2012 Benthic Macroinvertebrate Monitoring
El Dorado Hydroelectric Project (FERC 184)



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TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

INTRODUCTION

Pursuant to the El Dorado Hydroelectric Project (Project 184) Benthic Macroinvertebrate Monitoring Plan (Plan; GANDA 2010), El Dorado Irrigation District (District) is required conduct BMI monitoring in various Project-affected and reference stream reaches throughout Project 184 watersheds. Per the Plan, bioassessment surveys are required during the first two years of each five-year period of the current Project 184 License (including 2011 and 2012). BMI monitoring efforts conducted during the Project 184 relicensing process between 1999 and 2001 (ECORP 2002) helped establish the Project's ecological resource objective for BMIs which states that macroinvertebrate indices (metrics) in Project-affected reaches should be similar to those in reference reaches located within and outside of the South Fork American River (SFAR) and Upper Truckee River (UTR) drainages.

Previous bioassessment surveys conducted in the Project 184 area followed the California Stream Bioassessment Procedure (CSBP) originally developed by the California Department of Fish Game (CDFG 2003). The Project 184 license requires macroinvertebrate monitoring using the CSBP method or such method as revised in the future. The current accepted methodology is the State's Surface Water Ambient Monitoring Program (SWAMP) Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California (SWAMP 2007) which officially replaced the CSBP as the statewide standard for ambient bioassessment in 2007. Therefore, the SWAMP bioassessment protocol is the methodology specified by the Plan.

The District tasked Garcia and Associates (GANDA) to conduct 2012 BMI bioassessment surveys in Project 184 watersheds. This report presents the results of SWAMP bioassessment surveys conducted as specified in the Plan during fall 2012.

METHODS

Site Selection

The Plan specifies monitoring at a total of 18 sites in Project-affected reaches and associated reference reaches within Project 184 watersheds. These watersheds include the following (some of which contain paired sites located above and below existing diversion points):

- Echo Creek (Site EC-B1)
- Pyramid Creek (Site PY-B1)
- Caples Creek (Site CA-B1)
- Silver Fork American River (Site SV-B2)
- South Fork American River (Site SO-B1)
- No Name Creek (Sites NN-B1 and NN-B2)
- Alder Creek (Sites AR-B1 and AR-B2)
- Bull Creek (Sites BU-B1 and BU-B2)
- Ogilby Creek (Sites OG-B1 and OB-B2)

- Esmeralda Creek (Sites ES-B1 and ES-B2)
- Strawberry Creek (Site SB-B1)
- Sherman Canyon Creek (Site SH-B1)
- Woods Creek (Site WC-B1)

The 18 bioassessment sites are located in the same Project-affected and reference reaches specified in the Plan (see Figure 1). GPS locations for each site are listed in Table 1. Generally, 2011 and 2012 SWAMP bioassessment sites were located as close as possible to those sites selected previously during 1999-2001 relicensing efforts (ECORP 2002), although specific site boundaries for SWAMP survey reaches were established by GANDA field crews in 2011 that may be slightly upstream or downstream from the original areas sampled under the CSBP (for example, because the SWAMP protocol requires a longer survey reach than the CSBP). All sites sampled in 2012 were identical to those sampled in 2011.

Benthic Macroinvertebrate Sampling

Teams of two to four GANDA biologists conducted all benthic macroinvertebrate sampling following the SWAMP protocol. Field sampling was performed between October 8 and November 6, 2012. Sites consisted of 150-meter survey reaches wherever possible. Consistent with SWAMP protocol, shorter survey reaches were established at smaller tributaries including Esmeralda Creek (ES-B1 and ES-B2), No Name Creek (NN-B1 and NN-B2) and Ogilby Creek (OG-B1 and OG-B2) in order to avoid barriers or other confounding areas (*e.g.*, steep waterfalls, cliff areas, culverts, *etc.*). At each of these smaller tributary sites, there were numerous pool-riffle sequences to sample within the established survey reach. For larger streams (wetted width greater than 20 m), SWAMP protocol recommends increasing site length. There was one site where wetted width was consistently greater than 20 meters (Site SO-B1 on the South Fork American River [SFAR] below Kyburz Diversion Dam). However, the total survey reach length was not increased at this site because sufficient representative habitat was present within the 150-m reach and extending the site would have only added large, deep pool habitat that could not be sampled.

At sites located at elevations below 6,500 feet (PY-B1, SO-B1, NN-B1 and 2, AR-B1 and 2, BU-B1 and 2, OG-B1 and 2, ES-B1 and 2, SB-B1, SH-B1), BMI samples were collected as reach-wide benthos (RWB) samples. RWB samples were compilations of eleven 1-ft^2 kick samples collected at the 11 main transects comprising the SWAMP survey reach. At sites near or above 6,500 feet (EC-B1, CA-B1, SV-B2, WC-B1), BMI samples were collected as both RWB samples and targeted riffle composite (TRC) samples. RWB samples were collected as described above; TRC samples were compilations of eight 1-ft^2 kick samples collected at eight randomly selected riffle locations within each SWAMP survey reach. Decisions regarding which sample types to collect at which locations were made by the District in consultation with CDFG's SWAMP bioassessment coordinator.

All benthic samples were collected using a Wildco® 18-by-9- inch stream-bottom sampler fitted with a 0.5 mm (500 micron) mesh bag. Samples were collected from downstream to upstream before physical habitat measurements to prevent excessive bottom trampling. At sites where both types of samples were collected, TRC and RWB samples were collected simultaneously in two separate nets while moving from downstream to upstream between transects. All samples were elutriated and cleaned in the field, placed in jars, labeled, and preserved in 10 percent formalin.

Physical Habitat Characterization

Physical habitat parameters (bankfull and wetted width, bankfull height, water depth, substrate composition, cobble embeddedness, algal cover, riparian vegetation, instream habitat complexity, canopy cover, human influence, bank stability, *etc*.) were evaluated at a combination of 11 primary and 10 secondary cross-sectional transects located along the survey reach. The "full" level of effort for physical habitat characterization as described in the SWAMP protocol was performed at all sites. Stream gradient at each site was measured using a clinometer and stadia rod (with eye-level marked) positioned at water's surface from transect to transect; compass bearings between transect mid-points were also measured. The upper, middle and lower portions of each SWAMP survey reach were documented with photographs taken in both the upstream and downstream directions, and both ends of each survey reach were marked using GPS.

Discharge was measured using the standard USGS 20-point velocity-area method at all sites where stream gage data was not available; for streams where depths and velocities were too shallow and slow to measure flows in this manner, discharge was estimated using the buoyant object method to estimate surface velocities.

Basic *in situ* water quality measurements were also taken at each site. Measured parameters included water temperature, pH, specific conductance, and dissolved oxygen concentration. All water quality measurements were collected prior to benthic macroinvertebrate sampling efforts at each site.

Laboratory Protocol

All benthic samples were processed and identified by Jon Lee Consulting. The laboratory subsampling procedure allowed separation of large/rare specimens from finer subsampled material so that more accurate estimations of the whole-sample taxa lists could be made. All samples were subsampled to a minimum of 600 individuals, although the last grid section (*i.e.*, the aliquot containing the 600^{th} individual) was always picked through and identified in its entirety to allow accurate estimation of the total sample abundance (and thus benthic density); therefore, in practice typically 625-675 organisms were identified in the laboratory. This higher level of effort (identifying a minimum of 600 instead of 500 individuals from each sample) is recommended to insure that closer to 500 clearly identifiable specimens are achieved after excluding any ambiguous and/or immature specimens. All specimens were identified to Level II standard taxonomic effort (STE) as defined by the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT), which generally corresponds to the genus-species level for most insects, and slightly less rigorous effort (*e.g.*, class, family, or tribe/subfamily) for certain other taxa groups (Level II STE for California taxa is defined in SAFIT [2006]).

Data Analysis

Summary metrics for each replicate sample were calculated using a Microsoft Access database. Metrics are measurable attributes of macroinvertebrate communities that are known to change in response to disturbance or impairment of the stream environment. Metrics included standard richness, composition, tolerance/intolerance, and functional feeding group measures (see Table 2). All sample metrics were calculated from 500-organism fixed-count samples generated from the complete laboratory-identified taxa lists for each sample (500-count taxa lists are the standard for calculating metrics). Sample data were randomly re-sampled and standardized in this manner to achieve uniformity in count between all samples for comparative analyses (*e.g.*, so that the total number of taxa would be accurately represented for each site at a standardized level of effort, regardless of how many organisms were originally identified in the laboratory from each different sample).

In order to reduce the complexity of the information contained in the numerous metrics that describe each sample, data were compiled into a single multi-metric index, the Hydropower Index of Biotic Integrity, or Hydropower-IBI (Rehn 2010). This IBI was developed by the California Department of Fish and Game (CDFG) Aquatic Bioassessment Laboratory to be sensitive to the cumulative effects of hydropower operations on stream benthic communities. The seven component metrics of the Hydropower-IBI (ET taxa richness, %intolerant individuals, %scrapers, %non-insect taxa, Shannon diversity, %predators, and %tolerant individuals) were chosen from over 80 candidate metrics calculated using a combined dataset from nine separate studies of regulated rivers in California managed for hydropower. Values for these constituent metrics were scored (0-10) according to specific thresholds (defined in Table 3) and final Hydropower-IBI scores were achieved by summing the constituent metric scores and adjusting the index to a 100-point scale. Note that although this IBI was originally developed using only TRC-type samples, IBI scores were calculated for both TRC and RWB samples for all Project 184 SWAMP data because recent published and unpublished analyses suggest that RWB and TRC methods can produce generally comparable results across a broad range of settings within California (Van Buuren and Ode 2008). Therefore, it was assumed that RWB samples collected during this study contained sufficient riffle material for Hydropower-IBI analysis. Further details regarding development of the Hydropower-IBI are provided in Rehn (2010).

Ten percent of the benthic macroinvertebrate samples collected in 2011 and 2012 (2 randomly selected samples out of the 22 total samples collected each year) were submitted to CDFG's Aquatic Bioassessment Laboratory for an independent quality assurance/quality control (QA/QC) check for accuracy of enumeration and taxonomic identification.

RESULTS

2012 Benthic Macroinvertebrate Summary

In 2012, it is estimated that nearly 145,000 benthic macroinvertebrates were collected from the 18 sites in the Project 184 area (in TRC and RWB samples combined). Of these individuals, 15,113 specimens were identified, representing 221 different taxa from 72 families and 15 taxonomic orders (per SAFIT Level II STE). The most common taxa included clinger mayflies of the genus *Cinygmula,* the nemourid stonefly *Zapada cinctipes,* mayflies of the genus *Paraleptophlebia,* stoneflies of the genus *Sweltsa*, caddisflies of the genus *Lepidostoma*, elmid beetles of the genus *Heterlimnius,* and aquatic earthworms of the class Oligochaeta. Other common taxa included brachycentrid mayflies of the genus *Micrasema*, chironomid midges of the genus *Micropsectra*, blackflies of the genus *Simulium*, and mayflies of the genera *Ephemerella* and *Ironodes.* Complete taxa lists for 500-organism fixed-counts and estimated whole-sample taxa lists for all samples are presented in Appendices A and B, respectively.

The average number of taxa per sample for all sites (including both TRC and RWB samples) was 47, including an average of 23 EPT taxa. Shannon Diversity averaged 2.95 and Shannon Evenness average 0.77. Percent EPT averaged 64 percent (46% of which were sensitive EPT) and the dominant taxon comprised 12 percent of the average sample. Tolerant and intolerant individuals comprised 2 and 44 percent of the average sample, respectively. The mean weighted tolerance value was 3.2. On average, collectors were the dominant functional feeding group (33%), followed by shredders (19%), scrapers (18%), predators (17%), filterers (7%), macrophyte herbivores (4%), omnivores (1%), and piercer herbivores (<1%). Macroinvertebrate density averaged 596 individuals/ft^2 for all samples. A summary of biological metrics for 500-organism fixed-counts from all TRC and RWB samples is presented in Table 4. Results of the CDFG laboratory's taxonomic QA/QC check will be reported (as they become available) if any significant discrepancies are found.

2012 Physical Habitat/Water Quality Summary

SWAMP bioassessment sites surveyed in the Project 184 area in 2012 ranked between "optimal" and "marginal" in terms of available epifaunal substrate and cover, sediment deposition, and channel alteration (rapid bioassessment [RPB] scores are ranked by category as poor, marginal, suboptimal, or optimal). Stream gradient ranged from low (1.6% slope at Caples Creek) to very high (28.0% slope at upper Bull Creek). Human influences encountered in the vicinity of survey reaches included rip-rapped banks, cabins, roads, diversion pipes, campgrounds, historical logging, and bridge abutments (defined as "walls/rip-rap/dams," "buildings," "roads/railroads," "pipes (inlet/outlet)," "park/lawn," "logging operations," and 'bridges/abutments" on the SWAMP survey form, respectively).

Water quality parameters measured at SWAMP bioassessment sites were within acceptable ranges during the fall 2012 SWAMP surveys, with water temperatures ranging from 4.8 to

13.4°C, pH ranging from 6.9 to 7.9, and dissolved oxygen concentration ranging from 9.4 to 15.6 milligrams/liter. Discharge ranged from less than 1.0 cubic foot per second (cfs) in several smaller creeks to 33.5 cfs in the mainstem SFAR during our surveys. A summary of physical habitat data and water quality measurements collected at each site in 2012 is presented in Tables 5 and 6 (Table 5 summarizes reach-wide habitat measurements collected once at each SWAMP site and Tables 6a through 6c summarize transect-based measurements collected at multiple cross-sections within each SWAMP survey reach). Site photographs are compiled in Appendix C. Copies of original SWAMP field datasheets are provided in Appendix D.

DISCUSSION

Comparisons between Reference Reaches and Project-Affected Reaches (2012)

Overall, samples collected from Project-affected reaches scored slightly lower on average in terms of certain richness, composition, tolerance, and functional feeding group measures than those collected from reference reaches during 2012 SWAMP surveys (Table 4). Although some variation was apparent among individual metrics and samples, scores for the multi-metric Hydropower-IBI averaged 16 percent higher overall in references reaches (52) than Project-affected reaches (45) (Figure 2).

