RESULTS OF THE
AQUATIC MONITORING PROGRAM
IN BIG DRY CREEK, 2006

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Prepared for:

Big Dry Creek Watershed Association
c/o City and County of Broomfield,
Cities of Northglenn and Westminster,
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EXECUTIVE SUMMMARY

Results of the biological monitoring program for 2006 are presented in this report with references to previous study results for the 1997-2004 period as appropriate. The monitoring program included studies of physical habitat and fish and benthic macroinvertebrate populations at the eight established study sites in Big Dry Creek with key findings discussed below. In addition, a second collection of fish tissue from selected sites was analyzed for selenium for the Big Dry Creek Watershed Association's (BDCWA) selenium study in support of an ambient-based water quality standard which was recently adopted by the Colorado Water Quality Control Commission (CWQCC).

Beaver activity increased notably in 2006 and was sufficient to alter aquatic habitat at site bdc2.0 in the spring and sites bdc1.0 and bdc1.5 in the fall. At site bdc2.0 in the spring, the entire sampling reach was a long slow-moving pool and run habitat, as water was backed up from near Huron Street to well beyond the upstream boundary of site bdc2.0. In the fall, several beaver dams were present downstream from sites bdc1.0 and bdc1.5 with a log jam also found in middle of site bdc1.5. These dams increased the amount of pool and run habitat at both sites. Some of the riffles sampled for macroinvertebrates were inundated and new riffles had to be located and sampled. Fish sampling could only commence after the dams were breached and water levels were lowered to be workable. A reconnaissance survey of these sites in the fall of 2007 revealed that the breached beaver dams had been reconstructed at both sites bdc1.0 and bdc1.5. At site bdc5.0, extremely low flows were encountered in the fall due to irrigation diversions to the Yoxall Ditch reducing the aquatic habitat to several isolated pools with only trickles of water flowing in between them. Macroinvertebrate samples were collected just downstream of the study reach where irrigation flows re-entered the creek, while fish sampling was limited to only the isolated pools within the reach. The Rapid Bioassessment Protocol (RBP) habitat scores were somewhat lower in 2006 than in 2004 because of the ponding effects of beaver activity downstream from the sampling reaches at sites bdc1.0 and bdc1.5 in the fall. Otherwise, scores for the remaining sites were either the same or changed only slightly in 2006 compared to 2004.

The fish populations of Big Dry Creek continued to be reasonably healthy with numbers and species composition most affected by the extreme flow fluctuations that occur during major storm events and due to irrigation and flow augmentation activities. Localized but minor effects that were previously evident at sites bdc2.0 and bdc3.0 downstream from WWTPs coincided with the drought-affected years (2002-2004); however these effects were short term as populations have recovered in 2006 to pre-drought levels. The fishery has also not shown any detrimental effects due to elevated instream concentrations of selenium.

For the study to date, ten of the fish species collected in Big Dry Creek are native to the South Platte River Basin in Colorado. Eight of these species were collected in 2006 with the number of native species collected varying between eight and ten since 1997. Several non-native fishes were also found but were always represented by fewer species. Of the native species, the longnose dace was the only intolerant species collected. Longnose dace were present at all sites including site bdc2.0 where historically they have either been absent or scarce. As in the past, their abundance in 2006 was again highest at upstream sites bdc0.5 through bdc1.5 and generally less at the downstream sites where cobble substrates are scarce. Longnose dace had been the dominant species at site bdc0.5 in previous years, but they were less abundant in 2004 and 2006 with fathead minnows becoming more abundant at this site. However, at site bdc1.0 longnose dace abundance increased to record high numbers in 2006. Another notable species shift at site bdc1.0 was the dramatic increase in numbers of sand shiners. This species has been relatively abundant at this site for the third consecutive year, whereas prior to 2003 only a few had occasionally been collected. Overall, total fish numbers collected in 2006 were considerably higher than found in 2004 when numbers were at their lowest for the entire study period mainly due to high flows during the several large summer storm events of 2004.

Particularly noteworthy was the apparent recovery of fish populations at sites bdc2.0 and bdc3.0, which were likely affected (low numbers and species) during the 2002 through 2004 period by the drought-related low flows and warmer stream temperatures in 2002. Fish populations may have also been impaired by elevated ammonia releases from Broomfield's WWTP in July and November/December of 2002. The Broomfield WWTP was under construction to add biological nutrient removal capabilities, as prior to January 2005, the facility was not designed for ammonia removal. Fish numbers rebounded in 2006 to historical levels (1997-2001) from the low numbers collected in the drought-affected years (2002-2004) at sites bdc2.0 and bdc3.0. The johnny darter, although no longer listed as a State species of Special Concern, has still not been collected since 2002 when only one individual was found at site bdc1.0. Their distribution in Big Dry Creek is likely restricted by the lack of suitable substrates and excessive turbidity, although their scarcity in 2002, 2003, and 2004 may also be related to the drought and high flows during the large storm events.

Fish Index of Biotic Integrity (IBI) scores were highest at sites bdc1.0, bdc3.0, and bdc5.0, and as usual lowest at site bdc2.0. Annual mean IBI scores were essentially the same at the upstream and downstream sites in 2006 as well as in the pre-drought years (1999-2001), whereas annual mean scores were always higher at the upstream sites during the drought-affected years (2002-2004). Even though shifts in species composition and total abundance occurred at some individual sites, the fish IBI scores showed little variability among sites in 2006 compared to 2004, except at sites bdc2.0 and bdc5.0 where the greatest point increases were noted. Again, comparison of fish IBI and RBP habitat scores showed differing trends at downstream sites bdc3.0, bdc5.0, and bdc6.0 indicating that while habitat scores are valuable for documenting year-to-year changes in physical stream conditions, they do not accurately reflect the overall condition of the fish community. The fish IBI scores should be interpreted with caution as the methodology was originally developed for mesic Midwestern streams, which have greater species richness and numbers than the generally depauperate Great Plains streams.

The incidence of black spot disease in fish, which increased dramatically between 2000 and 2001, has remained high through 2004 and actually increased somewhat in 2006. The disease increase was likely exacerbated by drought conditions during that time frame. Numbers of infected fish and disease severity have historically been higher at the upstream sites than at the downstream sites due to the predominance of susceptible fish species and the relatively higher density of snails, which are an intermediate host for the disease. In 2006, the fish disease rate at downstream site bdc2.0 was the highest since disease monitoring began in 2000 because of the increased abundance of susceptible fathead minnows. Interestingly, although snail densities have been steadily decreasing at all sites since 2002, with a dramatic decrease in snail abundance occurring at site bdc0.5 in 2006, there has not been a corresponding decrease in the incidence of fish disease at any of the sites.

The 2006 whole body fish tissue results indicate selenium concentrations were considerably higher than found in 2004 at sites bdc1.0 though bdc5.0 for both omnivore and the insectivore fish, with higher concentrations in the insectivores. Instream selenium concentrations from 2003 to 2006 showed little change and even decreased slightly in 2006 indicating that the observed increase in fish tissue concentrations was probably not related to the instream selenium concentrations. The substantial increases in fish tissue selenium levels reported in 2006 (vs. the 2004 data) were also not related to laboratory analytical problems. Continued monitoring is needed to enhance the data base to validate fish tissue selenium concentrations.

Macroinvertebrates were sampled by kick net in both the spring and fall. Sampling by artificial substrates was not conducted in 2006. In general, the 2006 data continue to show that the benthic macroinvertebrate community of Big Dry Creek reflects the urban and agricultural characteristics of the watershed, especially the flashy nature of stream flows and predominance of shifting sand and silt substrates. As in past years, mayfly relative abundance was less in the spring than in the fall, with mayflies scarce or absent at some sites downstream from the WWTPs. In the spring 2006, mayflies were more abundant at the sites upstream from the WWTPs than at the downstream sites, and typical of past spring seasons, they were not collected at downstream site bdc2.0. In the fall of 2006 however, mayflies were collected at all sites and their numbers were nearly equal at both the upstream and downstream sites likely due to emergence timing and life history characteristics. Also typical of previous years, the greatest abundance of mayflies occurred at site bdc0.5 in both the spring and fall of 2006 with the species *Baetis tricaudatus* being most abundant in the spring and *Fallceon quilleri* the predominant mayfly in the fall. Caddisflies have never been very abundant, particularly in the spring. Overall, the 2006 macroinvertebrate community was dominated by both dipterans and aquatic worms (oligochaetes) in the spring, while in the fall dipterans became dominant at all sites except site bdc2.0 where oligochaetes (tubificids) were slightly more abundant. Dipterans were comprised mainly of midges (Chironomidae) and, as in the past, the common and moderately tolerant taxon *Cricotopus* sp. was the most abundant species with *Simulium vittatum* (black flies) more abundant than in previous years. Oligochaetes were dominated in the spring by the moderately tolerant taxa *Nais* spp. and in the fall by the more tolerant tubificids. The most abundant amphipod (scuds) was *Hyalella azteca*, which was most abundant in the fall and collected at all sites except site bdc0.5. Snail densities were highest in 2002 and have been generally decreasing since then. Even though snail densities decreased dramatically at site bdc0.5 in 2006, no corresponding decrease in fish disease was evident

The 2006 spring and fall macroinvertebrate densities were different as noted in previous years, with the mean fall densities at upstream vs. downstream sites being 1.4 vs. 4.3 times lower, respectively, than the spring mean densities. The spring to fall density reduction was not as dramatic as noted in 2004 when summer storm events were severe and the scouring effects of the high flows significantly reduced macroinvertebrate numbers. No major changes in community structure were evident in 2006. The effects of inundation caused by beaver activity at sites bdc2.0 in the spring and sites bdc1.0 and 1.5 in the fall on the benthic community at these locations were not discernable.

The Index of Community Integrity (ICI) and Rapid Bioassessment Protocol III (RBP) results again correlated well and generally showed that the communities at the downstream agricultural sites were more impaired and stressed than at the upstream urban sites, with the greatest impacts occurring in spring. The RBP condition categories or levels of impairment should be interpreted with some caution as the reference sites used (bdc1.5 and bdc1.5C) are already somewhat stressed as indicated by their respective ICI scores. Similar to previous years, the macroinvertebrate community was most stressed at site bdc2.0 in the spring, while in the fall the community was most stressed at site bdc6.0. Similar upstream/downstream trends were also indicated for the Hilsenhoff Biotic Index (HBI) and species diversity indices. The HBI values at all sites were typical of previous years with values indicating the macroinvertebrate community in Big Dry Creek is moderately stressed by organic matter, but to a lesser extent than by the habitat limitations (shifting sand and silt substrates and scouring high flows). Species diversity was similar in both spring and fall at the upstream sites, whereas at the downstream sites diversity was considerably less in the spring than in the fall. Overall, the 2006 benthic macroinvertebrate community in Big Dry Creek remained relatively healthy and was typical of Front Range warm water streams which are influenced by the urban and agricultural characteristics of their watersheds.

1.0 INTRODUCTION

This ongoing biological monitoring program was initiated in 1997 for the Big Dry Creek Watershed Association (BDCWA), which was founded in 1997 by the City and County of Broomfield, the Cities of Northglenn and Westminster (the Cities) and the Rocky Flats Environmental Technology Site (RFETS). The purpose of this program is to document changes in the abundance and distribution of fish and benthic macroinvertebrate populations and to monitor physical habitat conditions at established study sites in Big Dry Creek. The results of biological monitoring performed in 2006, with historical comparisons as appropriate, are presented in this report. Results of biological and habitat monitoring efforts conducted from 1997 through 2004 are presented in separate reports (Aquatics Associates, Inc. (AAI) 1998, 1999a, 1999b, 2002, 2005a, 2005b). Objectives of this program have been to establish a biological data base that can be used to support appropriate water quality standards for Segment 1 of Big Dry Creek and to document the effects and extent that changes in water quality and habitat conditions have on the aquatic community.

The scope of this project was somewhat limited during the initial three years of the program because of the Cities' budget considerations. However, since 2000, grant funding provided by DOE allowed for the continuation of the program. Although DOE funding for the 2004 monitoring year was substantially reduced, additional funding from the Woman Creek Reservoir Authority in 2004 and 2006 has helped the BDCWA sustain this program at previous levels. This financial support has helped to ensure the integrity of the program over a longer term to the benefit of the Cities, the Woman Creek Reservoir Authority, and other concerned parties.

Several changes to the monitoring program were made in 2000 based on study findings from previous years. An additional reference site (bdc1.5C) was added to the program in the spring of 2000, at a location immediately upstream from the Broomfield Wastewater Treatment Plant (WWTP). An artificial substrate study using Hester-Dendy samplers was conducted from 2000 through 2004 to separate out the relative impacts of water quality vs. instream habitat influences on the benthic community. Selected Hester-Dendy data were subjected to statistical comparisons with the kick data with no significant differences being found (AAI 2005b). Therefore, the artificial substrate study was discontinued in 2006 with kick sampling being the preferred method for monitoring the macroinvertebrate community.

The State of Colorado, Water Quality Control Commission (CWQCC) is currently evaluating the toxicity of selenium in surface waters statewide for the purpose of establishing appropriate water quality standards. In response to this issue, the Cities began monitoring instream selenium concentrations in Big

Dry Creek and associated effluent discharges in 2003. As reported in the 2003 water quality summary prepared by Wright Water Engineers, Inc. (WWE), the annual average selenium concentrations at all eight of the monitoring stations were slightly greater that the 2003 chronic standard of 4.6 *u*g/L, and except for one site (bdc1.5) were at or slightly below the then proposed State's temporary modification of 7.0 *u*g/L (WWE 2004). The average selenium water concentration at site bdc1.5 was 8.8 *u*g/L for samples collected during the 2003-2006 period for the Big Dry Creek selenium study (WWE 2007). Because of the high bioconcentration/bioaccumulation potential for selenium, the Cities provided funding for AAI to conduct a preliminary screening of the existing whole body burdens of selenium in selected omnivore and insectivore fishes from Big Dry Creek in the fall of 2004 with a second collection and analyses event occurring in 2006. Results and comparisons of the 2004 and 2006 fish tissue analyses are presented in this report. In December 2007, a seasonal ambient-based selenium water quality standard was formally adopted by the CWQCC, based on the results of the Big Dry Creek selenium study conducted by WWE (2006, 2007). During the irrigation season (April through October), ambient standards are 7.4 *u*g/L chronic (dissolved) and TVS *u*g/L acute (dissolved). For the non-irrigation season, the ambient-based standards are 15 *u*g/L chronic (dissolved) and 19.1 *u*g/L acute (dissolved) (CWQCC 2007). Both fish population and selenium tissue data collected for the monitoring program were used in support of the recently adopted ambient-based selenium water quality standards.

Recent precipitation patterns have likely returned stream flows to more normal conditions as stream flows were less affected by large summer storm events in 2006 than they were in 2004. Likewise in 2006, stream flows were comparatively lower than in 2004 due to the greater utilization of Westminster's and Broomfield's water re-use programs, which generally are in effect from April through November. The temporary releases to the creek from Northglenn's Bull Reservoir that occurred between November 2002 and February 2003 have not occurred since then, as these releases were only necessary to satisfy water augmentation obligations because of the 2002 drought. Lately, Northglenn has been satisfying their flow augmentation requirements with increased releases from Standley Lake.

Beaver activity was evident at three of the study sites in 2006 but was not noted in any of the previous sampling years. Site bdc2.0 was totally inundated in the spring by beaver dams constructed downstream, while in the fall beaver dams had partially inundated sites bdc1.0 and bdc1.5, and in all cases considerably more pool habitat was created. Although no biological sampling was conducted in 2007 which is an "off" monitoring year, a brief reconnaissance survey was performed in October 2007 to observe general habitat changes because of the significant beaver activity observed in 2006.

The project study area in Big Dry Creek extends from approximately 1.5 miles downstream from the Standley Lake dam to Wattenberg, which is 3.8 miles upstream from the confluence with the South Platte River. The total length of the study area is approximately 22.7 miles. The project study area and locations of study sites and WWTPs are depicted in Figure 1. Locations of the eight study sites on Big Dry Creek with distances between the sites and cumulative distances downstream (from Standley Lake dam to the lowest site) are provided in Table 1. Four of the Big Dry Creek sites are located upstream from the WWTPs, while the remaining four sites are located downstream. Sampling frequency and the types of samples collected are presented in Table 2 for the 2006 monitoring period. The spring and fall sampling events occurred in March and October, respectively.

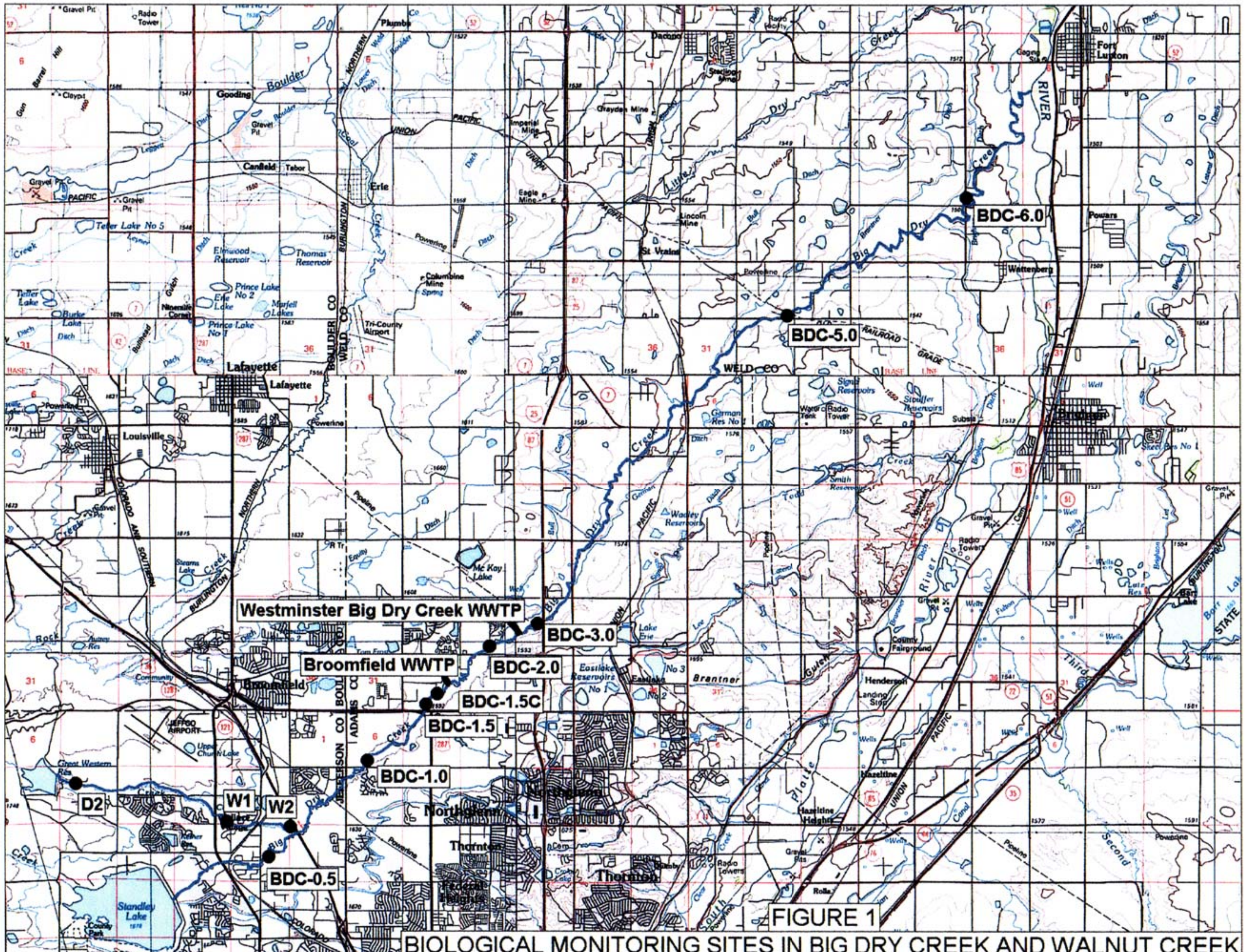

FIGURE 1
BIOLOGICAL MONITORING SITES IN BIG DRY CREEK AND WALNUT CREEK

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TABLE 1

BIOLOGICAL MONITORING SITES
IN BIG DRY CREEK, 1997-2006

Study Site	Location	Distance Between Sites	Cumulative Distance
BIG DRY CREEK			
UPSTREAM FROM TREATMENT PLANTS		*Distance from Standley Lake dam*	
bdc0.5	Church Ranch Open Space, downstream from Old Wadsworth Boulevard	1.5 mi.	1.5 mi.
bdc1.0	Downstream from 112th Avenue	2.8 mi.	4.3 mi.
bdc1.5	Downstream from 120th Avenue	1.5 mi.	5.8 mi.
bdc1.5C	Immediately upstream from Broomfield WWTP 2/	0.4 mi.	6.2 mi.
DOWNSTREAM FROM TREATMENT PLANTS			
bdc2.0	Upstream from 128th Avenue, downstream from Broomfield WWTP	1.5 mi.	7.7 mi.
bdc3.0	At Interstate-25, downstream from Westminster Big Dry Creek WWTP	1.0 mi.	8.7 mi.
bdc5.0	Downstream from Weld County Road 4	8.2 mi.	16.9 mi.
bdc6.0	Near Wattenberg and Weld County Road 23, Upstream from bridge on Weld County Road 8	5.8 mi.	22.7 mi.

1/ Walnut Creek sites were sampled from 2000 to 2003, with sampling discontinued in 2004.
2/ Site bdc1.5C was added to program in spring 2000.

TABLE 2

SAMPLING DATES AND TYPES OF SAMPLES COLLECTED AT BIG DRY CREEK MONITORING SITES, 2006 1/

Study Site	2006 spring	2006 fall
BIG DRY CREEK		
Upstream from WWTPs		
bdc0.5	*M*	*F, M, H*
bdc1.0	*M*	*F, M, H*
bdc1.5	*M*	*F, M, H*
bdc1.5C 2/	*M*	*F, M, H*
Downstream from WWTPs		
bdc2.0	*M*	*F, M H*
bdc3.0	*M*	*F,M, H*
bdc5.0	*M*	*F, M, H*
bdc6.0	*M*	*F, M, H*

1/ Fish, macroinvertebrate, and habitat sampling are denoted by *F*, *M*, and *H*, respectively.
2/ Site bdc1.5C (immediately upstream from Broomfield WWTP) was added to program in spring 2000.

2.0 METHODS

2.1 PHYSICAL HABITAT

Physical habitat characteristics were measured rigorously in the fall of 2000 during the low flow period to establish baseline conditions. Physical data were collected within the same stream reaches sampled for the fish population surveys. The assessment of habitat characteristics was performed primarily to provide supplemental data for distinguishing between habitat and water quality effects on fish and macroinvertebrate communities inhabiting the various study sites. Subsequent habitat evaluations have been conducted each year concurrent with the biological sampling and consisted of visual observations with measurements being made only when obvious changes were observed such as increased bank erosion and collapse, sediment deposition and movement within the channel due to flow changes and fluctuations which are often significant in this system, and/or changes in the relative amounts of pool (vs. run and riffle) habitat resulting from fallen trees and beaver activity.

Physical parameters were evaluated according to the most recent methods outlined for the Rapid Bioassessment Protocol (RBP) habitat assessment for low gradient streams. This analysis allows for determining habitat differences between sites and documenting yearly changes at individual sites (Barbour et al. 1999). The RBP analysis incorporates ten habitat parameters including available cover, pool substrate characterization, pool variability, sediment deposition, channel flow status, channel alteration, sinuosity, bank stability (erosion), bank vegetation protection, and riparian vegetation zone width. These habitat variables were measured in the field, and each parameter was rated as *optimal*, *suboptimal*, *marginal*, or *poor* based the data collected and scoring ranges designated for the RBP habitat assessment (Barbour et al. 1999). A total habitat assessment score was then calculated for each site by adding the ten habitat parameter scores. Habitat assessment scores may potentially range between 0 and 200, with higher scores generally indicating better habitat quality. The RBP habitat assessment scores were calculated primarily to document observed habitat changes and trends at individual sites from year to year and over time.

The presence and abundance of most fish and benthic macroinvertebrate species inhabiting a given stream reach are in part influenced by substrate composition and the relative amounts of macro-habitat (riffle, run, pool) available. Consequently, substrate composition and macro-habitat were also measured at study sites to supplement the RBP habitat analysis. Substrate particle size distribution was quantitatively measured at each site using the Wolman pebble count technique (Wolman 1954) in previous years (2000 and 2004), although this effort was not necessary in 2006 as substrate composition changes at study sites remained relatively constant. Photographs of study sites were taken to document habitat conditions, and general habitat descriptions and observed changes were also recorded on all sampling occasions.

2.2 FISH POPULATIONS

2.2.1 Sampling and Analysis

Fish populations were sampled at all study locations in the fall, with assistance by the Cities. Sampling methods were consistent with previous years. Shoreline or backpack electroshocking equipment with one negative and three to five positive electrodes were used, depending on stream width and water volume at each station. Fish were collected at all sites using two-pass removal techniques. Fish were collected in two consecutive passes with fish from each pass kept separate for processing. All fish captured were identified, counted, measured, and released to the stream, except for fish specimens that were kept for selenium analysis. For each species, lengths and weights were measured for all individuals collected. When a large number of a single species was collected, specimens were counted and weighed collectively after a representative sample of individual fish was measured. Individuals were visually examined and the incidence of disease was recorded. In addition, the level of disease severity was also rated on a scale of 0 to 3, with ratings of 0, 1, 2, or 3 denoting either no, slight, moderate, or heavy disease levels recorded for individuals examined.

Fish sampling was performed in the same reaches sampled on previous occasions. Sampling areas were representative of the stream reach and were of sufficient length to include all macro-habitats (riffle, run, pool) present. In most cases, natural physical barriers (very shallow depths over the riffle) prevented fish from moving into or out of the study reach. Study sites boundaries were permanently marked with rebar. The length of study areas ranged from approximately 85 to 168 meters (280 to 550 feet) at Big Dry Creek sites. Stream widths were measured at either 9 or 15-meter intervals throughout each study section depending on stream size. Average stream widths ranged from approximately 2 to 7 meters (7 to 22 feet) at Big Dry Creek sites. Average stream width and total station length were used to calculate the area sampled. General site characteristics encountered at the time of sampling were recorded.

A list of fish species collected including mean lengths and weights, relative abundance, and percent disease were calculated for all study sites. The Index of Biotic Integrity (IBI) was also calculated for the population at each site based on the methods outlined in Karr (1981), Karr et al. (1986), and the EPA Rapid Bioassessment Protocols (Barbour et al. 1999, Plafkin et al. 1989). The EPA has developed different sets of metrics that are specific for the various regions of North America based on the original

IBI developed by Karr (1981), which provide a consistent assessment methodology for analyzing fish assemblage data. Metrics developed specifically for Colorado Front Range streams were used to assess fish data collected from Big Dry Creek. The eleven metrics incorporated in IBI analysis include: 1) total number of native species, 2) number of darter species, 3) number of sunfish species, 4) number of minnow species, 5) number of intolerant species, 6) percent white suckers, 7) percent omnivores, 8) percent specialized insectivores, 9) total number of individuals collected, 10) percent introduced species, and 11) percent diseased individuals. Each metric value was calculated and scored based on the data collected. Metric values approximating, deviating slightly from, or deviating greatly from values for reference sites are scored as 5, 3, or 1, respectively. Species tolerance and trophic designations used in the IBI analysis are defined in Barbour et al. (1999). Site-specific fish abundance data for the 1997-2004 sampling period were used to determine scoring ranges for the total number of individuals metric. The final IBI scores calculated for each site are the sum of the eleven individual metric scores. Final IBI scores may range from 11 to 55, with higher scores indicating better community condition. Integrity categories and their corresponding numerical ranges were determined by modifying the numerical ranges provided in Karr (1981) and Plafkin et al. (1989). IBI score ranges and corresponding condition categories for the Big Dry Creek fish data are: *excellent* (53-55), *good* (44-52), *fair* (37-43), *poor* (29-36), and *very poor* (11-28) as calculated per EPA RBP guidance documents (Barbour et al. 1999, Plafkin et al. 1989).

It is important to note that the fish IBI as originally developed by Karr (1981) was for assessing degradation in mesic midwestern streams that are relatively rich in fish fauna, and furthermore, recent literature by Bramblett and Fausch (1991) cautions against a strict interpretation of fish IBI scores and respective condition categories when assessing western Great Plains streams, which comparatively are depauperate in fish fauna. Thus, because of these limitations, which represent the most recent research on the applicability of the IBI to western Great Plains streams, the Big Dry Creek fish IBI scores (rather than the condition categories) will be used as a point of reference for monitoring changes in the fish community at and among the study sites over time.

