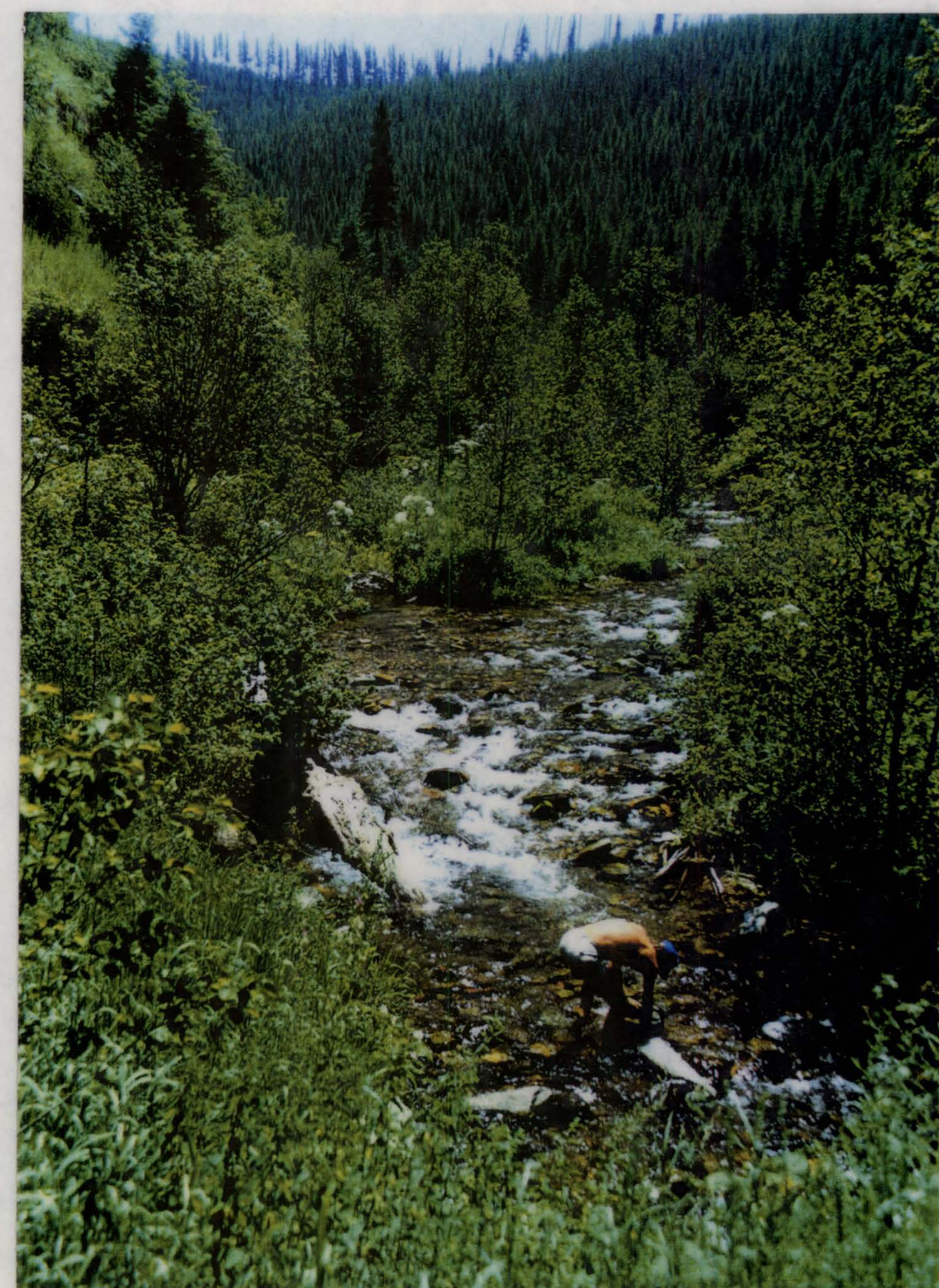
EFFECT OF PLACER MINING ON SELECTED STREAMS IN THE WALLACE RANGER DISTRICT OF IDAHO



Cinnamon Creek, Panhandle National Forest

By
Wade K. Hoiland and Fred W. Rabe
Department of Biological Sciences
University of Idaho

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INTRODUCTION

The original objective of this study in the Wallace Ranger District was to collect baseline data from selected stations on Tributary Creek and E. Fork Eagle Creek before placer mining operations were to begin and to measure any impact that might occur relating to physical, chemical, and biotic conditions following mining operations. West Fork Eagle Creek, not impacted by placer mining in the past, was to serve as a control.

Once we understood that the mining was to be postponed or curtailed altogether, we shifted the emphasis of the study to compare what effect placer operations had in the past on biotic conditions in E. Fork Eagle Creek and Tributary Creek as compared to the West Fork. We added Prichard Creek as another stream in an adjacent drainage that had also been placer mined.

After the first set of data was collected in June 1990, we discovered that the West Fork was not a suitable control due to a number of adverse conditions among which was the proximity of the road and the low gradient at an upstream station. As a result we selected sites on five streams outside the E. Fork Eagle Creek-Prichard Creek drainage as reference streams or controls. These locations were much improved over the West Fork since they exhibited a steeper gradient and little or no impact such as mining, logging, or road building had occurred in the drainage. Two of these reference streams were used as comparisons in our September sampling period to the three streams which had been placer mined in the past.

AREA DESCRIPTION

Four streams located in the Wallace Ranger District (Panhandle National Forest) were sampled during the months of June and September, 1990. Tributary Creek empties into East Fork Eagle Creek which merges with West Fork Eagle Creek to form Eagle Creek. Eagle Creek drains into Prichard Creek which flows into the North Fork of the Coeur d'Alene River just northeast of Prichard (Fig. 1). Station descriptions are provided in Table 1.

Samples were also collected from a single station at five separate reference streams located northwest of the study site in the Panhandle National Forest (Table 2). Collections from these reference streams were made only in September.

The study streams are all third or fourth order. East Fork of Eagle Creek and Prichard Creek have both been placer mined over the past century. The Jack Waite Mine is located upstream from Station 1 on Tributary Creek. Presently the mine is not operative, however concentrations of zinc, lead, mercury, and iron have been measured from runoff of tailings into the creek (U.S.F.S. files, 1977).

The five reference streams are the Upper Coeur d'Alene River, Jordan Creek, Alden Creek, Deer Creek, and Cinnamon Creek which are tributaries to the Coeur d'Alene River. These sites have not been impacted by mining or logging and are all third to fifth order streams.

Station 10 on West Fork of Eagle Creek was used in June as a reference station, but in September was unlike other stream reaches in the study. The site had mostly stretches of slow moving water as compared to few riffle areas. Station 11, 3 km below station 10, contains suitable riffle area but has been impacted somewhat by mining and logging in the Cottonwood Creek drainage. Cottonwood Creek flows into West Fork below station 10. A road adjacent to station 11 has also caused sedimentation problems.

METHODOLOGY

Eight stations, each consisting of a 20 m riffle, were established: one station on Tributary Cr. 100 m above the confluence with E.F. Eagle Cr., six sites on E.F. Eagle, two sites on W.F. Eagle, one of which was not used, two sites on Prichard Cr., one location 100 m above the confluence with Eagle Cr. and one station 400 m below the confluence with Eagle Cr. In addition, one station was established at each reference stream during the September sampling date. (Fig 1)

Sampling was performed on June 20-21 and September 15-16. Dates were chosen based on predicted stream flows. Residual spring runoff occurred during June sampling whereas the streams were at low flow level during the September date.

Water chemistries measured were alkalinity, conductivity, pH, and zinc concentration. Physical characteristics sampled were depth, width and velocity.

Alkalinity was performed by titrating with 0.02 N sulfuric acid using methyl orange as an indicator. Conductivity was taken using a YSI Model 33 conductivity meter. For heavy metals, nitric acid was added to the sample and later measured by atomic absorption spectrophotometry at the University of Idaho Veterinary

Science Laboratory and State Department of Environmental Quality in Coeur d'Alene, Idaho. The pH was determined in the lab using an electronic pH meter.

A transect was taken across the widest section of the stream reach and depth and velocity measured at 1/4, 1/2, and 3/4 the distance across. Velocity was determined using a Gurly current meter (Table 3).

Five replicate samples were collected randomly at each station within a two day period using a 0.093 m^2 Hess benthic sampler fitted with a 0.4 mm mesh net. Samples were preserved in 80% ethanol, organisms hand sorted in lab, and identified to at least genus. Chironomidae was an exception which was identified to subfamily (Merritt and Cummins 1984).

Habitat assessment was done using the Macroinvertebrate Rapid Bioassessment Protocols (MRBP) (Plafkin et al. 1989). This procedure involves determining bottom substrate composition which is the percent of bottom substrate composed of boulders, cobble, gravel and fine sediments, embeddedness which is a measure of sediments surrounding cobble and gravel, channel alteration, bank stability, and streamside cover.

In order to emphasize the most important parameters, various habitat metrics are weighed. A final habitat ranking for each station is accomplished by totaling and comparing ratings to reference streams (Tables 4 - 6).

A biotic index of stream macroinvertebrate communities was calculated using the MRBP. A brief description of metrics used follows:

TAXA RICHNESS - measurement of how many taxa are present in the sample. More taxa usually reflect a healthier community.

HILSENHOFF BIOTIC INDEX- measurement of species sensitivity to pollutants. Higher number indicates increased tolerance.

RATIO OF SCRAPERS AND COLLECTOR FILTERERS- high counts of collector-filterers indicate a switch from a periphyton food source such as diatoms to fine particulate organic matter (FPOM).

RATIO OF EPHEMEROPTERA, PLECOPTERA, TRICHOPTERA (EPT) AND CHIRONOMIDAE ABUNDANCES - Streams which are represented well by EPT groups are usually considered less impacted than a stream which has high densities of Diptera larvae.

