SC-I3
Dasyhelea								1		1	4					
Despaxia augusta						6										
Diamesinae	2	3	14	8	5	45	11	40	18	10		1	1	14	1	6
Dicranota		1			1											
Diphetor hageni	26	29	11	7			11	1	8	1		1	1	1	1	
Dixa								1		1				1		
Dolichopodidae									9							
Dolophilodes			4				3	4	5			2				
Doroneuria baumanni													6			
Drunella							1						6			
Empididae			1		6	1		16	2	4	2	1				1
Enchytraeidae	8	1	10	7	3			6	15	1		21	45	8		
Epeorus		6	9	9	37		2	18	11	34	8	5	28		98	41
Ephemerella		1	7	24	39	3	77	3		2	5	5	4	24	2	1
Ephemerellidae									1							
Eubrianax edwardsii	11	12	4	2	6							4	22	2		
Ferrissia																8
Glossosoma												3				
Gomphidae		1														
Gumaga	28	24	7	21	1							26	5			
Gyraulus	1															
Haploperla chilnualna		2														
Hemerodromia								2		4	20			3		7
Heptageniidae																1
Hesperoperla	11	10	11				2	7	12	2	2	11	7		1	
Heteroplectron californicum			1													
Hexatoma	3	3	2	5	1							2	1			
Hyalella																2
Hydra						2						1	1	2		
Hydraena (adult)													1			
Hydropsyche	4	19	86	38	59		27	29	39	87	93	66	13	40	42	28
Hydroptila		1		4	2	3	35	5	6	3	15			26	3	62

Fall 2003 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP uppper foothills metamorphic belt subregion.

Final ID	GC-I1	GC-I2	RPD-I1	RPD-I2	IH-I4	JD-I1	JD-I2	JD-I3	CD-I1	CD-I2	CD-I3	BC-I1	BC-I2	SC-I1	SC-I2	SC-I3
Hydroptilidae			2					2								
Hygrobates				2	3			1		4	4	1		3	1	19
Ironodes	19	66	25	9	2	34	29	36	93	16	8	158	84	5	11	
Isoperla		4	1	2			2			1		2	5	1	20	7
Juga											6	10	1			
Kogotus nomus						1										
Lara													3			
Lebertia	1	5	3	9	5	9	29	23	1	5	3	1		5	3	6
Lepidostoma	5	9	6	5	13		1	2	1	1		1	4	32		
Leucotrichia pictipes															1	
Leucrocuta/Nixe									1					1		
Leuctridae	3	1				1						5	2			
Limonia												1				
Malenka						35		21	4	8	2	7	9	45		
Maruina lanceolata								2								
Micrasema	39	10	16	8						2		26	5	8		1
Microcylloepus															1	14
Microcylloepus (adult)								1								1
Moselia infuscata									1			1	1			
Mystacides	1															1
Naididae	82	17	36	20	71	146	58	8	67	9	101	5	15	29	11	12
Narpus							1	1				2				
Nemoura spinoloba	1													1		
Nothotrichia shasta	44	5	1	21			6							2		1
Ochrotrichia							1									
Ochthebius (adult)											1					
Octogomphus specularis	5				1					1		1	1			
Oecetis	1	1														
Optioservus		7	2	30	46			3		6	1		8	6	7	7
Optioservus (adult)	2			1	25			3		2	1	2	2	3		
Ordobrevia nubifera		4			2					5	1	3	10	1	6	1
Ordobrevia nubifera (adullt)										1		1	1		1	

Fall 2003 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP uppper foothills metamorphic belt subregion.

Final ID	GC-I1	GC-I2	RPD-I1	RPD-I2	IH-I4	JD-I1	JD-I2	JD-I3	CD-I1	CD-I2	CD-I3	BC-I1	BC-I2	SC-I1	SC-I2	SC-I3
Orohermes crepusculus	4	18	18	5	6		4	9	2		1	11	12			
Orthocladiinae	6	14	85	80	51	427	141	123	295	120	174	78	62	77	72	128
Ostracoda	1											1				
Paraleptophlebia	17	85	36	48	73	3	24	27	23	74	1	85	148	64	24	3
Parapsyche												5	1			
Perlodidae							1	2		2						
Petrophila										4	2				1	5
Physa/ Physella																147
Planariidae		1		2	3	42	6	12	13	17	6	9	7	52	16	19
Planorbidae						2				2	1			4		6
Polycentropus	1	1						1						1		
Prosimulium									2							
Prostoma											22					9
Protzia								2				1				
Psephenus falli																4
Pseudochironomus								2								
Pteronarcys											1	6	3			
Rhithrogena								1		2			2	2	53	7
Rhyacophila	16	11	14	2	8	7	20	2	17	1	2	31	19	2		
Serratella							4									
Sialis	1						1	2								
Simulium	1	5	13		10	28	69	116	15	16	97	10	2	28	101	48
Skwala parallela					2			1		2						
Soliperla												1				
Soyedina												7	4			
Sperchon		9	4	4	2		4	10		9		2	3	4	12	3
Sperchonopsis	1	2					3	3	1		1	1	5	3		1
Sphaeriidae	416	8	12	2	1		5	36	6			24	49			1
Suwallia												1				
Sweltsa		4	5	11	13	1		20		9		17	32	2		
Tabanidae								1								
Tanypodinae	22	12	6	16	3	2	10	2	30	1	1		4	7		20

Fall 2003 benthic macroinvertebrate taxonomic list by site and number of individuals - UARP uppper foothills metamorphic belt subregion.

Final ID	GC-I1	GC-I2	RPD-I1	RPD-I2	IH-I4	JD-I1	JD-I2	JD-I3	CD-I1	CD-I2	CD-I3	BC-I1	BC-I2	SC-I1	SC-I2	SC-I3
Tanytarsini	21	117	216	222	116	59	102	37	25	38	51	15	31	37	20	54
Tinodes																1
Torrenticola	7	61	18	30	20		2	20		6		8	14	5		
Trichoclinocera/Clinocera								3	2	1				3	1	
Tricorythodes															1	1
Tubificidae				2												
Wiedemannia				1	1		5			2	1	1	1		1	2
Wormaldia					3									2	2	
Yoraperla				2			1									
Zaitzevia	1	14	2	30	23			1		36	4	1		2	3	6
Zaitzevia (adult)				1	3			1		1	4			1	2	
Zapada	47	130	56	43	11	21	73	9	66	2		84	34	12	5	
Total:	887	875	885	872	891	897	907	895	890	903	878	899	903	897	905	870

APPENDIX C

UARP BIOLOGICAL METRIC VALUES FOR YEARS 2002 AND 2003

UARP biological metric values - year 2002

Reach:	Rubicon Reservoir									Rockbound Lake			Buck Island Reservoir					
Site Code:	RR-I1	RR-I1	RR-I1	RR-I2	RR-I2	RR-I2	RR-I3	RR-I3	RR-I3	RLD-I1	RLD-I1	RLD-I1	BI-I1	BI-I1	BI-I1	BI-I2	BI-I2	BI-I2
Transect/spot:	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Taxonomic Richness	39	33	39	30	30	36	27	16	28	29	26	23	22	23	20	35	30	31
EPT Taxa	18	21	22	17	14	19	10	6	9	11	11	9	11	11	10	15	14	13
Ephemeroptera Taxa	7	7	10	7	7	7	4	4	5	4	4	2	4	4	6	6	7	5
Plecoptera Taxa	2	5	4	3	3	4	3	1	2	2	2	2	2	1	1	3	3	3
Trichoptera Taxa	9	9	8	7	4	8	3	1	2	5	5	5	5	6	3	6	4	5
EPT Index (%)	49	40	52	48	38	36	33	18	11	63	50	85	47	51	51	49	60	44
Sensitive EPT Index (%)	26	25	26	32	20	21	5	2	2	59	40	83	34	31	21	24	41	24
Shannon Diversity	3.0	2.7	2.9	2.6	2.5	2.5	2.0	1.5	2.2	2.0	2.2	1.6	2.4	2.7	2.5	2.9	2.6	2.7
Dominant Taxon (%)	23	25	20	33	37	35	37	52	29	51	32	61	25	14	23	14	22	16
Tolerance Value	4.2	4.2	4.0	3.9	4.3	4.4	5.9	7.0	5.7	3.1	3.7	1.9	4.5	4.6	5.2	4.5	3.4	4.7
Intolerant Organisms (%)	19	21	25	30	21	20	6	2	2	59	40	83	34	29	22	21	43	25
Tolerant Organisms (%)	2.6	1.0	1.7	2.6	3.1	3.4	41	66	13	11	3.4	4.8	18	16	26	14	3.4	17
Collector-Gatherers (%)	52	56	66	57	65	65	79	82	80	82	79	71	68	47	36	52	70	63
Collector-Filterers (%)	7	4	2	2	2	2	6	13	5	3	3	3	14	27	45	22	4	19
Scrapers (%)	17	13	11	13	7	10	4	1	1	3	1	0	2	3	6	12	6	2
Predators (%)	5	5	8	8	12	9	7	2	11	10	14	7	9	4	6	7	5	5
Shredders (%)	18	19	6	11	8	9	3	1	1	2	3	19	6	19	7	5	7	6
Other (%)	1	3	7	10	6	6	0	1	2	0	0	0	0	0	0	2	8	4
Sample Abundance (x1000)	3.1	2.5	3.2	2.0	2.4	1.2	2.8	3.3	2.4	1.9	2.3	0.50	4.0	3.0	3.0	2.6	2.4	2.6

Site Code:	RR-I1			RR-I2			RR-I3			RLD-I1			BI-I1			BI-I2		
	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST
Taxonomic Richness	37	2.0	50	32	2.0	45	24	3.8	42	26	1.7	36	22	0.9	32	32	1.5	47
EPT Taxa	20	1.2	25	17	1.5	24	8.3	1.2	17	10	0.7	13	11	0.3	16	14	0.6	21
Ephemeroptera Taxa	8.0	1.0	10	7.0	0.0	8	4.3	0.3	9	3.3	0.7	5	4.7	0.7	6	6.0	0.6	8
Plecoptera Taxa	3.7	0.9	5	3.3	0.3	6	2.0	0.6	4	2.0	0.0	2	1.3	0.3	2	3.0	0.0	5
Trichoptera Taxa	8.7	0.3	10	6.3	1.2	10	2.0	0.6	4	5.0	0.0	6	4.7	0.9	8	5.0	0.6	8
EPT Index (%)	47	3.5	47	41	3.7	41	21	6.3	21	66	10	66	50	1.3	50	51	4.7	51
Sensitive EPT Index (%)	25	0.3	25	24	3.8	24	3	1.2	3	61	12	61	29	4.0	29	29	5.7	29
Shannon Diversity	2.9	0.1	3.0	2.5	0.0	2.6	1.9	0.2	2.3	1.9	0.2	2.1	2.5	0.1	2.7	2.7	0.1	2.9
Dominant Taxon (%)	23	1.3	23	35	1.4	35	39	6.7	31	48	8.5	48	20	3.3	16	17	2.6	15
Tolerance Value	4.1	0.1	4.1	4.2	0.2	4.2	6.2	0.4	6.2	2.9	0.5	2.9	4.8	0.2	4.8	4.2	0.4	4.2
Intolerant Organisms (%)	22	1.9	22	24	3.3	24	3	1.5	3	60	12	60	28	3.6	28	30	6.7	29
Tolerant Organisms (%)	1.8	0.5	1.8	3.0	0.2	3.0	40	15	40	6.5	2.4	6.6	20	3.0	20	12	4.2	12
Sample Abundance (x1000)	2.9	0.2	8.8	1.9	0.4	5.6	2.8	0.3	8.5	1.6	0.5	4.7	3.3	0.3	10.0	2.5	0.1	7.6

UARP biological metric values - year 2002

Reach:	Loon Lake									Gerle Creek Reservoir						Robbs Peak Dam					
Site Code:	LL-I1	LL-I1	LL-I1	LL-I2	LL-I2	LL-I2	LL-I3	LL-I3	LL-I3	GC-I1	GC-I1	GC-I1	GC-I2	GC-I2	GC-I2	RPD-I1	RPD-I1	RPD-I1	RPD-I2	RPD-I2	RPD-I2
Transect/spot:	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Taxonomic Richness	29	26	25	36	31	38	30	35	42	21	16	14	30	23	22	31	23	34	24	30	24
EPT Taxa	17	13	13	21	20	23	23	25	24	13	13	8	16	14	12	17	14	18	13	19	15
Ephemeroptera Taxa	7	6	5	6	6	8	9	9	8	7	6	5	8	7	4	8	8	7	7	7	9
Plecoptera Taxa	4	3	4	7	6	6	4	5	5	3	2	2	3	4	4	2	3	4	3	5	3
Trichoptera Taxa	6	4	4	8	8	9	10	11	11	3	5	1	5	3	4	7	3	7	3	7	3
EPT Index (%)	60	46	59	53	64	50	57	55	55	33	61	81	21	32	27	72	73	68	40	62	77
Sensitive EPT Index (%)	51	37	47	22	26	26	37	38	30	24	39	59	14	14	14	37	39	35	13	28	40
Shannon Diversity	2.4	2.4	2.4	2.8	2.8	3.0	2.6	2.8	3.0	2.5	1.9	1.6	2.5	2.3	2.3	2.6	2.4	2.8	2.7	2.9	2.7
Dominant Taxon (%)	34	21	25	16	15	20	32	23	15	19	31	51	26	36	29	30	32	21	18	15	16
Tolerance Value	3.8	4.7	3.9	4.9	4.4	4.8	3.7	3.8	4.0	3.7	3.8	3.2	5.4	5.2	5.1	3.5	3.5	3.5	4.8	3.7	3.0
Intolerant Organisms (%)	50	37	47	22	25	24	36	37	30	43	39	59	12	13	12	37	41	36	13	27	38
Tolerant Organisms (%)	16	24	15	18	10	16	0.0	0.0	3.3	3.0	0.0	0.7	14	19	11	0.0	0.0	1.4	14	3.4	0.0
Collector-Gatherers (%)	27	34	28	25	23	38	50	39	43	39	18	7	67	73	71	35	26	42	66	44	40
Collector-Filterers (%)	11	20	14	39	32	25	7	13	11	11	27	17	7	6	5	9	18	7	2	11	9
Scrapers (%)	1	3	5	12	18	10	23	22	21	9	16	21	1	6	3	17	18	13	16	13	16
Predators (%)	9	6	8	10	7	9	6	7	5	25	4	4	14	10	8	7	6	8	12	18	24
Shredders (%)	46	33	38	13	17	16	12	18	17	14	31	51	11	6	13	31	33	23	3	11	11
Other (%)	6	5	7	1	2	3	3	1	2	1	3	0	0	0	1	0	0	0	0	3	0
Sample Abundance (x1000)	1.7	6.0	2.5	4.1	3.2	2.0	1.5	2.5	2.0	0.81	0.78	0.83	0.53	0.58	2.4	1.7	3.3	2.8	1.4	1.0	0.61

Site Code:	LL-I1			LL-I2			LL-I3			GC-I1			GC-I2			RPD-I1			RPD-I2		
	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST
Taxonomic Richness	27	1.2	35	35	2.1	43	36	3.5	47	17	2.1	27	25	2.5	38	29	3.3	40	26	2.0	39
EPT Taxa	14	1.3	20	21	0.9	25	24	0.6	27	11	1.7	19	14	1.2	22	16	1.2	21	16	1.8	23
Ephemeroptera Taxa	6.0	0.6	8	6.7	0.7	8	8.7	0.3	10	6.0	0.6	9	6.3	1.2	9	7.7	0.3	8	7.7	0.7	10
Plecoptera Taxa	3.7	0.3	4	6.3	0.3	7	4.7	0.3	5	2.3	0.3	4	3.7	0.3	6	3.0	0.6	4	3.7	0.7	5
Trichoptera Taxa	4.7	0.7	8	8.3	0.3	10	11	0.3	12	3.0	1.2	6	4.0	0.6	7	5.7	1.3	9	4.3	1.3	8
EPT Index (%)	55	4.4	55	56	4.4	56	56	0.9	56	58	14	58	27	3.2	27	71	1.5	71	60	11	60
Sensitive EPT Index (%)	45	4.1	45	25	1.2	25	35	2.7	35	40	10	40	14	0.2	14	37	1.3	37	27	7.7	27
Shannon Diversity	2.4	0.0	2.5	2.8	0.1	2.9	2.8	0.1	2.9	2.0	0.3	2.3	2.4	0.1	2.5	2.6	0.1	2.7	2.8	0.1	3.0
Dominant Taxon (%)	27	3.9	26	17	1.6	13	24	4.9	24	34	9.3	31	30	2.9	29	28	3.5	27	16	1.0	13
Tolerance Value	4.1	0.3	4.1	4.7	0.2	4.7	3.8	0.1	3.8	3.6	0.2	3.6	5.2	0.1	5.2	3.5	0.0	3.5	3.8	0.5	3.8
Intolerant Organisms (%)	45	4.0	45	24	0.9	24	34	2.0	34	47	6.2	47	12	0.4	12	38	1.8	38	26	7.1	26
Tolerant Organisms (%)	18	2.7	18	15	2.3	15	1.1	1.1	1.1	1.2	0.9	1.3	15	2.3	15	0.5	0.5	0.5	5.7	4.1	5.6
Sample Abundance (x1000)	3.4	1.3	10.2	3.1	0.6	9.3	2.0	0.3	6.0	0.81	0.01	2.4	1.2	0.6	3.5	2.6	0.5	7.8	1.0	0.2	3.0

UARP biological metric values - year 2002

Reach:	Ice House Reservoir												Union Valley and Junction Reservoirs								
Site Code:	IH-I1	IH-I1	IH-I1	IH-I2	IH-I2	IH-I2	IH-I3	IH-I3	IH-I3	IH-I4	IH-I4	IH-I4	JD-I1	JD-I1	JD-I1	JD-I2	JD-I2	JD-I2	JD-I3	JD-I3	JD-I3
Transect/spot:	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Taxonomic Richness	20	22	17	26	29	25	28	32	29	29	39	40	17	12	18	23	25	32	32	37	33
EPT Taxa	12	14	9	18	15	14	14	15	15	10	17	17	8	6	11	14	13	18	20	21	20
Ephemeroptera Taxa	7	8	5	7	9	6	5	6	6	5	5	7	4	4	5	7	5	9	9	10	9
Plecoptera Taxa	2	3	2	5	3	5	3	2	3	3	5	5	3	1	4	3	3	2	5	4	6
Trichoptera Taxa	3	3	2	6	3	3	6	7	6	2	7	5	1	1	2	4	5	7	6	7	5
EPT Index (%)	51	53	63	34	63	53	34	36	29	49	40	53	11	8	21	25	19	25	63	31	59
Sensitive EPT Index (%)	41	38	55	17	45	28	9	9	10	9	11	22	9	5	16	9	3	4	14	10	20
Shannon Diversity	1.9	1.9	1.7	2.0	2.5	2.3	2.5	2.8	2.6	2.6	2.9	3.0	1.5	1.2	1.9	1.9	1.5	2.1	2.7	2.3	2.5
Dominant Taxon (%)	36	33	50	53	24	30	28	17	29	26	16	13	59	64	35	55	68	52	17	48	33
Tolerance Value	4.1	4.0	3.6	4.7	3.3	4.2	4.4	4.7	4.8	4.8	4.7	4.1	6.6	6.9	5.6	5.0	4.9	5.2	4.4	4.6	4.1
Intolerant Organisms (%)	41	39	55	17	46	28	8	8	10	10	11	24	9	5	16	9	4	4	14	10	20
Tolerant Organisms (%)	10	7.0	4.4	0.0	4.8	2.3	6.0	6.3	14	14	10	8.9	59	65	35	6.9	3.8	6.9	7.5	5.5	3.3
Collector-Gatherers (%)	51	57	30	18	33	25	47	45	61	61	55	52	86	91	74	74	85	78	55	72	61
Collector-Filterers (%)	7	3	13	56	7	33	7	15	5	10	11	10	3	1	5	3	5	4	16	7	14
Scrapers (%)	4	3	4	12	17	14	32	27	22	18	18	16	0	2	4	5	3	3	15	10	9
Predators (%)	3	4	3	7	29	12	8	8	7	8	11	19	3	2	6	8	5	7	10	9	10
Shredders (%)	36	33	50	7	14	16	5	2	4	2	3	3	7	3	12	6	1	1	3	1	6
Other (%)	0	0	0	1	0	0	0	3	2	0	2	0	0	0	0	3	1	6	1	2	1
Sample Abundance (x1000)	4.0	1.4	2.2	3.0	3.1	7.2	2.0	1.1	3.1	1.6	2.7	2.0	1.5	1.9	3.1	1.3	1.2	2.9	2.0	1.4	1.7

