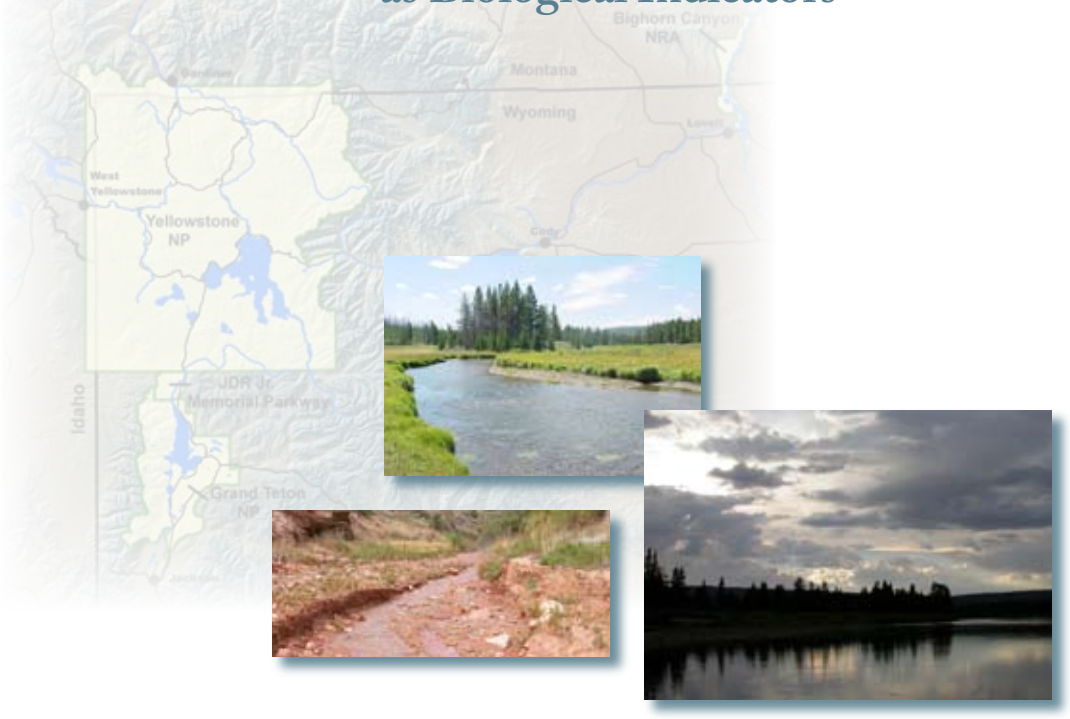
Evaluation of Stream Quality in the Greater Yellowstone Network Parks

using Benthic Macroinvertebrate Communities as Biological Indicators



Final Report to the
Greater Yellowstone Network

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ABSTRACT

The Greater Yellowstone Network (GRYN) is comprised of four National Park Service units: Bighorn Canyon National Recreation Area (BICA), John D. Rockefeller Jr. Memorial Parkway and Grand Teton National Park (collectively referred to as GRTE) and Yellowstone National Park (YELL). Maintaining high water quality standards within these parks is of considerable importance in fulfilling the park service mission. The primary objective of this study was to use benthic macroinvertebrates as a bioassessment tool to evaluate the current condition of selected park waters. Benthic macroinvertebrate sampling took place within all parks of the GRYN during a summer period between 06 August and 12 September 2002; and in GRTE and YELL during a fall period between 07 October and 13 November 2002. Four invertebrate sites on 3 streams were sampled in BICA, 16 sites on 8 streams were sampled in GRTE, and 20 sites on 8 streams were sampled in YELL. A Surber net (0.09 meter plot with 500 micron mesh) was used to collect benthic macroinvertebrates from selected streams within the three GRYN parks. A total of 232 invertebrate taxa were identified with 70 taxa collected from BICA and 165 taxa each being collected from GRTE and YELL. A variety of metrics were used to evaluate selected streams and include total number of taxa, invertebrate density, EPT Richness Index value (total number of distinct taxa belonging to the insect orders Ephemeroptera, Plecoptera, and Trichoptera), invertebrate tolerance values, and modified Hilsenhoff Biotic Index (HBI) values. Overall, number of EPT taxa for BICA was relatively low with a range between 5 and 8 taxa for the downstream site on North Fork Trail Creek and the Crooked Creek site respectively. Results from HBI values indicate that 2 invertebrate sites rate good, 1 site rated fair and 1 site rated fairly poor. Crooked Creek, which had an HBI water quality rating of fairly poor, receives much of its water from a drainage that is dominated by agriculture and rangeland. These land use practices, coupled with severe riparian habitat degradation within park boundaries, are most likely the reason for the high HBI value recorded. The number of EPT taxa for invertebrate sites in GRTE was generally high with a range between 11 and 32 taxa combined for both summer and fall sample periods. Most sites rated good to excellent for both sample periods with the exception of one site each on Cottonwood and Spread creeks which had HBI water quality ratings of fair during the summer sample period. Possible impacts to water quality were evident at both locations with the site on Cottonwood Creek periodically receiving water from an adjacent horse pasture and the site on Spread Creek having severe stream bank and habitat alterations in the direct vicinity of the sample reach. Because of the wide distribution of thermal features in YELL park waters, evaluating stream health using conventional methods becomes particularly challenging. Of the 20 invertebrate sites sampled in 2002, 5 sites were selected in stream segments with thermal influence. The number of EPT taxa for sites in YELL range between 0 and 37 taxa for both sample periods. Generally, streams lacking thermal influence had HBI values that range between good and excellent while streams having thermal influence had higher HBI values and lower stream water quality ratings. The downstream site on Obsidian Creek was the only invertebrate site that lacked an apparent stressor and yet received an HBI water quality rating of fair during the fall collection period. Streams segments which were sampled in areas of thermal activity generally had fewer numbers of total taxa, low numbers of EPT taxa, and higher percentages of tolerant taxa. In addition, the exotic New Zealand mud snail was collected from 3 invertebrate sample locations, all of which receive thermal runoff.

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INTRODUCTION

The Greater Yellowstone Network (GRYN) is comprised of 4 National Park Service (NPS) units and includes Bighorn Canyon National Recreation Area (BICA), Grand Teton National Park and John D. Rockefeller Jr. Memorial Parkway (collectively referred to as GRTE), and Yellowstone National Park (YELL) (Figure 1). A major goal of the GRYN is to develop and establish a long-term water quality monitoring program for each network park. A step towards achieving this goal was to conduct aquatic benthic macroinvertebrate community surveys as biological indicators of stream health. Bioassessment of streams using benthic macroinvertebrate assemblages has been widely used among state water resource agencies since 1989 (Southerland and Stribling, 1995). Aquatic benthic macroinvertebrates are ideal biotic indicators because they are easy to collect, relatively immobile, have long life spans (1 to 3 years), and are sensitive to environmental changes (Barbour, et al. 1999). Specific objectives for this study were to: 1) collect aquatic benthic macroinvertebrates using protocols established by Wyoming Department of Environmental Quality's Beneficial Use Reconnaissance Project (WYDEQ BURP) for water quality monitoring; 2) assess stream habitat; 3) collect synoptic water quality information (i.e. temperature, dissolved oxygen, pH, conductivity, turbidity, and discharge); and 4) use aquatic benthic macroinvertebrates to evaluate stream health between seasons and among sites. These data will be used to provide baseline inventories of aquatic organisms throughout GRYN, provide information regarding the status of water quality related issues within select streams of network park units, and help guide future water quality monitoring programs using aquatic invertebrates as biological indicators.

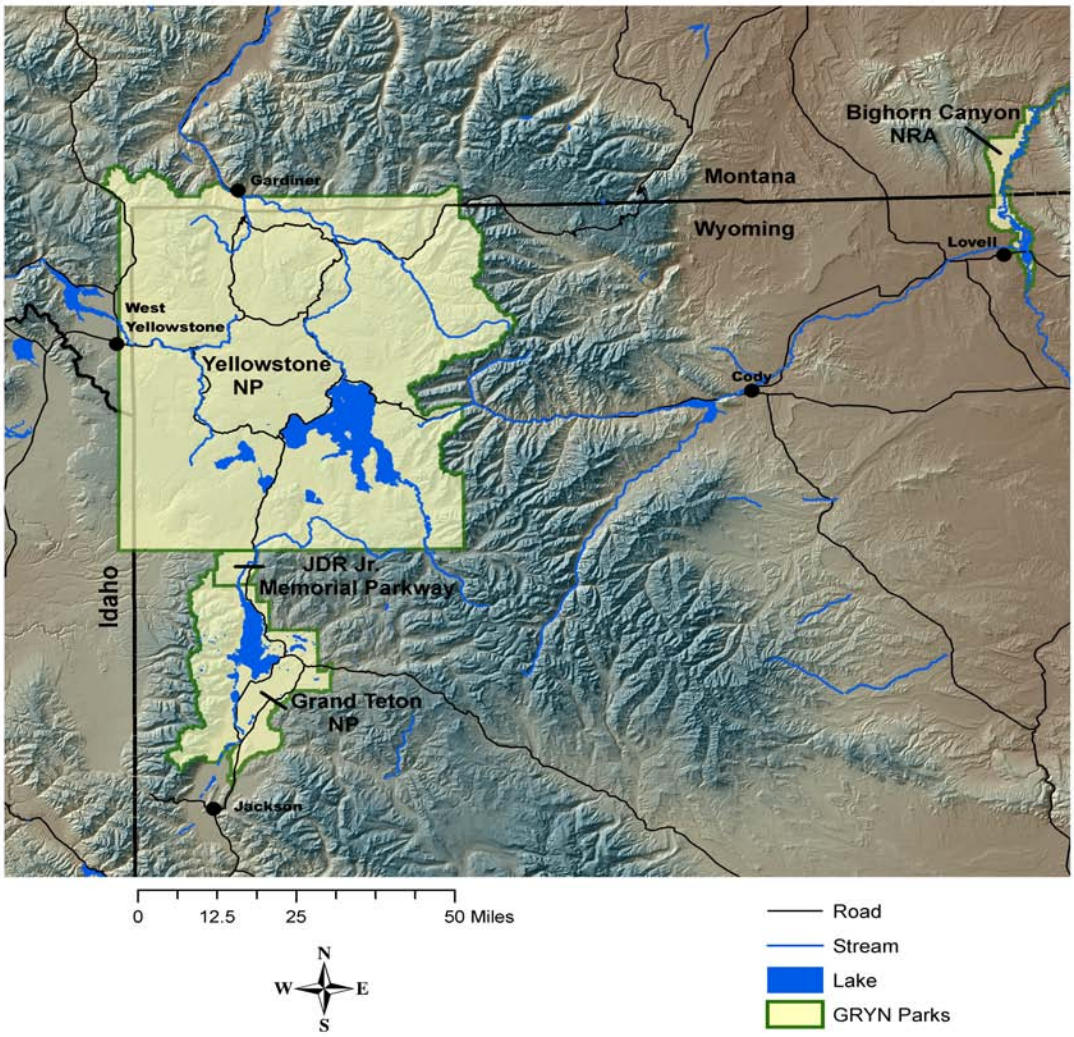

Figure 1. Greater Yellowstone Network park units in Idaho, Montana, and Wyoming.

STUDY AREAS

Bighorn Canyon National Recreation Area

BICA is a 48,682 hectare NPS unit that straddles the border between north-central Wyoming and south-central Montana (Figure 2) and lies within the Wyoming Basin ecoregion as defined by Omernik and Bailey, 1997. BICA was created in 1966 after the completion of Yellowtail Dam on the Bighorn River (NPS, n/a1) which consequently formed Bighorn Lake, the dominate water resource in the park. All rivers and streams found in BICA flow from outside park boundaries and into Bighorn Lake. The Shoshone and Bighorn rivers, two major tributaries to Bighorn Lake, have watersheds that encompass large portions of central Wyoming. Rangeland and agriculture comprise approximately 85 % of total land use within these two river basins (U.S. Geological Survey, 2001). Consequently, the quality of water found within BICA is negatively impacted by these land use practices. For example, in August 2000, the U.S. Geological Survey's (USGS) National Water-Quality Assessment program conducted sampling on Bighorn River above Bighorn Lake. They concluded that water conditions from this site exceed U.S. Environmental Protection Agency's (USEPA) proposed criteria for total nitrogen, total phosphorus, turbidity, plankton chlorophyll-*a* and periphyton chlorophyll-*a* (USGS, 2001). Additional studies have also concluded that fecal-coliform concentrations exceed USEPA's recommended limit for recreational contact at several stations along Shoshone and Bighorn rivers (USGS, 2003). Smaller streams that flow into Bighorn Lake and are important water resources in BICA include Crooked Creek, Layout Creek, North Fork Trail Creek, South Fork Trail Creek, and Dry Head Creek.

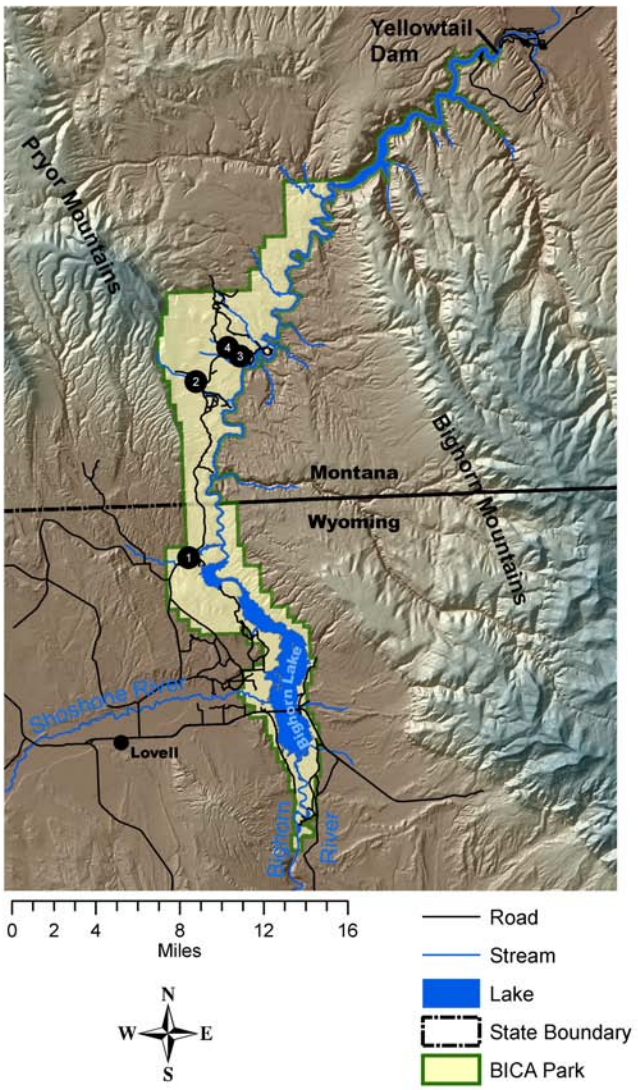

Figure 2. Location of benthic macroinvertebrate sites sampled in BICA during 2002. Sample sites are labeled 1-4.

During 12 September and 13 September 2002, 4 sites on 3 streams were sampled in BICA (Figure 2). One site each was sampled on Crooked and Layout creeks with the remaining 2 sites being sampled on North Fork Trail Creek, above and below a camping facility. Due to high water events at the time of sampling, Shoshone and Bighorn rivers were not included in this study.

Grand Teton National Park

GRTE is a 135,044 hectare park located in northwestern Wyoming (Figure 3) and lies within the Middle Rockies ecoregion (Omernik and Bailey, 1997). It was established in 1950 to protect the scenic mountains of the Teton Range and the 6 glacial lakes situated along the eastern flank of that range (NPS, n/a2). All water bodies in GRTE are of the highest quality and are classified as Outstanding Natural Resource Waters (ONRW) and designated as Class I waters by the state of Wyoming. Because of these classifications, degradation of any kind is prohibited. Jackson Lake Reservoir and the Snake River are the core water resources in GRTE. Lands surrounding GRTE are primarily managed by the federal government with YELL to the north, and Bridger-Teton National Forest and Targhee National Forest to the east and west respectively. The Snake River originates within Teton National Forest, flows north into YELL, circumvents Big Game Ridge and Mount Hancock, flows in a southwesterly direction into John D. Rockefeller Jr. Memorial Parkway where it enters GRTE from the north and then enters Jackson Lake Reservoir. The prominent waterbody within the park, Jackson Lake Reservoir, was created by the construction of Jackson Lake Dam during 1910-1911, and is operated by the U.S. Bureau of Reclamation (USBR, n/a). In general, streams entering the Snake River from the west originate within GRTE park boundaries. They are produced from snowmelt and glacial runoff from within the Teton Range. Streams

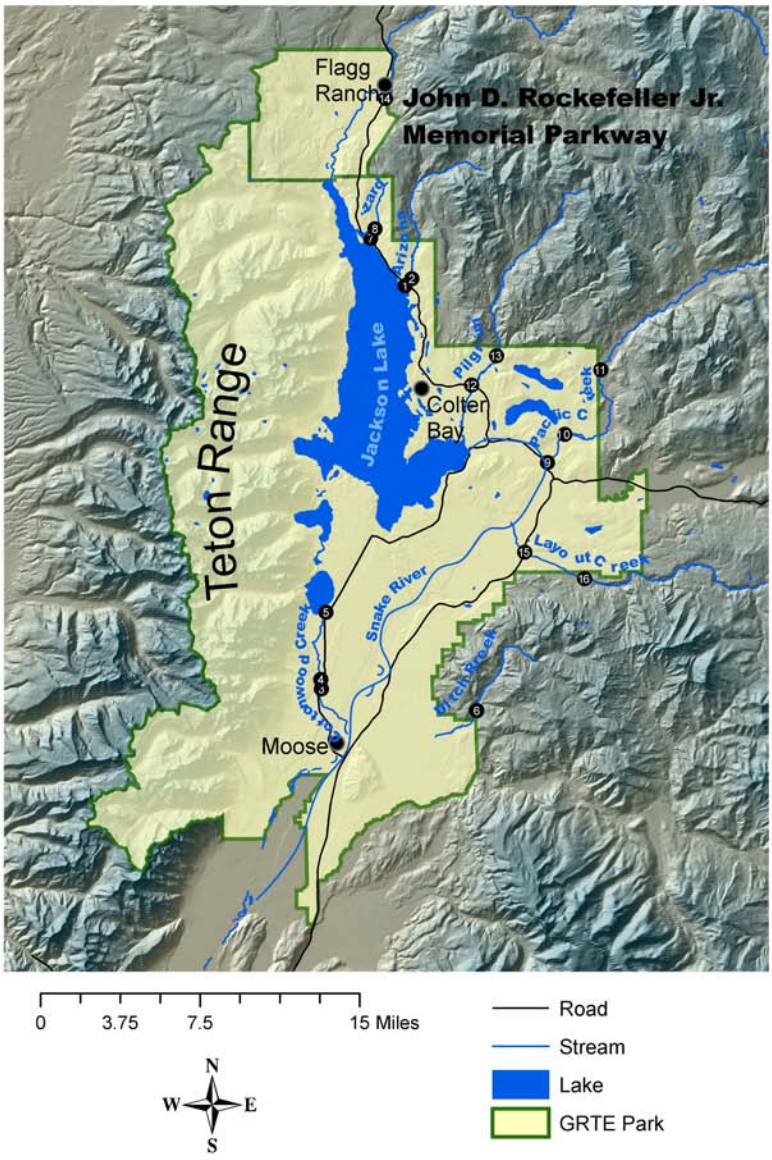

Figure 3. Location of benthic macroinvertebrate sites sampled in GRTE during 2002. Sample sites are labeled 1-16

that flow into the Snake River from the east primarily originate within Bridger-Teton National Forest and the adjacent Teton Wilderness.

During the summer and fall of 2002, 16 macroinvertebrate sites were sampled on 8 streams (Figure 3). Each site was visited twice, once during a summer period between 28 August and 06 September, and once during a fall period between 16 October and 25 October. Three sites each were sampled on Cottonwood and Pacific creeks while 2 sites were sampled on each of Arizona, Lizard, Pilgrim, and Spread creeks. Only 1 location was sampled on Ditch Creek and the Snake River (Figure 3). Buffalo Fork River, a major tributary on the east side of GRTE, was also selected for sampling but no suitable collection site was located. Of the 16 sites sampled, 6 were established to evaluate potential stressors to stream water quality and aquatic biota: 2 sites on Lizard and Arizona creeks were selected upstream and downstream of road crossings while 2 sites on Cottonwood Creek were selected to evaluate impacts from an intermittent stream that flows through an adjacent horse pasture.

Yellowstone National Park

YELL is located in the northwest corner of Wyoming and portions of southwest Montana and eastern Idaho (Figure 4) and lies within the Middle Rockies ecoregion (Omernik and Bailey, 1997). It was created in 1872 as the nation's first national park, primarily to protect the unique geothermal features and watersheds of the upper Yellowstone River, and encompasses approximately 898,321 hectares of pristine landscape. YELL forms the core of the Greater Yellowstone Ecosystem, which is the largest intact ecosystem in the lower 48 states. All water bodies within YELL are classified as ONRW and designated as Class I waters by the state of Wyoming. There are approximately 11,216 kilometers of streams and 43,706 hectares of lakes in YELL

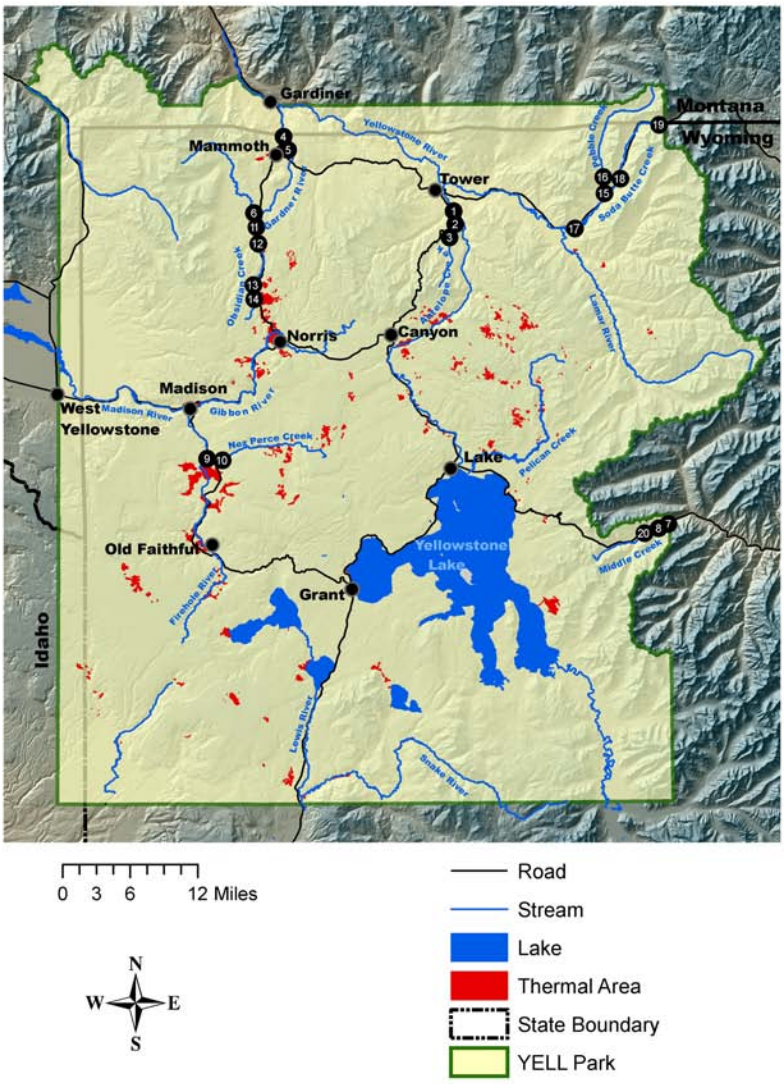

Figure 4. Location of benthic macroinvertebrate sites sampled in YELL during 2002. Sample locations are labeled 1-20.

(Varley and Schullery 1998). YELL and adjacent wilderness areas form the headwaters of three major rivers – Yellowstone, Madison and Snake rivers; contain four large, high elevation lakes – Yellowstone, Lewis, Shoshone, and Heart lakes; and more than 200 smaller lakes and ponds (Varley and Schullery 1998). In addition, YELL contains >10,000 geothermal features, which include geysers, hot springs, fumaroles and mud pots. These thermal features not only affect water temperatures, but they also vary in acidity, and are natural sources of mercury, arsenic, and other chemicals that affect surface water composition. Frequent high input levels of these chemicals have a direct impact on the type of organisms that are found in YELL surface waters.

During the summer and fall of 2002, 20 macroinvertebrate sites were sampled on 8 streams. Sites were sampled during a summer period between 06 August and 22 August, and a fall period between 07 October and 13 November. Four sites were sampled on Obsidian Creek; 3 sites were sampled on each of Antelope Creek, Soda Butte Creek, and Gardner River; 2 sites were sampled on each of Middle, Nez Perce, and Pebble creeks; and an unnamed tributary to Middle Creek was sampled at 1 location (Figure 4). Of the 20 sites sampled, 5 had major contributions from thermal sources and include the downstream site on the Gardner River, both sites on Nez Perce Creek, and the upper 2 sites on Obsidian Creek. During the fall period, inclement weather prevented sampling at 4 locations which include both sites on Pebble Creek and the middle and upper sites on Soda Butte Creek. In addition, the 2 sites on Pebble Creek were established above and below a campground facility to evaluate possible impacts this facility may have on water quality and aquatic biota.

METHODS

Macroinvertebrate sampling took place in the 3 GRYN parks units during a summer period between 06 August and 12 September 2002; and in GRTE and YELL during a fall period between 07 October and 13 November 2002. Site selection was primarily based on accessibility, water depth, and a minimum riffle or riffle-run stretch of at least 15 meters (m). In most cases, multiple sites within a stream were sampled to ascertain spatial differences within a stream or to evaluate stream condition above and below a potential stressor (e.g. road crossing or campground).

Prior to sampling, a global positioning systems unit (Garmin V) was used to record location in Universal Transverse Mercator (UTM) coordinates. In addition, basic water quality measurements were collected from each site. A Hydrolab datasonde 4a, mulitparameter probe was used to collect water temperature, dissolved oxygen (DO), pH, and specific conductance and a HACH 2100P instrument was used to measure turbidity readings from each site. Instruments were calibrated twice daily (i.e. once prior to sampling and once after sampling was completed) following manufacturer instructions for calibration procedures.

Methods used to sample invertebrates were adapted from those used by WYDEQ BURP (Wyoming Department of Environmental Quality, 1999). A Surber sampler (0.09 m^2 plot and 500 micron mesh) was utilized to collect benthic aquatic invertebrates. Eight Surbers were randomly placed within each sample reach. Prior to disturbance, individual plot areas were characterized by percent coverage of substrate, silt, and vegetation (i.e. aquatic macrophytes and algae) by using a 20 cm^2 piece of Plexiglas to view underwater benthic habitat. Stream substrate within plot areas were divided into 6 classes: boulder, > 25.4 centimeter (cm); cobble, 6.35-25.4 cm; coarse gravel, 2.54-6.35 cm; fine gravel,

0.76-2.54 cm; sand, 0.76-0.15 cm, gritty; and silt, <0.15, soft and fine. Substrate values for each of the 8 sample plots were then tallied and an average percent was obtained for substrate, silt, and vegetation cover. Following substrate characterization, aquatic benthic macroinvertebrates were then collected by gently rubbing the surface area of cobble and coarse gravel by hand and by thoroughly scrubbing the plot area with a soft bristle brush. Water currents washed materials that were dislodged from the substrate into the collection net. Subsequent to invertebrate collection and removal of each Surber net, water depth was recorded using a meter stick and velocity was obtained using a Marsh McBirney Flo-Mate Model 2000. The 8 Surbers were composited in the field and preserved in 70 % ethanol for future sample processing. Discharge was then calculated and a habitat assessment was conducted within the area immediately upstream of the sample reach. Habitat assessment was calculated by assigning a number to each of 12 separate habitat parameters outlined on the data sheet (Appendix 1). The range of values for each parameter is dependent upon the category of habitat being characterized. A higher habitat score is indicative of a higher quality of habitat for a sample reach. Scores for individual habitat parameters were averaged for each site with a possible range between 0 and 15.41. A complete list of measurements taken from each site is listed in Table 1.