PERCENT CONTRIBUTION OF DOMINANT GROUP - A community dominated by a few species usually indicates environmental stress within the community.

EPT INDEX - The number of taxa within these three groups generally increase in streams with high biotic indexes. These three groups are considered to be the most sensitive to impact.

COMMUNITY SIMILARITY INDICES - Using reference communities from one or more reference streams, similarity indices are used to compare streams which have been impacted to a stream which has not been impacted (reference streams).

Using the above metrics, macroinvertebrate communities were assessed and assigned a total score. Higher scores indicate streams with higher biotic indexes and are considered to be structurally and functionally more stable (Tables 7-14).

RESULTS AND DISCUSSION

Habitat assessments were performed to attempt to correlate suitable habitat with high macroinvertebrate diversity. At each station, the habitat was assessed by observations made 100 m upstream and downstream. Our hypothesis was that as habitat degradation occurs there is a resultant loss of biotic integrity and the calculated biotic index decreases.

Two of the most important habitat parameters include bottom substrate and embeddedness. As fine sediments fill the interstices between cobbles and pebbles, available habitat decreases and fewer insects are observed. This increases insect drift without upstream recruitment since there are few exposed surfaces for insects to adhere (Brusven and Prather 1974). Embeddedness was not a factor for streams in this drainage because spring runoff and winter floods clean much of the gravel deposits from the channel.

In a high velocity stream such as E. F. Eagle Creek with few pool areas, little bottom scouring of materials was observed except at station 2.

Stream channelization is associated with placer mining activities as wastes are deposited in the channel. These materials are subsequently picked up and carried downstream. When channelization increases, as is commonly observed on E. F. Eagle Creek, stream sinuosity is reduced and water velocity increases.

In June 1990, test stations on the East Fork and one reference station on W.F. Eagle Creek were sampled. Additional reference sites were sampled in September along with the test stations.

Observations made in June, 1990 revealed that streams receding from flood stage had velocities ranging from 165 cm/s at station 1 to 98 cm/s at station 7. In comparison, September flows at these two stations were 40 and 42 cm/s, respectively (Table 3). Stations 2 and 6 were sampled in June but station 2 had insufficient water for sampling and station 6 was completely dry in September. As expected, stream width increased further downstream and velocity decreased as gradient decreased. Reference streams had similar velocities and depths as test streams except for Upper Coeur d'Alene River which was much wider than any test stream.

Channelization also negatively affects fish and invertebrate populations by eliminating pools and decreasing available cover. Moyle (1976) observed that biomass of fish and invertebrates in a channelized section of a stream was less than one-third that in unchannelized sections. Channel alteration was extensive along all study streams but was only moderately altered on Prichard Creek.

Lack of riparian vegetation is a problem associated with placer mining. This type of mining on the East Fork is done not only in the stream channel but over the entire floodplain. The operation begins with cutting riparian bordering the stream followed by floodplain sediments being put through a gold extracting procedure. Only sparse amounts of vegetation grow back since little soil was conserved in past operations. In addition, deposition of waste rock downstream covers any topsoil and vegetation that might exist along stream banks.

Riparian vegetation not only provides shade thereby decreasing water temperature, but also is a source of allochthonous energy for insects. If this material is unavailable, feeding behavior patterns are upset and insects which use leaf litter and other organic debris for food are replaced in the community by filter feeding organisms (Cummins 1973).

E. F. Eagle Creek generally lacked a riparian zone with the exception of stations 2 and 5. Station 2 is located above any recent placer mining operations and station 5 was observed to have some plant growth along both sides of the stream although the banks were quite high.

The poorest habitat rating was observed at station 1 since it lacked a riparian zone and thus scored low for bank stability, bank vegetation stability, and streamside cover. In addition, Tributary Creek was extensively channelized and had a low score for channel alteration and pool/riffle ratio. Overall most stations were given habitat ratings of "fair to good".

Stations 8 and 9 on Prichard Creek were assigned ratings of "good" based on a high pool/riffle ratio and moderate stream channelization as compared to stations on the East Fork. Sites located on W.F. Eagle Creek scored high relative to East Fork but not nearly so well as the five reference streams in the Coeur d'Alene River drainage.

The Jack Waite mine is located on Tributary Creek, about 4 km upstream of station 1. Production of zinc, lead, iron, and cadmium ores started in the late 1800s and mine wastes were put directly into Tributary Creek until the 1920s when tailings impoundments were built (Hosterman 1956). However, the impoundments were poorly built and are eroding at the present time. There is also a significant flow of mine water into Tributary Creek directly from the mine portal. Some leaching of heavy metals from tailings deposited downstream takes place especially during spring runoff (Reece et al. 1978).

Zinc concentration was 3.6 mg/l at station 1 (Table 3). This was seventy times higher than at the mouth of Eagle Creek where zinc was in trace amounts. Zinc was also measured in trace amounts at station 2. This site is located above the confluence with Tributary Creek. At station 3, below the confluence of Tributary Creek and Eagle Creek, zinc readings were between those at stations 1 and 2.

As heavy metals become a significant problem in a stream, there is a resultant decrease in the density and diversity of benthic macroinvertebrate species (Winner et al. 1980). Certain taxa of insects are more sensitive than others to heavy metals (Armitage 1980, Chadwick et al. 1986, Clements et al. 1988, Winner et al 1980). Hilsenhoff (1988) has compiled tolerance values for different taxa of invertebrates subjected to organic pollution. Hilsenhoff's tolerance values were used in this study but it is recommended that these values not be used for evaluating streams with metal loading since some stations with high zinc levels (>2.0 mg/l) scored well for this metric.

An integrated biological index (IBI) was developed to assess the impact of pollutants on fish (Karr et al. 1986) and was modified by Plafkin et al. (1989) to include macroinvertebrates. For this study we used seven metrics comparing macroinvertebrate communities in impacted study streams with non-impacted reference streams (see methods above).

In June, a biotic index was tabulated for seven test sites and one reference stream (station 10) on W. F. Eagle Creek (Table 7). A total score was compiled based on how each metric at that site compared to the reference station (Tables 8 and 9).

As an example, in June, station 1 had a taxa richness value of 9 while the reference station had a value of 14 (Table 7). In reference to Table 8, taxa richness of the macroinvertebrate community from station 1 was 64% of taxa richness of the reference site community. Referring to the Rapid Bioassessment

Protocols proposed by Plafkin et al. (1989), 64% receives a bioassessment score of 4 (Table 9). Each metric is scored likewise and a total score is tabulated. An assessment is then made using the total bioassessment score.

The site is considered unimpaired if the total score falls between 35-42, slightly impaired (23-33), moderately impaired (9-21) and severely impaired if the total score is less than 7.

Taxa richness, Hilsenhoff's Biotic Index, and Community Loss Index evaluate what is actually found in a community as compared to what would be expected if no impact occurred. The ratio of scrapers to filter-feeder functional groups, percent contribution of dominant taxon, the ratio of Ephemeroptera, Plecoptera, Trichoptera (EPT) abundance to Chironomidae, and the EPT index evaluate the switch from functional groups expected in a normal stream system with no channelization and a healthy riparian zone, to an impacted system (Minshall et al. 1985).

Taxa richness is a measure of how many species are found within the sampled community. Generally taxa richness decreases as water quality decreases. When perturbation first occurs, the most sensitive taxon disappears, followed by species less sensitive to the impact (Winner et al. 1980). The remaining community consists of individuals which are least sensitive to perturbation.

In June 1990, taxa richness was one and a half times as high at the reference station (station 11) as station 1 (Table 7). In September, however, the community taxa richness of Jordan Creek was four and a half times that of station 1 (Table 10). Taxa richness in September at all the E. F. Eagle Creek stations, was not more than half of the reference station, whereas stations 8 and 9 on Prichard Creek had taxa richness values which were similar or exceeded that of the Coeur d'Alene River reference site (Table 11).

The Hilsenhoff Biotic Index (HBI) (Hilsenhoff 1987) establishes macroinvertebrate family tolerance values for organic pollutants. The values range from 0-10 where 0 is the most sensitive and 10 is most tolerant. Tolerance values used for organic pollution were not entirely consistent with macroinvertebrate sensitivity to sedimentation and heavy metal perturbation but correlated well except where zinc levels were greater than 2.0 mg/l.

The HBI was calculated in the following way:

$$HBI = \frac{\sum x_i t_i}{n}$$

where:

x_i = number of individuals of a family

t_i = tolerance value of a family

n = number of individuals in sample

The order Diptera generally has the highest tolerance values. These insects are often found in streams where little else can survive. As would be expected, HBI was higher for communities with large numbers of Diptera than for those with less. A higher HBI results in a lower bioassessment score.

In June, HBI for all communities including the West Fork were similar, whereas in September only station 7 had an HBI much higher than the average test site and reference station. Station 7 had an HBI of 4.5 which included 45 individuals of the order Diptera compared to Jordan Creek an HBI of 2.9 and 24 Diptera. Although no organic tests were taken, station 7 is the only station with the possibility of pollution due to septic tanks. This might be an explanation for high densities of chironomids.

Cummins (1973) organized macroinvertebrates into functional feeding groups based on feeding behavior. His classification included the kind and size of food consumed together with the type feeding mechanism.

A healthy macroinvertebrate community has representatives of all five functional groups: collector-gatherers, collector-filterers, shredders, scrapers, and predators. A comparison of macroinvertebrate functional feeding group composition between test and reference sites is shown in Figures 2-3.

Tributary Creek, as compared to Jordan Creek samples, contained basically no collector-filterer forms which are both herbivores and detritivores living on algal cells and decomposing vascular plant tissue. Little or no riparian vegetation exists along the site which might explain the lack of this functional group. In addition, few shredders were observed in Tributary Creek which would be expected since coarse particulate organic matter (CPOM) from riparian vegetation and fed on by shredders exists in only small amounts.