2.2.2 Selenium Monitoring

In 2006, fathead minnows (*Pimephales promelas*) and longnose dace (*Rhinichthys cataractae)* representing omnivores and insectivores, respectively, were collected for fish tissue selenium analysis as in 2004. Fish were collected from the following seven sites: bdc0.5, bdc1.0, bdc1.5, bdc1.5C, bdc2.0, bdc3.0, and bdc6.0. Minor changes from 2004 included adding site bdc1.5 in 2006 and excluding site bdc5.0 per the Cities request based on available funding. These species were collected in sufficient numbers to make a 15-20 specimen composite for each feeding group at each sampling site. Specimens selected were between 50 and 100 mm in length to provide uniformity in length/age (time of exposure) among sites, as well as provide a basis for comparison to the 2004 study. Fish specimens were handled using sterile surgical gloves to prevent cross contamination between species and among the different sites. The fish were placed in *Ziplock* freezer bags, double bagged, labeled, and placed on ice. After each sampling day, the fish samples were placed in a freezer until shipment to ACZ Laboratories, Inc. in Steamboat Springs, CO. Samples were delivered to the lab in coolers containing dry ice with full chain-of-custody procedures being followed. In the laboratory, each individual sample was thawed and blended using a laboratory grade blender. A sufficient sample aliquot was taken from each blended composite and weighed before acid extraction. Sample extracts were analyzed by ICP-MS, EPA method M6020. Results were expressed in *u*g/g (ppm) as wet weight. In order to compare the wet weight values with literature values that are usually expressed as dry weight, a conversion factor was applied to the reported values. Most fish tissue contains between 18.7% and 23.3 % dry matter (Brinkman 2004); consequently, an approximate mid-range value of 20% dry matter was chosen for conversion to dry weight, which provides the factor of 5X (1.0/0.20 = 5). Selenium results are presented in the Section 3.2.3 of this report.

2.3 MACROINVERTEBRATES

Macroinvertebrate sampling was performed in the spring before the irrigation season and in the fall. Sampling was performed according to methods outlined by Klemm et al. (1990) and the Colorado Water Quality Forum (1995). Benthic macroinvertebrates were collected from representative aquatic habitats (riffle, run, pool, and bank) found at each site using a kick net with a mesh size of 425 microns (*um)*. Kick net samples were collected from approximately one-square meter areas from representative habitats and were combined into one composite sample for analysis. The material collected from each sample was carefully placed into labeled sample containers and preserved with 10% formalin in the field. Samples were transported to the laboratory for analysis.

Identification of macroinvertebrates and laboratory techniques were performed according to the methods outlined in Klemm et al. (1990). In the laboratory, samples were thoroughly rinsed of excess preservative and debris in a 500 *u*m sieve before being placed in a white tray for processing. All macroinvertebrates were removed from the debris with forceps and placed in labeled vials filled with 80% ethanol. Macroinvertebrates were identified to the lowest taxonomic level possible with the aid of both binocular dissecting and compound microscopes using appropriate taxonomic literature (Aquatics Associates 1999b). Any new taxa encountered in the 2006 collections were added to the project macroinvertebrate reference collection, which contains representative specimens of each taxon in vials of 80% ethanol or on permanent slide mounts with Euparal or PVA (polyvinyl alcohol) when necessary.

Following identification and enumeration, a species list including the number of organisms collected, total density (organisms per square meter), total number of taxa, relative abundance, and diversity were calculated for each sample. Other community parameters were also calculated according to methods outlined for the Rapid Bioassessment Protocol III (RBP) analysis (Barbour et al. 1999, Plafkin et al. 1989). The RBP analysis incorporates several benthic community metrics and provides a standardized method for evaluating spatial, seasonal, and annual differences. The eight metrics calculated and incorporated in the RBP analysis include taxa richness, the modified Hilsenhoff Biotic Index (HBI), percent dominant taxon, the EPT Index (number of Ephemeroptera, Plecoptera, and Trichoptera taxa), ratio of EPT to Chironomidae abundances, ratio of scrapers to filtering collector feeding groups, ratio of the shredder feeding group to the total number of individuals collected, and the Community Loss Index. Tolerance values used in the HBI incorporate values presented by Barbour et al. (1999), with other references occasionally used as needed (MDEQ 1996, Bode 1988, and Winget and Mangum 1979). The HBI measures macroinvertebrate community responses to organic pollution. HBI values may range from 0 to 10, with higher values (generally >6) indicating higher degrees of organic pollution. Final RBP scores were calculated for each site based on the eight individual metrics, with the resulting scores compared to the upstream reference sites and expressed as a percent. RBP score ranges and corresponding condition categories are: *nonimpaired* (>83%), *slightly impaired* (54-79%), *moderately impaired* (21-50%), and *severely impaired* (<17%) (Plafkin et al. 1989).

Previously, three different RBP comparisons were calculated using upstream sites bdc0.5, bdc1.5 and bdc1.5C as reference sites to assess benthic community condition at sites downstream from WWTPs. However in 2004 and 2006, only sites bdc1.5 and 1.5C were used for RBP reference comparisons because habitat conditions at these sites is more representative and similar to the sites downstream from the WWTPs.

The Invertebrate Community Index (ICI) was also included in the evaluation of macroinvertebrate data to provide an additional objective measure of biological condition at Big Dry Creek study sites. The ICI values were calculated according to methods outlined by DeShon (1995), which provide the detailed methodology used by the Ohio EPA for assessing the biological condition of streams in Ohio and the surrounding region. The Ohio EPA approach for calculating ICI community ratings was appropriate for this project since general environmental conditions in Big Dry Creek were sufficiently similar to those of the streams in Ohio and the Midwest (meandering, slow moving, and generally turbid streams with predominantly silty, muddy substrates). The ICI analysis involves scoring ten different metrics with the sum of these metrics providing the final index score. The metrics used include: 1) total number of taxa, 2) number of mayfly taxa, 3) number of caddisfly taxa, 4) number of dipteran taxa, 5) percent mayflies, 6) percent caddisflies, 7) percent of tribe Tanytarsini midges, 8) percent other dipteran and non-insects, 9) percent tolerant organisms, and 10) number of qualitative ET (Ephemeroptera and Trichoptera) taxa. Each of these metrics is given a score of 6, 4, 2, or 0 depending on the value derived from macroinvertebrate data for each station. For tolerant species designations, any species with an HBI rating of 8 or higher was considered tolerant. Individual metric scores were determined by comparing derived values with species area plots for the reference data versus drainage area. A score of 6 for a given metric indicates the metric value is within the range exhibited by very good or exceptional aquatic communities, a score of 4 indicates that the value is characteristic of more typical or good communities, a score of 2 indicates the value is moderately deviating from the expected range of good to exceptional values, and a score of 0 indicates the value is strongly deviating from expected good or exceptional values. Final ICI scores were calculated for each site, and may range from 0 to 60. Corresponding benthic community condition ratings developed for the ICI are: *exceptional* (46-60), *good* (36-45), *fair* (13-35), and *poor* (0-12) (DeShon 1995).

3.0 RESULTS

3.1 PHYSICAL HABITAT

Physical habitat assessment results for Big Dry Creek are summarized in Table 3 for 2006 with total RBP habitat assessment scores for the previous five years also presented for comparison. A comparison of RBP habitat assessment scores for 2006 versus (vs.) the mean score for 2000-2004 is graphically presented in Figure 2. Physical habitat characteristics of the Big Dry Creek sites have been described in detail in previous reports (AAI 1999a, 1999b, 2002, 2005a, 2005b). Consequently, this report will focus on changes observed at the eight sites during the 2006 physical habitat assessment. Photographs of habitat conditions observed are presented in Appendix A.

RBP habitat assessment scores for 2006 ranged from 113 to 129 for the upstream sites, and from 74 to 108 for the downstream sites (of a possible maximum score 200) (Table 3). Scores were always lower at downstream sites bdc3.0, bdc5.0, and bdc6.0 in the channelized section of Big Dry Creek (74 to 88), and at site bdc2.0 but to a lesser extent, indicating a gradual downstream decrease in habitat quality as reported in previous years (Figure 2).

Compared to 2004, the 2006 habitat scores at individual sites were 9 and 13 points lower (worse) at sites bdc1.0 and bdc1.5, respectively, due to habitat changes caused by beaver dams that were constructed downstream from these sites. The score was also 4 points lower at site bdc5.0 because of extreme flow fluctuations with very low flows encountered on the fish sampling event in early October 2006. Otherwise scores were either the same or only 1-2 points different at the other sites (Table 3, Figure 2). Habitat changes were found at sites bdc1.0, bdc1.5, bdc2.0, and bdc5.0 and are discussed below.

Beaver activity was notable in 2006 while no significant activity was observed in previous monitoring years. The beaver dams that were created were sufficient to alter aquatic habitat at site bdc2.0 in the spring and at sites bdc1.0 and bdc1.5 in the fall. At site bdc2.0 in the spring, the entire sampling reach was a long, slow moving pool with no riffle habitat within the historical sampling reach (Appendix A). Beavers had dammed the creek in the area upstream from Huron Street, backing water upstream for a considerable distance extending beyond the upstream boundary of site bdc2.0. By the fall, the dams at site bdc2.0 had apparently been naturally breached (not man-caused) and site conditions had returned to normal (i.e., lotic conditions). The jam of fallen trees that obstructed the channel near the downstream site boundary in the spring was also washed downstream by the time of the fall sampling event.

TABLE 3

SUMMARY OF RAPID BIOASSESSMENT PROTOCOL (RBP) HABITAT ASSESSMENT SCORES
FOR BIG DRY CREEK SITES UPSTREAM AND DOWNSTREAM FROM WWTPs, FALL 2006 VS. 2000-2004

UPSTREAM FROM TREATMENT PLANTS

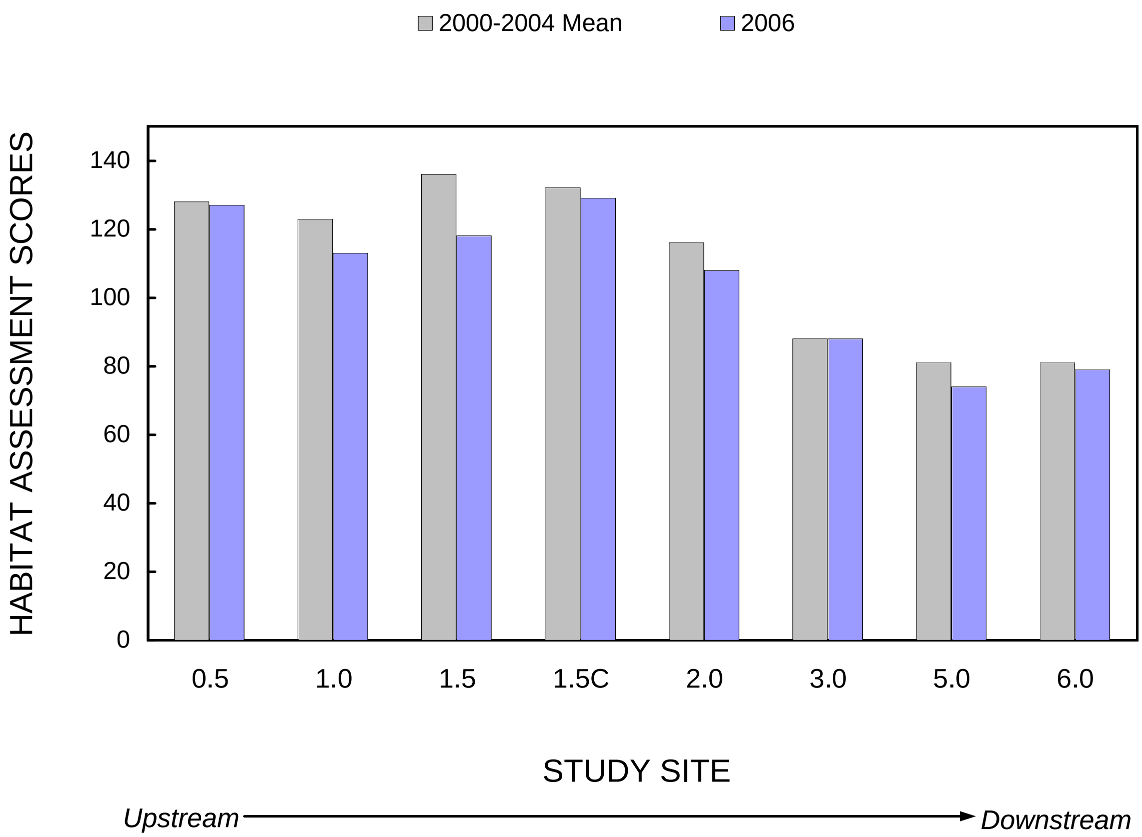
Habitat Parameter		BDC-0.5 Score	BDC-0.5 Condition Category	BDC-1.0 Score	BDC-1.0 Condition Category	BDC-1.5 Score	BDC-1.5 Condition Category	BDC-1.5C Score	BDC-1.5C Condition Category
Bottom Substrate/ Available Cover		13	Suboptimal	8	Marginal	13	Suboptimal	10	Marginal
Pool Substrate Characterization		16	Optimal	13	Suboptimal	14	Suboptimal	12	Suboptimal
Pool Variability		8	Marginal	11	Suboptimal	11	Suboptimal	7	Marginal
Sediment Deposition		9	Marginal	4	Poor	10	Marginal	8	Marginal
Channel Flow Status		10	Marginal	15	Suboptimal	15	Suboptimal	14	Suboptimal
Channel Alteration		19	Optimal	5	Poor	4	Poor	19	Optimal
Channel Sinuosity		9	Marginal	14	Suboptimal	14	Suboptimal	14	Suboptimal
Bank Stability		6	L-Suboptimal	6	L-Suboptimal	4	L-Marginal	4	L-Marginal
		6	R-Suboptimal	5	R-Marginal	1	R-Poor	7	R-Suboptimal
Bank Vegetative Protection		7	L-Suboptimal	9	L-Optimal	9	L-Optimal	7	L-Suboptimal
		8	R-Suboptimal	9	R-Optimal	6	R-Suboptimal	9	R-Optimal
Riparian Vegetation Zone Width		8	L-Suboptimal	8	L-Suboptimal	9	L-Optimal	9	L-Optimal
		8	R-Suboptimal	6	R-Suboptimal	8	R-Suboptimal	9	R-Optimal
Total Score	2006	127		113		118		129	
	2004	127		122		131		128	
	2003	127		121		135		131	
	2002	128		121		137		131	
	2001	128		125		138		135	
	2000	131		127		140		135	

DOWNSTREAM FROM TREATMENT PLANTS

Habitat Parameter		BDC-2.0 Score	BDC-2.0 Condition Category	BDC-3.0 Score	BDC-3.0 Condition Category	BDC-5.0 Score	BDC-5.0 Condition Category	BDC-6.0 Score	BDC-6.0 Condition Category
Bottom Substrate/ Available Cover		8	Marginal	9	Marginal	8	Marginal	7	Marginal
Pool Substrate Characterization		12	Suboptimal	11	Suboptimal	9	Marginal	6	Marginal
Pool Variability		8	Marginal	8	Marginal	4	Poor	1	Poor
Sediment Deposition		5	Poor	5	Poor	6	Marginal	4	Poor
Channel Flow Status		12	Suboptimal	16	Optimal	10	Marginal	17	Optimal
Channel Alteration		16	Optimal	2	Poor	2	Poor	2	Poor
Channel Sinuosity		8	Marginal	7	Marginal	7	Marginal	7	Marginal
Bank Stability		4	L-Marginal	3	L-Marginal	1	L-Poor	7	L-Suboptimal
		3	R-Marginal	3	R-Marginal	1	R-Poor	4	R-Marginal
Bank Vegetative Protection		8	L-Suboptimal	8	L-Suboptimal	9	L-Optimal	8	L-Suboptimal
		8	R-Suboptimal	8	R-Suboptimal	9	R-Optimal	8	R-Suboptimal
Riparian Vegetation Zone Width		8	L-Suboptimal	4	L-Marginal	4	L-Marginal	4	L-Marginal
		8	R-Suboptimal	4	R-Marginal	4	R-Marginal	4	R-Marginal
Total Score	2006	108		88		74		79	
	2004	110		86		78		79	
	2003	113		86		79		79	
	2002	118		87		78		80	
	2001	115		87		82		81	
	2000	123		96		86		84	

FIGURE 2

COMPARISON OF RAPID BIOASSESSMENT PROTOCOL (RBP)
HABITAT ASSESSMENT SCORES FOR BIG DRY CREEK SITES, 2000-2004 MEAN VS. 2006



At site bdc1.5 in the fall, three beaver dams were situated more than 200 feet downstream from the study site, which caused water to be backed up into most of the sampling reach. A significant log jam created by a fallen tree was also found in the middle of the reach which had to be removed to allow for fish sampling. Several beaver dams were also encountered downstream from site bdc1.0 in the fall that resulted in water being backed up throughout the entire reach. In both cases, the beaver dams increased the amount of pool and run habitat at these sites and inundated some of the historical riffle habitats sampled for macroinvertebrates with new riffles having to being located and sampled. Electrofishing activities could only commence after the beaver dams were breached (by field crew) to lower water levels for fish sampling. Regardless, the turbid conditions and poor visibility that persisted at site bdc1.5 after removing the dams resulted in reduced sampling efficiency during the 2006 fish sampling event, whereas poor visibility was not an issue at site bdc1.0.

At site bdc5.0, flows were reduced to a trickle as nearly all of the creek flow was diverted to the Yoxall Ditch for irrigation at the time of fish sampling on October 3, 2006. Aquatic habitat was reduced to several isolated pools with only trickles of water flowing between the pools. Macroinvertebrate samples were collected downstream of the reach boundary below where irrigation return flows re-entered the creek, while fish sampling was limited to the isolated pools that remained. By October 11, 2006 (8 days later), flows had returned to the low flow conditions typically observed in fall, illustrating the extreme flow fluctuations that periodically occur at this site. It was also apparent that flows occurring sometime prior to the spring 2006 macroinvertebrate sampling event (i.e., between fall 2004 and spring 2006 events) were sufficiently high to cause major erosion of banks, movement of sediment, and wash out (loss) of trees in the downstream portion of the study reach.

No biological sampling was conducted in 2007 which is an “off” year; however, considering the beaver-related habitat changes documented during the 2006 sampling season, all sites were briefly revisited by AAI on October 19, 2007, to observe current habitat conditions. Major beaver activity was again noted at sites bdc1.0 and bdc1.5, where water was backed up beyond the upstream boundary of these sites inundating the entire study reach (Appendix A). The beaver dams are now well established indicating that beavers have undoubtedly been present in these areas since sometime during the summer of 2006. At site bdc1.0, there is currently a major dam (~5’ height above the normal water elevation) situated in the downstream portion of the study reach so that the creek is now ponded and the riparian zone is completely flooded. While no dams have been constructed within the study reach itself at site bdc1.5, two beaver dams (4-5’ height) are located downstream from the site boundary that have impounded the creek well beyond the study reach boundaries. Consequently, only lentic (i.e., ponded) aquatic habitat is now present at site bdc1.5.

3.2 FISH

Fish monitoring in Big Dry Creek in 2006 included the fall population survey and collection of fish specimens for selenium tissue analyses at selected sites. Survey results including percent abundance, the total number and species of fish collected, and the Index of Biotic Integrity (IBI) scores at sites in Big Dry Creek are presented in Table 4 for 2006. Percent relative abundance of numerically dominant and important native fish species collected in 2002 through 2006 is presented in Figure 3. Comparisons of the total number and species of fish collected in 2006 vs. previous years (1999-2001 mean, 2002, 2003, and 2004) are depicted in Figure 4. Fish IBI scores for 2006 with comparisons to previous years and the RBP habitat score for 2006 are graphically presented in Figure 5. Fish population data including numbers and percent composition for the species collected in 2006 are presented in Appendix B. Summaries of both fish abundance and fish IBI scores for the pre-drought and drought-affected years for the 1999-2006 study period are also provided in Appendix B. Fish disease and selenium analytical results are discussed in Sections 3.2.2 and 3.2.3, respectively.

3.2.1 Populations

In general, the fish community is most influenced by the widely fluctuating stream flows. The fishery at sites bdc2.0 and bdc3.0 downstream from WWTPs also showed localized short term effects coinciding with the drought-affected years (2002-2004), however populations have recovered in 2006 to pre-drought levels. The 2006 data also indicate that fish abundance has increased from the overall low numbers reported in 2004, which was caused by high flows during several large summer storm events. Furthermore, the fish population showed no apparent effects due to elevated selenium concentrations.

Ten of the total fish species collected in Big Dry Creek during the 1997-2006 monitoring period are native to the South Platte River Basin in Colorado. Eight of these ten species were collected in 2006 (Table 4), with the number of native species collected varying between eight and ten since 1997. Longnose dace, creek chub, fathead minnow, sand shiner, white sucker, longnose sucker, and green sunfish were the native species always collected. Their percent abundance at each study site is depicted in Figure 3. Other native fishes occasionally collected over the years include the johnny darter, black bullhead, and brook stickleback. The remaining fish species collected have been introduced to the South Platte River drainage with from three to six non-native species found in any given year during the 1997-2006 period. Mosquitofish, largemouth bass, bluegill, yellow bullhead, and common carp were among

TABLE 4

PERCENT ABUNDANCE OF FISH SPECIES, TOTAL NUMBER COLLECTED, AND INDEX OF BIOTIC INTEGRITY (IBI) SCORES AT BIG DRY CREEK SITES, FALL 2006

	STUDY SITES							
SPECIES	bdc0.5	bdc1.0	bdc1.5	bdc1.5C	bdc2.0	bdc3.0	bdc5.0	bdc6.0
Longnose dace * *Rhinichthys cataractae*	20.2	34.4	15.9	8.8	0.3	37.0	4.6	11.2
Creek chub * *Semotilus atromaculatus*	11.8	3.2	11.0	17.3	--	--	--	--
Fathead minnow * *Pimephales promelas*	64.6	10.6	30.5	22.9	71.7	27.8	4.7	30.5
Sand shiner * *Notropis stramineus*	--	49.5	3.7	13.1	0.9	5.9	87.8	30.5
White sucker * *Catostomus commersoni*	3.3	1.9	25.0	29.4	24.7	10.4	0.8	13.5
Longnose sucker * *Catostomus catostomus*	0.1	--	--	--	--	--	--	--
Johnny darter * *Etheostoma nigrum*	None collected since 2002 when only one individual was collected at site bdc1.0.							
Green sunfish * *Lepomis cyanellus*	--	--	6.1	7.3	--	4.9	0.2	0.4
Mosquitofish *Gambusia affinis*	--	0.3	3.0	--	2.1	13.8	0.8	5.4
Largemouth bass *Micropterus salmoides*	--	0.1	1.8	0.3	--	--	0.5	--
Bluegill *Lepomis macrochirus*	--	--	3.1	1.0	--	--	0.1	--
Yellow bullhead *Ameiurus natalis*	--	--	--	--	--	--	<0.1	--
Common carp *Cyprinus carpio*	--	--	--	--	0.3	0.3	0.3	4.0
Brook stickleback * *Culaea inconstans*	--	--	--	--	--	--	--	4.5
TOTAL COLLECTED	841	2,171	164	398	336	762	2,660	223
SPECIES COLLECTED	5	7	9	8	6	7	10	8
IBI SCORE	33	37	29	31	27	35	41	29

* Fishes native to the South Platte River drainage.

FIGURE 3

PERCENT RELATIVE ABUNDANCE OF NUMERICALLY DOMINANT AND IMPORTANT NATIVE FISH SPECIES COLLECTED AT BIG DRY CREEK SITES, FALL 2002-2006

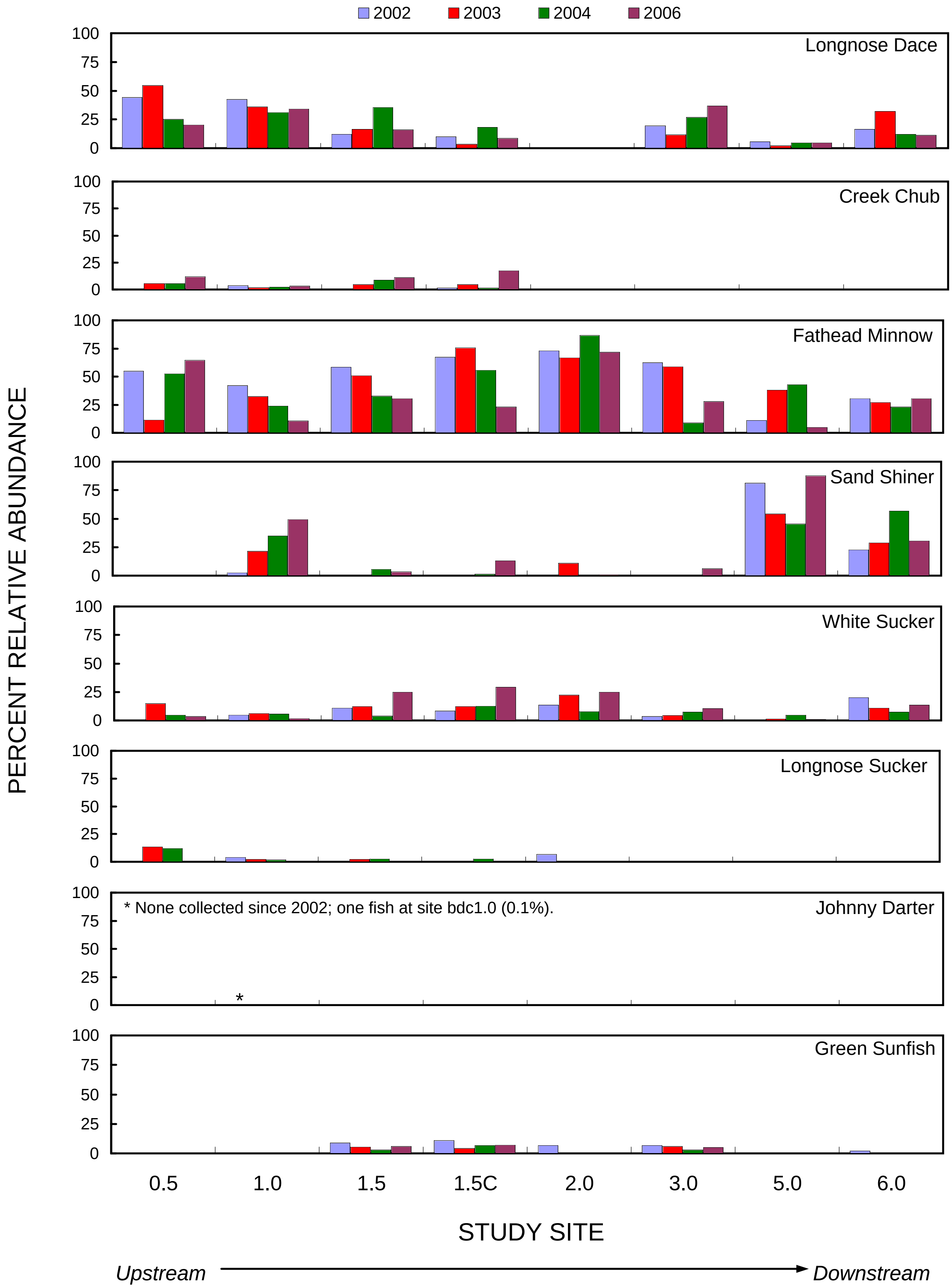


FIGURE 4

COMPARISONS OF NUMBERS OF FISH AND SPECIES COLLECTED AT
BIG DRY CREEK SITES, 1999-2001 MEAN VS. 2002-2006

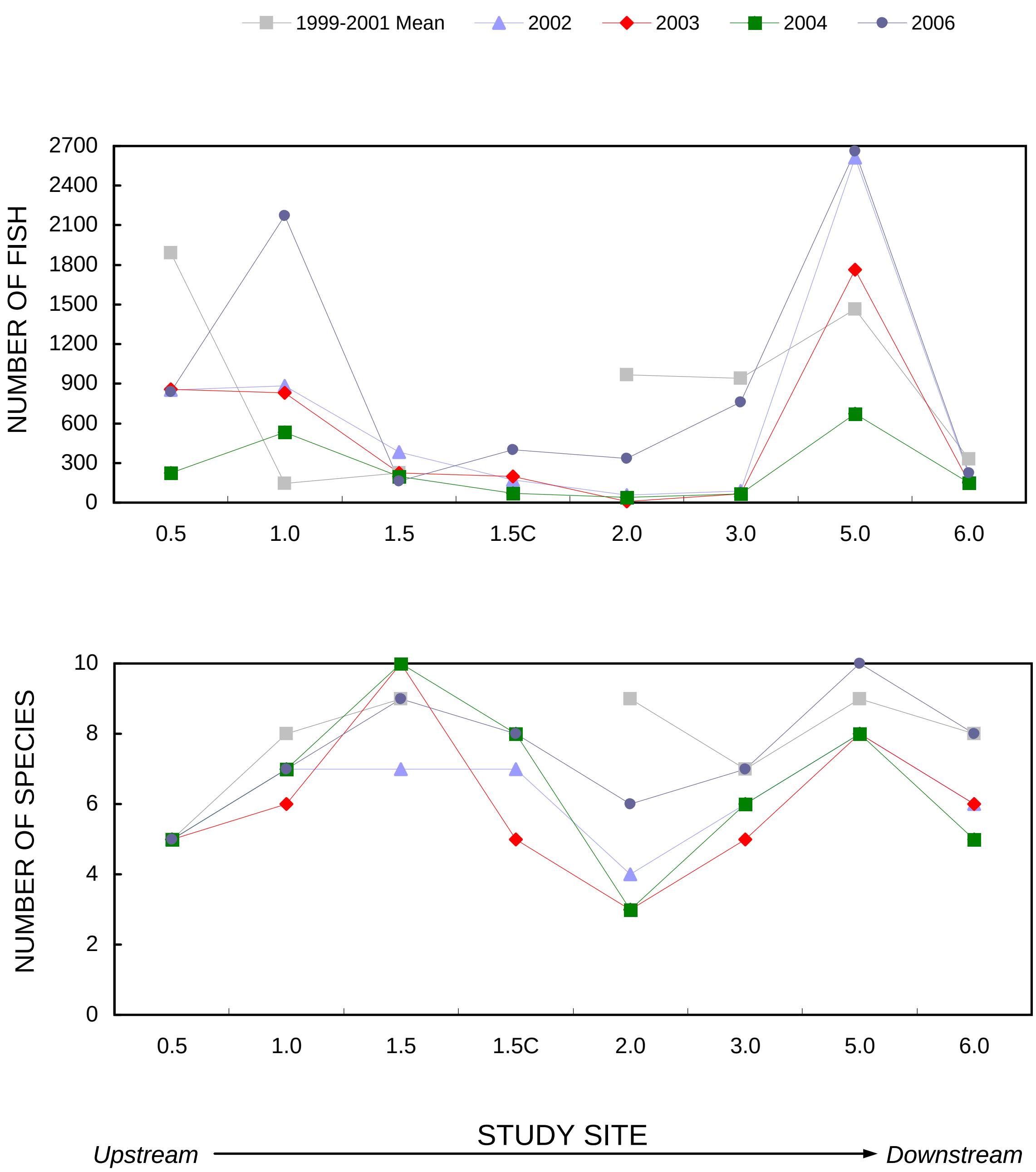
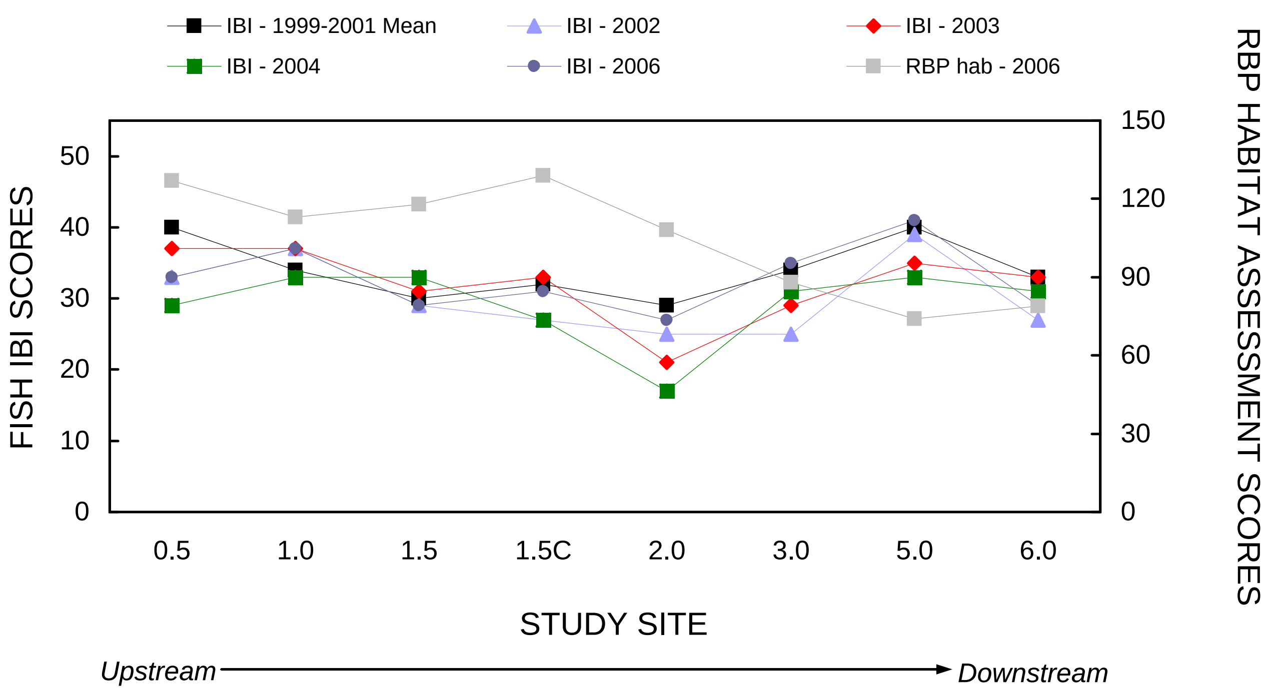


FIGURE 5

COMPARISONS OF FISH INDEX OF BIOTIC INTEGRITY (IBI) AND THE RAPID BIOASSESSMENT PROTOCOL (RBP) HABITAT ASSESSMENT SCORES FOR BIG DRY CREEK, 1999-2001 MEAN VS. 2002-2006



the introduced species (non-natives) collected in 2006. The presence of largemouth bass and bluegill at sites bdc1.5, bdc1.5C, and bdc5.0 is mainly the result of wash out from adjacent ponds.