Total taxa richness averaged 11 percent higher in reference reaches versus Project-affected reaches (50 vs. 45 total taxa, respectively). Richness of individual samples ranged from 61 taxa collected in the RWB sample from upper Bull Creek (Site BU-B2), to 27 taxa collected in the RWB sample from Caples Creek below Caples Lake (Site CA-B1). Shannon Diversity averaged seven percent higher at reference sites versus Project-affected sites (3.06 vs. 2.85, respectively; see Figure 3). Diversity of individual samples ranged from 3.56 in the RWB sample from upper upper Bull Creek (Site BU-B2), to 1.93 in the TRC sample from Woods Creek (Site WC-B1; note that this site was intermittent during summer 2012 prior to fall sampling). Macroinvertebrate density was slightly lower on average in reference reaches than Project-affected reaches (552 vs. 633 individuals/ft^2, respectively). Among individual samples, density was lowest in the RWB sample from Woods Creek above Caples Lake (Site WC-B1) (78 individuals/ft^2) and highest in the TRC sample from Caples Creek below Caples Lake (Site CA-B1) (2,061 individuals/ft^2).

Composition measures were more variable overall among reference and Project-affected sites. Average values for most composition measures were similar for reference and Project-affected reaches (Table 4). The overall percentage of insects was high for all samples (82% to 100%).

The average percent composition of tolerant organisms was very low for all samples (0% to 6%) and the average percent composition of intolerant organisms was typically high (21% to 80%). Thus, average weighted tolerance values were relatively low (*i.e.*, good) for both reference and Project-affected reaches.

Functional feeding group measures were similar overall among reference and Project-affected reaches, however samples from reference reaches had more scrapers (28% vs. 12%) and fewer filterers (4% vs. 10%) on average (Table 4).

The average composition of the major taxonomic groups differed slightly among reference reaches and Project-affected reaches in 2012. In terms of the major insect orders, mayflies (Order Ephemeroptera), stoneflies (Order Plecoptera), and beetles (Order Coleoptera) were more abundant on average in samples from reference reaches, whereas caddisflies (Order Trichoptera) and true flies (Order Diptera) were more abundant in samples from Project-affected reaches (Figure 4). Non-insect taxa were much less abundant overall than insects, although snails (Class Gastropoda) were more abundant on average in samples from reference reaches, while aquatic earthworms (Class Oligochaeta), freshwater mites (Class Acari), and clams (Order Bivalvia) were more abundant in samples from Project-affected reaches (Figure 5).

Comparisons between 2011 and 2012 Survey Results

Results of 2011 and 2012 surveys were very similar overall. Individual metrics (richness, composition, tolerance/intolerance, and functional feeding group measures) as well as multi-metric hydropower IBI scores from each year were similar both on a site-by-site and a Project-vs.-reference reach basis. IBI scores were slightly lower in 2012 than in 2011 (45 and 52 in 2012 vs. 49 and 57 in 2011 for Project-affected and reference reaches, respectively- see Figure 6). It appears that these small differences in IBI scores, along with other slight between-year differences in individual metrics, are well within the range of potential natural (inter-annual) variability. As such, 2011 and 2012 bioassessment data adequately characterize the existing biological and physical habitat conditions in Project watersheds for the current five-year operational period, while providing valuable baseline information for comparisons with future bioassessment data.

CONCLUSIONS

Bioassessment data collected in 2011 and 2012 indicate that Project 184 watersheds generally support relatively robust benthic communities (in terms of richness, composition, tolerance, and functional feeding group measures) characterized by good overall water quality. Physical habitat conditions were predominantly in the optimal to suboptimal range. Overall, these data suggest that no major problems with biological integrity are occurring in Project watersheds.

The ecological resource objective for benthic macroinvertebrates (as defined in the Appendix B, Section 1 of the El Dorado Relicensing Settlement Agreement) states that "macroinvertebrate indices (metrics) in Project-affected stream reaches should be similar to reference reaches." In 2011 and 2012, Project-affected reaches scored slightly lower on average than reference reaches in terms of many individual metrics as well as the multi-metric Hydropower-IBI. While some variability was evident between sites, most richness measures (total taxa richness, Shannon diversity and evenness, *etc.*) were higher on average at reference sites than Project-affected sites in 2011 and 2012. However, some composition measures (*e.g.*, %sensitive EPT), tolerance measures (*e.g.*, %intolerant individuals), and functional feeding group measures (*e.g.*, %shredders) averaged higher at Project-affected sites than at reference sites in these years. To a certain extent, IBI scores and component metric values would be expected to be higher at unregulated vs. regulated sites (*e.g.*, %scrapers was consistently higher at reference sites than at Project-affected sites in 2011 and 2012); and indeed, overall Hydropower-IBI scores were 17 and 16 percent higher for reference reaches than Project-affected reaches in 2011 and 2012, respectively. Furthermore, most reference sites are located nearer to headwater reaches where biological integrity tends to be naturally higher than in downstream reaches where most Project-affected sites are located.

As such, it is likely that many of the observed differences in metric averages between Project-affected reaches and reference reaches primarily reflect ecological differences between upstream and downstream locations (*i.e.*, underlying differences in stream hydrology, substrate, morphology, gradient, riparian influences, *etc.*) rather than Project-related differences. Given the existing variability in summary metrics and the potential measurement of mostly ecological differences, it is reasonable to conclude that the narrative ecological resources objective defined in Appendix B, Section 1 of the El Dorado Relicensing Settlement Agreement is currently being met (*i.e.*, Project-affected reaches and reference reaches are adequately "similar" overall).

RECOMMENDATIONS

Over the course of conducting the 2011 and 2012 bioassessment work, GANDA has developed the following recommendations for consideration in future monitoring efforts:

- Numerical ecological resource objectives should be developed based on 2011 and 2012 data to replace the current narrative objective.
- Better reference sites are needed for certain paired Project-affected sites (*i.e.*, Ogilby Creek, Caples/Woods Creek, Alder Creek) such that bioassessments may better isolate Project-related differences as opposed to simply measuring underlying ecological differences. Currently, such paired comparisons are not ecologically valid due to inherent differences in stream hydrology, substrate, morphology, gradient, and riparian influences between upstream and downstream sites. For example, upper Ogilby Creek (Site OG-B2) is consistently dry with zero surface flow for most of each summer, whereas lower Ogilby Creek (Site OG-B1) is perennial; Woods Creek (Site WC-B1) is a steep, headwater stream that becomes intermittent in low snowpack years, whereas Caples Creek is a low-gradient and higher-order perennial stream; upper Alder Creek (Site AR-B2 near the headwaters) is nearly three miles upstream of lower Alder Creek (Site AR-B1) which has much different stream morphology, gradient, substrate, and site elevation.

- Although 2011 and 2012 sampling was scheduled to correspond to the timing of previous relicensing surveys (October-November), future sampling should be conducted earlier in the season (*e.g.*, August-September as opposed to October-November) so as to conform to the standard index sampling period recommended by SWAMP (as well as to avoid access issues associated with the potential for early snowstorms later in the fall). Index periods help standardize sampling during the most stable flow periods in order to minimize variation in the biological communities being sampled (the index period for the Project 184 area is June-September). Sampling in September versus October, for example, would not appreciably affect summary metrics since benthic communities are relatively stable during these low-flow periods and metric scoring tools are generally very robust to such small seasonal differences. Therefore, September sampling would represent a reasonable compromise between conforming to the standard index period and maintaining maximum comparability with data previously collected primarily during the month of October.
- The collection of TRC samples should be omitted as RWB samples alone will suffice. SWAMP continues to focus on RWB samples only and the initial modification of the protocol to target riffles in order to ensure adequate representation of the benthos at steeper, higher elevation sites for this Project does not appear necessary.
- When sampling in consecutive years, physical habitat data collection could be minimized in the second year (although benthic samples and water quality data should continue to be collected at each site both years). Most of these sites are characterized by very stable stream morphology such that channel aggradation/degradation or meander is unlikely. Thus, perhaps only a subset of transects (*e.g.,* transects A, F, and K only) could be re-measured the second year to verify key aspects of the physical habitat characterization as opposed to repeating the full effort (labor associated with full physical habitat measurements comprises the vast majority of all field labor during a standard SWAMP effort). If conditions appear to have changed from one year to the next at a given site (*e.g.,* due to a landslide, bank failure, or other erosive event), the full level of effort could be repeated at that site to capture such local changes.

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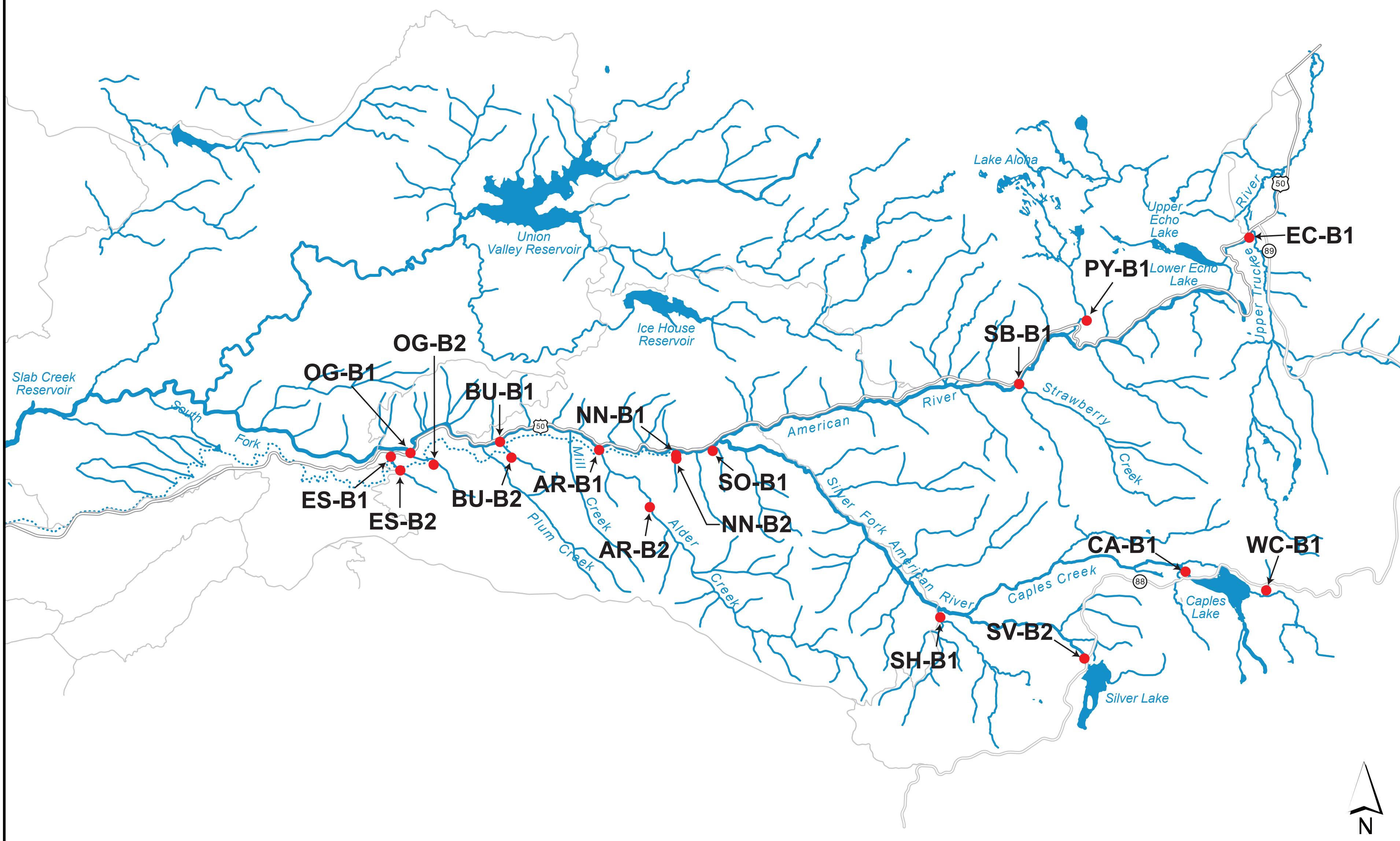

GANDA

Benthic Macroinvertebrate Survey Site

Major Waterway

U.S. Highway/Paved Road

Other Road

El Dorado Canal

0 2 4 6 8 10 miles

0 2 4 6 8 10 Kilometers

Figure 1. Benthic Macroinvertebrate Survey Site Locations.