After invertebrate samples were collected from GRYN parks, they were sent to Aquatic Biology Associates Inc., an independent laboratory in Corvallis, Oregon, for processing, invertebrate identification, and analysis. In the laboratory, samples were prepared by placing them on a 500 micron sieve and rinsing them with cold water. They were then elutriated by placing them in a large, white container and washing them several times to suspend all organic matter. The suspended material was poured back into the

Table 1. Habitat and water quality parameters measured in the three parks of the GRYN (adapted from Gerritsen et al. 2000).

Habitat Assessment	Water Quality	Physical
% fines, bottom substrate	Temperature	UTM easting
Embeddedness	Dissolved Oxygen	UTM northing
Instream cover	pH	Ecoregion
Velocity/depth ratio	Specific conductivity	Elevation
Channel flow status	Turbidity	Discharge
Channel shape		
Pool/riffle ratio		
Channelization or alteration		
Bank vegetation stability		
Bank stability		
Disruptive pressures to riparian zone		
Riparian zone width		
% composition of substrate*		

* Percent composition of substrate determined by 6 classes: boulder, cobble, coarse gravel, fine gravel, sand, and silt

500 micron sieve. This process was repeated until all organic matter was removed from the mineral residue. The mineral residue remaining in the container was searched for stonecased caddisfly and molluscs that may have been retained in the sample (Aquatic Biology Associates Inc., n/a). The sample was evenly distributed on a gridded Canton Tray and individual grids were randomly selected until a minimum of 550 organisms were counted. The remaining sample was searched for large/rare organisms that were not collected during the original subsampling process and placed in a separate container. Any organism found during the large/rare search and not found in the original subsample was given the abundance of 1.

DATA ANALYSIS

For each sample, total numbers of invertebrates were tallied for individual taxa, invertebrate abundance was converted to density per square meters (m^2), and tolerance values (percent tolerant and intolerant taxa) were calculated. EPT (Ephemeroptera, Plecoptera, and Trichoptera) Richness Index values and modified Hilsenhoff's Biotic Index (HBI) values, which are known water quality indicators (Lenz, 1997), were also calculated for each site.

EPT Richness Index is calculated by tallying distinct invertebrate taxa belonging to the insect orders Ephemeroptera, Plecoptera, and Trichoptera. As a group, EPT taxa are more pollution-sensitive organisms that respond readily to environmental changes in aquatic environments. Generally, number of EPT taxa increase with lower water temperatures, increased DO concentration and little organic pollution and decrease with higher water temperatures, decreased DO concentrations and increased organic pollution.

Modified HBI values (Hilsenhoff, 1987 and 1988) are obtained by evaluating the number of benthic invertebrates in the phylum Arthropoda at a site and their tolerance to pollution to ascertain the degree to which natural organic compounds, elevated temperatures, and low DO are likely to be present (USGS, 1999). Each benthic invertebrate is assigned a tolerance value from 0 to 10, with 0 assigned to invertebrates least tolerant to pollution and 10 assigned to invertebrates most tolerant of pollution (USGS, 1999). In general, benthic invertebrate taxa that are most sensitive to pollution are in the insect orders Ephemeroptera, Plecoptera, and Trichoptera; those organisms that are least sensitive to water pollution are in the orders Oligochaeta, Hirudinea, Odonata, and Diptera. The HBI is divided into 7 categories (Table 2). A low HBI value indicates

Table 2. Hilsenhoff Biotic Index values as an evaluation of water quality (Hilsenhoff, 19887)

Biotic Index	Water Quality	Degree of pollution
0.00 - 3.50	Excellent	None apparent
3.51 - 4.50	Very Good	Possible slight
4.51 - 5.50	Good	Some
5.51 - 6.50	Fair	Fairly Significant
6.51 - 7.50	Fairly Poor	Significant
7.51 - 8.50	Poor	Very Significant
8.51 - 10.00	Very Poor	Severe

excellent water quality with no pollution and a high HBI value indicates poor water quality with high amounts of pollution (USGS, 1999; Hilsenhoff, 1988).

Shannon-Wiener ($\log_{10}$) diversity indices (Zar, 1984) were calculated to evaluate site diversity. A *t*-test (Hutcheson, 1970) is used to test diversity indices between summer and fall sampling periods among individual sites. A *t*-test is also used to evaluate temporal differences between mean number of distinct taxa during summer and fall sample periods (Zar, 1984).

RESULTS AND DISCUSSION

Bighorn Canyon National Recreation Area

Specific stream site locations are recorded in UTMs and presented in Appendix B. Catchment areas for the 4 invertebrate sampling locations range from 1,162 hectares for North Fork Trail Creek to 25,141 hectares for Crooked Creek. Recorded discharge ranged from 0.002 m^3/sec (cubic meters per second) for Layout Creek to 0.053 m^3/sec for Crooked Creek (Table 3). Ranges for additional physical measurements collected during

Table 3. Site information and water quality measurements taken at benthic invertebrate sampling locations in BICA during September 2002.

Stream Site ID	Stream Name	Date	Elevation (m)	Catchment (hectares)	Discharge (m^3/sec)	Water Temp. (^oC)	DO (mg/L)	pH	Cond. (*u* S)	Turbidity (NTU)	Average Velocity (m/sec)	Average Depth (m)	Average Habitat Value
1	Crooked Cr.	13-Sep	1,143	25,141	0.053	20.9	9.6	8.3	1114	16.0	0.38	0.15	12.04
2	Layout Cr.	13-Sep	1,309	1,314	0.002	9.7	10.4	7.7	428	0.5	0.13	0.09	14.17
3	N. F. Trail Cr.	12-Sep	1,119	1,495	0.029	15.3	9.7	8.1	1482	2.6	0.49	0.11	11.75
4	N.F. Trail Cr.	12-Sep	1,153	1,162	0.010	13.0	10.3	7.8	1463	2.1	0.26	0.11	12.75

the 2002 sample season in BICA were as follows: water temperature, 9.7 – 20.9 ^{o}C (degrees Celsius); DO, 9.6 – 10.4 mg/L (milligrams per liter); pH, 7.7 – 8.3 (standard units); conductivity 428 – 1,482 µS cm^{-1} (µSiemens cm^{-1}); turbidity, 0.5 – 16.0 NTU (nephlometric turbidity units); average velocity, 0.13 – 0.49 m/sec (meters per second); average depth, 0.09 – 0.15 m ; and average habitat value, 11.75-14.17 (Table 3). Crooked Creek exhibited the highest water temperature, pH, and turbidity as well as the lowest DO concentration of all sites sampled. Conversely, Layout Creek exhibited the lowest water temperature, pH, conductivity, and turbidity as well as the highest DO concentration of all sites sampled. Three of 4 sites had conductivity values greater than 1100 µS cm^{-1}. These values greatly exceed the maximum criteria value for conductivity (600 µS cm^{-1}) listed by Gerritsen et al. (2000) for nonimpaired streams in the Wyoming Basin ecoregion. Two of 4 sites had a habitat value that indicated some degree of impairment with lower site on North Fork Trail Creek having the lowest habitat score of 11.75, followed by Crooked Creek with a habitat score of 12.04. The in-stream and riparian habitat surrounding the site on Layout Creek was generally good with a habitat score of 14.17.

Average percent substrate, silt cover and vegetation cover for each sample site are listed in Table 4. Crooked and Layout creek sites exhibited a higher percentage of cobble and coarse gravel combined (59.1% and 71.7 % respectively) than the lower or upper sites on North Fork Trail Creek with 36.7 % and 40.8 % respectively. Crooked and Layout creeks also had the highest average percent silt cover with an average rating between moderate and high. Mean percent vegetation (aquatic macrophytes) cover among the 4 sites was very low with a range between 0.5 % (SD=0.72% and 1.41%) for

Table 4. Site information and percent substrate type, silt cover and vegetation cover recorded in BICA during benthic invertebrate sampling in September 2002.

Stream			% Substrate								% Silt Cover					% Vegetation Cover	
Site		Sample		Coarse	Fine						Low		Moderate	High			
ID	Stream Name	Date	Cobble	Gravel	Gravel	Sand	Silt	Clay	Organic	Other	<5	5 - 25	25 - 50	50 - 75	>75	Macrophyte	Algae
1	Crooked Cr.	13-Sep	41.0	18.1	23.4	17.5	0	0	0	0	3.1	0	81.3	12.5	3.1	0.6	13.3
2	Layout Cr.	13-Sep	52.1	21.6	12.6	11.3	0	0	3.3	0	11.9	15.0	9.4	16.9	46.9	3.1	0
3	N.F. Trail Cr.	12-Sep	10.6	26.1	45.5	12.5	0	5.0	0.3	0	73.1	3.8	4.4	5.6	13.1	0.5	0
4	N.F. Trail Cr.	12-Sep	29.5	11.3	38.1	8.6	0	0	0	12.5	39.4	11.9	0	0	48.8	0.5	5.1

the downstream and upstream sites on North Fork Trail respectively, and 3.13 % (SD=5.30%) for Layout Creek.

Seventy invertebrate taxa were collected from 4 BICA sites (Appendix C). Between 11 and 42 distinct benthic invertebrate taxa were collected from each site. Density of macroinvertebrates range from 134 to 1,360 organisms/m^2 with a mean density of 562 organisms/m^2. The lowest number of invertebrate taxa and densities were recorded at the lower site of North Fork Trail Creek; the highest number of invertebrate taxa and densities were recorded at the Crooked Creek site (Table 5). The lower site of North Fork Trail Creek, with 11 taxa and 134 organisms/m^2, had a markedly fewer number of taxa and invertebrate density when compared to the upper site of North Fork Trail Creek, which had 28 taxa and a density of 467 organisms/m^2. These two sites are separated by several hundred meters with the lower site being located just downstream of a campground. The differences in number of taxa and invertebrate abundance between the 2 sites on North Fork Trail Creek could be explained by overall lower quality of habitat at the lower site. In general, density of aquatic invertebrates from both sites of North Fork Trail Creek and from the site on Layout Creek was three to ten times lower than the invertebrate density found on Crooked Creek.

Four distinct invertebrate taxa were found at all invertebrate sites and include: worms, Oligochaeta; a mayfly, *Baetis tricaudatus*; and 2 midge groups - midge pupae, and *Eukiefferiella spp.;* all are relatively pollution tolerant taxa. An additional 7 taxa were found at 3 sample locations and include: 2 stoneflies - *Hesperoperla pacifica* and *Zapada cinctipes*; a caddisfly, *Hydropsychae* spp.; a beetle, Dyticidae; and 3 midge taxa – *Micropsectra spp.*, *Orthocladius spp.*, and *Tvetenia Bavarica* Group (Appendix C). Dipterans, primarily a pollution tolerant group, range from 10 to 68 % with a mean of

Table 5. Summary of select benthic invertebrate metrics for sites in BICA during sampling in September 2002.

Stream Site ID	Stream Name	Date	Invertebrate Density (m2)	Number Taxa	EPT Richness Index	Perecent Dominant Taxa	Modified Hilsenhoff Biotic Index	HBI Water Quality Rating	Tolerance Values			
									Number Tolerant Taxa	Percent Tolerant Taxa	Number Intolerant Taxa	Percent Intolerant Taxa
1	Crooked Cr.	13-Sep	1,360	42	8	18.13	6.64	Fairly Poor	14	28.27	0	0
2	Layout Cr.	13-Sep	288	33	8	18.31	5.06	Good	2	0.94	1	0.47
3	N.F. Trail Cr.	12-Sep	134	11	5	50.51	5.83	Fair	2	3.03	0	0
4	N.F. Trail Cr.	12-Sep	467	28	7	30.92	5.17	Good	7	12.43	0	0

36.75 %. Dipterans dominated the invertebrate community at 2 of 4 sites sampled with Crooked and Layout creeks having 72 and 58 % respectively (Table 6). EPT taxa range between 10 and 87 % of the total invertebrates collected for each sample with a mean of 50.25 %. The lower and upper sites of North Fork Trail Creek had the highest percentage of EPT taxa with 87 and 77 % respectively (Table 6). EPT Richness Index values for all sites were relatively low with a range from 5 at the lower site of North Fork Trail Creek to 8 EPT taxa at Crooked and Layout creeks (Figure 5).

Overall HBI values range from 5.06 to 6.64. The site on Layout Creek and the upper site on North Fork Trail Creek rated good; the lower site on North Fork Trail Creek rated fair; and the site on Crooked Creek rated fairly poor (Figure 6). Number of tolerant taxa ranged between 2 and 14 with the sites on Layout Creek and the lower North Fork Trail Creek site having 2 tolerant taxa and the site on Crooked Creek having 14 tolerant taxa (Table 5). Similarly, percent tolerant taxa were lowest for the site on Layout Creek and the lower site on North Fork Trail Creek with 0.94 and 3.03 % respectively, and highest at the Crooked Creek site with 28.27 % tolerant taxa. The site on Layout Creek was the only sample location that contained an intolerant taxon which represented 0.47 % of the total taxa collected at that site (Table 5).

Shannon H' ($\log_{10}$) diversity measures ranged from 0.70 to 1.24 (Table 7). The lowest diversity measure was calculated for lower site on North Fork Trail Creek and the highest diversity measure was calculated for the Crooked Creek site. An explanation for the higher diversity indices calculated for Crooked and Layout creeks could be due to the greater percentage of cobble and coarse gravel substrate that would ultimately provide a more diversified instream habitat. Conversely, the low diversity indices for both sites on

Table 6. Percentages for select benthic invertebrate groups for sites in BICA during sampling in September 2002.

Stream			Annelida	Crustacea	Arachnida	Turbellaria	Nematoda	Insecta						Mollusca	
Site			Oligochaeta	Hyalella	Acari	Turbellaria	Nematoda	Ephemeroptera	Plecoptera	Trichoptera	Odonata	Coleoptera	Diptera	Gastropoda	Pelycopoda
ID	Stream Name	Date	%	%	%	%	%	%	%	%	%	%	%	%	%
1	Crooked Cr.	13-Sep	3	<1	<1	0	0	7	0	3	1	<1	68	18	0
2	Layout Cr.	13-Sep	1	0	0	9	0	18	8	<1	0	6	57	0	0
3	N.F. Trail Cr.	12-Sep	1	0	0	0	0	51	19	17	0	2	10	0	0
4	N.F. Trail Cr.	12-Sep	1	0	<1	0	0	25	47	5	0	7	12	3	0

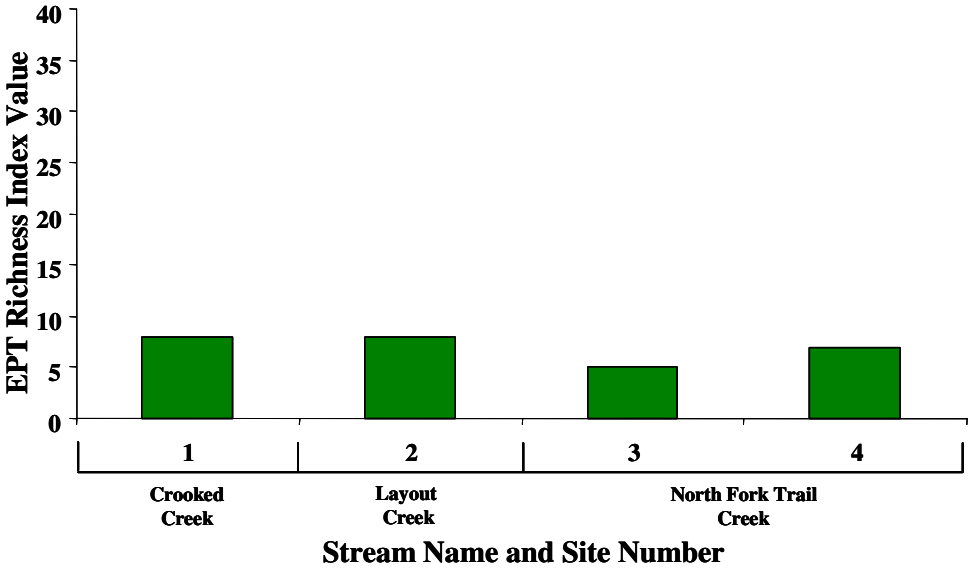

Figure 5. EPT Richness Index values for individual sites sampled in BICA during September 2002.

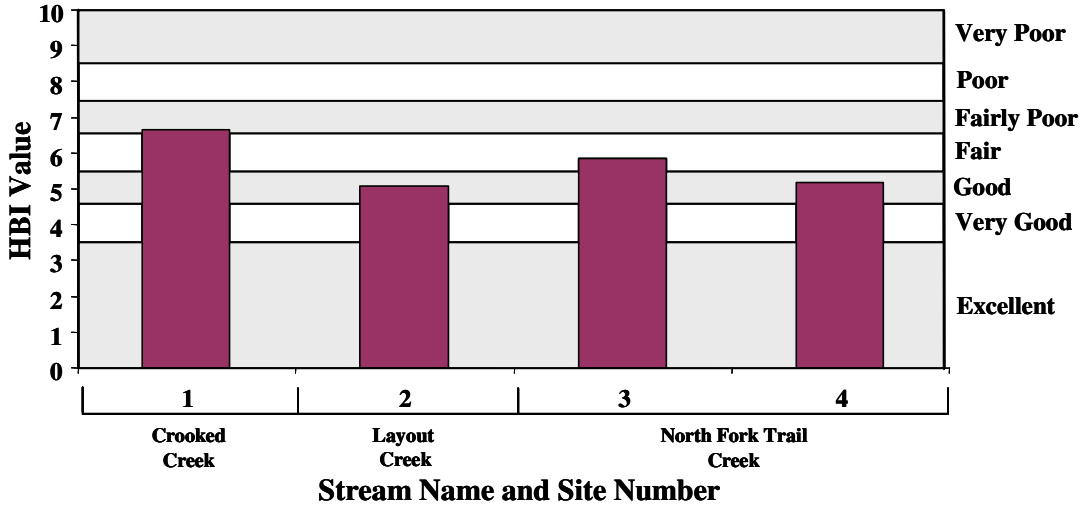

Figure 6. Modified Hilsenhoff Biotic Index values for individual sites sampled in BICA during September 2002. Horizontal shaded and clear bars indicate individual HBI rankings.

Table 7. Shannon H' diversity measures ($\log_{10}$) calculated for each invertebrate site during a summer and fall sample period. P values and degrees of freedom (v) for t-test which evaluates the significance between two diversity indices on a seasonal scale.

Park Unit	Stream Site ID	Stream Name	Diversity Measure Shannon H' (log10) Summer	Fall	*t*	*v*	P
BICA	1	Crooked Cr.	1.24				
	2	Layout Cr.	1.20				
	3	N. F. Trail Cr.	0.70				
	4	N.F. Trail Cr.	0.95				
GRTE	1	Arizona Cr.	1.43	1.15	20.27	6422.44	P > 0.001
	2	Arizona Cr.	1.42	1.22	11.42	3785.78	P > 0.001
	3	Cottonwood Cr.	0.93	1.07	9.33	2313.32	P > 0.001
	4	Cottonwood Cr.	0.91	1.09	-7.23	1329.95	P > 0.001
	5	Cottonwood Cr.	1.18	1.27	-13.01	6838.25	P > 0.001
	6	Ditch Cr.	0.73	0.65	8.07	12593.85	P > 0.001
	7	Lizard Cr.	1.30	1.15	7.92	1496.53	P > 0.001
	8	Lizard Cr.	1.43	0.74	36.18	920.45	P > 0.001
	9	Pacific Cr.	1.00	0.89	11.09	14235.47	P > 0.001
	10	Pacific Cr.	1.25	0.89	22.92	4396.25	P > 0.001
	11	Pacific Cr.	1.22	1.15	7.07	2887.16	P > 0.001
	12	Pilgrim Cr.	1.18	1.13	2.55	2126.38	0.01<P0.02
	13	Pilgrim Cr.	1.36	1.18	9.48	1736.35	P > 0.001
	14	Snake R.	1.13	0.98	11.66	1769.01	P > 0.001
	15	Spread Cr.	1.31	1.07	13.71	1897.56	P > 0.001
	16	Spread Cr.	1.04	1.10	-3.33	2610.66	P > 0.001
YELL	1	Antelope Cr.	1.45	1.33	10.05	5638.79	P > 0.001
	2	Antelope Cr.	1.39	1.29	7.83	3027.82	P > 0.001
	3	Antelope Cr.	1.32	1.18	14.38	13125.81	P > 0.001
	4*	Gardner Cr.	0.87	0.95	-4.85	1803.38	P > 0.001
	5	Gardner Cr.	1.12	1.23	-8.49	4758.61	P > 0.001
	6	Gardner Cr.	1.31	1.35	-2.81	3045.42	0.002<P<0.005
	7^	Middle Cr.	1.22	1.20	1.31	3233.45	0.10<P<0.20
	8	Middle Cr.	1.12	1.26	-13.19	7838.14	P > 0.001
	9*	Nez Perce Cr.	1.03	1.24	-6.58	502.19	P > 0.001
	10*	Nez Perce Cr.	0.83	1.05	-3.92	161.02	P > 0.001
	11	Obsidian Cr.	0.79	1.01	-9.92	3843.79	P > 0.001
	12	Obsidian Cr.	0.97	1.21	-13.94	2126.11	P > 0.001
	13*^	Obsidian Cr.	0.45	0.44	0.03	125.48	P<0.50
	14*	Obsidian Cr.	0.07	0.46	-7.37	79.19	P > 0.001
	15	Pebble Cr.	1.27				
	16	Pebble Cr.	1.34				
	17	Soda Butte Cr.	1.00	0.90	7.48	6892.59	P > 0.001
	18	Soda Butte Cr.	1.01				
	19	Soda Butte Cr.	0.87				
	20	unnamed trib.	1.27	1.42	-14.74	10634.32	P > 0.001

* indicate stream sites with significant thermal inputs.

^ indicate sites with similar diversity measures between summer and fall sample periods (P> 0.05)

North Fork Trail Creek could be the result of poor instream habitat resulting from the high percentage of fine gravel and sand substrates.

Grand Teton National Park

Summer Period

UTM coordinates for stream site locations are presented in Appendix B. Catchment areas for the 16 invertebrate sampling locations range from 1,112 hectares for Lizard Creek to 100,518 hectares at the Snake River site. Stream discharge ranged between 0.0006 m^3/sec and 7.840 m^3/sec at the Lizard Creek and Snake River sites respectively (Table 8). The range for additional physical measurements were as follows: water temperature, 8.9 -17.1 ^oC; DO, 8.1 – 9.7 mg/L; pH, 7.5 – 8.7; conductivity, 16 – 329 $\mu S\ cm^{-1}$; turbidity, 0.6 – 6.4 NTU; average velocity, 0.06 – 0.68 m/sec; average depth, 0.07 – 0.26 m; and average habitat value, 10.08-15.29 (Table 8). For all parameters, there was no obvious indication of impairment to water quality on stream segments sampled. However, both sites on Spread Creek had lower habitat value scores than other invertebrate sites. The lower habitat score for these 2 sites were attributed to a lower value given for stream embeddedness, channel shape, channel alteration, bank vegetation protection, and disruptive pressures which were recorded for 1 or both of these locations.

Percent substrate comprised of both cobble and coarse gravel was relatively high for all sites with a range between 56.8 % for the upstream site on Lizard Creek and 90.4 % for Snake River site (Table 9). Ten sites have greater than 75 % of their substrate comprised of both cobble and coarse gravel and include both sites on Arizona and Spread creeks, the middle and upstream sites on Cottonwood and Pacific creeks, the upstream site on Pilgrim Creek, and the Snake River site. Nine sites had a relatively low silt cover

Table 8. Site information and water quality measurements taken at benthic invertebrate sampling locations in GRTE during summer non-shaded and fall (shaded) periods 2002.

Stream Site ID	Stream Name	Date	Elevation (m)	Catchment (hectares)	Discharge (m^3/sec)	Water Temp. (^oC)	DO (mg/L)	pH	Cond. (*u* S)	Turbidity (NTU)	Average Velocity (m/sec.)	Average Depth (m)	Average Habitat Value
1	Arizona Creek	29-Aug	2,070	7,162	0.107	12.7	-	8.4	279	1.1	0.19	0.13	13.67
1	Arizona Creek	21-Oct	2,070	7,162	0.049	-	-			0.8	0.20	0.14	13.67
2	Arizona Creek	29-Aug	2,079	7,053	0.127	9.4	-	8.3	284	0.9	0.15	0.17	13.71
2	Arizona Creek	17-Oct	2,079	7,053	0.069	5.2	10.2	8.2	297	0.7	0.16	0.16	13.71
3	Cottonwood Cr.	9-Sep	2,034	16,084	0.648	12.0	8.6	7.6	16	1.4	0.28	0.24	14.21
3	Cottonwood Cr.	22-Oct	2,034	16,084	0.376	3.5	9.8	7.7	23	0.8	0.41	0.23	14.21
4	Cottonwood Cr.	4-Sep	2,034	15,955	0.648	16.2	8.2	7.5	16	1.2	0.37	0.23	15.29
4	Cottonwood Cr.	22-Oct	2,034	15,955	0.423	3.8	10.5	7.5	22	0.8	0.38	0.17	15.29
5	Cottonwood Cr.	4-Sep	2,086	12,498	1.186	17.1	8.1	7.7	21	0.6	0.40	0.21	14.33
5	Cottonwood Cr.	22-Oct	2,086	12,498	0.792	8.8	8.5	8.0	24	0.6	0.22	0.18	14.33
6	Ditch Cr.	5-Sep	2,174	6,795	0.030	10.2	9.5	8.4	329	1.4	0.16	0.17	14.42
6	Ditch Cr.	18-Oct	2,174	6,795	0.031	3.9	10.2	8.2	343	0.7	0.28	0.16	14.42
7	Lizard Cr.	6-Sep	2,075	1,112	0.006	8.9	8.4	7.7	98	0.9	0.11	0.07	14.13
7	Lizard Cr.	25-Oct	2,075	1,112	0.004	0.1	10.4	7.7	97	2.1	0.08	0.14	14.13
8	Lizard Cr.	6-Sep	2,082	1,112	0.006	9.5	8.2	7.7	97	1.0	0.06	0.10	13.00
8	Lizard Cr.	25-Oct	2,082	1,112	0.004	1.1	10.5	7.9	98	0.6	0.05	0.13	13.00
9	Pacific Cr.	3-Sep	2,056	43,056	1.440	10.4	9.5	8.0	225	0.7	0.65	0.24	12.67
9	Pacific Cr.	16-Oct	2,056	43,056	1.359	9.0	9.3	8.1	229	0.6	0.78	0.27	12.67
10	Pacific Cr.	30-Aug	2,079	41,150	1.629	11.2	9.7	8.2	217	1.0	0.68	0.21	14.58
10	Pacific Cr.	16-Oct	2,079	41,150	1.275	7.1	9.6	8.1	227	0.9	0.79	0.22	14.58
11	Pacific Cr.	30-Aug	2,121	35,289	1.755	14.2	8.4	8.4	210	1.3	0.54	0.26	13.75
11	Pacific Cr.	16-Oct	2,121	35,289	1.096	2.1	10.4	8.0	223	2.1	0.62	0.30	13.75
12	Pilgrim Cr.	28-Aug	2,108	12,381	0.453	16.0	-	8.5	187	4.6	0.39	0.15	12.58
12	Pilgrim Cr.	17-Oct	2,108	12,381	0.208	7.8	9.6	8.3	204	0.6	0.41	0.17	12.58
13	Pilgrim Cr.	28-Aug	2,141	6,971	0.575	8.9	-	8.3	187	6.4	0.43	0.21	12.92
13	Pilgrim Cr.	17-Oct	2,141	6,971	0.367	1.4	10.7	8.1	199	1.2	0.57	0.21	12.92
14	Snake R.	29-Aug	2,078	100,518	7.840	13.9	-	8.5	296	1.6	0.52	0.22	14.50
14	Snake R.	25-Oct	2,078	100,518	7.589	7.6	10.5	8.6	299	0.8	0.44	0.21	14.50
15	Spread Cr.	5-Sep	2,092	26,107	0.030	16.7	8.3	8.7	243	0.8	0.25	0.10	11.54
15	Spread Cr.	21-Oct	2,092	26,107	0.587	-	-	-	-	2.2	0.42	0.14	11.54
16	Spread Cr.	3-Sep	2,184	25,298	0.856	15.0	8.2	8.7	222	1.8	0.47	0.17	10.08
16	Spread Cr.	21-Oct	2,184	25,298	0.766	-	-	-	-	2.4	0.61	0.26	10.08

Table 9. Site information and percent substrate type, silt cover, and vegetation cover recorded in GRTE during summer (non-shaded) and fall (shaded) benthic invertebrate sampling periods in 2002.