The number of species collected at all sites in 2006 was similar to that collected during the 2002-2004 period. The greatest number of species collected was at site bdc5.0 where 10 species were collected in 2006, while the fewest species were found at site bdc0.5 with only five species collected (Table 4, Figure 4). Either five or six native species were collected at individual sites, except at site bdc2.0 where only four natives were collected (Table 4). Introduced species were not as well represented with two or three species collected at most sites, and five non-native species at site bdc5.0. Non-native fishes were again absent at site bdc0.5 which is consistent with previous years, and over the years sampled (1997-2006) the only non-native species ever collected at this site was in 2001, one largemouth bass. Species composition in Big Dry Creek was comparable to the historical data for fish species distribution and abundance in streams in the South Platte River drainage (Beckman 1952, Nessler et al. 1997, Propst 1982, Woodling 1985, 1996, Zuellig 2001). All of the native fish species collected in Big Dry Creek were either abundant or common in the South Platte River Basin and considered to have a relatively low risk of imperilment according to the Colorado Division of Wildlife's (CDOW) most recent inventory of streams in the Front Range and eastern plains (Nessler et al. 1997).

Species composition was generally similar to previous years at the upstream and downstream sites, although there were some differences in 2006. The longnose dace, creek chub, white sucker, and fathead minnow were usually more common at the upstream sites, whereas the sand shiner and occasionally the fathead minnow and white sucker were common at the downstream sites. Interestingly, sand shiner numbers continued to increase in recent years at sites bdc1.0 through bdc3.0, especially at site bdc1.0 (Figure 3). Of the native species, the longnose dace was the only intolerant species collected and was present at all sites including site bdc2.0, where historically they have been either absent or scarce (only one individual in 1999, 2000, and 2006). As in the past, their abundance in 2006 was again highest at upstream sites bdc0.5 through bdc1.5 and was generally less at downstream sites where cobble substrates are comparatively scarce. Longnose dace were most numerous at site bdc1.0 where with 746 individuals collected. Longnose dace have been the dominant species at site bdc0.5 in most years, but in 2006, as in 2004, they were again somewhat less abundant than during the 1999-2003 time period. Apparently stream conditions have been more favorable for fathead minnows since the 2002 drought as they have become more abundant than longnose dace and the dominant species at site bdc0.5.

Total numbers of fish collected at individual sites in 2006 increased over the historic lows recorded in 2004 for the entire monitoring period, and the highest numbers of fish were collected at sites bdc1.0 and bdc5.0 (Figure 4, Appendix B). In 2004, fish populations were overall low because of displacement (wash out) by high flows during the several large summer storm events in 2004 and the residual effects of the 2002 drought (AAI 2005b). Total abundance in 2006 ranged from 164 to 2,660 fish collected (sites bdc1.5 and bdc5.0, respectively) (Table 4). The trend in total abundance among the downstream sites in 2006 was generally similar to the pre-drought years (1999-2001) with comparatively fewer fish collected in the drought-affected years (2002-2004) at sites bdc2.0 and bdc3.0. For the upstream sites, site bdc0.5 has consistently had the highest fish abundance from year to year, and although fish numbers were low at this site in 2004, abundance rebounded in 2006 to previous levels. In 2006, site bdc1.0 replaced site bdc0.5 as the upstream site with the highest numbers of fish. In 2006, a total of 2,171 individuals (highest to date) were collected at site bdc1.0 compared to 841 individuals at bdc0.5. Fish numbers have increased substantially at site bdc1.0 in recent years as indicated by comparing mean fish numbers for the pre-drought years (1999-2001) to the drought-affected years (2002-2004) for this site (mean 285 vs. 748 individuals, respectively) (Appendix B). Substantial increases in numbers of longnose dace, fathead minnows, and the recent presence and abundance of sand shiners are the main reason for the notable increase in total fish numbers at site bdc1.0 during the last four sampling years (2002-2006). In 2006, sand shiners were very numerous (1,075 fish) at site bdc1.0 accounting for nearly 50% of the fish collected. They were relatively abundant for the third consecutive year and the dominant species in 2004 and 2006; whereas prior to 2003 only a few sand shiners were occasionally collected. Longnose dace have always been collected at site bdc1.0, but were also very numerous at site bdc1.0 in 2006 (746 fish) comprising a substantial portion (34%) of the total fish collected at this site.

Fish species composition also shifted slightly at site bdc1.5 in 2006, although the changes observed were within the normal variability for fish populations. White suckers and creek chubs were more numerous and fewer fathead minnows and longnose dace were collected in 2006 than in recent years. Creek chubs have become more numerous in 2004 and 2006 (17 and 18 individuals) compared to previous years. Longnose dace numbers have fluctuated at this site since 1999 (4 to 70 individuals) and have not been as numerous as found in 1997 and 1998 (196 and 176 individuals). While the recently constructed beaver dams and increased lentic habitat may have influenced the fish population at site bdc1.5 in 2006, the increased turbidity and poor visibility during the 2006 sampling event was likely the reason that overall fewer fish (longnose dace, fathead minnows, and other species) were collected at this site.

Typical of previous years, total abundance in 2006 was greatest at site bdc5.0 with comparatively high numbers of fish also collected at site bdc1.0 (Table 4, Figure 4). The lowest numbers of fish collected were at sites bdc1.5 and bdc6.0 with 164 and 223 individuals, respectively. While these fish numbers are typical for site bdc6.0, fish abundance at site bdc1.5 was somewhat less than the historical range for this site (198 to 1,141 total fish for 1997-2004). The comparatively low number of fish collected at site bdc1.5 was in part related to the log jam encountered in the middle of the reach and the beaver dams constructed downstream from the site, which backed up water almost to the top of the study reach increasing the amount of pool and run habitat and inundating all but the upstream riffle. The log jam and beaver dams were removed prior to sampling to lower water levels; however, the turbid conditions and poor visibility that persisted at site bdc1.5 after removal resulted in reduced sampling efficiency (visibility) and lower fish numbers during the 2006 sampling event. While beaver dams were also breached prior to sampling at site bdc1.0, the water was relatively clear at the time of sampling and poor visibility was not an issue.

During the 2002-2004 time period (drought-affected years), the lowest fish numbers were at sites bdc2.0 and bdc3.0. However, the fish populations at these two sites have recovered dramatically in 2006 as the numbers of fish collected have rebounded from lows of 9 to 88 individuals (2002-2004) to 336 and 762 individuals at sites bdc2.0 and 3.0, respectively (Appendix B). The fish population at sites bdc2.0 and bdc3.0 were likely affected (low numbers and species) during the 2002 through 2004 period by the combination of drought-related low flows and warmer stream temperatures in 2002 as well as the elevated concentrations of unionized ammonia discharged to the stream in July and November/December of 2002 during facility upgrades at the Broomfield WWTP. Even though ammonia levels had improved in the creek in 2003 and were well below the stream standard in 2004, the numbers of fish collected in 2004 remained low as expected because population recovery usually takes several years considering natural reproduction and recruitment (AAI 2005b). The increases in fish numbers and species in 2006 indicate populations at sites bdc2.0 and bdc3.0 have recovered to historical (1997-2001) levels.

Of the four downstream sites, bdc5.0 and bdc6.0 appear to have the most stable fish communities in terms of the relatively consistent total numbers of fish and species composition from year to year over the eight years sampled from 1997-2006. Monitoring results indicate populations are stable even though these sites are the most affected by the overall higher flows in the lower watershed and extreme flow fluctuations due to irrigation activities and large storm events. Furthermore, data do not indicate any affects attributable to the WWTP discharges on the fish populations at these two sites.

The johnny darter population in the Big Dry Creek drainage has been an important issue in previous monitoring years because of the CDOW's concern that the ammonia water quality standard was not stringent enough to protect this species, which until 2003 was classified as a State species of Special Concern. This species is no longer listed as a species of Special Concern, and in fact there are no fish species found in the Big Dry Creek drainage that are currently State or Federally listed as Endangered, Threatened, or of Special Concern (CDOW 2003). The johnny darter has not been collected since 2002 when only a single individual was collected at site bdc1.0. In the years 1999 to 2001, the johnny darter was found at upstream sites bdc0.5, bdc1.0, and bdc1.5, and at downstream site bdc2.0, and usually was most numerous at site bdc0.5. Their distribution in Big Dry Creek is likely restricted by the lack of suitable substrates and excessive turbidity rather than water quality. Their scarcity in recent years (2002-2006) may be also related to the 2002 drought and the high storm-related runoff flows in spring of 2003 and the summer of 2004.

Fish IBI scores in 2006 ranged between 27 and 41 for the Big Dry Creek sites (Table 4). The lowest IBI score was at site bdc2.0 as in previous years, and the highest score was at site bdc5.0. The 2006 IBI scores were within the range of scores reported for the 1999-2004 period (Figure 5, Appendix B). Compared to 2004, the IBI scores increased (improved) by at least 4 points at all sites except sites bdc1.5 and bdc6.0 (4 and 2 point decreases, respectively) with the greatest increases noted at sites bdc2.0 (10 points higher than in 2004) and bdc5.0 (8 points higher than 2004). Scores at sites bdc2.0, bdc3.0, and bdc5.0 also improved compared to the previous four to five years. Again, comparison of fish IBI and RBP habitat scores showed differing trends at downstream sites bdc3.0, bdc5.0, and bdc6.0 indicating that habitat scores are valuable for documenting year-to-year changes in physical stream conditions, but do not accurately reflect the overall condition of the fish community. The IBI scores for Big Dry Creek should be interpreted with caution as the IBI methodology was originally developed for mesic Midwestern streams, which have greater species richness and numbers than the generally depauperate Great Plains streams (Bramblett and Fausch 1991).

The mean IBI scores for the upstream and downstream sites were essentially the same in 2006 with mean scores of 32.5 (range 29-37) and 33.0 (range 27-41), respectively, which was also the case for the pre-drought years (1999-2001) when the 3-year mean scores were the nearly same for both upstream and downstream sites (34.3 and 34.0) (Appendix B). In contrast, mean annual IBI scores for the drought-affected years (2002-2004) were slightly higher at the upstream sites than at the downstream sites with 3-year mean IBI scores of 32.3 and 29.9, respectively. The lowest 7-year mean IBI score was at site bdc2.0 (25.3) compared to the highest mean score at site bdc5.0 (38.1) where fish abundance and species diversity have been consistently high. Site bdc2.0 also exhibited the greatest degree of change (18 points) over the study period with IBI scores ranging from 17 in 2004 to 35 in 1999. At site bdc3.0, the degree of change was similar at 16 points. The lowest IBI scores for both these sites occurred during the stressful 2002-2004 time period. The site with the least degree of change (four points) was site bdc1.0 where IBI scores ranged from 33 to 37 (mean of 35.3). Notably the 7-year mean IBI scores were essentially the same at sites bdc1.5 and bdc1.5C (30.4 and 30.3). This similarity provides further justification for eliminating one of these reference sites upstream from Broomfield WWTP discharge in an effort to streamline the monitoring program.

3.2.2 Fish Disease

Fish disease has been documented in Big Dry Creek during the 2000-2006 period by visually inspecting fish for disease and noting the type and extent of infection (slight, moderate, or heavy). The most prevalent disease observed was “black spot disease” which is the metacercaria stage of a specific flatworm (digenetic trematodes) (Hoffman 1999, Walker 2004). In the Big Dry Creek system, fish species susceptible to black spot disease are fathead minnows, longnose dace, creek chubs, white suckers, and longnose suckers. Commonly collected fish in Big Dry Creek that appeared not susceptible to black spot disease were sand shiners and mosquitofish, which is also consistent with that reported by Hoffman (1999). Other less commonly collected fish in the Big Dry Creek system that were also generally free of the parasite were largemouth bass and bluegills. The life history of this disease is presented in the previous monitoring report (AAI 2005b).

Comparisons of percent disease by site and at upstream vs. downstream sites in Big Dry Creek are provided in Table 5 for 2006 and the 2000-2004 period. Mean disease ratings and percent abundance of heavily infected fish are summarized in Table 6 for the last four sampling years (2002-2006). Fish disease occurrence is also graphically depicted in Figure 6 including the number of diseased fish compared to the total fish collected by site and year for the six years studied (2000-2006).

As shown in Table 5, the incidence of black spot disease in susceptible fishes (longnose dace, fathead minnows, creek chubs, and white suckers) continued to be high in 2006 and was higher than the 4-year mean (2001-2004) at sites bdc0.5 (99.8% vs. 79.3%), bdc1.5 (80.6% vs. 74.4%), bdc1.5C (81.5% vs. 70.2%), and bdc2.0 (92.9% vs. 69.1%). Overall, the incidence of the disease appears to be increasing as mean disease at the upstream sites increased from 77.4% (2001-2004 mean) to 81.8% in 2006, while at the downstream sites mean disease increased from 39.9% (2001-2004 mean) to 44.7% in 2006 (Table 5). Although incidence of disease has been comparatively lower at the downstream sites (vs. upstream sites), the mean disease rate has also increased in recent years (2004 and 2006) primarily because of disease increases occurring at site bdc2.0 in 2004 and 2006. The increase in mean disease rate for the downstream sites in 2006 was attributable to the relatively high incidence of disease at sites bdc2.0 and 3.0 (92.9% and 57.4%, respectively) rather than at sites bdc5.0 or bdc6.0, due to increases in the total numbers of susceptible fishes. More fathead minnows and white suckers were collected at site bdc2.0, while more longnose dace, fathead minnows, and white suckers were collected at site bdc3.0.

TABLE 5

COMPARISONS OF PERCENT DISEASE BY SITE AND UPSTREAM VS. DOWNSTREAM
AT SITES IN BIG DRY CREEK, 2000-2006

	Big Dry Creek							
	upstream sites				downstream sites			
	bdc0.5	bdc1.0	bdc1.5	bdc1.5C	bdc2.0	bdc3.0	bdc5.0	bdc6.0
Percent Disease by site								
2000	7.8	6.4	1.8	6.2	19.6	5.3	2.1	6.4
2001	69.4	90.3	79.0	26.8	46.4	70.4	6.8	28.2
2002	95.2	85.6	57.6	68.0	71.2	56.8	3.8	13.1
2003	66.6	75.6	76.5	94.4	66.7	50.0	5.2	37.2
2004	85.8	91.0	84.3	91.7	92.1	38.8	31.5	20.3
2006	99.8	65.4	80.6	81.5	92.9	57.4	7.5	21.1
4-yr Mean 2001-2004	79.3	85.5	74.4	70.2	69.1	54.0	11.8	24.7
5-yr Mean 2001-2006	83.4	81.6	75.6	72.5	73.9	54.7	11.0	24.0

Annual Mean Percent Disease	all sites	upstream sites	downstream sites	
2000	7.0	5.6	8.4	
2001	52.2	66.4	38.0	
2002	56.4	76.6	36.2	
2003	59.0	78.3	39.8	
2004	66.9	88.2	45.7	
2006	63.3	81.8	44.7	
4-yr Mean 2001-2004	58.6	77.4	39.9	(61.6 when sites bdc2.0 and bdc3.0 only)
5-yr Mean 2001-2006	59.6	78.3	40.9	(64.3 when sites bdc2.0 and bdc3.0 only)

TABLE 6

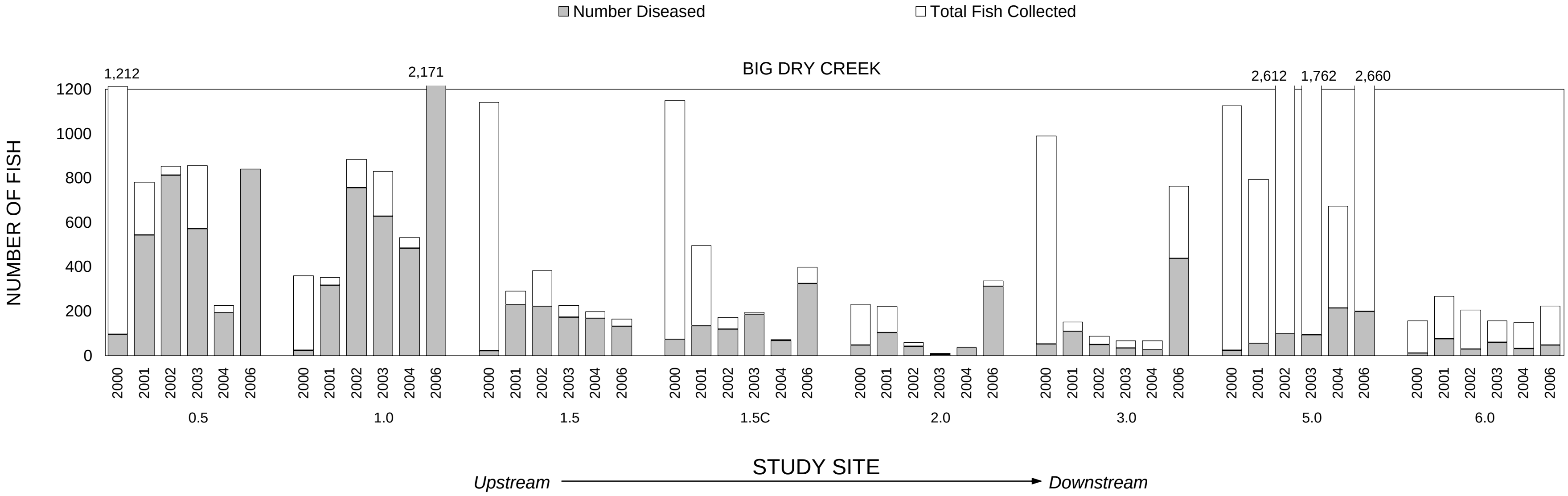
MEAN DISEASE RATINGS AND PERCENT OF HEAVY INFECTED FISH COLLECTED
AT BIG DRY CREEK SITES, FALL 2002-2006

	Big Dry Creek							
	upstream sites				downstream sites			
	bdc0.5	bdc1.0	bdc1.5	bdc1.5C	bdc2.0	bdc3.0	bdc5.0	bdc6.0
Fall 2002								
Mean Disease Rating 1/	1.7	1.2	0.9	0.7	0.9	0.6	0.04	0.2
upstream sites	1.1							
downstream sites	0.4							
Percent Heavy 2/	24.7	20.9	5.0	0.0	3.4	1.1	0.6	0.0
upstream sites	12.7							
downstream sites	1.3							
Fall 2003								
Mean Disease Rating	1.1	1.4	0.9	1.1	0.6	0.7	0.1	0.5
upstream sites	1.1							
downstream sites	0.4							
Percent Heavy	9.7	11.8	2.0	2.2	0.0	0.0	0.0	0.0
upstream sites	6.4							
downstream sites	0.0							
Fall 2004								
Mean Disease Rating	1.2	2.0	1.0	1.1	1.0	0.5	0.3	0.2
upstream sites	1.1							
downstream sites	0.5							
Percent Heavy	4.9	41.1	0.7	2.8	0.0	0.0	0.0	0.0
upstream sites	6.4							
downstream sites	0.0							
Fall 2006								
Mean Disease Rating	2.1	1.5	1.4	0.9	1.1	0.6	0.4	0.2
upstream sites	1.5							
downstream sites	0.6							
Percent Heavy	34.3	23.8	14.8	4.0	2.9	0.0	0.0	0.0
upstream sites	19.2							
downstream sites	0.7							

1/ Mean disease rating is the level of disease for the entire population sampled at each site on scale of 0-3, with ratings of 0, 1, 2, or 3 denoting either no, slight, moderate, or heavy level of disease for individuals collected.
2/ Percent of diseased fish that were rated as heavily infected.

FIGURE 6

FISH DISEASE OCCURRENCE AT
BIG DRY CREEK SITES, 2000-2006



The mean disease rating (degree of severity) in 2006 remained substantially higher at the upstream sites than at the downstream sites and was especially high at sites bdc0.5 and bdc1.0 where the degrees of severity were 2.1 (highest to date) and 1.5, respectively (Table 6). Snails, which are an essential life-cycle intermediate host, have consistently been present at all the upstream sites and have usually been most numerous at sites bdc0.5 and bdc1.0. Generally speaking, the higher the number of snails, the greater the numbers of cercariae that can be released into the water that are capable of attaching to the target fish. This situation is further exacerbated at sites bdc0.5 and bdc1.0 where stream flows are usually the lowest of the sites, resulting in overall higher concentrations of cercariae in the water compared to the remainder of the sites downstream. Lower flows can also result in warmer temperatures which can increase the susceptibility of disease prone fish. Snails became more numerous and widely distributed in 2001, which coincides with the system-wide increase in fish disease rates. Snail densities were highest in the fall 2002 (drought year), but since then have generally been decreasing during the 2003, 2004, and 2006 sampling years (see Macroinvertebrate Section 3.3.1). Snail densities decreased dramatically at site bdc0.5 in 2006, yet a corresponding decrease the incidence of fish disease has inexplicably not occurred at this site where the disease rate actually increased in 2006 (Table 5). Although less dramatic, similar decreases in snail densities were also noted at most of the other sites also with no consistent (decreasing) trend in fish disease evident.

In fall 2006, snails were present at all the upstream sites and at downstream sites bdc3.0 and bdc5.0 only. At site bdc2.0, snails historically have been absent, yet the incidence of disease is relatively high (92.9% in 2006, 69.1% 2001-2004 mean) (Table 5). Sites 1.5 and 1.5C have always had small populations of snails and are within reasonable proximity to site bdc2.0; thus the infection of fish at site bdc2.0 may be originating from snails at these two upstream sites. The relatively low percentage of infected fish at site bdc5.0 in 2006 (7.5%) and the 2000-2003 period (2.1 to 6.8%) was due to the high abundance of the non-susceptible sand shiners at this site. In 2004, when disease was unusually higher at this site (31.5%), there were nearly the same numbers of highly infected fathead minnows and non-susceptible sand shiners collected (290 vs. 306 fish). The 5-year (2001-2006) mean disease rates for sites bdc2.0 and bdc3.0 were 73.9% and 54.7%, respectively, compared to 78.3% for the four upstream sites (Table 5). This comparison continues to indicate that the WWTP discharges do not exacerbate the fish disease rate and may in fact help to decrease the infection rate due to increased dilution flows as previously concluded (AAI 2005b).

3.2.3 Fish Selenium Concentrations

Results of the selenium analysis in fish tissue samples collected in 2006 from selected sites in Big Dry Creek are discussed below with the analytical data summarized in Table 7. The 2006 sampling is the second collection made since the initial sampling in October 2004, and as in the 2004, analysis of selenium was conducted in omnivore (fathead minnows) and insectivore (longnose dace and sand shiners) whole body fish tissue. This fish tissue study is part of the selenium study that is currently being conducted by WWE for the BDCWA to develop a data base and better understanding of selenium concentrations in Big Dry Creek in support of an appropriate selenium standard for the creek (WWE 2006). The results of the selenium water quality study (WWE 2004, 2006, 2007), as well as other relevant selenium water quality and fish tissue studies are also discussed herein for reference purposes.

In December 2007, a seasonal ambient-based selenium water quality standard was formally adopted by the CWQCC for Segment 1 of Big Dry Creek, based on the results of the selenium study conducted by WWE (2006, 2007). During the irrigation season (April through October), the ambient standards are 7.4 *u*g/L chronic (dissolved) and TVS *u*g/L acute (dissolved). For the non-irrigation season, the ambient-based standards are 15 *u*g/L chronic (dissolved) and 19.1 *u*g/L acute (dissolved) (CWQCC 2007). Both fish population and selenium tissue data collected by AAI for the aquatic monitoring program were used in support of the recently adopted ambient-based selenium water quality standard.

As reported by WWE (2007), during the irrigation season, sites upstream from the WWTPs had average selenium concentrations of 4.4 *u*g/L whereas the downstream sites averaged 5.6 *u*g/L for the 2003-2006 study period. During the non-irrigation season, the upstream sites averaged 11.2 *u*g/L while the downstream sites averaged 6.7 *u*g/L. Compared to the recently adopted selenium standards, the irrigation season average instream concentrations were less than the chronic standard of 7.4 *u*g/L, and the non-irrigation season instream average concentrations were less than the chronic standard of 15 *u*g/L indicating the apparent appropriateness of the ambient-based selenium standards for Big Dry Creek.

To supplement the instream selenium study, additional samples were collected in 2006 to represent wet weather and dry weather conditions. Concentrations of dissolved selenium in water from supplemental samples collected by the Cities on 3/9/06 (wet weather) and 4/19/06 (dry weather) ranged from 2.0 *u*g/L at site bdc0.5 to 9.1 *u*g/L at sites bdc1.5 and bdc5.0 (WWE 2007). According to WWE (2006), the highest instream selenium concentrations have consistently been recorded at site bdc1.5 over the period of study with concentrations between 19.0 and 20.0 *u*g/L occurring either once or twice per year during the winter time. Interestingly, over the period of the selenium study (2003 to 2007) the instream selenium

TABLE 7

BIG DRY CREEK TOTAL SELENIUM CONCENTRATIONS (*u* g/g dry weight)
IN WHOLE BODY FISH SAMPLES, OCTOBER 2004 AND 2006

	Total Selenium			
Site	Omnivores		Insectivores	
	2004	2006	2004	2006
bdc 0.5	11.0	10.4	12.5	12.5
bdc 1.0	13.5	15.0	17.0	27.4
bdc 1.5	10.5	20.0	11.0	28.1
bdc 1.5c	ns*	17.5	ns	32.0
bdc 2.0	15.0	21.3	none collected	19.3
bdc 3.0	7.5	19.3	16.5	27.7
bdc 5.0	15.5	ns	8.5	ns
bdc 6.0	9.0	10.9	14.0	20.7
Means	11.7	16.3	13.3	24.0

*ns indicates not sampled.

data do not indicate either a spike or upstream to downstream increase in selenium concentrations during the irrigation season (WWE 2007). Analysis of the entire data base indicated that there was not a statistically significant upstream to downstream trend for selenium concentrations (WWE 2007). Thus, due to the lack of a discernable upstream to downstream trend in instream selenium concentrations for the study period to-date, fish from both the upstream and downstream sites are likely exposed to roughly the same amounts of selenium.