El Dorado County, CA

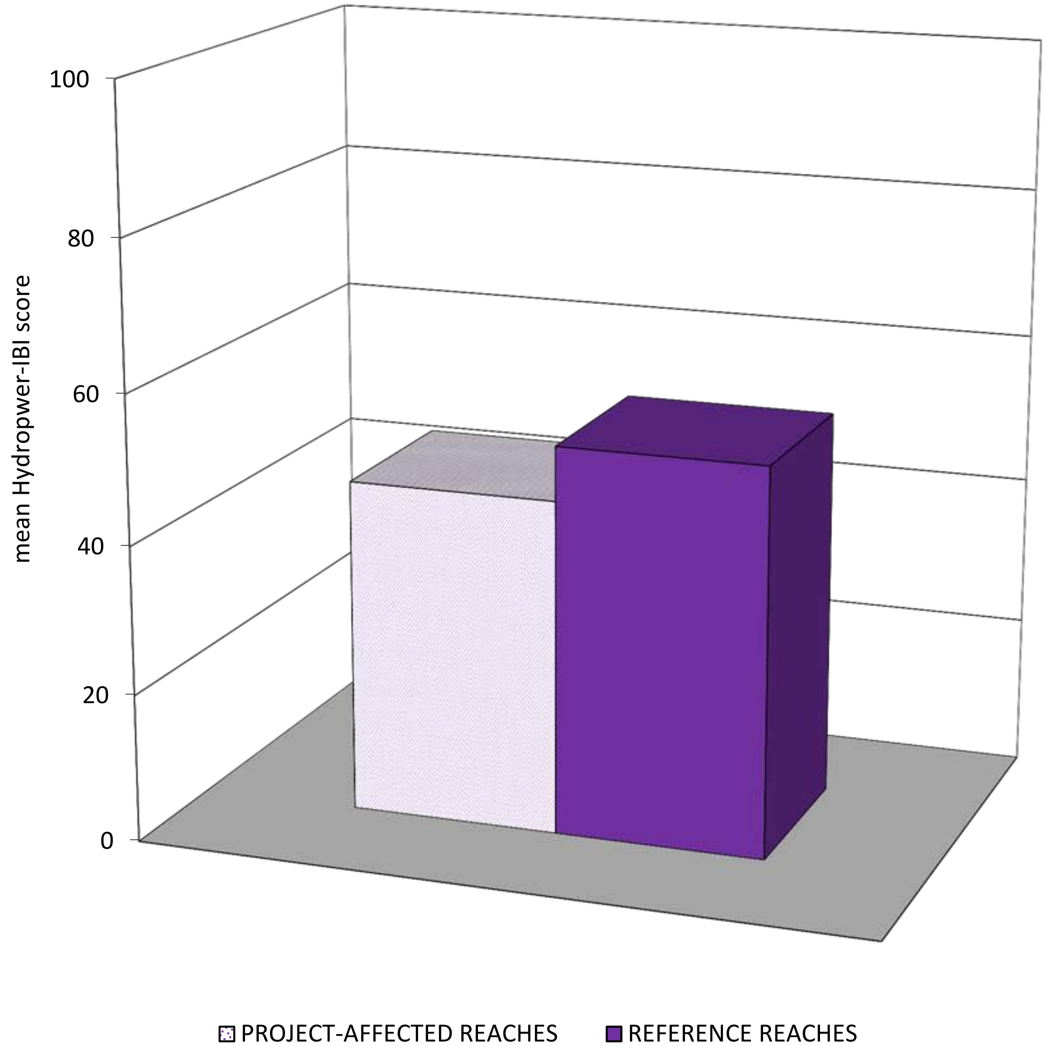

FIGURE 2. Multi-metric Hydropower-IBI scores in Project-affected vs. reference reaches

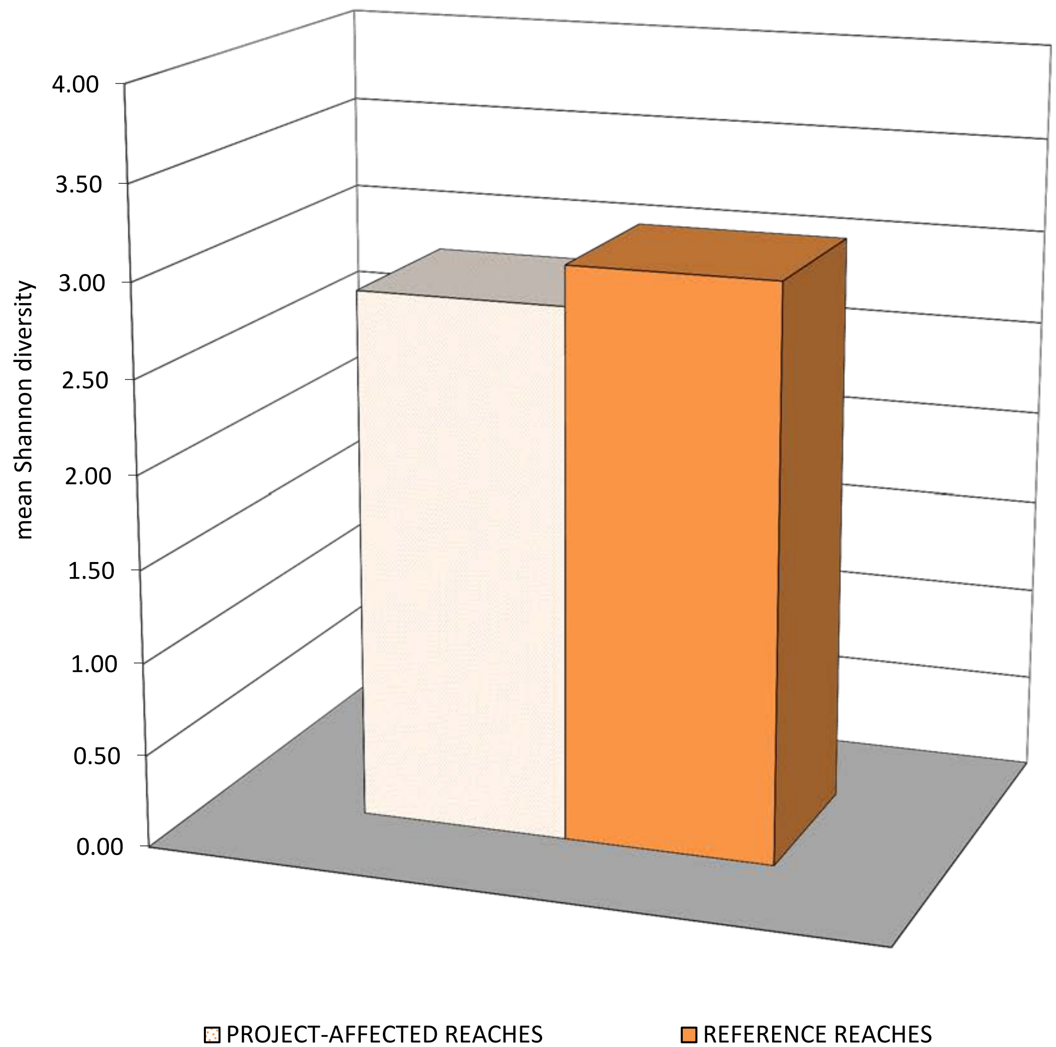

FIGURE 3. Benthic community diversity in Project-affected vs. reference reaches

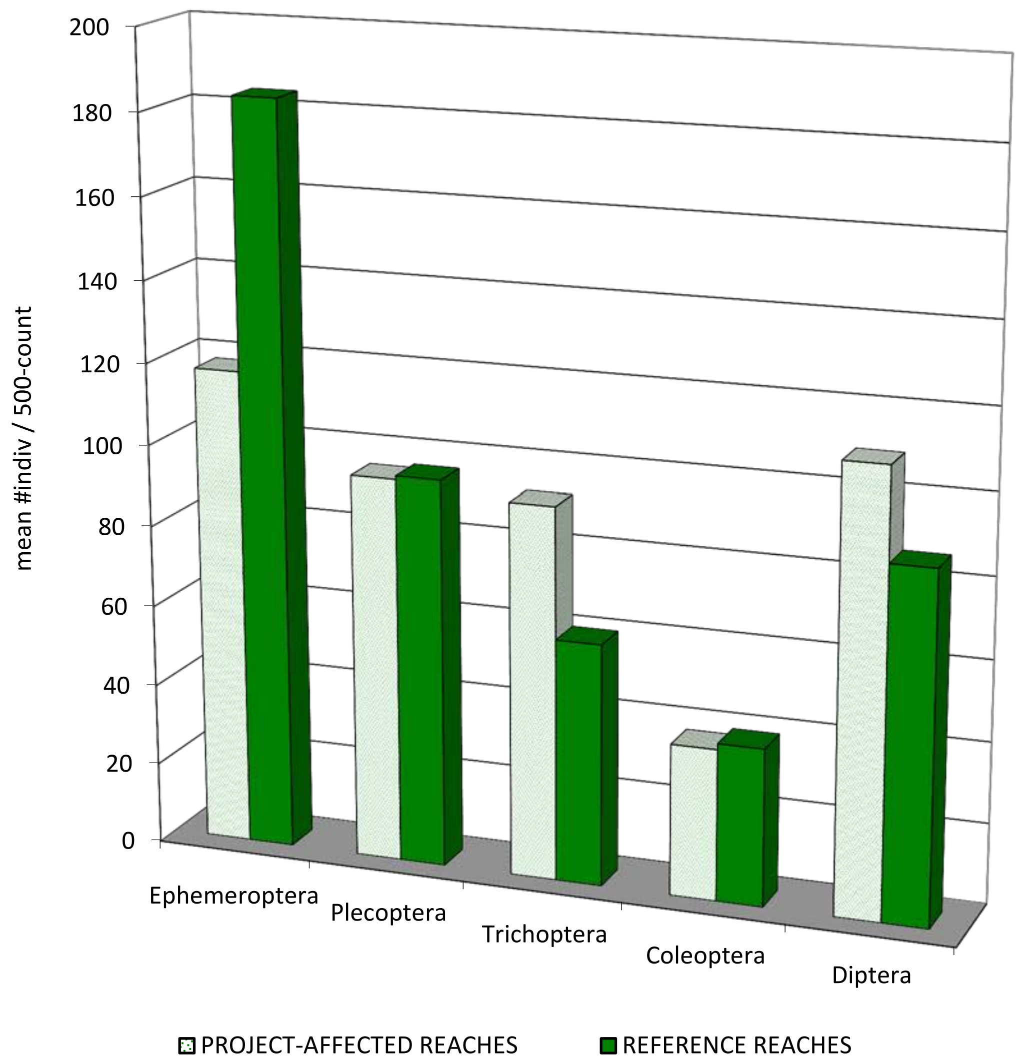

FIGURE 4. Abundance of major insect orders in Project-affected vs. reference reaches

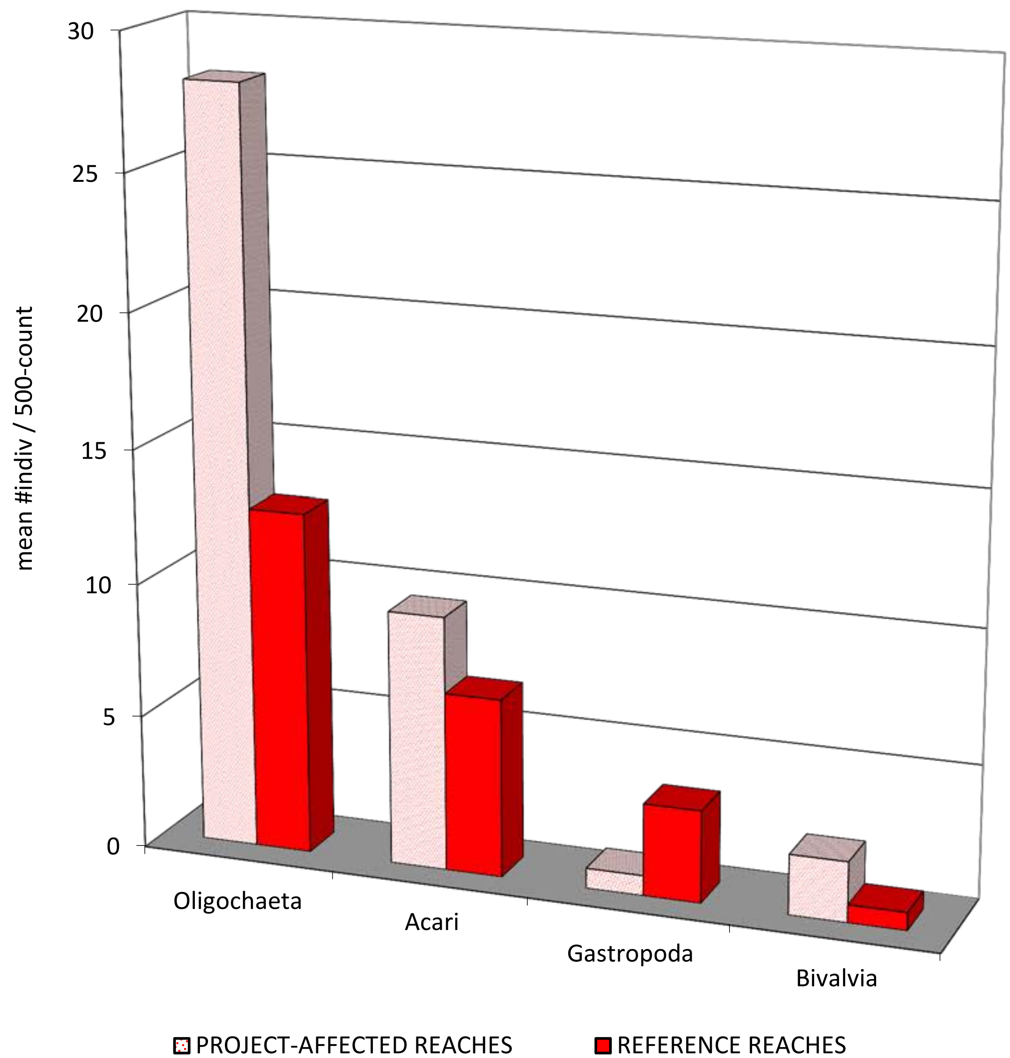

FIGURE 5. Abundance of major non-insect classes in Project-affected vs. reference reaches

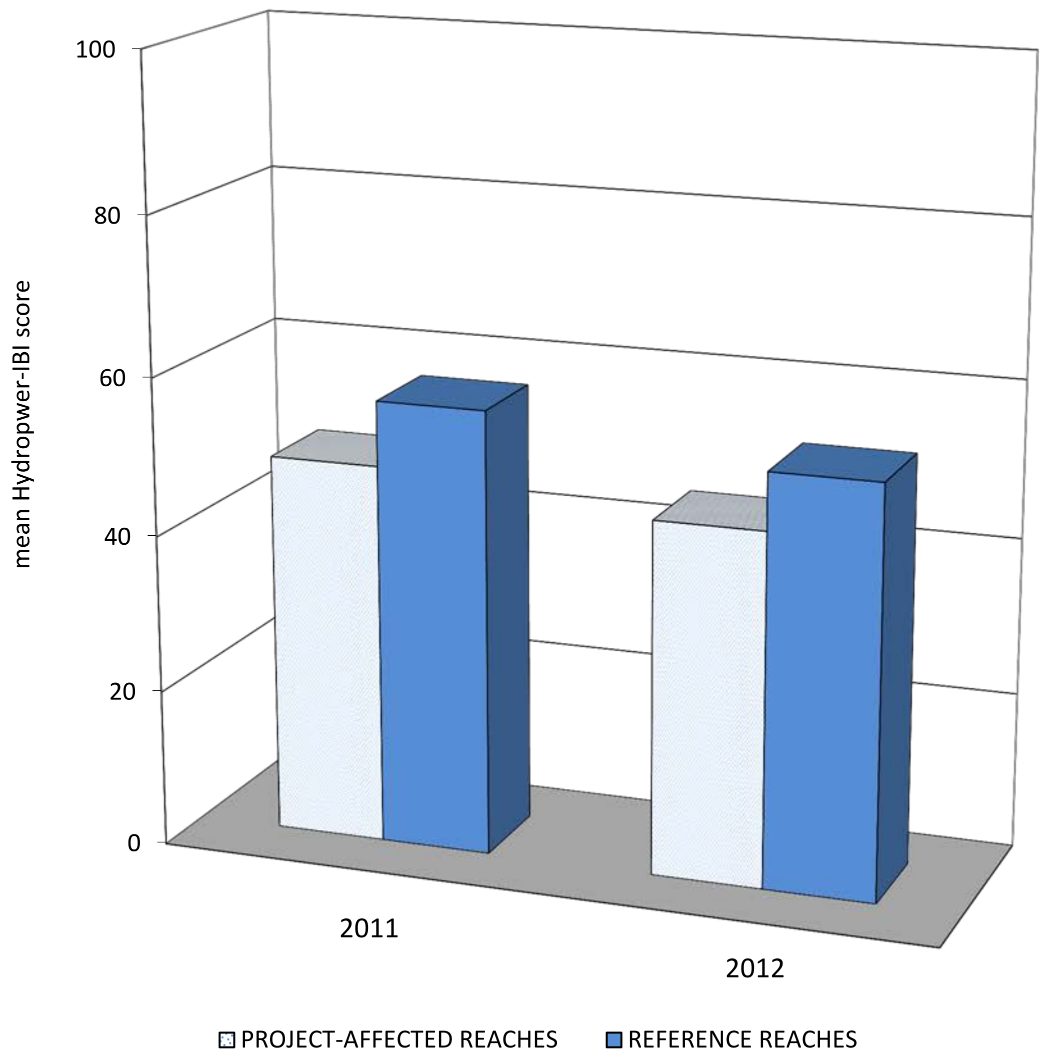

FIGURE 6. Multi-metric Hydropower-IBI scores in Project-affected vs. reference reaches (2011-2012)

TABLE 1. GPS locations of 2012 SWAMP bioassessment survey reaches in Project 184 area.