The Upper Coeur d'Alene River samples as compared to Prichard Creek also show a lack of shredders which feed on woody debris in the stream. Since the river is wide at this point, any riparian that does exist has little influence in providing ample CPOM. In contrast, a large proportion of scrapers exist in the Coeur d'Alene River compared to Prichard Creek since light conditions are much more optimal providing large amounts of algae or periphyton for scrapers. The ratio of scrapers to collector-filterers is a measure of the abundance of periphyton versus the availability of fine particulate organic matter (FPOM). Collector-filterers require attachment sites for the gathering of FPOM which is provided partly by filamentous algae. If periphyton is more abundant, however, scrapers proliferate and a high ratio would indicate a community dominated by scrapers.

In June, the reference macroinvertebrate community had a scraper to filterer ratio of 2.3 with stations 3,4, and 7 having a higher ratio, and thus a higher bioassessment score. In September, however, the Jordan Creek macroinvertebrate community had a very low ratio and all stations except 7 had a higher ratio. The low scraper to collector-filterer ratio at Jordan Creek was probably due to an extensive riparian zone which acts to shade the water. In shady conditions periphyton is not abundant, therefore few scrapers are found. Station 7 was the only site at which filamentous algae was abundant. This algae not only provides attachment sites for filterers but also acts to shade the substrate which would not be optimum for the growth of periphyton.

The Upper Coeur d'Alene River station is open to the sun's radiation. A high scraper to collector-filterer ratio existed at this station, whereas lower ratios were observed at both Prichard Creek sites.

The EPT/Chironomidae ratio is the abundance of individuals representing the more sensitive organisms in the community versus the more tolerant Chironomidae. Winner (1980) showed that as metal impacts increase, the numbers of Chironomidae increase and the number of insects of EPT decrease.

Zinc was observed in high concentrations at station 1 which probably had an effect on the macroinvertebrates in E. Fork Eagle Creek. The combination of high zinc levels, poor riparian zones and extreme channelization, showed a correlation with decreased biotic integrity of the benthic communities. Data collected in June and September 1990 show that taxa richness and total density of the most pollutant sensitive taxa were fewer in number than macroinvertebrates found at reference sites. It was surprising to note that although these less tolerant taxa decreased, they generally were not replaced by a greater number of more tolerant forms such as Chironomidae.

In June, the reference macroinvertebrate community had an EPT/Chironomidae abundance of 21 and all stations on E. Fork

Eagle Creek except 7 had a lower ratio. In September however, all stations except 7 had a higher ratio than the Jordan Creek community. Since the ratio was so low for Jordan Creek, the comparison resulted in higher scores for test streams. No filamentous algae was found growing at station 7 in June but by September this algae was very abundant.

At all test stations, including the Upper Coeur d'Alene River reference site, a dominant taxon made up over 25% of the total number of individuals comprising the community. At stations 3 and 5 on the East Fork, over 50 percent of the total community was comprised of but one species. The lack of diversity usually indicates a stressed community.

The dominant taxon observed at all study sites except station 7, was the family Heptageniidae. The Heptageniidae has a high pollutant tolerance value and derives its food from scraping or gathering algae from rocks. Little streamside vegetation was found at most test sites resulting in well lit conditions.

Since the Coeur d'Alene River station is very wide, the canopy has little effect in shading the river so scrapers were the most prevalent functional group with Lepidostoma sp. being the dominant form.

The EPT Index is the number of taxa observed which belong to the orders Ephemeroptera, Plecoptera, and Trichoptera. These orders are the most sensitive to perturbation and a loss in taxa from this group, as compared to a reference community, signals a degradation of the macroinvertebrate community.

In June, the West Fork reference community had an EPT Index of 11, as compared to stations on the East Fork which had indexes ranging from 6-10. These numbers would indicate little loss of sensitive groups. In September however, the Jordan Creek community had an EPT Index of 19 and although the test stations had indexes similar to June values, compared to the reference community the test communities showed a loss of less tolerant taxa. Both stations on Prichard Creek had EPT scores equal to or greater than those observed on the Coeur d'Alene River.

The Community Loss Index (CLI) (Courtemanch and Davies 1987) compares test macroinvertebrate communities to a reference community. As a community becomes impacted, macroinvertebrate species are lost and species richness decreases.
The CLI is computed in the following manner:

$$\text{Community Loss} = \frac{d-a}{e}$$

where:

a = number of species common to both

d = total number of species present in Sample A

e = total number of species present in Sample B

Reference communities are given the score of 0 and scores increase as community difference increases. A score less than 0.5 is considered "good" and thus little taxa loss has occurred. In June most test stations had a CBI close to 0.5. However, in September, East Fork sites had "poor" community loss indexes since Jordan Creek had a higher taxa richness than the reference used in June and a substantially higher taxa richness than any of the sites on the East Fork. The loss of taxa as compared to the reference station would indicate some amount of impact has occurred. In comparison, both communities on Prichard Creek scored high in comparison to the Coeur d'Alene River.

Overall biotic assessment scores for E. Fork Eagle Creek in June are shown in Table 9 and scores for both E. Fork and Prichard Creek are summarized in Table 12. Tables 13 and 14 convert bioassessment scores to a biotic condition evaluation. For example, station 7 had a bioassessment score of 14. Referring to Table 13, a score of 14 would indicate the macroinvertebrate community at this site has been moderately impaired. Table 14 is used in the same manner with the Prichard Creek stations 8 and 9. A difference in the community composition of the reference stations used, necessitated the slight difference in evaluations.

SUMMARY

1. Initially the objective of this study was to collect baseline data from one station on Tributary Creek and five stations on East Fork Eagle Creek and measure any impact that might occur following placer mining in these drainages.
2. Once mining operations were canceled, at least temporarily, a new objective was to compare what effect past placer mining had on habitat conditions and macroinvertebrate communities in these streams. The West Fork of Eagle Creek was to serve as a control since placer operations had not occurred in this drainage.
3. After collections in June 1990, it was apparent that the West Fork was not a quality control (reference stream) due to

extremely low gradient conditions upstream and roaded conditions downstream.

4. In regards to September collections, five streams outside the study area were considered as reference sites since no roading, mining, or logging had occurred there. A station on Jordan Creek was selected to compare conditions with Tributary Creek and East Fork Eagle Creek and a station on the Upper Coeur d'Alene River to compare with Prichard Creek since the latter two were of the same stream order.

5. The methodology employed involved the Macroinvertebrate Rapid Bioassessment Protocols for use in streams and rivers written for the EPA. This approach is a practical, cost-effective biological appraisal of a running water system. Assessment of selected physical and chemical attributes of the stream are also included.

6. Little embeddedness was observed in any of the stations studied. Spring runoff cleans out much of the material that would ordinarily compact the rock substrate which was primarily rubble and boulders.

7. Some bottom scouring and deposition occurred as evidenced by siltation in pools and riffles. This is expected since channelling was commonly observed in the test or study streams.

8. Channelization is a direct result of placer mining. Where the stream was channelized, sinuosity decreased and water velocity increased. As expected, stream velocity was significantly less in September than in June. All study sites showed signs of extreme channelization except Prichard Creek which was observed to have

less channel alteration than either station on the West Fork but more alteration than the Upper Coeur d'Alene reference site.

9. Lack of riparian vegetation is another important negative impact of placer mining. East Fork Eagle Creek generally lacked a riparian zone with the exception of station 2 located above recent mining operations and station 5 having some plant growth along both sides of the stream, although the banks were quite high and slightly unstable.

10. Overall Tributary Creek exhibited the poorest habitat rating (Fair) since it lacked a riparian zone and thus scored low for bank stability, bank vegetation stability, and streamside cover. In addition the creek was extensively channelized and had a low score for channel alteration and pool/riffle ratio.

11. The East Fork, Prichard Creek, and West Fork stations all rated a "Good" Habitat Assessment. In fact, Station 5, 3 km above the East Fork and West Fork road junction rates as high as Station 10 on the West Fork. Habitat assessment of all reference streams outside the Eagle Creek and Prichard Creek drainages rated "Excellent".

12. Water chemistry data were somewhat similar for all streams excepting heavy metals. Values for alkalinity and conductivity were low and pH readings close to neutrality.

13. Significant concentrations of zinc and other toxic wastes enter Tributary Creek from old tailing impoundments and the Jack Waite mine portal. These metal wastes become more diluted downstream on the East Fork.

14. Seven characteristics or metrics describing the structure and function of macroinvertebrate communities were used to compare communities from stations on Tributary Creek, East Fork Eagle Creek, and Prichard Creek all which had been placer mined at one time with reference sites on West Fork Eagle Creek in June and Jordan Creek and Upper Coeur d'Alene River in September.

15. A numerical value is calculated for each metric. The calculated values are then compared to values derived from the reference site. Scores for the seven metrics are then totaled and compared to the total metric score for the reference station. The percent comparison between the total score provides a final evaluation of biological condition.

16. All test sites had lower total bioassessment scores than reference stations for both June and September, especially samples in September where the reference stations were of higher quality than the West Fork sites used for comparison in June.

17. All test sites which had lower bioassessment scores than reference stations also had lower habitat assessment scores than reference stations especially as relates to channel alteration, pool-riffle ration, bank stability, bank vegetation stability, and streamside cover.

18. Tributary Creek which was impacted most severely by heavy metals together with having the lowest habitat score for both sample dates, had one of the lowest bioassessment scores.

19. Stations downstream from the confluence of Tributary Creek and East Fork Eagle Creek were somewhat similar regarding total

bioassessment as compared to the reference community, except station 7 in September and station 6 in June which dried up later in the summer.

20. Both stations on Prichard Creek scored well in taxa richness and EPT Index but scored low in metrics associated with a shift in functional group composition. Loss of riparian vegetation and channelization resulted in a low habitat assessment score for September.

