Technical Report No. 00-2

Aquatic Taxa Monitoring Study At Red Dog Mine, 1997-1998

by **Phyllis Weber Scannell**
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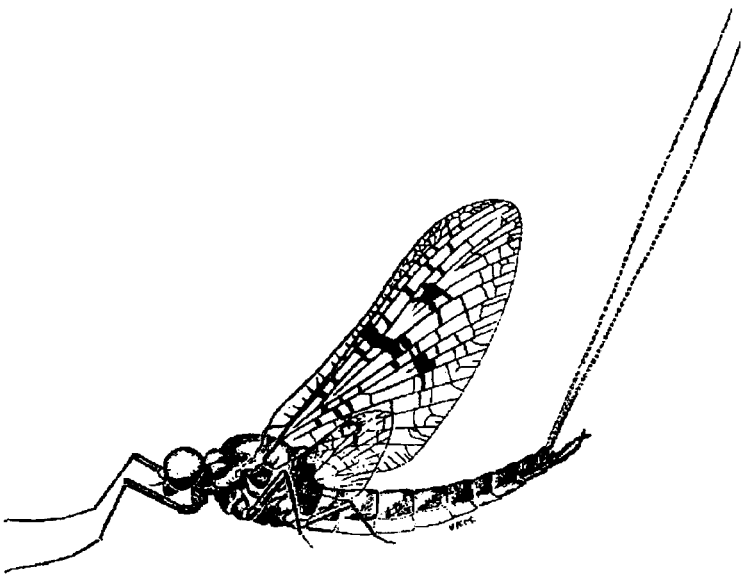

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The draft of this report was submitted to the following companies or agencies for their review and comment. All comments received by ADF&G were considered for the final report.

Requested Reviewers:

Alaska Department of Fish and Game
- Division of Habitat and Restoration
- Division of Sport Fish

Alaska Department of Environmental Conservation
- Air and Water Division

U.S. Environmental Protection Agency
- Office of Water, Water Quality Standards
- Office of Water, NPDES Compliance Unit
- Office of Regional Counsel
- Office of Water, NPDES Permit Unit

State of Alaska, Attorney General's Office
Hartig, Rhodes Inc.
Cominco Alaska Inc, Environmental Management Section

The Alaska Department of Fish and Game thanks all of the people who gave this document careful review and provided comments.

EXECUTIVE SUMMARY

The Alaska Department of Fish and Game, Division of Habitat and Restoration monitored streams adjacent to and downstream of the Red Dog Mine for two years (1997-1998) to determine the extent these sites continue to support communities of aquatic invertebrates and algae. We sampled aquatic invertebrates from drift and periphyton, or attached algae, in June and July. We also examined samples of stream substrate with 10 to 20 power hand lenses to detect colonization by micro-invertebrates. Sampling for micro-invertebrates did not produce useful results: we detected no new taxa, only those more effectively collected with drift nets. Therefore, these results were not presented.

Drift samples, combined with estimates of periphyton biomass (estimated by concentrations of chlorophyll-a) were valuable measures for characterizing the complexity of the aquatic communities. Both periphyton and aquatic invertebrate communities are sensitive to changes in water quality and reflect changes that occur within a small area of the watershed. Unlike fish, these species are not migratory and their continued success relates directly to water quality conditions within the area where they are collected.

Sampling occurred while the Red Dog ore body was being actively mined. We selected sites upstream of the ore body in Red Dog Creek and its tributaries and downstream of the mine effluent. Reference sites included creeks with natural mineralization. Because the surrounding areas are highly mineralized, it was not possible to locate any reference sites in creeks without some metal pollution. Predominant metals at all sites sampled were Al, Cd, Cu, Pb, Se, and Zn. Zn concentrations were highest in the right fork at the headwaters of Ikalukrok Creek (average for May-Sept. 1998 = 4450 *u*g/L) and upstream of the Red Dog ore body (average for May-Sept. 1998 = 2015 *u*g/L).

Lowest concentrations of Zn were found in the North Fork of Red Dog Creek (1998 average = 16 *u*g/L) and the left fork of the headwaters of Ikalukrok Creek, Alvinella

Site 2 (average = 12.5 *u*g/L). Neither of these sites are influenced by mining. Overall, these two sites have lowest concentrations of all metals.