SITE ID	DESCRIPTION	UTM LOCATION[1]	
		Upstream[2]	Downstream[2]
AR-B1	Alder Creek below diversion	10 S 0727817 4293722	10 S 0727783 4293846
AR-B2	Alder Creek above diversion	10 S 0730155 4291030	10 S 0730155 4291140
BU-B1	Bull Creek below diversion	10 S 0723080 4294280	10 S 0722997 4294368
BU-B2	Bull Creek above diversion	10 S 0723612 4293646	10 S 0723542 4293736
CA-B1	Caples Creek below Caples Lake	10 S 0756345 4288557	10 S 0756231 4288551
EC-B1	Echo Creek below Lower Echo Lake	10 S 0757821 4303759	10 S 0757934 4303807
ES-B1	Esmerelda Creek below diversion	10 S 0718115 4293217	10 S 0718078 4293288
ES-B2	Esmerelda Creek above diversion	10 S 0718332 4292992	10 S 0718311 4293066
NN-B1	No Name Creek below diversion	10 S 0731140 4293874	10 S 0731124 4293956
NN-B2	No Name Creek above diversion	10 S 0731173 4293746	10 S 0731153 4293794
OG-B1	Ogilby Creek below diversion	10 S 0718893 4293859	10 S 0718909 4293906
OG-B2	Ogilby Creek above diversion	10 S 0720413 4293075	10 S 0720346 4293141
PY-B1	Pyramid Creek below Lake Aloha	10 S 0750292 4300308	10 S 0750294 4300162
SB-B1	Strawberry Creek near SFAR confluence	10 S 0747420 4296859	10 S 0747312 4296920
SH-B1	Sherman Canyon Creek	10 S 0743689 4285807	10 S 0743619 4285914
SO-B1	South Fork American below Kyburz diversion	10 S 0732883 4294117	10 S 0732748 4294072
SV-B2	Silver Fork American below Silver Lake	10 S 0750229 4284442	10 S 0750132 4284527
WC-B1	Woods Creek above Caples Lake	10 S 0758190 4287291	10 S 0758071 4287309

[1] GPS datum: NAD 83; [2] Upsream and downstream locations are endpoints of each SWAMP survey reach (corresponding to main survey transects "K" and "A," respectively).

TABLE 2. Biological metrics used to describe benthic samples. Listed responses are for generalized ecological impairment.

METRIC	DESCRIPTION OF METRIC	RESPONSE TO IMPAIRMENT
RICHNESS-TYPE MEASURES		
# Total Taxa	Total number of taxa	Decrease
# Ephemeroptera Taxa	Number of mayfly taxa	Decrease
# Plecoptera Taxa	Number of stonefly taxa	Decrease
# Trichoptera Taxa	Number of caddisfly taxa	Decrease
# Diptera Taxa	Number of taxa in the order Diptera (true flies)	Variable
# Chironomid Taxa	Number of taxa in the dipteran family Chironomidae	Increase
# ET Taxa*	Number of taxa in the orders Ephemeroptera (mayflies) and Trichoptera (caddisflies)	Decrease
# EPT Taxa	Number of taxa in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies)	Decrease
Shannon Diversity*	General measure of sample diversity that incorporates richness and evenness (ln-based)	Decrease
Shannon Evenness	Measure of how evenly taxa abundances are distributed	Decrease
Density ($\#/ft^2$)	Estimated total number of individuals per square foot area	Variable
COMPOSITION-TYPE MEASURES		
% EPT	Percent composition of EPT taxa	Decrease
% Sensitive EPT	Percent composition of EPT taxa with tolerance values 0-3	Decrease
% Baetidae	Percent of individuals in mayfly family Baetidae	Increase
% Chironomidae	Percent of individuals in midge family Chironomidae	Increase
% Hydropsychidae	Percent of individuals in caddisfly family Hydropsychidae	Increase
% Dominant Taxon	Percent of sample comprised of individuals from the most common taxon	Increase
% Insect Individuals	Percent of individuals that are insects	Decrease
% Non-Insect Taxa*	Percent of taxa that are non-insect taxa	Increase
TOLERANCE / INTOLERANCE MEASURES		
% Tolerant Individuals*	Percent of individuals that are highly tolerant of impairment as indicated by tolerance values of 8, 9, or 10	Increase
% Intolerant Individuals*	Percent of individuals that are highly intolerant of impairment as indicated by tolerance values of 0, 1, or 2	Decrease
Weighted Tolerance Value	Value between 0 and 10, weighted by abundances of organisms designated as tolerant or intolerant	Increase
FUNCTIONAL FEEDING GROUP MEASURES		
% Filterers	Percent of individuals that filter fine particulate matter	Increase
% Scrapers*	Percent of individuals that graze upon periphyton	Variable
% Collectors	Percent of individuals that collect/gather fine particulate matter	Increase
% Shredders	Percent of individuals that shred coarse particulate matter	Decrease
% Predators*	Percent of individuals that feed on other organisms	Variable
% Macrophyte Herbivores	Percent of individuals that feed on plants	Variable
% Piercer Herbivores	Percent of individuals that pierce plants	Variable
% Omnivores	Percent of individuals that feed on various food items	Variable
% Parasites	Percent of individuals that parasitize other organisms	Variable
MULTI-METRIC INDEX		
Hydropwer-IBI	Composite index of 7 key metrics* selected to be sensitive to cumulative effects of hydropower operations (scores out of 100)	Decrease

TABLE 3. Scoring ranges for constituent metrics of the Hydropower-IBI. Thresholds shown are for 500-organism fixed-count samples identified to SAFIT Level II standard taxonomic effort (after Rehn 2010).

SCORE	#ET Taxa Richness	%Intolerant Individuals	%Scrapers	%Non-Insect Taxa	Shannon Diversity	%Predators	%Tolerant Individuals
0	0-4	0-5	0-2	≥20	≤2.35	0-7	≥18
1	5-6	6-9	3-7	19	2.36-2.47	8	16-17
2	7	10-13	8-11	17-18	2.48-2.60	9	15
3	8-9	14-17	12-15	16	2.61-2.72	10	13-14
4	10-11	18-21	16-19	15	2.73-2.84	11	12
5	12-13	22-25	20-23	14	2.85-2.96	12	10-11
6	14-15	26-29	24-27	13	2.97-3.08	13	9
7	16-17	30-33	28-31	11-12	3.09-3.20	14	7-8
8	18	34-37	32-35	10	3.21-3.33	15	6
9	19-20	38-41	36-39	9	3.34-3.49	16	4-5
10	≥21	≥42	≥40	≤8	≥3.50	≥17	≤3

TABLE 4. Summary of biological metrics for 2012 Project 184 SWAMP bioassessment samples

	PROJECT-AFFECTED SITES													REFERENCE SITES									AVERAGES	
2012 SWAMP BIOASSESSMENT	AR-B1 RWB	BU-B1 RWB	CA-B1 RWB	CA-B1 TRC	EC-B1 RWB	EC-B1 TRC	ES-B1 RWB	NN-B1 RWB	OG-B1 RWB	PY-B1 RWB	SO-B1 RWB	SV-B2 RWB	SV-B2 TRC	AR-B2 RWB	BU-B2 RWB	ES-B2 RWB	OG-B2 RWB	NN-B2 RWB	SB-B1 RWB	SH-B1 RWB	WC-B1 RWB	WC-B1 TRC	PROJECT	REFERENCE
RICHNESS-TYPE MEASURES																								
# Total Taxa	41	59	27	31	38	39	56	53	59	43	48	44	43	52	61	53	53	51	53	52	51	28	45	50
# Ephemeroptera Taxa	8	8	4	4	8	9	8	5	9	9	9	9	8	8	6	6	7	6	12	9	7	5	8	7
# Plecoptera Taxa	6	12	3	4	6	6	10	8	12	7	5	6	5	9	9	10	10	12	9	10	8	7	7	9
# Trichoptera Taxa	9	12	4	4	8	9	8	9	16	7	10	6	4	8	10	6	6	7	12	8	4	1	8	7
# Diptera Taxa	7	12	11	14	14	13	19	15	11	14	12	17	16	16	21	22	21	17	17	17	21	12	13	18
# Chironomid Taxa	5	8	8	10	13	8	14	6	8	9	8	11	10	10	13	17	13	9	10	13	12	6	9	11
# ET Taxa*	17	20	8	8	16	18	16	14	25	16	19	15	12	16	16	12	13	13	24	17	11	6	16	14
# EPT Taxa	23	32	11	12	22	24	26	22	37	23	24	21	17	25	25	22	23	25	33	27	19	13	23	24
Shannon Diversity*	2.23	3.31	2.20	2.06	2.60	2.70	3.23	3.03	3.30	3.24	3.05	3.04	3.09	3.05	3.56	3.27	3.30	3.25	3.32	2.95	2.94	1.93	2.85	3.06
Shannon Evenness	0.60	0.81	0.67	0.60	0.71	0.74	0.80	0.76	0.81	0.86	0.79	0.80	0.82	0.77	0.87	0.82	0.83	0.83	0.84	0.75	0.75	0.58	0.75	0.78
Density (#/ft^2)	683	146	1,231	2,061	753	465	288	328	309	293	330	549	793	366	320	651	506	414	1,110	753	78	766	633	552
COMPOSITION-TYPE MEASURES																								
% EPT	84	67	50	34	59	76	46	57	83	69	50	48	55	65	56	55	53	61	87	84	64	86	60	68
% Sensitive EPT	81	44	46	28	46	59	40	47	75	60	37	23	27	39	41	41	43	38	61	45	29	35	47	41
% Baetidae	<1	9	<1	3	<1	<1	3	9	5	1	2	5	8	0	5	3	<1	21	0	1	2	2	3	4
% Chironomidae	3	4	8	8	34	10	13	4	4	19	11	23	21	7	15	18	13	10	7	9	25	11	12	13
% Hydropsychidae	<1	<1	0	0	<1	3	<1	<1	3	3	2	2	1	<1	0	0	<1	4	9	1	0	0	1	2
% Dominant Taxon	14	11	17	10	16	15	10	14	7	9	16	13	10	14	8	9	11	9	10	10	14	21	12	12
% Insect Individuals	95	92	93	92	95	89	85	92	92	93	87	83	86	93	90	91	82	93	97	98	96	100	90	93
% Non-Insect Taxa*	15	10	19	16	5	5	11	19	12	12	17	7	16	12	13	13	11	10	6	12	10	4	13	10
TOLERANCE / INTOLERANCE MEASURES																								
% Tolerant Individuals*	2	1	2	2	<1	<1	4	1	1	2	4	<1	4	6	1	2	0	<1	<1	<1	2	0	2	1
% Intolerant Individuals*	80	36	46	29	43	52	43	40	63	62	39	21	26	38	42	35	32	35	60	43	32	36	45	39
Weighted Tolerance Value	1.8	3.2	3.6	4.4	3.8	3.1	3.2	3.2	2.3	2.7	3.3	4.2	4.0	3.2	3.4	3.3	3.2	3.4	2.0	2.8	3.5	3.2	3.3	3.1
FUNCTIONAL FEEDING GROUP MEASURES																								
% Filterers	2	2	37	52	3	5	<1	1	2	1	4	7	13	3	1	1	<1	<1	13	6	9	3	10	4
% Scrapers*	14	15	<1	2	10	14	8	12	13	7	36	11	15	43	8	20	21	10	36	47	20	49	12	28
% Collectors	10	47	27	21	44	25	51	38	27	47	23	58	51	26	37	48	29	53	23	16	28	10	36	30
% Shredders	15	11	13	8	34	45	17	32	18	26	19	8	8	7	26	16	17	17	12	18	13	15	19	16
% Predators*	11	22	21	15	7	8	22	16	18	16	13	15	12	16	25	14	31	15	11	10	29	23	15	19
% Macrophyte Herbivores	47	2	0	<1	0	0	<1	<1	22	0	3	0	<1	4	2	0	0	3	3	3	0	0	6	2
% Piercer Herbivores	0	0	<1	0	<1	<1	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	<1	0
% Omnivores	0	<1	1	2	1	3	1	<1	1	2	<1	1	1	2	1	<1	<1	1	3	<1	1	0	1	1
MULTI-METRIC INDEX																								
Hydropower-IBI	38	56	34	31	41	45	53	44	58	52	50	47	38	56	54	49	52	49	61	53	49	49	45	52

TABLE 5. Summary of reach-wide physical habitat measurements from 2012 Project 184 SWAMP bioassessment sites