21. A listing of macroinvertebrate taxa observed at test and reference stations for both months is provided. This information will be important if placer activities resume in the region, especially if comparing conditions such as stress tolerance, species richness, and dominance of macroinvertebrate communities.

RECOMMENDATIONS FOR FUTURE MONITORING

Test stations for this study were selected based on proposed placer workings within the Eagle Creek and Prichard Creek drainages. If placer mining is initiated at proposed sites between stations 1,2 and 3 or between stations 4 and 6, all stations could be used as valid test sites. If mining is initiated at other locations, some stations may not be valid and should be relocated so as to have upstream controls.

To assess impacts during placer operations, benthic communities at all stations or at least one station above and below mining, should be sampled using described methods. In additon, physical data and water chemistries should be collected.

In this manner, impacts can be assessed by comparing water chemistries and communities upstream and downstream from the perturbation. In addition, downstream communities could be compared to the data in this study to determine declining biotic health. From the results of these samples, if necessary, mining rehabilitation policies might be enforced.

Post-mining benthic community samples should be done based on predetermined objectives and results from previous samples. If samples are taken annually (during low flow), any rehabilitation projects can be evaluated.

Reference streams within the Wallace Ranger District, which include Jordan, Alden, Deer, and Cinnamon Creeks and the Coeur d'Alene River, were sampled since these streams were relatively unimpacted by mining and logging. If future land use activities take place, sampling of the affected stream(s) should be done and the results compared to the baseline data in this study. The results may be used to enforce land use practices and policies and assess program effectiveness.

TABLE 1. Study streams in the Wallace Ranger District

Station number	Description
1	Tributary Creek, 100 m above confluence with E.F. Eagle Creek
2	E.F.Eagle Creek, 100 m above confluence with Tributary Creek (station deleted after June sample)
3	E.F.Eagle Creek, 200 m below confluence with Tributary Creek
4	E.F.Eagle Creek, 4 km above E.Fork and W.Fork road junction
5	E.F.Eagle Creek, 3 km above E.Fork and W.Fork road junction
6	E.F.Eagle Creek, 1.5 km above E.Fork and W.Fork road junction (station deleted after June sample)
7	Eagle Creek, 50 m above main road bridge
8	Prichard Creek, 150 m upstream from confluence with Eagle Creek
9	Prichard Creek, 200 m downstream from confluence with Eagle Creek
10	W.F. Eagle Creek, (Settler's Grove), 10 km above E.F. and W.F. road junction
11	W.F. Eagle Creek, 5 km below Station 10

TABLE 2. Reference streams in the Upper Coeur d'Alene River drainage

Name	Location Description
Cinnamon Creek	T24N R3E S8
Jordan Creek	T25N R3E S15
Alden Creek	T25N R3E S8
Deer Creek	T25N R3E S8
Upper Coeur d'Alene River	T25N R3E S16

TABLE 3. Selected physical characteristics and water chemistries of stations on Eagle Creek and reference streams. June and September 1990

June 1990 — Stations

CHARACTERISTICS	1	2	3	4	5	7	8	9	10	11
DEPTH (cm)	21	27.5	35	33	36.6	32	41	41	24	-
WIDTH (m)	7	6	9	5	5.3	18	20	12	2	-
VELOCITY (cm/s)	165	117	122	148	133	98	110	95	133	-
CONDUCTIVITY (µmhos)	-	-	-	-	-	22	28	-	16	-
ALKALINITY (mg/l)	11	8	-	-	-	-	10	-	9	-
pH	-	-	-	-	-	-	-	-	-	-
ZINC (mg/l)	-	-	-	-		-	-	-	-	-

September 1990 — Stations

CHARACTERISTICS	1	2	3	4	5	7	8	9	10	11
DEPTH (cm)	10	9	16	7	6	4	13	17	14	4
WIDTH (m)	3	3	9	7	7	17	22	12	2	10
VELOCITY (cm/s)	40	11.5	33	33	54	42	38	28	38	36
CONDUCTIVITY (µmhos)	33	12	33	-	-	22	28	-	16	15
ALKALINITY (mg/l)	16	6	11	-	-	12	-	-	16	15
pH	7.1	6.9	7.0	-	-	6.8	6.9	-	7.2	7.1
ZINC (mg/l)	3.6	<.05	2.5	-	-	0.07	0.3	-	<.05	<.05

Reference streams Sept. 1990 — Stream

CHARACTERISTICS	ALDEN	DEER	JORDAN	UPPER CDA	CINNAMON
DEPTH (cm)	16	12	13	17	27
WIDTH (m)	2.5	3	7.5	24	2.5
VELOCITY (cm/s)	100	40	42	43	51
CONDUCTIVITY (µmhos)	-	-	-	-	-
ALKALINITY (mg/l)	45	33	31	32	27
ZINC (mg/l)	-	-	-	BDL*	BDL

*BDL- below detectable limits

TABLE 4. Habitat assessment for stations on Eagle Creek from Plafkin et al. Rapid Bioassessment Protocols (1989). Sept. 1990

	STATION									
HABITAT PARAMETER	1	2	3	4	5	7	8	9	10	11
BOTTOM SUBSTRATE	14	15	15	14	15	16	17	16	17	17
EMBEDDEDNESS (%)	18	19	18	19	19	18	19	19	20	20
CHANNEL ALTERATION	0	5	3	3	7	5	9	9	8	7
BOTTOM SCOURING	5	10	14	14	14	14	14	14	15	15
POOL / RIFFLE RATIO	5	8	4	4	11	3	7	7	12	10
BANK STABILITY	2	8	3	5	9	6	6	5	7	6
BANK VEGETATION STABILITY	4	10	5	3	9	5	5	6	7	9
STREAMSIDE COVER	2	10	4	2	8	6	5	5	6	5
TOTAL:	50	85	66	64	92	73	82	81	92	89

TABLE 5. Habitat assessment for reference streams. September 1990

	STREAM				
HABITAT PARAMETER	ALDEN	DEER	JORDAN	UPPER CDA	CINNAMON
BOTTOM SUBSTRATE	19	19	20	20	20
EMBEDDEDNESS (%)	20	20	20	20	20
CHANNEL ALTERATION	15	15	15	15	15
BOTTOM SCOURING	15	15	15	15	15
POOL / RIFFLE RATIO	15	15	13	12	15
BANK STABILITY	10	10	10	10	9
BANK VEGETATION STABILITY	10	10	10	10	10
STREAMSIDE COVER	10	10	10	8	10
TOTAL:	114	114	113	110	114

Table 6. Habitat assessment scoring criteria

CONDITION/PARAMETER	CONDITION			
	EXCELLENT	GOOD	FAIR	POOR
BOTTOM SUBSTRATE	16-20	11-15	6-10	0-5
EMBEDDEDNESS	16-20	11-15	6-10	0-5
CHANNEL ALTERATION	12-15	8-11	4-7	0-3
BOTTOM SCOURING	12-15	8-11	4-7	0-3
POOL/RIFFLE RATIO	12-15	8-11	4-7	0-3
BANK STABILITY	9-10	6-8	3-5	0-2
BANK VEGETATION STABILITY	9-10	6-8	3-5	0-2
STREAMSIDE COVER	9-10	6-8	3-5	0-2
TOTAL............................	95-115	64-87	33-56	0-25

TABLE 7. Metric values for stations on Eagle Creek - June 1990
-from Plafkin et al. Rapid Bioassessment Protocol (1989)

	STATION							
METRIC	1	2	3	4	5	6	7	R
TAXA RICHNESS	9	10	11	10	9	10	12	14
HILSENHOFF BIOTIC INDEX	3.81	3.31	3.24	4.25	3.82	3.69	3.42	3.53
SCRAPERS/FILTERERS	1.1	2.18	16.25	6.3	.78	.67	15	2.29
% DOMINANT TAXON	36	26	51	36	58	48	41	31
EPT/CHIRONOMIDS	2.3	11.42	15.3	18.8	17	3.7	62	21
EPT INDEX	8	8	10	7	7	6	10	11
COMMUNITY LOSS INDEX	.67	.5	.36	.5	.56	.7	.5	.1

TABLE 8. % Comparison of metrics on Eagle Creek with reference station - June 1990.
From Plafkin et al. Rapid Bioassessment Protocol (1989)

	STATION							
METRIC	1	2	3	4	5	6	7	R*
TAXA RICHNESS	64	71	79	71	64	71	86	100
HILSENHOFF BIOTIC INDEX	93	110	110	83	92	96	100	100
SCRAPERS/FILTERERS	48	95	701	275	34	29	655	100
% CONTRIBUTION OF DOMINANT TAXON	36	26	51	36	58	48	41	31
EPT/CHIRONOMIDAE	11	54	73	89	81	18	295	100
EPT INDEX	73	73	91	64	64	55	91	100

*Reference West Fork Eagle Creek Station #10

TABLE 9. Bioassessment score of stations on Eagle Creek - June 1990.
From Plafkin et al. Rapid Bioassessment Protocols (1989)

STATION SCORE

METRIC	1	2	3	4	5	6	7	R
TAXA RICHNESS	4	4	4	4	4	4	6	6
HILSENHOFF BIOTIC INDEX	6	6	6	4	6	6	6	6
SCRAPERS/FILTERERS	4	6	6	6	2	2	6	6
% CONTRIBUTION OF DOMINANT TAXON	2	4	0	2	0	0	0	6
EPT/CHIRONOMIDAE ABUNDANCES	0	4	4	6	6	0	6	6
EPT INDEX	2	2	6	0	0	0	6	6
COMMUNITY LOSS INDEX	4	4	6	4	4	4	4	6
TOTAL:	22	30	32	26	22	16	34	42

BIOASSESSMENT SCORES

35-42..................Nonimpaired

23-33..................Slightly impaired

9-21...................Moderately impaired

0-7....................Severely impaired

TABLE 10. Metric values for stations on Eagle Creek, Prichard Creek and Reference Streams* ** - Sept. 1991 -from Plafkin et al. Rapid Bioassessment Protocol (1989)