Site Code:	IH-I1			IH-I2			IH-I3			IH-I4			JD-I1			JD-I2			JD-I3		
	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST
Taxonomic Richness	20	1.5	32	27	1.2	41	30	1.2	45	36	3.5	55	16	1.9	21	27	2.7	37	34	1.5	48
EPT Taxa	12	1.5	19	16	1.2	23	15	0.3	23	15	2.3	24	8	1.5	12	15	1.5	22	20	0.3	28
Ephemeroptera Taxa	6.7	0.9	9	7.3	0.9	11	5.7	0.3	8	5.7	0.7	8	4.3	0.3	5	7.0	1.2	10	9.3	0.3	10
Plecoptera Taxa	2.3	0.3	4	4.3	0.7	6	2.7	0.3	3	4.3	0.7	6	2.7	0.9	5	2.7	0.3	4	5.0	0.6	8
Trichoptera Taxa	2.7	0.3	6	4.0	1.0	6	6.3	0.3	12	4.7	1.5	10	1.3	0.3	2	5.3	0.9	8	6.0	0.6	10
EPT Index (%)	56	3.6	56	50	8.4	50	33	1.9	33	47	3.8	47	14	3.8	14	23	2.0	23	51	10	51
Sensitive EPT Index (%)	44	5.1	45	30	8.1	30	9	0.4	9	14	4.1	14	10	3.3	10	6	1.8	6	15	3.0	15
Shannon Diversity	1.8	0.1	1.9	2.3	0.2	2.6	2.6	0.1	2.8	2.8	0.1	3.0	1.5	0.2	1.6	1.8	0.2	1.9	2.5	0.1	2.7
Dominant Taxon (%)	39	5.2	39	35	8.8	28	25	3.7	20	18	4.0	18	53	8.8	53	58	5.1	58	33	8.9	32
Tolerance Value	3.9	0.1	3.9	4.1	0.4	4.1	4.6	0.1	4.6	4.5	0.2	4.5	6.4	0.4	6.4	5.0	0.1	5.0	4.4	0.1	4.4
Intolerant Organisms (%)	45	5.0	45	30	8.3	30	9	0.5	9	15	4.4	15	10	3.3	10	6	1.6	6	15	2.9	15
Tolerant Organisms (%)	7.3	1.8	7.3	2.4	1.4	2.4	8.6	2.5	8.6	11	1.7	11	53	9.0	53	5.9	1.0	5.9	5.5	1.2	5.4
Sample Abundance (x1000)	2.5	0.8	7.6	4.4	1.4	13.3	2.1	0.6	6.2	2.1	0.3	6.3	2.2	0.5	6.5	1.8	0.6	5.4	1.7	0.2	5.1

UARP biological metric values - year 2002

Reach:	Camino Reservoir									Brush Creek Reservoir						Slab Creek Reservoir								
Site Code:	CD-I1	CD-I1	CD-I1	CD-I2	CD-I2	CD-I2	CD-I3	CD-I3	CD-I3	BC-I1	BC-I1	BC-I1	BC-I2	BC-I2	BC-I2	SC-I1	SC-I1	SC-I1	SC-I2	SC-I2	SC-I2	SC-I3	SC-I3	SC-I3
Transect/spot:	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Taxonomic Richness	22	27	24	33	26	26	26	25	25	41	41	33	44	41	36	38	37	41	27	24	23	31	21	26
EPT Taxa	13	17	14	13	14	16	11	9	11	25	22	20	21	23	18	21	19	22	14	13	14	9	10	12
Ephemeroptera Taxa	7	9	8	6	5	5	4	4	3	6	7	6	9	10	9	8	6	6	5	5	5	4	4	4
Plecoptera Taxa	3	4	3	4	5	6	2	2	4	10	10	9	6	6	4	6	8	9	5	5	5	1	3	3
Trichoptera Taxa	3	4	3	3	4	5	5	3	4	9	5	5	6	7	5	7	5	7	4	3	4	4	3	5
EPT Index (%)	36	46	41	55	58	71	41	43	65	80	73	77	61	64	69	47	56	66	77	88	49	49	80	79
Sensitive EPT Index (%)	15	21	23	11	8	14	3	1	2	44	38	39	24	30	25	19	23	26	24	23	15	4	20	21
Shannon Diversity	2.2	2.7	2.4	2.7	2.5	2.3	2.3	2.5	2.3	3.1	3.0	2.9	2.9	2.9	2.9	2.8	2.9	3.1	2.5	2.1	2.1	2.8	2.2	2.5
Dominant Taxon (%)	27	14	22	20	21	32	20	19	31	17	16	23	18	17	20	22	18	15	26	41	42	20	32	19
Tolerance Value	5.2	4.9	5.0	4.4	4.6	4.4	5.3	5.3	4.8	3.1	3.4	3.2	3.8	3.7	3.7	4.6	4.4	4.2	3.9	3.9	4.7	4.7	4.1	3.9
Intolerant Organisms (%)	14	21	23	11	8	14	2	1	1	44	40	42	25	30	27	18	23	23	24	23	12	5	20	21
Tolerant Organisms (%)	19	14	23	7.2	1.3	1.0	8.5	7.2	3.4	3.8	8.5	5.1	5.9	5.7	9.2	7.6	8.5	10	3.8	1.3	0.7	6.1	0.3	2.3
Collector-Gatherers (%)	54	52	56	43	50	43	44	41	29	34	39	25	43	40	29	56	54	55	28	19	23	42	40	28
Collector-Filterers (%)	14	8	12	19	33	41	42	32	55	4	2	6	10	8	9	21	11	13	40	54	58	29	34	45
Scrapers (%)	9	13	11	15	9	6	3	5	3	19	19	25	29	31	45	6	7	8	24	17	11	17	17	18
Predators (%)	10	13	6	21	6	9	8	19	12	25	23	27	14	18	14	6	9	10	8	10	7	12	9	10
Shredders (%)	12	13	15	0	1	1	0	1	0	10	16	17	1	1	2	9	13	10	0	0	0	0	0	0
Other (%)	0	1	0	1	1	0	2	2	0	8	1	1	3	2	0	3	6	5	0	0	0	0	0	0
ample Abundance (x1000)	1.3	0.91	2.1	0.52	1.3	0.81	1.1	1.1	1.2	0.39	0.61	1.0	2.4	3.4	2.3	1.2	1.0	1.3	0.93	1.4	2.6	1.2	0.65	2.7

Site Code:		CD-I1			CD-I2			CD-I3			BC-I1			BC-I2			SC-I1			SC-I2			SC-I3	
	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST
Taxonomic Richness	24	1.5	34	28	2.3	46	25	0.3	40	38	2.7	53	40	2.3	56	39	1.2	55	25	1.2	30	26	2.9	39
EPT Taxa	15	1.2	20	14	0.9	23	10	0.7	17	22	1.5	31	21	1.5	25	21	0.9	28	14	0.3	16	10	0.9	16
Ephemeroptera Taxa	8.0	0.6	10	5.3	0.3	8	3.7	0.3	7	6.3	0.3	7	9.3	0.3	11	6.7	0.7	8	5.0	0.0	5	4.0	0.0	6
Plecoptera Taxa	3.3	0.3	5	5.0	0.6	8	2.7	0.7	5	9.7	0.3	13	5.3	0.7	6	7.7	0.9	10	5.0	0.0	7	2.3	0.7	4
Trichoptera Taxa	3.3	0.3	5	4.0	0.6	7	4.0	0.6	5	6.3	1.3	11	6.0	0.6	8	6.3	0.7	10	3.7	0.3	4	4.0	0.6	6
EPT Index (%)	41	3.0	41	61	5.0	61	50	7.7	50	77	2.0	77	65	2.3	65	57	5.5	57	71	11.7	71	69	10.2	70
Sensitive EPT Index (%)	20	2.6	20	11	1.6	11	2	0.4	2	40	1.7	40	27	1.8	27	23	1.9	23	21	3.0	21	15	5.3	15
Shannon Diversity	2.5	0.1	2.6	2.5	0.1	2.7	2.4	0.1	2.5	3.0	0.1	3.1	2.9	0.0	3.1	2.9	0.1	3.1	2.2	0.1	2.5	2.5	0.2	2.7
Dominant Taxon (%)	21	3.8	20	24	4.0	21	24	3.8	21	19	2.2	19	18	1.1	14	18	2.0	16	36	5.0	24	24	4.2	21
Tolerance Value	5.0	0.1	5.0	4.5	0.1	4.5	5.1	0.2	5.1	3.2	0.1	3.2	3.7	0.1	3.7	4.4	0.1	4.4	4.2	0.3	4.2	4.2	0.2	4.2
Intolerant Organisms (%)	19	2.7	19	11	1.7	11	2	0.3	2	42	1.1	42	27	1.4	27	21	2.0	22	20	3.9	20	15	5.2	15
Tolerant Organisms (%)	18	2.5	18.4	3.2	2.0	3.2	6.4	1.5	6.4	5.8	1.4	5.8	6.9	1.1	6.9	8.8	0.8	8.8	1.9	1.0	1.9	2.9	1.7	2.9
ample Abundance (x1000)	1.4	0.4	4.3	0.88	0.23	2.6	1.1	0.0	3.4	0.67	0.18	2.0	2.7	0.4	8.1	1.2	0.1	3.5	1.6	0.5	4.9	1.5	0.6	4.6

UARP biological metric values - year 2002

Reach:	Big Silver Ref			SF American Ref		
Site Code:	BSC	BSC	BSC	SFAR	SFAR	SFAR
Transect/spot:	1	2	3	1	2	3
Taxonomic Richness	34	35	36	36	30	29
EPT Taxa	21	20	18	20	17	18
Ephemeroptera Taxa	8	8	8	8	7	5
Plecoptera Taxa	8	8	6	5	2	5
Trichoptera Taxa	5	4	4	7	8	8
EPT Index (%)	61	80	53	70	76	76
Sensitive EPT Index (%)	38	42	30	36	30	15
Shannon Diversity	2.7	2.6	2.5	2.7	2.6	2.1
Dominant Taxon (%)	16	31	24	17	24	48
Tolerance Value	3.3	2.9	3.8	3.1	3.5	3.9
Intolerant Organisms (%)	44	45	32	35	27	12
Tolerant Organisms (%)	1.3	1.0	2.6	1.7	0.3	0.3
Collector-Gatherers (%)	49	33	61	19	26	26
Collector-Filterers (%)	15	32	17	26	42	57
Scrapers (%)	8	8	7	42	25	10
Predators (%)	16	18	9	9	5	7
Shredders (%)	7	4	3	1	1	0
Other (%)	4	5	2	2	0	1
Sample Abundance (x1000)	1.9	1.3	2.7	0.82	1.6	1.6
Site Code:		BSC			SFAR	
	Mean	SE	CST	Mean	SE	CST
Taxonomic Richness	35	0.6	50	32	2.2	50
EPT Taxa	20	0.9	28	18	0.9	27
Ephemeroptera Taxa	8.0	0.0	11	6.7	0.9	10
Plecoptera Taxa	7.3	0.7	10	4.0	1.0	6
Trichoptera Taxa	4.3	0.3	7	7.7	0.3	11
EPT Index (%)	65	8.2	65	74	1.9	75
Sensitive EPT Index (%)	37	3.6	37	27	6.2	28
Shannon Diversity	2.6	0.1	2.7	2.5	0.2	2.6
Dominant Taxon (%)	24	4.4	21	30	9.3	29
Tolerance Value	3.3	0.3	3.3	3.5	0.2	3.5
Intolerant Organisms (%)	40	4.0	40	25	6.7	25
Tolerant Organisms (%)	1.6	0.5	1.6	0.8	0.5	0.8
Sample Abundance (x1000)	2.0	0.4	5.9	1.3	0.3	4.0

UARP biological metric values - year 2003

Reach:	Rubicon Reservoir									Buck Island Reservoir					
Site Code:	RR-I1	RR-I1	RR-I1	RR-I2	RR-I2	RR-I2	RR-I3	RR-I3	RR-I3	BI-I1	BI-I1	BI-I1	BI-I2	BI-I2	BI-I2
Transect/spot:	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Taxonomic Richness	30	35	36	31	39	42	28	26	24	22	25	29	31	29	24
EPT Taxa	18	18	19	20	17	20	13	10	12	12	12	14	16	16	6
Ephemeroptera Taxa	9	8	7	9	8	9	4	4	6	4	4	7	8	8	4
Plecoptera Taxa	3	3	3	2	2	3	6	4	2	2	2	2	4	2	0
Trichoptera Taxa	6	7	9	9	7	8	3	2	4	6	6	5	4	6	2
EPT Index (%)	36	39	35	65	39	50	23	13	20	33	35	39	48	41	24
Sensitive EPT Index (%)	23	13	12	19	21	26	5	5	9	15	20	20	25	25	14
Shannon Diversity	2.1	2.4	2.4	2.6	3.0	3.0	2.0	2.0	2.2	2.6	2.6	2.6	2.7	2.7	2.5
Dominant Taxon (%)	50	46	44	24	23	27	47	47	26	19	21	19	20	22	28
Tolerance Value	4.5	4.8	4.9	4.3	4.4	4.2	6.3	6.4	5.7	5.3	5.1	5.1	4.3	4.7	5.3
Intolerant Organisms (%)	15	11	9	17	22	25	5	5	9	15	19	20	25	24	14
Tolerant Organisms (%)	1	1	3	2	5	4	51	52	26	19	24	18	13	24	15
Collector-Gatherers (%)	69	69	69	66	57	56	83	84	84	50	49	61	59	50	78
Collector-Filterers (%)	0.3	2.0	3.1	0.7	2.5	3.7	1.7	2.7	5.5	24	29	12	13	25	6.0
Scrapers (%)	5	8.7	7.1	13	6.5	12	3.8	2.7	0.0	4.2	3.3	1.7	12	11	3.3
Predators (%)	6.7	7.3	9.2	6.4	18	14	9.4	8.2	4.1	15	11	23	9.1	5.1	12
Shredders (%)	16	5.7	3.1	5.4	5.4	4.0	1.4	2.1	3.8	4.5	6.6	2.1	1.3	6.1	0.0
Other (%)	2.3	7.7	8.8	8.7	10	10	0.7	0.0	2.4	1.4	0.7	0.0	5.2	2.4	0.7
Sample Abundance (x1000)	2.0	2.2	2.3	5.7	2.5	2.2	2.0	4.4	2.4	2.7	2.7	3.3	3.7	6.0	2.0

Site Code:	RR-I1			RR-I2			RR-I3			BI-I1			BI-I2		
	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST
Taxonomic Richness	34	1.9	46	37	3.3	47	26	1.2	39	25	2.0	37	28	2.1	42
EPT Taxa	18	0.3	23	19	1.0	21	12	0.9	19	13	0.7	20	13	3.3	20
Ephemeroptera Taxa	8.0	0.6	9	8.7	0.3	9	4.7	0.7	8	5.0	1.0	7	6.7	1.3	8
Plecoptera Taxa	3.0	0.0	3	2.3	0.3	3	4.0	1.2	6	2.0	0.0	4	2.0	1.2	4
Trichoptera Taxa	7.3	0.9	11	8.0	0.6	9	3.0	0.6	5	5.7	0.3	9	4.0	1.2	8
EPT Index (%)	36	1	36	51	8	51	18	3	18	36	2	36	38	7	38
Sensitive EPT Index (%)	16	4	16	22	2	22	6	1	6	18	2	18	21	4	21
Shannon Diversity	2.3	0.1	2.5	2.9	0.1	3.0	2.0	0.1	2.2	2.6	0.0	2.7	2.6	0.1	2.9
Dominant Taxon (%)	47	2	47	25	1	25	40	7	39	19	1	14	23	2	21
Tolerance Value	4.8	0.1	4.8	4.3	0.1	4.3	6.1	0.2	6.1	5.1	0.1	5.1	4.8	0.3	4.8
Intolerant Organisms (%)	12	2	12	21	2	21	6	1	6	18	2	18	21	4	21
Tolerant Organisms (%)	2	1	2	3	1	3	43	8	43	20	2	20	17	3	17
Sample Abundance (x1000)	2.2	0.1	6.5	3.5	1.1	10	2.9	0.7	8.8	2.9	0.2	8.7	3.9	1.2	12

UARP biological metric values - year 2003

Reach:	Loon Lake									Gerle Creek Reservoir						Robbs Peak Dam					
Site Code:	LL-I1	LL-I1	LL-I1	LL-I2	LL-I2	LL-I2	LL-I3	LL-I3	LL-I3	GC-I1	GC-I1	GC-I1	GC-I2	GC-I2	GC-I2	RPD-I1	RPD-I1	RPD-I1	RPD-I2	RPD-I2	RPD-I2
Transect/spot:	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Taxonomic Richness	25	31	27	38	33	31	33	36	39	30	30	24	38	39	41	41	35	36	38	42	38
EPT Taxa	17	18	12	27	22	17	20	23	22	16	15	10	17	18	22	22	17	17	19	19	19
Ephemeroptera Taxa	9	8	4	9	8	7	8	9	8	4	4	3	6	7	7	9	6	7	9	8	8
Plecoptera Taxa	5	5	4	6	6	4	3	3	5	5	3	1	5	5	7	5	4	3	3	6	3
Trichoptera Taxa	3	5	4	12	8	6	9	11	9	7	8	6	6	6	8	8	7	7	7	5	8
EPT Index (%)	46	57	54	60	54	30	29	42	43	52	25	16	53	57	53	46	56	25	31	33	57
Sensitive EPT Index (%)	31	37	48	26	26	13	22	32	30	32	18	6	24	34	29	22	27	13	16	16	32
Shannon Diversity	2.6	2.7	2.4	3.0	2.6	2.3	2.0	2.6	2.5	2.8	1.9	1.4	3.0	3.0	2.8	3.2	2.8	2.5	2.6	2.9	3.0
Dominant Taxon (%)	18	17	35	17	28	42	57	39	37	18	55	69	14	20	23	18	21	39	28	33	16
Tolerance Value	4.8	4.1	3.9	4.4	4.4	5.8	4.8	4.1	4.2	4.8	6.4	6.9	4.0	3.9	3.9	4.3	3.8	5.1	5.0	4.6	3.8
Intolerant Organisms (%)	31	37	49	25	26	14	18	29	29	30	12	6	23	32	30	23	28	14	16	15	25
Tolerant Organisms (%)	31	15	27	18	10	43	2	2	3	32	69	74	4	8	3	9	2	10	10	4	1
Collector-Gatherers (%)	37	45	24	29	38	25	71	59	56	33	17	8.5	38	38	48	60	41	69	71	56	44
Collector-Filterers (%)	19	8.8	16	28	18	46	1.4	4.2	6.3	19	55	69	4.2	5.6	1.0	9.1	24	6.3	2.8	3.4	8.2
Scrapers (%)	10	7	1	14	18	11	11	16	16	10	2	3	19	17	13	6.5	5.6	4.9	3.8	16	11
Predators (%)	11	12	16	9.0	6.8	9.2	5.4	9.8	6.9	14	5.9	6.5	23	13	18	12	15	11	12	17	19
Shredders (%)	22	27	42	13	18	7.2	6.4	7.3	13	16	10	1.7	16	25	17	9.4	13	7.3	9.3	6.9	10
Other (%)	0.0	0.7	0.3	7.3	1.4	2.0	4.4	4.2	2.6	8.9	8.7	11	1.0	1.7	2.8	2.6	2.1	1.7	1.4	1.7	8.2
Sample Abundance (x1000)	2.5	1.3	1.7	3.4	4.7	3.2	6.0	3.0	7.8	2.0	1.2	0.34	0.77	1.0	2.0	1.2	1.3	1.2	4.0	1.6	0.94
Site Code:		LL-I1			LL-I2			LL-I3			GC-I1			GC-I2			RPD-I1			RPD-I2	
	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST
Taxonomic Richness	28	1.8	38	34	2.1	44	36	1.7	51	28	2.0	42	39	0.9	55	37	1.9	50	39	1.3	54
EPT Taxa	16	1.9	21	22	2.9	27	22	0.9	28	14	1.9	19	19	1.5	27	19	1.7	26	19	0.0	26
Ephemeroptera Taxa	7.0	1.5	9	8.0	0.6	9	8.3	0.3	11	3.7	0.3	5	6.7	0.3	9	7.3	0.9	10	8.3	0.3	10
Plecoptera Taxa	4.7	0.3	5	5.3	0.7	6	3.7	0.7	6	3.0	1.2	5	5.7	0.7	8	4.0	0.6	5	4.0	1.0	6
Trichoptera Taxa	4.0	0.6	7	8.7	1.8	12	10	0.7	11	7.0	0.6	9	6.7	0.7	10	7.3	0.3	11	6.7	0.9	10
EPT Index (%)	52	3	52	48	9	48	38	5	38	31	11	31	55	1	55	43	9.0	43	40	8.3	40
Sensitive EPT Index (%)	39	5	39	22	4	22	28	3	28	18	8	19	29	3	29	21	4.3	21	21	5.3	21
Shannon Diversity	2.5	0.1	2.7	2.6	0.2	2.8	2.4	0.2	2.5	2.0	0.4	2.3	2.9	0.1	3.1	2.8	0.2	3.0	2.8	0.1	3.1
Dominant Taxon (%)	23	6	19	29	7	23	44	6	44	47	15	47	19	3	15	26	6.4	24	25	4.9	25
Tolerance Value	4.3	0.3	4.3	4.9	0.5	4.9	4.4	0.2	4.4	6.0	0.6	6.0	4.0	0.0	4.0	4.4	0.4	4.4	4.5	0.4	4.4
Intolerant Organisms (%)	39	5	39	22	4	22	25	4	25	16	7	16	28	3	28	22	4.1	22	18	3.1	18
Tolerant Organisms (%)	24	5	25	24	10	23	2	0	2	58	13	58	5	1	5	7	2.4	7.3	5	2.5	5.3
Sample Abundance (x1000)	1.8	0.4	5.5	3.8	0.5	11	5.6	1.4	17	1.2	0.5	3.5	1.3	0.4	3.8	1.2	0.0	3.7	2.2	0.9	6.5