	2012 SWAMP BIOASSESSMENT	AR-B1	AR-B2	BU-B1	BU-B2	CA-B1	EC-B1	ES-B1	ES-B2	NN-B1	NN-B2	OG-B1	OG-B2	PY-B1	SB-B1	SH-B1	SO-B1	SV-B2	WC-B1
REACH-WIDE MEASUREMENTS *(measured once per site)*																			
GENERAL	Site Elevation (m)	1082	1511	1002	1261	2367	1948	1159	1182	1164	1197	945	1240	1921	1733	1722	1199	2193	2388
	Evidence of Recent Rainfall	min	no	no	no	no	no	min	min	no	no	no	min	no	no	min	no	no	no
	Evidence of Fires (<500m)	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
	Dominat Land Use*	F	F	F	F	F	F/S	F	F	F	F	F	F	F	F	F	F	F	F
	Reach Length (m)	150	150	150	150	150	150	100	100	100	60	50	100	150	150	150	150	150	150
	Reach Slope (%)	4.8	3.8	11.8	8.0	1.6	6.0	6.3	4.3	17.1	28.0	6.8	4.1	2.2	4.8	3.2	2.4	2.5	4.8
	Reach Sinuosity	1.2	1.3	1.2	1.2	1.3	1.2	1.3	1.4	1.3	1.3	1.0	1.0	1.0	1.1	1.1	1.0	1.1	1.2
	Discharge (cfs)	1.9	1.3	0.2	0.3	6.0	8.6	0.1	0.1	0.2	0.2	0.2	0.1	4.6	9.1	0.5	33.5	4.9	1.1
RPB	Epifaunal Substrate/Cover (0-20)	18	19	16	17	18	17	19	17	18	14	17	16	19	18	19	18	19	17
	Sediment Deposition (0-20)	19	17	11	13	19	16	18	18	17	15	11	12	20	16	18	16	19	17
	Channel Alteration (0-20)	20	20	19	19	19	17	19	20	19	16	19	19	20	20	20	19	19	20
WATER QUALITY	Sample Date	10/26	11/5	10/26	10/8	10/11	10/17	10/25	10/25	10/17	10/27	11/6	11/6	10/12	10/19	10/18	10/25	10/18	11/5
	Sample Time	0900	1130	1300	1300	1030	1330	1200	1000	1000	1330	1220	0950	1030	1100	1230	1330	1025	1450
	Water Temperature (°C)	6.4	6.6	6.9	10.5	13.4	11.2	9.3	6.3	9.3	10.6	9.0	8.4	9.0	6.0	7.7	5.8	11.9	4.8
	pH	7.0	7.7	7.2	7.2	7.7	7.5	7.4	7.0	7.8	7.9	7.2	7.1	7.4	6.9	7.2	7.2	7.7	7.5
	DO Concentration (mg/L)	10.4	13.5	11.3	9.9	9.9	9.8	10.2	14.8	10.9	15.6	10.6	9.4	9.8	13.0	11.1	11.3	9.6	9.6
	Specific Conductance (µS/cm)	43	33	91	78	18	11	47	51	164	164	69	58	4	50	52	60	14	28

**Dominant land use= forest (F), subutrb/town (S), rangeland (R)*

TABLE 6a. Summary of transect-based physical habitat measurements from 2011 Project 184 SWAMP bioassessment sites

	2012 SWAMP BIOASSESSMENT	AR-B1	AR-B2	BU-B1	BU-B2	CA-B1	EC-B1	ES-B1	ES-B2	NN-B1	NN-B2	OG-B1	OG-B2	PY-B1	SB-B1	SH-B1	SO-B1	SV-B2	WC-B1
TRANSECT-BASED MEASUREMENTS *(measured at multiple cross-sectional transects within site)*																			
CHANNEL	Mean Wetted Width (m)	12.2	7.2	1.7	1.3	7.6	6.5	1.2	1.4	1.1	1.6	2.7	1.2	6.2	5.6	6.9	30.3	9.6	4.2
	Mean Bankfull Width (m)	23.2	16.5	6.0	3.9	8.7	8.4	3.1	2.8	4.1	3.9	5.7	4.3	8.0	7.2	11.2	42.5	13.1	7.3
	Mean Bankfull Height (m)	0.85	0.85	0.45	0.49	0.55	0.42	0.44	3.15	0.39	0.46	0.68	0.67	0.49	0.86	0.95	0.54	0.45	0.73
	Mean Depth (m)	0.21	0.18	0.08	0.92	0.22	0.15	0.07	0.06	0.04	0.04	0.05	0.03	0.18	0.18	0.14	0.31	0.21	0.23
BED	Median Particle Size (D_{50}) (mm)	415	55	45	19	29	75	44	20	7	70	44	55	200	120	43	385	90	30
	Mean Cobble Embeddedness (%)	11	13	16	24	10	17	22	14	26	29	11	10	17	20	29	14	17	10
	% Bedrock (>4m)	26	28	0	10	16	3	1	0	7	31	14	0	27	29	12	13	14	13
	% Boulder, large (>1m-4m)	9	1	2	0	0	5	0	0	0	0	1	0	5	2	4	6	2	1
	% Boulder, small (>25cm-1m)	25	6	15	5	2	17	7	0	3	5	5	7	13	9	13	38	7	7
	% Cobble (>64mm-25cm)	10	14	29	23	11	30	32	23	26	15	20	42	29	26	16	18	32	18
	% Gravel, coarse (>16-64mm)	14	14	17	13	41	24	29	32	10	11	24	24	7	13	11	7	23	15
	% Gravel, fine (>2-16mm)	10	15	27	17	15	13	18	19	18	13	8	9	6	10	20	15	10	9
	% Sand + %Fines (0-2mm)	7	22	10	32	14	8	13	26	37	24	29	19	14	12	23	3	12	38
	CPOM Presence (%)	95	85	93	99	91	83	100	100	100	100	100	99	78	80	78	71	94	96
	Mean Microalgae Thickness (mm)	1	<1	1	<1	1	<1	1	<1	<1	<1	<1	<1	1	<1	<1	<1	1	<1
	Attached Macroalgae Presence (%)	0	8	0	3	36	18	1	1	0	0	0	5	43	10	20	40	26	2
	Unattached Macroalgae Presence (%)	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	3	0	0
	Macrophyte Presence (%)	7	15	15	26	9	9	8	6	10	35	10	33	1	0	38	13	0	5
BANK	Stable Banks (%)	95	100	27	54	91	100	18	23	100	100	77	50	100	95	100	100	100	100
	Vulnerable Banks (%)	5	0	46	41	4	0	27	27	0	0	0	18	0	0	0	0	0	0
	Eroded Banks (%)	0	0	27	5	5	0	55	50	0	0	23	32	0	5	0	0	0	0

TABLE 6b. Summary of Transect-Based Physical Habitat Measurements from 2011 Project 184 SWAMP Bioassessment Sites (cont'd)

	2012 SWAMP BIOASSESSMENT	AR-B1	AR-B2	BU-B1	BU-B2	CA-B1	EC-B1	ES-B1	ES-B2	NN-B1	NN-B2	OG-B1	OG-B2	PY-B1	SB-B1	SH-B1	SO-B1	SV-B2	WC-B1
	TRANSECT-BASED MEASUREMENTS cont'd *(measured at multiple cross-sectional transects within site)*																		
HABITAT TYPE	Cascade/Fall (%)	3	3	4	1	1	9	0	1	6	18	0	0	1	4	3	1	1	2
	Rapid (%)	7	1	0	0	0	1	0	0	5	24	0	0	1	1	0	4	0	0
	Riffle (%)	24	17	52	51	33	65	50	50	51	29	17	10	40	48	26	37	37	5
	Run (%)	20	50	7	9	56	13	13	11	24	10	62	59	30	28	38	53	31	22
	Glide (%)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	8	2	4	0
	Pool (%)	47	28	33	40	11	13	38	38	15	20	19	9	28	20	25	5	27	71
	Dry Channel (%)	0	2	5	0	0	0	0	0	0	0	3	22	0	0	0	0	0	0
HABITAT COMPLEXITY	Filamentous Algae	A	S/M	A/S	A/S	S	A/s	A	A	A	A	A/S	A	A	A/S	A/S	S/M	A/S	A/S
	Aquatic Macrophytes	A/S	S/M	S/M	S/M	A/S	A	A/S	A/S	A/S	S/M	S/M	M	A/S	A/S	M/H	S	A/S	S
	Boulders	H/VH	M	M/H	M/H	S/M	H/VH	M	A/S	M/H	M/H	M/H	S/M	H/VH	H/VH	H	H/VH	H	S/M
	Woody Debris >3m	A/S	A/S	S	S/M	S/M	A/S	A/S	S	S/M	S/M	M/H	A/S	A/S	A/S	A/S	A/S	A/S	S/M
	Woody Debris <3m	A/S	A/S	S/M	S/M	S/M	S/M	S	S/M	S/M	S/M	S/M	S/M	S	S	A	A/S	S	S/M
	Undercut Banks	A	A/S	A/S	S/M	A/S	A/S	S/M	A/S	A/S	A/S	A/S	A/S	A/S	A/S	A/S	A	A/S	A/S
	Overhanging Vegetation	S	S/M	M/H	H	S/M	S/M	M/H	S/M	M/H	M/H	S/M	S/M	S/M	S	S/M	S	S	S/M
	Live Tree Roots	A/S	A	A/S	S/M	A/S	A/S	S	A/S	A/S	A/S	A/S	A/S	A/S	A	A	A/S	A/S	A/S
	Artificial Structures	A	A/S	A	A	A	A/S	A	A	A/S	A	A	A	A/S	A/S	A	A	A	A

**Habitat Complexity Codes= Absent (A), Sparse (S), Moderate (M), Heavy (H), Very Heavy (VH)*

TABLE 6c. Summary of Transect-Based Physical Habitat Measurements from 2011 Project 184 SWAMP Bioassessment Sites (cont'd)

	2012 SWAMP BIOASSESSMENT	AR-B1	AR-B2	BU-B1	BU-B2	CA-B1	EC-B1	ES-B1	ES-B2	NN-B1	NN-B2	OG-B1	OG-B2	PY-B1	SB-B1	SH-B1	SO-B1	SV-B2	WC-B1
TRANSECT-BASED MEASUREMENTS cont'd *(measured at multiple cross-sectional transects within site)*																			
RIPARIAN*	Mean Total Canopy Cover (%)	50	24	95	98	42	64	98	93	97	88	79	96	63	45	62	24	27	31
	Trees/Saplings (>5m high)	M/H	S	H/VH	H/VH	S/M	M/H	H/VH	M/H	H/VH	H/VH	S/M	M/H	M/H	M/H	M/H	M/H	M/H	A/S
	Shrubs/Saplings (0.5-5m high)	M/H	S/M	M/H	M/H	M/H	M/H	M/H	M/H	S/M	S/M	M	M	S/M	S/M	M/H	S/M	S/M	S/M
	Woody Shrubs/Saplings (<0.5m high)	S/M	S/M	S/M	S/M	S/M	S/M	S/M	S/M	S/M	A/S	S/M	S/M	S/M	S/M	S/M	S/M	S/M	S/M
	Herbs/Grasses (<0.5m high)	S/M	S	S/M	S/M	M/H	S/M	S/M	S/M	M/H	S/M	S/M	S/M	S/M	S/M	S/M	S/M	S/M	A/S
	Barren Soil/Duff (<0.5m high)	M/H	M/H	M/H	H	S/M	M/H	H	H	H	H/VH	M	S/M	M/H	H/VH	H/VH	M/H	H	M
HUMAN INFLUENCE	Walls/Rip-Rap/Dams (%)	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0
	Buildings (%)	0	0	18	0	0	9	0	0	5	0	0	0	0	91	0	0	0	0
	Pavement/Cleared Lot (%)	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0
	Road/Railroad (%)	77	0	5	0	0	41	50	95	0	0	0	0	0	45	0	50	0	0
	Pipes/(Inlet/Outlet) (%)	0	0	0	0	0	0	0	0	86	100	0	0	0	14	0	5	0	0
	Landfill/Trash (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Park/Lawn (%)	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	5	0
	Row Crops (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pasture/Range (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Logging Operations (%)	0	50	0	9	0	0	0	0	0	0	0	50	0	0	0	0	0	0
	Mining Activity (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Vegetation Management (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bridges/Abutments (%)	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Orchards/Vineyards (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

**Riparian Vegetation Codes= Absent (A), Sparse (S), Moderate (M), Heavy (H), Very Heavy (VH)*

Appendix A

500-Organism Fixed-Count Taxa Lists
2012 Project 184 SWAMP Bioassessment

APPENDIX A. 2012 Project 184 SWAMP Bioassessment 500-Organism Fixed-Count Taxa Lists