Stream Site ID	Stream Name	Sample Date	% Substrate								% Silt Cover					% Vegetation Cover	
											Low		Moderate	High			
			Cobble	Coarse Gravel	Fine Gravel	Sand	Silt	Clay	Organic	Other	<5	5 - 25	25 - 50	50 - 75	>75	Macrophyte	Algae
1	Arizona Creek	29-Aug	70.8	13.8	13.1	2.4	0	0	0	0	26.3	13.1	25.0	8.1	27.5	0	0.3
1	Arizona Creek	21-Oct	49.6	35.5	13.4	1.5	0	0	0	0	51.9	9.4	1.9	0	36.9	0	0.8
2	Arizona Creek	29-Aug	75.6	9.5	3.1	9.3	0	0	0	2.5	12.8	25.6	7.5	0	54.1	0	0.6
2	Arizona Creek	17-Oct	80.0	13.3	3.9	0.4	0	0	0	0	15.6	0	0	0	84.4	0	21.5
3	Cottonwood Cr.	9-Sep	54.1	20.6	19.6	5.6	0	0	0	0	100	0	0	0	0	0.6	1.8
3	Cottonwood Cr.	22-Oct	59.0	31.0	9.5	0.5	0	0	0	0	100	0	0	0	0	0.0	7.0
4	Cottonwood Cr.	4-Sep	47.8	32.3	15.6	4.4	0	0	0	0	100	0	0	0	0	0.1	1.6
4	Cottonwood Cr.	22-Oct	63.6	21.8	11.8	1.6	0	0	0	1.9	100	0	0	0	0	0	2.8
5	Cottonwood Cr.	4-Sep	69.6	11.9	13.4	4.5	0	0	0.6	0	87.5	0	0	0	12.5	0	0.0
5	Cottonwood Cr.	22-Oct	44.8	33.9	14.0	7.4	0	0	0	0	100	0	0	0	0	0	0.4
6	Ditch Cr.	5-Sep	48.8	24.4	13.1	3.8	0	0	0	10.0	23.8	8.1	7.5	15.6	45.0	0	18.8
6	Ditch Cr.	18-Oct	55.3	28.0	5.6	1.9	0	0	0	9.3	92.9	1.9	1.3	0	4.0	0	5.9
7	Lizard Cr.	6-Sep	39.1	23.5	18.8	10.4	0	0	6.4	0	99.4	0.6	0	0	0	0	0.5
7	Lizard Cr.	25-Oct	34.1	38.4	15.0	12.6	0	0	0	0	100	0	0	0	0	0	5.1
8	Lizard Cr.	6-Sep	38.6	18.1	20.0	21.1	0	0	2.1	0	93.8	0	0	0	6.3	2.5	0.0
8	Lizard Cr.	25-Oct	36.6	23.6	25.8	14.0	0	0	0	0	75.0	12.5	0	0	12.5	0	0.1
9	Pacific Cr.	3-Sep	51.6	21.9	22.5	3.4	0	0	0.6	0	98.8	1.3	0	0	0	0	0.0
9	Pacific Cr.	16-Oct	62.3	15.5	20.5	1.8	0	0	0	0	100	0	0	0	0	0	0.0
10	Pacific Cr.	30-Aug	61.9	15.0	13.4	9.8	0	0	0	0	68.1	1.9	13.8	1.9	13.1	1.9	0.6
10	Pacific Cr.	16-Oct	63.9	24.0	11.3	0.9	0	0	0	0	100	0	0	0	0	0	0.1
11	Pacific Cr.	30-Aug	70.9	14.8	10.1	4.3	0	0	0	0	67.9	9.4	3.8	2.5	16.5	0	0.3
11	Pacific Cr.	16-Oct	72.9	14.5	8.4	4.3	0	0	0	0	86.6	1.9	0	6.3	5.3	0	5.1
12	Pilgrim Cr.	28-Aug	53.8	20.6	19.1	6.5	0	0	0	0	71.3	16.3	0	0	12.5	0	0.0
12	Pilgrim Cr.	17-Oct	37.6	38.9	18.4	5.1	0	0	0	0	83.1	3.1	1.9	0	11.9	0	0.1
13	Pilgrim Cr.	28-Aug	66.9	12.3	17.4	3.5	0	0	0	0	58.8	0	6.3	3.1	31.9	0	0.0
13	Pilgrim Cr.	17-Oct	58.5	17.6	23.6	0.3	0	0	0	0	100	0	0	0	0	0	0.0
14	Snake R.	29-Aug	76.8	13.5	7.0	2.8	0	0	0	0	100	0	0	0	0	0	0.0
14	Snake R.	25-Oct	56.8	24.8	16.1	2.4	0	0	0	0	99.4	0	0	0	0.6	0	0.1
15	Spread Cr.	5-Sep	63.0	24.4	11.9	0.8	0	0	0	0	46.3	16.3	7.5	2.5	27.5	0	5.9
15	Spread Cr.	21-Oct	44.6	25.4	29.3	0.8	0	0	0	0	79.4	5.6	0	0	15.0	0	1.8
16	Spread Cr.	3-Sep	71.3	13.4	7.9	1.3	6.3	0	0	0	52.8	2.5	1.0	0	43.8	0	0.4
16	Spread Cr.	21-Oct	85.3	9.8	1.5	3.5	0	0	0	0	18.1	0.6	0	0	81.3	0	12.4

rating while seven sites had silt cover that ranked between moderate and high. The site on Ditch Creek was most severely covered by silt with approximately 68 % of the substrate covered by silt. Additional sites that had moderate to high silt cover include the two sites on Arizona Creek and the upstream site on Spread Creek (Table 9). Generally, aquatic vegetation cover was low for all sites sampled with a range between 0 and 2.5 % and a mean of 0.35 %. Aquatic vegetation was absent from 12 sites while the highest percentage was recorded for upstream site on Lizard Creek. Algae cover had a range from 0 to 18.75 % and a mean of 1.91 %. Algae was absent from 6 sites while the site on Ditch Creek had the highest percent algae cover (Table 9).

A total of 146 invertebrate taxa were collected during the summer sample period. Taxa and number of individuals/m^2 are listed in Appendix D. Distinct benthic invertebrate taxa ranged between 33 at the lower Pilgrim Creek site and 61 at the 2 Arizona Creek sites with a mean of 44.5 invertebrate taxa collected per site (Table 10). Density of benthic macroinvertebrates range between 737 and 7,545 organisms/m^2 with a mean density of 2,830 organisms/m^2. The lowest and highest benthic invertebrate densities were collected at upstream site of Lizard Creek and the Ditch Creek site respectively (Table 10).

Four distinct taxonomic groups were collected at all sample sites and include mites, Acari, and 3 midge groups – Chironomid pupae, *Micropsectra spp*., and *Tvetenia Bavarica* Group. In addition, a stonefly, *Sweltsa spp*., was collected at 15 invertebrate sites while 3 taxa which include 2 mayflies, *Ephemerella inermis* and *Baetis tricaudatus,* and a caddisfly, *Brachycentrus americanus,* were collected at 14 invertebrate locations. Percent Dipterans range from 6 to 62 % with a mean of 29.87 % (Table 11). Dipterans were the dominant taxonomic group at only 2 sites (both upstream sites on Cottonwood

Table 10. Summary of select benthic invertebrate metrics for sites in GRTE during summer (non-shaded) and fall (shaded) sampling periods in 2002.

Stream Site ID	Stream Name	Date	Number Taxa	Invertebrate Density (m2)	EPT Richness Index	Percent Dominant Taxa	Modified Hilsenhoff Biotic Index	HBI Water Quality Rating	Tolerance Values			
									Number Tolerant Taxa	Percent Tolerant Taxa	Number Intolerant Taxa	Percent Intolerant Taxa
1	Arizona Cr.	29-Aug	61	3,529	31	15	4.4	Very Good	8	9.4	3	2.1
1	Arizona Cr.	21-Oct	50	3,535	32	38	4.1	Very Good	5	4.9	4	1.2
2	Arizona Cr.	29-Aug	61	1,541	26	12	4.5	Very Good	8	10.8	4	8.6
2	Arizona Cr.	17-Oct	49	2,742	26	30	4.1	Very Good	4	3.3	4	2.3
3	Cottonwood Cr.	4-Sep	37	1,362	21	48	3.9	Very Good	4	7.5	0	0.0
3	Cottonwood Cr.	22-Oct	35	2,359	21	20	4.0	Very Good	3	0.9	2	0.6
4	Cottonwood Cr.	4-Sep	36	939	20	47	4.0	Very Good	3	5.9	0	0.0
4	Cottonwood Cr.	22-Oct	35	2,743	20	20	4.3	Very Good	1	0.1	2	0.7
5	Cottonwood Cr.	4-Sep	38	5,711	16	19	6.1	Fair	3	8.7	0	0.0
5	Cottonwood Cr.	22-Oct	38	36,055	16	13	4.9	Good	5	10.6	0	0.0
6	Ditch Cr.	5-Sep	34	7,545	16	64	5.1	Good	6	8.9	3	2.5
6	Ditch Cr.	18-Oct	38	26,591	19	70	4.9	Good	5	4.7	2	2.1
7	Lizard Cr.	6-Sep	51	953	32	16	3.6	Very Good	1	0.1	13	19.1
7	Lizard Cr.	25-Oct	42	4,525	19	26	4.5	Very Good	3	0.4	6	8.7
8	Lizard Cr.	6-Sep	58	737	31	11	4.0	Very Good	6	4.2	12	17.6
8	Lizard Cr.	25-Oct	32	14,288	11	61	5.4	Good	2	0.8	2	2.3
9	Pacific Cr.	3-Sep	36	7,467	18	38	4.2	Very Good	2	1.9	2	0.7
9	Pacific Cr.	16-Oct	25	6,768	16	35	4.4	Very Good	1	0.6	4	3.7
10	Pacific Cr.	30-Aug	43	1,794	20	17	4.9	Good	6	2.0	3	5.1
10	Pacific Cr.	16-Oct	27	3,497	20	46	3.1	Excellent	1	0.7	2	3.3
11	Pacific Cr.	30-Aug	37	1,983	19	15	4.1	Very Good	2	7.7	3	23.2
11	Pacific Cr.	16-Oct	40	14,730	21	28	4.7	Good	3	10.4	3	5.6
12	Pilgrim Cr.	28-Aug	33	906	22	19	4.6	Good	2	2.2	4	4.8
12	Pilgrim Cr.	17-Oct	40	1,326	23	21	4.0	Very Good	1	2.8	5	5.5
13	Pilgrim Cr.	28-Aug	52	848	25	12	4.2	Very Good	2	0.3	6	15.8
13	Pilgrim Cr.	17-Oct	42	2,323	23	28	3.8	Very Good	1	0.3	8	7.3
14	Snake R.	29-Aug	41	1,260	22	31	4.5	Very Good	3	4.8	1	2.7
14	Snake R.	25-Oct	30	7,457	16	40	3.5	Excellent	2	3.5	1	0.8
15	Spread Cr.	5-Sep	50	5,230	24	15	5.3	Good	4	2.0	2	0.8
15	Spread Cr.	21-Oct	41	1,353	19	25	3.8	Very Good	4	1.0	0	0.0
16	Spread Cr.	3-Sep	44	3,473	21	37	5.6	Fair	3	11.0	4	1.6
16	Spread Cr.	21-Oct	40	1,294	20	26	5.4	Good	2	15.6	2	2.0

Table 11. Percentages for select benthic invertebrate groups for sites in GRTE during summer (non-shaded) and fall (shaded) sampling in 2002.

Stream			Annelida	Crustacea	Arachnida	Turbellaria	Nematoda	Insecta						Mollusca	
Site			Oligochaeta	Hyalella	Acari	Turbellaria	Nematoda	Ephemeroptera	Plecoptera	Trichoptera	Odonata	Coleoptera	Diptera	Gastropoda	Pelycopoda
ID	Stream Name	Date	%	%	%	%	%	%	%	%	%	%	%	%	%
1	Arizona Cr.	29-Aug	0	0	2	0	0	41	10	8	0	10	30	0	0
1	Arizona Cr.	21-Oct	0	0	1	0	<1	55	11	20	0	4	9	<1	0
2	Arizona Cr.	29-Aug	0	0	8	0	0	32	5	16	0	9	28	1	0
2	Arizona Cr.	17-Oct	<1	0	2	0	0	59	4	14	0	3	17	0	0
3	Cottonwood Cr.	4-Sep	9	0	3	0	0	67	4	10	0	<1	7	<1	0
3	Cottonwood Cr.	22-Oct	2	0	4	0	0	53	4	30	0	<1	7	0	0
4	Cottonwood Cr.	4-Sep	4	0	2	0	0	62	5	21	<1	<1	6	0	0
4	Cottonwood Cr.	22-Oct	3	0	1	<1	<1	48	7	33	0	<1	8	0	0
5	Cottonwood Cr.	4-Sep	<1	0	2	0	0	11	2	27	0	0	55	0	1
5	Cottonwood Cr.	22-Oct	0	0	1	0	0	17	1	11	0	<1	70	0	0
6	Ditch Cr.	5-Sep	0	0	6	0	0	2	2	72	0	6	12	<1	0
6	Ditch Cr.	18-Oct	<1	0	0	0	0	5	2	78	0	4	11	0	0
7	Lizard Cr.	6-Sep	1	0	<1	0	0	27	30	12	0	9	20	0	0
7	Lizard Cr.	25-Oct	<1	0	1	0	<1	31	11	5	0	5	47	0	0
8	Lizard Cr.	6-Sep	1	0	<1	0	0	14	27	11	0	13	34	0	0
8	Lizard Cr.	25-Oct	<1	0	0	0	0	13	7	1	0	1	78	0	0
9	Pacific Cr.	3-Sep	<1	0	2	0	0	58	2	11	0	<1	26	0	0
9	Pacific Cr.	16-Oct	0	0	3	0	0	44	2	46	0	0	5	0	0
10	Pacific Cr.	30-Aug	0	0	3	0	0	34	2	18	0	<1	43	1	0
10	Pacific Cr.	16-Oct	0	0	<1	0	0	70	9	16	0	0	4	0	0
11	Pacific Cr.	30-Aug	<1	0	15	0	0	33	2	19	0	1	30	0	0
11	Pacific Cr.	16-Oct	0	0	28	0	<1	21	1	24	0	<1	24	0	0
12	Pilgrim Cr.	28-Aug	0	0	2	0	0	47	7	10	0	<1	34	0	0
12	Pilgrim Cr.	17-Oct	0	0	3	0	0	62	7	19	0	0	9	0	0
13	Pilgrim Cr.	28-Aug	0	0	5	0	0	37	17	8	0	<1	32	0	0
13	Pilgrim Cr.	17-Oct	0	0	<1	0	0	58	15	14	0	<1	12	0	0
14	Snake Riv.	29-Aug	0	0	1	0	0	56	2	16	0	3	21	2	0
14	Snake Riv.	25-Oct	<1	0	1	0	0	68	3	17	0	4	8	0	0
15	Spread Cr.	5-Sep	<1	0	15	0	0	12	7	27	0	<1	38	0	0
15	Spread Cr.	21-Oct	1	0	5	0	0	10	43	31	0	<1	11	0	0
16	Spread Cr.	3-Sep	<1	0	16	0	0	13	3	6	0	1	62	0	0
16	Spread Cr.	21-Oct	0	0	26	0	0	23	6	7	0	1	36	0	0

and Spread creeks) with 55 and 62 % respectively. Percent EPT taxa range between 22 and 88 % with a mean of 60.43 %. Percent EPT taxa were lowest at the upstream site on Spread Creek and highest on the downstream and middle site on Cottonwood Creek with 81 and 88 % respectively. EPT Richness Index values were generally high for all sites with a range between 16 and 32 taxa and a mean of 22.75 EPT taxa (Figure 7). Four sites had an EPT Richness Index value below 20 and include the upstream site on Cottonwood Creek, Ditch Creek, and the 2 sites on Pacific Creek (Table 10).

Modified HBI values range between 3.6 and 6.1 (Figure 8). Overall, 10 sites rated very good, 4 sites rated good and 2 sites (i.e. the 2 upstream sites on Cottonwood Creek and Spread Creek) rated fair. Number of tolerant taxa range between 1 and 8 while percent tolerant taxa range from 0.1 to 11 % with the downstream site on Lizard Creek and the upstream site on Spread Creek having the lowest and highest percent tolerant taxa respectively. All invertebrate sites, except the 3 sites on Cottonwood Creek, contain 1 or more intolerant taxa with most sites having between 1 and 4 intolerant taxa. Percent intolerant taxa range between 0 and 23.2 % with a mean of 6.54 % per site. Lowest percentages of intolerant taxa were recorded for the 3 sites on Cottonwood Creek (0 %) and highest for the upstream site on Pacific Creek (23.2 %).

Overall, diversity was high for all sites with a range between 0.73 and 1.43 (Table 7). Three sites had a diversity measure below 1.00 and include the 2 lower sites on Cottonwood Creek and the Ditch Creek site; highest diversity indices were recorded for downstream site on Arizona Creek and the upstream site on Lizard Creek each with a diversity measure of 1.43.

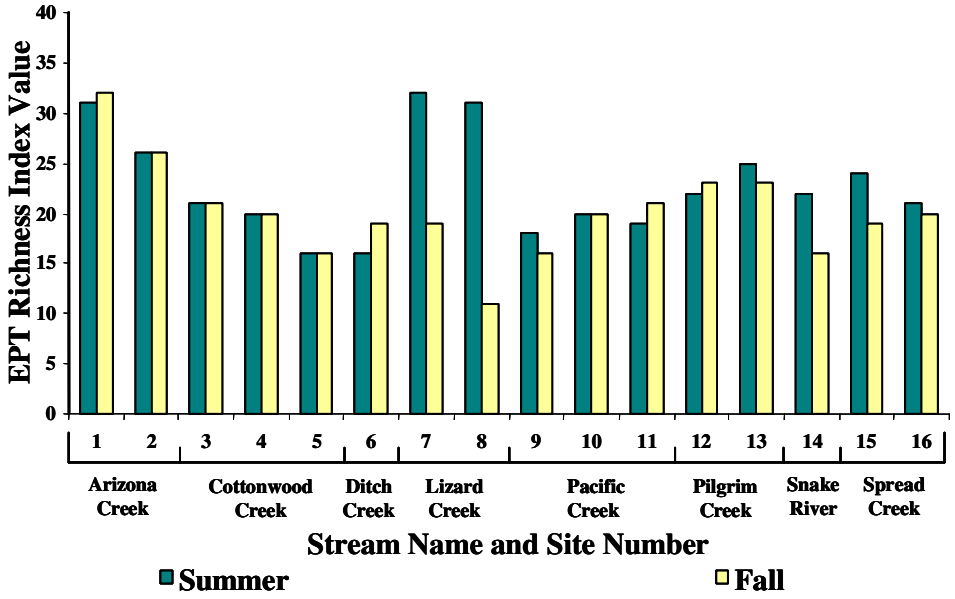

Figure 7. EPT Richness Index values for 16 sites sampled in GRTE during summer and fall 2002. Dark and light vertical bars represent summer and fall sampling respectively

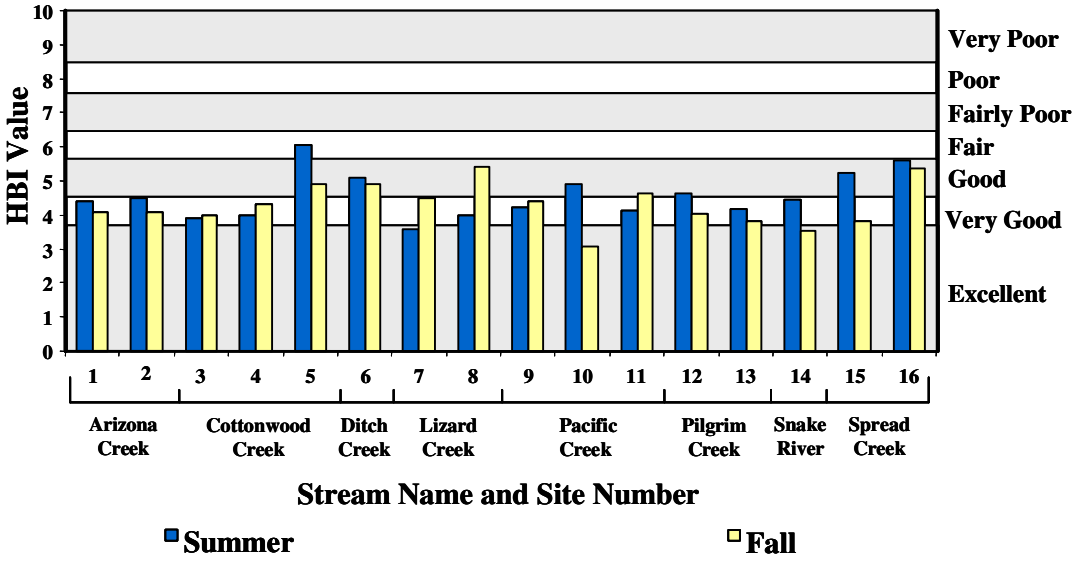

Figure 8. Modified HBI values for individual sites sampled in GRTE during summer and fall 2002. Horizontal shaded and clear bars indicate individual HBI rankings. Dark and light vertical bars represent summer and fall sampling respectively.

Fall Period

Site information regarding physical characteristics and stream water quality measurements are presented in Table 8. Catchment areas for the 16 invertebrate sampling locations are described in the previous section. Similar to the summer period, the sites on Lizard Creek and the Snake River exhibited the lowest and highest recorded discharge respectively, with a range between 0.004 m^3/sec and 7.589 m^3/sec. Additional physical measurements during the fall sampling period were as follows: water temperature, 0.1 – 9.0 ^oC; DO, 8.5 – 10.7 mg/L; pH, 7.5 – 8.6; conductivity, 22 – 343 µS cm^{-1}; turbidity, 0.6 – 2.4 NTU; average velocity, 0.05 – 0.78 m/sec; and average depth, 0.13 – 0.30 m (Table 8). All water quality measurements were within expected ranges with no water quality exceedances observed and no obvious indication of water quality impairment.

Similar to the summer sample period, mean substrate cover for all invertebrate sites was relatively high for both cobble and coarse gravel with a range between 60.2 and 95.1 % (Table 9). All but 3 sites (both sites on Lizard Creek and the downstream site on Spread Creek) had a mean cobble and coarse gravel substrate greater than 75 %. Thirteen sites had relatively low silt cover rating while 3 sites (both sites on Arizona Creek and the upstream site on Spread Creek) had moderate to high silt cover rating (Table 9). Aquatic vegetation was absent from all sites during the fall sample period. Percent cover for algae ranged from 0 to 21.5 % with mean of 3.9 %. Algae cover was absent from 2 sites (the upstream site on Pilgrim Creek and the downstream site on Pacific Creek) and highest at upstream site on Arizona Creek (Table 9).

A total of 124 invertebrate taxa were collected from GRTE during the fall sample period. Taxa and number of individuals/m^2 are listed in Appendix E. Distinct benthic

invertebrate taxa range from 25 at the downstream site on Pacific Creek to 50 at the downstream site on Arizona Creek with mean of 37.75 taxa collected (Table 10). Density of benthic macroinvertebrates range from 1,294 to 36,055 organisms/m^2 with a mean invertebrate density of 8,224 organisms/m^2. The lowest invertebrate density was collected at upstream site on Spread Creek and the highest invertebrate density was collected at the upstream site of Cottonwood Creek (Table 10).

The most common taxa were mites, Acari, and a mayfly, *Paraleptophlebia* spp., which were collected from 14 of 16 invertebrate sampling locations. In addition, 4 distinct taxa were collected at 13 sample sites and include a mayfly, *Ephemerella inermis*, a stonefly, *Sweltsa* spp., and 2 groups of caddisflies, *Brachycentrus americanus* and *Lepidostoma-Pluvial* Group (Appendix E). Percentages of Dipterans range from 4 to 78 % with a mean of 22.25 %. Dipterans comprised less than 10 % of the invertebrate community at 7 sites with the lowest percentages of Dipterans occurring on the lower and middle sites of Pacific Creek with 4 and 5 % respectively. Conversely, the upstream site on Lizard Creek had the highest percentage of Dipterans with 78 %, followed by the upstream site on Cottonwood Creek with 70 % (Table 11). Percent EPT taxa range from 21 to 95 % with the upstream site on Lizard Creek and the middle site on Pacific Creek having the lowest and highest percent EPT taxa respectively (Table 11). EPT Richness Index values range from 11 to 32 taxa (Figure 7). Seven invertebrate sites had EPT Richness Index values below 20 taxa and include the upstream site on Cottonwood Creek, Ditch Creek, both sites on Lizard Creek, the downstream sites on Pacific Creek and Spread Creek and the Snake River site. Highest EPT Richness Index values were recorded for the downstream and upstream sites on Arizona Creek with 32 and 26 EPT taxa respectively (Figure 7).

Modified HBI values range between 3.1 and 5.4 (Table 10). Overall, 2 sites rated excellent, 9 sites rated very good, and 5 sites rated good (Figure 8). Number of tolerant taxa was generally low and had a range from 1 to 5 tolerant taxa for individual invertebrate sites (Table 10). Percent tolerant taxa were also low with a range from 0.1 % at the middle site on Cottonwood Creek to 15.6 % at the upstream site on Spread Creek. Number of intolerant taxa had a range between 0 and 8. Intolerant taxa were absent from 2 sites (i.e. the downstream sites of Cottonwood and Spread creeks) and were most abundant at the upstream site on Pilgrim Creek (Table 10). Percent intolerant taxa range from 0 to 8.7 % with the lowest percent occurring on the downstream sites of Cottonwood and Spread creeks (0 %) and highest percent on the downstream site of Lizard Creek (8.7 %).

Individual diversity measures range from 0.65 to 1.27. Two sites had a diversity measure below 1.00 and include the sites on Ditch Creek and the Snake River. The highest diversity indices were recorded for the upstream site at Arizona Creek and Cottonwood Creek with diversity measures of 1.22 and 1.27 respectively (Table 7).

Seasonal Comparisons

Number of distinct benthic invertebrate taxa range between 33 and 61 for the summer period and between 25 and 50 for the fall period. Mean taxa collected for the summer and fall periods were 44.5 and 37.75 taxa respectively (Figure 9). Results of a two sample *t*-test indicate the differences between the summer and fall mean number of taxa were significant ($P<0.05$). Twelve sites had greater number of taxa during the summer period while only 4 sites had equal or fewer numbers of taxa during the same period.