In comparison to another plains stream in Colorado, May et al. (2001) reported instream concentrations of total selenium that ranged from 1.0 to 7.7 *u*g/L in an extensive study of selenium concentrations in water, sediment, and aquatic biota from water bodies in the Republican River basin in eastern Colorado and western Nebraska. In the Colorado River, in the vicinity of the Walker Walker State Wildlife Area, instream selenium concentrations ranged from 2.1 to 23.5 *u*g/L between 1995 and 1998 with lower values corresponding to periods or years of higher flows (Simmons and Wallschlager 2005). As an additional comparison, concentrations of aqueous selenium in a montane watershed, Elk Creek in British Columbia, were similar to those found in both the Colorado River and Big Dry Creek ranging from 4.6 to 25.0 *u*g/L (Orr et al. 2006).

The 2006 fish tissue results for Big Dry Creek indicate whole body fish tissue selenium concentrations (presented as dry weight) were on average 39% higher for the omnivore fish and nearly 80% higher for the insectivore fish than that reported in 2004. The overall mean selenium concentration for the omnivores was 16.3 *u*g/g compared to 11.7 *u*g/g in 2004, and for the insectivores the mean concentration was 24.0 *u*g/g compared to 13.3 *u*g/g in 2004 (Table 7). As expected, the highest selenium concentrations were in insectivore fish collected at sites bdc1.5 and bdc1.5C with concentrations of 28.1 *u*g/g and 32.0 *u*g/g, respectively. Fish from these sites were collected in reaches downstream from the water quality sampling location for site bdc1.5, which has had the highest average and peak instream selenium concentrations. The water quality sampling location at site bdc1.5 is just downstream from a seep/spring area which is one of the highest naturally occurring sources of selenium in the Big Dry Creek system (WWE 2006). Selenium concentrations were also relatively high for both omnivore and insectivore fish at sites bdc1.0, bdc2.0, and bdc3.0 and were higher than reported in 2004 (Table 7). The lowest concentrations of selenium found in 2006 were at site bdc0.5 with values of 10.4 *ug*/g and 12.5 *u*g/g in the omnivores and insectivores, respectively. Site bdc0.5 also has the lowest average water concentration of selenium for the entire study period with a value of 4.1 *u*g/L (WWE 2007). These low fish tissue values for site bdc0.5 were nearly the same as reported in 2004.

Interestingly, while all fish tissue concentrations for both the 2004 and 2006 collections were well above the suggested EPA criterion of 4.0 *ug*/g dry wt (Simmons and Wallschlager 2005), none of the fish collected from Big Dry Creek showed any signs of selenium toxicity (e.g., deformities, lowered reproduction and recruitment, mortality, etc.). This does not appear to be an unusual phenomenon in stream environments which has been frequently reported in the literature as discussed below.

Compared to other watersheds, fish populations in the La Plata River, where instream concentrations were as high as 12 *u*g/L, showed no obvious signs of impairment and according to the EIS, these fish may have adapted to the elevated selenium concentrations. In addition, tissue analyses of fish from the La Plata and Animas Rivers did not indicate biomagnification to levels of selenium that could reproductively impair fish (WWE 2006). Of the tissue concentrations in fish collected from the Republican River as reported by May et al. (2001), 75% were found to exceed the 4.0 *u*g/g biological effects threshold, but no impairment to the overall fishery was also noted. As reported for the La Plata River study, May et al. (2001) also postulated that because the selenium source was from naturally occurring shales in the watershed, that over a large span of time, the fish have likely adapted to the elevated selenium concentrations.

Several recent studies have compared the ecotoxicity of selenium in lentic (standing) vs. lotic (flowing) water environments and found selenium to be less toxic in lotic systems than in lentic systems (Hillwalker et al. 2006, Orr et al. 2006, Simmons and Wallschlager 2005). Reasons for this difference relate mainly to the ecological and biogeochemical differences between lotic and lentic systems and how these differences affect the chemical forms of selenium present in each system. Because the sediments in most lotic systems are largely oxic (oxygenated), the predominant form of selenium in streams is inorganic selenate compared to lentic systems where the sediments are more anoxic and form a reducing environment resulting in greater amounts of inorganic selenite, organic selenium, and elemental selenium. Selenite is the most biologically available form of selenium, especially to algae and cyanobacteria where it is converted to the more toxic and bioaccumulative organic seleno-amino forms (Simmons and Wallschlager 2005). Selenate on the other hand is less toxic than the other two forms, as well as being less readily bioaccumulated, especially in the presence of sulfate which inhibits its uptake in algae, macroinvertebrates, and fish. (Simmons and Wallschlager 2005). As reported by WWE (2006), selenate is the predominant form of selenium in Big Dry Creek.

The lack of any obvious toxic effects in the fish populations of Big Dry Creek, despite the elevated tissue concentrations may also be due, as reported in studies previously cited, to some form of adaptation to the naturally occurring and historically high concentrations of selenium in Big Dry Creek. Additionally, the predominant chemical form of selenium in fish tissue collected from Big Dry Creek may be relatively non-toxic. Lemly (1993) noted toxic effects in fathead minnows and largemouth bass in the form of deformities at tissue concentrations of ~19.6 *u*g/g, which was similar to some of the concentrations in Big Dry Creek fish. These fish however, were from a lentic environment where the more toxic organic seleno-amino form of selenium was much more prevalent than the other inorganic forms and more readily bioaccumulated within the food chain (Simmons and Wallschlager 2005).

Simmons and Wallschlager (2005) further noted that statistical analysis of published data on the bioaccumulation of selenium in fish strongly suggests that fish from lentic systems not only bioaccumulate selenium roughly 10 times greater than fish from lotic systems, but also accumulate selenium in its more toxic organic forms. This hypothesis, although not fully substantiated by any existing data, was partially verified experimentally in the field by Hillwalker et al. (2006) when they determined that selenium concentrations in similar aquatic insect taxa from lotic and lentic systems within the same watershed were up to 7 times greater in taxa from the lentic system than those from the lotic system.

At this point in time, there is no obvious reason for the apparent substantial increase in selenium concentrations in 2006 (vs. 2004 data) in fish from Big Dry Creek as reported at all sites except sites bdc0.5 and bdc6.0. Important variables such as instream selenium concentrations, habitat, incidence of disease, and population stability were all relatively similar in both 2004 and 2006. Laboratory analyses were also rigorously checked for errors with no problems or changes in method found. Continued monitoring is recommended to create a larger data base to validate fish tissue selenium concentrations.

3.3 MACROINVERTEBRATES

Macroinvertebrates were collected at the eight sites on Big Dry Creek in the spring and fall of 2006 (Table 2). Sampling results are summarized in Appendices C and D for the 2006 sampling period. Summaries of community metrics as well as the Rapid Bioassessment Protocol III (RBP) and Invertebrate Community Index (ICI) results are provided in Appendix C. Detailed data for individual sites and seasons are provided in Appendix D including a list of species collected, relative abundance, total density, number of taxa, and other community parameters. The percent abundance of the major macroinvertebrate taxonomic groups collected in kick net samples is presented graphically in Figure 7 for the spring and fall. A comparison of total taxa and density data for kick samples is presented in Figure 8 for the spring and fall seasons. A comparison of ICI scores for 2006 with 2003, 2004, and the mean ICI scores for 1997-2002 is graphically presented in Figure 9 for both the spring and fall seasons. The RBP and ICI scores for the spring and fall sampling events in 2006 are compared and summarized in Figure 10.

3.3.1 Community Characteristics

Macroinvertebrate study results for the 2006 sampling period are discussed below. In general, the 2006 data continue to show that the benthic macroinvertebrate community of Big Dry Creek reflects the urban and agricultural characteristics of the watershed, especially the flashy nature of stream flows and predominance of shifting sand and silt substrates. As in previous years, the macroinvertebrate community in both spring and fall was dominated either by dipterans or aquatic worms (oligochaetes). Dipterans were dominant at all upstream sites in both spring and fall, whereas at the downstream sites they were predominant only at site bdc5.0 in the spring and their abundance generally increased at all downstream sites by the fall (Figure 7). The dipterans were comprised mainly of midges (Chironomidae) with the moderately tolerant taxon *Cricotopus* sp. the most abundant species. Oligochaetes were dominant at the most of the downstream sites in the spring, whereas in the fall community dominance shifted to dipterans at these sites. At the upstream sites, the comparative abundance of oligochaetes and dipterans was similar for spring and fall with no seasonal species shifts occurring. Oligochaetes were dominated by the moderately tolerant taxa *Nais* spp. in the spring, which were particularly abundant at most of the downstream sites, whereas in the fall oligochaetes were dominated by the more tolerant tubificid worms with naidid worms often absent from the collections.

FIGURE 7

PERCENT RELATIVE ABUNDANCE OF MACROINVERTEBRATE TAXONOMIC GROUPS COLLECTED IN KICK SAMPLES FROM BIG DRY CREEK, SPRING AND FALL 2006

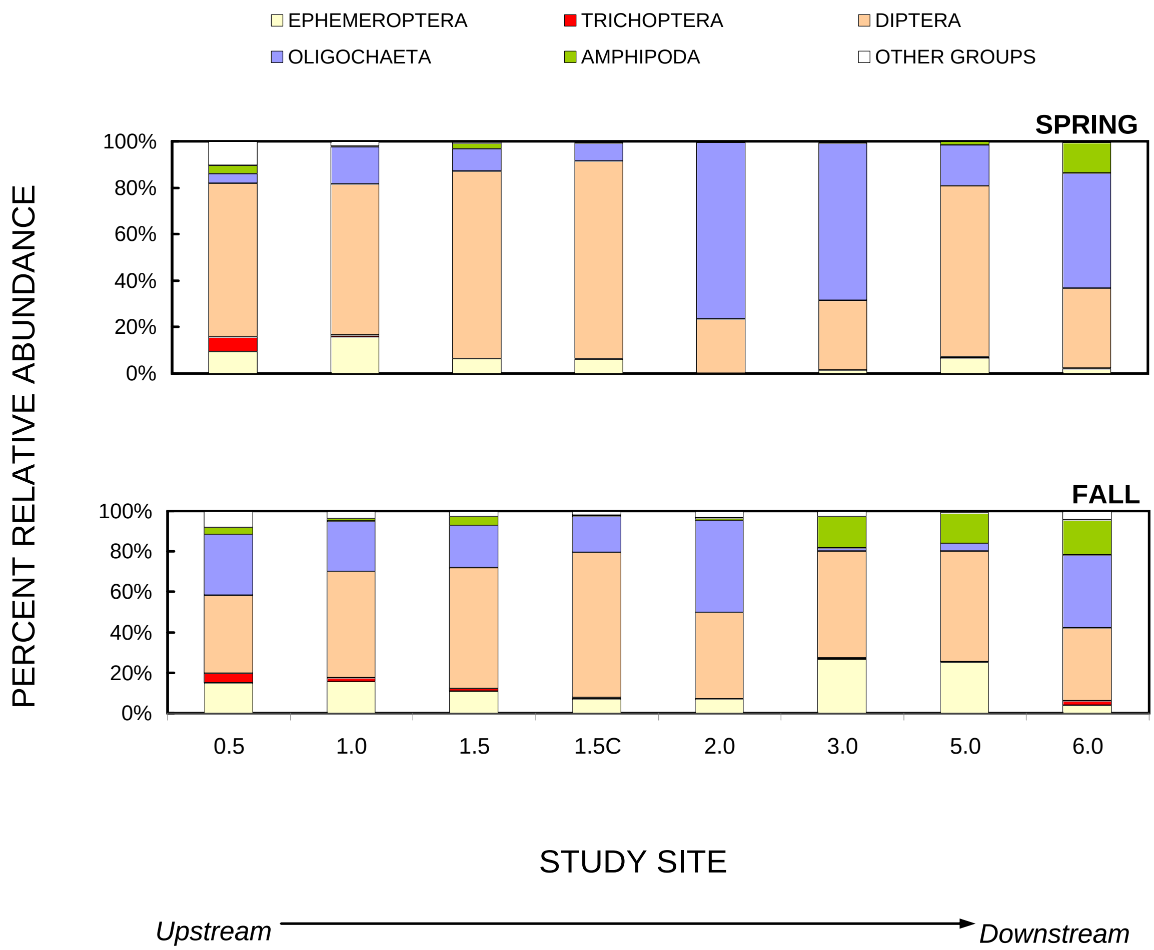


FIGURE 8

MACROINVERTEBRATE DENSITY AND TOTAL NUMBER OF TAXA COLLECTED IN KICK SAMPLES FROM BIG DRY CREEK, SRING AND FALL 2006

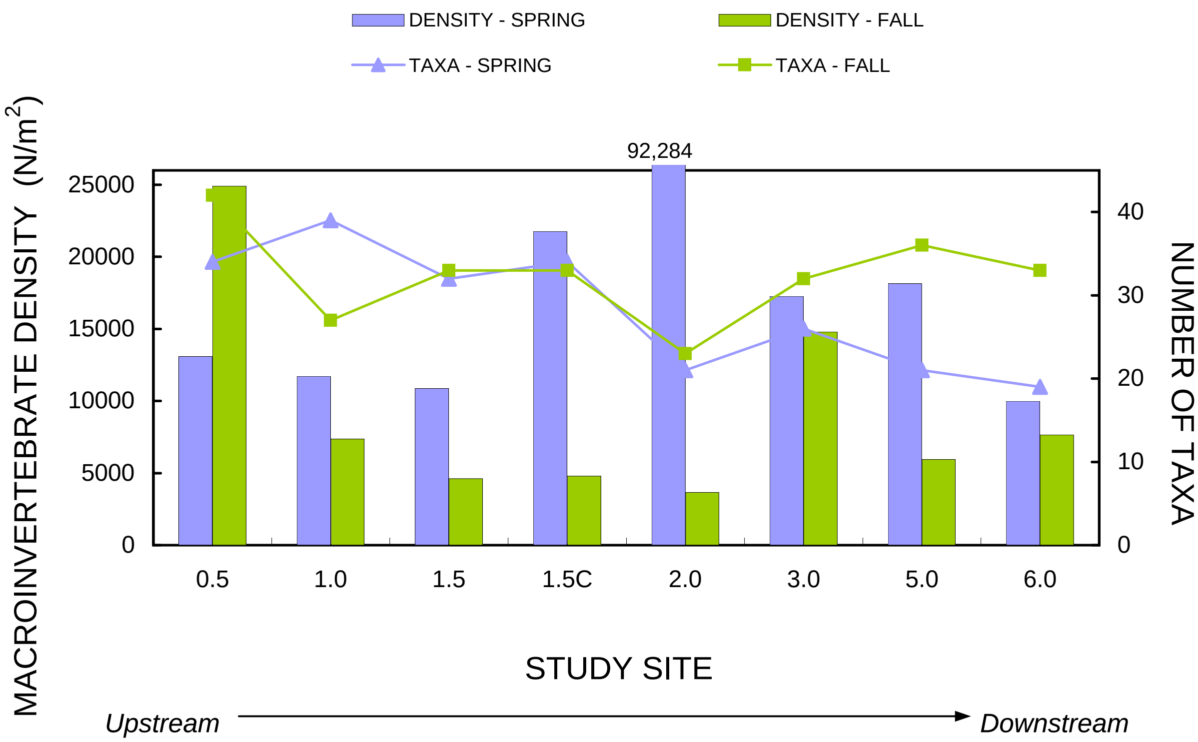


FIGURE 9

COMPARISON OF INVERTEBRATE COMMUNITY INDEX (ICI) SCORES FOR BIG DRY CREEK SITES IN SPRING AND FALL, 1997-2002 MEAN VS. 2003, 2004, AND 2006

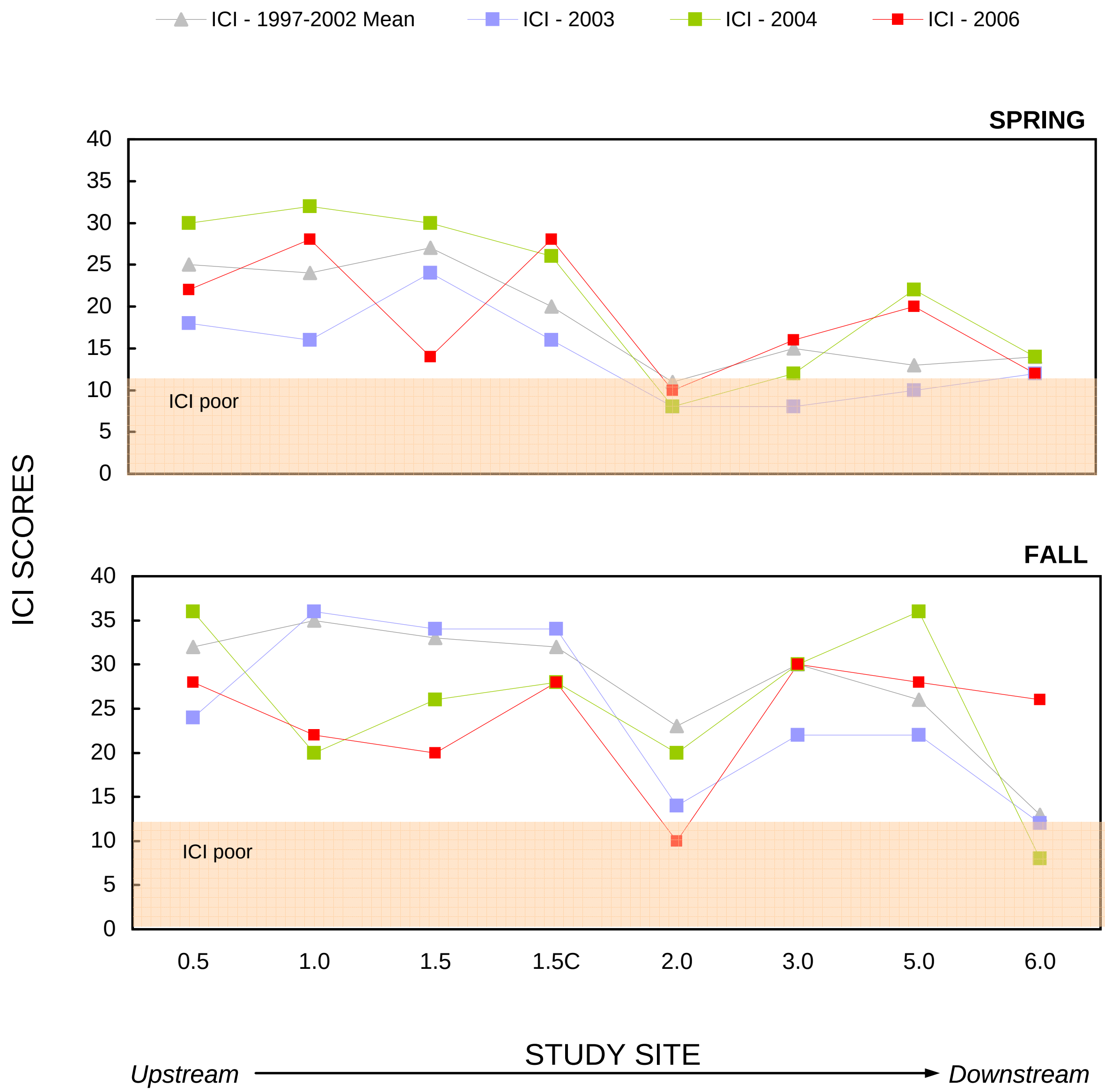
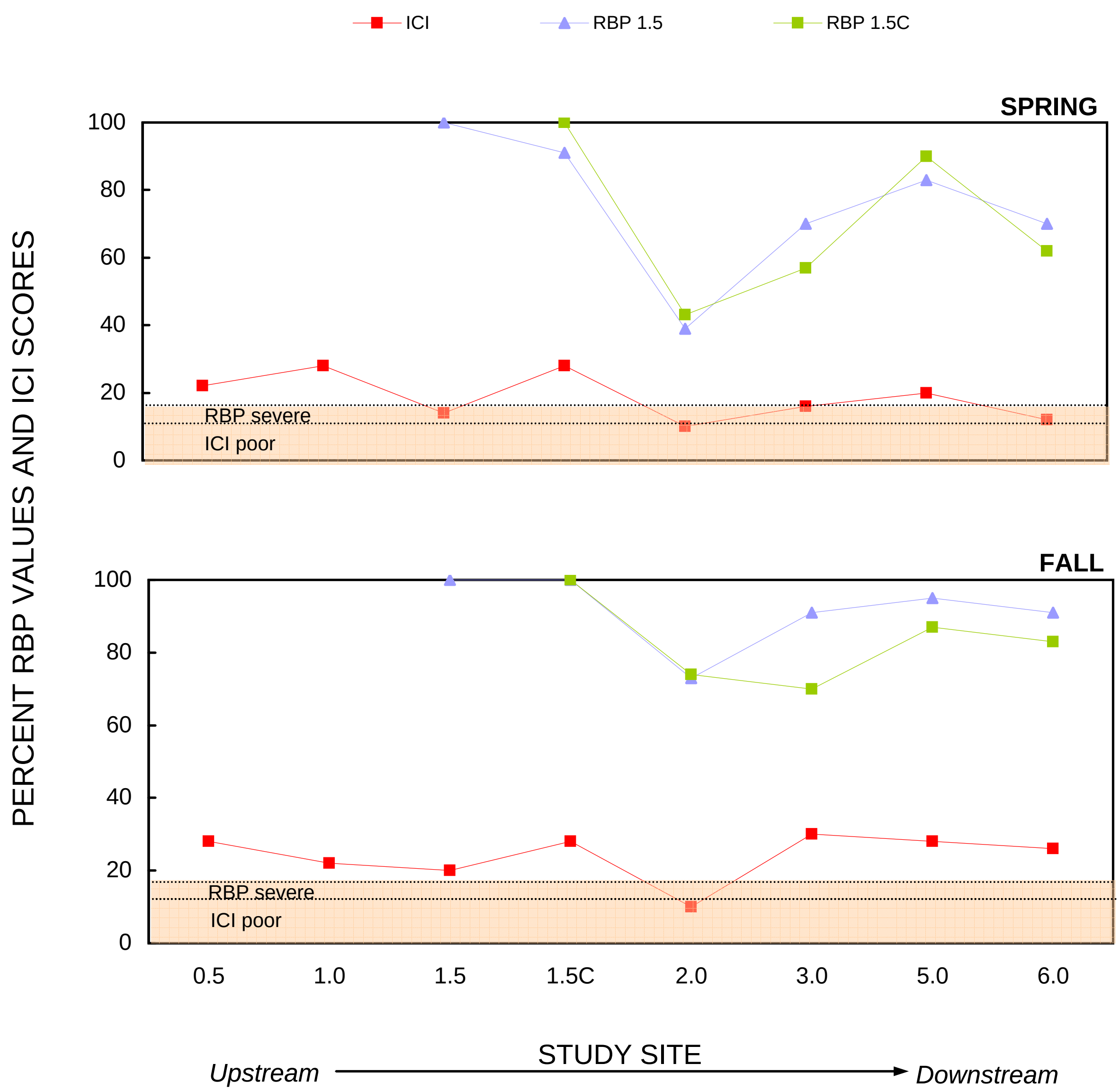


FIGURE 10

PERCENT RAPID BIOASSESSMENT PROTOCOL III (RBP) VALUES AS COMPARED TO REFERENCE SITES AND INVERTEBRATE COMMUNITY INDEX (ICI) SCORES FOR KICK SAMPLES FROM BIG DRY CREEK SITES, SPRING AND FALL 2006



Mayflies were poorly represented in the spring, but as in past years, their relative abundance increased in the fall. This was also the case for Amphipoda (scuds) which were generally scarce in the spring but increased in abundance in the fall, especially at downstream sites bdc3.0, bdc5.0, and bdc6.0. Gastropods (snails), which are associated with the fish disease issue (i.e., integral to the life cycle of black spot disease), were scarce at all sites in the spring, but increased in the fall and were most abundant at the upstream sites with percent abundances of 3.4%, 1.2%, and 1.7%, and at sites bdc1.0, bdc1.5, and bdc1.5C, respectively. The benthic macroinvertebrate community was represented by 15 taxonomic orders in both the spring and fall of 2006 (vs.16 and 14 in the spring and fall of 2004). The total number of unique taxa collected in kick samples at all sites was 62 taxa in the spring compared to 70 taxa in 2004. In the fall, 73 taxa were collected in both 2006 and 2004 (Appendix D). Nematoda (roundworms) were not collected in either season in 2006, while Isopoda (sow bugs) were present in the fall but only at site bdc6.0. One specimen of Hirudinea (leeches) was collected at site bdc1.5 in spring only. As observed in previous years, roundworms, sow bugs, and leeches were not very abundant.

Spring

As in past springs, macroinvertebrates were most abundant at site bdc2.0 downstream the Broomfield WWTP discharge with 92,284 organisms per square meter (organisms/m^2) and 21 taxa collected, and were least abundant at site bdc6.0 with 9,978 organisms/m^2 and 19 taxa collected (Figure 8). The highest number of taxa collected was 39 at site bdc1.0 with the upstream sites averaging 35 taxa vs. only 22 taxa for the downstream sites in 2006. Typically, more taxa have always been collected at the upstream sites than at downstream sites in the spring. The spring mean densities for the downstream sites were nearly 2.4 times higher than at the upstream sites due to the high numbers of *Nais* spp. at site bdc2.0 with mean total densities of 14,359 organisms/m^2 vs. 34,413 organisms/m^2 for the upstream and downstream sites, respectively.

The overall dominant taxa in spring were *Nais* spp. which were most abundant at the downstream sites where they represented 17.3% to 75.3% of the total community and the greatest abundance was at bdc2.0 as usual. The midge *Cricotopus* sp. was the dominant taxon at three of the upstream sites ranging from 28.1% to 43.7% and was dominant at site bdc5.0 at 58.2%. Black flies, *Simulium vittatum,* were dominant at site bdc1.0 at 22.6% relative abundance (%RA) and also represented a substantial portion of the community at site bdc1.5 at 20.5%. At the downstream sites, *S. vittatum* were absent at sites bdc2.0 and bdc6.0, while at sites bdc3.0 and bdc5.0 they comprised only 1.3% and 1.2%RA, respectively.

In aquatic systems, mayflies and caddisflies are good indicators of stable or improving water quality and habitat conditions, thus their presence continues to be important in monitoring the benthic community of

Big Dry Creek. Mayflies and caddisflies were more numerous at the upstream sites than the downstream sites in 2006 which has been typical of the spring season (Figure 7). The numbers of mayfly and caddisfly taxa collected were slightly greater in 2006 than in 2004 at most sites suggesting that water quality conditions have been stable for the benthic community over the past two years. In the spring, the ubiquitous and moderately tolerant mayfly *Baetis tricaudatus* was most abundant ranging from 1.5% to 12.9%RA at the upstream sites. At the downstream sites, mayflies were only absent at site bdc2.0, compared to 2004 when they were absent at sites bdc2.0, bdc3.0, and bdc6.0. The silt tolerant mayfly *Tricorythodes minutus* was also somewhat abundant at sites bdc0.5 and bdc1.0 at 8.0% and 2.4%RA, respectively. Typical of past years in the spring, mayflies were very scarce at most of the downstream sites in 2006 except at site bdc5.0 where five taxa were collected and collectively comprised 6.5% of the community (0.5% to 2.3%RA). Interestingly, extreme flow fluctuations occur at this site which negatively affect habitat conditions because of the narrow incised stream channel, but yet this site has the most diverse assemblage of mayflies. Caddisflies were nearly absent from the spring collections except at the most upstream site bdc0.5 where they comprised 6.1% (799 organisms/m^2) of the population (Appendix C).

Gastropods were relatively scarce throughout the Big Dry Creek system in the spring. The highest abundance of snails was at site bdc1.0 at only 1.2%RA, otherwise snails were sparse at sites bdc1.5, bdc1.5C, and bdc3.0 (<0.2%RA) and absent at all other sites including site bdc0.5 where fish disease is prevalent. Amphipods were collected at all sites and were especially numerous at site bdc6.0 at 13.3%RA and somewhat abundant at sites bdc0.5 and bdc1.5 (3.6% and 2.5%RA, respectively).

In the spring, the entire study reach at site bdc2.0 was impounded by downstream beaver activity which created a more lentic environment (mostly slow run and pool). Nonetheless, the macroinvertebrates showed no discernable changes in community structure.

Fall

In comparison to the spring, the fall macroinvertebrate densities typically decrease while the numbers of taxa increase with this trend continuing in 2006. The mean density for the upstream sites decreased from 14,359 organisms/m^2 in the spring to 10,421 organisms/m^2 in the fall, whereas at the downstream sites the change was more dramatic with the mean density decreasing from 34,413 organisms/m^2 to 8,015 organisms/m^2 (spring to fall). This reduction in density however was not as dramatic as in the fall of 2004 when mean density for the downstream sites was 4,503 organisms/m^2 because the fall community had not yet recovered from the several large storm events in July and August that undoubtedly washed out a significant portion of the macroinvertebrates. At the upstream sites, the highest density was 24,923 organisms/m^2 at site bdc0.5. Densities were lowest and similar at sites bdc1.5 and 1.5C with densities of 4,612 and 4,789 organisms/m^2, respectively, indicating that the community at site bdc1.5 was not affected by the beaver-related habitat changes (reduced riffle habitat due to damming) found at this site in the fall of 2006 (Figure 8). Fall densities at the downstream sites ranged from 3,666 to 14,801 organisms/m^2 at sites bdc2.0 and bdc3.0, respectively.