UARP biological metric values - year 2003

Reach:	Ice House Reservoir												Union Valley and Junction Reservoirs								
Site Code:	IH-I1	IH-I1	IH-I1	IH-I2	IH-I2	IH-I2	IH-I3	IH-I3	IH-I3	IH-I4	IH-I4	IH-I4	JD-I1	JD-I1	JD-I1	JD-I2	JD-I2	JD-I2	JD-I3	JD-I3	JD-I3
Transect/spot:	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Taxonomic Richness	20	21	21	29	29	32	39	42	36	29	34	37	18	16	16	36	33	33	37	43	32
EPT Taxa	10	11	10	13	13	16	18	18	15	11	15	17	9	9	10	21	21	18	18	19	17
Ephemeroptera Taxa	5	7	5	5	6	8	7	7	5	4	5	5	2	5	4	9	10	7	6	6	7
Plecoptera Taxa	3	3	3	4	4	4	3	2	3	3	4	5	5	2	4	4	5	4	5	7	4
Trichoptera Taxa	2	1	2	4	3	4	8	9	7	4	6	7	2	2	2	8	6	7	7	6	6
EPT Index (%)	35	43	54	37	30	28	34	43	32	58	46	47	9	10	25	49	43	53	40	54	39
Sensitive EPT Index (%)	24	35	31	26	12	16	14	16	11	21	21	24	8	5	14	22	21	32	17	20	14
Shannon Diversity	1.9	2.2	2.5	2.3	2.5	2.3	3.0	3.2	2.8	2.7	2.9	3.0	1.3	1.4	1.9	2.9	2.7	2.7	2.7	3.0	2.4
Dominant Taxon (%)	48	31	18	37	28	46	16	13	19	23	17	11	66	52	41	15	23	15	25	18	36
Tolerance Value	4.6	4.3	4.2	4.5	5.0	4.8	4.9	4.7	4.6	4.2	4.3	4.1	5.3	5.7	4.7	4.7	4.5	4.3	4.8	4.3	4.8
Intolerant Organisms (%)	24	35	31	26	13	16	13	16	11	22	21	23	8	5	14	23	22	33	18	23	14
Tolerant Organisms (%)	12	14	8	6	10	10	20	17	6	9	11	8	13	26	12	15	7	10	19	6	5
Collector-Gatherers (%)	73	53	44	60	70	75	41	51	35	62	56	50	87	91	56	64	47	58	54	49	34
Collector-Filterers (%)	1.0	2.0	6.4	5.4	4.5	1.7	24	14	24	10	4.7	12	0.7	1.3	7.3	3.4	20	10	14	6.5	41
Scrapers (%)	1.0	3.4	9.5	4.7	3.5	2.1	14	12	23	11	13	15	0.3	3.6	8.9	4.1	4.5	2.6	4.0	10	8.3
Predators (%)	7.6	16	20	19	16	11	12	14	7.7	11	20	20	5.9	1.0	16	15	20	10	23	30	12
Shredders (%)	16	26	20	10	2.1	6.2	4.8	7.5	6.0	4.9	4.7	3.1	5.5	3.0	13	5.9	3.6	15	4.7	4.5	2.0
Other (%)	1.0	0.0	0.3	0.7	4.2	3.5	3.4	2.4	3.3	0.0	0.7	0.0	0.7	0.3	0.0	6.6	4.2	2.9	0.7	0.0	1.7
Sample Abundance (x1000)	3.1	4.0	1.0	3.5	1.7	3.1	1.2	2.5	1.2	0.72	0.93	1.6	0.42	0.89	0.48	0.99	1.3	1.3	0.35	0.83	1.4
Site Code:		IH-I1			IH-I2			IH-I3			IH-I4			JD-I1			JD-I2			JD-I3	
	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST
Taxonomic Richness	21	0.3	26	30	1.0	46	39	1.7	52	33	2.3	50	17	0.7	28	34	1.0	45	37	3.2	64
EPT Taxa	10	0.3	13	14	1.0	21	17	1.0	22	14	1.8	20	9.3	0.3	15	20.0	1.0	26	18.0	0.6	28
Ephemeroptera Taxa	5.7	0.7	8	6.3	0.9	9	6.3	0.7	8	4.7	0.3	6	3.7	0.9	5	8.7	0.9	11	6.3	0.3	10
Plecoptera Taxa	3.0	0.0	3	4.0	0.0	6	2.7	0.3	3	4.0	0.6	5	3.7	0.9	7	4.3	0.3	6	5.3	0.9	7
Trichoptera Taxa	1.7	0.3	2	3.7	0.3	6	8.0	0.6	11	5.7	0.9	9	2.0	0.0	3	7.0	0.6	9	6.3	0.3	11
EPT Index (%)	44	5.7	44	32	2.9	32	36	3.5	36	51	3.8	51	14	5	14	48	3	48	44	5	44
Sensitive EPT Index (%)	30	3.3	30	18	4.0	18	14	1.5	14	22	1.1	22	9	3	9	25	4	25	17	2	17
Shannon Diversity	2.2	0.2	2.3	2.4	0.1	2.6	3.0	0.1	3.2	2.9	0.1	3.0	1.6	0.2	1.8	2.8	0.0	2.9	2.7	0.2	3.0
Dominant Taxon (%)	32	8.6	32	37	5.0	28	16	1.8	10	17	3.3	13	53	7	53	18	3	17	27	5	18
Tolerance Value	4.3	0.1	4.3	4.8	0.1	4.8	4.8	0.1	4.8	4.2	0.0	4.2	5.2	0.3	5.2	4.5	0.1	4.5	4.6	0.2	4.6
Intolerant Organisms (%)	30	3.3	30	18	4.0	19	13	1.3	13	22	0.5	22	9	3	9	26	4	26	18	3	18
Tolerant Organisms (%)	11	1.7	11.4	9	1.3	8.7	15	4.2	14.5	10	0.7	9.5	17	5	17	11	2	11	10	4	10
Sample Abundance (x1000)	2.7	0.9	8.1	2.8	0.5	8.3	1.6	0.4	4.9	1.1	0.3	3.3	0.60	0.1	1.8	1.20	0.1	3.6	0.86	0.3	2.6

UARP biological metric values - year 2003

Reach:	Camino Reservoir									Brush Creek Reservoir					
Site Code:	CD-I1	CD-I1	CD-I1	CD-I2	CD-I2	CD-I2	CD-I3	CD-I3	CD-I3	BC-I1	BC-I1	BC-I1	BC-I2	BC-I2	BC-I2
Transect/spot:	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Taxonomic Richness	26	25	28	32	34	35	28	30	23	39	46	39	43	42	40
EPT Taxa	13	14	17	11	18	17	13	11	6	22	24	22	21	26	19
Ephemeroptera Taxa	7	6	9	5	7	7	5	4	3	5	5	6	7	8	9
Plecoptera Taxa	3	5	4	3	7	6	3	3	0	9	10	9	8	11	7
Trichoptera Taxa	3	3	4	3	4	4	5	4	3	8	9	7	6	7	3
EPT Index (%)	46	34	48	64	59	71	40	41	15	72	69	80	71	69	49
Sensitive EPT Index (%)	18	10	18	13	8	21	6	2	0	38	32	29	33	35	23
Shannon Diversity	2.6	2.0	2.4	2.7	2.5	2.8	2.6	2.4	2.1	2.9	3.1	2.9	3.0	3.1	3.1
Dominant Taxon (%)	26	48	32	19	24	14	16	19	29	14	18	21	23	14	14
Tolerance Value	4.6	4.9	4.4	4.4	4.7	3.9	5.3	5.2	6.2	3.5	3.6	3.7	3.6	3.7	4.1
Intolerant Organisms (%)	18	10	19	13	8	21	6	2	0	33	33	28	33	34	26
Tolerant Organisms (%)	10	8	12	5	4	1	10	1	33	5	8	7	9	11	19
Collector-Gatherers (%)	52	76	52	45	56	39	44	44	74	27	35	33	43	40	39
Collector-Filterers (%)	9.1	2.3	11	29	24	24	31	35	6.6	13	7.8	14	5.4	4.7	11
Scrapers (%)	11	7.7	21	9.2	6.7	19	5.2	4.7	1.0	19	25	23	24	21	18
Predators (%)	17	6.3	7.9	17	11	15	16	15	17	20	17	13	21	19	25
Shredders (%)	10	6.3	7.9	0.0	1.3	2.6	0.3	0.3	0.0	16	15	14	6.0	13	5.9
Other (%)	0.0	1.7	0.3	0.0	0.7	1.0	3.4	0.7	1.4	6.6	1.4	2.7	1.0	1.7	0.0
Sample Abundance (x1000)	0.76	1.2	0.93	1.0	0.93	2.0	1.1	0.7	1.0	1.7	1.3	1.0	1.8	1.7	1.2

Site Code:	CD-I1			CD-I2			CD-I3			BC-I1			BC-I2		
	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST
Taxonomic Richness	26	0.9	38	34	0.9	53	27	2.1	44	41	2.3	68	42	0.9	61
EPT Taxa	15	1.2	21	15	2.2	23	10	2.1	16	23	0.7	33	22	2.1	31
Ephemeroptera Taxa	7.3	0.9	10	6.3	0.7	8	4.0	0.6	7	5.3	0.3	9	8.0	0.6	11
Plecoptera Taxa	4.0	0.6	6	5.3	1.2	9	2.0	1.0	4	9.3	0.3	13	8.7	1.2	12
Trichoptera Taxa	3.3	0.3	5	3.7	0.3	6	4.0	0.6	5	8.0	0.6	11	5.3	1.2	8
EPT Index (%)	43	4	43	65	3	65	32	8	32	74	3	74	63	7	63
Sensitive EPT Index (%)	16	3	16	14	4	14	3	2	3	33	3	33	30	4	30
Shannon Diversity	2.4	0.2	2.5	2.7	0.1	2.8	2.4	0.1	2.6	3.0	0.1	3.2	3.1	0.0	3.3
Dominant Taxon (%)	35	7	35	19	3	16	21	4	20	18	2	18	17	3	16
Tolerance Value	4.7	0.1	4.7	4.3	0.3	4.3	5.6	0.3	5.6	3.6	0.1	3.6	3.8	0.2	3.8
Intolerant Organisms (%)	16	3	16	14	4	14	3	2	3	31	2	31	31	2	31
Tolerant Organisms (%)	10	1	10	3	1	3	15	10	15	7	1	7	13	3	13
Sample Abundance (x1000)	0.96	0.1	2.9	1.31	0.3	3.9	0.94	0.1	2.8	1.3	0.2	4.0	1.6	0.2	4.7

UARP biological metric values - year 2003

Reach:	Slab Creek Reservoir									Big Silver Ref			SF American Ref			Silver Fork Ref		
Site Code:	SC-I1	SC-I1	SC-I1	SC-I2	SC-I2	SC-I2	SC-I3	SC-I3	SC-I3	BSC	BSC	BSC	SFAR	SFAR	SFAR	SILV	SILV	SILV
Transect/spot:	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Taxonomic Richness	40	42	38	28	22	28	23	31	28	36	41	40	27	36	41	34	29	39
EPT Taxa	19	22	16	14	11	14	6	10	10	18	24	24	15	20	21	18	16	24
Ephemeroptera Taxa	7	8	5	7	5	6	2	5	4	7	8	10	6	7	7	8	7	11
Plecoptera Taxa	5	7	5	2	3	3	0	0	1	4	4	4	3	8	7	4	4	4
Trichoptera Taxa	7	7	6	5	3	5	4	5	5	7	12	10	6	5	7	6	5	9
EPT Index (%)	52	41	51	75	71	63	17	21	58	68	70	64	68	77	64	69	47	60
Sensitive EPT Index (%)	19	19	23	29	17	14	1	1	18	35	44	41	21	54	22	41	34	40
Shannon Diversity	3.0	3.0	3.0	2.4	2.4	2.4	2.3	2.6	2.7	2.9	3.0	3.1	2.3	2.9	2.9	2.7	2.5	3.1
Dominant Taxon (%)	17	21	10	21	25	23	28	30	17	17	17	13	30	19	23	19	31	15
Tolerance Value	4.7	5.0	4.5	3.7	4.2	4.5	6.0	6.4	4.1	3.3	2.9	3.3	3.9	2.5	3.8	2.9	3.5	3.2
Intolerant Organisms (%)	19	18	22	29	17	13	1	1	18	33	41	33	21	55	22	50	40	45
Tolerant Organisms (%)	17	30	13	5	2	2	27	41	2	2	4	3	1	6	3	4	3	10
Collector-Gatherers (%)	62	62	55	43	36	39	47	36	34	22	22	38	17	22	18	28	21	39
Collector-Filterers (%)	8.3	6.6	13	21	39	42	4.3	2.5	37	9.8	5.7	3.4	58	14	38	20	33	13
Scrapers (%)	2.6	2.6	3.8	28	17	14	25	35	21	41	49	31	21	45	31	35	26	31
Predators (%)	14	17	10	6.5	6.6	5.4	15	13	7.5	11	8.7	20	2.9	10	9.7	16	18	14
Shredders (%)	11	6.6	14	0.3	1.0	0.3	0.0	0.0	0.0	11	13	6.2	0.7	3.8	2.8	0.0	1.3	1.0
Other (%)	2.3	5.3	4.5	0.7	0.0	0.3	8.9	13	0.7	4.9	2.0	1.7	0.0	5.1	1.4	1.0	0.4	1.0
Sample Abundance (x1000)	2.7	5.8	2.0	0.83	2.1	1.6	0.47	0.63	1.8	2.2	3.4	1.7	2.2	0.92	1.6	0.52	0.24	0.35

Site Code:	SC-I1			SC-I2			SC-I3			BSC			SFAR			SILV		
	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST	Mean	SE	CST
Taxonomic Richness	40	1.2	56	26	2.0	37	27	2.3	47	39	1.5	55	35	4.1	50	34	2.9	51
EPT Taxa	19	1.7	26	13	1.0	18	9	1.3	17	22	2.0	29	19	1.9	26	19	2.4	29
Ephemeroptera Taxa	6.7	0.9	9	6.0	0.6	8	3.7	0.9	8	8.3	0.9	11	7	0.3	9	9	1.2	11
Plecoptera Taxa	5.7	0.7	8	2.7	0.3	4	0.3	0.3	1	4.0	0.0	5	6	1.5	9	4	0.0	9
Trichoptera Taxa	6.7	0.3	9	4.3	0.7	6	4.7	0.3	8	9.7	1.5	13	6	0.6	8	7	1.2	9
EPT Index (%)	48	3	48	70	3	70	32	13	33	67	2	67	70	4	70	59	6	60
Sensitive EPT Index (%)	20	1	20	20	4	20	7	6	7	40	2	40	33	11	32	38	2	39
Shannon Diversity	3.0	0.0	3.1	2.4	0.0	2.5	2.5	0.1	3.0	3.0	0.0	3.1	2.7	0.2	2.9	2.8	0.2	2.9
Dominant Taxon (%)	16	3	14	23	1	23	25	4	17	16	1	15	24	3	21	22	5	15
Tolerance Value	4.7	0.2	4.7	4.1	0.3	4.1	5.5	0.7	5.5	3.2	0.1	3.2	3.4	0.4	3.4	3.2	0.2	3.2
Intolerant Organisms (%)	20	1	20	20	5	20	7	6	7	36	2	36	32	11	32	45	3	45
Tolerant Organisms (%)	20	5	20	3	1	3	24	11	23	3	1	3	3	1	3	6	2	6
Sample Abundance (x1000)	3.5	1.2	10.5	1.5	0.4	4.5	1.0	0.4	2.9	2.4	0.5	7.3	1.6	0.4	4.7	0.4	0.1	1.1

APPENDIX D

TAXONOMIC LISTS AND BIOLOGICAL METRIC VALUES FOR THE REACH DOWNSTREAM OF CHILI BAR FOR 2003 AND 2004

Taxonomic list of benthic macroinvertebrates including California Tolerance Values (CTV) and Functional Feeding Groups (FFG) for the Reach Downstream of Chili Bar (CB) by year and the reference sites (Ref).

Arthropoda			Totals		
Insecta			CB		Ref*
Coleoptera			n=18	n=18	n=9
Dytiscidae	CTV	FFG	2003	2004	95/04
Agabinus	5	p	0	0	1
Elmidae					
Ampumixis dispar	4	cg	1	0	0
Dubiraphia	6	cg	0	0	5
Microcylloepus	4	cg	0	1	75
Microcylloepus (A)	4	sc	0	0	24
Optioservus	4	sc	0	1	64
Optioservus (adult)	4	cg	1	0	20
Ordobrevia nubifera	4	sc	2	2	7
Ordobrevia nubifera (A)	4	cg	1	0	2
Zaitzevia	4	sc	67	52	50
Zaitzevia (A)	4	cg	10	3	24
Dropidae					
Helichus (A)	5	sh	0	0	1
Psephenidae					
Psephenus falli	4	sc	0	1	37
Ptilodactylidae					
Stenocolus scutellaris	?	sh	0	0	6
Diptera					
Ceratopogonidae					
Atrichopogon	6	cg	2	0	1
Dasyhelea	6	cg	1	0	22
Chironomidae					
Chironomini	6	cg	6	3	8
Diamesinae	2	cg	39	51	0
Orthocladiinae	5	cg	478	555	228
Pseudochironomini	5	cg	1	1	4
Tanypodinae	7	p	3	12	13
Tanytarsini	6	cg	50	70	52
Dolichopodidae					
Dolichopodidae	4	p	0	0	2
Empididae					
Chelifera/ Metachela	6	p	3	1	0
Hemerodromia	6	p	1	10	3
Clinocera	6	p	11	6	2
Wiedemannia	6	p	0	0	2
Simuliidae					
Simulium	6	cf	409	971	140
Tipulidae					
Antocha	3	cg	31	10	18
Limonia	6	sh	6	0	1
Ephemeroptera					
Baetidae					
Acentrella	4	cg	2	1	0

			Totals		
			CB		Ref*
			n=18	n=18	n=9
	CTV	FFG	2003	2004	95/04
Ephemeroptera (con'd)					
Baetis	5	cg	273	236	262
Camelobaetidius	4	cg	0	0	3
Centroptilum	2	cg	0	0	2
Diphetor hageni	5	cg	0	0	2
Fallceon quilleri	4	cg	0	0	15
Ephemerellidae					
Ephemerella	1	cg	48	138	2
Seratella	2	cg	0	0	4
Heptageniidae					
Cinygmula	4	sc	0	0	1
Epeorus	0	sc	30	38	101
Rhithrogena	0	sc	368	316	323
Leptohyphidae					
Tricorythodes	4	cg	0	1	9
Leptophlebiidae					
Paraleptophlebia	4	cg	11	16	0
Hemiptera					
Naucoridae					
Ambrysus	5	p	0	0	1
Lepidoptera					
Pyralidae					
Petrophila	5	sc	8	2	13
Megaloptera					
Corydalidae					
Corydalus	0	p	0	0	1
Odonata					
Coenagrionidae					
Argia	7	p	0	0	54
Libellulidae					
Brechmorhoga mendax	9	p	0	0	12
Plecoptera (early instar)	?	?	95	0	0
Capniidae					
Capniidae	1	sh	0	1	4
Chloroperlidae					
Haploperla chilnualna	1	p	5	0	0
Sweltsa	1	p	1	2	3
Nemouridae					
Malenka	2	sh	1	0	0
Zapada	2	sh	2	1	0
Perlidae					
Calineuria californica	1	p	2	2	11
Hesperoperla	2	p	4	4	1

			Totals		
			CB		Ref*
			n=18	n=18	n=9
	CTV	FFG	2003	2004	95/04
Plecoptera (con'd)					
Perlodidae					
Cultus	2	p	0	0	6
Isoperla	2	p	65	107	14
Skwala parallela	2	p	17	12	6
Pteronarcyidae					
Pteronarcys	0	om	15	21	1
Taeniopterygidae					
Taeniopterygidae	2	om	1	46	0
Trichoptera					
Brachycentridae					
Micrasema	1	mh	0	3	27
Glossosomatidae					
Protoptila	1	sc	0	0	11
Helicopsychidae					
Helicopsyche borealis	3	sc	0	0	5
Hydropsychidae					
Cheumatopsyche	5	cf	79	200	63
Hydropsyche	4	cf	542	296	165
Hydroptilidae	4	ph	0	0	7
Hydroptila	6	ph	4	8	20
Leucotrichia pictipes	6	sc	0	1	0
Lepidostomatidae					
Lepidostoma	1	sh	0	0	2
Leptoceridae					
Mystacides	4	om	0	0	5
Odontoceridae					
Marilia flexuosa	0	sh	0	0	6
Philopotamidae					
Chimarra	4	cf	2	9	133
Wormaldia	3	cf	4	15	1
Polycentropodidae					
Polycentropus	6	p	0	1	0
Rhyacophilidae					
Rhyacophila	0	p	16	1	1
Arachnoidea					
Acari	8	p	0	0	4
Hygrobatidae					
Atractides	8	p	0	1	0
Hygrobates	8	p	8	23	7
Lebertiidae					
Lebertia	8	p	62	71	5
Sperchontidae					
Sperchon	8	p	307	109	17
Sperchonopsis	8	p	0	1	0

			Totals		
			CB		Ref*
			n=18	n=18	n=9
	CTV	FFG	2003	2004	95/04
Torrenticolidae					
Torrenticola	5	p	4	2	13
Malacostraca					
Amphipoda					
Crangonyctidae					
Crangonyx	4	cg	5	21	3
Stygobromus	4	cg	1	1	0
Hyalellidae					
Hyalella	8	cg	4	4	1
Isopoda					
Asellidae					
Caecidotea	8	cg	165	0	0
Ostracoda	8	cg	0	0	7
Annelida					
Hirudinea					
Rhyncobdellida					
Glossiphoniidae					
Placobdella	6	pa	0	0	2
Oligochaeta	8	cg	0	0	90
Lumbriculida					
Lumbriculidae	8	cg	11	3	0
Tubificida					
Enchytraeidae	8	cg	386	455	2
Naididae/Tubificidae	8	cg	1469	1158	54
Mollusca					
Bivalvia					
Pelecypoda					
Corbiculidae					
Corbicula fluminea	10	cf	1	0	0
Sphaeriidae	8	cf	3	11	4
Gastropoda					
Pulmonata					
Lymnaeidae					
Fossaria	8	sc	0	2	14
Physidae					
Physa/ Physella	8	sc	0	6	79
Planorbidae					
Gyraulus/Menetus	8	sc	8	33	3
Nemertea					
Enopa					
Tertastemmatidae					
Prostoma	8	p	27	58	21

			Totals		
			CB		**Ref***
			n=18	n=18	n=9
	CTV	FFG	2003	2004	95/04
Platyhelminthes					
Turbellaria					
Tricladida					
Planariidae	4	p	136	138	44

Key to taxonomic list	
CTV: California Tolerance Value	
FFG: Functional Feeding Group:	
cg: collector-gatherer	sh: shredder
cf: collector-filterer	mh: macrophyte herbivore**
sc: scraper	om: omnivore**
p: predator	ph: piercer herbivore**
** combined into "other" category for metric calculations.	