Four sites in the headwaters of Ikalukrok Creek were sampled in 1997 and 1998. In July 1998, we also sampled an additional site upstream of known mineralization Alvinella 5. The sites at Alvinella provide a useful understanding of the effects of mineralization that are not related to development or operation of a mine.

The right fork at the headwaters of Ikalukrok Creek, Alvinella 1, is located below a small tributary draining an area of known mineralization. Productivity in Alvinella 1 was low. There were no detectable amounts of chlorophyll-a on the substrate at this site.

In contrast to Alvinella 1, the left fork of the headwaters of Ikalukrok Creek (Alvinella 2 is the upstream site and Alvinella 3 is the downstream site) contains clear water and has low concentrations of metals and high concentrations of chlorophyll-a, especially in July 1998. This site also is important for summer rearing of Arctic grayling.

Sites near and downstream of the Red Dog Mine may be influenced by a complex interaction of natural mineralization, mine effluent (with elevated total dissolved solids in the form of calcium sulfate), ground disturbance (including possible exposure of mineralized soils), and enrichment (from domestic sewage in the mine effluent). The lowest periphyton standing crop and aquatic invertebrate abundance and taxonomic richness occurred in sites with the highest concentrations of Cd and Zn.

The Main Stem of Red Dog Creek, after mixing with the North Fork of Red Dog Creek, shows a substantial increase in both periphyton and aquatic invertebrate populations, although invertebrate abundance is low compared to tributary and downstream sites. We found young-of-the-year Arctic grayling in this site in both 1997 and 1998. The small size of these fish (estimated 4 days post-hatch) suggests adult Arctic graying spawned in this site.

All sites in Ikalukrok Creek, including Station 9 upstream of Red Dog Creek, had high periphyton productivity and low to medium abundance of aquatic invertebrates. These sites are high energy systems with limited pool or run habitat. Physical habitat features,

including stream flows and substrate, likely constrain invertebrate populations in these sites. The North Fork of Red Dog Creek showed high productivity of both periphyton and aquatic invertebrates. This stream is relatively low in metals and has dense riparian vegetation. The North Fork of Red Dog Creek supports a healthy population of Arctic grayling and Dolly Varden.

Tributary streams upstream of the ore body, Connie Creek and Shelly Creek, had numerous aquatic invertebrates and sparse periphyton.

Overall, we found the relative productivity of the study sites to be similar to baseline studies. Sites closest to the Red Dog ore body show lowest productivity. Productivity in Ikalukrok Creek may be limited by a combination of chemical and physical features: some mineralization, precipitation of metals from upstream sites, high stream velocity, and lack of diverse pool-riffle habitat.

INTRODUCTION

The Red Dog Mine is located at approximately 68°13' N latitude by 163° W longitude in the southwestern DeLong Mountains, a component of the Brooks Range in Alaska's Arctic (Figure 1). Lying within the DeLong Mountains Quadrangle, the area termed the Red Dog Prospect is a rich surficial showing of copper, lead, zinc, and silver ore located throughout the upper reaches of the Red Dog Creek drainage. Dames and Moore (1983) described the geology:

> The DeLong Mountains lie within the Rocky Mountain System and are characterized by low mountains, plateaus, and highlands of a rolling topography with summits between 300 and 1500 m. Most peaks in the southwestern area are less than 900 m in height and unglaciated; lower hills have been rounded by extreme weathering, although upthrust rock formations with jagged peaks are not uncommon. The area is underlain by continuous permafrost to depths in excess of 60 m. The regional geology is sedimentary with some evidence of later volcanic activity. The geology is Mesozoic, characterized by sandstone and shale of marine and non-marine origin.

HYDROLOGY

Red Dog Creek from its source to Ikalukrok Creek, tributaries to Middle Fork Red Dog Creek, and portions of Ikalukrok Creek freeze in late October; by mid-winter there is no flowing surface water. Isolated pools may form in Ikalukrok Creek; this water usually has low (<1 mg/L) dissolved oxygen and high metals and dissolved solids concentrations. Fish do not survive in these conditions. The North Fork of Red Dog Creek may contain some spring water input, but probably does not contain any flowing water suitable for overwintering fish. The winter distribution of fish appears to be limited to Ikalukrok Creek downstream of the confluence with Dudd Creek and in the Wulik River. When breakup occurs (usually in late May), Arctic graying migrate upstream in Ikalukrok Creek to the Mainstem of Red Dog Creek and into the North Fork of Red Dog Creek.