The mean number of taxa at the upstream sites remained essentially unchanged from spring to fall (35 to 34), while for the downstream sites mean taxa richness increased from 22 in the spring to 31 in the fall. Increases in the number of mayfly and caddisfly taxa as well as chironomids, especially at sites bdc3.0 and bdc5.0, were largely responsible for the increase in taxa richness at the downstream sites in the fall.

The dominant groups in the fall were again oligochaetes and midges but with tubificid worms replacing the naidid worms in abundance. Tubificid worms were the dominant organisms at sites bdc0.5, bdc2.0, and bdc6.0 comprising 29.0%, 45.3%, and 28.1%RA, respectively, of the community. Two midges, *Cricotopus* sp. and the tolerant *Stictochironomus* sp. were either dominant or co-dominant in the fall. *Cricotopus* sp. was dominant at sites bdc1.0 and bdc5.0 (33.3% and 44.1%RA, respectively), *Stictochironomus* sp. was dominant at sites bdc1.5 and 1.5C (33.7% and 25.7%RA), and both species were co-dominant at site bdc1.5C (46.4%RA). At site bdc3.0, black flies were dominant at 24.2%RA. Numbers of taxa, densities, and dominant taxa tend to even out (less fluctuation) in the fall with more species being dominant among the sites rather than only a few species being dominant as found in spring (Appendix C).

Mayfly relative abundance and number of taxa increased in the fall compared to the spring collections in 2006 which is typical of past years. Total mayfly numbers (densities) however remained similar at the upstream sites for both seasons with little change in the overall density (mean density 1,268 vs. 1,411 organisms/m^2, spring vs. fall). This was not the case at the downstream sites as the mean overall density increased from 400 to 1,492 organisms/m^2 from spring to fall, representing an increase in mean abundance from 2.4% to 15.6%. The relative abundance of mayflies at downstream sites bdc3.0 and bdc5.0 were 26.6% and 25.0%, respectively, with the somewhat sensitive taxon *Fallceon quilleri* the predominant mayfly at both sites. Mayfly abundance also increased at sites bdc2.0 and bdc6.0 by the fall but to a lesser extent (6.8% and 3.8%RA). At the upstream sites, the moderately tolerant mayflies *Acentrella insignificans* and *Tricorythodes* sp. were predominant.

The presence of the beaver dams at sites bdc1.0 and bdc1.5 in the fall of 2006, did not reduce the number of mayfly and caddisfly taxa which was the same as or greater than that recorded in 2004 for these two sites. The upstream vs. downstream relative abundances of these two groups in the fall were also essentially the same in 2006 as in 2004, with a few site-specific differences that were well within the bounds of normal variability for these populations. In fall 2006, the mean relative abundance of mayflies plus caddisflies for the upstream sites was 14.2% (vs.17.4% in 2004) and for the downstream sites was 16.4% (vs. 16.5% in 2004).

Caddisflies were scarce in the fall collections, but were more numerous than found in the spring. Caddisflies were found at all sites except site bdc2.0, and when collected the species were either *Hydropsyche* sp. and/or *Cheumatopsyche* sp. They were again (as in spring) most abundant at site bdc0.5 (1,164 organisms/m^2).

Amphipods were more abundant in the fall than in the spring, which has usually been the case in most monitoring years (Figure 7). Their densities in 2006 were higher than in 2004 when the entire community was affected by wash out during the large summer storm events in that year. Typical of previous years, two species of amphipods were collected, *Crangonyx* sp. and *Hyalella azteca*, with *H. azteca* more abundant at most sites in 2006.

Gastropods have generally been more abundant in the fall than in the spring and were generally scarce prior to the fall of 2001. In recent years however, they have become more numerous and widely distributed, which coincides with the system-wide increase in fish disease rates between 2000 and 2001 (Table 5). Densities were highest in the fall 2002 (drought year), but have generally been decreasing since then as indicated by densities for the 2003, 2004, and 2006 sampling years. In 2006, densities in the fall ranged from 18 to 248 organisms/m^2 (sites bdc5.0 and bdc1.0, respectively) with snails absent at sites bdc2.0 and bdc6.0. Most notably, at site bdc0.5, snail densities (fall) have decreased dramatically from 4,774 organisms/m^2 in 2002, to approximately 500 organisms/m^2 in 2003 and 2004, to only 78 organisms/m^2 in 2006, yet the incidence of fish disease has inexplicably not shown a corresponding decrease at this site as percent disease actually increased at site bdc0.5 in 2006 (Table 5). Although less dramatic, similar decreases in snail densities were also noted at most of the other sites also with no consistent (decreasing) trend in fish disease evident.

Metrics

In addition to the community parameters previously discussed, the following metrics were used to further assess the macroinvertebrate community of Big Dry Creek. The selected metrics include species diversity, ICI, RBP, and HBI and are discussed below with values compared seasonally, spatially, and historically as appropriate (Appendix C).

Species diversity was greater at the upstream sites in the spring than at the downstream sites as has been the case in past years. At the upstream sites, little seasonal change was noted as the mean diversity for both spring and fall was similar (3.58 vs. 3.52, spring vs. fall). However, at the downstream sites diversity improved significantly by the fall with the mean increasing from 1.99 to 3.21 (spring to fall), which was similar to the upstream sites. The substantial decrease in the relative abundance of naidid worms at sites bdc2.0 and bdc3.0 in the fall was the main reason for the increase in the fall diversity index. The improvement in diversity in the fall at the downstream sites has been a typical occurrence during this study indicating that the macroinvertebrate community structure evens out by the fall among the upstream and downstream sites.

Mean ICIs for the upstream sites were similar for both seasons with scores of 23.0 and 24.5 in spring and fall, respectively; whereas for the downstream sites the mean ICI score improved dramatically in the fall increasing from 14.5 to 23.5 (Appendix C). In 2006, as in past years, site bdc2.0 was again the most severely impacted site with scores in the *poor* category in both spring and fall (score was 10 for both seasons). In 2004, it was also in the *poor* category with a score of 8, while in the fall it improved to *fair* with a score of 20. ICI scores at site bdc6.0 were also low in 2006 as in previous years with scores in the spring and fall in the *poor* (12) and *fair* (26) categories, respectively. Historically, sites bdc2.0 and bdc6.0 have been the most impaired sites in the Big Dry Creek biomonitoring study. In both the spring and fall of 2003, 2004 and 2006, most ICI scores at all sites have either been in the *fair* or *poor* categories (Figure 9), indicating the community was stressed enough to depress ICI scores in the Big Dry Creek system. The stressors are primarily due to physical habitat limitations, and to a lesser extent, the chemical characteristics of the stream as it flows through the urban (including storm runoff and discharges from the WWTPs) and agricultural environments of the Big Dry Creek watershed. In recent years, the only sites with ICI scores in the *good* category were bdc0.5 and bdc5.0, both in the fall of 2004, and at site bdc1.0 in the fall of 2003 (AAI 2005b).

The 2006 RBP scores, on the other hand, at the downstream sites in the spring indicate only *moderate* (bdc2.0) to *slight* impairments (bdc6.0) using either bdc1.5 or bdc1.5C as the reference sites, while in the fall these two sites improved to *slight* and *nonimpaired*, respectively (Figure 10, Appendix C). The mean RBP score for the downstream sites improved from 64.3 to 83.0 from spring to fall with the greatest degree of improvement occurring at site bdc2.0 (41.0 to 73.5, spring to fall; 32.5 point increase) while the mean RBP score changed the least at bdc5.0 (86.5 to 91, spring to fall; 4.5 point increase). The apparent low levels of impact as indicated by the resulting RBP condition categories, however are likely artificially elevated because the reference sites (bdc1.5 and bdc1.5C) are already somewhat impaired as indicated by their comparative ICI scores (Figure 10). The RBP scores in the Big Dry Creek study area, therefore should be interpreted with caution as the levels (categories) of impairment are likely to be significantly underestimated due to the use of reference sites in sections of Big Dry Creek that, according to the ICI scores are already stressed. For instance, in the fall at site bdc3.0, the RPB was *nonimpaired* to *slightly impaired* while the ICI rating was only *fair* (Appendix C). Nonetheless, the RBP scores have generally followed the same trends as the ICI scores as shown in Figure 10, and are useful to verify trends indicated by the ICI results as well as other metrics.

Modified HBI values varied little by site or season in 2006 with the lowest (better) value at site bdc3.0 (5.99) in the fall and the highest (worse) values at sites bdc2.0 (8.52) and bdc3.0 (8.05) in the spring. In 2004, HBI values ranged from 6.57 to 8.75 in the spring and in the fall from 5.62 to 7.38 indicating only minor changes between 2004 and 2006 (AAI 2005b). All individual HBI scores in 2006 were >5.99 with mean HBIs ranging from 6.63 to 7.88 (HBI scale 0-10) indicating that the macroinvertebrate community of Big Dry Creek is moderately stressed by organic matter (rather than chemical compounds). Site bdc2.0 had the highest HBI scores in both the spring and fall (8.52 and 7.91, respectively). Historically, the highest HBI score has most frequently, but not always, occurred at site bdc2.0 which is immediately downstream from the Broomfield WWTP discharge, a source of organic matter. However, the stream itself is also a source of organic material which comes from both internal (primary productivity – periphyton and aquatic macrophytes) and external sources (terrestrial inputs such as leaves, grasses, livestock waste, etc.), all of which likely contribute to the relatively high HBI scores that have been recorded at both upstream and downstream sites. Relatively high HBI values are occasionally found downstream from the Westminster WWTP at site bdc3.0, but less frequently than at site bdc2.0. In comparison to 2004, the biggest change among the individual sites was at site bdc0.5 where HBIs increased from 5.77 in 2004 to 7.28 in 2006 (~1.5 point increase). This increase was due to the higher abundance of tolerant tubificid worms in 2006 (29% vs. ~1.0% in 2004) with the increased presence of these worms at the upstream site not readily explainable.

3.3.2 Macroinvertebrate Summary and Conclusions

As noted in past years, the macroinvertebrate community at sites bdc2.0 and bdc3.0 in the spring was typical of that found downstream from WWTP outfalls, consisting mainly of naidid and tubificid worms. Community structure at these sites is no doubt most influenced by the preponderance of soft silt and sand substrates and to a lesser extent by the higher concentrations of whole effluent (greater nutrient loads) from the late fall through the winter months. In contrast, the benthic community may be less affected in the late spring and summer months (irrigation season) when there is more dilution water in the stream due to irrigation and augmentation releases from Standley Lake, ground water contributions from irrigation, urban runoff, and storm events. Recently, there is also less effluent being discharged to the creek when Broomfield and Westminster's water re-use programs are in effect (generally April though November, since 2004), which may have a positive effect on the communities at sites bdc2.0 and bdc3.0. The benthic community at sites farther downstream (sites bdc5.0 and bdc6.0) may not be as affected by effluent in the spring (non-irrigation season) than the two sites downstream from the WWTPs as the effluent gradually degrades and there is more dilution downstream in the drainage from groundwater inflows. During the irrigation season, there is even more dilution in the lower watershed due to irrigation activities and storm runoff. Over the course of this monitoring study, site bdc6.0 and to a lesser extent site bdc2.0 have continued to be the most impacted of all the study sites. At site bdc6.0, community impairment is probably due to poor physical habitat conditions, especially because of dominance of shifting sand and silt substrates, lack of riffle habitats, high turbidity, and fluctuating flows associated with large storm events and irrigation and augmentation activities. Community impairment at site bdc2.0 is also primarily attributable to physical habitat limitations, but with some contribution from the WWTP discharge, especially during the winter months.

Mayflies continued to be somewhat abundant in both spring and fall. Mayflies were more numerous at the upstream sites than at the downstream sites in the spring, while in the fall their abundance was similar for the upstream and downstream sites.

Snails were most prevalent at the upstream sites, especially in the fall as found in previous years, which correlates with the high incidence and severity of black spot disease in the fish population at the upstream sites. Snail densities at site bdc0.5 have decreased dramatically since 2002, however the incidence of fish disease observed at this site in 2006 did not show a corresponding decrease as percent disease actually increased at site bdc0.5. Although less dramatic, similar decreases in snail densities were also noted at most of the other sites also with no apparent decrease in fish disease rates.

Physical habitat changes were noted in the spring at site bdc2.0 and in the fall at sites bdc1.0 and bdc1.5 when more lentic habitat was created by the beaver dams constructed downstream from these study reaches. Regardless, the macroinvertebrates showed no discernable changes in community structure at any of these sites.

Overall, the ICI and RBP results continue to indicate that the community is generally more impaired in the spring than in the fall. As noted in previous years, both the RBP and ICI analyses appeared to be fairly robust measures of macroinvertebrate community condition as these scores correlated well with each other, but the RBP condition categories should be interpreted with some caution as the reference sites used (bdc1.5 and 1.5C) are already degraded as indicated by their respective ICI scores. For instance, the RPB was *nonimpaired* to *slightly impaired* while the ICI rating was only *fair* at site bdc3.0 in the fall. HBI values in 2006 were similar to those in 2004, and as in previous years were generally above 6.00 indicating that the macroinvertebrate population in Big Dry Creek is moderately stressed by organic inputs in addition to the stress caused by poor physical habitat conditions related to the preponderance of shifting silt and sand substrates and flashy flows.

4.0 RECOMMENDATIONS

The following are AAI's proposed recommendations for the Big Dry Creek biological monitoring program for 2008.

1. Terminate spring sampling for benthic macroinvertebrates, which will be permanent unless there is some compelling reason to reinstate.

2. Reduce the number of fall sampling sites to six (6) to include: bdc0.5, bdc1.0, bdc1.5C, bdc2.0, bdc3.0, and bdc5.0 (eliminating site bdc1.5). Keep bdc1.5C (vs. 1.5) because it is the best control site for the downstream sites (site bdc1.5C added in 2000 because habitat was more similar to bdc2.0 and other downstream sites than was site bdc1.5). Keep sites bdc0.5 and bdc1.0 because data are useful in monitoring selenium and urbanization impacts and are important to the Woman Creek Reservoir Authority which has provided significant financial support to the program.

3. If additional funding becomes available the biological monitoring program, then keep site bdc6.0 as there may be future land use changes from agriculture to urbanization in the vicinity of sites bdc5.0 and bdc6.0.

4. Continue to sample both macroinvertebrates and fish because of their importance as biomonitoring tools and their current use in future criteria development by the CWQCD. The CWQCD is currently developing for future use both fish and macroinvertebrate criteria bioassessment tools in support of water quality standard setting. Macroinvertebrate tools are nearly completed with fish in the early stages of development. Furthermore, the 2008 data are important as selenium, total ammonia, and temperature are all current regulatory issues related to aquatic life stream water quality standards.

5. Because of the absence of johnny darters, the low numbers of fish at sites bdc2.0 and bdc3.0 from 2002 through 2004, and the high fish disease rates noted since 2002, continued monitoring will allow for documenting recoveries from flow extremes (2002-2004) and releases of elevated ammonia in 2002.

6. Fish tissue selenium analysis should be continued as part of the 2008 monitoring program to increase the data base at the six key sites: bdc0.5, bdc1.0, bdc1.5C, bdc2.0, bdc3.0, and bdc5.0 (site bdc6.0 would be added if additional funding becomes available). Additional analyses will increase the validity of the selenium concentration data for fish.

7. The RBP habitat assessment should be continued in the fall with the primary purpose to measure and document changes in physical habitat conditions at the monitoring sites. In addition, a brief reconnaissance survey, like that conducted in October 2007, should also performed in the fall of interim years ("off" years, 2009, 2011, etc.) to observe general habitat changes in this highly dynamic watershed, especially considering the significant beaver activity that has been ongoing at sites bdc1.0 and bdc1.5 since the summer of 2006 and the habitat changes observed after major storm events. In addition, with termination of the spring sampling event, site conditions would not be observed for two years.

8. Periphyton sampling may be an additional monitoring task needed in 2008, depending on the progression of nutrient criteria for streams and rivers currently being developed by the CWQCD and Nutrient Work Group.

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APPENDIX A

PHOTOGRAPHIC DOCUMENTATION

Site bdc1.0 – March 2006   Well-developed island at bottom of reach

Site bdc1.0 – October 2006   Electrofishing after beaver dams were breached

Site bdc1.0 – October 2006   Flows receded to “normal” low flow conditions with clear water after beaver dams were breached

Site bdc1.0 – October 2006   Black spot disease in longnose dace

Site bdc1.0 – March 2006   Typical low flow conditions

Site bdc1.0 – October 2007   Well-established beaver dam constructed within sampling reach by 2007 recon survey

Site bdc1.0 – October 2007   The ponded stream and flooded riparian zone observed during 2007 recon survey

Site bdc1.0 – October 2007   Beaver activity and ponded stream near bottom of reach during 2007 recon survey

Site bdc1.5 – March 2006 Low flow conditions and eroded bank in middle of reach, downstream view

Site bdc1.5 – October 2006 Turbid conditions and poor visibility that persisted after beaver dams were breached

Site bdc1.5 – October 2007 Ponded habitat, eroded bank in middle of reach, downstream view during 2007 recon survey

Site bdc1.5 – October 2007 Ponding by beaver dams constructed downstream from reach

Site bdc2.0 – March 2006 Water backed up into reach due to beaver dams near Huron Street

Site bdc2.0 – March 2006 Water back up extended beyond upstream boundary of sampling reach

Site bdc2.0 – October 2006 Typical low flow condition had returned by the fall sampling event after beaver dams were breached

Site bdc3.0 – October 2006 New pedestrian bridge and trail upstream from I-25 completed November 2005

APPENDIX B

FISH POPULATION DATA

FISH POPULATION DATA SUMMARY   FALL 2006
BIG DRY CREEK

RELATIVE ABUNDANCE

	0.5	1.0	1.5	1.5C	2.0	3.0	5.0	6.0
Longnose Dace	20.2	34.4	15.9	8.8	0.3	37.0	4.6	11.2
Creek Chub	11.8	3.2	11.0	17.3	-	-	-	-
Fathead Minnow	64.6	10.6	30.5	22.9	71.7	27.8	4.7	30.5
Sand Shiner	-	49.5	3.7	13.1	0.9	5.9	87.8	30.5
White Sucker	3.3	1.9	25.0	29.4	24.7	10.4	0.8	13.5
Longnose Sucker	0.1	-	-	-	-	-	-	-
Johnny Darter	-	-	-	-	-	-	-	-
Green Sunfish	-	-	6.1	7.3	-	4.9	0.2	0.4
Mosquitofish	-	0.3	3.0	-	2.1	13.8	0.8	5.4
Largemouth Bass	-	0.1	1.8	0.3	-	-	0.5	-
Bluegill	-	-	3.1	1.0	-	-	0.1	-
Yellow Bullhead	-	-	-	-	-	-	<0.1	-
Common Carp	-	-	-	-	0.3	0.3	0.3	4.0
Brook Stickleback	-	-	-	-	-	-	-	4.5

NUMBER COLLECTED

	0.5	1.0	1.5	1.5C	2.0	3.0	5.0	6.0
Longnose Dace	170	746	26	35	1	282	123	25
Creek Chub	99	70	18	69	-	-	-	-
Fathead Minnow	543	231	50	91	241	212	126	68
Sand Shiner	-	1075	6	52	3	45	2336	68
White Sucker	28	42	41	117	83	79	22	30
Longnose Sucker	1	-	-	-	-	-	-	-
Johnny Darter	-	-	-	-	-	-	-	-
Green Sunfish	-	-	10	29	1	37	6	1
Mosquitofish	-	6	5	-	7	105	22	12
Largemouth Bass	-	1	3	1	-	-	14	-
Bluegill	-	-	5	4	-	-	3	-
Yellow Bullhead	-	-	-	-	-	-	1	-
Common Carp	-	-	-	-	-	2	7	9
Brook Stickleback	-	-	-	-	-	-	-	10
Total Collected	841	2171	164	398	336	762	2660	223
Species Collected	5	7	9	8	6	7	10	8

FISH SUMMARY DATA
BIG DRY CREEK   1999-2006
Comparison of Pre- Drought Vs. Drought-Affected Years

	Numbers of Fish Collected							
Years	0.5	1.0	1.5	1.5C	2.0	3.0	5.0	6.0
Pre-Drought Years								
1999	1892	144	226	ns*	967	940	1464	329
2000	1212	360	1141	1149	230	990	1125	156
2001	780	351	290	496	222	152	794	266
3-yr. Mean 1999-2001	1295	285	552	823	473	694	1128	250
Drought-Affected Years								
2002	854	883	382	172	59	88	2612	206
2003	856	831	226	196	9	68	1762	156
2004	226	531	198	72	38	67	674	148
2006	841	2171	164	398	336	762	2660	223

* ns indicates not sampled.

FISH IBI SCORES
BIG DRY CREEK 1999-2006

IBI Score	0.5	1.0	1.5	1.5C	2.0	3.0	5.0	6.0
1999	41	31	29		35	41	41	35
2000	41	37	35	35	31	33	39	31
2001	39	35	27	29	21	29	39	33
2002	33	37	29	27	25	25	39	27
2003	37	37	31	33	21	29	35	33
2004	29	33	33	27	17	31	33	31
2006	33	37	29	31	27	35	41	29
7-yr Mean IBI 1999-2006	36.1	35.3	30.4	30.3	25.3	31.9	38.1	31.3

Pre-Drought Years								
3-yr Mean IBI 1999-2001	40.3	34.3	30.3	32.0	29.0	34.3	39.7	33.0
3-yr mean up/down	34.3 upstream sites				34.0 downstream sites			
Drought-Affected Years								
3-yr Mean IBI 2002-2004	33.0	36.0	30.5	29.5	22.5	30.0	37.0	30.0
3-yr mean up/down	32.3 upstream sites				29.9 downstream sites			
2002 mean	31.5 (range 27-37)				29.0 (range 25-39)			
2003 mean	34.5 (range 31-37)				29.5 (range 21-35)			
2004 mean	30.5 (range 27-33)				28.0 (range 17-33)			
2006 mean	32.5 (range 29-37)				33.0 (range 27-41)			

Condition Category	Score Range
Excellent	53 - 55
Good	44 - 52
Fair	37 - 43
Poor	29 - 36
Very Poor	11 - 28

APPENDIX C

MACROINVERTEBRATE COMMUNITY SUMMARIES AND METRICS

MACROINVERTEBRATE DATA SUMMARY - METRICS COMPARISONS
BIG DRY CREEK SPRING vs. FALL 2006

SPRING 2006

				upstream sites					downstream sites
metric	0.5	1	1.5	1.5C	**Means**	2	3	5	6	**Means**
diversity	3.79	3.83	3.53	3.16	**3.58**	1.35	1.97	2.28	2.34	**1.99**
HBI	6.44	6.68	6.67	6.71	**6.63**	8.52	8.05	7.04	7.92	**7.88**
ICI	22	28	14	28	**23.0**	10	16	20	12	**14.5**
mean RBP						41.0	63.5	86.5	66.0	**64.3**
# taxa	34	39	32	34	**35**	21	26	21	19	**22**
density	13094	11714	10871	21756	**14359**	92284	17254	18136	9978	**34413**

FALL 2006

				upstream sites					downstream sites
metric	0.5	1	1.5	1.5C	**Means**	2	3	5	6	**Means**
diversity	3.83	3.30	3.51	3.44	**3.52**	3.08	3.41	3.11	3.25	**3.21**
HBI	7.28	7.08	6.91	6.97	**7.06**	7.91	5.99	6.66	7.80	**7.09**
ICI	28	22	20	28	**24.5**	10	30	28	26	**23.5**
mean RBP						73.5	80.5	91.0	87.0	**83.0**
# taxa	42	27	33	33	**34**	23	32	36	33	**31**
density	24923	7359	4612	4789	**10421**	3666	14801	5944	7650	**8015**

MACROINVERTEBRATE DATA SUMMARY - ICI AND RBP METRICS COMPARISONS
FALL 2000-2006 Kick Samples

ICI Comparison

		downstream sites				
	1.5	2	3	5	6	mean (all sites)
2000	22	30	36	14	6	21.6
2001	36	14	32	32	8	24.4
2002	24	16	22	28	16	21.2
2003	34	14	22	22	12	20.8
2004	26	20	30	36	8	24.0
2006	20	10	30	28	26	22.8
6-yr mean ICI (for each site)- fall 2000-2006						ICI overall mean (all sites)- fall 2000-2006
	27.0	17.3	28.7	26.7	12.7	22.5

RBP Comparison - 1.5 as Reference Site

	1.5	2	3	5	6	mean (downstream sites)
2000	100	96	100	65	48	77.3
2001	100	57	87	87	48	69.8
2002	100	71	100	100	81	88.0
2003	100	57	52	48	39	49.0
2004	100	54	88	75	46	65.8
2006	100	73	91	95	91	87.5
6-yr mean RBP (for each site)- fall 2000-2006						RBP overall mean (downstream sites)- fall 2000-2006
	100	68.0	86.3	78.3	58.8	72.9

RBP Comparison - 1.5C as Reference Site

	1.5C	2	3	5	6	mean (downstream sites)
2000	100	100	100	61	43	76.0
2001	100	61	91	87	43	70.5
2002	100	62	90	95	86	83.3
2003	100	59	55	55	41	52.5
2004	100	54	88	71	50	65.8
2006	100	74	70	87	83	78.5
6-yr mean RBP (for each site)- fall 2000-2006						RBP overall mean (downstream sites)- fall 2000-2006
	100	68.3	82.3	76.0	57.7	71.1

MACROINVERTEBRATE DATA SUMMARY
BIG DRY CREEK
2006 Summary of Invertebrate Community Index (ICI) Results

	Study Site							
	BDC-0.5	**BDC-1.0**	**BDC-1.5**	**BDC-1.5C**	**BDC-2.0**	**BDC-3.0**	**BDC-5.0**	**BDC-6.0**
Spring 2006								
Kick Samples								
Total Score	22	28	14	28	10	16	20	12
Biological Condition Category	fair	fair	fair	fair	poor	fair	fair	poor
Fall 2006								
Kick Samples								
Total Score	28	22	20	28	10	30	28	26
Biological Condition Category	fair	fair	fair	fair	poor	fair	fair	fair

MACROINVERTEBRATE DATA SUMMARY
BIG DRY CREEK
2006 Summary of Rapid Bioassessment Protocol III Results

	Study Site					
	BDC-1.5	**BDC-1.5C**	**BDC-2.0**	**BDC-3.0**	**BDC-5.0**	**BDC-6.0**
Spring 2006- Kick Samples						
BDC-1.5 to downstream sites						
Total Score	46	42	18	32	38	32
Percent of Reference Score	100	91	39	70	83	70
Biological Condition Category	ref. site	nonimpaired	moderate	slight	nonimpaired	slight
BDC-1.5C to downstream sites						
Total Score		42	18	24	38	26
Percent of Reference Score		100	43	57	90	62
Biological Condition Category		ref. site	moderate	slight	nonimpaired	slight
Fall 2006- Kick Samples						
BDC-1.5 to downstream sites						
Total Score	44	44	32	40	42	40
Percent of Reference Score	100	100	73	91	95	91
Biological Condition Category	ref. site	nonimpaired	slight	nonimpaired	nonimpaired	nonimpaired
BDC-1.5C to downstream sites						
Total Score		46	34	32	40	38
Percent of Reference Score		100	74	70	87	83
Biological Condition Category		ref. site	slight	slight	nonimpaired	nonimpaired

MACROINVERTEBRATE DATA SUMMARY
BIG DRY CREEK SPRING 2006

DENSITY
KICK SAMPLES

Density by Order	BDC-0.5	BDC-1.0	BDC-1.5	BDC-1.5C	BDC-2.0	BDC-3.0	BDC-5.0	BDC-6.0
TURBELLARIA	744	0	0	0	0	28	0	0
OLIGOCHAETA	551	1847	1049	1654	70113	11687	3197	4934
HIRUDINEA	0	0	2	0	0	0	0	0
ISOPODA	0	0	0	0	0	0	0	0
AMPHIPODA	469	55	276	110	316	55	303	1323
DECAPODA	2	0	0	2	0	0	0	0
ACARI	469	83	55	28	0	28	0	0
COLLEMBOLA	0	28	0	0	0	0	0	28
EPHEMEROPTERA	1240	1847	689	1295	0	221	1185	193
ODONATA	28	0	28	28	63	28	0	28
HEMIPTERA	110	0	0	0	0	0	0	0
TRICHOPTERA	799	83	0	110	0	28	138	28
COLEOPTERA	0	0	0	0	126	0	0	0
DIPTERA	8655	7635	8770	18502	21666	5154	13313	3445
GASTROPODA	0	138	2	28	0	28	0	0
BIVALVIA	28	0	0	0	0	0	0	0
Total	13094	11714	10871	21756	92284	17254	18136	9978