* Reference sites located on the North Fork American River (year 2004) and Cosumnes River (years 1995 and 2004).
1995 Cosumnes River data from the California Department of Fish and Game, unpublished.

Taxonomic list of benthic macroinvertebrates by sample for the Reach Downstream of Chili Bar, fall 2003.

Site Code:	CB-I1	CB-I1	CB-I1	CB-I2	CB-I2	CB-I2	CB-I3	CB-I3	CB-I3	CB-I4	CB-I4	CB-I4	CB-I5	CB-I5	CB-I5	CB-I7	CB-I7	CB-I7
Transect:	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Acentrella																2		
Ampumixis dispar					1													
Antocha				2	1		9	5	3	2	2	1			1			5
Atrichopogon																		2
Baetis	4	1	4	10	17	6	6	4	3	16	26	30	18	44	18	12	15	39
Caecidotea					16	114	27				1	7						
Calineuria californica												1					1	
Chelifera/ Metachela				1	1		1											
Cheumatopsyche			1	1	2	3	6	1	2	5	3	6	1	13	26	3		6
Chimarra															1			1
Chironomini										4			1				1	
Corbicula fluminea																1		
Crangonyx						1	1							1	1		1	
Dasyhelea																1		
Diamesinae	3	1	1	4			1			2						7	8	12
Empididae				1		1		1	2	3								
Enchytraeidae	11	3	53	19	41	13	51	53	81	28	17	14			2			
Epeorus								1				5	4	8	7		5	
Ephemerella				8	4	1				1			9	15	8			2
Ephemerellidae	4	9	15									3				3	2	
Gyraulus	2	2	1	1			1							1				
Haploperla chilnualna													5					
Hemerodromia																		1
Hesperoperla					1					1	1	1						
Hyalella																	2	2
Hydropsyche	2	1	4	45	45	35	19	58	30	14	77	27	20	56	68	14	4	23
Hydroptila										1		1				1		1
Hygrobates				1			1			3				2	1			
Isoperla				18	9	1	3	1	8	2		1	6	7	5		1	3
Lebertia	2	1	4	2	3	1	9	4	5	8	5	4	1	1	3		7	2
Limonia																		6
Lumbriculidae				2			1		2				2		1	2	1	
Malenka			1															
Naididae	224	234	121	63	10	16	63	89	66	147	57	74	81	5	39	104	68	8

Taxonomic list of benthic macroinvertebrates by sample for the Reach Downstream of Chili Bar, fall 2003.

Site Code:	CB-I1	CB-I1	CB-I1	CB-I2	CB-I2	CB-I2	CB-I3	CB-I3	CB-I3	CB-I4	CB-I4	CB-I4	CB-I5	CB-I5	CB-I5	CB-I7	CB-I7	CB-I7
Transect:	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Optioservus (adult)												1						
Ordobrevia nubifera													1				1	
Ordobrevia nubifera (adullt)																	1	
Orthocladiinae	27	11	35	62	34	9	7	3	10	7	12	18	16	19	10	52	81	65
Paraleptophlebia	2	1	1		1		1					1	1		2			1
Petrophila																1	4	3
Philopotamidae								1										
Planariidae	11	26	28	7	9	11	1	6	5	3	3	11	4	1	7	1	2	
Plecoptera							54	29	10							2		
Prostoma			3				4	2	3	8		2	2			2	1	
Pseudochironomus																		1
Pteronarcys					1					1		3	3	5	1	1		
Rhithrogena			1	1	9	11	1	19	33	3	51	48	59	35	39	3	35	20
Rhyacophila					2	1	5	2	2					2	1			1
Simulium	11	6	24	34	75	71	2	5	7	4	16	14	40	59	27	1	2	11
Skwala parallela					1		1	2	5	4	1		1					2
Sperchon	2	3	3	2	4		11	2	10	14	19	26	7	21	21	33	49	80
Sphaeriidae									1		2							
Stygobromus									1									
Sweltsa													1					
Taeniopterygidae								1										
Tanypodinae							2				1							
Tanytarsini	7	4	2	6	5	3	5			1	1	4	2			6	3	1
Torrenticola				1						2		1						
Trichoclinocera/Clinocera					1			2	2	2	1		2	1				
Wormaldia					1	1		2										
Zaitzevia						2	3	2	4		3	5	19	3	15	3	4	4
Zaitzevia (adult)						1			1		2	3			2			1
Zapada		1	1															

Taxonomic list of benthic macroinvertebrates from the Reach Downstream of Chili Bar - fall 2004.

	2004 CB-I1	2004 CB-I1	2004 CB-I1	2004 CB-I2	2004 CB-I2	2004 CB-I2	2004 CB-I3	2004 CB-I3	2004 CB-I3	2004 CB-I4	2004 CB-I4	2004 CB-I4	2004 CB-I5	2004 CB-I5	2004 CB-I5	2004 CB-I7	2004 CB-I7	2004 CB-I7
Acentrella																	1	
Antocha					1		1	1	1	1					1	4		
Atractides														1				
Baetis	4	1	1	3	8	6	3	3	3	2	2	6	20	6	3	58	90	17
Calineuria californica									1					1				
Capniidae			1															
Chelifera/ Metachela									1									
Cheumatopsyche				1	7	5	10	12	22	20	11	18	2	35	28	10	6	13
Chimarra								3	1			1				1		3
Chironomini		1									1					1		
Crangonyx	1	1	5	4						5	1		1		2		1	
Diamesinae			1	12	6	3	1	1	1	9	2	2		1			5	7
Empididae																		1
Enchytraeidae	34	5	25	114	115	53	11	34	28	25	4	7						
Epeorus							4	2	3			8	1		11	5	2	2
Ephemerella	6	21	20					2	2	15	3	11	5	3	26	7	15	2
Fossaria										1	1							
Hemerodromia					1					4	2	1		1	1			
Hesperoperla				1			1		1						1			
Hyalella																		4
Hydropsyche	2	1		15	17	14	26	25	25	2	5	8	26	24	47	30	14	15
Hydroptila													1			3	3	1
Hygrobates			1		15	2	2			2							1	
Isoperla				3	8	7	3	3	8	3	3	9	12	10	20	3	10	5
Lebertia		2	2	3	6	5	3	9	2	11	8	3	3	3	3	2	5	1
Leucotrichia pictipes																	1	
Lumbriculidae																		3
Gyraulus	1	11	10	8					1	2								
Micrasema																3		
Microcylloepus													1					
Naididae/Tubificidae	166	145	83	3	20	5	74	48	52	106	187	116	16	48	19	14	30	26
Optioservus						1												
Ordobrevia nubifera														2				

Taxonomic list of benthic macroinvertebrates from the Reach Downstream of Chili Bar - fall 2004.

	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004
	CB-I1	CB-I1	CB-I1	CB-I2	CB-I2	CB-I2	CB-I3	CB-I3	CB-I3	CB-I4	CB-I4	CB-I4	CB-I5	CB-I5	CB-I5	CB-I7	CB-I7	CB-I7
Orthocladiinae	12	9	12	39	39	63	27	21	17	20	9	33	30	24	28	34	53	85
Paraleptophlebia	1			2	1		3			1	1	1	1	2				3
Petrophila														1			1	
Physa/ Physella		1	1	2	1									1				
Pisidium				4	1	4		1	1									
Planariidae	19	9	15	9	9	3	4	12	3	11	5	4	14	9	2	3		7
Polycentropus										1								
Prostoma			2	3	3	4	1	1		16	10	11	1	1		2	1	2
Psephenus falli																		1
Pseudochironomus			1															
Pteronarcys							2					1		3	10	3	2	
Rhithrogena				2	1	1	28	19	37	1	13	17	8	49	37	26	4	73
Rhyacophila							1											
Simulium	46	101	94	51	25	99	45	53	67	7	3	19	156	44	44	69	38	10
Skwala parallela					1				1	1	2	1		1	2		2	1
Sperchon			1	1	10	5	4	17	7	8	7	3		6	5	6	11	18
Sperchonopsis																	1	
Stygobromus								1										
Sweltsa					1		1											
Taeniopterygidae		1	1			2	15	10	6	1	3	3				1	2	1
Tanypodinae					1		1	2		5		1						2
Tanytarsini	1	1	4	7	12	7	12	3	1	7	5	2	1	2		2	2	1
Torrenticola				1													1	
Trichoclinocera/Clinocera							2	1						1			2	
Tricorythodes					1													
Wormaldia				2	3		3		4			1		2				
Zaitzevia							4	2	1	1		1	7	14	7	7		8
Zaitzevia (adult)								1						1		1		
Zapada												1						

Taxonomic list of benthic macroinvertebrates from the North Fork American River (NF-PON) and Cosumnes River (COS-2) reference sites - fall 1995 and 2004.

	2004 NF-PON	2004 NF-PON	2004 NF-PON	2004 COS-2	2004 COS-2	2004 COS-2	1995* COS-2	1995* COS-2	1995* COS-2
Acari							3	1	
Agabinus						1			
Ambrysus	1								
Antocha	3	14	1						
Argia	20	12	1	1		7	8	1	4
Atrichopogon				1					
Baetis	68	73	48	3	6	17	15	15	17
Brechmorhoga mendax	1	4	5		2				
Calineuria californica	5		2		1		2	1	
Camelobaetidius	1	2							
Capniidae			1	2			1		
Centroptilum	2								
Cheumatopsyche	11	3	3				18	19	9
Chimarra	3	3	3	4	3	16	20	40	41
Chironomini			1	1		1	1	1	3
Cinygmula				1					
Corydalus									1
Crangonyx						3			
Cultus	1	3					1	1	
Dasyhelea	1		12	3	1	1		4	
Diphetor hageni	1					1			
Dolichopodidae				1		1			
Dubiraphia				3	1	1			
Enchytraeidae						2			
Epeorus	2	25	5			4	23	20	22
Ephemerella		1		1					
Fallceon quilleri	2	1	5	2	4	1			
Fossaria	3	1	3	2	1	4			
Helichus (adult)									1
Helicopsyche borealis		3	1				1		
Hemerodromia			1				1		1
Hesperoperla									1
Hyalella						1			
Hydropsyche	3	7	8	13	3	22	12	29	68
Hydroptila		4	4	1	1	3	3	2	2
Hydroptilidae	4						1	2	
Hygrobates		2	5						
Isoperla			1	3		2	3	2	3
Lebertia	2	2				1			
Lepidostoma								2	
Limonia	1								
Lumbriculidae	6			(combined into Oligochaeta)			(combined into Oligochaeta)		
Marilia flexuosa	5	1							
Gyraulus				2		1			
Micrasema				5	1	12	3	6	
Microcylloepus	1		2	21	3	23	6	11	8
Microcylloepus (adult)				1	1	12		3	7

Taxonomic list of benthic macroinvertebrates from the North Fork American River (NF-PON) and Cosumnes River (COS-2) reference sites - fall 1995 and 2004.

	2004 NF-PON	2004 NF-PON	2004 NF-PON	2004 COS-2	2004 COS-2	2004 COS-2	1995* COS-2	1995* COS-2	1995* COS-2
Mystacides				1	2	2			
Naididae	7	8	18	3	10	8	(combined into Oligochaeta)		
Oligochaeta				31	27	8	5	10	9
Optioservus	1	2	5	3	1	2	36	3	11
Optioservus (adult)	1	1				2	1	3	12
Ordobrevia nubifera	1						3	3	
Ordobrevia nubifera (adullt)						1	1		
Orthocladiinae	28	48	45	14	3	21	28	15	26
Ostracoda		2		1	2	2			
Petrophila	1	10	2						
Physa/ Physella	19	11	14	8	7	20			
Pisidium				2		2			
Placobdella						2			
Planariidae	17	6	13	2					6
Prostoma	3		8	2	6	2			
Protoptila	1						8		2
Psephenus falli	14	2	1		3	5	3	7	2
Pseudochironomus			4						
Pteronarcys	1								
Rhithrogena	16	7	31	76	10	34	61	72	16
Rhyacophila									1
Seratella							3	1	
Simulium	15	16	12	42	22	26		4	3
Skwala parallela	1		1		1	1	1		1
Sperchon	8	1	5	3					
Stenocolus scutellaris				1		3	1		1
Sweltsa			2				1		
Tanypodinae		2		2	3	2		1	3
Tanytarsini	1	19	10	5	2	7	8		
Torrenticola	1	1	8			3			
Trichoclinocera/Clinocera									2
Tricorythodes	1	1			4	3			
Wiedemannia	1	1							
Wormaldia									1
Zaitzevia	5	1	14	2	1	7	5	9	6
Zaitzevia (adult)	2	1			1	9	1	6	4

*1995 Cosumnes River data from the California Department of Fish and Game, unpublished.

Biological metric values for the Reach Downstream of Chili Bar - fall 2003 (SE: standard error, CST: cumulative site total).

Site Code:	CB-I1	CB-I1	CB-I1	CB-I2	CB-I2	CB-I2	CB-I3	CB-I3	CB-I3	CB-I4	CB-I4	CB-I4	CB-I5	CB-I5	CB-I5	CB-I7	CB-I7	CB-I7
Transect/spot:	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Taxonomic Richness	14	15	19	22	25	20	28	22	24	26	21	27	25	20	24	22	24	27
EPT Taxa	4	5	8	6	12	8	9	10	8	10	6	12	12	9	11	9	7	11
Ephemeroptera Taxa	3	3	4	3	4	3	3	3	2	3	2	5	5	4	5	4	4	4
Plecoptera Taxa	0	1	2	1	4	1	3	3	3	4	2	4	5	2	2	2	2	2
Trichoptera Taxa	1	1	2	2	4	4	3	4	3	3	2	3	2	3	4	3	1	5
EPT Index (%)	3.8	4.3	9.2	29	32	20	32	41	31	17	53	41	42	62	58	16	21	33
Sensitive EPT Index (%)	1.3	3.3	5.9	9.3	9.2	4.6	22	19	20	4.2	18	20	29	24	20	3.5	15	9.2
Shannon Diversity	1.2	1.0	1.9	2.3	2.4	1.9	2.5	2.1	2.3	2.0	2.2	2.6	2.4	2.3	2.5	2.0	2.1	2.4
Dominant Taxon (%)	72	77	40	22	26	38	21	30	27	51	26	24	26	20	22	41	27	26
Tolerance Value	7.2	7.2	6.6	5.5	5.5	6.3	5.9	5.6	5.8	7.0	4.9	5.2	4.6	4.2	4.5	6.4	5.5	5.3
Intolerant Organisms (%)	2.2	3.6	6.3	11	9.2	4.6	22	19	20	4.9	18	20	29	24	20	6.3	17	13
Tolerant Organisms (%)	77	80	61	31	25	48	57	51	57	73	34	41	30	10	22	56	43	30
Collector-Gatherers (%)	90	87	77	60	44	54	58	52	56	73	39	50	42	28	27	74	61	46
Collector-Filterers (%)	4.2	2.3	9.6	27	42	36	9.1	23	14	8.0	33	15	20	43	40	7.5	2.0	14
Scrapers (%)	0.6	0.7	0.7	0.7	3.1	4.3	1.7	7.5	13	1.0	18	19	27	16	20	2.7	16	8.9
Predators (%)	4.8	9.9	13	11	11	5.0	13	7.5	14	17	10	15	9.5	12	12	14	20	29
Shredders (%)	0.0	0.3	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
Other (%)	0.0	0.0	0.0	0.0	0.3	0.0	18	10	3.4	0.7	0.0	1.3	1.0	1.7	0.3	1.6	0.0	0.3
Sample Abundance (x1000)	0.93	1.5	0.86	0.77	0.85	3.3	0.37	0.68	0.71	0.68	0.55	0.79	0.9	1.5	1.3	0.26	1.2	1.3

	CB-I1			CB-I2			CB-I3			CB-I4			CB-I5			CB-I7		
	mean	SE	CST	mean	SE	CST	mean	SE	CST	mean	SE	CST	mean	SE	CST	mean	SE	CST
Taxonomic Richness	16	1.5	19	22	1.5	34	25	1.8	35	25	1.9	36	23	1.5	33	24	1.5	41
EPT Taxa	5.7	1.2	8	8.7	1.8	12	9.0	0.6	11	9.3	1.8	14	11	0.9	14	9.0	1.2	16
Ephemeroptera Taxa	3.3	0.3	4	3.3	0.3	4	2.7	0.3	4	3.3	0.9	6	4.7	0.3	5	4.0	0.0	7
Plecoptera Taxa	1.0	0.6	2	2.0	1.0	4	3.0	0.0	3	3.3	0.7	5	3.0	1.0	5	2.0	0.0	4
Trichoptera Taxa	1.3	0.3	2	3.3	0.7	4	3.3	0.3	4	2.7	0.3	3	3.0	0.6	4	3.0	1.2	5
EPT Index (%)	5.8	1.7	6	27	3.6	26	35	3.0	24	37	10.6	37	54	6.1	54	23	4.9	23
Sensitive EPT Index (%)	3.5	1.3	3	7.7	1.5	8	20	0.9	9	14	4.9	14	24	2.5	24	9.2	3.2	9
Shannon Diversity	1.4	0.3	1.5	2.2	0.1	2.4	2.3	0.1	2.4	2.3	0.2	2.4	2.4	0.1	2.6	2.2	0.1	2.3
Dominant Taxon (%)	63	11.6	63	28	4.9	20	26	2.6	25	34	8.9	31	23	2.0	16	31	4.7	23
Tolerance Value	7.0	0.2	7.0	5.8	0.3	5.8	5.7	0.1	5.5	5.7	0.7	5.7	4.4	0.1	4.4	5.7	0.3	5.7
Intolerant Organisms (%)	4.0	1.2	4	8.2	1.8	8	20	1.0	10	14	4.7	14	24	2.5	24	12	3.2	12
Tolerant Organisms (%)	73	5.9	73	35	6.8	35	55	2.0	55	49	12.0	48	21	5.9	21	43	7.3	42
Sample Abundance (x1000)	1.1	0.2	3.3	1.6	0.8	4.9	0.6	0.1	1.8	0.7	0.1	2.0	1.2	0.2	3.7	0.9	0.3	2.8

Biological metric values for the Reach Downstream of Chili Bar - fall 2004 (SE: standard error, CST: cumulative site total).