	STATION								
METRIC	1	3	4	5	7	8	9	R1*	R2*
TAXA RICHNESS	6	12	11	12	13	18	25	27	19
HILSENHOFF BIOTIC INDEX	1.01	3.31	1.92	3.26	4.49	3.7	2.56	2.95	2.02
SCRAPERS/FILTERERS	21	5.5	4.9	14	.22	.56	.39	.33	10.4
EPT/CHIRONOMIDAE ABUNDANCE	74	16.8	10.75	98	1.51	8.9	7.6	4.8	97
% CONTRIBUTION OF DOMINANT TAXON	54	41	35	54	42	.60	26	20	44
EPT INDEX	6	11	10	11	11	12	19	19	12
COMMUNITY LOSS INDEX	3.67	3.16	3.0	3.16	3.0	.67	.36	1	1

TABLE 11. Comparison of metrics on Eagle and Prichard Creek with reference stations- Sept 1991. From Plafkin et al. Rapid Bioassessment Protocol (1989)
*Reference station 1 - Jordan Creek
**Reference station 2 - Upper Coeur d'Alene River

	STATION								
METRIC	1	3	4	5	7	8	9	R1*	R2*
TAXA RICHNESS	22	44	41	44	48	95	131	100	100
HILSENHOFF BIOTIC INDEX	292	89	153	90	65	55	79	100	100
SCRAPERS/FILTERERS	6562	1710	1530	4370	69	05	04	100	100
EPT/CHIRONOMIDAE ABUNDANCE	1541	350	223	2041	31	09	08	100	100
% CONTRIBUTION OF DOMINANT TAXON	54	41	35	54	42	60	26	20	44
EPT INDEX	31	58	52	58	58	100	158	100	100
COMMUNITY LOSS INDEX	3.67	3.16	3.0	3.16	3.0	.67	.36	1	1

TABLE 12. Bioassessment score of stations on Eagle and Prichard Creek- Sept 1990
From Plafkin et al. Rapid Bioassessment Protocols (1989)

STATION SCORE

METRIC	1	3	4	5	7	8	9	R1	R2
TAXA RICHNESS	0	2	2	2	2	6	6	6	6
HILSENHOFF BIOTIC INDEX	6	6	6	6	2	2	4	6	6
SCRAPERS/FILTERERS	6	6	6	6	6	0	0	6	6
EPT/CHIRONOMIDAE ABUNDANCE	6	6	6	6	2	0	0	6	6
% CONTRIBUTION DOMINANT TAXON	0	0	2	0	0	0	4	6	0
EPT INDEX	0	0	0	0	0	6	6	6	6
COMMUNITY LOSS INDEX	2	2	2	2	2	4	6	6	6
TOTAL:	20	22	24	22	14	18	26	42	36

Table 13. BIOASSESSMENT EVALUATION OF E. FORK AND TRIBUTARY CREEK STUDY SITES

35-42...................Nonimpaired

21-33...................Slightly impaired

9-20....................Moderately impaired

0-7.....................Severely impaired

Table 14. BIOASSESSMENT EVALUATION OF PRICHARD CREEK STATIONS

30-36...................Nonimpaired

19-28...................Slightly impaired

8-18....................Moderately impaired

0-6.....................Severely impaired

Table 15. Listing of macroinvertebrates observed at test and reference stations in June and September, 1990.
* - June only
\# - September only

	STATION															
Genus	1*	2	3	4	5	6	7	8#	9#	10	11	Jordan#	Cinnamon#	CDA#	Alder#	Deer#
Baetis tricaudatis	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
B. bicaudatis										x				x		
Psuedocloeon sp											x					
Drunella doddsi	x	x	x	x	x		x		x	x	x	x	x	x	x	x
D. grandis							x		x	x	x	x		x	x	x
Ephemerella sp			x				x				x					
E. flavilinea									x							
E. infrequens									x					x		
Seratella sp							x					x			x	
Cinygmula sp	x	x	x	x	x	x	x		x	x	x		x		x	
Epeorus sp		x	x	x	x	x	x		x	x	x				x	
E. longimanus									x							
Ironodes sp					x				x				x			
Rhithrogena hageni									x							
R. robusta	x		x	x	x		x	x	x	x	x	x	x	x		x
Paraleptophlebia sp												x				
Ameletus sp	x					x		x								
Alloperla sp													x			x
Sweltsa sp	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Kathroperla sp			x							x		x				
Setvena sp											x					
S. bradleyi					x											
Paraleuctra sp					x				x	x		x				
Zapada columbiana	x		x	x			x		x	x	x	x				
Calineuria californica				x	x			x	x		x	x		x	x	
Hesperoperla pacifica							x									
Cultus sp																x
Isoperla sp								x	x							
Megarcys sp			x												x	
Skwala sp											x	x	x			x
Amiocentrus sp	x	x	x							x						
Brachycentrus sp									x		x	x	x			x
Micrasema sp								x	x							
Anagapetus sp													x			
Glossosoma sp									x							
Arctopsyche sp							x	x	x		x	x			x	x
A. grandis														x		
Hydropsyche sp							x		x						x	
Parapsyche sp	x	x	x							x			x			
Agraylea sp			x					x	x		x	x				x
Leucotrichia sp								x								
Lepidostoma									x				x	x		
Apatania sp									x			x				

Table 15 cont.

	1	2	3	4	5	6	7	8	9	10	11	Jordan	Cinnamon	CDA	Alden	Deer
Ecclisomyia sp															x	x
Neophylax sp									x	x						
Neothremma sp								x								
Polycentrus sp							x									
Psychomyia															x	
Rhyacophila sp	x	x	x	x	x	x	x	x		x	x		x		x	x
R. acropedis												x		x		
R. angelita									x							
R. arnaudi														x		
R. hyalinata				x	x											
R. narvae										x						
R. vaccua										x		x				
Ostioservus sp							x	x	x	x	x	x	x	x		x
Zaitzevia parvula														x		
Atherix sp								x	x	x		x				
A. variegata									x							
Bezzia sp														x		
Clinocera sp						x										
Oreogeton sp		x		x							x				x	
Simulium sp				x	x	x			x	x	x	x		x		
Antocha sp								x			x	x	x	x		
Hexatoma sp									x						x	x
Limnophila sp														x		
Rhabdomastix				x		x										
Pericoma sp												x				
Glutops sp												x				
Chironomidae																
Subfamily Chironominae			x					x	x		x	x	x			
Orthocladinae	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Tanypodinae							x		x					x	x	