RELATIVE ABUNDANCE
KICK SAMPLES

Relative Abundance by Order	BDC-0.5	BDC-1.0	BDC-1.5	BDC-1.5C	BDC-2.0	BDC-3.0	BDC-5.0	BDC-6.0
TURBELLARIA	5.68	0.00	0.00	0.00	0.00	0.16	0.00	0.00
OLIGOCHAETA	4.21	15.76	9.65	7.60	75.98	67.73	17.63	49.45
HIRUDINEA	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
ISOPODA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AMPHIPODA	3.58	0.47	2.54	0.51	0.34	0.32	1.67	13.26
DECAPODA	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
ACARI	3.58	0.71	0.51	0.13	0.00	0.16	0.00	0.00
COLLEMBOLA	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.28
EPHEMEROPTERA	9.47	15.76	6.34	5.95	0.00	1.28	6.53	1.93
ODONATA	0.21	0.00	0.25	0.13	0.07	0.16	0.00	0.28
HEMIPTERA	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRICHOPTERA	6.10	0.71	0.00	0.51	0.00	0.16	0.76	0.28
COLEOPTERA	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00
DIPTERA	66.10	65.18	80.68	85.04	23.48	29.87	73.40	34.53
GASTROPODA	0.00	1.18	0.02	0.13	0.00	0.16	0.00	0.00
BIVALVIA	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

MACROINVERTEBRATE DATA SUMMARY
BIG DRY CREEK FALL 2006

DENSITY
KICK SAMPLES

Density by Order	BDC-0.5	BDC-1.0	BDC-1.5	BDC-1.5C	BDC-2.0	BDC-3.0	BDC-5.0	BDC-6.0
TURBELLARIA	737	0	9	0	0	28	0	178
OLIGOCHAETA	7491	1847	956	864	1668	221	230	2756
HIRUDINEA	0	0	0	0	0	0	0	0
ISOPODA	0	0	0	0	0	0	0	83
AMPHIPODA	932	97	202	28	40	2288	900	1323
DECAPODA	3	0	0	2	0	0	6	0
ACARI	78	13	0	0	0	0	0	28
COLLEMBOLA	0	0	18	0	7	28	9	0
EPHEMEROPTERA	3687	1130	496	331	250	3941	1488	290
ODONATA	0	0	9	9	0	0	13	40
HEMIPTERA	932	13	28	9	103	55	0	0
TRICHOPTERA	1164	153	64	37	0	110	9	167
COLEOPTERA	80	0	18	0	20	276	9	13
DIPTERA	9626	3859	2756	3427	1577	7800	3262	2771
GASTROPODA	78	248	55	83	0	55	18	0
BIVALVIA	116	0	0	0	0	0	0	0
Total	24923	7359	4612	4789	3666	14801	5944	7650

RELATIVE ABUNDANCE
KICK SAMPLES

Relative Abundance by Order	BDC-0.5	BDC-1.0	BDC-1.5	BDC-1.5C	BDC-2.0	BDC-3.0	BDC-5.0	BDC-6.0
TURBELLARIA	2.96	0.00	0.20	0.00	0.00	0.19	0.00	2.33
OLIGOCHAETA	30.06	25.09	20.72	18.04	45.51	1.49	3.86	36.03
HIRUDINEA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ISOPODA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.08
AMPHIPODA	3.74	1.32	4.38	0.58	1.10	15.46	15.15	17.30
DECAPODA	0.01	0.00	0.00	0.04	0.00	0.00	0.09	0.00
ACARI	0.31	0.17	0.00	0.00	0.00	0.00	0.00	0.36
COLLEMBOLA	0.00	0.00	0.40	0.00	0.20	0.19	0.15	0.00
EPHEMEROPTERA	14.79	15.36	10.76	6.91	6.82	26.63	25.04	3.80
ODONATA	0.00	0.00	0.20	0.19	0.00	0.00	0.22	0.53
HEMIPTERA	3.74	0.17	0.60	0.19	2.81	0.37	0.00	0.00
TRICHOPTERA	4.67	2.07	1.39	0.77	0.00	0.74	0.15	2.19
COLEOPTERA	0.32	0.00	0.40	0.00	0.55	1.86	0.15	0.17
DIPTERA	38.62	52.43	59.76	71.57	43.01	52.70	54.87	36.22
GASTROPODA	0.31	3.37	1.20	1.73	0.00	0.37	0.31	0.00
BIVALVIA	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

MACROINVERTEBRATE SUMMARY DATA
COMMUNITY PARAMETERS

SPRING 2006
KICK SAMPLES

	BDC-0.5	BDC-1.0	BDC-1.5	BDC-1.5C	BDC-2.0	BDC-3.0	BDC-5.0	BDC-6.0
Taxa Richness	34	39	32	34	21	26	21	19
Total Density (N/m^2)	13094	11714	10871	21756	92284	17254	18136	9978
Diversity (d)	3.79	3.83	3.53	3.16	1.35	1.97	2.28	2.34
% Dominant Taxon	33.68	22.59	28.14	43.71	75.29	63.90	58.21	46.69
EPT Index	4	5	1	6	0	2	6	3
EPT abundance	2039.63	1929.38	689.06	1405.69	0.00	248.06	1323.00	220.50
Chironomid abundance	8241.19	4933.69	6504.75	16785.56	21602.43	4988.81	12237.75	3224.81
Ratio of EPT to Chironomids	0.25	0.39	0.11	0.08	0.00	0.05	0.11	0.07
Scraper abundance	192.94	937.13	442.84	744.19	568.49	82.69	441.00	55.13
Filterer abundance	1047.38	2756.25	2232.56	1791.56	0.00	137.81	1074.94	220.50
Ratio of Scrapers to Filterers	0.18	0.34	0.20	0.42	n/a	0.60	0.41	0.25
Shredder abundance	4410.00	1764.00	3120.08	9957.41	3347.75	2397.94	10556.44	2177.44
Ratio of Shredders to Total	0.34	0.15	0.29	0.46	0.04	0.14	0.58	0.22
HBI	6.44	6.68	6.67	6.71	8.52	8.05	7.04	7.92
ICI	22	28	14	28	10	16	20	12

FALL 2006
KICK SAMPLES

	BDC-0.5	BDC-1.0	BDC-1.5	BDC-1.5C	BDC-2.0	BDC-3.0	BDC-5.0	BDC-6.0
Taxa Richness	42	27	33	33	23	32	36	33
Total Density (N/m^2)	24923	7359	4612	4789	3666	14801	5944	7650
Diversity (d)	3.83	3.30	3.51	3.44	3.08	3.41	3.11	3.25
% Dominant Taxon	23.67	33.33	33.67	25.71	39.10	24.21	44.05	27.74
EPT Index	6	6	7	9	4	7	8	8
EPT abundance	4851.56	1282.58	560.44	367.50	249.90	4051.69	1497.56	457.54
Chironomid abundance	9198.56	3750.34	2609.25	3031.88	1383.64	4217.06	3215.63	1765.84
Ratio of EPT to Chironomids	0.53	0.34	0.21	0.12	0.18	0.96	0.47	0.26
Scraper abundance	349.31	565.95	284.81	349.13	102.90	55.13	698.25	124.95
Filterer abundance	1397.25	207.64	183.75	422.63	185.59	3693.38	36.75	1144.76
Ratio of Scrapers to Filterers	0.25	2.73	1.55	0.83	0.55	0.01	19.00	0.11
Shredder abundance	3842.44	2453.06	578.81	1029.00	453.86	964.69	2618.44	1214.59
Ratio of Shredders to Total	0.15	0.33	0.13	0.21	0.12	0.07	0.44	0.16
HBI	7.28	7.08	6.91	6.97	7.91	5.99	6.66	7.80
ICI	28	22	20	28	10	30	28	26

MACROINVERTEBRATE DATA SUMMARY
BIG DRY CREEK SPRING 2006
Rapid Bioassessment Protocol III Results

BDC-1.5 as Reference Site

COMMUNITY PARAMETERS
KICK SAMPLES

	BDC-1.5	BDC-1.5C	BDC-2.0	BDC-3.0	BDC-5.0	BDC-6.0
Taxa Richness	32	34	21	26	21	19
Total Density (N/m^2)	10871	21756	92284	17254	18136	9978
Diversity (d)	3.53	3.16	1.35	1.97	2.28	2.34
% Dominant Taxon	28.14	43.71	75.29	63.90	58.21	46.69
EPT Index	1	6	0	2	6	3
EPT abundance	689.06	1405.69	0.00	248.06	1323.00	220.50
Chironomid abundance	6504.75	16785.56	21602.43	4988.81	12237.75	3224.81
Ratio of EPT to Chironomids	0.11	0.08	0.00	0.05	0.11	0.07
Scraper abundance	442.84	744.19	568.49	82.69	441.00	55.13
Filterer abundance	2232.56	1791.56	0.00	137.81	1074.94	220.50
Ratio of Scrapers to Filterers	0.20	0.42	n/a	0.60	0.41	0.25
Shredder abundance	3120.08	9957.41	3347.75	2397.94	10556.44	2177.44
Ratio of Shredders to Total	0.29	0.46	0.04	0.14	0.58	0.22
Modified HBI	6.67	6.71	8.52	8.05	7.04	7.92
Community Loss Index	n/a	0.32	0.76	0.54	0.81	1.05
Total Score	46	42	18	32	38	32
Percent of Reference Score	100	91	39	70	83	70
Biological Condition Category	ref. site	nonimpaired	moderate	slight	nonimpaired	slight

BDC-1.5C as Reference Site

COMMUNITY PARAMETERS
KICK SAMPLES

	BDC-1.5C	BDC-2.0	BDC-3.0	BDC-5.0	BDC-6.0
Taxa Richness	34	21	26	21	19
Total Density (N/m^2)	21756	92284	17254	18136	9978
Diversity (d)	3.16	1.35	1.97	2.28	2.34
% Dominant Taxon	43.71	75.29	63.90	58.21	46.69
EPT Index	6	0	2	6	3
EPT abundance	1405.69	0.00	248.06	1323.00	220.50
Chironomid abundance	16785.56	21602.43	4988.81	12237.75	3224.81
Ratio of EPT to Chironomids	0.08	0.00	0.05	0.11	0.07
Scraper abundance	744.19	568.49	82.69	441.00	55.13
Filterer abundance	1791.56	0.00	137.81	1074.94	220.50
Ratio of Scrapers to Filterers	0.42	n/a	0.60	0.41	0.25
Shredder abundance	9957.41	3347.75	2397.94	10556.44	2177.44
Ratio of Shredders to Total	0.46	0.04	0.14	0.58	0.22
Modified HBI	6.71	8.52	8.05	7.04	7.92
Community Loss Index	n/a	0.95	0.65	0.86	1.11
Total Score	42	18	24	38	26
Percent of Reference Score	100	43	57	90	62
Biological Condition Category	ref. site	moderate	slight	nonimpaired	slight

MACROINVERTEBRATE DATA SUMMARY
BIG DRY CREEK FALL 2006
Rapid Bioassessment Protocol III Results

BDC-1.5 as Reference Site

COMMUNITY PARAMETERS
KICK SAMPLES

	BDC-1.5	BDC-1.5C	BDC-2.0	BDC-3.0	BDC-5.0	BDC-6.0
Taxa Richness	33	33	23	32	36	33
Total Density (N/m^2)	4612	4789	3666	14801	5944	7650
Diversity (d)	3.51	3.44	3.08	3.41	3.11	3.25
% Dominant Taxon	33.67	25.71	39.10	24.21	44.05	27.74
EPT Index	7	9	4	7	8	8
EPT abundance	560.44	367.50	249.90	4051.69	1497.56	457.54
Chironomid abundance	2609.25	3031.88	1383.64	4217.06	3215.63	1765.84
Ratio of EPT to Chironomids	0.21	0.12	0.18	0.96	0.47	0.26
Scraper abundance	284.81	349.13	102.90	55.13	698.25	124.95
Filterer abundance	183.75	422.63	185.59	3693.38	36.75	1144.76
Ratio of Scrapers to Filterers	1.55	0.83	0.55	0.01	19.00	0.11
Shredder abundance	578.81	1029.00	453.86	964.69	2618.44	1214.59
Ratio of Shredders to Total	0.13	0.21	0.12	0.07	0.44	0.16
Modified HBI	6.91	6.97	7.91	5.99	6.66	7.80
Community Loss Index	n/a	0.45	0.70	0.38	0.25	0.39
Total Score	44	44	32	40	42	40
Percent of Reference Score	100	100	73	91	95	91
Biological Condition Category	ref. site	nonimpaired	slight	nonimpaired	nonimpaired	nonimpaired

BDC-1.5C as Reference Site

COMMUNITY PARAMETERS
KICK SAMPLES

	BDC-1.5C	BDC-2.0	BDC-3.0	BDC-5.0	BDC-6.0
Taxa Richness	33	23	32	36	33
Total Density (N/m^2)	4789	3666	14801	5944	7650
Diversity (d)	3.44	3.08	3.41	3.11	3.25
% Dominant Taxon	25.71	39.10	24.21	44.05	27.74
EPT Index	9	4	7	8	8
EPT abundance	367.50	249.90	4051.69	1497.56	457.54
Chironomid abundance	3031.88	1383.64	4217.06	3215.63	1765.84
Ratio of EPT to Chironomids	0.12	0.18	0.96	0.47	0.26
Scraper abundance	349.13	102.90	55.13	698.25	124.95
Filterer abundance	422.63	185.59	3693.38	36.75	1144.76
Ratio of Scrapers to Filterers	0.83	0.55	0.01	19.00	0.11
Shredder abundance	1029.00	453.86	964.69	2618.44	1214.59
Ratio of Shredders to Total	0.21	0.12	0.07	0.44	0.16
Modified HBI	6.97	7.91	5.99	6.66	7.80
Community Loss Index	n/a	0.70	0.44	0.31	0.48
Total Score	46	34	32	40	38
Percent of Reference Score	100	74	70	87	83
Biological Condition Category	ref. site	slight	slight	nonimpaired	nonimpaired

APPENDIX D

MACROINVERTEBRATE DATA

BDC-0.5

Sample Date: 17 March 2006

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
TURBELLARIA			
Dugesia sp.	405	744.19	5.68
OLIGOCHAETA			
Enchytraeidae			
Lumbricidae	60	110.25	0.84
Nais spp.			
Ophidonais serpentina			
Tubificidae with hair chaetae	45	82.69	0.63
Tubificidae w/o hair chaetae	195	358.31	2.74
HIRUNDINEA			
Mooreobdella microstoma			
AMPHIPODA			
Crangonyx sp.	255	468.56	3.58
Hyalella azteca			
DECAPODA			
Orconectes sp.	1	1.84	0.01
ACARI			
Sperchon sp.	255	468.56	3.58
COLLEMBOLA			
EPHEMEROPTERA			
Acentrella insignificans			
Baetis tricaudatus	105	192.94	1.47
Fallceon quilleri			
Heptagenia diabasia			
Tricorythodes minutus	570	1047.38	8.00
ODONATA			
Coenagrionidae	15	27.56	0.21
Hetaerina americana			
Ophiogomphus severus			
HEMIPTERA			
Sigara grossolineata	60	110.25	0.84
TRICHOPTERA			
Cheumatopsyche sp.	405	744.19	5.68
Hydropsyche sp.			
Hydroptila sp.	30	55.13	0.42
COLEOPTERA			
Agabus sp.			
DIPTERA			
Brillia sp.			
Caloparyphus sp.	45	82.69	0.63
Ceratopogonidae	30	55.13	0.42
Chironomus sp.	15	27.56	0.21
Cladotanytarsus sp.			
Cricotopus sp.	2400	4410.00	33.68
Cryptochironomus sp.	30	55.13	0.42
Dasyhelea sp.			
Diamesa sp.			
Dicrotendipes sp.	360	661.50	5.05
Eukiefferiella sp.	345	633.94	4.84
Hydrobaenus sp.	60	110.25	0.84
Limnophyes sp.			
Micropsectra sp.	75	137.81	1.05
Microtendipes sp.			
Nanocladius sp.	30	55.13	0.42
Neoplasta sp.			
Odontomesa sp.	75	137.81	1.05

BDC-0.5 (Continued)

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
DIPTERA (continued)			
Pagastia sp.	15	27.56	0.21
Parakiefferiella sp.	90	165.38	1.26
Parametriocnemus sp.	120	220.50	1.68
Paraphaenocladius sp.			
Paratanytarsus sp.	465	854.44	6.53
Paratendipes sp.			
Phaenopsectra sp.	15	27.56	0.21
Polypedilum sp.			
Saetheria tylus			
Simulium vittatum complex	150	275.63	2.10
Stictochironomus sp.	105	192.94	1.47
Thienemanniella sp.			
Thienemannimyia group	180	330.75	2.53
Tipula sp.			
Tvetenia sp.	105	192.94	1.47
GASTROPODA			
Ferrissia sp.			
Physidae			
BIVALVIA			
Pisidium sp.	15	27.56	0.21
Totals:	7126	13094.03	100.00

Total Density (N/m^2)	13094
Total Number of Taxa	34
Diversity (d)	3.79

BDC-0.5

Community Parameters	Kick Sample	
Total Density (N/m^2)	13094	
Diversity (d)	3.79	
Total Number of Taxa	34	
% Dominant Taxon	33.68	
EPT Richness 2/0/2	4	
EPT (abundance)	2039.63	
Chiron (abundance)	8241.19	
EPT/Chironomid ratio	0.25	
Scraper (abundance)	192.94	
Filterer (abundance)	1047.38	
SC/F ratio	0.18	
Shredder (abundance)	4410.00	
SH/Total ratio	0.34	
HBI	6.44	
ICI	22	fair

Relative Abundance by Order	
TURBELLARIA	5.68
NEMATODA	0
OLIGOCHAETA	4.21
HIRUDINEA	0.00
ISOPODA	0
AMPHIPODA	3.58
DECAPODA	0.01
ACARI	3.58
COLLEMBOLA	0.00
EPHEMEROPTERA	9.47
ODONATA	0.21
HEMIPTERA	0.84
TRICHOPTERA	6.10
COLEOPTERA	0.00
DIPTERA	66.10
GASTROPODA	0.00
BIVALVIA	0.21
Totals:	100.00

Density by Order	
TURBELLARIA	744
NEMATODA	0
OLIGOCHAETA	551
HIRUDINEA	0
ISOPODA	0
AMPHIPODA	469
DECAPODA	2
ACARI	469
COLLEMBOLA	0
EPHEMEROPTERA	1240
ODONATA	28
HEMIPTERA	110
TRICHOPTERA	799
COLEOPTERA	0
DIPTERA	8655
GASTROPODA	0
BIVALVIA	28
Totals:	13094

BDC-1.0

Sample Date: 17 March 2006

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
TURBELLARIA			
Dugesia sp.			
OLIGOCHAETA			
Enchytraeidae	75	137.81	1.18
Lumbricidae			
Nais spp.	675	1240.31	10.59
Ophidonais serpentina			
Tubificidae with hair chaetae	75	137.81	1.18
Tubificidae w/o hair chaetae	180	330.75	2.82
HIRUNDINEA			
Mooreobdella microstoma			
AMPHIPODA			
Crangonyx sp.	15	27.56	0.24
Hyalella azteca	15	27.56	0.24
DECAPODA			
Orconectes sp.			
ACARI			
Sperchon sp.	45	82.69	0.71
COLLEMBOLA	15	27.56	0.24
EPHEMEROPTERA			
Acentrella insignificans			
Baetis tricaudatus	825	1515.94	12.94
Fallceon quilleri	15	27.56	0.24
Heptagenia diabasia	15	27.56	0.24
Tricorythodes minutus	150	275.63	2.35
ODONATA			
Coenagrionidae			
Hetaerina americana			
Ophiogomphus severus			
HEMIPTERA			
Sigara grossolineata			
TRICHOPTERA			
Cheumatopsyche sp.	45	82.69	0.71
Hydropsyche sp.			
Hydroptila sp.			
COLEOPTERA			
Agabus sp.			
DIPTERA			
Brillia sp.	15	27.56	0.24
Caloparyphus sp.			
Ceratopogonidae			
Chironomus sp.	45	82.69	0.71
Cladotanytarsus sp.			
Cricotopus sp.	885	1626.19	13.88
Cryptochironomus sp.	15	27.56	0.24
Dasyhelea sp.	15	27.56	0.24
Diamesa sp.	15	27.56	0.24
Dicrotendipes sp.	15	27.56	0.24
Eukiefferiella sp.	165	303.19	2.59
Hydrobaenus sp.	315	578.81	4.94
Limnophyes sp.	15	27.56	0.24
Micropsectra sp.	60	110.25	0.94
Microtendipes sp.	15	27.56	0.24
Nanocladius sp.	15	27.56	0.24
Neoplasta sp.			
Odontomesa sp.	30	55.13	0.47

BDC-1.0 (Continued)

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
DIPTERA (continued)			
Pagastia sp.			
Parakiefferiella sp.	510	937.13	8.00
Parametriocnemus sp.	60	110.25	0.94
Paraphaenocladius sp.	15	27.56	0.24
Paratanytarsus sp.	105	192.94	1.65
Paratendipes sp.			
Phaenopsectra sp.	105	192.94	1.65
Polypedilum sp.	45	82.69	0.71
Saetheria tylus			
Simulium vittatum complex	1440	2646.00	22.59
Stictochironomus sp.	180	330.75	2.82
Thienemanniella sp.			
Thienemannimyia group	45	82.69	0.71
Tipula sp.	15	27.56	0.24
Tvetenia sp.	15	27.56	0.24
GASTROPODA			
Ferrissia sp.	75	137.81	1.18
Physidae			
BIVALVIA			
Pisidium sp.			
Totals:	6375	11714.06	100.00

Total Density (N/m^2)	11714
Total Number of Taxa	39
Diversity (d)	3.83

BDC-1.0

Community Parameters	Kick Sample	
Total Density (N/m^2)	11714	
Diversity (d)	3.83	
Total Number of Taxa	39	
% Dominant Taxon	22.59	
EPT Richness 4/0/1	5	
EPT (abundance)	1929.38	
Chiron (abundance)	4933.69	
EPT/Chironomid ratio	0.39	
Scraper (abundance)	937.13	
Filterer (abundance)	2756.25	
SC/F ratio	0.34	
Shredder (abundance)	1764.00	
SH/Total ratio	0.15	
HBI	6.68	
ICI	28	fair

Relative Abundance by Order	
TURBELLARIA	0.00
NEMATODA	0
OLIGOCHAETA	15.76
HIRUDINEA	0.00
ISOPODA	0
AMPHIPODA	0.47
DECAPODA	0.00
ACARI	0.71
COLLEMBOLA	0.24
EPHEMEROPTERA	15.76
ODONATA	0.00
HEMIPTERA	0.00
TRICHOPTERA	0.71
COLEOPTERA	0.00
DIPTERA	65.18
GASTROPODA	1.18
BIVALVIA	0.00
Totals:	100.00

Density by Order	
TURBELLARIA	0
NEMATODA	0
OLIGOCHAETA	1847
HIRUDINEA	0
ISOPODA	0
AMPHIPODA	55
DECAPODA	0
ACARI	83
COLLEMBOLA	28
EPHEMEROPTERA	1847
ODONATA	0
HEMIPTERA	0
TRICHOPTERA	83
COLEOPTERA	0
DIPTERA	7635
GASTROPODA	138
BIVALVIA	0
Totals:	11714

BDC-1.5

Sample Date: 17 March 2006

Taxon	Kick Sample n	N/m²	Relative Abundance (%)
TURBELLARIA			
Dugesia sp.			
OLIGOCHAETA			
Enchytraeidae	15	27.56	0.25
Lumbricidae	1	1.84	0.02
Nais spp.	285	523.69	4.82
Ophidonais serpentina			
Tubificidae with hair chaetae	75	137.81	1.27
Tubificidae w/o hair chaetae	195	358.31	3.30
HIRUNDINEA			
Mooreobdella microstoma	1	1.84	0.02
AMPHIPODA			
Crangonyx sp.	75	137.81	1.27
Hyalella azteca	75	137.81	1.27
DECAPODA			
Orconectes sp.			
ACARI			
Sperchon sp.	30	55.13	0.51
COLLEMBOLA			
EPHEMEROPTERA			
Acentrella insignificans			
Baetis tricaudatus	375	689.06	6.34
Fallceon quilleri			
Heptagenia diabasia			
Tricorythodes minutus			
ODONATA			
Coenagrionidae	15	27.56	0.25
Hetaerina americana			
Ophiogomphus severus			
HEMIPTERA			
Sigara grossolineata			
TRICHOPTERA			
Cheumatopsyche sp.			
Hydropsyche sp.			
Hydroptila sp.			
COLEOPTERA			
Agabus sp.			
DIPTERA			
Brillia sp.	30	55.13	0.51
Caloparyphus sp.			
Ceratopogonidae			
Chironomus sp.			
Cladotanytarsus sp.			
Cricotopus sp.	1665	3059.44	28.14
Cryptochironomus sp.	105	192.94	1.77
Dasyhelea sp.			
Diamesa sp.	60	110.25	1.01
Dicrotendipes sp.			
Eukiefferiella sp.	135	248.06	2.28
Hydrobaenus sp.	195	358.31	3.30
Limnophyes sp.			
Micropsectra sp.	60	110.25	1.01
Microtendipes sp.			
Nanocladius sp.	75	137.81	1.27
Neoplasta sp.	15	27.56	0.25
Odontomesa sp.	15	27.56	0.25

BDC-1.5 (Continued)

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
DIPTERA (continued)			
Pagastia sp.	15	27.56	0.25
Parakiefferiella sp.	660	1212.75	11.16
Parametriocnemus sp.	105	192.94	1.77
Paraphaenocladius sp.			
Paratanytarsus sp.	30	55.13	0.51
Paratendipes sp.			
Phaenopsectra sp.	45	82.69	0.76
Polypedilum sp.			
Saetheria tylus			
Simulium vittatum complex	1215	2232.56	20.54
Stictochironomus sp.	75	137.81	1.27
Thienemanniella sp.	135	248.06	2.28
Thienemannimyia group	135	248.06	2.28
Tipula sp.	3	5.51	0.05
Tvetenia sp.			
GASTROPODA			
Ferrissia sp.			
Physidae	1	1.84	0.02
BIVALVIA			
Pisidium sp.			
Totals:	5916	10870.65	100.00

Total Density (N/m^2)		10871
Total Number of Taxa		32
Diversity (d)		3.53

BDC-1.5

Community Parameters	Kick Sample	
Total Density (N/m^2)	10871	
Diversity (d)	3.53	
Total Number of Taxa	32	
% Dominant Taxon	28.14	
EPT Richness 1/0/0	1	
EPT (abundance)	689.06	
Chiron (abundance)	6504.75	
EPT/Chironomid ratio	0.11	
Scraper (abundance)	442.84	
Filterer (abundance)	2232.56	
SC/F ratio	0.20	
Shredder (abundance)	3120.08	
SH/Total ratio	0.29	
HBI	6.67	
ICI	14	fair

Relative Abundance by Order	
TURBELLARIA	0.00
NEMATODA	0
OLIGOCHAETA	9.65
HIRUDINEA	0.02
ISOPODA	0
AMPHIPODA	2.54
DECAPODA	0.00
ACARI	0.51
COLLEMBOLA	0.00
EPHEMEROPTERA	6.34
ODONATA	0.25
HEMIPTERA	0.00
TRICHOPTERA	0.00
COLEOPTERA	0.00
DIPTERA	80.68
GASTROPODA	0.02
BIVALVIA	0.00
Totals:	100.00

Density by Order	
TURBELLARIA	0
NEMATODA	0
OLIGOCHAETA	1049
HIRUDINEA	2
ISOPODA	0
AMPHIPODA	276
DECAPODA	0
ACARI	55
COLLEMBOLA	0
EPHEMEROPTERA	689
ODONATA	28
HEMIPTERA	0
TRICHOPTERA	0
COLEOPTERA	0
DIPTERA	8770
GASTROPODA	2
BIVALVIA	0
Totals:	10871

BDC-1.5C

Sample Date: 17 March 2006

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
TURBELLARIA			
Dugesia sp.			
OLIGOCHAETA			
Enchytraeidae			
Lumbricidae			
Nais spp.	495	909.56	4.18
Ophidonais serpentina			
Tubificidae with hair chaetae	60	110.25	0.51
Tubificidae w/o hair chaetae	345	633.94	2.91
HIRUNDINEA			
Mooreobdella microstoma			
AMPHIPODA			
Crangonyx sp.	60	110.25	0.51
Hyalella azteca			
DECAPODA			
Orconectes sp.	1	1.84	0.01
ACARI			
Sperchon sp.	15	27.56	0.13
COLLEMBOLA			
EPHEMEROPTERA			
Acentrella insignificans			
Baetis tricaudatus	615	1130.06	5.19
Fallceon quilleri			
Heptagenia diabasia	15	27.56	0.13
Tricorythodes minutus	75	137.81	0.63
ODONATA			
Coenagrionidae			
Hetaerina americana	15	27.56	0.13
Ophiogomphus severus			
HEMIPTERA			
Sigara grossolineata			
TRICHOPTERA			
Cheumatopsyche sp.	15	27.56	0.13
Hydropsyche sp.	30	55.13	0.25
Hydroptila sp.	15	27.56	0.13
COLEOPTERA			
Agabus sp.			
DIPTERA			
Brillia sp.	150	275.63	1.27
Caloparyphus sp.			
Ceratopogonidae			
Chironomus sp.	45	82.69	0.38
Cladotanytarsus sp.			
Cricotopus sp.	5175	9509.06	43.71
Cryptochironomus sp.	60	110.25	0.51
Dasyhelea sp.			
Diamesa sp.	210	385.88	1.77
Dicrotendipes sp.			
Eukiefferiella sp.	150	275.63	1.27
Hydrobaenus sp.	270	496.13	2.28
Limnophyes sp.	15	27.56	0.13
Micropsectra sp.	375	689.06	3.17
Microtendipes sp.			
Nanocladius sp.			
Neoplasta sp.			
Odontomesa sp.			