Site Code:	CB-I1	CB-I1	CB-I1	CB-I2	CB-I2	CB-I2	CB-I3	CB-I3	CB-I3	CB-I4	CB-I4	CB-I4	CB-I5	CB-I5	CB-I5	CB-I7	CB-I7	CB-I7
Transect/spot:	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Taxonomic Richness	12	15	19	23	26	19	28	26	27	28	23	27	19	28	20	24	27	27
EPT Taxa	4	4	4	8	10	6	13	9	13	10	9	14	9	11	10	12	13	12
Ephemeroptera Taxa	3	2	2	3	4	2	4	4	4	4	4	5	5	4	4	4	5	5
Plecoptera Taxa	0	1	2	2	3	2	5	2	5	3	3	5	1	4	4	3	4	3
Trichoptera Taxa	1	1	0	3	3	2	4	3	4	3	2	4	3	3	2	5	4	4
EPT Index (%)	4.4	7.7	8.0	10	15	12	34	28	38	16	15	29	25	46	62	51	50	44
Sensitive EPT Index (%)	2.0	7.1	7.7	2.1	3.5	3.5	19	13	20	7.3	8.3	17	8.5	23	36	16	12	27
Shannon Diversity	1.4	1.5	1.9	2.1	2.3	2.0	2.5	2.6	2.4	2.4	1.6	2.3	1.8	2.5	2.5	2.4	2.3	2.4
Dominant Taxon (%)	57	47	33	39	37	34	25	18	23	37	65	42	51	17	16	23	30	27
Tolerance Value	7.1	6.6	6.3	6.3	6.5	6.0	5.2	5.7	5.1	6.4	6.9	5.8	5.2	4.5	3.7	4.6	5.1	4.1
Intolerant Organisms (%)	2.0	7.1	8.0	6.2	5.4	4.5	19	13	20	10	9.0	18	8.5	23	36	16	14	29
Tolerant Organisms (%)	69	53	46	48	55	27	33	38	31	59	75	50	6.5	20	9.1	8.1	16	17
Collector-Gatherers (%)	77	59	55	63	65	47	45	40	35	66	75	63	25	29	27	41	65	47
Collector-Filterers (%)	16	33	33	25	17	42	29	33	40	10.1	6.6	16	60	35	40	37	19	13
Scrapers (%)	0.3	3.9	3.8	4.1	0.6	0.7	12	8.0	14	1.7	4.9	8.7	5.2	23	19	12.9	2.6	27
Predators (%)	6.5	3.5	7.3	7.2	18	9.0	7.9	16	8.1	22	13	11	9.8	11	11	5.4	11	12
Shredders (%)	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Other (%)	0.0	0.3	0.3	0.0	0.0	0.7	5.8	3.5	2.0	0.3	1.0	1.3	0.3	1.0	3.4	3.4	2.3	0.6
Sample Abundance (x1000)	6.1	5.0	2.5	1.2	0.43	1.4	0.96	0.86	1.1	0.38	0.66	1.0	2.3	1.6	1.9	1.5	2.0	2.1

	CB-I1			CB-I2			CB-I3			CB-I4			CB-I5			CB-I7		
	mean	SE	CST	mean	SE	CST	mean	SE	CST	mean	SE	CST	mean	SE	CST	mean	SE	CST
Taxonomic Richness	15	2.0	23	23	2.0	33	27	0.6	38	26	1.5	35	22	2.8	35	26	1.0	40
EPT Taxa	4.0	0.0	6	8.0	1.2	12	12	1.3	17	11	1.5	15	10	0.6	14	12	0.3	16
Ephemeroptera Taxa	2.3	0.3	3	3.0	0.6	4	4.0	0.0	5	4.3	0.3	5	4.3	0.3	5	4.7	0.3	6
Plecoptera Taxa	1.0	0.6	2	2.3	0.3	5	4.0	1.0	7	3.7	0.7	5	3.0	1.0	5	3.3	0.3	4
Trichoptera Taxa	0.7	0.3	1	2.7	0.3	3	3.7	0.3	5	3.0	0.6	5	2.7	0.3	4	4.3	0.3	6
EPT Index (%)	6.7	1.1	7	12	1.6	13	33	3.2	33	20	4.4	20	44	10.8	44	48	2.3	48
Sensitive EPT Index (%)	5.6	1.8	6	3.0	0.5	3	17	2.3	17	11	3.1	11	22	7.9	22	18	4.4	19
Shannon Diversity	1.6	0.2	1.7	2.2	0.1	2.3	2.5	0.0	2.6	2.1	0.2	2.3	2.3	0.2	2.5	2.4	0.0	2.6
Dominant Taxon (%)	45	6.9	44	37	1.5	32	22	2.0	20	48	8.6	46	28	11.6	27	27	1.8	19
Tolerance Value	6.7	0.2	6.7	6.3	0.1	6.3	5.3	0.2	5.4	6.4	0.3	6.4	4.5	0.4	4.5	4.6	0.3	4.6
Intolerant Organisms (%)	5.7	1.9	6	5.4	0.5	5	17	2.3	17	12	2.7	12	22	8.0	22	20	4.8	20
Tolerant Organisms (%)	56	6.7	56	43	8.3	44	34	2.3	34	62	7.4	62	12	4.2	12	14	2.9	14
Sample Abundance (x1000)	4.5	1.1	14	1.0	0.3	3.0	1.0	0.1	2.9	0.7	0.2	2.0	1.9	0.2	5.8	1.9	0.2	5.6

Biological metric values for reference sites - fall 1995 and 2004 (SE: standard error, CST: cumulative site total).

Year:	2004	2004	2004	2004	2004	2004	1995	1995	1995
Site Code:	NF-PON	NF-PON	NF-PON	COS-2	COS-2	COS-2	COS-2	COS-2	COS-2
Transect/spot:	1	2	3	1	2	3	1	2	3
Taxonomic Richness	45	37	37	37	30	46	34	30	32
EPT Taxa	18	14	14	12	11	13	18	14	13
Ephemeroptera Taxa	8	7	4	5	4	6	4	4	3
Plecoptera Taxa	4	1	5	2	2	2	6	3	3
Trichoptera Taxa	6	6	5	5	5	5	8	7	7
EPT Index (%)	44	45	38	42	27	38	61	72	63
Sensitive EPT Index (%)	12	12	14	32	9.8	17	37	36	16
Shannon Diversity	3.0	2.8	3.0	2.6	2.8	3.3	2.8	2.7	2.8
Dominant Taxon (%)	23	24	16	28	20	11	21	24	23
Tolerance Value	5.0	4.8	4.9	3.8	5.4	4.5	3.1	3.0	3.8
Intolerant Organisms (%)	12	12	14	32	9.8	17	37	36	16
Tolerant Organisms (%)	17	10	19	9	21	14	1	0	0
Collector-Gatherers (%)	43	57	48	33	48	36	24	22	27
Collector-Filterers (%)	11	9.6	8.5	23	21	21	17	31	41
Scrapers (%)	22	21	25	35	18	29	49	40	22
Predators (%)	21	11	17	5.2	9.8	6.5	6.9	2.4	7.8
Shredders (%)	2.1	0.3	0.3	1.1	0.0	1.0	0.7	0.7	0.7
Other (%)	1.7	1.3	1.3	2.6	3.0	5.5	2.4	3.4	0.7
Sample Abundance (x1000)	0.95	1.2	1.9	0.27	0.13	0.68	1.9	2.0	2.2
	NF-PON			COS-2			COS-2		
	mean	SE	CST	mean	SE	CST	mean	SE	CST
Taxonomic Richness	40	2.7	57	38	4.6	54	32	1.2	46
EPT Taxa	15	1.3	24	12	0.6	17	15	1.5	22
Ephemeroptera Taxa	6.3	1.2	9	5.0	0.6	8	3.7	0.3	4
Plecoptera Taxa	3.3	1.2	7	2.0	0.0	4	4.0	1.0	7
Trichoptera Taxa	5.7	0.3	8	5.0	0.0	5	7.3	0.3	11
EPT Index (%)	42	2.2	42	36	4.4	37	65	3.4	65
Sensitive EPT Index (%)	13	0.7	13	20	6.6	22	30	6.9	29
Shannon Diversity	2.9	0.1	3.1	2.9	0.2	3.1	2.7	0.0	2.9
Dominant Taxon (%)	21	2.7	21	20	5.0	17	23	1.0	17
Tolerance Value	4.9	0.1	4.9	4.6	0.5	4.6	3.3	0.3	3.3
Intolerant Organisms (%)	13	0.7	13	20	6.6	22	30	6.8	30
Tolerant Organisms (%)	15	2.6	15	15	3.6	23	0	0.3	0
Sample Abundance (x1000)	1.4	0.3	4.1	0.36	0.2	1.1	2.0	0.1	6.1

APPENDIX E

QUALITY CONTROL RESULT SUMMARY LETTERS FROM THE CALIFORNIA DEPARTMENT OF FISH AND GAME

STATE OF CALIFORNIA - THE RESOURCES AGENCY GRAY DAVIS, governor

DEPARTMENT OF FISH AND GAME

AQUATIC BIOASSESSMENT LABORATORY
FISH AND WILDLIFE WATER POLLUTION CONTROL LABORATORY
2005 NIMBUS ROAD
RANCHO CORDOVA, CA 95670
(916) 358-0316

May 1, 2003

Dear Sapna,

Attached are the results of my QC analysis of 18 BMI samples from the October 2002 Upper American River FERC Project. The results are presented in four separate summary tables accompanied by a guidance document designed to aid in interpretation.

Taxonomy was performed very well and in accordance with the CSBP. The few recurrent problems worth mentioning here are as follows:

1) Tiny specimens of mayflies and stoneflies (especially Taeniopterygidae) were sometimes identified to genus, but the diagnostic characters are not developed in early instars, and these specimens would be better left at family.

2) The chironomid subfamily Diamesinae was generally not recognized in these samples.

3) The sphaeriid genus *Pisidium* was left at superfamily (Corbiculacea).

4) The hydroptilid *Nothotrichia shasta* was identified as *Stactobiella* in several samples. The larva of *N. shasta* is undescribed (one of our taxonomists is in the process of describing it), and is therefore not identifiable in published keys. However, I have included it as a discrepancy because specimens of *N. shasta* properly key to *Ochrotrichia* in published keys, and because I am trying to alert taxonomists about the true identity of this very distinctive caddisfly. This "discrepancy" should not be viewed as a problem, but is included here for the edification of people working in mid-elevation watersheds in northern California.

I encourage you and your taxonomists to review all specimens whose identification has been disputed. Taxonomists benefit most thoroughly from the QC process through such a review, and I welcome any comments or questions you might have concerning these reports.

STATE OF CALIFORNIA - THE RESOURCES AGENCY Arnold Schwarzenegger, governor

DEPARTMENT OF FISH AND GAME

AQUATIC BIOASSESSMENT LABORATORY-CHICO
CALIFORNIA STATE UNIVERSITY, CHICO
CHICO, CA 95929-0555
530-898-4792

July 27, 2004

Tom King
BioAssessment Services Inc.
PMB 164
24988 Blue Ravine Road, Suite 108
Folsom, CA 95630

Dear Tom,

Attached are the results of our QC analysis of 18 BMI samples from the Upper American River project from fall 2003. The results are presented in four summary tables.

Overall taxonomy was very good and performed in accordance with the CSBP 1 standards. The summary tables are self explanatory and describe our QC findings. We would like to make the following point.

1. There were 22 disputed determinations in this set of samples.
2. We recommend you review your Acari and elmid determinations since there appears to be repeated errors in determination of these two groups.
3. There were two incidents of “tag along” organisms, which we define as specimens accidentally included in a vial of organisms of another taxon.

We welcome any questions or comments you may have concerning this report.

Sincerely,

Joe Slusark and Brady Richards

APPENDIX F

TRANSECT SCALE HABITAT DATA
FOR THE UARP AND
THE REACH DOWNSTREAM OF CHILI BAR

UARP transect scale habitat values - year 2002

Site Code	Transect/spot Number	Sample ID	Riffle Length	Location	Ave. Riffle Width	Ave. Depth	Ave. Velocity	Canopy	Substrate Complexity	Embeddedness	Riffle Gradient	Sand	Gravel	Cobble	Boulder	Bedrock	Consolidation
			m	m	m	cm	ft/s	%	rank	rank	%	%	%	%	%	%	
RR-I1	1	1381	9.8	8	4.1	6	0.56	45	17	17	2.4	25	35	40	0	0	loose
RR-I1	2	1382	27	26	7.3	7	1.02	40	17	19	2.1	20	35	40	5	0	loose
RR-I1	3	1383	12	12	6.5	15	0.92	30	18	19	2.7	10	20	30	40	0	loose
RR-I2	1	1384	11	spot	8.5	12	0.92	20	14	18	3.8	10	25	30	35	0	moderate
RR-I2	2	1385	13	spot	10	14	1.25	25	13	18	1.3	5	30	25	40	0	moderate
RR-I2	3	1386	6.7	spot	8.1	16	0.85	20	13	18	4.5	5	15	20	60	0	moderate
RR-I3	1	1387	11	spot	7.5	8	0.75	5	17	13	1.1	15	58	25	2	0	moderate
RR-I3	2	1388	52	spot	4.6	13	0.39	30	17	18	0.6	7	25	6	30	32	loose
RR-I3	3	1389	100	spot	7.9	18	1.1	10	3	19	5.9	0	5	10	10	75	loose
RLD-I1	1	1390	11.1	spot	1.9	5	0.59	10	12	11	2.7	15	35	30	20	0	loose
RLD-I1	2	1391	8.5	spot	1.9	6	0.30	5	10	13	11	10	20	15	55	0	moderate
RLD-I1	3	1392	10	spot	6.2	1	0.49	5	10	13	13	5	15	15	65	0	cemented
BI-I1	1	1393	8.8	spot	2.7	40	0.36	25	13	14	4.2	35	35	5	0	25	loose
BI-I1	2	1394	12	spot	4.2	21	1.1	15	14	16	4.1	20	30	5	20	25	loose
BI-I1	3	1395	8.0	spot	2.0	8	0.85	35	13	15	4.5	20	60	5	15	0	moderate
BI-I2	1	1396	28	spot	7.9	18	0.77	10	10	19	3.2	0	40	22	38	0	moderate
BI-I2	2	1397	52	spot	4.3	11	0.68	20	11	18	4.4	0	35	28	37	0	cemented
BI-I2	3	1398	27	spot	2.4	15	1.4	10	5	19	3.9	2	27	7	32	32	moderate
LL-I1	1	1399	14	11	6.8	22	0.66	40	15	8	1.3	30	30	30	10	0	moderate
LL-I1	2	1400	10	9	7.1	29	1.4	45	16	9	1.2	30	35	25	10	0	moderate
LL-I1	3	1401	14	12	5.2	22	2.4	40	16	9	2.2	15	20	25	40	0	moderate
LL-I2	1	1402	7.0	5	6.0	16	1.7	35	15	16	3.0	25	50	25	0	0	moderate
LL-I2	2	1403	6.5	5	5.0	22	1.4	45	15	17	2.8	15	15	70	0	0	moderate
LL-I2	3	1404	12	10	6.5	25	0.92	40	16	16	0.76	20	15	30	35	0	moderate
LL-I3	1	1405	11	10	4.9	22	2.2	30	11	20	2.2	0	15	40	45	0	cemented
LL-I3	2	1406	9	7	6.0	24	2.3	25	11	20	4.7	5	10	10	75	0	cemented
LL-I3	3	1407	11	8	11	17	1.0	25	13	20	3.6	10	20	15	55	0	cemented
GC-I1	1	1408	9.5	spot	6.5	26	0.55	45	10	20	8.5	0	35	25	40	0	cemented
GC-I1	2	1409	15	spot	8.8	14	1.6	40	10	20	15	0	5	35	60	0	cemented
GC-I1	3	1410	7.5	spot	8.2	16	1.1	25	10	20	12	0	5	35	60	0	moderate
GC-I2	1	1411	39	spot	6.5	67	1.1	45	15	20	1.8	5	30	45	20	0	moderate
GC-I2	2	1412	61	spot	6.0	34	0.92	40	15	20	0.9	10	35	30	25	0	moderate
GC-I2	3	1413	23	spot	7.0	28	1.5	45	15	20	1.9	5	50	35	10	0	loose
RPD-I1	1	1414	4.5	3	7.5	14	1.3	40	17	20	2.7	0	50	50	0	0	loose
RPD-I1	2	1415	3.0	1	8.0	12	1.8	40	16	20	2.4	0	55	45	0	0	cemented
RPD-I1	3	1416	12	9.5	7.0	20	1.1	45	16	20	1.5	10	15	30	45	0	moderate
RPD-I2	1	1417	26	spot	8.8	43	1.1	10	3	19	1.3	15	60	5	20	0	loose
RPD-I2	2	1418	47	spot	9.1	40	0.88	15	3	19	1.1	20	50	5	5	20	loose
RPD-I2	3	1419	36	spot	8.0	30	0.7	15	3	19	0.4	10	60	20	0	10	moderate
IH-I1	1	1420	27	spot	7.9	12	1.8	15	14	19	2.6	5	10	60	25	0	moderate
IH-I1	2	1421	22	spot	5.3	28	1.3	10	13	19	1.4	5	15	25	35	20	moderate
IH-I1	3	1422	11	spot	11	19	0.72	10	16	19	0.6	10	20	50	20	0	moderate
IH-I2	1	1423	9.0	7	5.2	15	2.7	24	14	12	0.9	25	65	10	0	0	loose
IH-I2	2	1424	4.0	2	7.2	10	1.4	20	11	13	0.4	50	50	0	0	0	loose

Site Code	Transect/spot Number	Sample ID	Riffle Length	Location	Ave. Riffle Width	Ave. Depth	Ave. Velocity	Canopy	Substrate Complexity	Embeddedness	Riffle Gradient	Sand	Gravel	Cobble	Boulder	Bedrock	Consolidation
			m	m	m	cm	ft/s	%	rank	rank	%	%	%	%	%	%	
IH-I2	3	1425	1	1	4.5	7	2.2	25	12	12	0.4	25	65	5	0	5	loose
IH-I3	1	1426	5.3	5	11	26	1.5	0	15	17	0.6	40	25	20	15	0	moderate
IH-I3	2	1427	4.5	4	11	30	2.6	0	15	19	2.0	15	20	20	10	35	loose
IH-I3	3	1428	35	31	13.0	22	2.0	0	15	19	2.1	20	30	20	15	15	loose
IH-I4	1	1429	27	25	10	34	2.4	15	18	19	2.2	5	40	20	20	15	moderate
IH-I4	2	1430	11	8	9.6	27	1.8	25	17	18	1.6	15	50	25	5	5	moderate
IH-I4	3	1431	19	16	9.0	31	2.0	20	17	16	4.0	20	25	20	25	10	loose
JD-I1	1	1432	9.8	spot	12	16	0.96	20	6	19	0.6	0	17	18	65	0	moderate
JD-I1	2	1433	24	spot	14	13	0.78	20	8	19	0.2	0	8	62	30	0	moderate
JD-I1	3	1434	22	spot	9.4	18	0.83	10	10	19	3.0	0	13	40	47	0	moderate
JD-I2	1	1435	19	15	15	14	1.0	30	10	20	3.6	0	10	35	55	0	moderate
JD-I2	2	1436	34	31	10	23	1.1	30	11	20	1.4	5	5	30	60	0	moderate
JD-I2	3	1437	28	22	10	17	0.65	20	10	20	1.2	0	15	35	50	0	loose
JD-I3	1	1438	15	spot	12	10	1.1	20	14	19	4.6	0	5	15	80	0	loose
JD-I3	2	1439	12	spot	10	12	1.2	25	16	19	nd	5	70	25	0	0	loose
JD-I3	3	1440	20	spot	9	15	1.6	25	16	19	nd	5	70	15	10	0	loose
CD-I1	1	1441	12	spot	17	8	0.91	60	11	19	4.8	0	15	75	10	0	moderate
CD-I1	2	1442	26	spot	17	19	0.91	60	11	19	1.8	0	50	42	8	0	moderate
CD-I1	3	1443	27	spot	17	17	1.4	60	11	19	1.8	0	38	40	22	0	moderate
CD-I2	1	1444	17	spot	7.0	54	1.1	15	16	14	<0.3	21	37	37	5	0	cemented
CD-I2	2	1445	42	spot	7.0	28	1.6	30	18	16	0.4	13	47	22	18	0	moderate
CD-I2	3	1446	53	spot	7.0	26	1.2	40	18	18	2.8	0	35	50	15	0	loose
CD-I3	1	1447	18	spot	10	25	1.0	20	16	20	1.6	0	20	30	50	0	loose
CD-I3	2	1448	14	spot	10	16	2.2	5	16	19	2.9	10	25	45	20	0	moderate
CD-I3	3	1449	11	spot	9.8	30	2.2	20	16	20	5.0	5	20	35	40	0	moderate
BC-I1	1	1450	6.0	spot	2.4	21	2.1	85	18	17	4.5	10	10	30	50	0	moderate
BC-I1	2	1451	9.0	spot	1.8	18	1.1	80	18	18	4.7	10	15	40	35	0	moderate
BC-I1	3	1452	10	spot	1.3	14	1.6	75	18	17	2.5	15	20	50	15	0	moderate
BC-I2	1	1453	15	15	2.5	12	1.1	70	17	18	3.2	10	80	10	0	0	loose
BC-I2	2	1454	8.6	6.0	4.0	15	1.6	60	18	18	1.6	5	50	45	0	0	loose
BC-I2	3	1455	5.0	4	3.5	15	1.5	90	18	18	0.6	10	70	20	0	0	loose
SC-I1	1	1456	35	spot	21	15	1.2	10	15	19	2.3	0	50	20	30	0	moderate
SC-I1	2	1457	16	spot	19	21	0.65	15	16	17	0.7	3	40	12	45	0	moderate
SC-I1	3	1458	26	spot	16	16	0.59	15	16	17	0.5	13	72	5	10	0	moderate
SC-I2	1	1459	50	spot	6.0	19	0.68	15	15	20	5.2	0	30	40	30	0	moderate
SC-I2	2	1460	27	spot	14	11	1.6	10	16	18	3.4	5	50	25	20	0	moderate
SC-I2	3	1461	34	spot	13	20	2.6	10	13	20	4.7	0	50	40	10	0	loose
SC-I3	1	1462	21	15	19	15	2.4	10	12	19	1.3	0	40	60	0	0	moderate
SC-I3	2	1463	13	spot	18	34	1.5	5	11	19	0.9	5	0	60	0	35	moderate
SC-I3	3	1464	30	25	17	30	1.7	5	18	17	2.9	10	15	75	0	0	loose
BSC	1	1465	20	spot	7.0	9	1.6	20	15	14	0.3	5	65	30	0	0	loose
BSC	2	1466	16	spot	5.0	12	2.1	25	15	13	1.5	10	35	50	5	0	moderate
BSC	3	1467	29	spot	9.0	9	1.3	15	15	12	0.5	20	40	40	0	0	loose
SFAR	1	1468	22	19	37	32	1.1	15	16	12	2.1	25	20	20	35	0	moderate
SFAR	2	1469	46	44	40	25	1.4	10	16	12	0.5	25	20	25	30	0	moderate
SFAR	3	1470	72	50	40	25	1.8	10	16	12	0.6	25	15	5	55	0	cemented