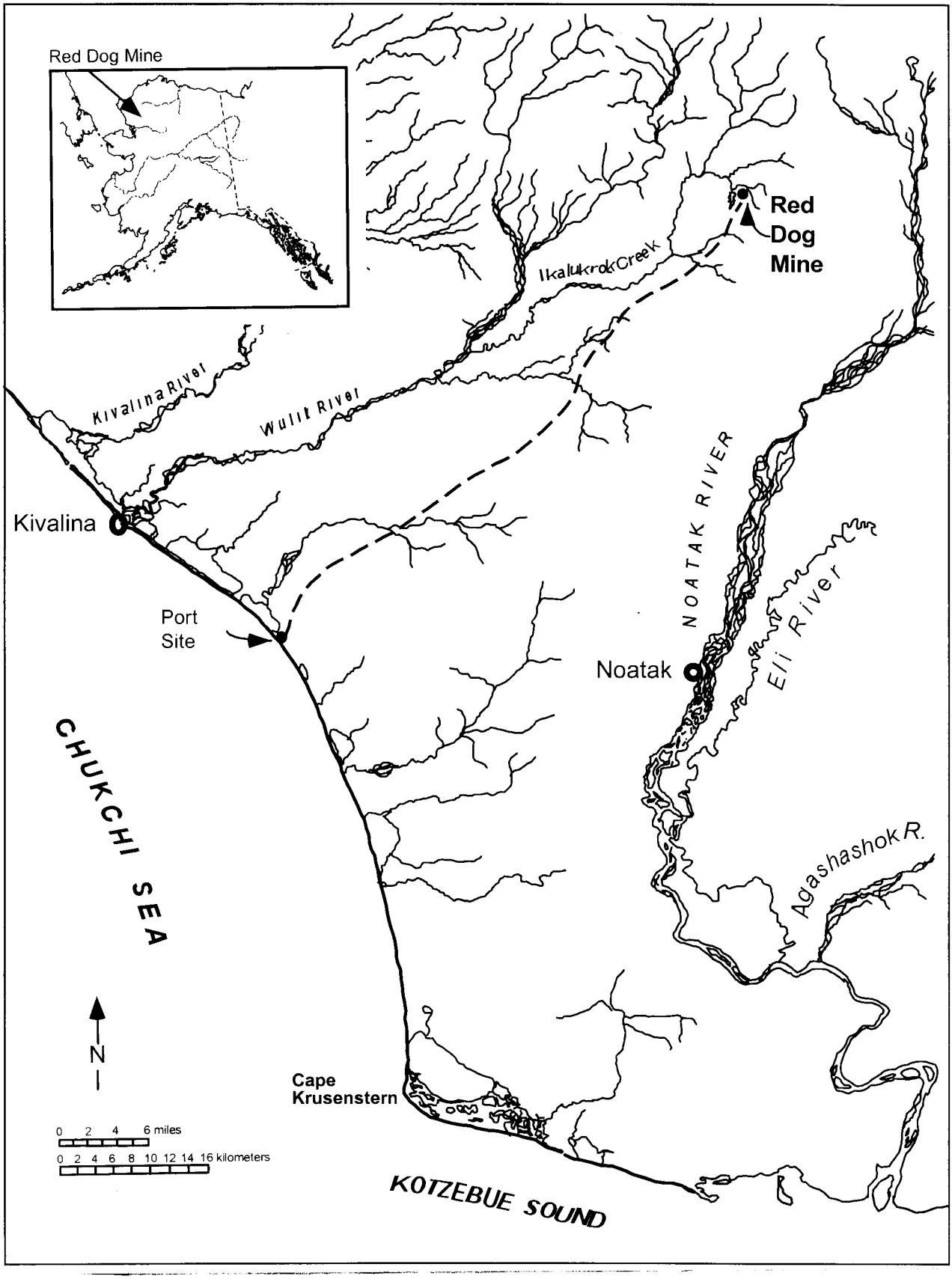

Figure 1. Location of the Red Dog Mine, in northwestern Alaska.

The area is treeless, frequently windswept with a mean annual temperature of 2 to 4°C. The area is remote, with access by airplane or summer barge. The mine site is approximately 90 km (55 miles) by gravel road from the ocean port. Vegetation ranges from open tall scrub along stream margins to open low scrub on the hillsides. The terrain is characterized by continuous permafrost. Waterfowl and shorebirds frequent the coast during spring and fall migrations. The Western Arctic caribou herd migrates through the region of the Red Dog Mine. Other large mammals found near the mine site are musk oxen, moose, Dall's sheep, wolf, and brown bear.