BDC-1.5C (Continued)

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
DIPTERA (continued)			
Pagastia sp.			
Parakiefferiella sp.	1620	2976.75	13.68
Parametriocnemus sp.	210	385.88	1.77
Paraphaenocladius sp.			
Paratanytarsus sp.			
Paratendipes sp.			
Phaenopsectra sp.	90	165.38	0.76
Polypedilum sp.	90	165.38	0.76
Saetheria tylus	45	82.69	0.38
Simulium vittatum complex	930	1708.88	7.85
Stictochironomus sp.	345	633.94	2.91
Thienemanniella sp.	75	137.81	0.63
Thienemannimyia group	180	330.75	1.52
Tipula sp.	4	7.35	0.03
Tvetenia sp.	30	55.13	0.25
GASTROPODA			
Ferrissia sp.	15	27.56	0.13
Physidae			
BIVALVIA			
Pisidium sp.			
Totals:	11840	21756.00	100.00

Total Density (N/m^2)	21756
Total Number of Taxa	34
Diversity (d)	3.16

BDC-1.5C

Community Parameters	Kick Sample	
Total Density (N/m^2)	21756	
Diversity (d)	3.16	
Total Number of Taxa	34	
% Dominant Taxon	43.71	
EPT Richness 3/0/3	6	
EPT (abundance)	1405.69	
Chiron (abundance)	16785.56	
EPT/Chironomid ratio	0.08	
Scraper (abundance)	744.19	
Filterer (abundance)	1791.56	
SC/F ratio	0.42	
Shredder (abundance)	9957.41	
SH/Total ratio	0.46	
HBI	6.71	
ICI	28	fair

Relative Abundance by Order	
TURBELLARIA	0.00
NEMATODA	0
OLIGOCHAETA	7.60
HIRUDINEA	0.00
ISOPODA	0
AMPHIPODA	0.51
DECAPODA	0.01
ACARI	0.13
COLLEMBOLA	0.00
EPHEMEROPTERA	5.95
ODONATA	0.13
HEMIPTERA	0.00
TRICHOPTERA	0.51
COLEOPTERA	0.00
DIPTERA	85.04
GASTROPODA	0.13
BIVALVIA	0.00
Totals:	100.00

Density by Order	
TURBELLARIA	0
NEMATODA	0
OLIGOCHAETA	1654
HIRUDINEA	0
ISOPODA	0
AMPHIPODA	110
DECAPODA	2
ACARI	28
COLLEMBOLA	0
EPHEMEROPTERA	1295
ODONATA	28
HEMIPTERA	0
TRICHOPTERA	110
COLEOPTERA	0
DIPTERA	18502
GASTROPODA	28
BIVALVIA	0
Totals:	21756

BDC-2.0

Sample Date: 17 March 2006 Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
TURBELLARIA			
Dugesia sp.			
OLIGOCHAETA			
Enchytraeidae			
Lumbricidae			
Nais spp.	33000	69481.50	75.29
Ophidonais serpentina			
Tubificidae with hair chaetae	90	189.50	0.21
Tubificidae w/o hair chaetae	210	442.16	0.48
HIRUNDINEA			
Mooreobdella microstoma			
AMPHIPODA			
Crangonyx sp.	150	315.83	0.34
Hyalella azteca			
DECAPODA			
Orconectes sp.			
ACARI			
Sperchon sp.			
COLLEMBOLA			
EPHEMEROPTERA			
Acentrella insignificans			
Baetis tricaudatus			
Fallceon quilleri			
Heptagenia diabasia			
Tricorythodes minutus			
ODONATA			
Coenagrionidae	30	63.17	0.07
Hetaerina americana			
Ophiogomphus severus			
HEMIPTERA			
Sigara grossolineata			
TRICHOPTERA			
Cheumatopsyche sp.			
Hydropsyche sp.			
Hydroptila sp.			
COLEOPTERA			
Agabus sp.	60	126.33	0.14
DIPTERA			
Brillia sp.	60	126.33	0.14
Caloparyphus sp.			
Ceratopogonidae			
Chironomus sp.	360	757.98	0.82
Cladotanytarsus sp.	90	189.50	0.21
Cricotopus sp.	1530	3221.42	3.49
Cryptochironomus sp.	120	252.66	0.27
Dasyhelea sp.			
Diamesa sp.			
Dicrotendipes sp.	60	126.33	0.14
Eukiefferiella sp.			
Hydrobaenus sp.	180	378.99	0.41
Limnophyes sp.			
Micropsectra sp.	6720	14148.96	15.33
Microtendipes sp.			
Nanocladius sp.			
Neoplasta sp.	30	63.17	0.07
Odontomesa sp.	240	505.32	0.55

BDC-2.0 (Continued)

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
DIPTERA (continued)			
Pagastia sp.			
Parakiefferiella sp.	510	1073.81	1.16
Parametriocnemus sp.			
Paraphaenocladius sp.			
Paratanytarsus sp.			
Paratendipes sp.	30	63.17	0.07
Phaenopsectra sp.	90	189.50	0.21
Polypedilum sp.			
Saetheria tylus			
Simulium vittatum complex			
Stictochironomus sp.	180	378.99	0.41
Thienemanniella sp.			
Thienemannimyia group	90	189.50	0.21
Tipula sp.			
Tvetenia sp.			
GASTROPODA			
Ferrissia sp.			
Physidae			
BIVALVIA			
Pisidium sp.			
Totals:	43830	92284.07	100.00

Total Density (N/m^2)	92284
Total Number of Taxa	21
Diversity (d)	1.35

BDC-2.0

Community Parameters	Kick Sample	
Total Density (N/m^2)	92284	
Diversity (d)	1.35	
Total Number of Taxa	21	
% Dominant Taxon	75.29	
EPT Richness 0/0/0	0	
EPT (abundance)	0.00	
Chiron (abundance)	21602.43	
EPT/Chironomid ratio	0.00	
Scraper (abundance)	568.49	
Filterer (abundance)	0.00	
SC/F ratio	n/a	
Shredder (abundance)	3347.75	
SH/Total ratio	0.04	
HBI	8.52	
ICI	10	poor

Relative Abundance by Order	
TURBELLARIA	0.00
NEMATODA	0
OLIGOCHAETA	75.98
HIRUDINEA	0.00
ISOPODA	0
AMPHIPODA	0.34
DECAPODA	0.00
ACARI	0.00
COLLEMBOLA	0.00
EPHEMEROPTERA	0.00
ODONATA	0.07
HEMIPTERA	0.00
TRICHOPTERA	0.00
COLEOPTERA	0.14
DIPTERA	23.48
GASTROPODA	0.00
BIVALVIA	0.00
Totals:	100.00

Density by Order	
TURBELLARIA	0
NEMATODA	0
OLIGOCHAETA	70113
HIRUDINEA	0
ISOPODA	0
AMPHIPODA	316
DECAPODA	0
ACARI	0
COLLEMBOLA	0
EPHEMEROPTERA	0
ODONATA	63
HEMIPTERA	0
TRICHOPTERA	0
COLEOPTERA	126
DIPTERA	21666
GASTROPODA	0
BIVALVIA	0
Totals:	92284

BDC-3.0

Sample Date: 17 March 2006

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
TURBELLARIA			
Dugesia sp.	15	27.56	0.16
OLIGOCHAETA			
Enchytraeidae			
Lumbricidae			
Nais spp.	6000	11025.00	63.90
Ophidonais serpentina	315	578.81	3.35
Tubificidae with hair chaetae			
Tubificidae w/o hair chaetae	45	82.69	0.48
HIRUNDINEA			
Mooreobdella microstoma			
AMPHIPODA			
Crangonyx sp.	15	27.56	0.16
Hyalella azteca	15	27.56	0.16
DECAPODA			
Orconectes sp.			
ACARI			
Sperchon sp.	15	27.56	0.16
COLLEMBOLA			
EPHEMEROPTERA			
Acentrella insignificans			
Baetis tricaudatus	120	220.50	1.28
Fallceon quilleri			
Heptagenia diabasia			
Tricorythodes minutus			
ODONATA			
Coenagrionidae	15	27.56	0.16
Hetaerina americana			
Ophiogomphus severus			
HEMIPTERA			
Sigara grossolineata			
TRICHOPTERA			
Cheumatopsyche sp.			
Hydropsyche sp.			
Hydroptila sp.	15	27.56	0.16
COLEOPTERA			
Agabus sp.			
DIPTERA			
Brillia sp.			
Caloparyphus sp.			
Ceratopogonidae	15	27.56	0.16
Chironomus sp.			
Cladotanytarsus sp.	30	55.13	0.32
Cricotopus sp.	1305	2397.94	13.90
Cryptochironomus sp.	15	27.56	0.16
Dasyhelea sp.			
Diamesa sp.			
Dicrotendipes sp.			
Eukiefferiella sp.	90	165.38	0.96
Hydrobaenus sp.	15	27.56	0.16
Limnophyes sp.	30	55.13	0.32
Micropsectra sp.	840	1543.50	8.95
Microtendipes sp.			
Nanocladius sp.			
Neoplasta sp.			
Odontomesa sp.	15	27.56	0.16

BDC-3.0 (Continued)

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
DIPTERA (continued)			
Pagastia sp.			
Parakiefferiella sp.	285	523.69	3.04
Parametriocnemus sp.	45	82.69	0.48
Paraphaenocladius sp.	15	27.56	0.16
Paratanytarsus sp.			
Paratendipes sp.			
Phaenopsectra sp.			
Polypedilum sp.			
Saetheria tylus	15	27.56	0.16
Simulium vittatum complex	75	137.81	0.80
Stictochironomus sp.	15	27.56	0.16
Thienemanniella sp.			
Thienemannimyia group			
Tipula sp.			
Tvetenia sp.			
GASTROPODA			
Ferrissia sp.			
Physidae	15	27.56	0.16
BIVALVIA			
Pisidium sp.			
Totals:	9390	17254.13	100.00

Total Density (N/m^2)	17254
Total Number of Taxa	26
Diversity (d)	1.97

BDC-3.0

Community Parameters	Kick Sample	
Total Density (N/m^2)	17254	
Diversity (d)	1.97	
Total Number of Taxa	26	
% Dominant Taxon	63.90	
EPT Richness 1/0/1	2	
EPT (abundance)	248.06	
Chiron (abundance)	4988.81	
EPT/Chironomid ratio	0.05	
Scraper (abundance)	82.69	
Filterer (abundance)	137.81	
SC/F ratio	0.60	
Shredder (abundance)	2397.94	
SH/Total ratio	0.14	
HBI	8.05	
ICI	16	fair

Relative Abundance by Order	
TURBELLARIA	0.16
NEMATODA	0
OLIGOCHAETA	67.73
HIRUDINEA	0.00
ISOPODA	0
AMPHIPODA	0.32
DECAPODA	0.00
ACARI	0.16
COLLEMBOLA	0.00
EPHEMEROPTERA	1.28
ODONATA	0.16
HEMIPTERA	0.00
TRICHOPTERA	0.16
COLEOPTERA	0.00
DIPTERA	29.87
GASTROPODA	0.16
BIVALVIA	0.00
Totals:	100.00

Density by Order	
TURBELLARIA	28
NEMATODA	0
OLIGOCHAETA	11687
HIRUDINEA	0
ISOPODA	0
AMPHIPODA	55
DECAPODA	0
ACARI	28
COLLEMBOLA	0
EPHEMEROPTERA	221
ODONATA	28
HEMIPTERA	0
TRICHOPTERA	28
COLEOPTERA	0
DIPTERA	5154
GASTROPODA	28
BIVALVIA	0
Totals:	17254

BDC-5.0

Sample Date: 17 March 2006

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
TURBELLARIA			
Dugesia sp.			
OLIGOCHAETA			
Enchytraeidae	30	55.13	0.30
Lumbricidae			
Nais spp.	1710	3142.13	17.33
Ophidonais serpentina			
Tubificidae with hair chaetae			
Tubificidae w/o hair chaetae			
HIRUNDINEA			
Mooreobdella microstoma			
AMPHIPODA			
Crangonyx sp.	75	137.81	0.76
Hyalella azteca	90	165.38	0.91
DECAPODA			
Orconectes sp.			
ACARI			
Sperchon sp.			
COLLEMBOLA			
EPHEMEROPTERA			
Acentrella insignificans	225	413.44	2.28
Baetis tricaudatus	120	220.50	1.22
Fallceon quilleri	105	192.94	1.06
Heptagenia diabasia	150	275.63	1.52
Tricorythodes minutus	45	82.69	0.46
ODONATA			
Coenagrionidae			
Hetaerina americana			
Ophiogomphus severus			
HEMIPTERA			
Sigara grossolineata			
TRICHOPTERA			
Cheumatopsyche sp.			
Hydropsyche sp.			
Hydroptila sp.	75	137.81	0.76
COLEOPTERA			
Agabus sp.			
DIPTERA			
Brillia sp.			
Caloparyphus sp.			
Ceratopogonidae			
Chironomus sp.			
Cladotanytarsus sp.			
Cricotopus sp.	5745	10556.44	58.21
Cryptochironomus sp.			
Dasyhelea sp.			
Diamesa sp.			
Dicrotendipes sp.			
Eukiefferiella sp.	120	220.50	1.22
Hydrobaenus sp.			
Limnophyes sp.			
Micropsectra sp.	45	82.69	0.46
Microtendipes sp.			
Nanocladius sp.	15	27.56	0.15
Neoplasta sp.			
Odontomesa sp.			

BDC-5.0 (Continued)

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
DIPTERA (continued)			
Pagastia sp.			
Parakiefferiella sp.	225	413.44	2.28
Parametriocnemus sp.	15	27.56	0.15
Paraphaenocladius sp.			
Paratanytarsus sp.			
Paratendipes sp.			
Phaenopsectra sp.	15	27.56	0.15
Polypedilum sp.			
Saetheria tylus	285	523.69	2.89
Simulium vittatum complex	585	1074.94	5.93
Stictochironomus sp.			
Thienemanniella sp.	150	275.63	1.52
Thienemannimyia group	45	82.69	0.46
Tipula sp.			
Tvetenia sp.			
GASTROPODA			
Ferrissia sp.			
Physidae			
BIVALVIA			
Pisidium sp.			
Totals:	9870	18136.13	100.00

Total Density (N/m^2)	18136
Total Number of Taxa	21
Diversity (d)	2.28

BDC-5.0

Community Parameters	Kick Sample	
Total Density (N/m^2)	18136	
Diversity (d)	2.28	
Total Number of Taxa	21	
% Dominant Taxon	58.21	
EPT Richness 5/0/1	6	
EPT (abundance)	1323.00	
Chiron (abundance)	12237.75	
EPT/Chironomid ratio	0.11	
Scraper (abundance)	441.00	
Filterer (abundance)	1074.94	
SC/F ratio	0.41	
Shredder (abundance)	10556.44	
SH/Total ratio	0.58	
HBI	7.04	
ICI	20	fair

Relative Abundance by Order	
TURBELLARIA	0.00
NEMATODA	0
OLIGOCHAETA	17.63
HIRUDINEA	0.00
ISOPODA	0
AMPHIPODA	1.67
DECAPODA	0.00
ACARI	0.00
COLLEMBOLA	0.00
EPHEMEROPTERA	6.53
ODONATA	0.00
HEMIPTERA	0.00
TRICHOPTERA	0.76
COLEOPTERA	0.00
DIPTERA	73.40
GASTROPODA	0.00
BIVALVIA	0.00
Totals:	100.00

Density by Order	
TURBELLARIA	0
NEMATODA	0
OLIGOCHAETA	3197
HIRUDINEA	0
ISOPODA	0
AMPHIPODA	303
DECAPODA	0
ACARI	0
COLLEMBOLA	0
EPHEMEROPTERA	1185
ODONATA	0
HEMIPTERA	0
TRICHOPTERA	138
COLEOPTERA	0
DIPTERA	13313
GASTROPODA	0
BIVALVIA	0
Totals:	18136

BDC-6.0

Sample Date: 17 March 2006 Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
TURBELLARIA			
Dugesia sp.			
OLIGOCHAETA			
Enchytraeidae	15	27.56	0.28
Lumbricidae			
Nais spp.	2535	4658.06	46.69
Ophidonais serpentina	15	27.56	0.28
Tubificidae with hair chaetae			
Tubificidae w/o hair chaetae	120	220.50	2.21
HIRUNDINEA			
Mooreobdella microstoma			
AMPHIPODA			
Crangonyx sp.	15	27.56	0.28
Hyalella azteca	705	1295.44	12.98
DECAPODA			
Orconectes sp.			
ACARI			
Sperchon sp.			
COLLEMBOLA	15	27.56	0.28
EPHEMEROPTERA			
Acentrella insignificans	90	165.38	1.66
Baetis tricaudatus			
Fallceon quilleri			
Heptagenia diabasia	15	27.56	0.28
Tricorythodes minutus			
ODONATA			
Coenagrionidae			
Hetaerina americana			
Ophiogomphus severus	15	27.56	0.28
HEMIPTERA			
Sigara grossolineata			
TRICHOPTERA			
Cheumatopsyche sp.			
Hydropsyche sp.			
Hydroptila sp.	15	27.56	0.28
COLEOPTERA			
Agabus sp.			
DIPTERA			
Brillia sp.			
Caloparyphus sp.			
Ceratopogonidae			
Chironomus sp.			
Cladotanytarsus sp.			
Cricotopus sp.	1185	2177.44	21.82
Cryptochironomus sp.			
Dasyhelea sp.			
Diamesa sp.	30	55.13	0.55
Dicrotendipes sp.			
Eukiefferiella sp.			
Hydrobaenus sp.			
Limnophyes sp.			
Micropsectra sp.	15	27.56	0.28
Microtendipes sp.			
Nanocladius sp.			
Neoplasta sp.			
Odontomesa sp.			

BDC-6.0 (Continued)

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
DIPTERA (continued)			
Pagastia sp.			
Parakiefferiella sp.	30	55.13	0.55
Parametriocnemus sp.			
Paraphaenocladius sp.			
Paratanytarsus sp.			
Paratendipes sp.			
Phaenopsectra sp.			
Polypedilum sp.			
Saetheria tylus	15	27.56	0.28
Simulium vittatum complex	120	220.50	2.21
Stictochironomus sp.			
Thienemanniella sp.	465	854.44	8.56
Thienemannimyia group	15	27.56	0.28
Tipula sp.			
Tvetenia sp.			
GASTROPODA			
Ferrissia sp.			
Physidae			
BIVALVIA			
Pisidium sp.			
Totals:	5430	9977.63	100.00

Total Density (N/m^2)	9978
Total Number of Taxa	19
Diversity (d)	2.34

BDC-6.0

Community Parameters	Kick Sample	
Total Density (N/m^2)	9978	
Diversity (d)	2.34	
Total Number of Taxa	19	
% Dominant Taxon	46.69	
EPT Richness 2/0/1	3	
EPT (abundance)	220.50	
Chiron (abundance)	3224.81	
EPT/Chironomid ratio	0.07	
Scraper (abundance)	55.13	
Filterer (abundance)	220.50	
SC/F ratio	0.25	
Shredder (abundance)	2177.44	
SH/Total ratio	0.22	
HBI	7.92	
ICI	12	poor

Relative Abundance by Order	
TURBELLARIA	0.00
NEMATODA	0
OLIGOCHAETA	49.45
HIRUDINEA	0.00
ISOPODA	0
AMPHIPODA	13.26
DECAPODA	0.00
ACARI	0.00
COLLEMBOLA	0.28
EPHEMEROPTERA	1.93
ODONATA	0.28
HEMIPTERA	0.00
TRICHOPTERA	0.28
COLEOPTERA	0.00
DIPTERA	34.53
GASTROPODA	0.00
BIVALVIA	0.00
Totals:	100.00

Density by Order	
TURBELLARIA	0
NEMATODA	0
OLIGOCHAETA	4934
HIRUDINEA	0
ISOPODA	0
AMPHIPODA	1323
DECAPODA	0
ACARI	0
COLLEMBOLA	28
EPHEMEROPTERA	193
ODONATA	28
HEMIPTERA	0
TRICHOPTERA	28
COLEOPTERA	0
DIPTERA	3445
GASTROPODA	0
BIVALVIA	0
Totals:	9978

BDC-0.5

Sample Date: 11 October 2006

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
TURBELLARIA			
Dugesia sp.	285	737.44	2.96
OLIGOCHAETA			
Dero nivea	15	38.81	0.16
Enchytraeidae			
Lumbriculidae			
Nais spp.	90	232.88	0.93
Tubificidae with hair chaetae	510	1319.63	5.29
Tubificidae w/o hair chaetae	2280	5899.50	23.67
ISOPODA			
Caecidotea sp.			
AMPHIPODA			
Crangonyx sp.	180	465.75	1.87
Hyalella azteca	180	465.75	1.87
DECAPODA			
Orconectes sp.	1	2.59	0.01
ACARI			
Sperchon sp.	30	77.63	0.31
COLLEMBOLA			
EPHEMEROPTERA			
Acentrella insignificans			
Baetis flavistriga	15	38.81	0.16
Baetis notos			
Baetis tricaudatus	15	38.81	0.16
Callibaetis sp.			
Fallceon quilleri	255	659.81	2.65
Heptagenia diabasia			
Paracloeodes minutus			
Pseudocloeon dardanum			
Tricorythodes minutus	1140	2949.75	11.84
ODONATA			
Coenagrionidae			
Hetaerina americana			
Ophiogomphus severus			
HEMIPTERA			
Cenocorixa utahensis	15	38.81	0.16
Corixidae	225	582.19	2.34
Microvelia sp.	15	38.81	0.16
Rhagovelia distincta			
Sigara grossolineata	45	116.44	0.47
Trichocorixa calva	60	155.25	0.62
TRICHOPTERA			
Cheumatopsyche sp.	375	970.31	3.89
Hydropsyche sp.			
Hydroptila sp.	75	194.06	0.78
COLEOPTERA			
Agabus semivittatus	1	2.59	0.01
Agabus sp.	30	77.63	0.31
Dubiraphia sp.			

BDC-0.5 (Continued)

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
DIPTERA			
Brillia sp.			
Ceratopogonidae			
Chironomus sp.	300	776.25	3.11
Cladotanytarsus sp.			
Cricotopus sp.	1470	3803.63	15.26
Cryptochironomus sp.	105	271.69	1.09
Dicrotendipes sp.	30	77.63	0.31
Eukiefferiella sp.			
Glyptotendipes sp.			
Hemerodromia sp.	30	77.63	0.31
Hydrobaenus sp.	15	38.81	0.16
Limnophyes sp.			
Limnophora sp.	15	38.81	0.16
Micropsectra sp.			
Nanocladius sp.	15	38.81	0.16
Neoplasta sp.			
Parachironomus sp.			
Parakiefferiella sp.	15	38.81	0.16
Paraphaenocladius sp.			
Paratanytarsus sp.	285	737.44	2.96
Phaenopsectra sp.	15	38.81	0.16
Polypedilum sp.	15	38.81	0.16
Procladius sp.	30	77.63	0.31
Pseudosmittia sp.			
Psychoda sp.			
Saetheria tylus			
Simulium vittatum complex	120	310.50	1.25
Stictochironomus sp.	990	2561.63	10.28
Synorthocladius sp.	15	38.81	0.16
Thienemanniella sp.	165	426.94	1.71
Thienemannimyia group	90	232.88	0.93
Tvetenia sp.			
GASTROPODA			
Ferrissia sp.			
Physidae	30	77.63	0.31
BIVALVIA			
Pisidium sp.	45	116.44	0.47
Totals:	9632	24922.80	100.00

Total Density (N/m^2)	24923
Total Number of Taxa	42
Diversity (d)	3.83

BDC-0.5

Community Parameters	Kick Sample	
Total Density (N/m^2)	24923	
Diversity (d)	3.83	
Total Number of Taxa	42	
% Dominant Taxon	23.67	
EPT Richness 4/0/2	6	
EPT (abundance)	4851.56	
Chiron (abundance)	9198.56	
EPT/Chironomid ratio	0.53	
Scraper (abundance)	349.31	
Filterer (abundance)	1397.25	
SC/F ratio	0.25	
Shredder (abundance)	3842.44	
SH/Total ratio	0.15	
HBI	7.28	
ICI	28	fair

Relative Abundance by Order	
TURBELLARIA	2.96
NEMATODA	0
OLIGOCHAETA	30.06
HIRUDINEA	0
ISOPODA	0.00
AMPHIPODA	3.74
DECAPODA	0.01
ACARI	0.31
COLLEMBOLA	0.00
EPHEMEROPTERA	14.79
ODONATA	0.00
HEMIPTERA	3.74
TRICHOPTERA	4.67
COLEOPTERA	0.32
DIPTERA	38.62
GASTROPODA	0.31
BIVALVIA	0.47
Totals:	100.00

Density by Order	
TURBELLARIA	737
NEMATODA	0
OLIGOCHAETA	7491
HIRUDINEA	0
ISOPODA	0
AMPHIPODA	932
DECAPODA	3
ACARI	78
COLLEMBOLA	0
EPHEMEROPTERA	3687
ODONATA	0
HEMIPTERA	932
TRICHOPTERA	1164
COLEOPTERA	80
DIPTERA	9626
GASTROPODA	78
BIVALVIA	116
Totals:	24923

BDC-1.0

Sample Date: 11 October 2006	Kick Sample n	N/m^2	Relative Abundance (%)
TURBELLARIA			
Dugesia sp.			
OLIGOCHAETA			
Dero nivea			
Enchytraeidae	15	27.56	0.37
Lumbriculidae			
Nais spp.	128	235.20	3.20
Tubificidae with hair chaetae	397	729.49	9.91
Tubificidae w/o hair chaetae	465	854.44	11.61
ISOPODA			
Caecidotea sp.			
AMPHIPODA			
Crangonyx sp.	8	14.70	0.20
Hyalella azteca	45	82.69	1.12
DECAPODA			
Orconectes sp.			
ACARI			
Sperchon sp.	7	12.86	0.17
COLLEMBOLA			
EPHEMEROPTERA			
Acentrella insignificans	398	731.33	9.94
Baetis flavistriga			
Baetis notos			
Baetis tricaudatus			
Callibaetis sp.			
Fallceon quilleri	52	95.55	1.30
Heptagenia diabasia	30	55.13	0.75
Paracloeodes minutus			
Pseudocloeon dardanum			
Tricorythodes minutus	135	248.06	3.37
ODONATA			
Coenagrionidae			
Hetaerina americana			
Ophiogomphus severus			
HEMIPTERA			
Cenocorixa utahensis			
Corixidae			
Microvelia sp.	7	12.86	0.17
Rhagovelia distincta			
Sigara grossolineata			
Trichocorixa calva			
TRICHOPTERA			
Cheumatopsyche sp.	75	137.81	1.87
Hydropsyche sp.	8	14.70	0.20
Hydroptila sp.			
COLEOPTERA			
Agabus semivittatus			
Agabus sp.			
Dubiraphia sp.			