UARP transect scale habitat values - year 2003

Site Code	Transect/spot Number	Sample ID	Riffle Length	Location	Ave. Riffle Width	Ave. Depth	Ave. Velocity	Canopy	Substrate Complexity	Embeddedness	Riffle Gradient	Sand	Gravel	Cobble	Boulder	Bedrock	Consolidation
			m	m	m	cm	ft/s	%	rank	rank	%	%	%	%	%	%	
RR-I1	1	1658	11	32	7.3	8	0.2	30	18	17	ND	20	20	60	0	0	moderate
RR-I1	2	1659	22	spot	4.8	9	1.0	40	19	15	ND	5	10	50	35	0	moderate
RR-I1	3	1660	7.0	spot	5.2	11	0.4	25	18	18	ND	10	30	50	10	0	loose
RR-I2	1	1661	9.8	spot	8.7	14	0.6	10	16	15	13	12	32	50	6	0	loose
RR-I2	2	1662	12	spot	11	13	0.8	15	18	15	1.4	10	32	50	8	0	moderate
RR-I2	3	1663	7.3	spot	8.6	22	0.8	15	18	16	2.9	8	20	38	30	4	moderate
RR-I3	1	1664	15	spot	8.5	10	0.8	10	15	18	1.5	42	23	30	5	0	moderate
RR-I3	2	1665	31	spot	4	15	2.1	10	11	20	0.6	5	8	5	0	82	loose
RR-I3	3	1666	12	spot	17	26	0.7	0	10	20	8.8	0	7	10	3	80	loose
BI-I1	1	1667	16	spot	2.7	19	0.4	20	16	11	1.2	5	40	45	5	5	loose
BI-I1	2	1668	8.0	spot	3.7	11	0.9	10	18	11	ND	25	35	30	0	10	moderate
BI-I1	3	1669	11	spot	5.8	16	1.1	5	17	10	ND	5	40	35	20	0	cemented
BI-I2	1	1670	13	spot	3.3	18	0.7	3	15	16	3.4	17	16	57	10	0	moderate
BI-I2	2	1671	13	spot	12	14	1.1	5	16	18	4.7	5	35	37	23	0	loose
BI-I2	3	1672	31	spot	4.6	19	1.2	5	15	17	5.2	13	13	44	17	13	moderate
LL-I1	1	1673	20	17	7.6	10	1.9	5	17	10	2.5	18	37	45	0	0	loose
LL-I1	2	1674	9.2	spot	6.4	12	2.4	6	18	10	5.8	58	17	25	0	0	loose
LL-I1	3	1675	16	spot	4.6	15	1.2	6	18	11	6.0	33	32	35	0	0	loose
LL-I2	1	1676	11	spot	5.2	25	0.9	7	19	18	2.6	7	10	60	23	0	moderate
LL-I2	2	1677	15	spot	6.1	16	1.6	20	19	18	3.3	0	7	85	8	0	moderate
LL-I2	3	1678	23	spot	5.5	16	2.0	20	20	16	3.0	10	12	58	20	0	moderate
LL-I3	1	1679	21	spot	7.3	16	0.9	11	19	19	2.9	2	8	53	37	0	moderate
LL-I3	2	1680	11	spot	7.3	21	1.1	35	19	19	2.9	10	15	52	23	0	moderate
LL-I3	3	1681	14	spot	4.9	21	0.7	9	19	19	3.7	3	12	37	48	0	cemented
GC-I1	1	1682	9.2	spot	9.5	16	0.4	7	16	16	11	11	20	28	40	0	moderate
GC-I1	2	1683	13	spot	13	21	0.4	6	17	16	3.5	6	22	35	36	0	moderate
GC-I1	3	1684	8.5	spot	14	17	0.4	4	17	16	5.5	15	35	30	30	0	moderate
GC-I2	1	1685	6.4	spot	5.5	21	1.2	30	16	15	7.0	5	15	40	40	0	moderate
GC-I2	2	1686	5.5	spot	4.3	21	1.2	30	16	15	8.3	15	25	50	10	0	moderate
GC-I2	3	1687	15	spot	7.6	24	0.9	50	16	15	1.7	10	20	40	30	0	moderate
RPD-I1	1	1688	8.5	spot	6.1	34	1.9	20	16	12	1.4	5	25	20	50	0	moderate
RPD-I1	2	1689	14	spot	7.6	30	2.6	20	13	12	3.0	15	15	15	55	0	moderate
RPD-I1	3	1690	13	spot	7.6	43	1.0	20	11	12	2.8	20	20	30	30	0	moderate
RPD-I2	1	1691	12	spot	15	41	1.0	25	11	20	6.8	20	40	20	20	0	loose
RPD-I2	2	1692	31	spot	10	21	0.8	15	11	20	2.6	32	47	13	8	0	loose
RPD-I2	3	1693	57	spot	6.7	41	1.3	20	11	20	4.2	7	38	8	0	47	loose
IH-I1	1	1694	7.3	2.1	13	24	1.5	5	16	19	0.04	0	12	41	47	0	moderate
IH-I1	2	1695	12	11.9	14	20	1.5	3	16	14	3.1	3	18	32	47	0	moderate
IH-I1	3	1696	5.5	0.6	8.5	27	1.9	0	14	19	2.2	2	17	23	58	0	loose
IH-I2	1	1697	4.6	4.0	8.5	17	1.0	5	12	11	3.0	63	30	7	0	0	loose
IH-I2	2	1698	6.7	spot	11	43	1.1	5	13	16	6.0	8	20	12	60	0	moderate
IH-I2	3	1699	12	spot	14	34	1.6	0	13	16	10	5	14	8	60	13	cemented
IH-I3	1	1700	20	spot	12	24	1.5	0	15	19	6.6	13	7	27	27	26	moderate
IH-I3	2	1701	25	spot	13	28	1.3	2	17	18	4.5	7	17	55	11	10	moderate

Site Code	Transect/spot Number	Sample ID	Riffle Length	Location	Ave. Riffle Width	Ave. Depth	Ave. Velocity	Canopy	Substrate Complexity	Embeddedness	Riffle Gradient	Sand	Gravel	Cobble	Boulder	Bedrock	Consolidation
			m	m	m	cm	ft/s	%	rank	rank	%	%	%	%	%	%	
IH-I3	3	1702	30	spot	14	21	1.6	0	19	17	2.8	13	32	42	13	0	moderate
IH-I4	1	1703	28	24	14	16	1.6	10	16	16	5.3	25	40	35	0	0	loose
IH-I4	2	1704	12	8.5	9.8	34	1.4	10	16	14	2.8	18	33	47	2	0	loose
IH-I4	3	1705	46	4.3	9.2	20	2.0	15	16	14	5.8	3	25	37	35	0	moderate
JD-I1	1	1706	25	spot	15	31	1.2	10	18	19	0.4	0	5	33	62	0	moderate
JD-I1	2	1707	16	spot	12	31	1.1	5	18	19	1.5	0	7	8	85	0	moderate
JD-I1	3	1708	22	spot	24	30	1.0	0	14	19	10	0	0	18	82	0	cemented
JD-I2	1	1709	17	spot	7.6	31	1.4	40	15	18	ND	0	0	37	63	0	moderate
JD-I2	2	1710	12	spot	9.5	30	2.4	40	15	18	ND	0	7	33	60	0	moderate
JD-I2	3	1711	16	spot	13	30	2.2	35	16	18	ND	0	3	20	77	0	cemented
JD-I3	1	1712	20	spot	17	20	0.7	9	11	19	31	2	20	47	31	0	moderate
JD-I3	2	1713	17	spot	12	30	1.5	6	12	19	6.6	6	22	47	25	0	loose
JD-I3	3	1714	31	spot	24	28	1.9	15	13	19	5.2	7	13	33	47	0	moderate
CD-I1	1	1715	40	spot	16	15	1.1	15	12	19	0.9	0	17	33	50	0	moderate
CD-I1	2	1716	31	spot	25	30	1.4	10	12	19	6.3	0	2	50	48	0	moderate
CD-I1	3	1717	28	spot	19	15	1.3	15	12	19	6.5	0	2	45	53	0	moderate
CD-I2	1	1718	10	spot	8.6	43	1.4	5	13	18	1.0	5	35	40	20	0	loose
CD-I2	2	1719	17	spot	15	40	1.8	30	15	18	1.0	5	20	15	60	0	moderate
CD-I2	3	1720	8.8	spot	11	34	1.2	40	15	18	1.0	0	40	20	40	0	moderate
CD-I3	1	1721	26	spot	23	22	1.3	5	17	19	14	0	18	62	20	0	loose
CD-I3	2	1722	15	spot	34	17	1.2	7	17	19	7.5	0	23	70	7	0	moderate
CD-I3	3	1723	29	spot	40	26	1.0	10	17	19	6.0	0	10	55	35	0	moderate
BC-I1	1	1724	7.6	spot	5.8	6	1.1	87	19	19	8.8	8	38	48	2	4	loose
BC-I1	2	1725	10	spot	10	6	1.0	78	19	18	2.1	8	47	42	3	0	loose
BC-I1	3	1726	9.8	spot	4.9	12	1.2	70	18	18	14	13	20	43	24	0	loose
BC-I2	1	1727	23	21	3.7	1	0.5	60	16	16	2.0	22	58	20	0	0	loose
BC-I2	2	1728	23	20	3.4	16	12.1	70	16	18	4.0	22	15	63	0	0	moderate
BC-I2	3	1729	5.0	4.0	3.7	12	1.5	93	13	14	5.0	15	80	5	0	0	loose
SC-I1	1	1730	40	spot	31	14	1.1	12	12	19	8.3	10	45	38	7	0	loose
SC-I1	2	1731	31	spot	13	17	0.9	15	12	19	7.1	10	33	32	25	0	moderate
SC-I1	3	1732	19	spot	15	18	1.3	5	14	17	7.2	18	30	24	25	3	loose
SC-I2	1	1733	43	spot	11	9	1.1	5	11	19	5.6	2	13	18	67	0	cemented
SC-I2	2	1734	29	spot	24	28	1.7	0	13	19	5.2	0	30	35	35	0	moderate
SC-I2	3	1735	25	spot	28	18	1.0	5	13	19	6.0	3	27	37	33	0	loose
SC-I3	1	1736	9.8	6.1	12	25	2.9	20	16	19	7.2	0	20	75	5	0	loose
SC-I3	2	1737	31	29.3	12	30	0.9	0	13	19	1.9	10	25	65	0	0	loose
SC-I3	3	1738	20	13.7	17	21	1.7	0	16	19	1.7	10	15	65	10	0	moderate
BSC	1	1739	10	spot	5.2	12	0.5	40	14	6	0.6	15	20	40	25	0	moderate
BSC	2	1740	10	spot	6.7	13	0.6	30	15	10	5.0	15	10	50	25	0	cemented
BSC	3	1741	9.8	spot	3.4	18	0.4	30	15	10	8.0	20	20	25	35	0	moderate
SFAR	1	1742	6.4	2.1	30	21	1.8	5	17	15	8.6	3	10	50	37	0	moderate
SFAR	2	1743	23	2.7	34	24	1.3	0	17	16	1.1	15	27	55	3	0	loose
SFAR	3	1744	21	3.7	34	4	1.0	5	17	16	2.1	17	10	20	53	0	cemented
SILV	1	1745	25	spot	26	28	1.0	5	16	9	3.5	0	10	20	70	0	cemented
SILV	2	1746	40	spot	26	43	0.8	5	14	9	1.5	5	0	0	95	0	cemented
SILV	3	1747	30	spot	18	30	2.3	5	16	9	1.7	5	5	15	75		cemented

Transect scale habitat assessed for the Reach Downstream of Chili Bar and reference sites.

Year	Site Code	Transect/spot	Sample ID	Riffle Length	Location	Ave. Riffle Width	Ave. Depth	Ave. Velocity	Canopy	Substrate Complexity	Embeddedness	Riffle Gradient	Sand (sample)	Sand (site)	Gravel (sample)	Gravel (site)	Cobble (sample)	Cobble (site)	Boulder (sample)	Boulder (site)	Bedrock (sample)	Bedrock (site)	Consolidation
				m	m	m	cm	ft/s	%	rank	rank	%	%		%		%		%		%		
2003	CB-I1	a	1748	ND	7.6	40	32	1.2	0	9	19	0.4	2	ND	3	ND	5	ND	30	ND	60	ND	bedrock
2003	CB-I1	b	1749	ND	20	40	30	1.0	0	9	19	4.7	0	ND	4	ND	5	ND	18	ND	73	ND	bedrock
2003	CB-I1	c	1750	ND	46	40	26	1.5	0	9	19	3.1	0	ND	0	ND	0	ND	1	ND	99	ND	bedrock
2003	CB-I2	a	1751	46	spot	30	21	1.2	0	13	19	2.0	0	ND	3	ND	7	ND	37	ND	53	ND	moderate
2003	CB-I2	b	1752	15	spot	40	43	3.2	0	13	19	6.5	0	ND	2	ND	5	ND	37	ND	56	ND	moderate
2003	CB-I2	c	1753	30	spot	18	30	2.7	0	13	19	3.2	5	ND	7	ND	10	ND	70	ND	8	ND	moderate
2003	CB-I3	a	1754	30	3.7	23	34	3.1	0	13	14	1.1	15	ND	35	ND	25	ND	25	ND	0	ND	moderate
2003	CB-I3	b	1755	27	7.9	15	49	2.4	5	13	14	3.0	16	ND	22	ND	32	ND	30	ND	0	ND	moderate
2003	CB-I3	c	1756	23	4.9	26	46	1.5	5	13	14	2.7	20	ND	18	ND	40	ND	22	ND	0	ND	moderate
2003	CB-I4	a	1757	30	3.4	37	26	2.0	0	12	17	0.0	5	ND	20	ND	72	ND	3	ND	0	ND	moderate
2003	CB-I4	b	1758	30	4.0	43	21	1.7	0	12	17	0.3	10	ND	48	ND	42	ND	0	ND	0	ND	moderate
2003	CB-I4	c	1759	37	10	37	17	1.1	0	12	15	0.0	22	ND	38	ND	40	ND	0	ND	0	ND	moderate
2003	CB-I5	a	1760	15	2.4	21	24	2.1	5	17	15	5.9	7	ND	23	ND	60	ND	10	ND	0	ND	moderate
2003	CB-I5	b	1761	26	2.1	14	12	1.4	5	17	17	1.6	3	ND	13	ND	47	ND	37	ND	0	ND	moderate
2003	CB-I5	c	1762	17	4.0	24	28	1.9	0	17	16	1.5	10	ND	32	ND	30	ND	28	ND	0	ND	moderate
2003	CB-I7	a	1763	24	spot	28	30	2.7	0	11	14	0.5	5	ND	20	ND	30	ND	45	ND	0	ND	moderate
2003	CB-I7	b	1764	24	spot	21	40	1.8	0	11	12	0.5	10	ND	40	ND	30	ND	20	ND	0	ND	moderate
2003	CB-I7	c	1765	24	spot	21	40	1.7	0	11	14	0.5	10	ND	0	ND	30	ND	60	ND	0	ND	moderate
2004	CB-I1	a	2051	32	spot	40	29	1.5	0	4	20	1.0	0	0	3	5	2	5	3	0	92	90	loose
2004	CB-I1	b	2052	15	spot	48	18	1.3	0	10	20	3.0	0	0	20	5	35	10	0	10	45	75	loose
2004	CB-I1	c	2053	18	spot	50	25	1.2	0	8	19	1.0	2	0	8	0	10	25	0	10	80	65	loose
2004	CB-I2	a	2054	18	spot	30	18	1.0	0	14	16	4.0	0	0	8	5	27	15	47	40	18	40	moderate
2004	CB-I2	b	2055	20	spot	30	37	1.0	0	14	16	3.0	2	0	8	5	23	15	40	40	27	40	moderate
2004	CB-I2	c	2056	22	spot	30	16	2.2	0	13	16	3.0	0	0	7	0	17	15	43	25	33	60	moderate
2004	CB-I3	a	2057	16	11	25	36	1.9	0	14	16	2.0	2	0	10	30	85	50	3	20	0	0	loose
2004	CB-I3	b	2058	37	spot	28	24	2.0	0	18	14	5.0	10	0	30	25	55	50	5	25	0	0	loose
2004	CB-I3	c	2059	14	12	32	27	2.2	0	16	15	1.0	6	0	25	35	67	50	2	15	0	0	loose

Transect scale habitat assessed for the Reach Downstream of Chili Bar and reference sites.

Year	Site Code	Transect/spot	Sample ID	Riffle Length	Location	Ave. Riffle Width	Ave. Depth	Ave. Velocity	Canopy	Substrate Complexity	Embeddedness	Riffle Gradient	Sand (sample)	Sand (site)	Gravel (sample)	Gravel (site)	Cobble (sample)	Cobble (site)	Boulder (sample)	Boulder (site)	Bedrock (sample)	Bedrock (site)	Consolidation
				m	m	m	cm	ft/s	%	rank	rank	%	%		%		%		%		%		
2004	CB-I4	a	2060	47	34	21	20	1.6	0	12	14	0.4	0	0	20	15	30	85	50	0	0	0	loose
2004	CB-I4	b	2061	19	16	41	19	1.7	0	14	14	1.0	0	0	20	35	46	65	34	0	0	0	loose
2004	CB-I4	c	2062	10	spot	54	21	1.8	0	12	15	3.0	0	0	17	0	30	95	53	5	0	0	loose
2004	CB-I5	a	2063	51	9.4	6.1	24	2.3	4	14	18	3.0	5	0	23	15	30	70	42	15	0	0	moderate
2004	CB-I5	b	2064	12	2.1	12.2	23	1.8	8	16	18	2.0	2	0	42	15	51	85	5	0	0	0	loose
2004	CB-I5	c	2065	18	spot	15	34	2.2	0	12	18	1.0	0	0	12	5	8	15	80	75	0	5	moderate
2004	CB-I7	a	2066	9.2	spot	20	19	2.1	10	17	10	3.0	5	0	27	10	36	40	32	50	0	0	moderate
2004	CB-I7	b	2067	35	spot	20	21	1.6	10	15	18	1.0	2	0	10	0	38	20	50	30	0	50	loose
2004	CB-I7	c	2068	8.4	spot	35	21	2.5	10	19	16	3.0	8	0	52	10	33	20	7	70	0	0	moderate
2004	NF-PON	a	2069	26	25	10	28	1.3	10	18	18	2.0	8	0	30	15	58	70	4	15	0	0	loose
2004	NF-PON	b	2070	20	44	25	26	2.2	10	17	17	2.0	8	0	22	20	57	70	13	10	0	0	loose
2004	NF-PON	c	2071	35	73	15	32	2.1	10	15	19	2.0	10	0	17	25	73	75	0	0	0	0	loose
2004	COS-2	a	2072	12	spot	6.1	21	2.8	100	13	16	2.0	15	5	30	10	52	65	0	20	3	0	loose
2004	COS-2	b	2073	8.5	spot	7.6	22	1.4	85	19	16	1.0	13	5	39	15	38	70	10	5	0	5	loose
2004	COS-2	c	2074	16	spot	11	29	2.4	65	17	15	0.5	3	0	22	15	65	20	10	10	0	55	loose

APPENDIX G

SITE PHOTOGRAPHS

(Provided on CD)

PHOTOGRAPH INDEX		
Reach	**Site**	**Pages**
Rubicon Dam Reach	RR-I3	4-10
	RR-I2	11-17
	RR-I1	18-23
Rockbound Dam Reach	RLD-I1	25-27
Buck Island Dam Reach	BI-I1	29-34
	BI-I2	35-40
Loon Lake Dam Reach	LL-I1	42-45
	LL-I2	46-50
	LL-I3	51-55
Gerle Creek Dam Reach	GC-I1	57-62
	GC-I2	63-65
Robbs Peak Dam Reach	RPD-I1	67-69
	RPD-I2	70-75
Ice House Dam Reach	IH-I4	77-83
	IH-I3	84-90
	IH-I2	91-96
	IH-I1	97-102
Junction Dam Reach	JD-I1	104-111
	JD-I2	112-117
	JD-I3	118-123
Camino Dam Reach	CD-I1	125-131
	CD-I2	132-137
	CD-I3	138-143
Brush Creek Dam Reach	BC-I1	145-152
	BC-I2	153-158
Slab Creek Dam Reach	SC-I1	160-165
	SC-I2	166-173
	SC-I3	174-180
SF American River Reference	SFAR	243-248
Big Silver Creek Reference	BSC	249-252
Silver Fork American River Reference	SILV	253-256

APPENDIX H

FOLLOW-UP DOCUMENT PRESENTED TO TWG FOR YEAR 2002 DATA

UPPER AMERICAN RIVER PROJECT (UARP) HYDRO RELICENSING PROJECT

AQUATIC RESOURCES, WATER QUALITY, GEOMORPHOLOGY & HYDROLOGY TECHNICAL WORKING GROUP (TWG) MEETING

SMUD
Customer Service Center
S Street, Sacramento, California

Re: Follow-up items from the May 13, 2003 aquatic bioassessment meeting

During the May 13, 2003 meeting, data from the aquatic bioassessment survey were presented to the TWG. TWG participants suggested several items for further review/ analysis. These items are addressed in the following discussion.