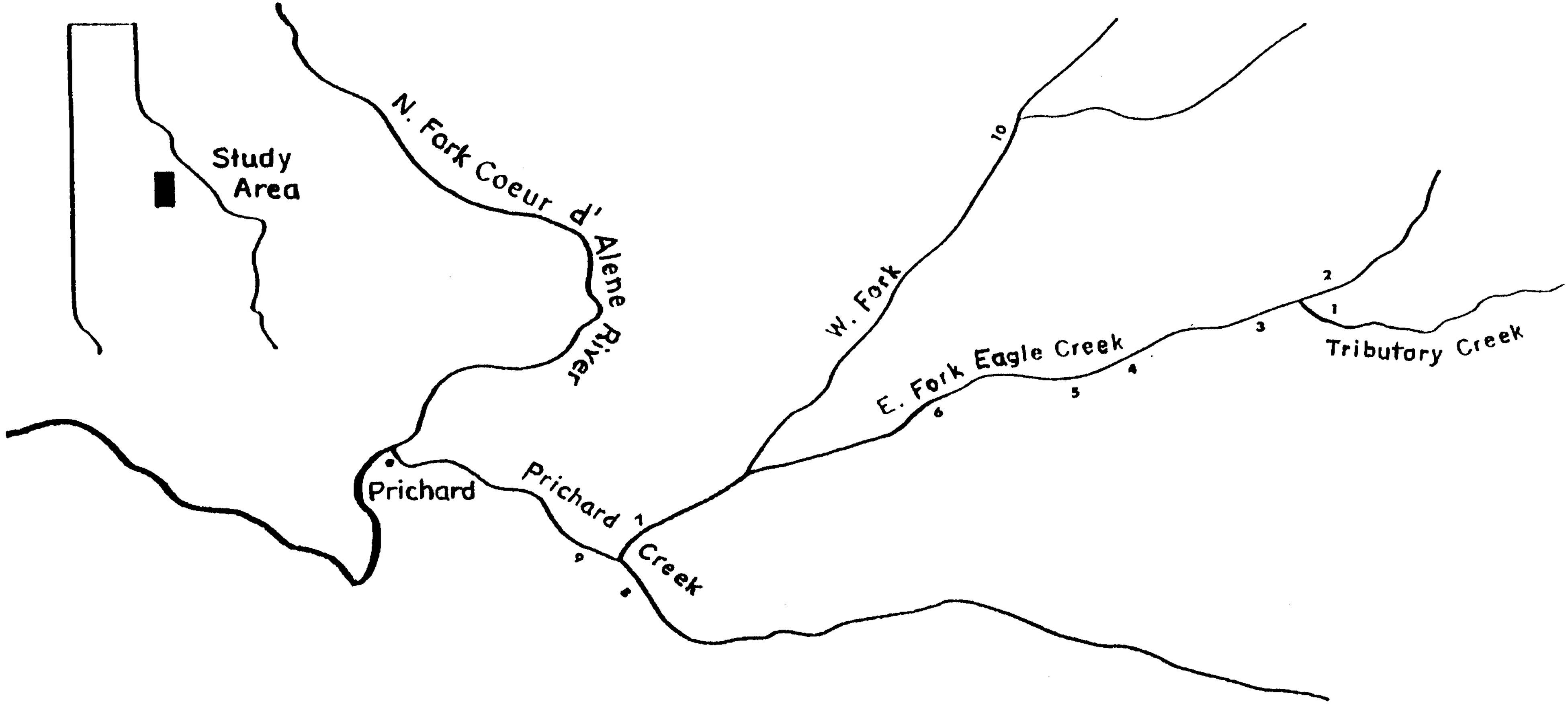


FIGURE 1 MAP OF STUDY AREA

FUNCTIONAL FEEDING GROUPS
COMPARISON OF TEST AND REFERENCE SITES

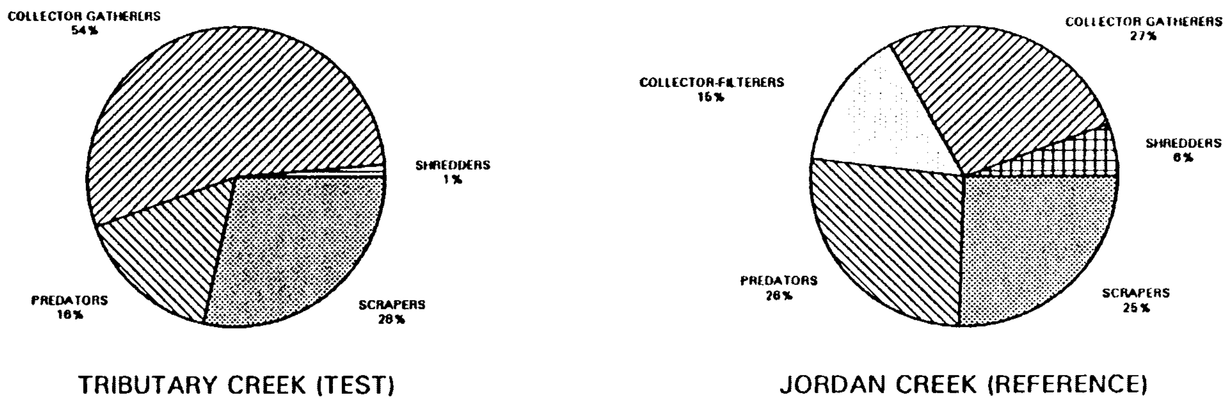
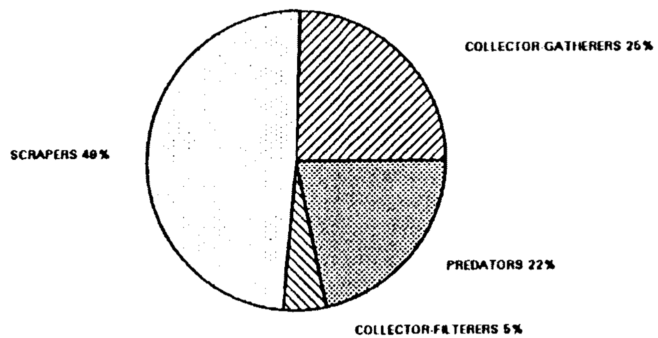


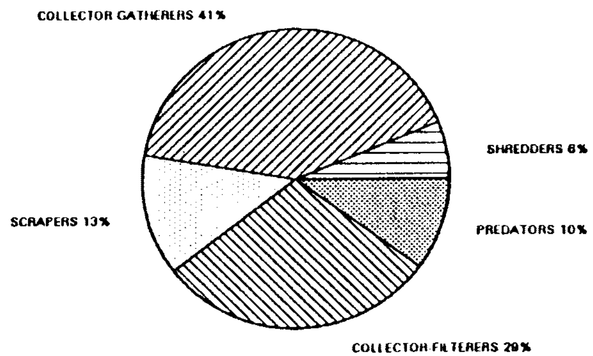
FIGURE 2

FUNCTIONAL FEEDING GROUPS

UPPER COEUR D'ALENE R. AND PRICHARD CR.



UPPER COEUR D'ALENE RIVER



PRICHARD CREEK (STATION 9)

FIGURE 3

LITERATURE CITED

Armitage, P.D. 1980. The effects of mine drainage and organic enrichment on benthos in the River Nent System, Northern Pennines. Hydrobiologia. 74:119-128.

Brusven, M.A., and K. Prather. 1974. Influence of stream sediments on distribution of macrobenthos. Journal of Entomological Society of British Columbia. 71:25-32.

Chadwick, J.W., S.P. Canton, and R.L. Dent. 1986. Recovery of benthic invertebrate communities in Silver Bow Creek, Montana, following improved metal mine wastewater treatment. Water, Air, and Soil Pollution. 28:427-438.

Clements, W.H., D.J. Cherry, and J. Cairns, Jr. 1988. Structural alterations in aquatic insect commmunities exposed to copper in laboratory streams. Environmental Toxicology and Chemistry. 7:715-722.

Courtemanch, D.L. and S.P. Davies. 1987. A coefficient of community loss to assess detrimental change in aquatic communities. Water Research. 21:217-222.

Cummins, K.W. 1973. Trophic relations of aquatic insects. Annual Review of Entomology. 18:183-206.

Hilsenhoff, W.L. 1987. An improved biotic index of organic stream pollution. Great Lakes Entomology. 20:31-39.

Hilsenhoff, W.L. 1988. Rapid field assessment of organic pollution with a family level biotic index. Journal of the North American Benthological Society. 7:65-68.

Hosterman, J.W. 1956. Geology of the Murray area, Shoshone Co., Idaho. U.S. Geological Survey Bulletin 1027-P. pp. 725-748.

Karr, J.R., K.D. Fausch, P.L. Anermeier, P.R. Yant, and I.J. Schlosser. 1986. Assessing biological integrity in running waters: a method and its rationale. Illinois Natural History Survey Special Publication Number 5, Champaign.

Merritt, R.W. and K.W. Cummins, eds. 1984. An Introduction to The Aquatic Insects of North America. Second edition. Kendall/Hunt Publishing Co., Dubuque, Iowa.

Minshall, G.W., K.W. Cummins, R.C. Petersen, C.E. Cushing, D.A. Bruns, J.R. Sedell, and R.L. Vannote. 1985. Developments in stream ecosystem theory. Canadian Journal of Fisheries and Aquatic Sciences. 42:1045-1055.

Moyle, P.B. 1976. Some effects of channelization of the fishes and invertebrates of Rush Creek, Medoc County, California. California Fish and Game. 62:179-186.

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross, and R.M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates and fish. EPA/444/4-89-001. Assessment and Watershed Protection Division, Washington, D.C.

Reece, D.E., J.R. Felkey, and C.M Wai. 1978. Heavy metal pollution in the sediments of the Coeur d'Alene River, Idaho. Environmental Geology. 2:289-293.

___________. 1977. Water Quality Report for Wallace Ranger District. U.S.F.S. Files.

Winner, R.W.,M.W. Boesel, and M.P. Farrell. 1980. Insect community structure as an index of heavy-metal pllution in lotic ecosystems. Canadian Journal of Fisheries and Aquatic Sciences. 37:647-655.

Fig 4 Tributary Creek (Station 1), June 1990. Note steep gradient and lack of riparian. Tailings pond on left. Further downstream trees removed along channel in anticipation of placer mining operations.

Fig 5. West Fork Eagle Creek (Station 10). Sept. 1990. Note high pool/riffle ratio, low gradient and closed canopy conditions.

Fig 6. East Fork Eagle Creek (Station 4). Sept. 1990. Observe straight channel, limited riparian, unstable banks, and boulder-rubble substrate.

Fig 7. Prichard Creek (Station 8). Sept. 1990. Notice the marginal riparian, some channelization, low gradient, and road on left of picture.

Fig 8. Jordan Creek (Reference stream 1). Sept. 1990. Excellent riparian, substrate, bank and vegetation stability.

Fig 9. Coeur d'Alene River (Reference stream 2). Sept. 1990. Wide stream, excellent riparian and substrate. Limited pool/riffle ratio.

APPENDIX
Insects collected, date and station.

JUNE 20, 1990

TRIBUTARY CREEK
STATION #1

EPHEMEROPTERA		
Baetidae	Baetis tricaudatis	1
Heptageniidae	Cinygmula sp.	26
	Rhithrogena robusta	3
Siphlonuridae	Ameletus sp.	1
PLECOPTERA		
Chloroperlidae	Sweltsa sp.	7
TRICHOPTERA		
Brachycentridae	Amiocentrus sp.	4
Hydropsychidae	Parapsyche sp.	2
Rhyacophilidae	Rhyacophila sp	5
DIPTERA		
Chironomidae Subfamily Orthocladinae		24
TOTALS:		
	TAXA RICHNESS:	9
	INDIVIDUALS:	73

Density* whole sample

* refers to how much of sample needed to total 100 insects

JUNE 20, 1990

EAST FORK EAGLE CREEK
STATION #2

EPHEMEROPTERA

Baetidae	Baetis tricaudatis	9
Ephemerellidae	Drunella doddsi	2
Heptageniidae	Cinygmula sp	22
	Epeorus longimanus	18

PLECOPTERA

Chloroperlidae	Sweltsa sp	24

TRICHOPTERA

Brachycentridae	Amiocentrus sp	2
Hydropsychidae	Parapsyche sp	2
Rhyacophilidae	Rhyacophila sp	1

DIPTERA

Chironomidae Subfamily Orthocladinae		7
Empididae	Oreogeton sp	5

TOTALS:

	INDIVIDUALS:	92
	TAXA RICHNESS:	10

Density 1/2 sample

JUNE 20, 1990

EAST FORK EAGLE CREEK
STATION #3

EPHEMEROPTERA

Baetidae	Baetis tricaudatis	3
Ephemerellidae	Drunella doddsi	10
	Ephemerella sp	1
Heptageniidae	Cinygmula sp	50
	Epeorus longimanus	10

PLECOPTERA

Chloroperlidae	Sweltsa sp	12
	Kathroperla sp	1

TRICHOPTERA

Brachycentridae	Amiocentrus sp	1
Hydropsychidae	Parapsyche sp	1
Rhyacophilidae	Rhyacophila sp	3