BDC-1.0 (Continued)

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
DIPTERA			
Brillia sp.			
Ceratopogonidae	22	40.43	0.55
Chironomus sp.			
Cladotanytarsus sp.	15	27.56	0.37
Cricotopus sp.	1335	2453.06	33.33
Cryptochironomus sp.	23	42.26	0.57
Dicrotendipes sp.			
Eukiefferiella sp.			
Glyptotendipes sp.			
Hemerodromia sp.			
Hydrobaenus sp.	143	262.76	3.57
Limnophyes sp.			
Limnophora sp.			
Micropsectra sp.			
Nanocladius sp.	7	12.86	0.17
Neoplasta sp.	7	12.86	0.17
Parachironomus sp.			
Parakiefferiella sp.	30	55.13	0.75
Paraphaenocladius sp.			
Paratanytarsus sp.			
Phaenopsectra sp.			
Polypedilum sp.			
Procladius sp.			
Pseudosmittia sp.			
Psychoda sp.			
Saetheria tylus			
Simulium vittatum complex	30	55.13	0.75
Stictochironomus sp.	450	826.88	11.24
Synorthocladius sp.			
Thienemanniella sp.	30	55.13	0.75
Thienemannimyia group			
Tvetenia sp.	8	14.70	0.20
GASTROPODA			
Ferrissia sp.	135	248.06	3.37
Physidae			
BIVALVIA			
Pisidium sp.			
Totals:	4005	7359.19	100.00

Total Density (N/m^2)		7359	
Total Number of Taxa		27	
Diversity (d)		3.30	

BDC-1.0

Community Parameters	Kick Sample	
Total Density (N/m^2)	7359	
Diversity (d)	3.30	
Total Number of Taxa	27	
% Dominant Taxon	33.33	
EPT Richness 4/0/2	6	
EPT (abundance)	1282.58	
Chiron (abundance)	3750.34	
EPT/Chironomid ratio	0.34	
Scraper (abundance)	565.95	
Filterer (abundance)	207.64	
SC/F ratio	2.73	
Shredder (abundance)	2453.06	
SH/Total ratio	0.33	
HBI	7.08	
ICI	22	fair

Relative Abundance by Order	
TURBELLARIA	0.00
NEMATODA	0
OLIGOCHAETA	25.09
HIRUDINEA	0
ISOPODA	0.00
AMPHIPODA	1.32
DECAPODA	0.00
ACARI	0.17
COLLEMBOLA	0.00
EPHEMEROPTERA	15.36
ODONATA	0.00
HEMIPTERA	0.17
TRICHOPTERA	2.07
COLEOPTERA	0.00
DIPTERA	52.43
GASTROPODA	3.37
BIVALVIA	0.00
Totals:	100.00

Density by Order	
TURBELLARIA	0
NEMATODA	0
OLIGOCHAETA	1847
HIRUDINEA	0
ISOPODA	0
AMPHIPODA	97
DECAPODA	0
ACARI	13
COLLEMBOLA	0
EPHEMEROPTERA	1130
ODONATA	0
HEMIPTERA	13
TRICHOPTERA	153
COLEOPTERA	0
DIPTERA	3859
GASTROPODA	248
BIVALVIA	0
Totals:	7359

BDC-1.5

Sample Date: 11 October 2006

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
TURBELLARIA			
Dugesia sp.	5	9.19	0.20
OLIGOCHAETA			
Dero nivea			
Enchytraeidae			
Lumbriculidae			
Nais spp.	35	64.31	1.39
Tubificidae with hair chaetae	245	450.19	9.76
Tubificidae w/o hair chaetae	240	441.00	9.56
ISOPODA			
Caecidotea sp.			
AMPHIPODA			
Crangonyx sp.	25	45.94	1.00
Hyalella azteca	85	156.19	3.39
DECAPODA			
Orconectes sp.			
ACARI			
Sperchon sp.			
COLLEMBOLA	10	18.38	0.40
EPHEMEROPTERA			
Acentrella insignificans	90	165.38	3.59
Baetis flavistriga			
Baetis notos			
Baetis tricaudatus	5	9.19	0.20
Callibaetis sp.	5	9.19	0.20
Fallceon quilleri	30	55.13	1.20
Heptagenia diabasia	15	27.56	0.60
Paracloeodes minutus			
Pseudocloeon dardanum			
Tricorythodes minutus	125	229.69	4.98
ODONATA			
Coenagrionidae	5	9.19	0.20
Hetaerina americana			
Ophiogomphus severus			
HEMIPTERA			
Cenocorixa utahensis			
Corixidae			
Microvelia sp.	15	27.56	0.60
Rhagovelia distincta			
Sigara grossolineata			
Trichocorixa calva			
TRICHOPTERA			
Cheumatopsyche sp.	35	64.31	1.39
Hydropsyche sp.			
Hydroptila sp.			
COLEOPTERA			
Agabus semivittatus			
Agabus sp.	5	9.19	0.20
Dubiraphia sp.	5	9.19	0.20

BDC-1.5 (Continued)

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
DIPTERA			
Brillia sp.			
Ceratopogonidae	10	18.38	0.40
Chironomus sp.			
Cladotanytarsus sp.			
Cricotopus sp.	310	569.63	12.35
Cryptochironomus sp.	30	55.13	1.20
Dicrotendipes sp.	5	9.19	0.20
Eukiefferiella sp.			
Glyptotendipes sp.			
Hemerodromia sp.			
Hydrobaenus sp.	110	202.13	4.38
Limnophyes sp.	5	9.19	0.20
Limnophora sp.			
Micropsectra sp.			
Nanocladius sp.	15	27.56	0.60
Neoplasta sp.			
Parachironomus sp.			
Parakiefferiella sp.	45	82.69	1.79
Paraphaenocladius sp.	5	9.19	0.20
Paratanytarsus sp.			
Phaenopsectra sp.			
Polypedilum sp.	5	9.19	0.20
Procladius sp.			
Pseudosmittia sp.			
Psychoda sp.	5	9.19	0.20
Saetheria tylus			
Simulium vittatum complex	65	119.44	2.59
Stictochironomus sp.	845	1552.69	33.67
Synorthocladius sp.			
Thienemanniella sp.	45	82.69	1.79
Thienemannimyia group			
Tvetenia sp.			
GASTROPODA			
Ferrissia sp.	30	55.13	1.20
Physidae			
BIVALVIA			
Pisidium sp.			
Totals:	2510	4612.13	100.00

Total Density (N/m^2)	4612
Total Number of Taxa	33
Diversity (d)	3.51

BDC-1.5

Community Parameters	Kick Sample	
Total Density (N/m^2)	4612	
Diversity (d)	3.51	
Total Number of Taxa	33	
% Dominant Taxon	33.67	
EPT Richness 6/0/1	7	
EPT (abundance)	560.44	
Chiron (abundance)	2609.25	
EPT/Chironomid ratio	0.21	
Scraper (abundance)	284.81	
Filterer (abundance)	183.75	
SC/F ratio	1.55	
Shredder (abundance)	578.81	
SH/Total ratio	0.13	
HBI	6.91	
ICI	20	fair

Relative Abundance by Order	
TURBELLARIA	0.20
NEMATODA	0
OLIGOCHAETA	20.72
HIRUDINEA	0
ISOPODA	0.00
AMPHIPODA	4.38
DECAPODA	0.00
ACARI	0.00
COLLEMBOLA	0.40
EPHEMEROPTERA	10.76
ODONATA	0.20
HEMIPTERA	0.60
TRICHOPTERA	1.39
COLEOPTERA	0.40
DIPTERA	59.76
GASTROPODA	1.20
BIVALVIA	0.00
Totals:	100.00

Density by Order	
TURBELLARIA	9
NEMATODA	0
OLIGOCHAETA	956
HIRUDINEA	0
ISOPODA	0
AMPHIPODA	202
DECAPODA	0
ACARI	0
COLLEMBOLA	18
EPHEMEROPTERA	496
ODONATA	9
HEMIPTERA	28
TRICHOPTERA	64
COLEOPTERA	18
DIPTERA	2756
GASTROPODA	55
BIVALVIA	0
Totals:	4612

BDC-1.5C

Sample Date: 11 October 2006

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
TURBELLARIA			
Dugesia sp.			
OLIGOCHAETA			
Dero nivea			
Enchytraeidae	5	9.19	0.19
Lumbriculidae			
Nais spp.	10	18.38	0.38
Tubificidae with hair chaetae	115	211.31	4.41
Tubificidae w/o hair chaetae	340	624.75	13.05
ISOPODA			
Caecidotea sp.			
AMPHIPODA			
Crangonyx sp.	15	27.56	0.58
Hyalella azteca			
DECAPODA			
Orconectes sp.	1	1.84	0.04
ACARI			
Sperchon sp.			
COLLEMBOLA			
EPHEMEROPTERA			
Acentrella insignificans	45	82.69	1.73
Baetis flavistriga	5	9.19	0.19
Baetis notos	5	9.19	0.19
Baetis tricaudatus			
Callibaetis sp.	5	9.19	0.19
Fallceon quilleri	55	101.06	2.11
Heptagenia diabasia			
Paracloeodes minutus			
Pseudocloeon dardanum	5	9.19	0.19
Tricorythodes minutus	60	110.25	2.30
ODONATA			
Coenagrionidae			
Hetaerina americana	5	9.19	0.19
Ophiogomphus severus			
HEMIPTERA			
Cenocorixa utahensis			
Corixidae			
Microvelia sp.			
Rhagovelia distincta	5	9.19	0.19
Sigara grossolineata			
Trichocorixa calva			
TRICHOPTERA			
Cheumatopsyche sp.	15	27.56	0.58
Hydropsyche sp.	5	9.19	0.19
Hydroptila sp.			
COLEOPTERA			
Agabus semivittatus			
Agabus sp.			
Dubiraphia sp.			

BDC-1.5C (Continued)

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
DIPTERA			
Brillia sp.	5	9.19	0.19
Ceratopogonidae			
Chironomus sp.	30	55.13	1.15
Cladotanytarsus sp.	5	9.19	0.19
Cricotopus sp.	540	992.25	20.72
Cryptochironomus sp.	35	64.31	1.34
Dicrotendipes sp.			
Eukiefferiella sp.	5	9.19	0.19
Glyptotendipes sp.	5	9.19	0.19
Hemerodromia sp.			
Hydrobaenus sp.	140	257.25	5.37
Limnophyes sp.			
Limnophora sp.			
Micropsectra sp.			
Nanocladius sp.			
Neoplasta sp.	10	18.38	0.38
Parachironomus sp.			
Parakiefferiella sp.	130	238.88	4.99
Paraphaenocladius sp.			
Paratanytarsus sp.			
Phaenopsectra sp.			
Polypedilum sp.	15	27.56	0.58
Procladius sp.			
Pseudosmittia sp.			
Psychoda sp.			
Saetheria tylus			
Simulium vittatum complex	205	376.69	7.87
Stictochironomus sp.	670	1231.13	25.71
Synorthocladius sp.			
Thienemanniella sp.	65	119.44	2.49
Thienemannimyia group	5	9.19	0.19
Tvetenia sp.			
GASTROPODA			
Ferrissia sp.	45	82.69	1.73
Physidae			
BIVALVIA			
Pisidium sp.			
Totals:	2606	4788.53	100.00

Total Density (N/m^2)	4789
Total Number of Taxa	33
Diversity (d)	3.44

BDC-1.5C

Community Parameters	Kick Sample	
Total Density (N/m^2)	4789	
Diversity (d)	3.44	
Total Number of Taxa	33	
% Dominant Taxon	25.71	
EPT Richness 7/0/2	9	
EPT (abundance)	367.50	
Chiron (abundance)	3031.88	
EPT/Chironomid ratio	0.12	
Scraper (abundance)	349.13	
Filterer (abundance)	422.63	
SC/F ratio	0.83	
Shredder (abundance)	1029.00	
SH/Total ratio	0.21	
HBI	6.97	
ICI	28	fair

Relative Abundance by Order	
TURBELLARIA	0.00
NEMATODA	0
OLIGOCHAETA	18.04
HIRUDINEA	0
ISOPODA	0.00
AMPHIPODA	0.58
DECAPODA	0.04
ACARI	0.00
COLLEMBOLA	0.00
EPHEMEROPTERA	6.91
ODONATA	0.19
HEMIPTERA	0.19
TRICHOPTERA	0.77
COLEOPTERA	0.00
DIPTERA	71.57
GASTROPODA	1.73
BIVALVIA	0.00
Totals:	100.00

Density by Order	
TURBELLARIA	0
NEMATODA	0
OLIGOCHAETA	864
HIRUDINEA	0
ISOPODA	0
AMPHIPODA	28
DECAPODA	2
ACARI	0
COLLEMBOLA	0
EPHEMEROPTERA	331
ODONATA	9
HEMIPTERA	9
TRICHOPTERA	37
COLEOPTERA	0
DIPTERA	3427
GASTROPODA	83
BIVALVIA	0
Totals:	4789

BDC-2.0

Sample Date: 11 October 2006

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
TURBELLARIA			
Dugesia sp.			
OLIGOCHAETA			
Dero nivea			
Enchytraeidae			
Lumbriculidae			
Nais spp.	4	7.35	0.20
Tubificidae with hair chaetae	124	227.85	6.22
Tubificidae w/o hair chaetae	780	1433.25	39.10
ISOPODA			
Caecidotea sp.			
AMPHIPODA			
Crangonyx sp.	22	40.43	1.10
Hyalella azteca			
DECAPODA			
Orconectes sp.			
ACARI			
Sperchon sp.			
COLLEMBOLA	4	7.35	0.20
EPHEMEROPTERA			
Acentrella insignificans	38	69.83	1.90
Baetis flavistriga			
Baetis notos			
Baetis tricaudatus			
Callibaetis sp.			
Fallceon quilleri	71	130.46	3.56
Heptagenia diabasia			
Paracloeodes minutus			
Pseudocloeon dardanum	19	34.91	0.95
Tricorythodes minutus	8	14.70	0.40
ODONATA			
Coenagrionidae			
Hetaerina americana			
Ophiogomphus severus			
HEMIPTERA			
Cenocorixa utahensis			
Corixidae			
Microvelia sp.	56	102.90	2.81
Rhagovelia distincta			
Sigara grossolineata			
Trichocorixa calva			
TRICHOPTERA			
Cheumatopsyche sp.			
Hydropsyche sp.			
Hydroptila sp.			
COLEOPTERA			
Agabus semivittatus			
Agabus sp.	11	20.21	0.55
Dubiraphia sp.			

BDC-2.0 (Continued)

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
DIPTERA			
Brillia sp.			
Ceratopogonidae	4	7.35	0.20
Chironomus sp.	8	14.70	0.40
Cladotanytarsus sp.	41	75.34	2.06
Cricotopus sp.	247	453.86	12.38
Cryptochironomus sp.			
Dicrotendipes sp.			
Eukiefferiella sp.	4	7.35	0.20
Glyptotendipes sp.			
Hemerodromia sp.			
Hydrobaenus sp.	37	67.99	1.85
Limnophyes sp.			
Limnophora sp.			
Micropsectra sp.	15	27.56	0.75
Nanocladius sp.			
Neoplasta sp.			
Parachironomus sp.			
Parakiefferiella sp.	56	102.90	2.81
Paraphaenocladius sp.			
Paratanytarsus sp.			
Phaenopsectra sp.			
Polypedilum sp.			
Procladius sp.			
Pseudosmittia sp.			
Psychoda sp.			
Saetheria tylus	4	7.35	0.20
Simulium vittatum complex	101	185.59	5.06
Stictochironomus sp.	296	543.90	14.84
Synorthocladius sp.			
Thienemanniella sp.	45	82.69	2.26
Thienemannimyia group			
Tvetenia sp.			
GASTROPODA			
Ferrissia sp.			
Physidae			
BIVALVIA			
Pisidium sp.			
Totals:	1995	3665.81	100.00

Total Density (N/m^2)	3666
Total Number of Taxa	23
Diversity (d)	3.08

BDC-2.0

Community Parameters	Kick Sample	
Total Density (N/m^2)	3666	
Diversity (d)	3.08	
Total Number of Taxa	23	
% Dominant Taxon	39.10	
EPT Richness 4/0/0	4	
EPT (abundance)	249.90	
Chiron (abundance)	1383.64	
EPT/Chironomid ratio	0.18	
Scraper (abundance)	102.90	
Filterer (abundance)	185.59	
SC/F ratio	0.55	
Shredder (abundance)	453.86	
SH/Total ratio	0.12	
HBI	7.91	
ICI	10	poor

Relative Abundance by Order	
TURBELLARIA	0.00
NEMATODA	0
OLIGOCHAETA	45.51
HIRUDINEA	0
ISOPODA	0.00
AMPHIPODA	1.10
DECAPODA	0.00
ACARI	0.00
COLLEMBOLA	0.20
EPHEMEROPTERA	6.82
ODONATA	0.00
HEMIPTERA	2.81
TRICHOPTERA	0.00
COLEOPTERA	0.55
DIPTERA	43.01
GASTROPODA	0.00
BIVALVIA	0.00
Totals:	100.00

Density by Order	
TURBELLARIA	0
NEMATODA	0
OLIGOCHAETA	1668
HIRUDINEA	0
ISOPODA	0
AMPHIPODA	40
DECAPODA	0
ACARI	0
COLLEMBOLA	7
EPHEMEROPTERA	250
ODONATA	0
HEMIPTERA	103
TRICHOPTERA	0
COLEOPTERA	20
DIPTERA	1577
GASTROPODA	0
BIVALVIA	0
Totals:	3666

BDC-3.0

Sample Date: 11 October 2006

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
TURBELLARIA			
Dugesia sp.	15	27.56	0.19
OLIGOCHAETA			
Dero nivea			
Enchytraeidae			
Lumbriculidae			
Nais spp.	45	82.69	0.56
Tubificidae with hair chaetae			
Tubificidae w/o hair chaetae	75	137.81	0.93
ISOPODA			
Caecidotea sp.			
AMPHIPODA			
Crangonyx sp.	225	413.44	2.79
Hyalella azteca	1020	1874.25	12.66
DECAPODA			
Orconectes sp.			
ACARI			
Sperchon sp.			
COLLEMBOLA	15	27.56	0.19
EPHEMEROPTERA			
Acentrella insignificans	165	303.19	2.05
Baetis flavistriga	75	137.81	0.93
Baetis notos			
Baetis tricaudatus	180	330.75	2.23
Callibaetis sp.			
Fallceon quilleri	1650	3031.88	20.48
Heptagenia diabasia			
Paracloeodes minutus			
Pseudocloeon dardanum			
Tricorythodes minutus	75	137.81	0.93
ODONATA			
Coenagrionidae			
Hetaerina americana			
Ophiogomphus severus			
HEMIPTERA			
Cenocorixa utahensis			
Corixidae			
Microvelia sp.	15	27.56	0.19
Rhagovelia distincta			
Sigara grossolineata			
Trichocorixa calva	15	27.56	0.19
TRICHOPTERA			
Cheumatopsyche sp.	15	27.56	0.19
Hydropsyche sp.	45	82.69	0.56
Hydroptila sp.			
COLEOPTERA			
Agabus semivittatus			
Agabus sp.	150	275.63	1.86
Dubiraphia sp.			

BDC-3.0 (Continued)

Taxon	Kick Sample n	N/m²	Relative Abundance (%)
DIPTERA			
Brillia sp.			
Ceratopogonidae			
Chironomus sp.	60	110.25	0.74
Cladotanytarsus sp.	180	330.75	2.23
Cricotopus sp.	510	937.13	6.33
Cryptochironomus sp.	165	303.19	2.05
Dicrotendipes sp.			
Eukiefferiella sp.			
Glyptotendipes sp.			
Hemerodromia sp.			
Hydrobaenus sp.			
Limnophyes sp.			
Limnophora sp.			
Micropsectra sp.			
Nanocladius sp.	15	27.56	0.19
Neoplasta sp.			
Parachironomus sp.	15	27.56	0.19
Parakiefferiella sp.	30	55.13	0.37
Paraphaenocladius sp.			
Paratanytarsus sp.	30	55.13	0.37
Phaenopsectra sp.			
Polypedilum sp.	15	27.56	0.19
Procladius sp.	15	27.56	0.19
Pseudosmittia sp.	30	55.13	0.37
Psychoda sp.			
Saetheria tylus			
Simulium vittatum complex	1950	3583.13	24.21
Stictochironomus sp.	1110	2039.63	13.78
Synorthocladius sp.			
Thienemanniella sp.	105	192.94	1.30
Thienemannimyia group	15	27.56	0.19
Tvetenia sp.			
GASTROPODA			
Ferrissia sp.			
Physidae	30	55.13	0.37
BIVALVIA			
Pisidium sp.			
Totals:	8055	14801.06	100.00
Total Density (N/m²)		14801	
Total Number of Taxa		32	
Diversity (d)		3.41	

BDC-3.0

Community Parameters	Kick Sample	
Total Density (N/m^2)	14801	
Diversity (d)	3.41	
Total Number of Taxa	32	
% Dominant Taxon	24.21	
EPT Richness 5/0/2	7	
EPT (abundance)	4051.69	
Chiron (abundance)	4217.06	
EPT/Chironomid ratio	0.96	
Scraper (abundance)	55.13	
Filterer (abundance)	3693.38	
SC/F ratio	0.01	
Shredder (abundance)	964.69	
SH/Total ratio	0.07	
HBI	5.99	
ICI	30	fair

Relative Abundance by Order	
TURBELLARIA	0.19
NEMATODA	0
OLIGOCHAETA	1.49
HIRUDINEA	0
ISOPODA	0.00
AMPHIPODA	15.46
DECAPODA	0.00
ACARI	0.00
COLLEMBOLA	0.19
EPHEMEROPTERA	26.63
ODONATA	0.00
HEMIPTERA	0.37
TRICHOPTERA	0.74
COLEOPTERA	1.86
DIPTERA	52.70
GASTROPODA	0.37
BIVALVIA	0.00
Totals:	100.00

Density by Order	
TURBELLARIA	28
NEMATODA	0
OLIGOCHAETA	221
HIRUDINEA	0
ISOPODA	0
AMPHIPODA	2288
DECAPODA	0
ACARI	0
COLLEMBOLA	28
EPHEMEROPTERA	3941
ODONATA	0
HEMIPTERA	55
TRICHOPTERA	110
COLEOPTERA	276
DIPTERA	7800
GASTROPODA	55
BIVALVIA	0
Totals:	14801

BDC-5.0

Sample Date: 11 October 2006

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
TURBELLARIA			
Dugesia sp.			
OLIGOCHAETA			
Dero nivea			
Enchytraeidae			
Lumbriculidae			
Nais spp.	60	110.25	1.85
Tubificidae with hair chaetae	25	45.94	0.77
Tubificidae w/o hair chaetae	40	73.50	1.24
ISOPODA			
Caecidotea sp.			
AMPHIPODA			
Crangonyx sp.	135	248.06	4.17
Hyalella azteca	355	652.31	10.97
DECAPODA			
Orconectes sp.	3	5.51	0.09
ACARI			
Sperchon sp.			
COLLEMBOLA	5	9.19	0.15
EPHEMEROPTERA			
Acentrella insignificans	70	128.63	2.16
Baetis flavistriga			
Baetis notos			
Baetis tricaudatus	5	9.19	0.15
Callibaetis sp.	15	27.56	0.46
Fallceon quilleri	300	551.25	9.27
Heptagenia diabasia	165	303.19	5.10
Paracloeodes minutus	200	367.50	6.18
Pseudocloeon dardanum			
Tricorythodes minutus	55	101.06	1.70
ODONATA			
Coenagrionidae			
Hetaerina americana	5	9.19	0.15
Ophiogomphus severus	2	3.68	0.06
HEMIPTERA			
Cenocorixa utahensis			
Corixidae			
Microvelia sp.			
Rhagovelia distincta			
Sigara grossolineata			
Trichocorixa calva			
TRICHOPTERA			
Cheumatopsyche sp.	5	9.19	0.15
Hydropsyche sp.			
Hydroptila sp.			
COLEOPTERA			
Agabus semivittatus			
Agabus sp.	5	9.19	0.15
Dubiraphia sp.			

BDC-5.0 (Continued)

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
DIPTERA			
Brillia sp.			
Ceratopogonidae	5	9.19	0.15
Chironomus sp.	10	18.38	0.31
Cladotanytarsus sp.	5	9.19	0.15
Cricotopus sp.	1425	2618.44	44.05
Cryptochironomus sp.	5	9.19	0.15
Dicrotendipes sp.			
Eukiefferiella sp.	5	9.19	0.15
Glyptotendipes sp.			
Hemerodromia sp.			
Hydrobaenus sp.	5	9.19	0.15
Limnophyes sp.	5	9.19	0.15
Limnophora sp.			
Micropsectra sp.	10	18.38	0.31
Nanocladius sp.			
Neoplasta sp.			
Parachironomus sp.			
Parakiefferiella sp.	100	183.75	3.09
Paraphaenocladius sp.			
Paratanytarsus sp.	5	9.19	0.15
Phaenopsectra sp.			
Polypedilum sp.			
Procladius sp.			
Pseudosmittia sp.			
Psychoda sp.	5	9.19	0.15
Saetheria tylus	5	9.19	0.15
Simulium vittatum complex	15	27.56	0.46
Stictochironomus sp.	40	73.50	1.24
Synorthocladius sp.			
Thienemanniella sp.	120	220.50	3.71
Thienemannimyia group	10	18.38	0.31
Tvetenia sp.			
GASTROPODA			
Ferrissia sp.			
Physidae	10	18.38	0.31
BIVALVIA			
Pisidium sp.			
Totals:	3235	5944.31	100.00

Total Density (N/m^2)	5944
Total Number of Taxa	36
Diversity (d)	3.11

BDC-5.0

Community Parameters	Kick Sample	
Total Density (N/m^2)	5944	
Diversity (d)	3.11	
Total Number of Taxa	36	
% Dominant Taxon	44.05	
EPT Richness 7/0/1	8	
EPT (abundance)	1497.56	
Chiron (abundance)	3215.63	
EPT/Chironomid ratio	0.47	
Scraper (abundance)	698.25	
Filterer (abundance)	36.75	
SC/F ratio	19.00	
Shredder (abundance)	2618.44	
SH/Total ratio	0.44	
HBI	6.66	
ICI	28	fair

Relative Abundance by Order	
TURBELLARIA	0.00
NEMATODA	0
OLIGOCHAETA	3.86
HIRUDINEA	0
ISOPODA	0.00
AMPHIPODA	15.15
DECAPODA	0.09
ACARI	0.00
COLLEMBOLA	0.15
EPHEMEROPTERA	25.04
ODONATA	0.22
HEMIPTERA	0.00
TRICHOPTERA	0.15
COLEOPTERA	0.15
DIPTERA	54.87
GASTROPODA	0.31
BIVALVIA	0.00
Totals:	100.00

Density by Order	
TURBELLARIA	0
NEMATODA	0
OLIGOCHAETA	230
HIRUDINEA	0
ISOPODA	0
AMPHIPODA	900
DECAPODA	6
ACARI	0
COLLEMBOLA	9
EPHEMEROPTERA	1488
ODONATA	13
HEMIPTERA	0
TRICHOPTERA	9
COLEOPTERA	9
DIPTERA	3262
GASTROPODA	18
BIVALVIA	0
Totals:	5944

BDC-6.0

Sample Date: 11 October 2006

Taxon	Kick Sample n	N/m²	Relative Abundance (%)
TURBELLARIA			
Dugesia sp.	97	178.24	2.33
OLIGOCHAETA			
Dero nivea			
Enchytraeidae			
Lumbriculidae	15	27.56	0.36
Nais spp.	315	578.81	7.57
Tubificidae with hair chaetae	15	27.56	0.36
Tubificidae w/o hair chaetae	1155	2122.31	27.74
ISOPODA			
Caecidotea sp.	45	82.69	1.08
AMPHIPODA			
Crangonyx sp.			
Hyalella azteca	720	1323.00	17.30
DECAPODA			
Orconectes sp.			
ACARI			
Sperchon sp.	15	27.56	0.36
COLLEMBOLA			
EPHEMEROPTERA			
Acentrella insignificans	75	137.81	1.80
Baetis flavistriga			
Baetis notos			
Baetis tricaudatus			
Callibaetis sp.			
Fallceon quilleri	15	27.56	0.36
Heptagenia diabasia	53	97.39	1.27
Paracloeodes minutus	7	12.86	0.17
Pseudocloeon dardanum			
Tricorythodes minutus	8	14.70	0.19
ODONATA			
Coenagrionidae	7	12.86	0.17
Hetaerina americana	7	12.86	0.17
Ophiogomphus severus	8	14.70	0.19
HEMIPTERA			
Cenocorixa utahensis			
Corixidae			
Microvelia sp.			
Rhagovelia distincta			
Sigara grossolineata			
Trichocorixa calva			
TRICHOPTERA			
Cheumatopsyche sp.	75	137.81	1.80
Hydropsyche sp.	8	14.70	0.19
Hydroptila sp.	8	14.70	0.19
COLEOPTERA			
Agabus semivittatus			
Agabus sp.	7	12.86	0.17
Dubiraphia sp.			

BDC-6.0 (Continued)

Taxon	Kick Sample n	N/m^2	Relative Abundance (%)
DIPTERA			
Brillia sp.			
Ceratopogonidae	7	12.86	0.17
Chironomus sp.	15	27.56	0.36
Cladotanytarsus sp.			
Cricotopus sp.	653	1199.89	15.69
Cryptochironomus sp.	38	69.83	0.91
Dicrotendipes sp.	22	40.43	0.53
Eukiefferiella sp.			
Glyptotendipes sp.			
Hemerodromia sp.			
Hydrobaenus sp.			
Limnophyes sp.			
Limnophora sp.			
Micropsectra sp.	8	14.70	0.19
Nanocladius sp.			
Neoplasta sp.			
Parachironomus sp.			
Parakiefferiella sp.	15	27.56	0.36
Paraphaenocladius sp.			
Paratanytarsus sp.	7	12.86	0.17
Phaenopsectra sp.			
Polypedilum sp.	8	14.70	0.19
Procladius sp.	8	14.70	0.19
Pseudosmittia sp.			
Psychoda sp.			
Saetheria tylus			
Simulium vittatum complex	540	992.25	12.97
Stictochironomus sp.			
Synorthocladius sp.			
Thienemanniella sp.	142	260.93	3.41
Thienemannimyia group	45	82.69	1.08
Tvetenia sp.			
GASTROPODA			
Ferrissia sp.			
Physidae			
BIVALVIA			
Pisidium sp.			
Totals:	4163	7649.51	100.00

Total Density (N/m^2)	7650
Total Number of Taxa	33
Diversity (d)	3.25

BDC-6.0

Community Parameters	Kick Sample	
Total Density (N/m^2)	7650	
Diversity (d)	3.25	
Total Number of Taxa	33	
% Dominant Taxon	27.74	
EPT Richness 5/0/3	8	
EPT (abundance)	457.54	
Chiron (abundance)	1765.84	
EPT/Chironomid ratio	0.26	
Scraper (abundance)	124.95	
Filterer (abundance)	1144.76	
SC/F ratio	0.11	
Shredder (abundance)	1214.59	
SH/Total ratio	0.16	
HBI	7.80	
ICI	26	fair

Relative Abundance by Order	
TURBELLARIA	2.33
NEMATODA	0
OLIGOCHAETA	36.03
HIRUDINEA	0
ISOPODA	1.08
AMPHIPODA	17.30
DECAPODA	0.00
ACARI	0.36
COLLEMBOLA	0.00
EPHEMEROPTERA	3.80
ODONATA	0.53
HEMIPTERA	0.00
TRICHOPTERA	2.19
COLEOPTERA	0.17
DIPTERA	36.22
GASTROPODA	0.00
BIVALVIA	0.00
Totals:	100.00

Density by Order	
TURBELLARIA	178
NEMATODA	0
OLIGOCHAETA	2756
HIRUDINEA	0
ISOPODA	83
AMPHIPODA	1323
DECAPODA	0
ACARI	28
COLLEMBOLA	0
EPHEMEROPTERA	290
ODONATA	40
HEMIPTERA	0
TRICHOPTERA	167
COLEOPTERA	13
DIPTERA	2771
GASTROPODA	0
BIVALVIA	0
Totals:	7650