Final SAFIT ID	AR-B1 RWB	AR-B2 RWB	BU-B1 RWB	BU-B2 RWB	CA-B1 RWB	CA-B1 TRC	EC-B1 RWB	EC-B1 TRC	ES-B1 RWB	ES-B2 RWB	NN-B1 RWB	NN-B2 RWB	OG-B1 RWB	OG-B2 RWB	PY-B1 RWB	SB-B1 RWB	SH-B1 RWB	SO-B1 RWB	SV-B2 RWB	SV-B2 TRC	WC-B1 RWB	WC-B1 TRC
Hydra					6	3						1					3					
Turbellaria	3			5	7	19			4	2	6	2	4	60	7		2					
Prostoma																		10				
Pisidium	1	2		2	4	3				2	5				2					12		
Juga			4	12					2	4	5			11								
Planorbidae										1												
Gyraulus				3																		
Oligochaeta	7	24	24	15	13	13	26	52	39	24	18	25	26	6	19	7	1	26	66	48	11	2
Utaxatax									2		1			1								
Hydrovolzia											1											
Cyclothyas											3	8										
Protzia	5	1	3								1					2						
Atractides												1								1	1	
Hygrobates																		2				
Estelloxus											1											
Lebertia	6	2											3		2			6		1	6	
Mideopsis			2	2							1											
Sperchon		3											3					7		4	1	
Sperchonopsis															5		1		2			
Stygothrombium		2											1	4				6		2		
Testudacarus				2									3	6			1	1				
Torrenticola	4		7	7			1	2	8	3			2			4	1	6	16	3	1	
Ostracoda			2		5	2			19	8												
Ameletus	2	4	1				9	5	3				6	6	18	1	15	2	10	11	12	
Acentrella insignificans																		2				
Baetis tricaudatus	1		2	1	2	15	1	2			4	41	23		5			8	16	13	2	2
Cloeodes																	2					
Diphetor hageni			44	24					13	15	40	66	2	4			4		7	27	8	8
Attenella delantala																2						
Caudatella hystrix								2	1			6			8	10						
Drunella doddsi	1	3														30						
Drunella grandis							5	1													1	
Drunella pelosa													4			8						
Drunella spinifera															34	6						
Ephemerella	18	27	19	18	76	48	7	7	20	36			20	17	36	7	8	22	3	3		
Ephemerella velmae																						
Cinygma			12	1					17	4	2	2	1	6					1			
Cinygmula	9	84	4		2	10	29	44	6	31			3	32	7	21	144	21	1	9	94	239
Epeorus	26	18					12	3					1		25	28	52	25	26	35		
Ironodes	1	2	40	15			6	18	12	47	44	19	37	57		8	1	1	13	13		
Rhithrogena		13													5	61	21	7			4	7
Paraleptophlebia	3	42	55	39	12	5	21	22	12	26	3	9		11	32	16	28	10	78	87	71	7
Capniidae	1	4	5	4					2	14	42	46	7	37		9	13	2			24	18
Eucapnopsis brevicauda		1												2		2	3	1			8	15
Kathroperla			2						2	1												
Sweltsa	15	42	37	5	85	46	19	24	26	29	6	3		21	6	2	8	7	13	24	64	104
Leuctridae			1		7	6						1		1							9	4
Moselia infuscata			25	50					50	26	2	3	9	8								
Malenka											7	2										
Soyedina			2	14						1	10	3	9	3								
Visoka cataractae									7	5				10							1	
Zapada cinctipes	1	1	2	25	35	30	79	118	6	7	68	3	28		46	3	16		24	29	2	12
Zapada columbiana													5									
Zapada frigida														8	3		2					
Zapada oregonensis group	1	2	5	7		1	3	13	1	4	5	4	13		16		11		7	4		1
Sierraperla cora												1										
Yoraperla				8								6	1		42		1					
Calineuria californica	9	13	17	19			1	2	23	4			15	3	5	7	3	5	1			
Doroneuria baumanni								1					1		7	1						
Hesperoperla hoguei			7	7					2	1	14	14		1								

Final SAFIT ID	**AR-B1 RWB**	**AR-B2 RWB**	**BU-B1 RWB**	**BU-B2 RWB**	**CA-B1 RWB**	**CA-B1 TRC**	**EC-B1 RWB**	**EC-B1 TRC**	**ES-B1 RWB**	**ES-B2 RWB**	**NN-B1 RWB**	**NN-B2 RWB**	**OG-B1 RWB**	**OG-B2 RWB**	**PY-B1 RWB**	**SB-B1 RWB**	**SH-B1 RWB**	**SO-B1 RWB**	**SV-B2 RWB**	**SV-B2 TRC**	**WC-B1 RWB**	**WC-B1 TRC**
Cultus																	2					
Frisonia picticeps																1						
Isoperla	5												16				6	3	5	3	1	
Oroperla barbara		1														5						
Perlinodes aurea		1																				
Skwala							2												6	2	2	3
Susulus venustus			1									1										
Pteronarcys princeps			2						1				2									
Taeniopterygidae		9					3	4					2			14						
Apatania	2		1		2	2																
Amiocentrus aspilus	4	1	1				1						21		2	2	3					
Micrasema	236	19	8	8					1		2	17	108			16	16	13		2		
Heteroplectron californicum	2		3	1					3	3			1									
Anagapetus			4	2					3	12	3	3	10									
Glossosoma		2											9			8		5				
Helicopsyche																		2				
Arctopsyche grandis															11	8						
Cheumatopsyche																		5				
Hydropsyche	4	2					3	13					9		2	38	6	7	12	7		
Parapsyche			2						1		4	18	5	2								
Agraylea							3	3														
Hydroptila					2														1			
Lepidostoma	70	20	6	1	24	3	72	77	9		5		15	10	23	43	34	90	5	6	5	9
Oecetis																		3				
Limnephilidae							1	1					2								6	
Cryptochia												2									3	
Dolophilodes			5										2			14		2				
Wormaldia				1																		
Yphria californica				2					1													
Polycentropus		3	11	15			2			2	2		1				3	3	10			
Rhyacophila arnaudi																3						
Rhyacophila betteni group	3	5	1	2				2		1	7	5	11	12	2				1	1		
Rhyacophila brunnea group	6				1	3		1			2		10		6	1	3		1			
Rhyacophila grandis group			1						1	3				1								
Rhyacophila hyalinata group													2			7						
Rhyacophila sibirica group			8	7					6	5	9	3	1	11	3						1	
Rhyacophila verrula group						3																
Gumaga		6		6			12	14						1			8					
Farula											3	26										
Neophylax occidentis							4	3					2			2		3				
Oligophlebodes	1							1								51	9					
Cordulegaster dorsalis			1								7	3	1									
Octogomphus specularis	1		4	4																		
Ophiogomphus																		1				
Corydalidae									1													
Dysmicohermes																						
Orohermes crepusculus		1																				
Sialis				3					1								7		1		1	
Oreodytes crassulus																					1	
Oreodytes picturatus																					3	
Ampumixis dispar	3												5									
Cleptelmis addenda															12				31	14	1	1
Heterlimnius			58	39					101	71	102	46	7	45								
Lara	1			5							16	11		3							4	
Narpus				3					4	2	1		1									1
Optioservus	20	72	7														8	80			1	
Ordobrevia nubifera		2																1				
Zaitzevia parvula	11	11																34	14	11		
Zaitzevia posthonia			1	6																		
Hydraena											1			1								
Ametor scabrosus			2																			
Eubrianax edwardsii		10	2																	9		
Anchycteis			3	1					1		1	3										
Elodes			2																			

Final SAFIT ID	AR-B1 RWB	AR-B2 RWB	BU-B1 RWB	BU-B2 RWB	CA-B1 RWB	CA-B1 TRC	EC-B1 RWB	EC-B1 TRC	ES-B1 RWB	ES-B2 RWB	NN-B1 RWB	NN-B2 RWB	OG-B1 RWB	OG-B2 RWB	PY-B1 RWB	SB-B1 RWB	SH-B1 RWB	SO-B1 RWB	SV-B2 RWB	SV-B2 TRC	WC-B1 RWB	WC-B1 TRC
Atherix pachypus															3			10				
Atrichopogon			2						1					1								
Bezzia/Palpomyia		4		3						3		3		8	3	4			4	2	3	1
Probezzia				1																		
Stilobezzia											1											
Microtendipes pedellus group		1																	16			
Microtendipes rydalensis group		2	2				2								1	6		4	4	16		
Polypedilum				6	1	2	3	8	4	1					7			4	6	5		
Robackia																		1				
Cladotanytarsus																1						
Micropsectra	6	1		15	16	5	135		7	16	2	19	3	6	53		9		64	40	5	20
Micropsectra/Tanytarsus								29								1		8				
Paratanytarsus					4	5	1														5	
Rheotanytarsus	2	3					2	4		2					1	5	18			1	2	1
Stempellina				23					21	13	2	3	1									
Stempellinella																					4	
Tanytarsus	4	3	2	4	1	3	1		4	3				3			2	2		28	34	14
Pagastia									3	2												
Potthastia gaedii group																		1				
Potthastia longimana group						1													2	2		
Orthocladiinae												4	7	1			1					
Brillia			5	5			4	1	4	18	6			3		2	1				7	15
Chaetocladius																					2	
Corynoneura	1	3	3	2					2	8				22			1		1		1	
Cricotopus ssp.							2	1		1			1		6				2			
Cricotopus (Nostococladius)	1	1		3													1					
Eukiefferiella brehmi group															3							
Eukiefferiella claripennis group																	1					
Eukiefferiella devonica group					2	7																
Heleniella									1	3		2				2						
Heterotrissocladius																					13	
Krenosmittia										1												
Nanocladius						1				2			1	5					4	6		1
Orthocladius																10		35				
Orthocladius complex							5	2	1				1			2						
O. (Symposiocladius) lignicola															2						1	
Parametriocnemus				3			3	2		12	6	4		14			2					3
Parorthocladius														2								
Psectrocladius		17																				
Rheocricotopus									2	2	2	6		2			2					
Synorthocladius		2	1		2	1			4	1					10							
Thienemanniella			2						2				4									
Tvetenia bavarica group			1	1	9	11	3					7	3	2		4	2	1	2	1		
Boreochlus														3								
Monodiamesa												2										
Tanypodinae														1								
Ablabesmyia		3																				
Brundiniella eumorpha											2	4										
Conchapelopia							4	3													45	
Macropelopia				9						2				1								
Natarsia				2																		
Paramerina																						
Rheopelopia					4	2	7								11				7	4		
Reomyia			6																			
Zavrelimyia				2					6	1							2				4	
Thienemannimyia group				2					5							4	2		7	1		
Dixa	2										4											
Meringodixa chalonensis			2								1	2										
Neoplasta				17	2	1		3	8	8	7	5	6	3	7		4	1	2	3	2	1
Oreogeton			1	3					3			2	2			1						
Wiedemannia								3							1			2		1		
Glutops				2					8	3	2	2	1	5								
Maruina lanceolata	1											1						2				
Pericoma/Telmatoscopus			17					1			6	28				3	2				8	1
Prosimulium																3						
Simulium ssp.					174	247	6	7			2	2			1		3		1	2		
Caloparyphus/Euparyphus		1																				
Antocha						1										1			4	1	1	
Cryptolabis		1																	2			
Dicranota		1							3		2			11		2	1				3	5
Hesperoconopa				2										1							5	3
Hexatoma				3						3				2		1			1	6	1	2
Limnophila				1										3							4	
Molophilus		1																				
Rhabdomastix																					1	
Tipula		1			2	1		1		1	1											
TOTAL	*500*	*500*	*500*	*500*	*500*	*500*	*500*	*500*	*500*	*500*	*500*	*500*	*500*	*500*	*500*	*500*	*500*	*500*	*500*	*500*	*500*	*500*

Appendix B

Estimated Whole-Sample Taxa Lists
2012 Project 184 SWAMP Bioassessment

APPENDIX B. 2012 Project 184 SWAMP Bioassessment Estimated Whole-Sample Taxa Lists

Final SAFIT ID	AR-B1 RWB	AR-B2 RWB	BU-B1 RWB	BU-B2 RWB	CA-B1 RWB	CA-B1 TRC	EC-B1 RWB	EC-B1 TRC	ES-B1 RWB	ES-B2 RWB	NN-B1 RWB	NN-B2 RWB	OG-B1 RWB	OG-B2 RWB	PY-B1 RWB	SB-B1 RWB	SH-B1 RWB	SO-B1 RWB	SV-B2 RWB	SV-B2 TRC	WC-B1 RWB	WC-B1 TRC
Hydra					260	133						7					67					
Turbellaria	11		3	46	180	427		6	25	23	34	22	27	596	15	20	27					
Prostoma																		80				
Pisidum	11	7		34	160	107				34	34	7			5				20	160		
Juga			13	97					20	46	46			89								
Planorbidae										11												
Gyraulus				17									5									
Oligochaeta	160	167	75	63	400	373	507	443	245	480	126	233	181	142	165	180	27	143	650	580	30	21
Utaxatax			3	6					5		11			9								
Aturus														9								
Hydrovolzia											6	15										
Cyclothyas											29	87										
Protzia	34	7	11								6					60		6				
Atractides							13	6				7				20				10		1
Hygrobates							27										13	11				
Estelloxus			8								11	7	16									
Lebertia	57	7	3									7	11		15		27	57	10	10		10
Limnochares														9								
Mideopsis			3	34							6											
Paramideopsis																						
Sperchon	11	13									6	7	11				13	17		20		1
Sperchonopsis		7						6							25		13		20			
Stygothrombium		7								11			5	18				29		10		
Testudacarus				6							11	7	21	27		20	13	6				
Torrenticola	91	7	13	63		27	27	6	40	57	11	7	11	27		100	40	63	240	70		1
Ostracoda			8		100	53			175	171			5									
Ameletus	23	33	5				120	25	20				43	80	125	60	160	29	90	180	10	19
Acentrella insignificans																		17				
Baetis tricaudatus	34	7	3	6	80	373	27	12			29	342	155		45	40		63	190	160	20	3
Cloeodes																	13					
Diphetor hageni			157	143					85	194	269	509	21	80		20	107		100	330	100	14
Attenella delantala																40						
Caudatella hystrix						80		18	5			36	16		40	160						
Drunella doddsi	11	13						6								660						
Drunella grandis	11					53	40	25														1
Drunella pelosa													11			200						
Drunella spinifera															250	160	27					
Ephemerella	274	193	51	143	2280	1920	120	68	85	434			112	196	210	180	120	166	80	50		6
Ephemerella velmae															5							
Cinygma			37	11					105	91	11	22	11	62					10	10		
Cinygmula	183	713	16	6	100	373	560	351	40	423			37	320	45	480	2520	200	20	110	2800	169
Epeorus	286	133					120	18					5		135	720	760	183	290	500		
Ironodes	11	7	128	103			67	117	90	617	354	255	240	507		140	27	11	130	180		
Rhithrogena		107						6							40	1460	373	46			150	10
Tricorythodes		7																				
Paraleptophlebia	46	313	160	320	300	160	387	166	85	331	40	80	11	160	230	300	427	69	950	960	200	120
Capniidae	11	20	16	23					10	206	269	451	43	320		280	320	29			130	43
Eucapnopsis brevicauda	23	7												18		20	67	17			180	14
Chloroperlidae													5									
Kathroperla			3						15	11												
Sweltsa	126	367	123	57	2200	1760	347	142	185	400	46	36		240	50	120	213	34	190	360	1290	126
Leuctridae			8		200	187						7		9	5						90	10
Despaxia augusta									5													
Moselia infuscata			75	297					295	251	23	15	59	44								
Malenka				6							46	15	5	9								
Soyedina			11	109				6		11	57	22	43	18								
Visoka cataractae									30	46				107		20						1
Zapada cinctipes	11	7	27	171	800	1333	1320	794	20	206	474	51	219	27	275	220	240		380	440	130	6
Zapada columbiana													27									
Zapada frigida				6						11				53	10		40					1
Zapada oregonensis group	11	27	16	34	20	27	40	68	15	23	69	29	123	9	115	60	173		110	50	20	1