1. *Evaluating benthic macroinvertebrate data from the Silver Fork American River for use as a potential reference.*

Habitat and benthic macroinvertebrate (BMI) data collected from site SV-B1 on the lower Silver Fork American River (Silver Fork) during the fall of 1999 were reviewed for application to the Upper American River Project (UARP) bioassessment. Site SV-B1 data were accessed from the El Dorado Irrigation District's website (http://www.project184.org/). For generating composite metric scores and conducting definitive site comparisons, taxa lists from other laboratories need to be reviewed for compatibility. Since raw data were not available, site comparisons were based on cumulative site total metric values without examination of source data; the subsequent comparisons are therefore preliminary and subject to change.

Site SV-B1 is located on the Silver Fork American River just downstream of the China Flat campground at an elevation of 4700 feet. In 1999, the site had a physical habitat score of 163 (optimal) and mean substrate composition of: cobble (65%), gravel (25%) and boulder (10%). Mean canopy cover was 8%, mean riffle width was 17 feet and mean riffle depth was 0.9 feet (ECORP 2001, unpublished data; http://www.project184.org/).

The Silver Fork is a third order stream at the SV-B1 site, which likely makes it a more representative reference to the UARP sites than the South Fork American River (SFAR) reference site. The SFAR reference site is located downstream of the Silver Fork confluence near State Highway 50 and Ice House Road.

Figure 1 shows total taxa and EPT richness values for sites within the middle elevation region (Batholith and Volcanic Flow ecological subregion) of the UARP with site SV-B1 included for reference. Taxa richness values for site SV-B1 and site BSC were 54 and 50, respectively, and EPT richness values were identical (28).

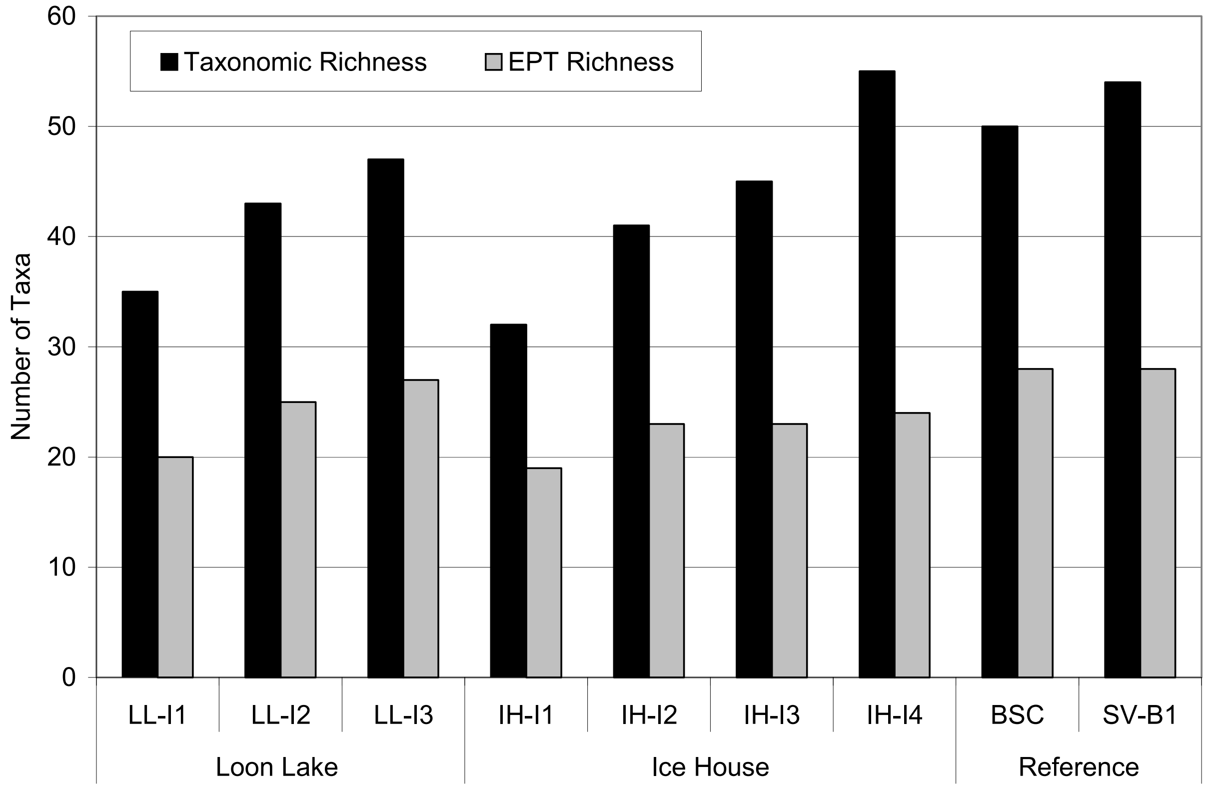

Figure H1. Benthic macroinvertebrate richness values for mid elevation sites sampled in the fall of 2002 within the Upper American River Project (UARP). Site SV-B1 is south of the UARP on the Silver Fork American River and was sampled during the fall of 1999 by the El Dorado Irrigation District http://www.project184.org/).

Figure 2 shows total taxa and EPT richness values for sites within the lower elevation region (Upper Foothills Metamorphic Belt ecological subregion) of the UARP with site SV-B1 included for reference. Taxa richness values for site SV-B1 and site SFAR were 54 and 50, respectively. EPT richness values for sites SV-B1 and SFAR were 28 and 27, respectively.

It is important to emphasise that the metric comparisons shown in Figures 1 and 2 are based on cumulative site totals and that the taxa list from which the SV-B1 metrics were based was not reviewed for compatibility. However, since the laboratory that collected and processed the SV-

B1 samples used the CSBP and standard taxonomic level, the data presented are likely representative and comparable.

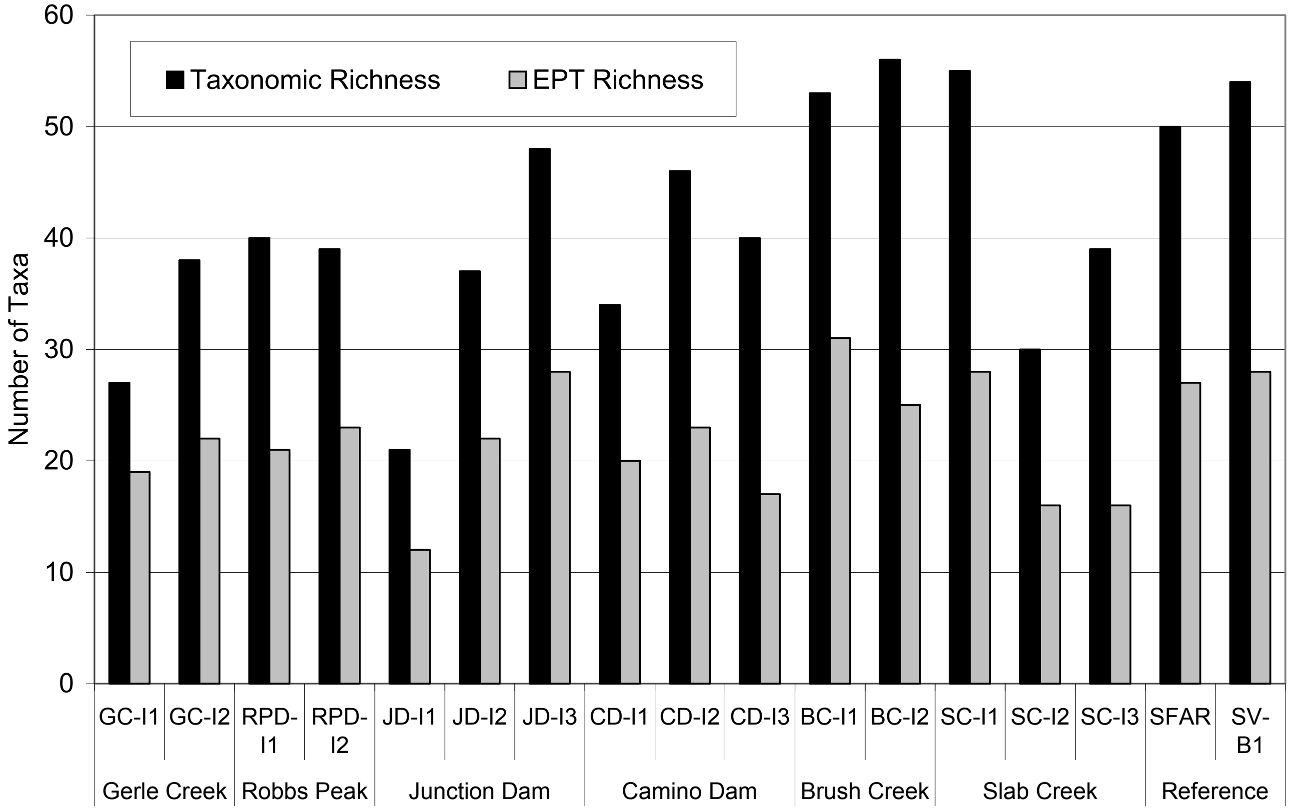

Figure H2. Benthic macroinvertebrate richness values for foothill elevation sites sampled in the fall of 2002 within the Upper American River Project (UARP). Site SV-B1 is south of the UARP on the Silver Fork American River and was sampled during the fall of 1999 by the El Dorado Irrigation District http://www.project184.org/).

2. Re-evaluate the site scale habitat assessment scores for sites that ranked in the suboptimal category.

Field crews that conducted the habitat surveys confirmed most of the suboptimal scores. One question concerned the ranking of sites with predominately bedrock channels: what riparian zone width score should be applied to predominately bedrock channels that are otherwise undisturbed? Sites that scored low for riparian vegetative zone width because of predominately bedrock channels were usually scored moderately. The score for one site (BI-I2) with a predominately bedrock channel that was originally scored low for riparian zone width was changed to the moderate range to be consistent with other sites with similar habitat. Typically, it is uncommon to assess sites with predominately bedrock channels because they lack adequate substrate for sampling.

Sites RR-I3 and JD-I1 were given low scores for riparian zone width but field crews confirmed low scores because of road debris and rip-rap within the riparian zones. Site IH-I3 was scored low for riparian zone width because of past wildfire. Most sites scored in the suboptimal range for epifaunal substrate/ available cover because large woody debris was lacking at most sites. The few changes that were made to habitat scores did not affect data presented during the bioassessment presentation on May 13, 2003: 13 sites scored in the optimal range while 17 sites ranked in the suboptimal range; the median habitat score was 146 (range 114 to 185).

3. *Examining benthic macroinvertebrate taxa identified for the UARP that may be particularly sensitive to flow/temperature regime.*

Monitoring sites were located serially downstream of project dam faces with the uppermost site located as close to the dam face as was practical. If a dam's effect on flow, temperature and fluvial processes was affecting BMI assemblages then BMI assemblages closest to dam faces would be the most likely to show a response. With increasing distance downstream of the project dams, sites receive increasingly more flow from unregulated tributaries and subsurface flow, which may dampen the effect of the dam's influence. We looked for trends in taxonomic composition downstream of the dams within the UARP area to identify taxa that may be vulnerable to regulated flow regime.

While several taxa were either scarce or increased in numerical abundance directly downstream of the dams, trends were usually inconsistent. Oligochaetes were numerically dominant at the site immediately downstream of Junction/Union Valley reservoirs, comprising nearly 50 percent of total BMIs, but their abundance at sites immediately downstream of other reservoirs was variable, ranging from zero to 50 percent. Peltoperlid stoneflies (*Yoraperla*) were abundant at the site immediately downstream of Loon Lake, comprising 26 percent of the BMIs at the site but were absent from most other samples and never comprised more than one percent of the BMIs in all other samples.

The most consistent trend observed at sites directly downstream of the three largest reservoirs (Loon Lake [LL], Junction/Union Valley [JD] and Ice House [IH]) was the absence of elmid beetles (riffle beetles; family Elmidae) and the perlid stonefly *Calineuria californica* (Figure 3). Numerical abundance of elmids and *Calineuria californica* downstream of the smaller reservoirs was inconsistent. While elmids were absent from sites immediately downstream of Gerle Creek (GC) and Camino (CD) reservoirs they were present downstream of the upper elevation reservoirs (RR, RLD, BI) and Robbs Peak (RPD) and Slab Creek (SC) reservoirs; *Calineuria californica* was similarly distributed. Figure 3 also shows the recovery of elmids and *Calineuria californica* downstream of sites where they were scarce or absent.

Camargo and Voelz (1998) reported an absence of elmids at sites on the Colorado River, directly downstream of Granby Dam. Petts (1984) cited research that described a reduction of elmids from sites on a regulated section of Strawberry River in Utah when compared to sites on an unregulated section of the same river. Conversely, Gore (1977) described a numerically dominant population of *Stenelmis*, an elmid, downstream of a deep release dam on the Tongue River in Montana. Species of *Stenelmis* are distributed primarily in the eastern and midwestern states however, and are not typically encountered in benthic samples from streams draining the Sierra Nevada Mountains.

Most elmid beetles and perlid stoneflies are relatively long-lived taxa, requiring a full annual cycle or more (univoltine to semivoltine) for their development (Thorp and Covitch 2001, Siegried and Knight 1978, Sheldon 1969). Development for elmids include egg through the adult stage and, unlike most aquatic insects, many elmid adults are aquatic. Perlid stonefly aquatic development includes egg through adult emergence with a terrestrial adult stage.

Length of life cycle (voltinism) is an important factor when evaluating macroinvertebrate taxa for vulnerability to effects of flow and temperature regime because many species require thermal cues for egg development, hatching, and emergence of adults. Alterations of the normal seasonal changes in water temperature and flow can disrupt the timing of these events to varying degrees (Ward and Stanford 1979, Erman 1996). Alterations in temperature and flow regime downstream of the larger reservoirs within the UARP may have contributed to the lack of elmids and *Calineuria californica* at sites located directly downstream of the reservoirs, where the reservoir's effect on river temperature and flow would not be dampened by influence of unregulated tributaries.

There are limits to applications of voltinism because life cycle duration is dependent on region and species, and information is lacking for many species. Also, long-lived taxa may show a range of sensitivity to alterations in temperature and flow regime. The elmids and *Calineuria californica* however, are good candidate indicators because they are commonly encountered and widely distributed in California, and in the case of elmid beetles, taxonomically rich.

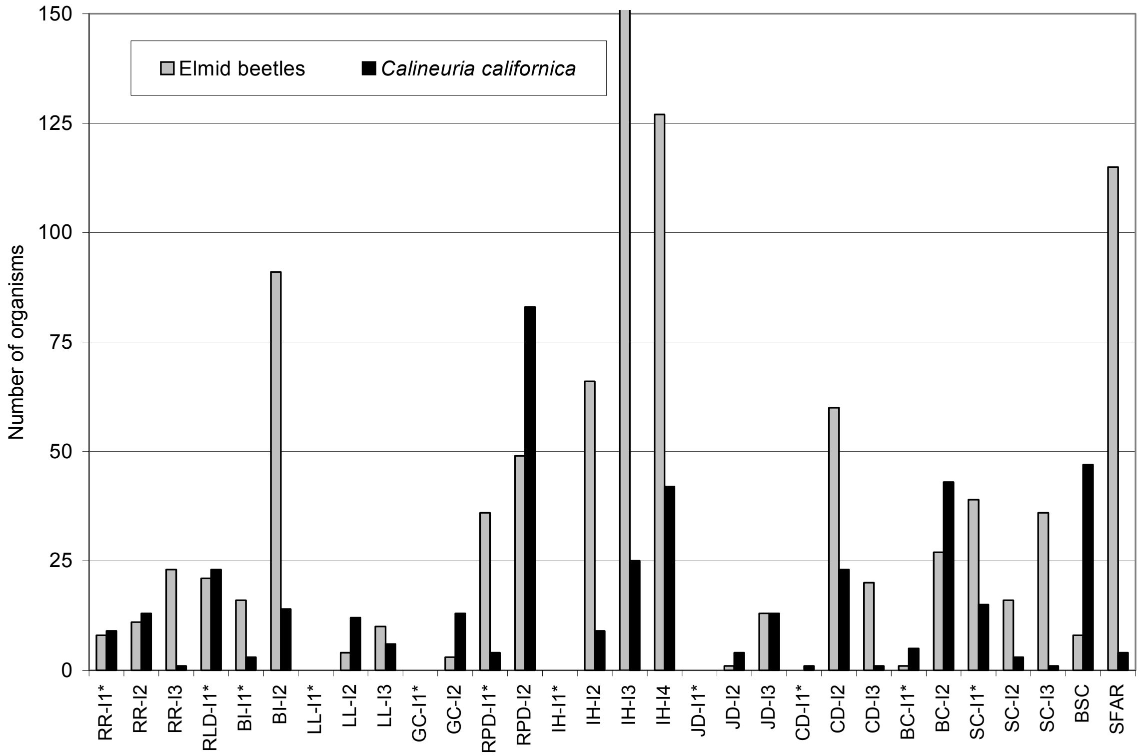

Figure H3. Numerical abundance of elmid beetles (family Elmidae) and the perlid stonefly *Calineuria californica* sampled from UARP sites in the fall of 2002. Sites directly downstream of project dam faces are identified with an asterisk

4. Comparing other hydro-project benthic macroinvertebrate data sets with an emphasis on overall project metrics such as project Taxa Richness and project EPT Taxa values.

A wide range of methods have been used in California for assessing benthic assemblages, which has contributed to lack of consistency in datasets. This lack of consistency has made it difficult to impossible to assess changes in benthic composition spatially and temporally. Nets of different shape and net mesh sizes of 0.25 mm, 0.5 mm, 0.8 mm and 1.0 mm have all been used for benthic sampling in California as well as varying levels of subsampling, including total counts, and taxonomic effort ranging from family level to species level and commonly "lowest possible taxon". One primary attribute of the CSBP is standardization. Samples collected using the CSBP utilize a stratified random sampling design, D-frame kicknet with 0.5 mm mesh net, a subsampling of 300 organisms and standard taxonomic effort (STE) coupled with an evaluation of conformance of the STE by independent taxonomists. Because of the emphasis on standardization, CSBP data sets from other projects and intra-project data sets collected in different years have a much higher potential for compatibility.

Table 1 shows seven commonly reported metrics for three hydro-power BMI data sets derived using the CSBP. Prior to development of inter-project comparisons (Table 1) several factors were considered for the data sets to be comparable. These factors included the STE, which included the consistent treatment of indistinct taxa and the assignment of current California Tolerance Values and functional feeding groups. Of course more information would need to be assessed before drawing conclusions from inter-project BMI assemblage comparisons. However, questions regarding the efficacy of the data set comparisons would emphasize differences in region, localized habitat and sampling year, not differences in methods.

While drawing conclusions from inter-project BMI data comparisons are premature, intra-project data evaluations have suggested that metrics (attributes of biological assemblages) may be robust enough to withstand some differences in localized habitat, region and habitat changes along elevational gradients. Karr and Chu (1999) have discussed the robustness of multi-metric approaches and identified a group of metrics that are reliable responders to anthropogenic disturbance. The California Department of Fish and Game's Aquatic Bioassessment Laboratory is currently working on a regionally-based, multi-metric approach for assessing biotic integrity. Because of a lack of unregulated second to fourth order stream systems in California, reference streams are uncommon and may be too few in many drainages for assessing project effects. If the spatial scale for selecting references broadens, then the pool of potential reference sites would increase, which would contribute to a more thorough and credible assessment of potential project effects.

Table H1. Comparison of commonly reported biological metrics for three hydro-power projects. All samples were collected in the fall of 2002 except Stanislaus samples, which were collected in the fall of 2000.

Project:	**UARP (n=90)**		**Bucks (n=27)**		**Stanislaus (n=144)**	
Elevation Range (ft):	**980 – 6,470**		**1,800 – 5,400**		**1,100 – 6,720**	
Metric	**Project Total**	**Median (range)**	**Project Total**	**Median (range)**	**Project Total**	**Median (range)**
Taxa Richness	151	29 (12 – 44)	115	38 (20 – 45)	134	28 (16 – 41)
EPT Taxa	72	14 (6 – 25)	62	22 (10 – 28)	62	18 (11 – 26)
Ephemeroptera	19	6 (2 – 10)	14	8 (3 – 10)	19	8 (4 – 12)
Plecoptera	23	3 (1 – 10)	23	6 (3 – 13)	21	6 (1 – 10)
Trichoptera	30	5 (1 – 11)	24	7 (1 – 11)	22	5 (1 – 10)
Tolerance Value	4.3	4.3 (1.9 – 7.0)	3.2	3.1 (1.5 – 4.9)	3.5	3.6 (0.9 – 5.2)
Shannon Diversity	3.4	2.5 (1.2 – 3.1)	3.5	2.8 (1.6 – 3.2)	3.1	2.4 (1.6 – 3.2)

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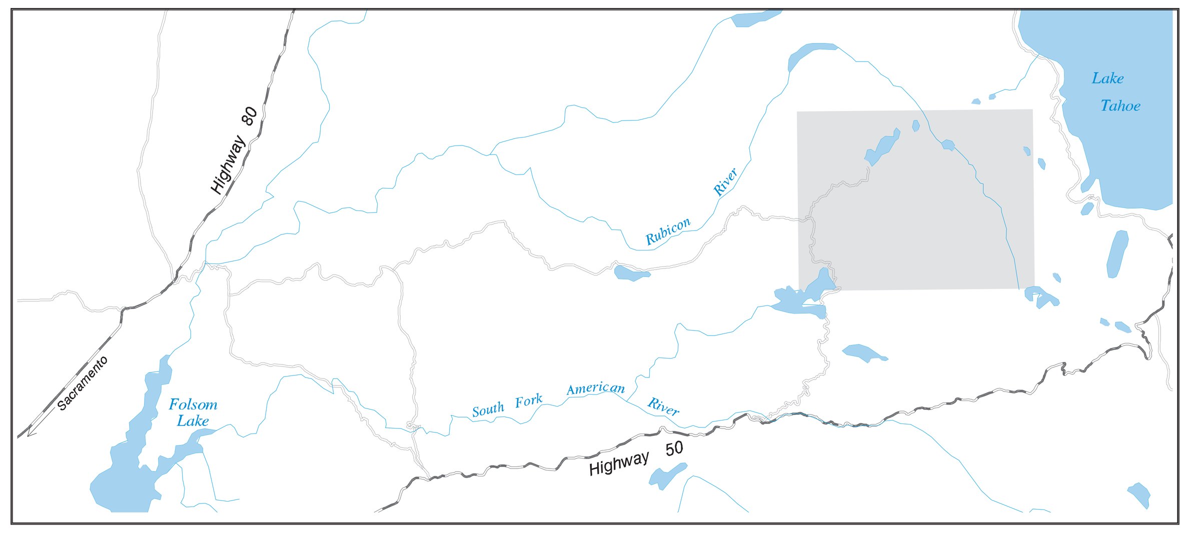
APPENDIX I

UARP AND CHILI BAR PROJECT MAPS

Upper American River Project

FERC Project No. 2101

Northeast Area



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The Power To Do More.