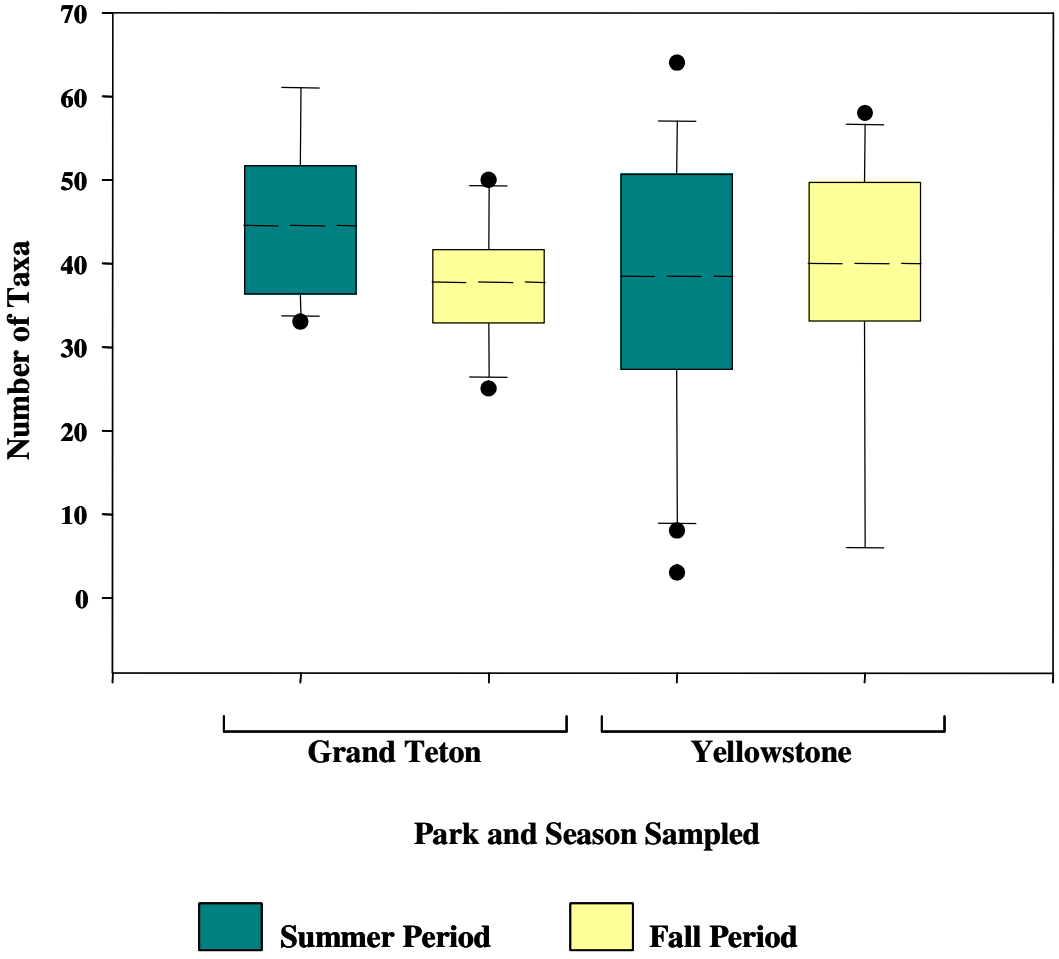

Figure 9. Box and whisker plot illustrating range of taxa collected from GRTE and YELL during summer and fall sampling periods in 2002. Dashed line indicates mean number of taxa per park and sample period. Lower and upper portions of box represent 25th and 75th percentile respectively; lower and upper whisker caps represent 10th and 90th percentile respectively; solid circles indicate outliers.

Overall, comparisons between summer and fall sample periods in GRTE were very similar with the number of EPT taxa and HBI values rating good for most sites. The number of EPT taxa ranged from 16 to 32 for the summer period, and between 11 and 32 for the fall period (Figure 7). In general, these values were similar among sites and between sample periods with the exception of the 2 sites on Lizard Creek which had markedly greater numbers of EPT taxa during the summer period versus the fall period. HBI values are also very comparable between the 2 sample periods (Figure 8). Most sites had an HBI water quality rating between good and excellent for both sample periods with the exception the 2 upstream sites on Cottonwood and Spread creeks, which had an HBI water quality rating of fair during the summer period and good during the fall period.

Comparisons of Shannon Diversity Indices were made between the summer and fall sample periods. Results of a *t*-test indicate the differences between diversity indices between summer and fall sample periods were significant ($P< 0.05$) for all sites sampled (Table 7).

Yellowstone National Park

Summer Period

UTM coordinates for stream site locations are recorded in Appendix B. Catchment areas from the 20 invertebrate sampling locations range from 283 hectares at the unnamed tributary of Middle Creek to 26,194 hectares at the downstream site on Soda Butte Creek. Stream discharge ranged between 0.013 m^3/sec on the unnamed tributary to 3,680 m^3/sec at the downstream site of the Gardner River (Table 12). Ranges for additional physical measurements during the summer sample period are as follows: water temperature, 6.2 – 35.2 ^oC; DO, 5.3 – 10.5 mg/L; pH 2.7 – 8.6; conductivity, 71 – 1627 $\mu S\ cm^{-1}$; turbidity, 0.3 – 3.5 NTU; average velocity, 0.21 – 0.50 m/sec; average depth,

Table 12. Site information and water quality measurements taken at benthic invertebrate sampling locations in YELL during summer (non-shaded) and fall (shaded) periods 2002.

Stream Site ID	Stream Name	Date	Elevation (m)	Catchment (hectares)	Discharge (m^3/sec)	Water Temp. (^oC)	DO (mg/L)	pH	Cond (μ S)	Turbidity (NTU)	Average Velocity (m/sec.)	Average Depth (m)	Average Habitat Value
1	Antelope Cr.	14-Aug	1,973	3,442	0.053	8.8	10.5	8.1	159	1.0	0.47	0.14	14.92
1	Antelope Cr.	8-Oct	1,973	3,442	0.084	3.9	10.5	8.0	165	1.0	0.38	0.11	14.92
2	Antelope Cr.	13-Aug	2,052	3,280	0.036	15.7	7.8	8.5	147	0.8	0.21	0.13	14.67
2	Antelope Cr.	8-Oct	2,052	3,280	0.031	4.8	10.5	8.5	148	1.3	0.20	0.19	14.75
3	Antelope Cr.	14-Aug	2,116	3,128	0.033	15.6	8.6	8.6	147	0.7	0.27	0.12	14.75
3	Antelope Cr.	8-Oct	2,116	3,128	0.031	8.3	10.3	9.0	146	1.2	0.14	0.15	14.75
4*	Gardner R.	21-Aug	1,726	51,548	3.680	23.0	8.2	7.2	701	2.1	0.50	0.31	12.67
4*	Gardner R.	13-Nov	1,726	51,548	2.832	17.8	8.8	7.2	776	2.5	0.76	0.35	12.67
5	Gardner R.	21-Aug	1,739	49,890	3.197	10.2	9.4	8.2	204	0.9	0.33	0.20	13.54
5	Gardner R.	7-Nov	1,739	49,890		0.9	11.9	8.0	223	1.6	0.61	0.30	13.54
6	Gardner R.	12-Aug	2,234	17,682	1.715	12.9	8.5	8.3	263	0.7	0.41	0.22	12.83
6	Gardner R.	6-Nov	2,234	17,682	0.583	1.7	10.4	7.9	323	1.0	0.41	0.25	12.83
7	Middle Cr.	19-Aug	2,126	8,414	0.753	13.1	8.8	7.7	85	0.7	0.46	0.16	14.67
7	Middle Cr.	9-Oct	2,126	8,414	0.559	4.9	10.2	7.7	88	0.6	0.50	0.16	14.67
8	Middle Cr.	19-Aug	2,160	7,807	0.610	9.0	8.8	7.6	87	3.5	0.50	0.18	13.75
8	Middle Cr.	9-Oct	2,160	7,807	0.373	5.7	10.2	7.7	88	0.6	0.50	0.26	13.75
9*	Nez Perce Cr.	22-Aug	2,198	25,168	1.246	15.4	8.0	8.0	396	0.6	0.34	0.24	14.04
9*	Nez Perce Cr.	7-Oct	2,198	25,168	1.296	16.2	8.6	8.0	425	0.5	0.49	0.29	14.04
10*	Nez Perce Cr.	22-Aug	2,188	24,565	1.504	18.9	8.1	8.0	344	0.4	0.37	0.30	12.50
10*	Nez Perce Cr.	7-Oct	2,188	24,565	1.527	15.9	8.1	8.0	365	0.7	0.53	0.30	12.50
11	Obsidian Cr.	6-Aug	2,222	10,116	1.054	14.0	8.7	7.3	165	0.9	0.29	0.29	13.75
11	Obsidian Cr.	7-Nov	2,222	10,116	0.759	0.3	10.3	7.0	203	1.0	0.59	0.32	13.83
12	Obsidian Cr.	7-Aug	2,226	9,299	0.997	12.0	8.2	7.3	153	0.9	0.36	0.24	14.00
12	Obsidian Cr.	6-Nov	2,226	9,299	0.634	0.3	10.7	7.0	193	0.7	0.52	0.21	14.00
13*	Obsidian Cr.	7-Aug	2,271	681	0.056	29.5	5.9	3.3	1125	0.3	0.33	0.14	13.17
13*	Obsidian Cr.	12-Nov	2,271	681	0.041	17.2	7.9	2.8	1435	0.8	0.37	0.24	13.25
14*	Obsidian Cr.	13-Aug	2,302	490	0.031	35.2	5.3	2.7	1627	-	0.49	0.12	14.92
14*	Obsidian Cr.	12-Nov	2,302	490	0.026	28.9	5.7	2.3	2178	1.3	0.24	0.15	14.92

Table 12. (continued)

Stream Site ID	Stream Name	Date	Elevation (m)	Catchment (hectares)	Discharge (m˘/sec)	Water Temp. (˘C)	DO (mg/L)	pH	Cond (*u* S)	Turbidity (NTU)	Average Velocity (m/sec.)	Average Depth (m)	Average Habitat Value
15	Pebble Cr	16-Aug	2,084	6,544	0.406	11.1	9.0	8.1	187	0.9	0.39	0.21	-
15	Pebble Cr	-	-	-	-	-	-	-	-	-	-	-	-
16	Pebble Cr.	16-Aug	2,099	6,506	0.358	13.2	9.0	8.2	188	0.8	0.29	0.14	13.96
16	Pebble Cr.	-	-	-	-	-	-	-	-	-	-	-	-
17	Soda Butte Cr.	16-Aug	2,023	26,194	1.930	9.9	9.2	7.4	236	1.9	0.42	0.22	14.29
17	Soda Butte Cr.	5-Nov	2,023	26,194	0.623	3.6	10.5	7.1	294	-	0.13	0.21	14.29
18	Soda Butte Cr.	20-Aug	2,128	12,215	1.005	7.4	9.6	8.2	233	1.5	0.39	0.20	13.25
18	Soda Butte Cr.	-	-	-	-	-	-	-	-	-	-	-	-
19	Soda Butte Cr.	20-Aug	2,234	8,170	0.450	10.0	8.7	8.1	183	2.2	0.28	0.19	14.63
19	Soda Butte Cr.	-	-	-	-	-	-	-	-	-	-	-	-
20	Unnamed Trib.	19-Aug	2,224	283	0.013	6.2	9.2	7.7	71	0.8	0.24	0.14	14.42
20	Unnamed Trib.	9-Oct	2,224	283	0.006	3.4	10.0	7.8	76	0.6	0.14	0.14	14.42

* Indicates stream sites with significant thermal inputs

0.12 – 0.31 m; and average habitat value, 12.50-14.92 (Table 12). Since many YELL park waters are heavily influenced by thermal contributions, conventional methods for assessing water quality in the park are difficult to ascertain. Sites sampled within thermal areas contribute greatly to the observed wider range of water quality values. In general, sites sampled within thermal areas exhibited a wider range in values for water temperature, DO, pH, and conductivity. Habitat values for streams sampled in YELL were exceptionally good with all average habitat scores rating above 12.50.

Mean substrate cover that was comprised of both cobble and coarse gravel combined had a range between 4.3 and 91.25 % with 10 sites having greater than 75 % substrate comprised of cobble and coarse gravel (Table 13). Three of 4 sample locations on Obsidian Creek had less than 50 % substrate comprised of cobble and coarse gravel. Overall, most sites had a low silt cover rating with less than 25 % of the substrate being covered by silt, while both sites on Pebble Creek exhibited a moderate to high silt cover rating (Table 13). Generally, mean percent vegetation cover was low for all sites. The range for percent cover of aquatic macrophytes was between 0 and 14.13 % with a mean macrophyte cover of 1.2 % (Table 13). Aquatic macrophytes were absent from 10 sites and most abundant at downstream site on Nez Perce Creek. Algae cover had a range from 0 to 90.13 % with a mean of 8.1 % (Table 13). Algae was absent from 12 invertebrate sites and most abundant at the most upstream site of Obsidian Creek.

A total of 155 invertebrate taxa were collected from YELL during the summer sample season. Distinct benthic invertebrate taxa range from 3 at the most upstream site on Obsidian Creek to 64 at the downstream site on Antelope Creek with mean of 38.45 taxa (Table 14). Benthic macroinvertebrate densities range from 113 to 7,330 organisms/m^2 with a mean invertebrate density of 2,650 organisms/m^2. The lowest

Table 13. Site information and percent substrate type, silt cover and vegetation cover recorded in YELL during summer (non-shaded) and fall (shaded) benthic invertebrate sampling periods in 2002.

Stream			% Substrate								% Silt Cover					% Vegetation Cover	
Site		Sample		Coarse	Fine						Low		Moderate	High			
ID.	Stream Name	Date	Cobble	Gravel	Gravel	Sand	Silt	Clay	Organic	Other	<5	5 - 25	25 - 50	50 - 75	>75	Macrophyte	Algae
1	Antelope Cr.	14-Aug	53.5	20.3	5.5	12.9	0	0	7.9	0	100	0	0	0	0	0.5	0
1	Antelope Cr.	8-Oct	51.3	12.0	21.3	15.0	0	0	0	1.3	100	0	0	0	0	0	6.3
2	Antelope Cr.	13-Aug	60.6	16.6	9.8	9.9	0	0	3.1	0	100	0	0	0	0	0	7.5
2	Antelope Cr.	8-Oct	66.9	4.3	14.4	4.5	0	0	0	10.0	91.6	0	0	0	8.4	0	31.0
3	Antelope Cr.	14-Aug	42.1	19.0	12.8	19.3	1.3	0	0	5.6	100	0	0	0	0	0.1	0
3	Antelope Cr.	8-Oct	58.4	19.6	13.1	8.9	0	0	0	0	100	0	0	0	0	0	24.1
4*	Gardner R.	21-Aug	46.9	12.0	11.1	30.0	0	0	0	0	100	0	0	0	0	0	2.8
4*	Gardner R.	13-Nov	45.9	26.5	16.6	11.0	0	0	0	0	100	0	0	0	12.5	0	1.4
5	Gardner R.	21-Aug	58.1	16.3	13.1	12.5	0	0	0	0	97.9	2.1	0	0	0	0	0
5	Gardner R.	7-Nov	54.6	26.8	14.9	3.8	0	0	0	0	86.3	5.6	0	0	8.1	0	11.9
6	Gardner R.	12-Aug	77.5	5.4	5.8	11.4	0	0	0	0	100	0	0	0	0	0	0
6	Gardner R.	6-Nov	73.3	12.8	6.0	8.0	0	0	0	0	100	0	0	0	0	0	1.9
7	Middle Cr.	19-Aug	81.9	9.4	6.9	0.6	0	0	0	0	100	0	0	0	0	0	0
7	Middle Cr.	9-Oct	63.6	12.6	13.6	0.8	0	0	0	9.4	100	0	0	0	0	0	0
8	Middle Cr.	19-Aug	73.8	14.4	6.6	5.3	0	0	0	0	100	0	0	0	0	0	0
8	Middle Cr.	9-Oct	81.0	7.9	3.9	7.3	0	0	0	0	100	0	0	0	0	0	0
9*	Nez Perce Cr.	22-Aug	40.0	12.5	15.9	31.6	0	0	0	0	100	0	0	0	0	14.1	7.1
9*	Nez Perce Cr.	7-Oct	40.6	21.3	11.9	26.3	0	0	0	0	96.9	0	0	0	3.1	25.5	0.5
10*	Nez Perce Cr.	22-Aug	37.8	16.3	22.5	23.5	0	0	0	0	100	0	0	0	0	8.1	9.6
10*	Nez Perce Cr.	7-Oct	47.1	6.9	24.4	21.6	0	0	0	0	100	0	0	0	0	6.0	1.0
11	Obsidian Cr.	6-Aug	24.6	21.5	25.4	29.1	0	0	0	0	99.4	0.6	0	0	0	1.5	15.1
11	Obsidian Cr.	7-Nov	3.8	23.8	51.8	20.8	0	0	0	0	100	0	0	0	0	8.4	2.5
12	Obsidian Cr.	7-Aug	36.3	38.8	19.8	5.3	0	0	0	0	100	0	0	0	0	3.1	2.3
12	Obsidian Cr.	6-Nov	32.1	48.5	16.5	2.9	0	0	0	0	100	0	0	0	0	0	0.4
13*	Obsidian Cr.	7-Aug	1.6	3.0	49.8	24.4	18.1	0	3.1	0	76.9	0	0	0	23.1	6.9	0.0
13*	Obsidian Cr.	12-Nov	0.0	17.9	36.9	32.8	12.5	0	0	0	90.6	3.1	0	0	6.3	21.0	14.0
14*	Obsidian Cr.	13-Aug	31.3	5.1	1.9	2.6	0	0	0	59.1	100	0	0	0	0	0	90.1
14*	Obsidian Cr.	12-Nov	34.4	21.4	23.6	20.6	0	0	0	0	100	0	0	0	0	0	1.9

Table 13. (Continued)

Stream			% Substrate								% Silt Cover					% Vegetation Cover	
Site		Sample		Coarse	Fine						Low		Moderate	High			
ID.	Stream Name	Date	Cobble	Gravel	Gravel	Sand	Silt	Clay	Organic	Other	<5	5 - 25	25 - 50	50 - 75	>75	Macrophyte	Algae
15	Pebble Cr	16-Aug	75.6	12.4	9.0	3.0	0	0	0	0	22.8	3.8	0	27.5	46.0	0	0
15	Pebble Cr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	Pebble Cr.	16-Aug	50.0	25.6	21.4	0.6	0	3.8	0	1.3	33.8	0	16.9	15.6	33.8	1.3	0
16	Pebble Cr.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	Soda Butte Cr.	16-Aug	28.8	25.6	28.8	4.4	2.5	0	0	10.0	91.3	3.8	5.0	0	0	1.3	0
17	Soda Butte Cr.	5-Nov	21.3	52.6	14.3	11.9	0	0	0	0	100	0	0	0	0	0	0
18	Soda Butte Cr.	20-Aug	56.3	20.0	11.5	12.9	0	0	0	0	90.6	5.0	4.4	0	0	0	0
18	Soda Butte Cr.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	Soda Butte Cr.	20-Aug	67.1	20.7	7.4	4.7	0	0	0	0	100	0	0	0	0	0	0
19	Soda Butte Cr.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	Unnamed Trib.	19-Aug	73.1	11.5	2.3	1.9	0	0	0	11.3	100	0	0	0	0	1.3	27.5
20	Unnamed Trib.	9-Oct	83.3	6.6	5.8	1.9	0	0	0	2.5	100	0	0	0	0	26.9	0

* Indicates stream sites with significant thermal inputs.

Table 14. Summary of select benthic invertebrate metrics for sites in YELL during summer (non-shaded) and fall (shaded) sampling periods in 2002. Stream site ID with asterisks denotes sample areas with thermal contributions.

									Tolerance Values			
Stream Site ID	Stream Name	Date	Number Taxa	Invertebrate Abundance (m2)	EPT Richness Index	Percent Dominant Taxa	Modified Hilsenhoff Biotic Index	HBI Water Quality Rating	Number Tolerant Taxa	Percent Tolerant Taxa	Number Intolerant Taxa	Percent Intolerant Taxa
1	Antelope Cr.	14-Aug	64	2,554	37	10	4.29	Very Good	4	5.7	13	28.2
1	Antelope Cr.	8-Oct	56	5,290	30	21	3.66	Very Good	2	0.5	11	18
2	Antelope Cr.	13-Aug	57	2,020	29	24	4.22	Very Good	4	6.7	14	17.3
2	Antelope Cr.	8-Oct	49	8,042	33	22	3.71	Very Good	1	0.1	12	19.4
3	Antelope Cr.	14-Aug	57	6,871	31	25	4.27	Very Good	3	1.6	14	18.8
3	Antelope Cr.	8-Oct	42	6,306	27	21	3.9	Very Good	1	0.5	7	7.4
4*	Gardner R.	21-Aug	31	1,515	14	41	6.09	Fair	5	25.2	0	0
4*	Gardner R.	13-Nov	32	16,326	16	42	6.03	Fair	5	18.7	1	0.9
5	Gardner R.	21-Aug	49	2,905	29	29	4.79	Good	6	30	2	1.9
5	Gardner R.	7-Nov	50	6,908	26	20	5.02	Good	3	19.2	3	0.8
6	Gardner R.	12-Aug	51	1,671	24	23	4.51	Good	4	8.2	7	10.3
6	Gardner R.	6-Nov	58	4,213	31	16	4.6	Good	2	3.7	8	15.5
7	Middle Cr.	19-Aug	41	1,781	30	24	3.37	Excellent	0	0	11	24.2
7	Middle Cr.	9-Oct	45	4,383	30	23	2.86	Excellent	0	0	12	28.5
8	Middle Cr.	19-Aug	42	3,997	26	22	2.78	Excellent	0	0	11	45
8	Middle Cr.	9-Oct	45	3,966	30	17	2.77	Excellent	1	0.1	10	27.8
9*	Nez Perce Cr.	22-Aug	23	302	12	31	5.6	Fair	5	45.5	0	0
9*	Nez Perce Cr.	7-Oct	42	893	17	16	6.21	Fair	12	38.7	1	0.2
10*	Nez Perce Cr.	22-Aug	17	117	8	45	6.49	Fair	7	78.2	0	0
10*	Nez Perce Cr.	7-Oct	33	577	16	20	6	Fair	8	53.2	2	0.7
11	Obsidian Cr.	6-Aug	39	1,764	14	58	5.14	Good	6	60.4	2	0.6
11	Obsidian Cr.	7-Nov	41	3,028	24	41	5.88	Fair	6	15.7	0	0
12	Obsidian Cr.	7-Aug	40	1,721	23	41	4.91	Good	4	41.4	2	1.5
12	Obsidian Cr.	6-Nov	46	7,760	26	18	4.64	Good	1	14.4	5	1.2
13*	Obsidian Cr.	7-Aug	8	113	1	63	8.95	Very Poor	2	66.7	0	0
13*	Obsidian Cr.	12-Nov	6	1,351	1	50	7.44	Fairly Poor	1	4.2	0	0
14*	Obsidian Cr.	13-Aug	3	5,510	0	96	9.85	Very Poor	1	96.3	0	0
14*	Obsidian Cr.	12-Nov	6	78	2	69	7.76	Poor	2	75.9	0	0

Table 14 (continued)

Stream Site ID	Stream Name	Date	Number Taxa	Invertebrate Abundance (m2)	EPT Richness Index	Percent Dominant Taxa	Modified Hilsenhoff Biotic Index	HBI Water Quality Rating	Tolerance Values			
									Number Tolerant Taxa	Percent Tolerant Taxa	Number Intolerant Taxa	Percent Intolerant Taxa
15	Pebble Cr.	16-Aug	53	1,481	28	29	4.63	Good	2	3.5	12	10.1
15	Pebble Cr.	-	-	-	-	-	-	-	-	-	-	-
16	Pebble Cr.	16-Aug	49	1,823	27	19	4.46	Very Good	0	0	9	11.7
16	Pebble Cr.	-	-	-	-	-	-	-	-	-	-	-
17	Soda Butte Cr.	16-Aug	34	5,236	21	29	3.69	Very Good	2	0.8	4	10
17	Soda Butte Cr.	5-Nov	33	3,405	17	38	3.09	Excellent	2	0.48	3	5.8
18	Soda Butte Cr.	20-Aug	35	1,418	22	29	3.51	Very Good	1	0.4	9	31.3
18	Soda Butte Cr.	-	-	-	-	-	-	-	-	-	-	-
19	Soda Butte Cr.	20-Aug	26	2,862	16	42	3.72	Very Good	0	0	8	33.8
19	Soda Butte Cr.	-	-	-	-	-	-	-	-	-	-	-
20	Unnamed Trib.	19-Aug	50	7,330	30	19	3.8	Very Good	1	0.2	15	34.1
20	Unnamed Trib.	9-Oct	56	4,624	30	14	3.54	Very Good	0	0	15	35.8

* Indicates stream sites with significant thermal inputs

invertebrate density was collected from a thermal site on Obsidian Creek while the highest density of invertebrates was collected at the unnamed tributary of Middle Creek (Table 14).

The most common invertebrate group collected were Chironomid (midge) pupae which were found at 18 of 20 invertebrate sampling sites. A mayfly, *Baetis tricaudatus*, was collected at 17 site locations, while mites, Acari, a stonefly, *Sweltsa* spp., a caddisfly, *Glossosoma* spp., and a midge, *Eukiefferiella* spp., were collected from 16 site locations. In addition, the exotic New Zealand mud snail, *Potamopyrgus antipodarum*, was collected from the downstream site on the Gardner River and both sites on Nez Perce Creek; all 3 of which are thermally influenced streams. As a group, percent Dipterans range from 4 to 100 % (Table 15). Sites with the lowest percentage of Dipterans include both sites on Nez Perce Creek while the invertebrate community on the upper most site on Obsidian Creek was comprised entirely of Dipterans. The New Zealand mud snail, a pollution-tolerant taxon, was present in high densities at both invertebrate locations on Nez Perce Creek where they comprised 8 and 45 % of the total invertebrates collected. EPT taxa range from 0 to 93 % (Table 15). EPT taxa were absent from upper most site on Obsidian Creek and were most abundant at the three sites on Soda Butte Creek (Table 15). The number of EPT taxa for all sites range from 0 to 37 taxa (Figure 10). Seven invertebrate sites had EPT Richness Index value below 15 taxa, 5 of which were sites with heavy thermal contributions; the remaining 2 site include the most downstream site on Obsidian Creek and the upstream site on Soda Butte Creek near the park boundary.

Modified HBI values range between 2.78 and 9.85 (Table 14). Overall, 2 sites rated excellent, 8 sites rated very good, 5 sites rated good, 3 sites rated fair, and 2 sites rated very poor (Figure 11). The 5 invertebrate sites that rated fair and very poor are

Table 15. Percentages for select benthic invertebrate groups for sites in YELL during summer (non-shaded) and fall (shaded) sampling periods in 2002.

Stream			Annelida	Crustacea	Arachnida	Turbellaria	Nematoda	Insecta						Mollusca	
Site	Stream		Oligochaeta	Hyalella	Acari	Turbellaria	Nematoda	Ephemeroptera	Plecoptera	Trichoptera	Odonata	Coleoptera	Diptera	Gastropoda	Pelycopoda
ID	Name	Date	%	%	%	%	%	%	%	%	%	%	%	%	%
1	Antelope Cr.	14-Aug	<1	0	1	0	0	23	5	15	0	11	45	0	0
1	Antelope Cr.	8-Oct	<1	0	1	<1	0	14	23	13	0	21	28	0	0
2	Antelope Cr.	13-Aug	<1	0	1	0	0	15	6	11	0	28	40	0	0
2	Antelope Cr.	8-Oct	0	0	<1	0	0	30	8	8	0	22	31	0	0
3	Antelope Cr.	14-Aug	1	0	1	0	<1	15	5	8	0	25	44	0	0
3	Antelope Cr.	8-Oct	<1	0	0	0	0	45	6	4	0	21	23	0	0
4*	Gardner Rv.	21-Aug	0	0	1	2	0	18	2	49	0	20	7	1	0
4*	Gardner Rv.	13-Nov	<1	0	3	4	<1	15	<1	54	0	12	8	3	0
5	Gardner Rv.	21-Aug	<1	0	3	0	<1	37	4	18	0	30	7	0	0
5	Gardner Rv.	7-Nov	3	0	5	<1	2	20	3	29	0	19	19	0	0
6	Gardner Rv.	12-Aug	1	0	<1	0	0	40	5	19	0	12	23	0	0
6	Gardner Rv.	6-Nov	2	0	1	<1	1	27	4	30	0	6	23	0	0
7	Middle Cr.	19-Aug	0	0	<1	0	0	71	8	9	0	0	12	0	0
7	Middle Cr.	9-Nov	<1	0	0	<1	0	55	18	10	0	<1	17	0	0
8	Middle Cr.	19-Aug	0	0	<1	0	0	75	3	5	0	0	16	0	0
8	Middle Cr.	9-Oct	0	0	1	<1	0	62	12	16	0	<1	9	0	0
9*	Nez Perce Cr.	22-Aug	3	0	<1	1	0	12	2	32	1	36	5	8	0
9*	Nez Perce Cr.	7-Oct	2	10	2	1	<1	14	1	33	3	16	5	7	7
10*	Nez Perce Cr.	22-Aug	0	0	0	1	0	9	1	10	0	27	4	45	1
10*	Nez Perce Cr.	7-Oct	<1	0	1	<1	0	15	2	28	2	34	3	15	0
11	Obsidian Cr.	6-Aug	1	0	1	0	0	10	6	2	0	60	21	0	0
11	Obsidian Cr.	7-Nov	<1	0	<1	0	0	11	4	8	0	15	61	0	<1
12	Obsidian Cr.	7-Aug	<1	0	0	0	0	34	4	8	0	41	12	0	0
12	Obsidian Cr.	6-Nov	1	0	0	0	0	49	5	14	0	14	16	0	0
13*	Obsidian Cr.	7-Aug	0	0	0	0	0	0	0	4	28	1	66	0	0
13*	Obsidian Cr.	12-Nov	0	0	0	0	0	0	0	4	50	0	46	0	0
14*	Obsidian Cr.	13-Aug	0	0	0	0	0	0	0	0	0	<1	100	0	0
14*	Obsidian Cr.	12-Nov	0	0	0	0	0	1	0	69	0	10	19	0	0

Table 15. (continued)

Stream			Annelida	Crustacea	Arachnida	Turbellaria	Nematoda	Insecta						Mollusca	
Site	Stream		Oligochaeta	Hyalella	Acari	Turbellaria	Nematoda	Ephemeroptera	Plecoptera	Trichoptera	Odonata	Coleoptera	Diptera	Gastropoda	Pelycopoda
ID	Name	Date	%	%	%	%	%	%	%	%	%	%	%	%	%
15	Pebble Cr.	16-Aug	0	0	1	0	0	28	7	4	0	2	58	0	0
15	Pebble Cr.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	Pebble Cr.	16-Aug	<1	0	1	0	0	33	9	9	0	3	46	0	0
16	Pebble Cr.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	Soda Butte Cr.	16-Aug	0	0	1	0	0	71	7	12	0	0	9	0	0
17	Soda Butte Cr.	5-Nov	<1	0	<1	1	0	61	8	24	0	1	5	0	0
18	Soda Butte Cr.	20-Aug	0	0	<1	1	0	73	2	18	0	0	7	0	0
18	Soda Butte Cr.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	Soda Butte Cr.	20-Aug	0	0	3	0	0	81	3	7	0	0	6	0	0
19	Soda Butte Cr.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	Unnamed Trib.	19-Aug	<1	0	2	1	0	20	22	7	0	0	48	0	0
20	Unnamed Trib.	9-Oct	<1	0	3	<1	<1	17	33	13	0	0	34	0	0

* Indicates stream sites with significant thermal inputs.