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Sierraperla cora												15	5									
Yoraperla				80								58	5		240		40		10			
Calineuria																						
Calineuria californica	163	95	59	84			16	12	146	103			76	55	32	103	70	52	10	33		
Doroneuria baumanni								12					5		58	8						
Hesperoperla hoguei			21	51					15	23	88	136	6	27								
Hesperoperla pacifica	12																					
Cultus		7															13					
Frisonia picticeps																20						
Isoperla	34												96			20	67	29	100	50		3
Oroperla barbara		1														52						
Perlinodes aurea		7														22		2				
Skwala							13												50	20	30	4
Susulus venustus			3									7										
Pteronarcys princeps		1	5						13	1			5	1		3						
Taeniopterygidae		47					40	18					16			280	13					
Apatania	11	7	3		20	53								9								
Pedomoecus sierra																			10			
Amiocentrus aspilus	46	60	3				13						117	9	5	60	53					
Micrasema	3703	147	27	69					30		40	196	709	9		320	227	143		10		
Heteroplectron californicum	11		8	23				6	15	69		7	5			20						
Agapetus																	13	6				
Anagapetus			13	6					45	240	23	22	101	9								
Glossosoma		7											64			160		40				
Helicopsyche																		11				
Arctopsyche grandis															70	140						
Cheumatopsyche																		34				
Hydropsyche	80	13					67	135					48		10	1000	133	86	120	90		
Parapsyche			3						5		80	167	32	18								
Agraylea							40	25														
Hydroptila		7			60		13											6	10			
Lepidostoma	949	180	24	6	740	80	1373	542	35	11	23	7	128	116	215	1340	360	606	70	40	110	7
Mystacides																				10		
Oecetis																		6				
Limnephilidae						27	13	6					16									9
Cryptochia												22										3
Dolophilodes			5										11	18		280		6				
Wormaldia				6										9								
Yphria californica				6					10	11												
Polycentropus		73	29	74			53		5	23	6	7	5	9	10		27	11	130	10		3
Rhyacophila arnaudi																21						
Rhyacophila betteni group	34	20	5	29			13	25	5	34	57	44	59	151	5	20			10	20		
Rhyacophila brunnea group	57			6	20	108		12			11		59		30	20	53		20			
Rhyacophila grandis group			3						5	23				9								
Rhyacophila hyalinata group										11			11			140		6				
Rhyacophila sibirica group			21	63		27			45	91	97	36	11	231	10	20	13					1
Rhyacophila verrula group					2	29																
Gumaga		33		29			160	74				7		27			80			10		
Farula											6	262										
Neophylax occidentis	11						40	6					11			20		46				
Oligophlebodes	11							6								1240	80					
Cordulegaster dorsalis			3	3							49	22	5									
Octogomphus specularis	34		8	17									5									
Ophiogomphus																		6				
Corydalidae									5													
Dysmicohermes																						
Orohermes crepusculus	34	9															30		24	1		
Sialis		7	5	23					10						5		160		10			7
Agabinus sculpturellus				6																		
Oreodytes crassulus																						1
Oreodytes picturatus																						3
Ampumixis dispar	23	7											32									

Final SAFIT ID	AR-B1 RWB	AR-B2 RWB	BU-B1 RWB	BU-B2 RWB	CA-B1 RWB	CA-B1 TRC	EC-B1 RWB	EC-B1 TRC	ES-B1 RWB	ES-B2 RWB	NN-B1 RWB	NN-B2 RWB	OG-B1 RWB	OG-B2 RWB	PY-B1 RWB	SB-B1 RWB	SH-B1 RWB	SO-B1 RWB	SV-B2 RWB	SV-B2 TRC	WC-B1 RWB	WC-B1 TRC
Cleptelmis addenda															40		13		420	140	20	1
Heterlimnius			189	291					595	914	651	429	48	596								
Lara	11			46						23	63	58		18	5	20						4
Narpus	11		5	23					25	23	17		11		5						10	
Optioservus	297	613	13														120	526				1
Ordobrevia nubifera	34	7																17				
Zaitzevia parvula	137	87															13	229	130	110		
Zaitzevia posthonia			3	40																		
Hydraena								6			11		5	9								
Ametor scabrosus (adult)			3																			
Eubrianax edwardsii		40	5														13		30	90		
Anchycteis			16	12					10	1	18	24										
Elodes			3									7										
Atherix pachypus															15	20		74				
Atrichopogon			3						5					9				6				
Bezzia/Palpomyia	23	53		11				6		46		15	5	89	20	60			30	70	10	3
Dasyhelea														9								
Probezzia				11																		
Stilobezzia											6	7										
Microtendipes pedellus group		13															13		200	40		
Microtendipes rydalensis group		13	8	6			53	6						9	5	120		17	40	150		
Polypedilum	23			34	40	27	40	55	10	23					40		13	17	70	80		
Robackia																		11				
Cladotanytarsus																20						
Micropsectra	69	7		97	440	240	2067		30	229	40	95	32	80	325		200		740	550	330	9
Micropsectra/Tanytarsus								246								20		57				
Paratanytarsus					120	27	13															9
Rheotanytarsus	46	47		17			13	31	5	11					5	100	227	11		20	10	3
Stempellina			3	154					165	171	29	22	5									
Stempellinella																						6
Tanytarsus	57	20	3	34	40	80	40	6	20	11				18			13	11		270	140	53
Diamesinae																20						
Pagastia									5	23			5				27					
Potthastia gaedii group							13								5			6				
Potthastia longimana group						80													20	10		
Orthocladiinae larva													37				13					
Orthocladiinae pupa												22		9								
Brillia	11		8	46			53	12	35	229	34	7	5	36	10	40	27				140	13
Chaetocladius																						6
Corynoneura	11	7	19	17					15	126			5	196			13	11	10			1
Cricotopus		7				27	53	6		23			5		50		13		20			
Cricotopus (Nostococladius)	11	7		11												40	27					
Eukiefferiella brehmi group											6				20							
Eukiefferiella claripennis group													5				13	6				
Eukiefferiella devonica group					40	133									5							
Gymnometriocnemus									5													
Heleniella			3	6					5	34		22				40						
Heterotrissocladius																						20
Krenosmittia										23												
Limnophyes	11																					
Nanocladius						27				11			5	53					20	30	10	
Orthocladius																220		217				
Orthocladius complex	11						27	6	5				5			80						
O. (Symposiocladius) lignicola									5						10							1
Parachaetocladius												15										
Parametriocnemus				29			27	18	10	194	46	65	5	213			13				30	
Parorthocladius														36								
Psectrocladius		127																				3
Rheocricotopus				17			13		10	23	11	29		36			40				10	
Synorthocladius		13	3		80	27			45	11					40							
Thienemanniella			5						5				27					6				
Tvetenia bavarica group			3	17	280	267	27				11	36	11	9		100	27	6	20	50	10	

Final SAFIT ID	AR-B1 RWB	AR-B2 RWB	BU-B1 RWB	BU-B2 RWB	CA-B1 RWB	CA-B1 TRC	EC-B1 RWB	EC-B1 TRC	ES-B1 RWB	ES-B2 RWB	NN-B1 RWB	NN-B2 RWB	OG-B1 RWB	OG-B2 RWB	PY-B1 RWB	SB-B1 RWB	SH-B1 RWB	SO-B1 RWB	SV-B2 RWB	SV-B2 TRC	WC-B1 RWB	WC-B1 TRC
Boreochlus														36								
Monodiamesa												7										
Tanypodinae														9								
Ablabesmyia		20																				
Brundiniella eumorpha				6							6	29										
Conchapelopia							93	25														67
Larsia										11						20						
Macropelopia				40						11				18								
Natarsia				11																		
Paramerina																						
Rheopelopia					60	27	67	6							50				50	50		
Reomyia			21																			
Zavrelimyia				23				6	15	34							40					6
Thienemannimyia complex	11		5	17					30					9		40	27		60	30	10	
Dixa	23						13				29											
Meringodixa chalonensis			8								11	15										
Neoplasta			11	63	100	27	13	18	55	103	29	29	32	27	50		27	6	40	40	20	3
Oreogeton	11		5	11			13		20			15	5			20						
Wiedemannia	11							18					5		15			11		30		
Glutops				6					30	34	6	7	5	44								
Maruina lanceolata	23								5			15						11				
Pericoma/Telmatoscopus			40	6				6			46	247				40	13				20	9
Prosimulium																40						
Simulium					4400	7707	53	55			17	36			5		53		20	20		
Caloparyphus/Euparyphus		20																				
Tipulidae							13															
Antocha						53		6								60			30	10		1
Cryptolabis		7																	10			
Dicranota	11	7		6					15	23	11		5	53	10	20	27				40	4
Hesperoconopa				6										18		20					20	6
Hexatoma				11				6		47				12		3			20	73	10	4
Limnophila				17										18								4
Molophilus		7																				
Pedicia										1												
Rhabdomastix														9								1
Tipula		8			23	30		6		11	6											
TOTAL	*7,491*	*4,026*	*1,606*	*3,478*	*13,082*	*15,899*	*8,280*	*3,706*	*3,144*	*7,118*	*3,568*	*4,522*	*3,368*	*4,974*	*3,210*	*12,192*	*8,190*	*3,628*	*6,034*	*6,347*	*6,130*	*857*