Red Dog Creek runs through the mine deposit, emptying into Ikalukrok Creek, which then drains into the Wulik River. Pink salmon (*Oncorhynchus gorbuscha*), chum (*O. keta*), coho (*O. kisutch*), sockeye (*O. nerka*), and chinook salmon (*O. tshawytscha*), Dolly Varden (*Salvelinus malma*), burbot (*Lota lota*), slimy sculpin (*Cottus cognatus*), humpback (*Coregonus pidschian*) and round whitefish (*Prosopium cylindraceum*), least (*Coregonus sardinella*) and Bering (*C. laurettae*) cisco, Alaska blackfish (*Dallia pectoralis*), ninespine stickleback (*Pungitius pungitius*) and Arctic grayling (*Thymallus arcticus*) are found in the Wulik River. Arctic grayling, slimy sculpin, and juvenile Dolly Varden migrate upstream in Ikalukrok Creek, through the Mainstem of Red Dog Creek, and into the North Fork of Red Dog Creek in early summer to rear and then return to the Wulik River in fall to overwinter. Chum salmon spawn in the lower reaches of Ikalukrok Creek in late July and in August. Dolly Varden spawn in Ikalukrok Creek during late August through September.

The Red Dog deposit is located in the valley of Red Dog Creek. Since 1989, Cominco Alaska Incorporated (Cominco) has operated the Red Dog Mine, producing concentrates of zinc, lead, and smaller amounts of other metals. Metal-bearing rock is removed from an open pit and transferred to the mill, where it is ground. A flotation process removes metals from the ground ore and produces a concentrate. Water from the tailing pond and mill process water is treated on site and discharged to Red Dog Creek. The effluent contains concentrations of metals that are typically lower than the receiving water, but with elevated total dissolved solids.

The Inupiaq village of Kivalina is located at the mouth of the Wulik River. Residents of Kivalina use water from the Wulik River for drinking, and depend on fish from the river year around as a major food source. Local residents from Kivalina and Noatak hunt for caribou and moose in the areas surrounding the mine.

OBJECTIVES

The purpose of this study is to gather information on aquatic invertebrate communities to allow the government agencies who monitor and regulate discharges from the mine to better understand and manage the effects of the discharge, if any, over time on the aquatic taxa and fish populations found in the receiving waters. Periphyton density and invertebrate communities are sensitive to changes in water quality and may be used as a monitoring tool.

The project includes gathering data on benthic macro and micro invertebrates and on periphyton from selected sites downstream from the Red Dog Mine water treatment plant. These data will be compared with historical data and data from sites unaffected by the mine to identify any significant changes. This information, with existing fish and water quality information, will be used as the basis for evaluating whether observed changes, if any, occur in the types and numbers of aquatic taxa, and whether these changes may be due to natural or mining related conditions or events.

LOCATIONS OF SAMPLE SITES

The study focused on stream habitats that were directly exposed to mining activity or treated mine effluent (Figure 2). Several sites, including the sites in upstream Ikalukrok Creek at Alvinella (Figure 3), were included as examples of sites that, although not influenced by mining activity, are located in areas of known mineralization. The North Fork of Red Dog Creek provides an example of stream habitat not potentially affected by mining activities, of known high productivity for fish, and of relatively low mineralization. A description of the sites included in this study is listed below, followed by the station number.

Stream or Site Name	Station Number
Ikalukrok Creek downstream of Dudd Creek	Station 7
Ikalukrok Creek upstream of Dudd Creek	
Ikalukrok Creek downstream of Red Dog Creek	Station 8
Ikalukrok Creek upstream of Red Dog Creek	Station 9
Ikalukrok Creek at the headwaters: (4 sites):	
Right fork below mineralized input	Alvinella 1
left fork, about 4 km upstream of confluence	Alvinella 2
left fork, at confluence	Alvinella 3
below the confluence of the right and left forks	Alvinella 4
Shelly Creek	
Connie Creek	
North Fork of Red Dog Creek	Station 12
Red Dog Creek at three sites:	
Above the mine pit	
Below the effluent	Station 20
Below the confluence with the North Fork	Station 10

DESCRIPTION OF STREAMS

All of the streams in this study are in the Wulik River watershed. Middle Fork Red Dog Creek flows adjacent to the Red Dog ore body; Shelly and Connie Creek flow into the stream bypass ditch. Water quality and fisheries data collected during baseline studies (1979-1982) represent pre-mining conditions because no disturbance had occurred in this drainage at that time.