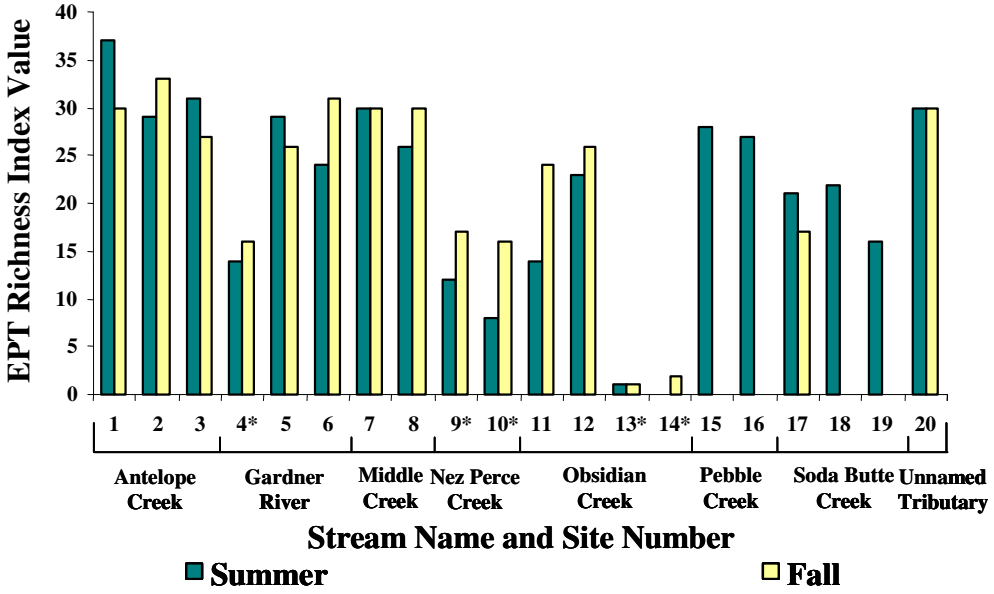

Figure 10. EPT Richness Index values for individual sites sampled in YELL during summer and fall sample periods in 2002. Dark and light vertical bars represent summer and fall sampling respectively. Site numbers with asterisks denotes sample locations with thermal influence. Sites 15, 16, 18 and 19 were not sampled during the fall period.

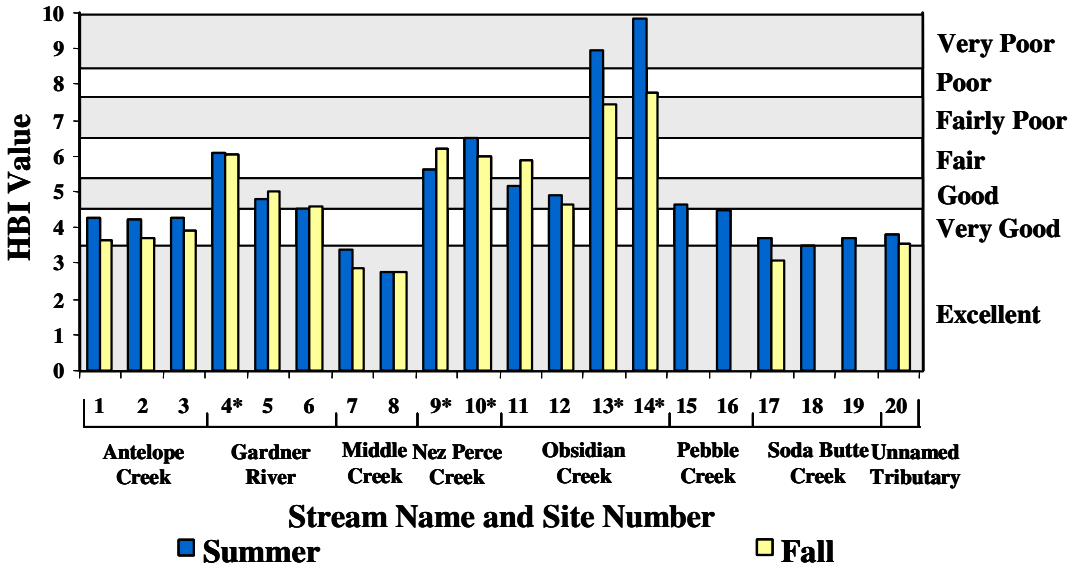

Figure 11. Modified HBI values for individual sites sampled in YELL during summer and fall sample periods in 2002. Horizontal shaded and clear bars indicate individual HBI rankings. Dark and light vertical bars represent summer and fall sampling respectively. Site numbers with asterisks denotes sample locations with thermal influence. Sites 15,16, 18, and 19 were not sampled during the fall period.

associated with stream segments with thermal contributions and include the downstream site on the Gardner River, both Nez Perce Creek sites, and the 2 upper most sites on Obsidian Creek. Number of tolerant taxa was generally low for all sites with a range from 0 to 7 tolerant taxa (Table 14). Tolerant taxa were absent from the 2 sites on Middle Creek and the upstream sites of Pebble and Soda Butte creeks; and highest for the upstream site on Nez Perce Creek. Percent tolerant taxa varied considerably among sites with a range from 0 to 96 % and a mean of 24 % (Table 14). Obsidian Creek, site 14, had the highest percentage of tolerant taxa with 96 %, which was generally represented by 1 taxon, a midge, *Chironomus* spp. Number of intolerant taxa for invertebrate sites had a range between 0 and 15 intolerant taxa (Table 14). Intolerant taxa were absent from the 5 invertebrate sites that receive thermal contributions and most prevalent at the unnamed tributary. Percent intolerant taxa ranged between 0 and 45 % with the 5 thermally influenced invertebrate sites having 0 intolerant taxa and the upstream site of Middle Creek having the highest percentage. The middle and upstream sites on Soda Butte Creek and the unnamed tributary also had high percentages of intolerant taxa with 31.3, 33.8, and 34.1 % intolerant taxa respectively.

Shannon H' (log 10) diversity measures are shown in table 7. Overall, diversity values were highly variable with a range between .07 and 1.45. Seven sites had a diversity measure below 1.00 and include the downstream site on the Gardner River, the upstream sites on Nez Perce and Soda Butte creeks, and the 4 sites on Obsidian Creek. In general, diversity measures were lowest from stream segments with thermal influence. Lowest diversity measures were recorded from the 2 upstream sites on Obsidian Creek; highest diversity measures were recorded from the downstream and middle site on Antelope Creek.

Fall Period

Poor weather conditions prohibited sampling from 4 invertebrate sites during the fall sample period. Those sites not sampled include both locations on Pebble Creek and the middle and upstream sites on Soda Butte Creek. Site information regarding physical characteristics and stream water quality measurements collected from 16 invertebrate sites are presented in table 12. Catchment areas from YELL invertebrate locations were discussed in the previous section. Stream discharge ranged between 0.006 m^3/sec on the unnamed tributary to 2,832 m^3/sec at the lower site on the Gardner River. Ranges for additional physical measurements during the fall sampling period were as follows: water temperature, 0.3 – 28.98 ^oC; DO, 5.7 – 11.9; pH, 2.3 – 9.0; conductivity, 76 – 2,178 μS; turbidity, 0.5 – 2.5 NTU; average velocity, 0.13 – .61 m/sec; and average depth, 0.11 – 0.32 m. The five sites sampled within thermal areas contributed greatly to the wide range of water quality values observed from the 16 sites sampled. In general, sites sampled within thermal areas led to a wider range of values for water temperature, DO, pH, and conductivity.

Average percent substrate, silt cover, and vegetation cover for each sample site are listed in table 13. Percent substrate comprised of both cobble and coarse gravel combined had a range from 27.50 to 89.88 % with 7 sites having greater than 75 % substrate comprised of both cobble and coarse gravel. The downstream and upper middle sites on Obsidian Creek were the only two invertebrate locations with a combined cobble and coarse gravel substrate less than 50 %. All sites exhibited a low percentage of silt covering the substrates. Percent aquatic macrophytes had a range between 0 and 26.90 %, with a mean macrophyte cover of 5.5 %. Aquatic macrophytes were absent from 11 sites and most abundant at the site on the unnamed tributary. Algae cover had a range

from 0 to 31 % with a mean of 6 %. Algae was absent from 4 sites and most abundant at the upstream site on Antelope Creek.

A total of 154 invertebrate taxa were collected from YELL during the fall sampling period. Numbers of invertebrate taxa, invertebrate densities, EPT Richness Index values, and HBI and tolerance values are shown in table 14. Distinct benthic invertebrate taxa range from 6 at the upper 2 sites on Obsidian Creek to 56 at the downstream site on Antelope Creek and the unnamed tributary, with a mean number of 40 taxa. Benthic macroinvertebrate densities range from 78 to 16,326 organisms/m^2 with a mean density of 4,822 organisms/m^2. The lowest invertebrate densities were collected at the upstream site on Obsidian Creek, while highest invertebrate densities were collected from the lower site on the Gardner River.

The most common invertebrate taxon collected was a caddisfly, *Glossosoma* spp. which was found at 14 of 16 invertebrate sites; followed by the mayfly, *Baetis tricaudatus*, found at 13 invertebrate sites. Two mayfly taxa, *Ephemerella inermis* and *Cinygmula* spp., a midge, *Eukiefferiella* spp., and worms, Oligochaeta spp., were collected at 12 sites; while mites, Acari spp., a mayfly, *Rhithrogena* spp., a stonefly, Capniidae spp., and a midge, *Orthocladius* Complex, were collected from 11 sites. Similar to the summer period, the New Zealand mud snail was collected from 3 sites including the lower site on the Gardner River and both sites on Nez Perce Creek. As a group, Dipterans range from 3 to 61 % with a mean of 22 %. Percent Dipterans were lowest at both sites on Nez Perce Creek with 5 and 3 % at the lower and upper site respectively; and highest on the downstream site on Obsidian Creek. In addition, the New Zealand mud snail comprised 7 and 15 % of the invertebrate community at the lower and upper sites of Nez Perce Creek respectively. Percent EPT taxa range from 4 to

93 % with the upper middle site on Obsidian Creek and downstream site on Soda Butte Creek having the lowest and highest percentage respectively. The EPT Richness index values for sites in YELL during the fall period are presented in Table 14. EPT Richness Index values for all sites range from 1 to 33 taxa (Figure 10). Three of 5 sites sampled in thermal areas had EPT Richness Values below 15 taxa. EPT Richness Index values were lowest for the upper middle and upper most sites on Obsidian Creek with 1 and 2 EPT taxa respectively, and highest for the middle site on Antelope Creek with 33 EPT taxa.

HBI and tolerance values are presented in Table 14. Modified HBI values range between 2.77 and 7.76. Overall, 3 sites rated excellent, 4 sites rated very good, 3 sites rated good, 4 sites rated fair, 1 site rated fairly poor, and 1 site rated poor (Figure 11). Five of the 6 sites that rated between fair and poor were from stream segments with thermal influence; the non-thermal invertebrate site that rated fair was the lower most sample on Obsidian Creek. This site exhibited higher percentages of fine substrates (i.e. fine gravel and sand) and thus could be the result of higher HBI score; however, it is also located downstream of Indian Creek campground, which also could be a source of negative impact to the water quality at this site. Number of tolerant taxa had a range between 0 and 12 for individual sites and percent tolerant taxa had a range between 0 and 75.9 %. Number of intolerant taxa had a range between 0 and 15 with percent intolerant taxa being between 0 and 35.8 %. Generally, invertebrate sites that had thermal contributions had higher numbers and percentages of tolerant taxa than invertebrate sites without thermal contributions. Conversely, numbers and percentages of intolerant taxa were generally higher at invertebrate sites that were not influenced by thermal activity.

Seasonal Comparisons

Number of distinct benthic invertebrate taxa ranged between 3 and 64 for the summer period and between 6 and 58 for the fall period. Mean taxa collected from the summer and fall periods were 38 and 40 taxa respectively (Figure 9). Results of a two sample t-test indicate differences between the summer and fall mean number of taxa were not significant ($P>0.05$).

EPT Richness Index values were compared for both sample periods (Figure 10); in general, the numbers of EPT taxa were similar among sites between summer and fall sample periods. However, both sites on Nez Perce Creek and the lower site on Obsidian Creek did show an obvious increase in the number of EPT taxa during the fall period.

The modified Hilsenhoff Biotic Index is comparable for the 2 sample periods (Figure 11). Most sites rated excellent to good for both sample periods, with the exception of 5 locations with considerable thermal contributions, which rated between fair and very poor. In addition, the downstream site on Obsidian Creek also received a fair rating during the fall period.

Comparisons of Shannon Diversity Indices were made between summer and fall sample periods. Results of a *t*-test indicate that differences between diversity indices between both sample periods were significant ($P<0.05$) for 14 invertebrate sites and were not significant for downstream site on Middle Creek or for the middle upper site on Obsidian Creek (Table 7).

CONCLUSIONS

Bighorn Canyon National Recreation Area

Data from invertebrate samples collected in BICA during September 2002 suggest that 2 of 4 invertebrate sites demonstrate some type of impairment to stream water quality. HBI values indicate that the site on Layout Creek and the upstream site on North Fork Trail Creek have relatively good water quality. These 2 sites are characterized by minimal stream bank alterations and good riparian habitat. HBI values for Crooked Creek and the downstream site on North Fork Trail Creek suggest that these stream segments have less than desirable water quality conditions. Crooked Creek has the largest drainage of all sites sampled with large portions of its basin extending outside BICA boundaries. Much of the water present in Crooked Creek is afflicted by altered flow regimes and agriculturally derived runoff. In addition, riparian areas adjacent to Crooked Creek inside the park boundaries have been degraded by overgrazing and stream bank alterations resulting in a loss of quality riparian vegetation and canopy cover. This degradation can lead to higher water temperatures, lower DO, and higher transport of suspended solids, all of which ultimately affect stream biota. Water quality and stream degradation is evident at Crooked Creek by the high numbers and percentages of tolerant taxa found in this stream reach. The downstream site of North Fork Trail Creek is located downstream of a campground in an area with minimal canopy cover. This site is characterized by patches of moderately eroded stream banks with very limited riparian vegetation. Substrate composition at the downstream site of North Fork Trail Creek is predominately fine gravel which provides little instream habitat for aquatic invertebrates.

A continuous water quality monitoring program should be established on both Crooked and North Fork Trail creeks. In addition to using benthic macroinvertebrates as

indicators of stream water quality, chemical and physical data should also be collected at both of these sites to better analyze seasonal and annual variations in stream water quality.

Grand Teton National Park

During the summer sample period, a total of 146 distinct invertebrate taxa were collected from the 16 sample sites as compared to 124 invertebrate taxa collected during the fall period. For both sample periods, all invertebrate sites exhibited good water quality measurements, high percentages of substrate comprised of cobble and coarse gravel, and relatively high habitat values (with the exception Spread Creek, site 16). HBI water quality ratings indicate that 14 of 16 invertebrate sites rated between good and very good during the summer period and all 16 invertebrate sites rated from good to excellent during the fall period. The invertebrate communities at Arizona and Lizard creeks, the 2 streams that were sample above and below the road crossing, showed no obvious impacts to water quality due to the road or bridge crossing. The downstream site on Cottonwood Creek and the upstream site on Spread Creek were the only 2 sites that had an HBI water quality rating of fair for the summer period. This is an indication that some type of impairment exists at these 2 invertebrate sites and stream reaches.

The middle and downstream sites on Cottonwood Creek are separated by a few hundred meters, have similar substrate composition, discharge, water quality measurements and habitat values. The middle site on Cottonwood Creek had an HBI water quality rating of very good while the downstream site had an HBI water quality rating of fair during the summer period. The only visible stressor that exists for this site is a small intermittent stream that runs through an adjacent horse pasture and empties into Cottonwood Creek approximately 25 meters upstream of the sample site. This small

stream could be the source for the lower HBI value. The upstream site on Spread Creek had a HBI water quality rating of fair during the summer period and is located on GRTE boundary which receives water from the adjacent Teton National Forest. This site had a high percent silt cover and the lowest habitat value recorded for all sites in GRTE. The primary factor contributing to the lower habitat value was severe channel alterations in the immediate vicinity of the invertebrate sampling area. Possible stressors to water quality in this area are habitat, stream channel and flow alterations, sedimentation, and grazing activity in the adjacent National Forest.

Yellowstone National Park

During the summer sample period, a total of 155 distinct invertebrate taxa were collected from the 20 sample sites as compared to 154 invertebrate taxa collected from the 16 invertebrate sites during the fall period. Due to thermal influences at several invertebrate sites, water quality measurements were highly variable between sites. Most sites had a high percentage of substrate comprised of cobble and coarse gravel as well as high habitat values. HBI water quality ratings indicate that 15 of 20 invertebrate sites rated between good and excellent during the summer period, and 10 of 16 invertebrate sites rated from good to excellent during the fall period. Each of the five invertebrate sites that receive thermal inputs had an HBI water quality rating of fair or higher indicating poor water quality conditions in these streams. The downstream site on Obsidian Creek was the only sample without thermal influence that rated fair during the fall sample period indicating some type of environmental degradation. This site contained 6 tolerant taxa which comprised 60.4 percent of the total invertebrates collected and is located immediately downstream of Indian Creek campground. Obvious impacts to this site are not apparent but recreational activity at the campground or the

large number of ungulates that are known to graze in the area could possibly contribute to stream degradation.

In addition to using benthic macroinvertebrates at the lower site of Obsidian Creek, additional water quality measurements (physical and chemical) should be collected to better understand the impacts occurring at this site. Also, a more comprehensive collection of benthic macroinvertebrates should be conducted in waters impacted by the natural thermal contributions found throughout YELL. This would allow a better understanding of the invertebrate communities residing within waters affected by the wide temperature ranges and the varying degree of water chemistry associated with these areas.

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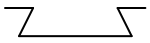
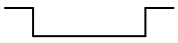
Appendix A. Habitat data sheet for invertebrate sampling in YELL.

HABITAT ASSESSMENT FOR RIFFLE/RUN STREAMS (>10% IN REACH)

	HABITAT PARAMET	HIGH → → → → → → LOW Record Estimated Percentages if applicable, circle individual components that are present, use field notes if necessary			
1	BOTTOM SUBSTRATE-PERCENT FINES* SCORE Est. (_____)	< 10% Fines (Sand + Silt) (20-16)	10-20% Fines (15-11)	20-50% Fines (10-6)	> 50% Fines (5-0)
2	SILT COVERING (EMBEDDEDNES)* SCORE Est. (_____)	Large and fines gravel, cobble, and boulder particles are 0-25% Covered or surrounded by fine sediment. Layering of cobble Rovides diversity of niche space.	Large and fine gravel, cobble, and boulder particles are 25-50% covered or surrounded by fine sediment. (15-11)	Large and fine gravel, cobble, and boulder particles are 50-75% covered or surrounded by fine sediments.	Large and fine gravel, cobble, and boulder particles are >75% covered or surrounded by fine sediment.
Note: ASSESS HABITAT PARAMETERS #1 AND #2 ONLY FOR THE RIFFLE OR RUN SAMPLED FOR MACROINVERTEBRATES. REMAINING HABITAT PARAMETERES #3 THROUGH #12 ARE ASSESSED FOR ENTIRE REACH					
3	INSTREAM COVER (FOR FISH) SCORE (_____)	>50% of large cobble, gravels, boulders, submerged logs, snags, undercut banks, variety of substrate and habitat types; other stable fish habitat; most favorable is a mix of the above (20-16)	30-50% for all previous criteria; adequate fish cover. (15-11)	10-30% for all previous criteria; less than desired variety of substrate and habitat types; reduced fish cover (10-6)	<10% for all previous criteria; poor variety of substrate and habitat types; obvious lack of fish cover.
4	VELOCITY/DEPTH SCORE (_____)	All four velocity/depth regimes present (slow-deep; slow-shallow; fast-deep; fast-shallow) (20-16)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes). (15-11)	Only 2 of the 4 regimes present (if fast-shallow or slow-shallow are missing score low) (10-6)	Dominated by 1 velocity/depth regime (5-0)
5	CHANNEL FLOW STATUS SCORE (_____)	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed. (20-16)	Water fills >75% of the available channel; or <25% of channel substrate is exposed. (15-11)	Water fills 25-75% of the available channel, and/or riffle substrate are mostly exposed. (10-6)	Very little water in channel and mostly present as standing pools. (5-0)
6	CHANNEL SHAPE (Bankfull Channel) SCORE (_____)	Trapezoidal (undercut  (15-12)	Rectangula  (11-8)	Triangular  (7-	Inverse  (3-
7	POOL/RIFFLE SEQUENCE (Mean distance between riffles in the sample reach divided by wetted stream width). SCORE (_____)	Ratio 5-7; Occurrence of riffles relatively frequent; ratio of distance between riffles divided by the width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstructions is important. (15-12)	Ratio 7-15; Occurrence of riffles infrequent; ratio of distance between riffles divided by the width of the stream is between 7 to 15. (11-8)	Ratio 15-25; Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25. (7-4)	Ratio > 25; homogenous habitat. Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25. (3-0)

Appendix A. continued.

HABITAT ASSESSMENT FOR RIFFLE/RUN STREAMS (>10% IN

	HABITAT PARAMET	HIG → → → → → → LO Record Estimated Percentages if applicable, circle individual components that are present, use field notes if necessary			
8	CHANNELIZATION / ALTERATION SCORE (_____)	Channalization or dredging absent or minimal, stream with normal pattern. (15-12)	Some channalization present, usually downstream of bridges, evidence of past channalization, i.e., dredging, (greater than past 20 yr) may be present, but recent channalization no present. (11-8)	Channalization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted. (7-4)	Extensive channalization, banks shored with gabion or cement; heavily urbanized areas; over 80% of the stream reach channalized or disrupted. Instream habitat greatly altered or removed entirely. (3-0)
9	BANK VEGETATION PROTECTION (Bankfull) SCORE (_____) LB SCORE (_____) RB	>90% Streambank covered by vegetation, boulders, cobble, or large woody debris. (10-9)	70-90% Streambank covered by vegetation, boulders, cobble, or large woody debris. (8-6)	50-70% Streambank covered by vegetation, boulders, cobble, or large woody debris. (5-3)	< 50% Streambank covered by vegetation, boulders, cobble, or large woody debris. (2-0)
1	BANK STABILLITY (Bankfull) SCORE (_____) LB SCORE (_____) RB	Bank stable; no erosion or bank failure; little potential for future problems.] (10-9)	Moderately stable; few small areas of erosion mostly healed over. (8-6)	Moderately unstable; up to 60% of banks in reach have areas of erosion; high erosion potential during floods. (5-3)	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60 – 100% of bank has erosional scars. (2-0)
1	DISRUPTIVE PRESSURES (Riparian Zone immediately adjacent to stream) SCORE (_____) LB SCORE (_____) RB	Vegetative disruption minimal or not evident; almost all potential plant biomass at present stage of development remains. (10-9)	Disruption evident but not affecting community vigor; ≥50% potential biomass remains. (8-6)	Disruption obvious, some patches of bare soil or closely cropped vegetation; < 50% potential biomass remains. (5-3)	Very high disruption of vegetation; patches of bare soil; vegetation removed to ≤ 2 inches average stubble height. (2-0)
1	RIPARIAN VEGETATIVE ZONE WIDTH (From bankfull to upland) SCORE (_____) LB SCORE (_____) RB	Natural riparian zone intact. Human activities (i.e. roads parking lots, clear-cuts, lawns, or crops) have not impacted natural zone. Potential for impacts from adjacent uplands low or high based on stream type (natural riparian width and percent slope of uplands). (10-9)	Human activities have impacted natural riparian zone only minimally, either directly or through upland contributions. Existing riparian zone provides good, moderate, or limited filtering potential to channel due to width of unimpacted zone. (8-6)	Human activities have impacted natural riparian zone a great deal. Existing riparian zone provides good, moderate, or limited filtering potential to channel due to width of unimpacted zone. (5-3)	Little or no riparian vegetation due to human activities. Existing riparian zone provides limited, poor, or no filtering potential to channel due to proximity of human activities to the channel (2-0)

Appendix B. Location information for invertebrate sites sampled in the GRYN park units during 2002. Site coordinates are recorded in Universal Transverse Mercator (UTM)

Park Unit	Stream Site ID	Stream Name	UTM Easting	UTM Northing
Bighorn Canyon	1	Crooked Cr.	714690	4982519
	2	Layout Cr.	715245	4996015
	3	N.F. Trail Cr.	718640	4997974
	4	N.F. Trail Cr.	717684	4998629
Grand Teton	1	Arizona Cr.	528379	4868861
	2	Arizona Cr.	528543	4869066
	3	Cottonwood Cr.	521819	4838366
	4	Cottonwood Cr.	521798	4838557
	5	Cottonwood Cr.	522171	4844145
	6	Ditch Cr.	533576	4836717
	7	Lizard Cr.	525577	4872670
	8	Lizard Cr.	525588	4872694
	9	Pacific Cr.	538913	4855454
	10	Pacific Cr.	540205	4857571
	11	Pacific Cr.	542936	4862440
	12	Pilgrim Cr.	533189	4861304
	13	Pilgrim Cr.	535057	4863509
	14	Snake R.	526679	4882935
	15	Spread Cr.	537193	4848681
	16	Spread Cr.	541710	4846680
Yellowstone	1	Antelope Cr.	548531	4970854
	2	Antelope Cr.	548865	4969650
	3	Antelope Cr.	548531	4968680
	4	Gardner R.	524379	4981806
	5	Gardner R.	525026	4979920
	6	Gardner R.	521062	4970464
	7	Middle Cr.	579231	4926592
	8	Middle Cr.	577844	4925990
	9	Nez Perce Cr.	513432	4936231
	10	Nez Perce Cr.	514421	4935528
	11	Obsidian Cr.	521106	4970235
	12	Obsidian Cr.	520798	4966547
	13	Obsidian Cr.	520092	4960643
	14	Obsidian Cr.	520591	4959359
	15	Pebble Cr	570118	4973747
	16	Pebble Cr	570062	4974151
	17	Soda Butte Cr.	565921	4968736
	18	Soda Butte Cr.	572413	4975839
	19	Soda Butte Cr.	577951	4983507
	20	Unnamed Trib.	575852	4925266

APPENDIX C. Benthic invertebrate taxon and densities collected in BICA during September 2002. Invertebrate densities are recorded in square meters. Stream name, site number and collection date are indicated for each site.