Appendix C

Site Photographs
2012 Project 184 SWAMP Bioassessment

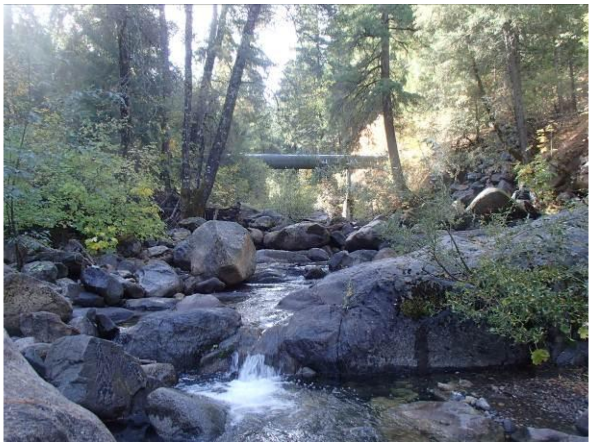

FIGURE AR-B1-1. Looking upstream from the bottom transect (A) at Site AR-B1

FIGURE AR-B1-2. Looking downstream from the bottom transect (A) at Site AR-B1

FIGURE AR-B1-3. Looking upstream from the middle transect (F) at Site AR-B1

FIGURE AR-B1-4. Looking downstream from the middle transect (F) at Site AR-B1

FIGURE AR-B1-5. Looking upstream from the upper transect (K) at Site AR-B1

FIGURE AR-B1-6. Looking downstream from the upper transect (K) at Site AR-B1

FIGURE AR-B2-1. Looking upstream from the bottom transect (A) at Site AR-B2

FIGURE AR-B2-2. Looking downstream from the bottom transect (A) at Site AR-B2

FIGURE AR-B2-3. Looking upstream from the middle transect (F) at Site AR-B2

FIGURE AR-B2-4. Looking downstream from the middle transect (F) at Site AR-B2

FIGURE AR-B2-5. Looking upstream from the upper transect (K) at Site AR-B2

FIGURE AR-B2-6. Looking downstream from the upper transect (K) at Site AR-B2

FIGURE BU-B1-1. Looking upstream from the bottom transect (A) at Site BU-B1

FIGURE BU-B1-2. Looking downstream from the bottom transect (A) at Site BU-B1

FIGURE BU-B1-3. Looking upstream from the middle transect (F) at Site BU-B1

FIGURE BU-B1-4. Looking downstream from the middle transect (F) at Site BU-B1

FIGURE BU-B1-5. Looking upstream from the upper transect (K) at Site BU-B1

FIGURE BU-B1-6. Looking downstream from the upper transect (K) at Site BU-B1

FIGURE BU-B2-1. Looking upstream from the bottom transect (A) at Site BU-B2

FIGURE BU-B2-2. Looking downstream from the bottom transect (A) at Site BU-B2

FIGURE BU-B2-3. Looking upstream from the middle transect (F) at Site BU-B2

FIGURE BU-B2-4. Looking downstream from the middle transect (F) at Site BU-B2

FIGURE BU-B2-5. Looking upstream from the upper transect (K) at Site BU-B2

FIGURE BU-B2-6. Looking downstream from the upper transect (K) at Site BU-B2

FIGURE CA-B1-1. Looking upstream from the bottom transect (A) at Site CA-B1

FIGURE CA-B1-2. Looking downstream from the bottom transect (A) at Site CA-B1

FIGURE CA-B1-3. Looking upstream from the middle transect (F) at Site CA-B1

FIGURE CA-B1-4. Looking downstream from the middle transect (F) at Site CA-B1

FIGURE CA-B1-5. Looking upstream from the upper transect (K) at Site CA-B1

FIGURE CA-B1-6. Looking downstream from the upper transect (K) at Site CA-B1

FIGURE EC-B1-1. Looking upstream from the bottom transect (A) at Site EC-B1

FIGURE EC-B1-2. Looking downstream from the bottom transect (A) at Site EC-B1

FIGURE EC-B1-3. Looking upstream from the middle transect (F) at Site EC-B1

FIGURE EC-B1-4. Looking downstream from the middle transect (F) at Site EC-B1

FIGURE EC-B1-5. Looking upstream from the upper transect (K) at Site EC-B1

FIGURE EC-B1-6. Looking downstream from the upper transect (K) at Site EC-B1

FIGURE ES-B1-1. Looking upstream from the bottom transect (A) at Site ES-B1

FIGURE ES-B1-2. Looking downstream from the bottom transect (A) at Site ES-B1

FIGURE ES-B1-3. Looking upstream from the middle transect (F) at Site ES-B1

FIGURE ES-B1-4. Looking downstream from the middle transect (F) at Site ES-B1

FIGURE ES-B1-5. Looking upstream from the upper transect (K) at Site ES-B1

FIGURE ES-B1-6. Looking downstream from the upper transect (K) at Site ES-B1

FIGURE ES-B2-1. Looking upstream from the bottom transect (A) at Site ES-B2

FIGURE ES-B2-2. Looking downstream from the bottom transect (A) at Site ES-B2

FIGURE ES-B2-3. Looking upstream from the middle transect (F) at Site ES-B2

FIGURE ES-B2-4. Looking downstream from the middle transect (F) at Site ES-B2

FIGURE ES-B2-5. Looking upstream from the upper transect (K) at Site ES-B2

FIGURE ES-B2-6. Looking downstream from the upper transect (K) at Site ES-B2

FIGURE NN-B1-1. Looking upstream from the bottom transect (A) at Site NN-B1

FIGURE NN-B1-2. Looking downstream from the bottom transect (A) at Site NN-B1

FIGURE NN-B1-3. Looking upstream from the middle transect (F) at Site NN-B1

FIGURE NN-B1-4. Looking downstream from the middle transect (F) at Site NN-B1

FIGURE NN-B1-5. Looking upstream from the upper transect (K) at Site NN-B1

FIGURE NN-B1-6. Looking downstream from the upper transect (K) at Site NN-B1

FIGURE NN-B2-1. Looking upstream from the bottom transect (A) at Site NN-B2

FIGURE NN-B2-2. Looking downstream from the bottom transect (A) at Site NN-B2

FIGURE NN-B2-3. Looking upstream from the middle transect (F) at Site NN-B2

FIGURE NN-B2-4. Looking downstream from the middle transect (F) at Site NN-B2

FIGURE NN-B2-5. Looking upstream from the upper transect (K) at Site NN-B2

FIGURE NN-B2-6. Looking downstream from the upper transect (K) at Site NN-B2

FIGURE OG-B1-1. Looking upstream from the bottom transect (A) at Site OG-B1

FIGURE OG-B1-2. Looking downstream from the bottom transect (A) at Site OG-B1

FIGURE OG-B1-3. Looking upstream from the middle transect (F) at Site OG-B1

FIGURE OG-B1-4. Looking downstream from the middle transect (F) at Site OG-B1

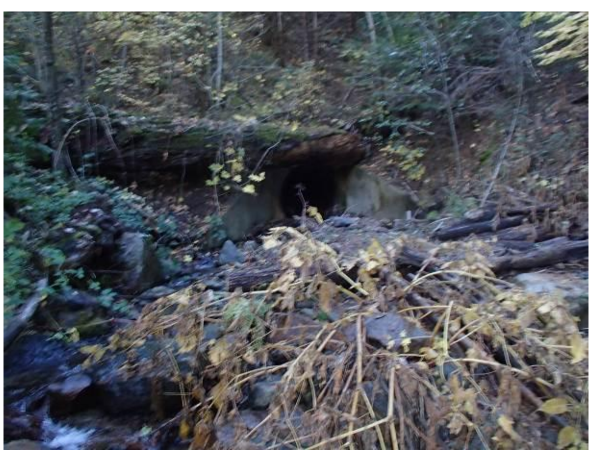

FIGURE OG-B1-5. Looking upstream from the upper transect (K) at Site OG-B1

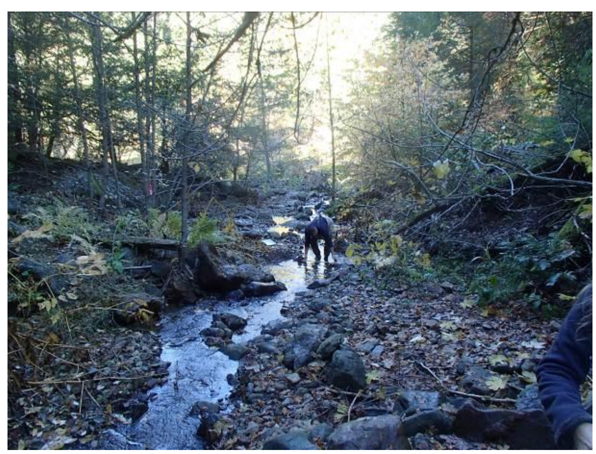

FIGURE OG-B1-6. Looking downstream from the upper transect (K) at Site OG-B1

FIGURE OG-B2-1. Looking upstream from the bottom transect (A) at Site OG-B2

FIGURE OG-B2-2. Looking downstream from the bottom transect (A) at Site OG-B2

FIGURE OG-B2-3. Looking upstream from the middle transect (F) at Site OG-B2

FIGURE OG-B2-4. Looking downstream from the middle transect (F) at Site OG-B2

FIGURE OG-B2-5. Looking upstream from the upper transect (K) at Site OG-B2

FIGURE OG-B2-6. Looking downstream from the upper transect (K) at Site OG-B2

FIGURE PY-B1-1. Looking upstream from the bottom transect (A) at Site PY-B1

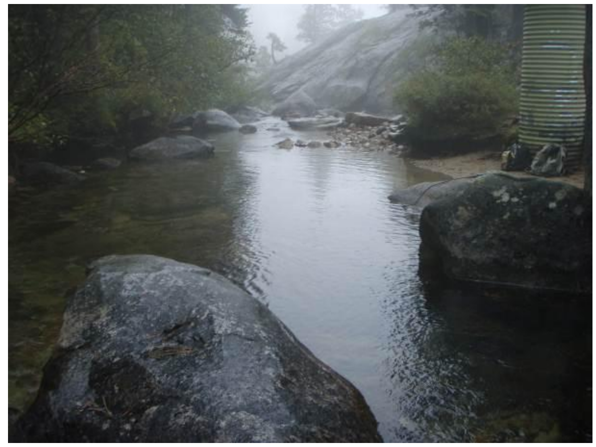

FIGURE PY-B1-2. Looking downstream from the bottom transect (A) at Site PY-B1

FIGURE PY-B1-3. Looking upstream from the middle transect (F) at Site PY-B1

FIGURE PY-B1-4. Looking downstream from the middle transect (F) at Site PY-B1

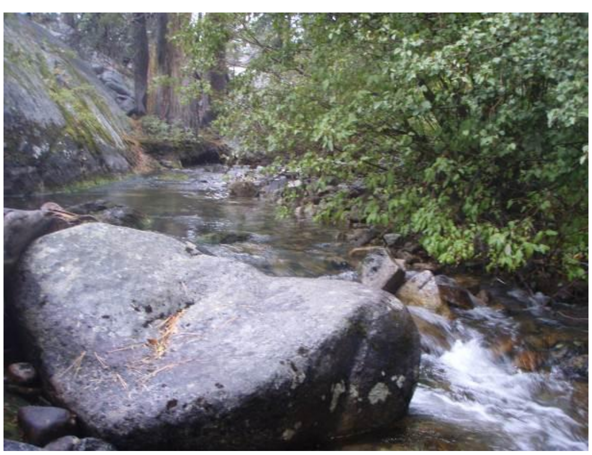

FIGURE PY-B1-5. Looking upstream from the upper transect (K) at Site PY-B1

FIGURE PY-B1-6. Looking downstream from the upper transect (K) at Site PY-B1

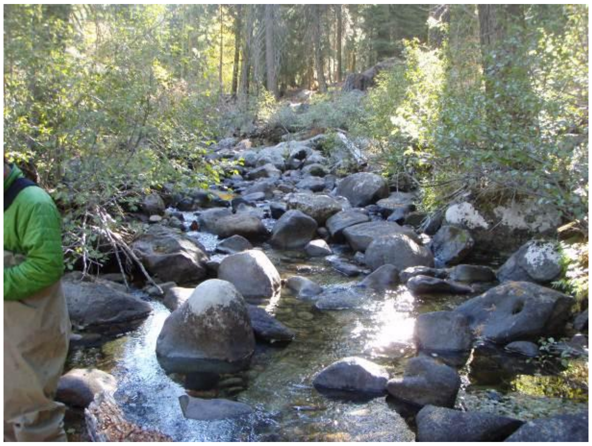

FIGURE SB-B1-1. Looking upstream from the bottom transect (A) at Site SB-B1

FIGURE SB-B1-2. Looking downstream from the bottom transect (A) at Site SB-B1

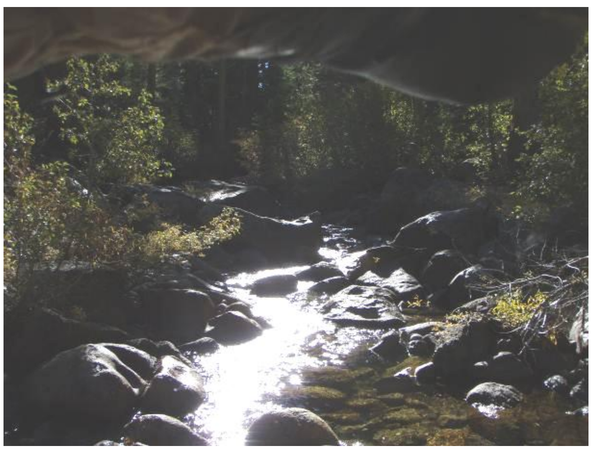

FIGURE SB-B1-3. Looking upstream from the middle transect (F) at Site SB-B1

FIGURE SB-B1-4. Looking downstream from the middle transect (F) at Site SB-B1

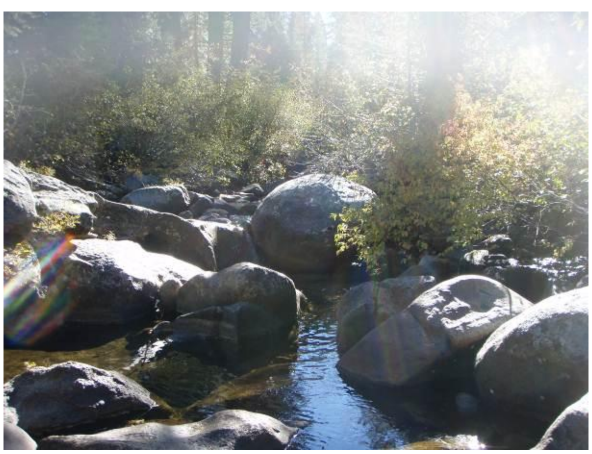

FIGURE SB-B1-5. Looking upstream from the upper transect (K) at Site SB-B1

FIGURE SB-B1-6. Looking downstream from the upper transect (K) at Site SB-B1

FIGURE SH-B1-1. Looking upstream from the bottom transect (A) at Site SH-B1

FIGURE SH-B1-2. Looking downstream from the bottom transect (A) at Site SH-B1

FIGURE SH-B1-3. Looking upstream from the middle transect (F) at Site SH-B1

FIGURE SH-B1-4. Looking downstream from the middle transect (F) at Site SH-B1

FIGURE SH-B1-5. Looking upstream from the upper transect (K) at Site SH-B1

FIGURE SH-B1-6. Looking downstream from the upper transect (K) at Site SH-B1

FIGURE SO-B1-1. Looking upstream from the bottom transect (A) at Site SO-B1

FIGURE SO-B1-2. Looking downstream from the bottom transect (A) at Site SO-B1

FIGURE SO-B1-3. Looking upstream from the middle transect (F) at Site SO-B1

FIGURE SO-B1-4. Looking downstream from the middle transect (F) at Site SO-B1

FIGURE SO-B1-5. Looking upstream from the upper transect (K) at Site SO-B1

FIGURE SO-B1-6. Looking downstream from the upper transect (K) at Site SO-B1

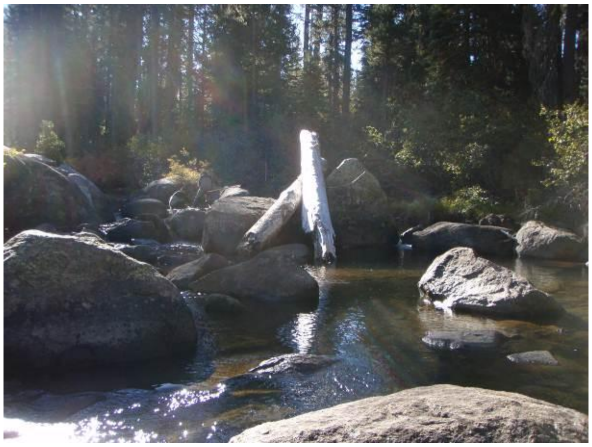

FIGURE SV-B2-1. Looking upstream from the bottom transect (A) at Site SV-B2

FIGURE SV-B2-2. Looking downstream from the bottom transect (A) at Site SV-B2

FIGURE SV-B2-3. Looking upstream from the middle transect (F) at Site SV-B2

FIGURE SV-B2-4. Looking downstream from the middle transect (F) at Site SV-B2

FIGURE SV-B2-5. Looking upstream from the upper transect (K) at Site SV-B2

FIGURE SV-B2-6. Looking downstream from the upper transect (K) at Site SV-B2

FIGURE WC-B1-1. Looking upstream from the bottom transect (A) at Site WC-B1

FIGURE WC-B1-2. Looking downstream from the bottom transect (A) at Site WC-B1

FIGURE WC-B1-3. Looking upstream from the middle transect (F) at Site WC-B1

FIGURE WC-B1-4. Looking downstream from the middle transect (F) at Site WC-B1

FIGURE WC-B1-5. Looking upstream from the upper transect (K) at Site WC-B1

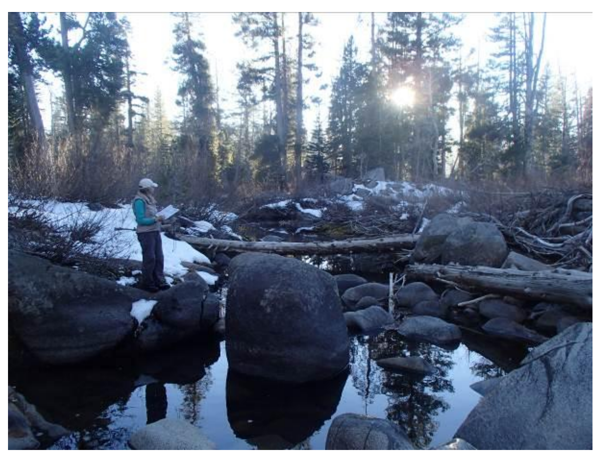

FIGURE WC-B1-6. Looking downstream from the upper transect (K) at Site WC-B1

Appendix D

Copies of Field Datasheets
2012 Project 184 SWAMP Bioassessment