DIPTERA

Chironomidae		
Subfamily Orthocladinae		6

TOTALS:

	INDIVIDUALS:	98
	TAXA RICHNESS:	11

Density 1/4 sample

JUNE 20, 1990

EAST FORK EAGLE CREEK
STATION #4

EPHEMEROPTERA

Baetidae	Baetis tricaudatis	13
Ephemerellidae	Drunella doddsi	3
Heptageniidae	Cinygmula sp	35
	Epeorus longimanus	37
	Rhithrogena robusta	10

PLECOPTERA

Chloroperlidae	Sweltsa sp	5

TRICHOPTERA

Rhyacophilidae	Rhyacophila sp	2

DIPTERA

Chironomidae Subfamily Orthocladinae		5
Empididae	Oreogeton sp	1
Simulidae	Simulium sp	1
Tipulidae	Rhabdomastix sp	1

TOTALS:	INDIVIDUALS:	113
	TAXA RICHNESS:	10

Density 1/4 sample

JUNE 20, 1990

EAST FORK EAGLE CREEK
STATION #5

EPHEMEROPTERA		
Baetidae	Baetis tricaudatis	7
Ephemerellidae	Drunella doddsi	2
Heptageniidae	Cinygmula sp	9
	Epeorus longimanus	67
	Rhithrogena robusta	4
PLECOPTERA		
Chloroperlidae	Sweltsa sp	9
TRICHOPTERA		
Rhyacophilidae	Rhyacophila sp	4
DIPTERA		
Chironomidae		
Subfamily Orthocladinae		6
Simuliidae	Simulium sp	8
TOTALS:	INDIVIDUALS:	116
	TAXA RICHNESS:	9

Density 1/4 sample

JUNE 20, 1990

EAST FORK EAGLE CREEK
STATION #6

EPHEMEROPTERA

Baetidae	Baetis tricaudatis	2
Heptageniidae	Cinygmula sp	2
	Epeorus longimanus	16
Siphlonuridae	Ameletus sp	1

PLECOPTERA

Chloroperlidae	Sweltsa sp	3

TRICHOPTERA

Rhyacophilidae	Rhyacophila sp	2

DIPTERA

Chironomidae		
Subfamily Orthocladinae		2
Empididae	Clinocera sp	3
Simuliidae	Simulium sp	1
Tipulidae	Rhabdomastix sp	1

TOTALS:

	INDIVIDUALS:	33
	TAXA RICHNESS:	10

Density whole sample

JUNE 20, 1990

MAIN FORK EAGLE CREEK
STATION #7

EPHEMEROPTERA		
Baetidae	Baetis tricaudatis	6
Ephemerellidae	Drunella doddsi	3
	Ephemerella sp.	1
	Serratella sp.	1
Heptageniidae	Cinygmula sp.	11
	Epeorus longimanus	26
	Rhithrogena robusta	2
PLECOPTERA		
Chloroperlidae	Sweltsa sp.	8
TRICHOPTERA		
Polycentropodiae	Polycentrus sp.	2
Rhyacophilidae	Rhyacophila sp.	1
COLEOPTERA		
Elmidae	Optioservus sp.	1
DIPTERA		
Chironomidae sub-family Tanypodinae		1
TOTALS:		
	INDIVIDUALS:	63
	TAXA RICHNESS:	12

Density whole sample

JUNE 20, 1990

WEST FORK EAGLE CREEK
STATION #10

EPEMEROPTERA		
Baetidae	Baetis tricaudatis	1
Ephemerellidae	Drunella doddsi	3
Heptageniidae	Cinygmula sp	31
	Epeorus longimanus	14
	Rhithrogena robusta	8
PLECOPTERA		
Chloroperlidae	Sweltsa sp	18
	Kathloperla sp	1
TRICHOPTERA		
Brachycentridae	Amiocentrus sp	1
Hydropsychidae	Parapsyche sp	1
Limnephilidae	Neophylax sp	4
Rhyacophilidae	Rhyacophila sp	1
DIPTERA		
Simuliidae	Simulium sp	11
Chironomidae		
Subfamily Orthocladinae		4
COLEOPTERA		
Elmidae	Optioservus sp	1
TOTALS:		
	INDIVIDUALS:	99
	TAXA RICHNESS:	14

Density 1/4 sample

JUNE 20, 1990

WEST FORK EAGLE CREEK
STATION #11

EPHEMEROPTERA			
Baetidae	Baetis tricaudatis	18	
Ephemerellidae	Drunella doddsi	5	
	Ephemerella sp		12
Heptageniidae	Cinygmula sp	1	
	Epeorus longimanus	3	
PLECOPTERA			
Chloroperlidae	Swelsta sp	14	
TRICHOPTERA			
Brachycentridae	Brachycentrus sp	1	
COLEOPTERA			
Elmidae	Optioservus sp	2	
DIPTERA			
Chironomidae			
Subfamily Orthocladinae		3	
Empididae	Oreogeton sp	1	
Simuliidae	Simulium sp	44	
TOTALS:	INDIVIDUALS:	104	
	TAXA RICHNESS:	11	

Density 1/4 sample

Sept. 15, 1990

TRIBUTARY CREEK
STATION #1

EPHEMEROPTERA		
Baetidae	Baetis tricaudatis	40
Ephemerellidae	Drunella doddsi	11
Heptageniidae	Cinygmula sp	10
PLECOPTERA		
Chloroperlidae	Sweltsa sp	11
Nemouridae	Zapada columbiana	1
TRICHOPTERA		
Rhyacophilidae	Rhyacophila sp	1
TOTALS:		
	INDIVIDUALS:	74
	TAXA RICHNESS:	6

Density: whole sample

Sept. 15, 1990

E.F. EAGLE CREEK
STATION #2

EPHEMEROPTERA

Ephemerellidae	Drunella doddsi	2

TRICHOPTERA

Hydropsychidae	Parapsyche sp	1

DIPTERA

Chironomidae Subfamily Tanypodinae		3

TOTALS:

INDIVIDUALS:	6
TAXA RICHNESS:	3

COMMENTS: Station had insufficient water for sampling

Sept. 16, 1990

E.F. EAGLE CREEK
STATION #3

EPHEMEROPTERA		
Baetidae	Baetis tricaudatis	19
Ephemerellidae	Drunella doddsi	14
	Ephemerella sp	1
Heptageniidae	Cinygmula sp	44
	Rhithrogena robusta	1
PLECOPTERA		
Chloroperlidae	Sweltsa sp	17
Nemouridae	Zapada columbiana	4
Perlodidae	Megarcys sp	1
TRICHOPTERA		
Hydropsychidae	Parapsyche sp	4
Rhyacophilidae	Rhyacophila sp	1
Hydroptilidae	Agraylea sp	1
DIPTERA		
Chironomidae		
Subfamily Orthocladinae		5
Chironominae		1
TOTALS:		
	INDIVIDUALS:	113
	TAXA RICHNESS:	12

Density whole sample

Sept. 16, 1990

EAST FORK EAGLE CREEK
STATION #4

EPHEMEROPTERA		
Baetidae	Baetis tricaudatis	18
Ephemerellidae	Drunella doddsi	6
Heptageniidae	Cinygmula sp	33
	Rhithrogena robusta	12
PLECOPTERA		
Chloroperlidae	Sweltsa sp	4
Perlidae	Calineuria californica	2
Nemouridae	Zapada columbiana	2
TRICHOPTERA		
Rhyacophilidae	Rhyacophila sp 1	5
	Rhyacophila sp 2	1
	Rhyacophila hyalinata	3
DIPTERA		
Chironomidae		
Subfamily Orthocladinae		8
TOTALS:		
	INDIVIDUALS:	94
	TAXA RICHNESS:	11

Density 1/2 sample

Sept. 16, 1990

EAST FORK EAGLE CREEK
STATION #5

EPHEMEROPTERA		
Baetidae	Baetis tricaudatis	5
Ephemerellidae	Drunella doddsi	2
Heptageniidae	Cinygmula sp	12
	Rhithrogena robusta	56
	Ironodes sp	1
PLECOPTERA		
Chloroperlidae	Sweltsa sp	8
Perlidae	Calineuria californica	2
Perlodidae	Setvena bradleyi	2
Leuctridae	Paraleuctra sp	1
TRICHOPTERA		
Rhyacophilidae	Rhyacophila sp 1	5
	Rhyacophila hyalinata	3
DIPTERA		
Chironomidae		
Subfamily Orthocladinae		1
TOTALS:		
	INDIVIDUALS:	98
	TAXA RICHNESS:	12

Density whole sample

Sept. 16, 1990

MAIN FORK EAGLE CREEK
STATION #7

EPHEMEROPTERA

Baetidae	Baetis tricaudatis	4
Ephemerellidae	Drunella doddsi	2
	Drunella grandis	2
	Seratella sp	2
Heptageniidae	Cinygmula sp	8
	Rhithrogena robusta	15

PLECOPTERA

Chloroperlidae	Sweltsa sp	20
Perlidae	Hesperoperla pacifica	1
Nemouridae	Zapada columbiana	7

TRICHOPTERA

Hydropsychidae	Arctopsyche sp	2
	Hydropsyche sp	8

DIPTERA

Chironomidae		
Subfamily Orthocladinae		43
Tanypodinae		2

TOTALS:

INDIVIDUALS:	116
TAXA RICHNESS:	13

Density 1/16 sample

Sept. 16, 1990

PRICHARD CREEK
STATION #8

EPHEMEROPTERA		
Baetidae	Baetis tricaudatis	3
	Baetis bicaudatis	1
Heptageniidae	Rhithrogena robusta	50
Siphlonuridae	Ameletus sp	1
PLECOPTERA		
Chloroperlidae	Sweltsa sp	2
Perlidae	Calineuria californica	2
Perlodidae	Isoperla sp	3
TRICHOPTERA		
Brachycentridae	Micrasema sp	1
Hydropsychidae	Arctopsyche sp	1
Hydroptilidae	Agraylea sp	2
	Leucotrichia sp	1
Limnephilidae	Neothremma sp	2
Rhyacophilidae	Rhyacophila sp	1
COLEOPTERA		
Elmidae	Ostioservus sp	1
DIPTERA		
Athericidae	Atherix sp	1
Chironomidae		
Subfamily Orthocladinae		6
Chironominae		2
Tipulidae	Antocha sp	2
TOTALS:		
	INDIVIDUALS:	82
	TAXA RICHNESS:	18

Density 1/4 sample

Sept. 16, 1990

PRICHARD CREEK
STATION #9

EPHEMEROPTERA		
Baetidae	Baetis tricaudatis	9
Ephemerellidae	Drunella doddsi	1
	Drunella grandis	5
Heptageniidae	Eporeus longimanus	1
	Ironodes sp	1
	Rhithrogena robusta	33
PLECOPTERA		
Chloroperlidae	Sweltsa sp	8
Leuctridae	Paraleuctra sp	1
Nemouridae	Zapada columbiana	7
Perlidae	Calineuria californica	1
Perlodidae	Isoperla sp	2
TRICHOPTERA		
Brachycentridae	Brachycentrus sp	3
	Microsema sp	1
Glossostomatidae	Glossosoma sp	1
Hydropsychidae	Arctopsyche sp	4
	Hydropsyche sp	16
Hydroptilidae	Agraylea sp	11
Lepidostomatidae	Lepidostoma sp	2
Limnephilidae	Apatania sp	4
COLEOPTERA		
Elmidae	Ostioservus sp	1
DIPTERA		
Athericidae	Atherix sp	2
Chironomidae		
Subfamily Orthocladinae		10
Chironominae		3
Tanypodinae		1
Simuliidae	Simulium sp	1
TOTALS:		
	INDIVIDUALS:	129
	TAXA RICHNESS:	25

DENSITY 1/8 SAMPLE

Sept. 16, 1990

WEST FORK EAGLE CREEK
STATION #10

EPHEMEROPTERA		
Baetidae	Baetis tricaudatis	5
	Baetis bicaudatis	1
Ephemerellidae	Drunella grandis	15
Heptageniidae	Cinygmula sp	2
	Rhithrogena robusta	23
PLECOPTERA		
Chloroperlidae	Sweltsa sp	22
Leuctridae	Paraleuctra sp	1
Nemouridae	Zapada columbiana	2
TRICHOPTERA		
Rhyacophilidae	Rhyacophila narvae	2
	Rhyacophila vaccua	1
	Rhyacophila sp 3	4
COLEOPTERA		
Elmidae	Ostioservus sp	12
DIPTERA		
Athericidae	Atherix sp	4
Chironomidae		
Subfamily Orthocladinae		1
TOTALS:		
	INDIVIDUALS:	95
	TAXA RICHNESS:	14

DENSITY 1/2 SAMPLE

Sept. 16, 1990

WEST FORK EAGLE CREEK
STATION #11

EPHEMEROPTERA		
Baetidae	Baetis tricaudatis	8
	Psuedocloeon sp	1
Ephemerellidae	Drunella doddsi	4
	Drunella grandis	6
Heptageniidae	Rhithrogena robusta	22
PLECOPTERA		
Chloroperlidae	Sweltsa sp	11
	Sweltsa sp 2	2
Nemouridae	Zapada columbiana	2
Perlidae	Calineuria californica	1
Perlodidae	Skwala sp	6
	Setvena bradleyi	1
TRICHOPTERA		
Brachycentridae	Brachycentrus sp	4
Hydropsychidae	Arctopsyche sp	14
Hydroptilidae	Agraylea sp	1
Rhyacophilidae	Rhyacophila sp	1
Limnephilidae	Unknown #1	1
	Unknown #2	1
COLEOPTERA		
Elmidae	Ostioservus sp	2
DIPTERA		
Chironomidae		
Subfamily Orthocladinae		11
Chironominae		4
Empididae	Oreogeton sp	1
Simuliidae	Simulium sp	4
Tipulidae	Antocha sp	4
TOTALS:		
	INDIVIDUALS:	112
	TAXA RICHNESS:	23

DENSITY 1/8 SAMPLE

Sept 16, 1990

UPPER COEUR D'ALENE RIVER

EPHEMEROPTERA		
Baetidae	Baetis tricaudatus	1
	Baetis bicaudatus	1
Ephemerellidae	Drunella doddsi	1
	Drunella grandis	1
	Ephemerella infrequens	3
Heptageniidae	Rhithrogena robusta	19
PLECOPTERA		
Perlidae	Calineuria californica	16
TRICHOPTERA		
Hydropsychidae	Arctopsyche grandis	2
	Hydropsyche sp	1
Lepidostomatidae	Lepidostoma sp	45
Rhyacophilidae	Rhyacophila acropedes	2
	Rhyacophila arnaudi	2
COLEOPTERA		
Elmidae	Ostioservus sp	4
	Zaitzevia parvula	1
DIPTERA		
Ceratopogonidae	Bezzia sp	1
Chironomidae		
Subfamily Tanypodinae		1
Simuliidae	Simulium sp	1
Tipulidae	Antocha sp	2
	Limnophila sp	1
TOTALS:		
	INDIVIDUALS:	105
	TAXA RICHNESS:	19

Density 1/8 sample

Sept. 16, 1990

JORDAN CREEK

EPHEMEROPTERA		
Baetidae	Baetis tricaudatis	10
Ephemerellidae	Drunella doddsi	1
	Drunella grandis	1
	Serratella sp	11
Heptageniidae	Rhithrogena robusta	22
Leptophlebiidae	Paraleptophlebia sp	3
PLECOPTERA		
Chloroperlidae	Sweltsa sp 1	15
	Sweltsa sp 2	1
	Kathroperla sp	1
Leuctridae	Paraleuctra sp	1
Nemouridae	Zapada columbiana	5
Perlidae	Calineuria californica	1
Perlodidae	Skwala sp	2
TRICHOPTERA		
Brachycentridae	Brachycentrus sp	1
Hydropsychidae	Arctopsyche sp	1
Hydroptilidae	Agraylea sp	1
Limnephilidae	Apatania sp	1
Rhyacophilidae	Rhyacophila acropedis	2
	Rhyacophila vaccua	2
COLEOPTERA		
Elmidae	Ostioservus sp	2
DIPTERA		
Athericidae	Atherix sp	1
Chironomidae		
Subfamily Orthocladinae		11
Chironominae		2
Simuliidae	Simulium sp	1
Tipulidae	Antocha sp	2
Psychodidae	Pericoma sp	2
Pelecorhynchidae	Gluctops sp	3
TOTALS:		
	INDIVIDUALS:	106
	TAXA RICHNESS:	26

Sept. 16, 1990

CINNAMON CREEK

EPHEMEROPTERA		
Baetidae	Baetis tricaudatis	12
Ephemerellidae	Drunella doddsi	15
Heptageniidae	Rhithrogena robusta	7
	Cinygmula sp	4
	Ironodes sp	3
PLECOPTERA		
Chloroperlidae	Sweltsa sp	21
	Alloperla sp	1
Perlodidae	Skwala sp	1
TRICHOPTERA		
Brachycentridae	Brachycentrus sp	1
Glossosomatidae	Anagapetus sp	1
Hydropsychidae	Parapsyche sp	1
Lepidostomatidae	Lepidostomatidae sp	2
Rhyacophilidae	Rhyacophila sp	1
COLEOPTERA		
Elmidae	Ostioservus sp	7
DIPTERA		
Chironomidae		
Subfamily Orthocladinae		19
Chironominae		2
Tipulidae	Antocha sp	3
TOTALS:		
	INDIVIDUALS:	101
	TAXA RICHNESS:	17

DENSITY 1/4 SAMPLE

Sept. 16, 1990

ALDEN CREEK

EPHEMEROPTERA

Baetidae	Baetis tricaudatis	5
Ephemerellidae	Drunella doddsi	12
	Drunella grandis	2
	Seratella sp	8
Heptageniidae	Cinygmula sp	12
	Epeorus longimanus	1

PLECOPTERA

Chloroperlidae	Sweltsa sp	28
Perlidae	Calineuria californica	1
Perlodidae	Megarcys sp	2

TRICHOPTERA

Hydropsychidae	Arctopsyche sp	2
Limnephilidae	Ecclisomyia sp	1
Psychomyiidae	Psychomyia sp	1
Rhyacophilidae	Rhyacophila sp	1

COLEOPTERA

Elmidae	Ostioservus sp	7

DIPTERA

Chironomidae		
Subfamily Orthocladinae		10
Tanypodinae		7
Tipulidae	Hexatoma sp	1

TOTALS:

	INDIVIDUALS:	101
	TAXA RICHNESS:	17

Density 1/8 sample

Sept. 16, 1990

DEER CREEK

EPHEMEROPTERA		
Baetidae	Baetis tricaudatis	1
Ephemerellidae	Drunella doddsi	1
	Drunella grandis	3
Heptageniidae	Rhithrogena robusta	8
PLECOPTERA		
Chloroperlidae	Sweltsa sp	23
	Alloperla sp	3
Perlodidae	Skwala sp	8
	Cultus sp	2
TRICHOPTERA		
Brachycentridae	Brachycentrus sp	1
Hydropsychidae	Arctopsyche sp	3
Hydroptilidae	Agraylea sp	1
Limnephilidae	Ecclisomyia sp	1
Rhyacophilidae	Rhyacophila sp	1
COLEOPTERA		
Elmidae	Ostioservus sp	2
DIPTERA		
Chironomidae		
Subfamily Orthocladinae		7
Tipulidae	Hexatoma sp	1
TOTALS:		
	INDIVIDUALS:	66
	TAXA RICHNESS:	16

Density 1/2 sample