Taxon	Crooked Cr. Site - 1 13-Sep	Layout Cr Site - 2 13-Sep	N.F. Trail Cr. Site - 3 12-Sep	N.F. Trail Cr. Site - 4 12-Sep
Acari	3	0	0	1
Hyalella	2	0	0	0
Lymnaeidae	11	0	0	0
Oligochaeta	47	4	1	7
Physa/Physella	229	0	0	12
Turbellaria	0	26	0	0
TOTAL: NON INSECTS	**291**	**30**	**1**	**20**
Argia	8	0	0	0
TOTAL: ODONATA	**8**	**0**	**0**	**0**
Acentrella	3	0	0	0
Baetidae	2	0	0	0
Baetis tricaudatus	84	41	68	116
Cinygmula	0	4	0	0
Paraleptophlebia	0	8	0	0
Tricorythodes minutus	3	0	0	0
TOTAL: EPHEMEROPTERA	**91**	**53**	**68**	**116**
Hesperoperla pacifica	0	12	18	68
Malenka	0	3	0	7
Sweltsa	0	5	0	0
Zapada cinctipes	0	3	8	144
TOTAL: PLECOPTERA	**0**	**23**	**26**	**219**
Cheumatopsyche	28	0	0	0
Hesperophylax	3	0	0	0
Hydropsyche	6	0	22	18
Hydroptila	6	0	0	1
Lepidostoma-turret case larvae	0	0	0	3
Ochrotrichia	0	1	0	0
Rhyacophila narvae	0	0	1	0
TOTAL: TRICHOPTERA	**43**	**1**	**23**	**22**
Dytiscidae	2	0	3	1
Helichus	2	0	0	0
Heterlimnius	0	9	0	3
Hydrophilidae	2	0	0	0
Narpus	0	7	0	1

APPENDIX C. (continued)

Taxon	Crooked Cr. Site - 1 13-Sep	Layout Cr Site - 2 13-Sep	N.F. Trail Cr. Site - 3 12-Sep	N.F. Trail Cr. Site - 4 12-Sep
Postelichus	2	0	0	8
Optioservus	0	0	0	20
TOTAL: COLEOPTERA	**6**	**16**	**3**	**34**
Caloparyphus	0	0	1	14
Ceratopogoninae	19	0	0	0
Chelifera/Metachela	2	0	0	0
Dicranota	0	1	0	5
Hemerodromia	47	0	0	0
Limnophora	43	1	0	0
Ormosia	0	1	0	0
Simulium	246	9	5	0
Tipula	0	4	0	1
TOTAL: DIPTERA	**357**	**18**	**7**	**20**
Apedilum	5	0	0	0
Brillia	0	1	0	1
Chironomidae-pupae	88	4	5	8
Corynoneura	3	5	0	0
Cricotopus	110	0	0	0
Cricotopus Bicinctus Group	8	0	0	0
Diamesa	0	49	0	0
Dicrotendipes	3	0	0	0
Epoicocladius	0	1	0	0
Eukiefferiella	26	4	1	4
Heleniella	0	0	0	3
Limnophyes	5	0	0	0
Micropsectra	17	1	0	11
Orthocladius	51	1	0	1
Orthocladius Complex	40	5	0	0
Pagastia	0	1	0	0
Parakiefferiella	26	0	0	0
Paramerina	9	0	0	0
Parametriocnemus	23	11	0	0
Parorthocladius	0	1	0	0
Prodiamesa	0	0	0	3

APPENDIX C. (continued)

Taxon	Crooked Cr. Site - 1 13-Sep	Layout Cr Site - 2 13-Sep	N.F. Trail Cr. Site - 3 12-Sep	N.F. Trail Cr. Site - 4 12-Sep
Pseudosmittia	5	0	0	0
Psilometriocnemus	0	0	0	3
Rheocricotopus	0	5	0	0
Rheotanytarsus	9	0	0	0
Tanytarsus	93	1	0	0
Thienemanniella	0	1	0	0
Thienemannimyia Complex	23	0	0	0
Tvetenia Bavarica Group	17	53	0	1
Zavrelimyia	0	0	0	1
TOTAL: CHIRONOMIDAE	**563**	**147**	**7**	**36**
GRAND TOTAL	**1359**	**288**	**134**	**467**

APPENDIX D. Benthic invertebrate taxon and densities collected from sites 1 - 16 in GRTE during the 2002 summer sampling period. Invertebrate densities are recorded in square meters. Stream name, site number, and date of collection are indicated for each site.

Taxon	Arizona Site - 1 29-Aug	Arizona Site - 2 29-Aug	Cottonwood Site - 3 4-Sep	Cottonwood Site - 4 4-Sep	Cottonwood Site - 5 4-Sep	Ditch Site - 6 5-Sep	Lizard Site - 7 6-Sep	Lizard Site - 8 6-Sep
Acari	54	130	39	15	141	417	1	3
Lymnaeidae	0	12	0	0	0	0	0	0
Oligochaeta	0	0	124	39	20	0	5	7
Physa/Physella	0	0	2	0	0	13	0	0
Pisidium	0	0	0	0	50	0	0	0
TOTAL: NON INSECTS	**54**	**142**	**165**	**54**	**212**	**430**	**7**	**9**
Ophiogomphus	0	0	0	3	0	0	0	0
TOTAL: ODONATA	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**
Acentrella turbida	97	7	23	26	0	0	0	0
Ameletus	5	47	0	0	0	27	28	24
Baetidae	0	0	95	49	0	0	1	0
Baetis tricaudatus	43	9	50	17	10	0	0	1
Centroptilum	5	7	0	0	0	0	0	1
Cinygma	0	0	0	0	0	0	0	1
Cinygmula	188	85	0	0	0	13	154	34
Diphetor hageni	0	2	5	5	10	0	23	0
Drunella doddsi	48	7	0	0	0	27	19	4
Drunella grandis	91	47	0	0	0	40	0	0
Drunella spinifera	0	0	0	0	0	0	9	4
Epeorus	0	0	0	0	0	13	0	0
Epeorus albertae	0	0	2	2	0	0	0	0
Ephemerella inermis	527	88	11	6	474	13	3	15
Paraleptophlebia	231	185	77	31	161	13	19	18
Paraleptophlebia bicornuta	5	0	0	0	0	0	0	0
Rhithrogena	194	5	648	445	0	0	1	0
Serratella tibialis	5	2	2	2	0	0	1	0
TOTAL: EPHEMEROPTERA	**1442**	**493**	**913**	**582**	**656**	**148**	**259**	**103**
Capniidae	16	9	0	0	0	0	0	8
Chloroperlidae	0	0	5	3	0	0	1	3
Claassenia sabulosa	11	0	9	25	10	0	0	0
Cultus	0	7	0	0	0	0	0	0
Doroneuria	0	0	0	0	0	0	24	8
Hesperoperla pacifica	0	0	4	2	10	0	0	1
Isoperla	59	5	0	0	20	13	4	14

APPENDIX D. (continued)

Taxon	Arizona Site - 1 29-Aug	Arizona Site - 2 29-Aug	Cottonwood Site - 3 4-Sep	Cottonwood Site - 4 4-Sep	Cottonwood Site - 5 4-Sep	Ditch Site - 6 5-Sep	Lizard Site - 7 6-Sep	Lizard Site - 8 6-Sep
Megarcys	0	0	0	0	0	0	1	0
Paraperla	0	0	0	0	0	0	4	1
Perlodidae	16	9	0	2	0	13	7	1
Skwala	59	7	29	8	0	0	12	7
Sweltsa	59	40	2	2	101	81	86	74
Visoka cataractae	0	0	0	0	0	0	0	3
Zapada cinctipes	129	2	5	3	0	27	146	82
Zapada columbiana	0	0	0	0	0	0	1	0
Zapada Oregonensis Group	0	0	0	0	0	0	3	0
TOTAL: PLECOPTERA	**350**	**81**	**54**	**43**	**141**	**135**	**290**	**203**
Sialis	0	0	0	0	0	27	0	3
TOTAL: MEGALOPTERA	**0**	**0**	**0**	**0**	**0**	**27**	**0**	**3**
Agapetus	27	14	0	0	0	0	0	1
Amiocentrus aspilus	11	0	0	0	0	323	0	0
Apatania	11	19	0	0	0	54	18	5
Arctopsyche grandis	16	7	0	0	0	0	0	0
Brachycentrus americanus	5	2	14	17	10	40	0	0
Ceraclea	0	0	0	0	40	0	0	0
Cheumatopsyche	0	0	0	0	404	0	0	0
Chyranda centralis	0	0	0	0	0	0	14	0
Ecclisomyia	0	0	0	0	0	0	7	15
Glossosoma	5	0	5	12	0	0	18	3
Hydropsyche	11	0	88	159	1049	0	0	0
Hydroptila	11	21	0	0	0	0	0	0
Lepidostoma cascadense	0	0	0	0	0	0	12	7
Lepidostoma-panel case larvae	0	0	0	0	10	0	0	0
Lepidostoma Pluviale Group	178	182	23	8	0	4855	0	0
Limnephilidae	0	0	0	0	0	0	11	19
Micrasema	11	0	5	0	0	0	0	8
Ochrotrichia	5	0	0	0	0	0	0	0
Oecetis	0	0	0	0	0	148	0	0
Parapsyche elsis	0	0	0	0	0	0	1	3
Rhyacophila	0	0	0	0	10	0	7	1
Rhyacophila Betteni Group	0	0	0	0	0	0	1	0

APPENDIX D. (continued)

Taxon	Arizona Site - 1 29-Aug	Arizona Site - 2 29-Aug	Cottonwood Site - 3 4-Sep	Cottonwood Site - 4 4-Sep	Cottonwood Site - 5 4-Sep	Ditch Site - 6 5-Sep	Lizard Site - 7 6-Sep	Lizard Site - 8 6-Sep
Rhyacophila Brunnea/Vemna Group	0	0	2	0	30	0	3	3
Rhyacophila Coloradensis Group	5	7	0	0	10	0	0	0
Rhyacophila narvae	0	0	0	0	0	0	24	14
TOTAL: TRICHOPTERA	**296**	**254**	**138**	**196**	**1564**	**5420**	**115**	**78**
Cleptelmis addenda	0	0	0	0	0	0	0	11
Dytiscidae	11	31	0	0	0	0	0	1
Heterlimnius	43	12	0	0	0	0	89	81
Lara	0	0	2	0	0	0	0	0
Narpus	0	7	0	0	0	0	0	0
Optioservus	280	85	0	0	0	296	0	0
Zaitzevia	5	2	0	3	0	161	0	0
TOTAL: COLEOPTERA	**339**	**137**	**2**	**3**	**0**	**457**	**89**	**93**
Antocha	5	2	0	0	0	27	1	0
Atherix	11	5	4	3	0	40	0	0
Ceratopogoninae	0	5	0	0	0	0	1	0
Chelifera/Metachela	22	24	7	3	20	0	0	0
Clinocera	0	0	0	0	0	0	0	9
Dicranota	22	0	0	0	0	27	0	0
Empididae	0	0	2	0	0	0	0	0
Glutops	0	0	0	0	0	0	1	0
Hexatoma	22	5	2	0	0	13	0	1
Limnophila	0	2	0	0	0	0	0	0
Meringodixa	0	0	0	0	0	0	0	1
Pericoma	81	95	0	0	0	229	54	36
Ptychoptera	0	0	0	0	0	0	0	9
Simulium	5	0	0	0	91	0	0	0
Tipulidae	0	2	0	0	0	0	0	0
Tipula	0	0	0	0	0	0	5	3
Wiedemannia	5	2	0	0	0	0	0	0
TOTAL: DIPTERA	**172**	**142**	**14**	**6**	**111**	**336**	**63**	**61**
Apedilum	5	7	0	0	0	0	0	0
Brillia	0	0	0	3	0	0	4	9
Chaetocladius	0	0	0	0	0	0	1	0
Chironomidae-pupae	135	36	36	14	242	27	16	20

APPENDIX D. (continued)

Taxon	Arizona Site - 1 29-Aug	Arizona Site - 2 29-Aug	Cottonwood Site - 3 4-Sep	Cottonwood Site - 4 4-Sep	Cottonwood Site - 5 4-Sep	Ditch Site - 6 5-Sep	Lizard Site - 7 6-Sep	Lizard Site - 8 6-Sep
Chironomus	0	0	2	0	0	0	0	0
Cladotanytarsus	5	0	0	0	0	0	0	0
Corynoneura	16	5	0	3	0	0	0	0
Cricotopus	108	45	0	0	202	0	0	1
Cricotopus Bicinctus Group	0	0	0	6	1080	0	0	0
Cricotopus Nostococladius	16	100	0	0	0	108	70	77
Diamesa	0	2	0	0	0	0	0	0
Eukiefferiella	27	2	2	2	131	0	0	0
Heleniella	0	0	0	0	0	0	0	1
Larsia	0	2	0	0	0	0	1	0
Micropsectra	27	5	4	6	20	188	14	20
Microtendipes	0	9	0	0	0	0	0	0
Nanocladius	0	0	0	0	20	0	0	0
Orthocladius Complex	312	26	0	0	686	27	3	0
Orthocladius (Euorthocladius)	5	0	0	0	0	0	0	0
Paracladopelma	0	2	0	0	0	0	0	0
Parakiefferiella	0	2	0	0	0	0	0	0
Parametriocnemus	0	5	5	0	0	0	0	0
Parorthocladius	0	0	0	0	0	0	0	1
Polypedilum	5	0	0	0	0	0	0	8
Potthastia Gaedii Group	0	0	0	0	111	0	0	0
Psectrocladius	0	0	0	0	40	0	0	0
Pseudosmittia	0	0	0	0	91	0	0	0
Radotanypus	0	0	0	0	0	0	0	4
Rheocricotopus	16	7	5	0	61	0	3	0
Rheotanytarsus	0	0	0	0	0	94	0	0
Stictochironomus	0	0	0	0	0	13	0	7
Sublettea	70	12	0	0	20	0	0	0
Symposiocladius	0	0	0	0	0	0	0	1
Synorthocladius	0	0	0	0	20	0	0	0
Tanytarsus	16	5	0	2	20	108	4	26
Thienemanniella	11	0	0	2	0	0	0	0
Thienemannimyia Complex	16	7	18	6	151	27	8	3
Tvetenia Bavarica Group	86	12	5	9	40	0	5	7

APPENDIX D. (continued)

Taxon	Arizona Site - 1 29-Aug	Arizona Site - 2 29-Aug	Cottonwood Site - 3 4-Sep	Cottonwood Site - 4 4-Sep	Cottonwood Site - 5 4-Sep	Ditch Site - 6 5-Sep	Lizard Site - 7 6-Sep	Lizard Site - 8 6-Sep
Tvetenia Vitracies Group	0	0	0	0	91	0	0	0
Zavrelimyia	0	0	0	0	0	0	0	1
TOTAL: CHIRONOMIDAE	**877**	**292**	**77**	**52**	**3027**	**592**	**130**	**188**
GRAND TOTAL	**3529**	**1541**	**1362**	**939**	**5711**	**7545**	**953**	**737**

APPENDIX D. (continued)

Taxon	Pacific Site - 9 3-Sep	Pacific Site - 10 30-Aug	Pacific Site - 11 30-Aug	Pilgrim Site - 12 28-Aug	Pilgrim Site - 13 28-Aug	Snake Site - 14 29-Aug	Spread Site - 15 5-Sep	Spread Site - 16 3-Sep
Acari	151	46	291	15	45	14	799	538
Lymnaeidae	0	3	0	0	0	26	0	0
Oligochaeta	22	0	3	0	0	0	16	7
Physa/Physella	0	5	0	0	0	0	0	0
Planorbidae	0	11	0	0	0	0	0	0
TOTAL: NON INSECTS	**172**	**65**	**293**	**15**	**45**	**40**	**815**	**545**
Acentrella insignificans	1184	0	0	0	0	0	0	0
Acentrella turbida	0	299	89	87	39	145	56	101
Ameletus	0	0	3	0	3	0	0	0
Attenella margarita	22	5	0	0	0	0	0	0
Baetis tricaudatus	215	22	78	84	30	115	73	209
Cinygma	0	0	0	8	0	0	0	0
Cinygmula	0	3	0	0	19	0	24	27
Diphetor hageni	0	0	0	0	0	0	8	0
Drunella doddsi	22	65	242	30	92	34	32	13
Drunella grandis	43	27	191	3	3	8	48	20
Epeorus albertae	0	0	0	2	3	0	0	0
Ephemerella inermis	54	0	16	66	52	0	48	34
Paraleptophlebia	11	0	0	3	6	0	81	0
Paraleptophlebia bicornuta	0	3	0	0	0	0	0	0
Rhithrogena	2808	183	35	136	62	386	226	47
Serratella tibialis	0	0	0	3	6	14	0	0
Timpanoga hecuba	0	0	0	0	0	0	8	0
TOTAL: EPHEMEROPTERA	**4358**	**605**	**654**	**423**	**314**	**703**	**605**	**451**
Capniidae	0	0	0	7	1	0	0	27
Chloroperlidae	54	0	0	0	1	2	0	0
Claassenia sabulosa	0	0	0	0	0	8	0	0
Cultus	0	0	0	0	7	0	0	0
Doroneuria	0	0	0	2	6	0	0	0
Hesperoperla pacifica	11	3	0	0	0	0	32	13
Isoperla	0	0	0	0	0	2	0	0
Megarcys	0	0	0	3	0	0	0	0
Perlodidae	0	0	0	3	0	0	0	0
Pteronarcella	0	16	19	0	0	2	169	34

APPENDIX D. (continued)

Taxon	Pacific Site - 9 3-Sep	Pacific Site - 10 30-Aug	Pacific Site - 11 30-Aug	Pilgrim Site - 12 28-Aug	Pilgrim Site - 13 28-Aug	Snake Site - 14 29-Aug	Spread Site - 15 5-Sep	Spread Site - 16 3-Sep
Pteronarcys californica	65	0	0	0	0	2	0	0
Skwala	54	8	11	0	6	2	113	7
Sweltsa	0	5	8	25	76	6	8	7
Zapada cinctipes	0	0	5	20	46	2	24	13
Zapada Oregonensis Group	0	0	0	0	1	0	0	0
TOTAL: PLECOPTERA	**183**	**32**	**43**	**60**	**145**	**26**	**347**	**101**
Amiocentrus aspilus	32	8	0	0	0	0	161	7
Apatania	0	24	207	8	26	0	8	7
Arctopsyche grandis	0	3	8	13	9	2	32	13
Brachycentrus americanus	65	40	135	29	12	4	323	114
Brachycentrus occidentalis	43	19	11	0	0	0	16	0
Ceraclea	0	0	0	0	0	2	0	0
Cheumatopsyche	0	0	0	0	0	0	8	0
Glossosoma	43	5	8	0	6	30	0	7
Hydropsyche	129	22	5	0	0	81	81	7
Hydroptila	0	0	0	0	0	0	24	0
Lepidostoma Pluviale Group	473	196	8	40	13	69	783	40
Limnephilidae	0	0	0	2	0	0	0	0
Protoptila	0	0	0	0	0	8	0	0
Psychomyia	0	0	0	0	0	2	0	0
Rhyacophila Brunnea/Vemna Group	0	0	0	2	6	0	0	0
Rhyacophila Coloradensis Group	0	0	3	0	0	0	0	13
TOTAL: TRICHOPTERA	**785**	**317**	**385**	**94**	**71**	**198**	**1436**	**209**
Cleptelmis addenda	0	0	0	0	0	0	0	7
Dytiscidae	11	8	11	0	1	0	0	0
Optioservus	0	0	0	2	1	28	24	20
Zaitzevia	0	0	0	0	0	6	0	0
TOTAL: COLEOPTERA	**11**	**8**	**11**	**2**	**3**	**34**	**24**	**27**
Antocha	0	0	0	0	0	0	24	7
Atherix	129	5	143	18	0	0	48	357
Blephariceridae	0	3	11	0	1	0	0	20
Ceratopogoninae	0	0	0	0	0	0	16	0
Chelifera/Metachela	0	0	0	0	0	0	24	7
Clinocera	0	0	3	0	1	0	0	0

APPENDIX D. (continued)

Taxon	Pacific Site - 9 3-Sep	Pacific Site - 10 30-Aug	Pacific Site - 11 30-Aug	Pilgrim Site - 12 28-Aug	Pilgrim Site - 13 28-Aug	Snake Site - 14 29-Aug	Spread Site - 15 5-Sep	Spread Site - 16 3-Sep
Empididae	0	0	0	0	1	0	8	0
Hexatoma	43	3	0	0	1	6	8	27
Pericoma	0	0	11	0	1	0	0	0
Simulium	635	253	105	170	17	85	56	1292
Tipula	11	5	0	0	0	0	8	0
Wiedemannia	11	0	0	0	0	0	48	0
TOTAL: DIPTERA	**829**	**269**	**272**	**188**	**24**	**91**	**242**	**1709**
Abiskomyia	0	0	0	0	0	0	24	0
Brillia	0	0	0	0	1	0	0	0
Cardiocladius	0	16	0	0	0	2	0	0
Chironomidae-pupae	646	94	118	24	69	42	202	175
Cladotanytarsus	0	0	0	0	0	2	0	0
Corynoneura	0	0	0	0	1	0	0	0
Cricotopus	0	30	0	0	1	2	266	61
Cricotopus Bicinctus Group	0	0	0	0	6	0	8	0
Cricotopus Nostococladius	32	0	0	0	0	0	0	13
Diamesa	0	0	0	0	1	0	0	0
Eukiefferiella	86	19	0	3	0	6	24	7
Eukiefferiella Devonica Group	0	0	3	0	0	4	0	7
Micropsectra	11	13	13	66	99	32	662	7
Orthocladius	22	19	5	2	0	4	0	13
Orthocladius Complex	22	62	97	3	16	0	282	101
Orthocladius (Euorthocladius)	0	0	24	0	3	0	0	0
Pagastia	0	0	0	0	1	0	0	0
Paracladopelma	0	0	0	0	1	0	0	0
Parametriocnemus	0	0	0	0	1	0	8	13
Polypedilum	0	0	0	0	0	2	0	0
Potthastia Gaedii Group	0	16	0	0	0	0	8	0
Rheocricotopus	0	0	3	2	9	0	0	7
Rheotanytarsus	0	0	0	0	0	4	0	0
Stempellinella	0	0	0	0	6	0	0	0
Sublettea	97	65	5	0	1	0	8	7
Synorthocladius	11	3	0	0	0	0	0	7
Tanytarsus	0	11	0	0	9	24	40	0

Taxon	Pacific Site - 9 3-Sep	Pacific Site - 10 30-Aug	Pacific Site - 11 30-Aug	Pilgrim Site - 12 28-Aug	Pilgrim Site - 13 28-Aug	Snake Site - 14 29-Aug	Spread Site - 15 5-Sep	Spread Site - 16 3-Sep
Thienemanniella	0	3	3	0	1	0	121	0
Thienemannimyia Complex	11	0	0	0	0	2	32	0
Tvetenia Bavarica Group	194	148	54	24	17	40	73	13
TOTAL: CHIRONOMIDAE	**1130**	**498**	**325**	**123**	**246**	**168**	**1759**	**431**
GRAND TOTAL	**7467**	**1794**	**1983**	**906**	**848**	**1260**	**5229**	**3473**

APPENDIX E. Benthic invertebrate taxon and densities collected from sites 1 - 16 in GRTE during the 2002 fall sampling period. Invertebrate densities are recorded in square meters. Stream name, site number, and date of collection are indicated for each site.

Taxon	Arizona Site - 1 21-Oct	Arizona Site - 2 17-Oct	Cottonwood Site - 3 22-Oct	Cottonwood Site - 4 22-Oct	Cottonwood Site - 5 22-Oct	Ditch Site - 6 18-Oct	Lizard Site - 7 25-Oct	Lizard Site - 8 25-Oct
Acari	43	45	101	25	355	0	32	0
Lymnaeidae	11	0	0	0	0	0	0	0
Nematoda	5	0	0	4	0	0	5	0
Oligochaeta	0	4	43	72	0	40	5	20
Turbellaria	0	0	0	4	0	0	0	0
TOTAL: NON INSECTS	**59**	**49**	**144**	**104**	**355**	**40**	**43**	**20**
Acentrella turbida	11	0	4	0	0	0	0	0
Ameletus	27	36	0	0	0	0	54	121
Baetis tricaudatus	91	67	83	104	1323	0	0	0
Cinygmula	1340	829	83	11	0	565	1173	1534
Diphetor hageni	22	22	18	11	258	323	135	202
Drunella coloradensis/flavilinea	16	0	0	0	0	0	0	0
Drunella doddsi	27	9	0	0	0	161	27	0
Drunella grandis	11	27	0	0	0	0	0	0
Epeorus	124	211	118	93	32	40	0	0
Ephemerella inermis	178	121	14	57	3389	161	0	0
Paraleptophlebia	0	287	456	474	1162	121	32	0
Paraleptophlebia bicornuta	0	4	0	0	0	0	0	0
Rhithrogena	97	13	474	556	0	0	0	0
TOTAL: EPHEMEROPTERA	**1942**	**1626**	**1249**	**1307**	**6165**	**1372**	**1420**	**1857**
Capniidae	178	22	4	7	0	121	140	807
Chloroperlidae	0	0	4	83	32	40	32	0
Claassenia sabulosa	5	9	0	7	0	0	0	0
Cultus	0	4	0	0	0	0	0	0
Doroneuria	5	0	11	14	0	0	16	0
Hesperoperla pacifica	5	0	14	22	32	0	0	0
Isoperla	22	22	0	0	0	121	0	20
Perlodidae	22	27	7	0	0	81	11	0
Skwala	5	0	7	18	0	0	5	0
Sweltsa	43	18	39	0	194	161	210	141
Zapada cinctipes	97	18	0	50	0	40	75	20
TOTAL: PLECOPTERA	**382**	**121**	**86**	**201**	**258**	**565**	**490**	**989**

APPENDIX E. (continued)

Taxon	Arizona Site - 1 21-Oct	Arizona Site - 2 17-Oct	Cottonwood Site - 3 22-Oct	Cottonwood Site - 4 22-Oct	Cottonwood Site - 5 22-Oct	Ditch Site - 6 18-Oct	Lizard Site - 7 25-Oct	Lizard Site - 8 25-Oct
Agraylea	0	0	0	0	32	0	0	0
Amiocentrus aspilus	27	9	0	0	0	1614	0	0
Anagapetus	0	0	0	0	0	0	32	0
Arctopsyche grandis	0	0	0	0	0	81	0	0
Brachycentrus americanus	81	31	456	370	1259	202	0	0
Cheumatopsyche	5	0	0	0	968	0	0	0
Chyranda centralis	0	0	0	0	0	0	0	20
Glossosoma	97	36	0	18	0	0	22	20
Hydropsyche	16	0	187	474	1098	40	0	0
Hydroptila	22	9	4	0	194	0	0	0
Lepidostoma	0	0	0	0	32	0	0	0
Lepidostoma cascadense	5	0	4	4	0	0	91	0
Lepidostoma-panel case larvae	5	0	0	0	0	0	0	0
Lepidostoma Pluviale Group	360	264	39	25	0	18642	0	0
Lepidostoma-turret case larvae	0	0	14	14	0	0	0	0
Limnephilidae	0	0	0	0	0	0	11	0
Micrasema	54	18	0	0	0	81	5	0
Rhyacophila	0	0	0	0	0	0	16	20
Rhyacophila Brunnea/Vemna Group	11	4	0	0	161	0	0	0
Rhyacophila Coloradensis Group	11	9	0	0	97	40	0	0
Rhyacophila narvae	0	0	0	0	0	0	54	20
TOTAL: TRICHOPTERA	**694**	**381**	**704**	**905**	**3841**	**20700**	**231**	**81**
Cleptelmis addenda	0	13	0	0	0	40	0	0
Dytiscidae	0	0	0	0	0	0	5	0
Heterlimnius	0	4	0	0	0	0	204	202
Lara	5	0	0	0	0	0	0	0
Narpus	0	4	0	0	0	0	0	0
Optioservus	129	63	0	0	0	968	5	0
Zaitzevia	5	0	11	4	97	81	0	0
TOTAL: COLEOPTERA	**140**	**85**	**11**	**4**	**97**	**1089**	**215**	**202**