GEOMORPHOLOGY

Level II/III Site Maps with
Level I Stream Type Delineation

Level I Stream Types

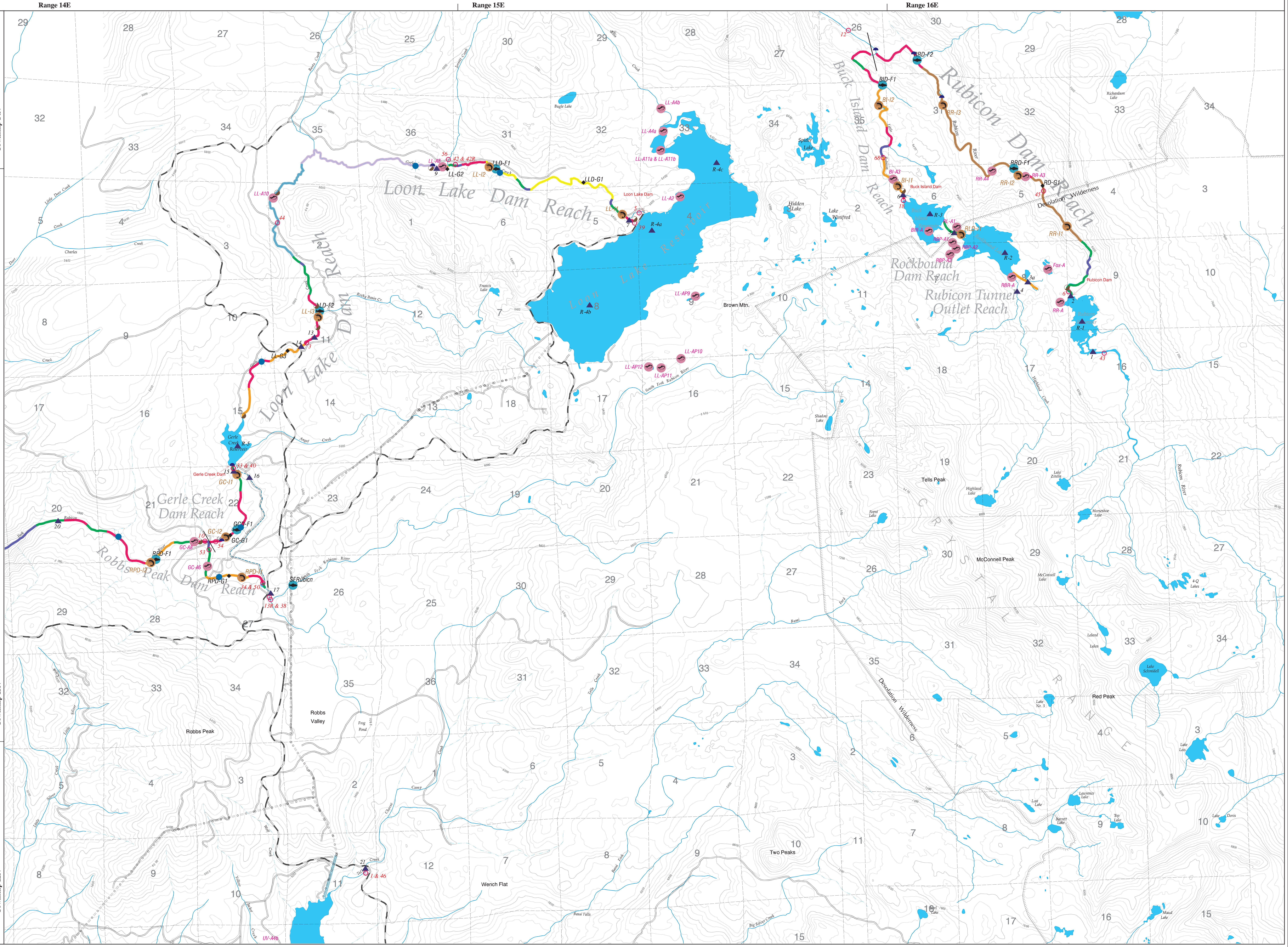
- A
- Aa+
- B
- C
- C/E/D
- C/E
- C/F
- C/F/G
- E/F/C
- F
- (denotes division between reaches)

Level II/III Sites

- Rosgen Level II Site Locations

AQUATIC SURVEYS

- Amphibians
- Fish
- Invertebrates
- PHABSIM Sites
- Water Quality Stations
- Water Temperature Sensor Sites
- Hydrology Nodes
- Hydrology Nodes/Gaging Stations
- Flow Fluctuation Fish Sample



North

Miles

Feet

VESTRA

Prepared by VESTRA Resources, Redding, CA
June 22, 2004

Upper American River Project

FERC Project No. 2101

Southeast Area

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Range 13E | Range 14E | Range 15E

GEOMORPHOLOGY

Level II/III Site Maps with
Level I Stream Type Delineation

Level I Stream Types

- A
- Aa+
- B
- C
- C/E/D
- C/E
- C/F
- C/F/G
- E/F/C
- F
- (denotes division between reaches)

Level II/III Sites

- Rosgen Level II Site Locations

AQUATIC SURVEYS

- Amphibians
- Fish
- Invertebrates
- PHABSIM Sites
- Water Quality Stations
- Water Temperature Sensor Sites
- Hydrology Nodes
- Hydrology Nodes/Gaging Stations
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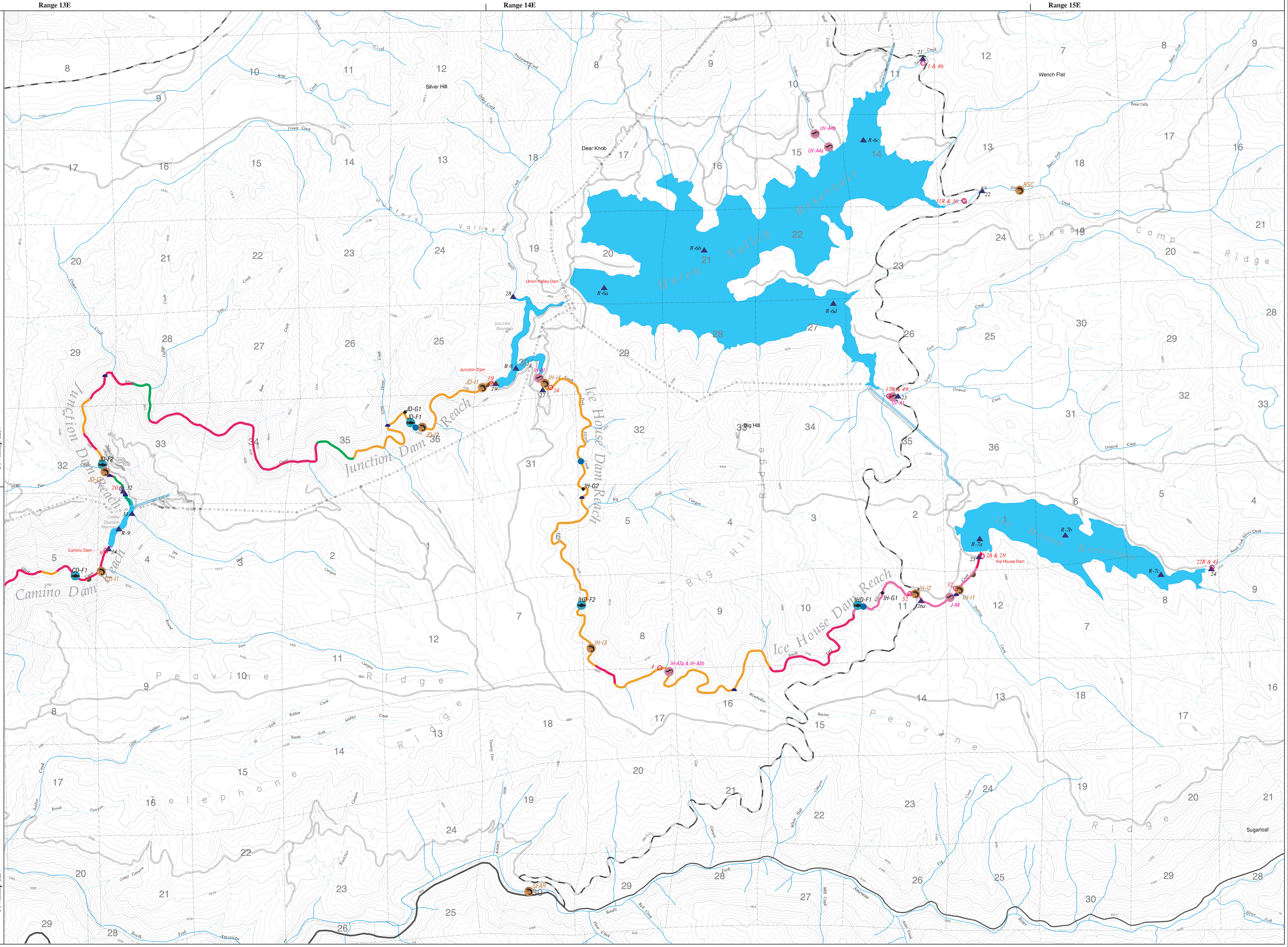

North

Prepared by VESTRA Resources, Redding, CA
June 22, 2004

Upper American River Project

FERC Project No. 2101

Southwest Area

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GEOMORPHOLOGY

Level II/III Site Maps with
Level I Stream Type Delineation

Level I Stream Types

- A
- Aa+
- B
- C
- C/E/D
- C/E
- C/F
- C/F/G
- E/F/C
- F
- (denotes division between reaches)

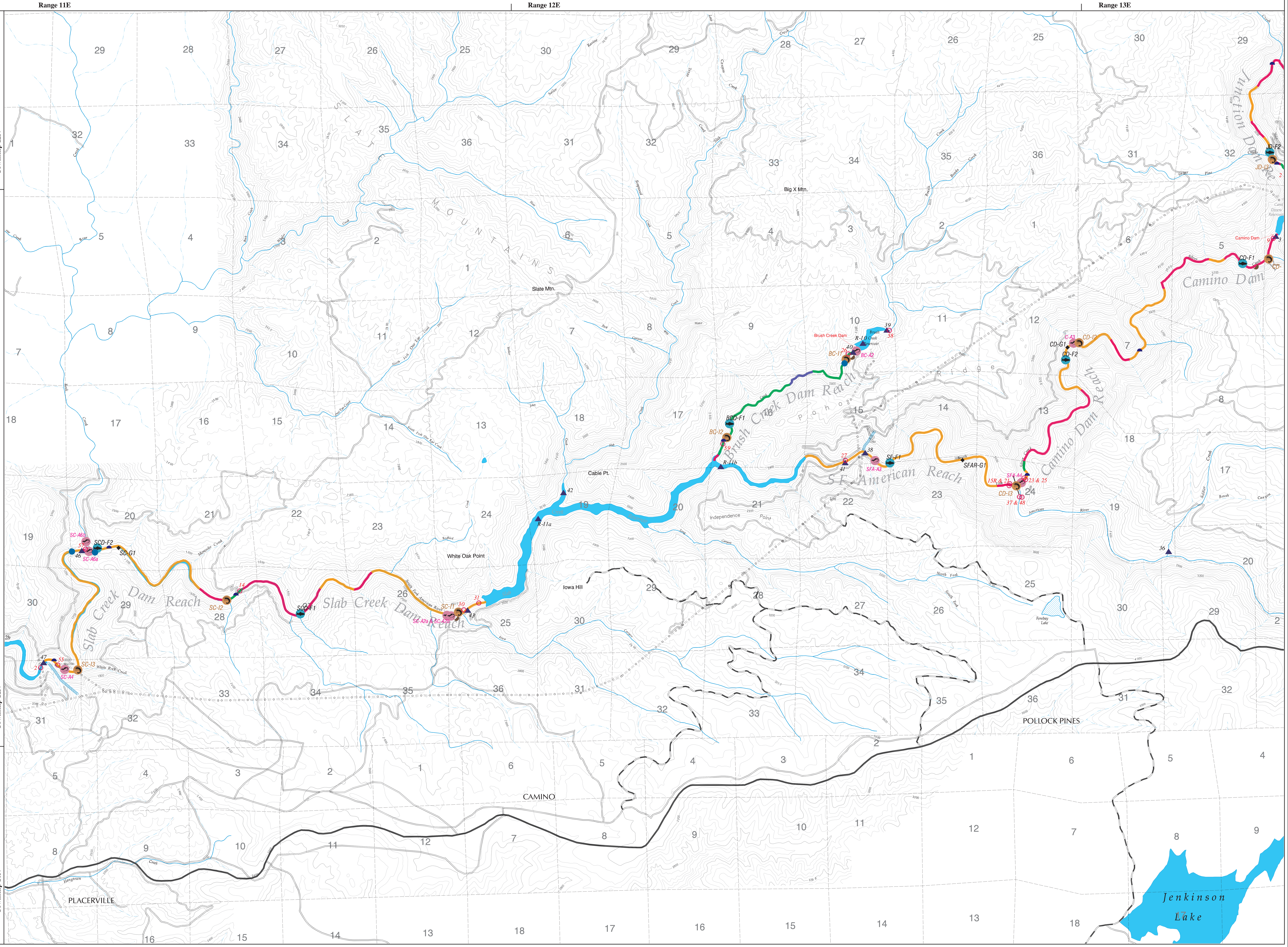
Level II/III Sites

- Rosgen Level II Site Locations

AQUATIC SURVEYS

- Amphibians
- Fish
- Invertebrates
- PHABSIM Sites
- Water Quality Stations
- Water Temperature Sensor Sites
- Hydrology Nodes
- Hydrology Nodes/Gaging Stations
- Flow Fluctuation Fish Sample

North

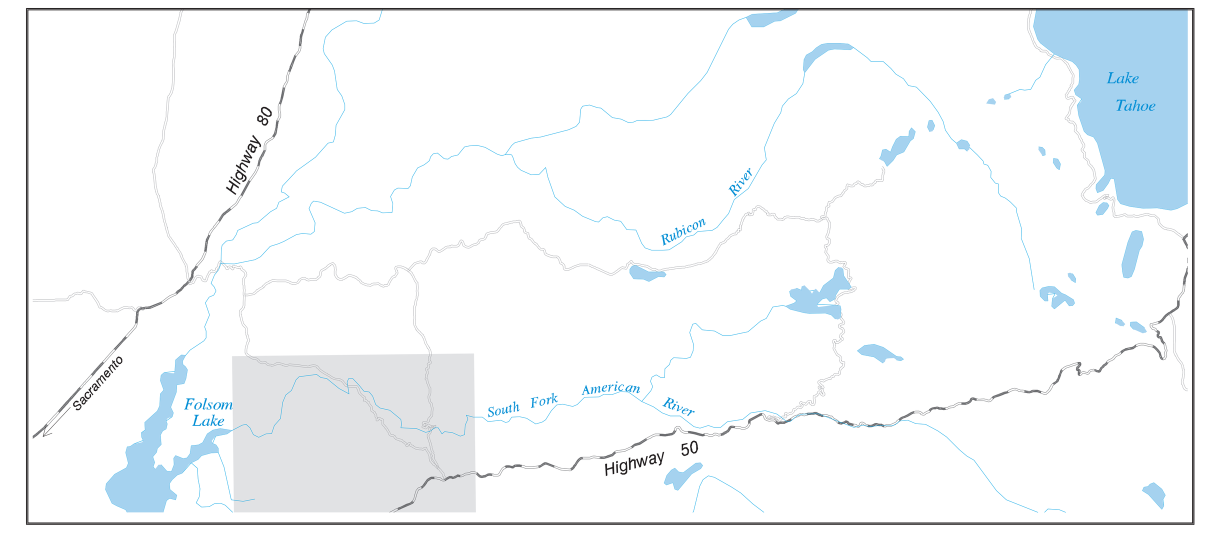


Prepared by VESTRA Resources, Redding, CA
June 22, 2004

Upper American River Project

FERC Project No. 2101

Western Area



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SACRAMENTO MUNICIPAL UTILITY DISTRICT
The Power To Do More.

GEOMORPHOLOGY

Level II/III Site Maps with
Level I Stream Type Delineation

Level I Stream Types

- A
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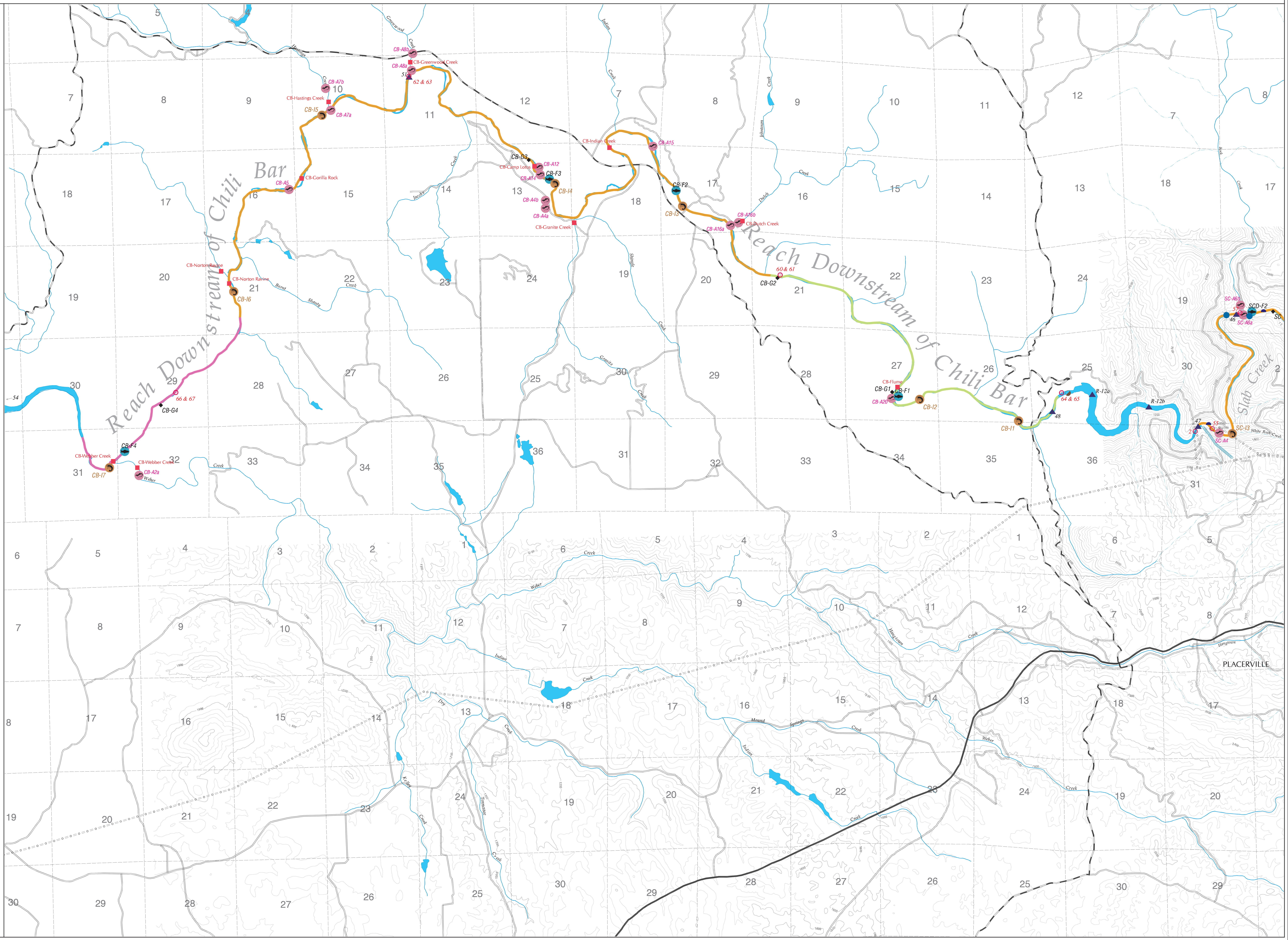

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