APPENDIX E. (continued)

Taxon	Arizona Site - 1 21-Oct	Arizona Site - 2 17-Oct	Cottonwood Site - 3 22-Oct	Cottonwood Site - 4 22-Oct	Cottonwood Site - 5 22-Oct	Ditch Site - 6 18-Oct	Lizard Site - 7 25-Oct	Lizard Site - 8 25-Oct
Antocha	22	27	0	0	0	161	0	0
Atherix	0	0	7	0	0	121	0	0
Caloparyphus	0	0	0	0	0	40	0	0
Ceratopogoninae	0	0	0	0	0	0	5	20
Chelifera/Metachela	11	31	25	11	129	40	0	0
Clinocera	0	0	0	0	32	0	0	0
Dicranota	0	4	0	0	0	81	0	0
Hexatoma	16	4	0	0	32	0	11	20
Limnophora	0	0	0	0	0	0	5	0
Pericoma	135	112	0	0	0	726	97	141
Simulium	0	0	0	0	0	81	0	0
Tipula	0	0	0	0	0	0	5	20
Wiedemannia	0	4	0	0	0	0	0	0
TOTAL: DIPTERA	**183**	**184**	**32**	**11**	**194**	**1251**	**124**	**202**
Brillia	0	0	4	29	0	0	301	262
Chaetocladius	0	0	0	0	0	0	11	0
Chironomidae-pupae	0	13	4	0	65	0	0	0
Cladotanytarsus	0	4	0	0	0	0	0	0
Corynoneura	5	0	0	0	0	0	0	0
Cricotopus	32	49	0	0	0	0	0	0
Cricotopus Bicinctus Group	0	0	0	0	2389	0	0	0
Cricotopus Nostococladius	0	45	0	0	0	404	204	303
Diamesa	0	4	0	0	0	0	0	0
Eukiefferiella	0	0	0	7	1549	0	0	0
Heleniella	0	0	0	0	0	0	48	0
Larsia	0	0	0	0	0	0	11	141
Micropsectra	0	0	11	14	161	0	70	343
Microtendipes	0	0	7	0	0	0	0	0
Orthocladius	0	0	0	4	161	0	0	0
Orthocladius Complex	54	49	0	0	4616	242	102	141
Orthocladius (Euorthocladius)	0	0	0	7	0	0	0	0
Pagastia	0	0	0	0	1872	0	22	0
Paracladopelma	0	0	0	0	0	0	0	141
Parakiefferiella	11	36	0	0	0	0	0	0

APPENDIX E. (continued)

Taxon	Arizona Site - 1 21-Oct	Arizona Site - 2 17-Oct	Cottonwood Site - 3 22-Oct	Cottonwood Site - 4 22-Oct	Cottonwood Site - 5 22-Oct	Ditch Site - 6 18-Oct	Lizard Site - 7 25-Oct	Lizard Site - 8 25-Oct
Parametriocnemus	0	0	4	0	161	0	0	0
Phaenopsectra	0	0	0	0	0	40	0	0
Polypedilum	11	0	0	0	0	363	0	262
Potthastia Gaedii Group	0	0	0	0	2744	0	0	0
Potthastia Longimana Group	0	4	0	0	678	0	0	0
Pseudodiamesa	0	0	0	0	0	0	0	141
Pseudosmittia	0	0	0	0	161	0	0	0
Radotanypus	0	0	0	0	0	0	0	61
Rheocricotopus	0	0	0	11	1194	81	32	61
Rheotanytarsus	5	0	4	0	516	323	0	0
Stempellina	5	0	0	0	0	0	0	0
Stictochironomus	0	0	0	0	0	0	0	61
Stilocladius	0	36	0	0	0	0	0	0
Sublettea	0	0	0	0	1872	0	0	0
Tanytarsus	11	9	65	90	0	81	979	8758
Thienemannimyia Complex	0	45	11	29	2227	40	118	141
Tvetenia Bavarica Group	0	0	25	22	161	0	102	61
Tvetenia Vitracies Group	0	0	0	0	4616	0	0	0
Zavrelimyia	0	0	0	0	0	0	0	61
TOTAL: CHIRONOMIDAE	**135**	**296**	**133**	**212**	**25146**	**1574**	**2001**	**10938**
GRAND TOTAL	**3535**	**2742**	**2359**	**2743**	**36057**	**26591**	**4525**	**14287**

APPENDIX E. (continued)

Taxon	Pacific Cr. Site - 9 16-Oct	Pacific Cr. Site - 10 16-Oct	Pacific Cr. Site - 11 16-Oct	Pilgrim Cr. Site - 12 17-Oct	Pilgrim Cr. Site - 13 17-Oct	Snake R. Site - 14 25-Oct	Spread Cr. Site - 15 21-Oct	Spread Cr. Site - 16 21-Oct
Acari	215	17	4197	45	11	50	62	333
Hirudinea	0	0	20	0	0	0	0	0
Nematoda	0	0	40	0	0	0	0	0
Oligochaeta	0	0	0	0	0	10	15	0
TOTAL: NON INSECTS	**215**	**17**	**4258**	**45**	**11**	**61**	**77**	**333**
Acentrella turbida	32	46	424	23	32	50	0	12
Ameletus	0	0	0	2	0	0	2	0
Baetis tricaudatus	22	6	40	267	118	161	0	247
Cinygmula	0	0	222	98	639	0	15	8
Diphetor hageni	0	0	0	0	4	0	2	0
Drunella coloradensis/flavilinea	0	0	0	0	7	0	0	0
Drunella doddsi	86	109	706	59	108	61	0	0
Drunella grandis	43	17	666	2	0	40	7	7
Epeorus	0	0	0	0	0	111	0	0
Ephemerella inermis	0	530	323	77	226	827	22	15
Ephemerella inermis/infrequens	1302	0	0	0	0	0	0	0
Paraleptophlebia	108	138	81	5	11	807	48	5
Rhithrogena	1399	1596	686	283	197	2987	37	7
TOTAL: EPHEMEROPTERA	**2991**	**2442**	**3148**	**816**	**1343**	**5045**	**132**	**301**
Capniidae	0	0	0	29	18	0	187	8
Chloroperlidae	97	150	40	7	25	0	7	0
Claassenia sabulosa	11	0	0	0	0	10	0	0
Doroneuria	0	0	0	0	4	0	0	0
Hesperoperla pacifica	0	12	0	0	0	0	0	3
Isoperla	0	6	0	0	0	131	0	0
Megarcys	0	0	0	0	4	0	0	0
Perlodidae	0	0	20	0	0	50	2	0
Pteronarcella	0	92	61	0	0	30	20	2
Pteronarcys californica	0	0	0	0	0	0	0	3
Skwala	0	23	0	2	4	0	18	2
Sweltsa	0	46	20	14	129	30	2	0
Taeniopterygidae	0	0	61	21	39	0	339	60
Zapada cinctipes	0	0	0	18	129	0	2	0
TOTAL: PLECOPTERA	**108**	**328**	**202**	**91**	**352**	**252**	**576**	**79**

APPENDIX E. (continued)

Taxon	Pacific Cr. Site - 9 16-Oct	Pacific Cr. Site - 10 16-Oct	Pacific Cr. Site - 11 16-Oct	Pilgrim Cr. Site - 12 17-Oct	Pilgrim Cr. Site - 13 17-Oct	Snake R. Site - 14 25-Oct	Spread Cr. Site - 15 21-Oct	Spread Cr. Site - 16 21-Oct
Amiocentrus aspilus	54	29	1049	2	29	0	13	20
Apatania	22	6	101	5	22	0	0	0
Arctopsyche grandis	0	0	20	2	4	0	0	0
Brachycentrus americanus	108	75	1493	141	108	0	64	25
Brachycentrus occidentalis	108	12	0	0	0	0	0	7
Glossosoma	312	0	20	5	0	182	2	0
Hydropsyche	140	81	20	7	0	585	0	7
Lepidostoma cascadense	0	0	0	0	7	0	0	0
Lepidostoma Pluviale Group	2356	340	767	93	165	474	339	32
Limnephilidae	0	23	0	0	0	0	0	0
Micrasema	0	0	0	0	0	0	0	2
Rhyacophila Brunnea/Vemna Group	0	0	0	2	0	0	0	0
Rhyacophila Coloradensis Group	0	0	40	0	0	0	0	3
TOTAL: TRICHOPTERA	**3099**	**564**	**3511**	**258**	**334**	**1241**	**417**	**96**
Optioservus	0	0	20	0	7	242	5	15
Zaitzevia	0	0	0	0	0	20	0	0
TOTAL: COLEOPTERA	**0**	**0**	**20**	**0**	**7**	**262**	**5**	**15**
Antocha	0	0	0	4	0	0	0	12
Atherix	43	23	1493	38	0	0	4	186
Blephariceridae	0	0	0	0	11	0	0	0
Chelifera/Metachela	0	6	61	2	18	0	9	0
Dicranota	0	0	40	0	0	0	0	2
Hexatoma	32	0	20	0	4	81	9	5
Limnophora	0	0	20	0	0	0	0	0
Pericoma	22	0	484	16	83	0	0	10
Simulium	86	52	0	4	4	91	0	55
Stratiomyiidae	0	0	0	0	0	0	2	0
Tanyderidae	0	0	0	2	0	0	0	0
Tipula	0	0	0	0	0	0	16	0
Wiedemannia	0	0	0	0	0	0	20	2
TOTAL: DIPTERA	**183**	**81**	**2119**	**64**	**118**	**172**	**60**	**272**

APPENDIX E. (continued)

Taxon	Pacific Cr. Site - 9 16-Oct	Pacific Cr. Site - 10 16-Oct	Pacific Cr. Site - 11 16-Oct	Pilgrim Cr. Site - 12 17-Oct	Pilgrim Cr. Site - 13 17-Oct	Snake R. Site - 14 25-Oct	Spread Cr. Site - 15 21-Oct	Spread Cr. Site - 16 21-Oct
Cardiocladius	0	0	0	0	0	20	0	0
Chaetocladius	0	0	20	0	4	0	9	0
Chironomidae-pupae	0	17	363	20	14	71	9	22
Cladotanytarsus	0	0	0	0	0	20	0	0
Corynoneura	0	0	0	0	0	0	0	2
Cricotopus	0	0	0	0	0	0	15	13
Cricotopus Nostococladius	129	0	20	5	4	0	0	22
Diamesa	0	0	0	0	4	192	0	2
Eukiefferiella	0	0	40	2	4	10	2	0
Limnophyes	0	0	0	0	0	0	2	0
Micropsectra	0	0	0	4	0	0	7	0
Orthocladius	0	0	40	0	4	0	2	2
Orthocladius Complex	22	35	565	4	29	10	15	92
Orthocladius (Euorthocladius)	0	12	262	0	0	81	0	2
Parametriocnemus	0	0	0	0	0	0	2	0
Polypedilum	0	0	0	2	72	0	0	0
Potthastia Longimana Group	0	0	0	0	0	0	0	3
Rheocricotopus	0	0	0	0	0	0	2	0
Rheotanytarsus	0	0	0	0	4	0	0	27
Stempellina	11	0	20	2	11	0	0	0
Stempellinella	0	0	0	0	0	0	11	0
Sublettea	0	0	141	0	0	0	0	12
Symposiocladius	0	0	0	0	0	0	0	0
Tanytarsus	0	0	0	7	4	0	2	0
Thienemanniella	0	0	0	2	0	0	0	0
Thienemannimyia Complex	0	0	0	0	7	20	7	0
Tvetenia Bavarica Group	11	0	0	5	0	0	0	0
TOTAL: CHIRONOMIDAE	**172**	**63**	**1473**	**52**	**158**	**424**	**84**	**198**
GRAND TOTAL	**6768**	**3496**	**14731**	**1326**	**2323**	**7457**	**1352**	**1294**

APPENDIX F. Benthic invertebrate taxon and densities collected from sites 1 - 20 in YELL during the 2002 summer sampling period. Invertebrate densities are recorded in square meters. Stream name, site number, and date of collection are indicated for each site.

Taxon	Antelope Site - 1 14-Aug	Antelope Site - 2 13-Aug	Antelope Site - 3 14-Aug	Gardner Site - 4 21-Aug	Gardner Site - 5 21-Aug	Gardner Site - 6 12-Aug	Middle Site - 7 19-Aug	Middle Site - 8 19-Aug	Nez Perce Site - 9 22-Aug	Nez Perce Site - 10 22-Aug
Acari	18	13	71	19	97	5	3	6	1	0
Nematoda	0	0	20	0	5	0	0	0	0	0
Oligochaeta	4	3	40	0	11	11	0	0	8	0
Pisidium	0	0	0	0	0	0	0	0	0	1
Potamopyrgus antipodarum	0	0	0	13	0	0	0	0	23	53
Turbellaria	0	0	0	24	0	0	0	0	4	1
TOTAL: NON INSECTS	**22**	**16**	**131**	**56**	**113**	**16**	**3**	**6**	**36**	**55**
Argia	0	0	0	0	0	0	0	0	4	0
TOTAL: ODONATA	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**0**
Acentrella insignificans	0	0	0	54	65	0	0	0	0	0
Acentrella turbida	0	0	0	0	5	0	0	0	0	0
Ameletus	11	7	50	0	16	3	3	12	0	0
Attenella margarita	0	0	0	0	22	0	0	0	0	0
Baetidae	0	0	0	0	0	70	0	0	5	1
Baetis bicaudatus	224	69	71	0	0	0	0	0	0	0
Baetis tricaudatus	48	0	81	218	608	387	430	755	23	4
Caudatella hystrix	29	13	81	0	0	13	16	23	0	0
Cinygmula	4	36	61	0	38	8	54	109	0	0
Diphetor hageni	0	0	0	0	16	0	0	0	4	0
Drunella coloradensis/flavilinea	4	13	40	0	0	0	51	23	0	0
Drunella doddsi	18	79	373	0	38	105	186	501	0	0
Drunella grandis	0	0	50	0	81	32	8	81	0	0
Drunella spinifera	0	16	0	0	0	0	0	0	0	0
Epeorus albertae	0	0	10	0	0	16	196	357	3	5
Epeorus longimanus	18	0	20	0	0	11	5	17	0	0
Epeorus grandis	209	3	30	0	0	0	59	864	0	0
Ephemerella inermis	0	0	141	0	5	5	0	0	0	0
Ephemerella infrequens	4	26	0	0	0	0	0	0	0	0
Paraleptophlebia	4	7	0	0	5	3	0	0	0	0

APPENDIX F. (continued)

Taxon	Antelope Site - 1 14-Aug	Antelope Site - 2 13-Aug	Antelope Site - 3 14-Aug	Gardner Site - 4 21-Aug	Gardner Site - 5 21-Aug	Gardner Site - 6 12-Aug	Middle Site - 7 19-Aug	Middle Site - 8 19-Aug	Nez Perce Site - 9 22-Aug	Nez Perce Site - 10 22-Aug
Rhithrogena	4	16	10	0	161	16	194	248	0	0
Serratella tibialis	11	10	20	0	5	5	70	23	0	0
TOTAL: EPHEMEROPTERA	**587**	**296**	**1039**	**272**	**1065**	**675**	**1272**	**3012**	**35**	**11**
Capniidae	0	0	0	0	0	0	3	6	0	0
Chloroperlidae	4	0	0	0	0	0	24	0	0	0
Claassenia sabulosa	0	0	0	3	38	0	0	0	0	0
Doroneuria	29	26	121	0	0	5	0	0	0	0
Hesperoperla pacifica	0	0	0	3	38	5	0	0	3	0
Isoperla	4	0	0	3	0	0	0	0	0	0
Kogotus	0	0	0	0	0	0	5	0	0	0
Malenka	7	0	0	0	0	0	0	0	0	0
Megarcys	0	3	50	0	0	0	16	17	0	0
Paraperla	7	0	10	0	0	0	0	0	0	0
Perlodidae	4	7	0	0	0	0	5	40	0	0
Pteronarcys californica	0	0	0	13	22	0	0	0	4	1
Skwala	0	0	0	0	5	0	0	0	0	0
Sweltsa	29	76	151	3	11	67	54	46	0	0
Zapada cinctipes	33	3	10	0	16	0	3	0	0	0
Zapada columbiana	0	0	0	0	0	0	5	0	0	0
Zapada Oregonensis Group	4	3	10	0	0	0	22	17	0	0
TOTAL: PLECOPTERA	**121**	**118**	**353**	**24**	**129**	**78**	**137**	**127**	**7**	**1**
Apatania	4	0	10	0	0	0	16	6	0	0
Arctopsyche grandis	0	0	0	0	16	30	0	0	0	0
Brachycentrus americanus	0	0	0	3	5	19	3	6	3	0
Brachycentrus occidentalis	0	0	0	0	0	0	0	0	38	0
Culoptila	0	0	0	11	0	0	0	0	0	0
Chyranda centralis	0	3	0	0	0	0	0	0	0	0
Dicosmoecus atripes	4	0	10	0	0	0	0	6	0	0
Dolophilodes	77	30	61	0	0	5	0	0	0	0
Ecclisomyia	18	10	0	0	0	0	0	0	0	0

APPENDIX F. (continued)

Taxon	Antelope Site - 1 14-Aug	Antelope Site - 2 13-Aug	Antelope Site - 3 14-Aug	Gardner Site - 4 21-Aug	Gardner Site - 5 21-Aug	Gardner Site - 6 12-Aug	Middle Site - 7 19-Aug	Middle Site - 8 19-Aug	Nez Perce Site - 9 22-Aug	Nez Perce Site - 10 22-Aug
Glossosoma	70	69	50	48	344	116	24	69	1	0
Helicopsyche borealis	0	0	0	40	5	0	0	0	0	1
Hydropsyche	0	0	0	621	59	0	0	0	43	0
Hydroptila	0	0	0	16	5	0	0	0	0	3
Lepidostoma Pluviale Group	0	0	0	3	59	0	0	0	0	0
Micrasema	15	26	40	0	5	132	0	0	0	0
Neophylax	33	0	0	0	0	0	0	0	0	0
Ochrotrichia	0	3	0	0	5	0	0	0	0	0
Oligophlebodes	11	7	151	0	0	8	0	0	0	0
Parapsyche elsis	70	30	81	0	0	0	43	6	0	0
Protoptila	0	0	0	0	0	0	0	0	8	5
Rhyacophila Angelita Group	4	0	20	0	0	5	3	0	0	0
Rhyacophila Brunnea/Vemna Group	66	33	91	0	0	0	19	63	0	0
Rhyacophila Coloradensis Group	0	0	0	0	5	0	0	0	0	0
Rhyacophila Hyalinata Group	4	10	10	0	0	3	30	23	0	0
Rhyacophila Iranda Group	0	0	0	0	0	0	13	12	0	0
Rhyacophila narvae	4	0	0	0	0	0	0	0	0	0
Rhyacophila pellisa/valuma	4	3	50	0	0	0	5	6	0	0
Rhyacophila Sibirica Group	11	0	0	0	0	0	0	0	0	0
Wormaldia	0	0	0	0	0	0	0	0	3	3
TOTAL: TRICHOPTERA	**393**	**224**	**575**	**742**	**511**	**317**	**156**	**196**	**96**	**12**
Petrophila	0	0	0	5	0	0	0	0	0	0
TOTAL: LEPIDOPTERA	**0**	**0**	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**0**
Cleptelmis addenda	11	13	0	0	5	5	0	0	15	9
Dytiscidae	22	69	40	0	0	0	0	0	0	0
Heterlimnius	242	484	1695	0	27	132	0	0	0	0
Optioservus	0	0	0	307	845	59	0	0	93	23
Zaitzevia	0	0	0	0	0	0	0	0	1	0
TOTAL: COLEOPTERA	**275**	**566**	**1735**	**307**	**877**	**196**	**0**	**0**	**109**	**32**

APPENDIX F. (continued)

Taxon	Antelope Site - 1 14-Aug	Antelope Site - 2 13-Aug	Antelope Site - 3 14-Aug	Gardner Site - 4 21-Aug	Gardner Site - 5 21-Aug	Gardner Site - 6 12-Aug	Middle Site - 7 19-Aug	Middle Site - 8 19-Aug	Nez Perce Site - 9 22-Aug	Nez Perce Site - 10 22-Aug
Antocha	4	0	20	0	5	40	0	0	0	0
Atherix	0	0	0	5	5	0	0	0	0	0
Blephariceridae	0	0	0	0	0	0	0	6	0	0
Ceratopogoninae	4	7	10	0	0	0	0	0	0	0
Chelifera/Metachela	4	0	0	0	0	3	0	0	0	0
Clinocera	0	3	10	0	0	5	0	0	0	0
Deuterophlebia	0	0	0	0	0	3	3	12	0	0
Dicranota	0	0	0	0	0	0	0	0	0	0
Empididae	0	3	0	0	16	0	0	0	0	0
Glutops	0	3	10	0	0	0	0	0	0	0
Hexatoma	0	0	0	5	32	0	11	6	0	0
Pericoma	33	49	202	0	0	11	0	0	0	0
Prosimulium	18	0	0	0	0	0	0	0	0	0
Simulium	172	0	10	8	38	32	0	98	9	1
Tipula	0	0	0	0	0	0	0	6	0	0
Wiedemannia	0	3	0	0	0	0	0	0	0	0
TOTAL: DIPTERA	**235**	**69**	**262**	**19**	**97**	**94**	**13**	**127**	**9**	**1**
Brillia	7	3	0	0	0	0	0	0	0	0
Cardiocladius	0	0	0	35	5	0	0	0	0	0
Chaetocladius	0	0	0	0	0	0	0	6	0	0
Chironomidae-pupae	51	33	141	3	16	16	38	29	0	0
Cladotanytarsus	0	0	0	0	5	3	0	0	0	0
Corynoneura	0	20	50	0	0	3	0	0	0	0
Cricotopus	0	0	20	8	0	0	0	0	1	1
Cricotopus Nostococladius	0	0	0	0	0	0	67	346	0	0
Diamesa	0	3	0	0	0	5	0	0	0	0
Epoicocladius	0	0	0	0	11	0	0	0	0	0
Eukiefferiella	217	148	999	3	0	100	5	12	0	0
Eukiefferiella Devonica Group	33	43	30	3	0	3	5	0	0	0
Hydrobaenus	11	0	50	0	0	3	0	0	0	0

APPENDIX F. (continued)

Taxon	Antelope Site - 1 14-Aug	Antelope Site - 2 13-Aug	Antelope Site - 3 14-Aug	Gardner Site - 4 21-Aug	Gardner Site - 5 21-Aug	Gardner Site - 6 12-Aug	Middle Site - 7 19-Aug	Middle Site - 8 19-Aug	Nez Perce Site - 9 22-Aug	Nez Perce Site - 10 22-Aug
Micropsectra	246	122	101	0	16	19	11	6	0	0
Orthocladius	0	0	50	8	0	0	0	0	0	0
Orthocladius Complex	40	95	525	8	11	54	8	12	4	0
Orthocladius (Euorthocladius)	7	0	0	0	0	0	0	0	0	0
Pagastia	18	56	232	0	16	32	0	0	0	0
Parametriocnemus	0	3	0	0	0	0	0	0	0	0
Parorthocladius	7	0	50	0	0	0	0	0	0	0
Pentaneura	0	0	0	0	0	0	0	0	0	1
Polypedilum	0	0	0	19	5	5	0	0	0	0
Pseudochironomus	0	0	0	0	0	0	0	0	0	1
Pseudodiamesa	7	0	0	0	0	0	0	0	0	0
Rheocricotopus	7	33	212	0	0	5	0	12	0	0
Rheotanytarsus	0	7	0	3	0	0	0	0	0	0
Stempellinella	51	43	101	0	0	32	11	35	0	0
Stictochironomus	103	49	20	0	0	0	0	0	0	0
Sublettea	0	3	0	0	0	8	0	0	0	0
Tanytarsus	0	0	0	0	27	0	0	6	0	0
Thienemanniella	29	30	0	0	0	3	0	0	0	0
Tvetenia Bavarica Group	84	39	192	0	0	3	54	69	0	0
TOTAL: CHIRONOMIDAE	**921**	**730**	**2775**	**89**	**113**	**293**	**199**	**530**	**5**	**4**
GRAND TOTAL	**2554**	**2020**	**6871**	**1514**	**2905**	**1670**	**1781**	**3997**	**302**	**117**

APPENDIX F. (continued)

Taxon	Obsidian Site - 11 6-Aug	Obsidian Site - 12 7-Aug	Obsidian Site - 13 7-Aug	Obsidian Site - 14 13-Aug	Pebble Site - 15 16-Aug	Pebble Site - 16 16-Aug	Soda Butte Site - 17 16-Aug	Soda Butte Site - 18 20-Aug	Soda Butte Site - 19 20-Aug	unnamed Site - 20 19-Aug
Acari	17	0	0	0	12	12	30	3	75	135
Oligochaeta	13	8	0	0	0	6	0	0	0	13
Turbellaria	0	0	0	0	0	0	0	13	0	40
TOTAL: NON INSECTS	**30**	**8**	**0**	**0**	**12**	**19**	**30**	**16**	**75**	**188**
Argia	0	0	31	0	0	0	0	0	0	0
Libellulidae	0	0	1	0	0	0	0	0	0	0
TOTAL: ODONATA	**0**	**0**	**32**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Acentrella	0	0	0	0	2	0	0	0	0	0
Acentrella insignificans	3	4	0	0	0	0	0	0	0	0
Ameletus	0	6	0	0	9	6	0	0	0	27
Attenella margarita	3	2	0	0	0	0	0	0	0	0
Baetidae	0	0	0	0	2	0	0	0	0	0
Baetis tricaudatus	144	388	0	0	128	264	1503	404	1200	511
Caudatella hystrix	0	0	0	0	0	0	0	0	0	13
Cinygma	0	0	0	0	0	0	0	0	0	27
Cinygmula	0	2	0	0	40	112	40	56	32	94
Diphetor hageni	3	6	0	0	0	0	0	0	0	0
Drunella coloradensis/flavilinea	0	0	0	0	9	6	10	51	108	27
Drunella doddsi	0	16	0	0	9	28	20	358	732	40
Drunella grandis	7	0	0	0	2	0	1059	0	0	0
Drunella grandis/spinifera	0	22	0	0	0	0	0	0	0	0
Drunella spinifera	0	0	0	0	0	0	0	0	0	108
Epeorus albertae	0	2	0	0	12	31	30	5	151	202
Epeorus longimanus	0	0	0	0	33	0	0	0	0	27
Epeorus grandis	0	0	0	0	47	0	0	0	11	81
Ephemerella inermis	0	6	0	0	0	6	20	16	0	0
Ephemerella infrequens	0	0	0	0	0	0	0	0	0	282
Paraleptophlebia	0	89	0	0	0	0	0	0	0	0
Rhithrogena	20	32	0	0	114	121	837	105	97	40
Serratella tibialis	0	10	0	0	12	28	202	35	0	0

APPENDIX F. (continued)

Taxon	Obsidian Site - 11 6-Aug	Obsidian Site - 12 7-Aug	Obsidian Site - 13 7-Aug	Obsidian Site - 14 13-Aug	Pebble Site - 15 16-Aug	Pebble Site - 16 16-Aug	Soda Butte Site - 17 16-Aug	Soda Butte Site - 18 20-Aug	Soda Butte Site - 19 20-Aug	unnamed Site - 20 19-Aug
Timpanoga hecuba	0	0	0	0	0	0	10	0	0	0
TOTAL: EPHEMEROPTERA	**181**	**586**	**0**	**0**	**422**	**601**	**3733**	**1030**	**2330**	**1480**
Capniidae	0	0	0	0	0	6	0	0	0	13
Chloroperlidae	0	0	0	0	0	9	30	3	0	0
Claassenia sabulosa	7	8	0	0	0	0	0	0	0	0
Doroneuria	0	0	0	0	26	25	0	0	0	0
Hesperoperla pacifica	3	0	0	0	0	0	0	0	0	0
Isoperla	0	0	0	0	0	0	0	0	0	81
Kogotus	0	0	0	0	7	0	0	3	0	0
Megarcys	0	0	0	0	14	56	10	8	48	0
Perlodidae	7	14	0	0	21	6	10	0	0	13
Pteronarcella	0	0	0	0	0	0	293	3	0	0
Skwala	0	0	0	0	0	0	20	0	0	0
Sweltsa	84	55	0	0	26	37	10	5	11	67
Yoraperla	0	0	0	0	0	0	0	0	0	13
Zapada cinctipes	0	0	0	0	0	0	0	0	0	135
Zapada columbiana	0	0	0	0	2	3	0	0	11	1278
Zapada Oregonensis Group	0	0	0	0	12	19	0	5	22	27
TOTAL: PLECOPTERA	**101**	**77**	**0**	**0**	**109**	**161**	**373**	**27**	**91**	**1627**
Apatania	0	0	0	0	5	59	414	54	48	40
Arctopsyche grandis	0	32	0	0	0	0	81	0	0	0
Brachycentrus americanus	0	18	0	0	19	6	91	11	0	0
Dicosmoecus atripes	0	0	0	0	0	0	0	0	0	13
Glossosoma	10	42	0	0	2	19	40	143	32	0
Hydropsyche	0	2	0	0	0	0	0	0	0	0
Hydroptila	3	0	0	0	0	0	0	0	0	0
Lepidostoma Pluviale Group	0	22	0	0	0	0	0	0	0	0
Micrasema	13	4	0	0	0	12	0	0	0	0
Neophylax	0	10	0	0	0	0	0	0	0	0
Neothremma	0	0	0	0	2	0	0	0	0	121

APPENDIX F. (continued)

Taxon	Obsidian Site - 11 6-Aug	Obsidian Site - 12 7-Aug	Obsidian Site - 13 7-Aug	Obsidian Site - 14 13-Aug	Pebble Site - 15 16-Aug	Pebble Site - 16 16-Aug	Soda Butte Site - 17 16-Aug	Soda Butte Site - 18 20-Aug	Soda Butte Site - 19 20-Aug	unnamed Site - 20 19-Aug
Oligophlebodes	0	0	0	0	7	0	0	0	0	0
Onocosmoecus unicolor	0	0	0	0	0	0	10	0	0	0
Oxyethira	3	0	4	0	0	0	0	0	0	0
Parapsyche elsis	0	0	0	0	14	6	0	3	38	27
Rhyacophila	0	0	0	0	0	0	0	0	0	27
Rhyacophila Angelita Group	0	0	0	0	0	0	0	13	0	0
Rhyacophila Betteni Group	0	0	0	0	0	16	0	0	0	188
Rhyacophila Brunnea/Vemna Group	0	0	0	0	5	16	0	11	0	27
Rhyacophila Hyalinata Group	0	0	0	0	7	19	0	13	22	0
Rhyacophila Iranda Group	0	0	0	0	0	6	0	0	48	67
Rhyacophila pellisa/valuma	0	0	0	0	0	3	0	0	0	13
Rhyacophila verrula	0	0	0	0	0	0	0	3	0	0
TOTAL: TRICHOPTERA	**30**	**131**	**4**	**0**	**62**	**161**	**636**	**250**	**188**	**525**
Brychius	3	0	0	0	0	0	0	0	0	0
Cleptelmis addenda	24	4	0	0	0	0	0	0	0	0
Dytiscidae	0	10	0	0	0	0	0	0	0	0
Heterlimnius	0	0	0	0	24	47	0	0	0	0
Hydrophilidae	0	0	1	11	0	0	0	0	0	0
Narpus	3	0	0	0	0	0	0	0	0	0
Optioservus	1028	697	0	0	0	0	0	0	0	0
Zaitzevia	0	2	0	0	0	0	0	0	0	0
TOTAL: COLEOPTERA	**1058**	**713**	**1**	**11**	**24**	**47**	**0**	**0**	**0**	**0**
Atherix	0	0	0	0	0	0	30	5	0	0
Ceratopogoninae	3	0	1	0	2	6	0	3	0	0
Chelifera/Metachela	0	0	0	0	2	16	0	0	0	0
Clinocera	0	0	0	0	2	22	10	0	5	27
Dixa	0	0	0	0	0	0	0	0	0	13
Empididae	0	0	0	0	2	0	0	0	0	27
Glutops	0	0	0	0	0	0	0	0	0	40
Hexatoma	7	0	0	0	2	3	10	3	0	0

APPENDIX F. (continued)

Taxon	Obsidian Site - 11 6-Aug	Obsidian Site - 12 7-Aug	Obsidian Site - 13 7-Aug	Obsidian Site - 14 13-Aug	Pebble Site - 15 16-Aug	Pebble Site - 16 16-Aug	Soda Butte Site - 17 16-Aug	Soda Butte Site - 18 20-Aug	Soda Butte Site - 19 20-Aug	unnamed Site - 20 19-Aug
Limonia	0	0	0	0	0	0	0	0	0	13
Maruina	0	0	0	0	0	0	0	0	0	0
Pericoma	0	0	0	0	7	6	0	8	0	13
Prosimulium	0	0	0	0	5	3	0	0	0	0
Rhabdomastix	0	0	0	0	0	0	0	3	0	0
Simulium	155	10	0	0	5	0	10	0	5	0
Tabanidae	3	0	0	0	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0	0	0	5	0
Wiedemannia	0	0	0	0	0	0	0	0	0	40
TOTAL: DIPTERA	**168**	**10**	**1**	**0**	**28**	**56**	**61**	**22**	**16**	**175**
Brillia	0	0	0	0	5	0	0	0	0	0
Boreoheptagyia	0	0	0	0	0	0	0	0	0	13
Chironomidae-pupae	7	20	1	194	95	50	91	19	54	54
Chironomus	0	0	72	5305	0	0	0	0	0	0
Cladotanytarsus	3	8	0	0	0	0	0	0	0	0
Corynoneura	7	10	0	0	5	6	0	0	0	54
Cricotopus	0	0	0	0	14	9	0	0	0	0
Cricotopus Bicinctus Group	3	0	0	0	0	0	0	0	0	0
Cricotopus Nostococladius	0	0	0	0	5	12	0	11	0	525
Diamesa	0	0	0	0	14	53	0	0	16	0
Eukiefferiella	7	8	1	0	5	6	61	8	5	673
Eukiefferiella Devonica Group	0	0	0	0	0	0	0	0	0	390
Heterotrissocladius	3	0	0	0	0	0	0	0	0	0
Hydrobaenus	0	0	0	0	50	0	10	0	0	0
Micropsectra	50	22	0	0	24	34	20	0	0	0
Orthocladius	3	0	0	0	5	0	10	0	0	40
Orthocladius Complex	0	6	0	0	429	347	101	27	32	0
Orthocladius (Euorthocladius)	0	0	0	0	9	9	0	0	0	0
Pagastia	7	10	0	0	9	19	81	3	32	108
Parakiefferiella	7	0	0	0	0	0	0	0	0	0

APPENDIX F. (continued)

Taxon	Obsidian Site - 11 6-Aug	Obsidian Site - 12 7-Aug	Obsidian Site - 13 7-Aug	Obsidian Site - 14 13-Aug	Pebble Site - 15 16-Aug	Pebble Site - 16 16-Aug	Soda Butte Site - 17 16-Aug	Soda Butte Site - 18 20-Aug	Soda Butte Site - 19 20-Aug	unnamed Site - 20 19-Aug
Parametriocnemus	3	0	0	0	0	0	0	0	0	0
Polypedilum	0	4	0	0	0	0	0	0	0	0
Rheocricotopus	0	0	0	0	0	25	0	0	0	0
Rheotanytarsus	0	2	0	0	0	0	0	0	0	0
Stempellinella	20	22	0	0	55	81	0	0	0	0
Tanytarsus	47	0	0	0	0	0	0	0	0	0
Thienemanniella	0	0	0	0	0	0	0	0	0	94
Thienemannimyia Complex	17	0	0	0	0	0	0	0	0	0
Tvetenia Bavarica Group	10	83	0	0	102	127	30	5	22	1385
TOTAL: CHIRONOMIDAE	**195**	**196**	**74**	**5498**	**825**	**778**	**404**	**73**	**161**	**3336**
GRAND TOTAL	**1764**	**1721**	**113**	**5509**	**1481**	**1823**	**5237**	**1418**	**2862**	**7330**

APPENDIX G. Benthic invertebrate taxon and densities collected from sites 1 - 20 in YELL during the 2002 fall sampling period. Invertebrate densities are recorded in square meters. Stream name, site number, and date of collection are indicated for each site.

Taxon	Antelope Site - 1 8-Oct	Antelope Site - 2 8-Oct	Antelope Site - 3 8-Oct	Gardner Site - 4 13-Nov	Gardner Site - 5 7-Nov	Gardner Site - 6 6-Nov	Middle Site - 7 9-Oct	Middle Site - 8 9-Oct	Nez Perce Site - 9 7-Oct	Nez Perce Site - 10 7-Oct
Acari	27	20	0	545	344	48	0	20	15	5
Hyalella	0	0	0	0	0	0	0	0	86	0
Nematoda	0	0	0	40	129	27	0	0	4	0
Oligochaeta	7	0	10	20	183	70	6	0	20	1
Pisidium	0	0	0	0	0	0	0	0	58	0
Potamopyrgus antipodarum	0	0	0	484	0	0	0	0	58	85
Turbellaria	7	0	0	585	11	5	12	10	9	1
Unionacea	0	0	0	0	0	0	0	0	1	0
TOTAL: NON INSECTS	**40**	**20**	**10**	**1675**	**667**	**151**	**17**	**30**	**252**	**93**
Argia	0	0	0	0	0	0	0	0	18	9
Coenagrionidae	0	0	0	0	0	0	0	0	3	0
Libellulidae	0	0	0	0	0	0	0	0	8	0
Ophiogomphus	0	0	0	0	0	0	0	0	0	1
TOTAL: ODONATA	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**28**	**11**
Ameletus	13	61	121	0	11	5	23	262	0	0
Baetidae	0	0	0	0	0	0	0	0	39	7
Baetis bicaudatus	0	636	0	0	0	0	17	237	0	0
Baetis tricaudatus	74	30	646	2038	699	269	346	0	77	55
Caudatella hystrix	61	192	121	0	22	317	109	45	0	0
Cinygmula	155	202	595	0	65	70	357	670	0	0
Diphetor hageni	0	50	10	0	22	5	0	0	0	1
Drunella coloradensis/flavilinea	13	91	151	0	0	0	6	15	0	0
Drunella doddsi	61	172	151	0	11	108	150	181	0	0
Drunella grandis	0	0	0	0	11	27	6	50	0	0
Drunella grandis/spinifera	0	0	10	0	0	0	0	0	0	0
Drunella spinifera	0	50	0	0	0	0	0	0	0	0
Epeorus	0	10	0	61	97	0	0	5	5	19
Epeorus longimanus	0	0	0	0	0	5	0	0	0	0
Epeorus grandis	108	20	0	0	0	11	81	71	0	0
Ephemerella inermis	269	918	1019	161	312	274	271	418	0	3
Rhithrogena	7	20	0	141	129	54	1025	509	0	0
Tricorythodes minutus	0	0	0	0	0	0	0	0	1	0
TOTAL: EPHEMEROPTERA	**760**	**2452**	**2825**	**2401**	**1377**	**1146**	**2390**	**2465**	**123**	**85**

APPENDIX G. (continued)

Taxon	Antelope Site - 1 8-Oct	Antelope Site - 2 8-Oct	Antelope Site - 3 8-Oct	Gardner Site - 4 13-Nov	Gardner Site - 5 7-Nov	Gardner Site - 6 6-Nov	Middle Site - 7 9-Oct	Middle Site - 8 9-Oct	Nez Perce Site - 9 7-Oct	Nez Perce Site - 10 7-Oct
Capniidae	13	10	30	0	22	5	6	5	0	0
Chloroperlidae	13	0	10	0	0	0	17	5	0	0
Claassenia sabulosa	0	0	0	20	22	0	0	0	0	0
Doroneuria	155	101	50	0	0	32	0	0	0	0
Hesperoperla pacifica	0	0	0	20	11	5	0	0	5	8
Isoperla	0	0	0	0	11	16	0	10	1	0
Megarcys	0	0	0	0	0	0	40	15	0	0
Paraperla	0	0	10	0	0	0	0	0	0	0
Perlodidae	7	20	40	0	11	0	86	50	0	0
Pteronarcys californica	0	0	0	20	22	0	0	0	1	4
Skwala	0	0	0	0	0	5	0	0	0	0
Sweltsa	121	151	111	0	0	59	219	116	0	0
Taeniopterygidae	20	0	10	0	97	5	346	136	0	0
Zapada cinctipes	767	283	30	0	11	48	46	81	0	0
Zapada columbiana	0	0	0	0	0	0	6	5	0	0
Zapada Oregonensis Group	108	81	71	0	0	0	29	50	0	0
TOTAL: PLECOPTERA	**1205**	**646**	**363**	**61**	**204**	**178**	**795**	**474**	**8**	**12**
Agapetus	54	0	0	0	0	0	0	0	0	0
Anagapetus	0	0	101	0	0	0	0	0	0	0
Apatania	0	0	0	0	0	0	0	5	0	0
Arctopsyche grandis	0	0	0	0	11	38	0	35	0	0
Brachycentrus americanus	0	0	0	161	108	81	6	0	0	0
Brachycentrus occidentalis	0	0	0	0	0	0	0	0	81	7
Culoptila	0	0	0	0	0	0	0	0	4	8
Chimarra	0	0	0	0	0	0	0	0	16	0
Dicosmoecus atripes	7	0	0	0	0	0	0	0	0	0
Dicosmoecus gilvipes	0	0	0	0	0	5	0	0	0	0
Dolophilodes	54	10	0	0	0	22	0	0	0	0
Ecclisomyia	0	10	0	0	0	0	0	0	0	0
Glossosoma	20	40	20	565	312	656	58	176	4	1
Helicopsyche borealis	0	0	0	464	11	0	0	0	14	1
Hydropsyche	0	0	0	6801	151	0	0	0	142	117
Hydroptila	0	10	0	40	0	0	0	0	24	16

APPENDIX G. (continued)

Taxon	Antelope Site - 1 8-Oct	Antelope Site - 2 8-Oct	Antelope Site - 3 8-Oct	Gardner Site - 4 13-Nov	Gardner Site - 5 7-Nov	Gardner Site - 6 6-Nov	Middle Site - 7 9-Oct	Middle Site - 8 9-Oct	Nez Perce Site - 9 7-Oct	Nez Perce Site - 10 7-Oct
Lepidostoma cascadense	0	20	0	0	0	0	0	0	0	0
Lepidostoma Pluviale Group	0	10	0	646	1356	0	0	0	0	0
Micrasema	27	81	61	40	32	334	0	0	1	1
Neophylax	13	0	10	0	0	0	0	0	0	0
Oligophlebodes	141	283	20	0	0	48	236	277	0	0
Parapsyche elsis	269	40	10	0	0	0	63	45	0	0
Protoptila	0	0	0	40	0	0	0	0	4	4
Rhyacophila	7	10	0	0	0	0	17	0	0	0
Rhyacophila Brunnea/Vemna Group	81	30	20	0	0	11	12	30	0	0
Rhyacophila Coloradensis Group	0	0	0	61	22	54	6	0	0	0
Rhyacophila Hyalinata Group	7	91	0	0	0	11	17	15	0	0
Rhyacophila Iranda Group	0	0	0	0	0	0	6	0	0	0
Rhyacophila narvae	27	10	20	0	0	5	0	5	0	0
Rhyacophila pellisa/valuma	7	20	20	0	0	16	12	35	0	0
Wormaldia	0	0	0	0	0	0	0	0	3	5
TOTAL: TRICHOPTERA	**713**	**666**	**283**	**8819**	**2001**	**1280**	**432**	**625**	**293**	**162**
Cleptelmis addenda	20	0	0	0	11	102	0	0	16	82
Heterlimnius	1084	1786	1352	0	11	81	6	5	0	0
Lara	0	0	0	0	11	5	0	0	0	0
Microcylloepus	0	0	0	0	0	0	0	0	1	0
Optioservus	0	0	0	2038	1302	54	0	0	123	108
Zaitzevia	0	0	0	0	0	0	0	0	5	4
TOTAL: COLEOPTERA	**1104**	**1786**	**1352**	**2038**	**1334**	**242**	**6**	**5**	**146**	**194**
Antocha	114	272	272	323	97	183	0	0	0	1
Atherix	0	0	0	20	0	0	0	0	0	0
Blephariceridae	0	0	0	0	0	0	0	0	1	0
Ceratopogoninae	7	20	10	0	0	0	0	0	0	0
Chelifera/Metachela	7	0	0	0	0	5	6	0	0	0
Clinocera	0	0	0	0	0	11	0	0	0	0
Deuterophlebia	0	0	0	0	0	0	0	0	0	3
Dicranota	0	0	0	0	0	5	0	10	0	0
Glutops	34	30	0	0	0	0	0	0	3	0
Hemerodromia	0	0	0	0	0	0	0	0	0	3

APPENDIX G. (continued)

Taxon	Antelope Site - 1 8-Oct	Antelope Site - 2 8-Oct	Antelope Site - 3 8-Oct	Gardner Site - 4 13-Nov	Gardner Site - 5 7-Nov	Gardner Site - 6 6-Nov	Middle Site - 7 9-Oct	Middle Site - 8 9-Oct	Nez Perce Site - 9 7-Oct	Nez Perce Site - 10 7-Oct
Hesperoconopa	7	0	0	0	0	0	6	0	0	0
Hexatoma	0	0	0	61	11	5	17	5	0	0
Maruina	0	0	0	0	11	0	0	0	0	0
Pericoma	397	686	494	0	0	22	12	40	0	0
Prosimulium	7	0	0	0	0	11	0	0	0	0
Simulium	13	0	0	0	0	5	12	5	12	7
Wiedemannia	13	40	0	0	0	0	0	0	0	0
TOTAL: DIPTERA	**599**	**1049**	**777**	**404**	**118**	**247**	**52**	**60**	**16**	**14**
Brillia	7	10	0	0	0	0	0	5	0	0
Chaetocladius	0	0	0	0	22	0	23	0	0	0
Chironomidae-pupae	168	151	81	0	11	5	0	5	0	0
Cladotanytarsus	0	0	0	0	32	32	0	0	0	0
Cricotopus Bicinctus Group	0	0	0	0	0	0	0	0	1	0
Cricotopus Nostococladius	0	0	0	0	0	16	530	222	0	1
Diamesa	27	40	121	61	344	0	0	0	0	0
Eukiefferiella	47	262	30	424	65	646	17	10	0	0
Eukiefferiella Devonica Group	7	0	0	121	0	0	0	0	0	0
Heleniella	0	0	0	0	11	0	0	0	0	0
Hydrobaenus	7	0	0	0	0	0	0	0	0	0
Micropsectra	0	0	10	0	129	59	98	35	0	0
Orthocladius	195	131	10	20	86	0	0	0	0	0
Orthocladius Complex	87	484	272	141	377	48	6	0	1	1
Orthocladius (Euorthocladius)	182	50	121	0	0	0	0	0	0	0
Pagastia	0	0	0	141	22	97	0	0	0	0
Parorthocladius	13	0	0	0	0	0	0	0	0	0
Pentaneura	0	0	0	0	0	0	0	0	1	0
Polypedilum	0	0	10	0	43	11	0	0	0	0
Procladius	0	0	0	0	0	0	0	0	3	0
Pseudochironomus	0	0	0	0	0	0	0	0	12	0
Pseudodiamesa	0	0	0	0	22	0	0	0	0	0
Rheocricotopus	0	0	0	0	0	0	0	5	0	0
Rheotanytarsus	101	283	10	0	0	16	0	0	1	0
Stempellina	0	0	0	0	0	0	6	0	0	0

APPENDIX G. (continued)

Taxon	Antelope Site - 1 8-Oct	Antelope Site - 2 8-Oct	Antelope Site - 3 8-Oct	Gardner Site - 4 13-Nov	Gardner Site - 5 7-Nov	Gardner Site - 6 6-Nov	Middle Site - 7 9-Oct	Middle Site - 8 9-Oct	Nez Perce Site - 9 7-Oct	Nez Perce Site - 10 7-Oct
Stictochironomus	0	0	30	0	0	0	0	0	0	0
Tanytarsus	0	0	0	0	0	27	0	0	0	0
Thienemanniella	27	10	0	0	0	0	0	0	5	1
Thienemannimyia Complex	0	0	0	0	43	0	0	0	0	0
Tvetenia Bavarica Group	0	0	0	20	0	11	12	20	0	1
Zavrelimyia	0	0	0	0	0	0	0	5	0	0
TOTAL: CHIRONOMIDAE	**868**	**1423**	**696**	**928**	**1205**	**968**	**691**	**307**	**26**	**5**
GRAND TOTAL	**5290**	**8042**	**6306**	**16326**	**6908**	**4213**	**4383**	**3966**	**892**	**576**

APPENDIX G. (continued)

Taxon	Obsidian Site - 11 7-Nov	Obsidian Site - 12 6-Nov	Obsidian Site - 13 12-Nov	Obsidian Site - 14 12-Nov	Pebble Site - 15	Pebble Site - 16	Soda Butte Site - 17 5-Nov	Soda Butte Site - 18	Soda Butte Site - 19	unnamed Site - 20 9-Oct
Acari	9	0	0	0			16			121
Nematoda	0	0	0	0			0			13
Oligochaeta	9	101	0	0			11			20
Pisidium	9	0	0	0			0			0
Turbellaria	0	0	0	0			22			7
TOTAL: NON INSECTS	**27**	**101**	**0**	**0**			**48**			**162**
Argia	0	0	669	0			0			0
TOTAL: ODONATA	**0**	**0**	**669**	**0**			**0**			**0**
Ameletus	13	10	0	0			0			202
Baetidae	4	0	0	0			0			0
Baetis tricaudatus	72	737	0	0			5			128
Caudatella hystrix	0	20	0	0			0			0
Cinygma	0	0	0	0			0			27
Cinygmula	81	1423	0	1			581			67
Diphetor hageni	13	20	0	0			0			13
Drunella coloradensis/flavilinea	0	0	0	0			5			121
Drunella doddsi	0	40	0	0			22			7
Drunella grandis	0	10	0	0			22			0
Drunella spinifera	0	0	0	0			0			54
Epeorus	4	232	0	0			0			0
Ephemerella inermis	13	434	0	0			156			0
Ephemerella infrequens	0	0	0	0			0			128
Paraleptophlebia	27	545	0	0			0			0
Rhithrogena	108	313	0	0			1280			27
TOTAL: EPHEMEROPTERA	**336**	**3784**	**0**	**1**			**2071**			**774**
Capniidae	4	10	0	0			27			27
Chloroperlidae	4	20	0	0			81			13
Claassenia sabulosa	18	30	0	0			0			0
Cultus	0	10	0	0			0			0
Hesperoperla pacifica	4	20	0	0			0			0
Isoperla	9	0	0	0			0			101
Megarcys	0	0	0	0			0			13
Perlodidae	4	10	0	0			0			81

APPENDIX G. (continued)

Taxon	Obsidian Site - 11 7-Nov	Obsidian Site - 12 6-Nov	Obsidian Site - 13 12-Nov	Obsidian Site - 14 12-Nov	Pebble Site - 15	Pebble Site - 16	Soda Butte Site - 17 5-Nov	Soda Butte Site - 18	Soda Butte Site - 19	unnamed Site - 20 9-Oct
Pteronarcella	0	0	0	0			48			0
Skwala	0	10	0	0			5			0
Sweltsa	81	293	0	0			75			0
Taeniopterygidae	0	0	0	0			27			0
Yoraperla	0	0	0	0			0			81
Zapada cinctipes	0	20	0	0			0			559
Zapada columbiana	0	0	0	0			0			626
Zapada Oregonensis Group	0	0	0	0			0			34
TOTAL: PLECOPTERA	**125**	**424**	**0**	**0**			**264**			**1534**
Agraylea	4	0	0	0			0			0
Anagapetus	0	0	0	0			0			67
Apatania	0	0	0	0			156			0
Arctopsyche grandis	0	20	0	0			11			0
Brachycentrus americanus	76	131	0	0			16			0
Chyranda centralis	0	0	0	0			0			128
Glossosoma	94	202	0	0			651			13
Hydropsyche	0	121	0	0			0			0
Lepidostoma ?hoodi	0	0	0	0			0			13
Lepidostoma Pluviale Group	22	615	0	0			0			0
Micrasema	22	20	0	0			0			0
Neothremma	0	0	0	0			0			114
Oxyethira	4	0	57	54			0			0
Parapsyche elsis	0	0	0	0			0			74
Rhyacophila	4	0	0	0			0			27
Rhyacophila Betteni Group	0	0	0	0			0			128
Rhyacophila Brunnea/Vemna Group	4	0	0	0			0			13
Rhyacophila Iranda Group	0	0	0	0			0			7
Rhyacophila pellisa/valuma	0	0	0	0			0			7
TOTAL: TRICHOPTERA	**233**	**1110**	**57**	**54**			**834**			**592**
Brychius	4	0	0	0			0			0
Dytiscidae	0	0	0	0			5			0
Heterlimnius	0	0	0	0			16			0
Hydrophilidae	0	0	0	8			0			0

APPENDIX G. (continued)

Taxon	Obsidian Site - 11 7-Nov	Obsidian Site - 12 6-Nov	Obsidian Site - 13 12-Nov	Obsidian Site - 14 12-Nov	Pebble Site - 15	Pebble Site - 16	Soda Butte Site - 17 5-Nov	Soda Butte Site - 18	Soda Butte Site - 19	unnamed Site - 20 9-Oct
Optioservus	444	1120	0	0			0			0
TOTAL: COLEOPTERA	**448**	**1120**	**0**	**8**			**22**			**0**
Antocha	4	20	0	0			0			0
Atherix	0	0	0	0			11			0
Ceratopogoninae	0	10	32	8			0			0
Chelifera/Metachela	0	0	0	0			11			20
Dicranota	0	0	0	0			5			13
Ephydridae	0	0	0	5			0			0
Empididae	0	0	0	0			0			7
Glutops	0	0	0	0			0			94
Hexatoma	18	20	0	0			27			0
Limnophila	9	0	0	0			0			0
Pericoma	0	40	0	0			0			74
Prosimulium	0	20	0	0			0			0
Simulium	13	30	0	0			0			13
Tipula	0	10	0	0			0			7
Wiedemannia	0	0	0	0			0			47
TOTAL: DIPTERA	**45**	**151**	**32**	**14**			**54**			**276**
Brillia	0	0	0	0			0			7
Chaetocladius	0	0	0	0			43			7
Chironomidae-pupae	0	0	14	1			5			13
Cladotanytarsus	1245	131	0	0			0			0
Cricotopus	22	0	0	0			0			0
Cricotopus Nostococladius	0	0	0	0			0			87
Diamesa	22	10	0	0			0			0
Eukiefferiella	72	151	568	0			0			155
Eukiefferiella Devonica Group	0	0	0	0			0			34
Heleniella	0	0	0	0			0			13
Micropsectra	202	656	0	0			27			606
Microtendipes	13	0	0	0			0			0
Orthocladius	0	0	0	0			5			0
Orthocladius Complex	36	30	0	0			0			0
Orthocladius (Euorthocladius)	0	10	0	0			0			0

APPENDIX G. (continued)

Taxon	Obsidian Site - 11 7-Nov	Obsidian Site - 12 6-Nov	Obsidian Site - 13 12-Nov	Obsidian Site - 14 12-Nov	Pebble Site - 15	Pebble Site - 16	Soda Butte Site - 17 5-Nov	Soda Butte Site - 18	Soda Butte Site - 19	unnamed Site - 20 9-Oct
Pagastia	0	10	0	0			22			121
Parametriocnemus	0	0	0	0			0			13
Paraphaenocladius	0	0	0	0			0			13
Polypedilum	0	20	0	0			0			0
Rheocricotopus	0	0	0	0			0			27
Rheotanytarsus	202	0	0	0			0			0
Stempellina	0	10	0	0			0			155
Tanytarsus	0	0	0	0			5			0
Thienemannimyia Complex	0	10	12	0			5			0
Tvetenia Bavarica Group	0	30	0	0			0			34
TOTAL: CHIRONOMIDAE	**1814**	**1070**	**594**	**1**			**113**			**1285**
GRAND TOTAL	**3028**	**7759**	**1351**	**78**			**3406**			**4624**