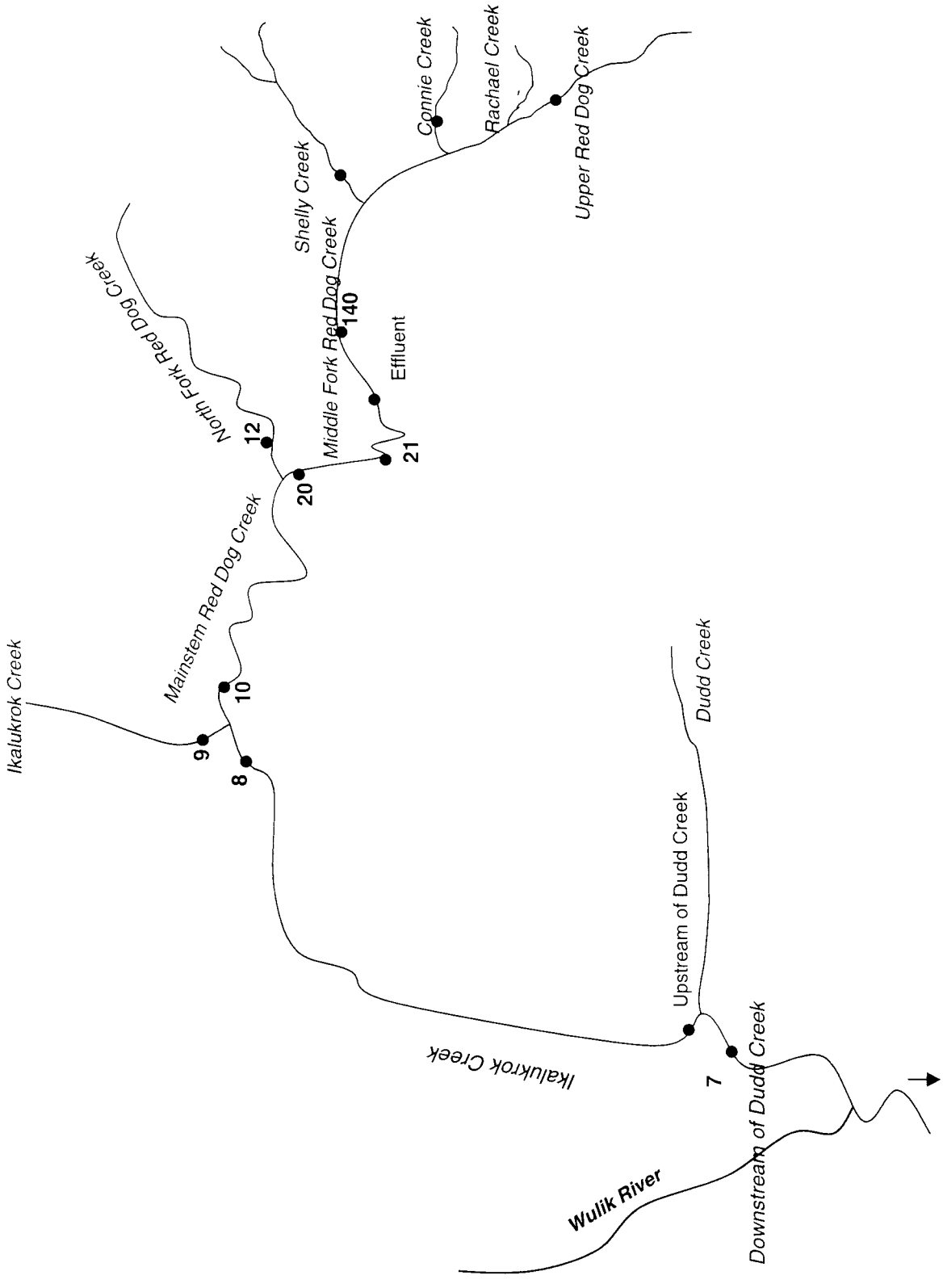

Figure 2. Locations of sites in the Red Dog Creek drainage for aquatic sampling. Station numbers correspond to the numbers used by Dames and Moore (1983) in baseline studies and current water sampling conducted by Cominco Alaska.

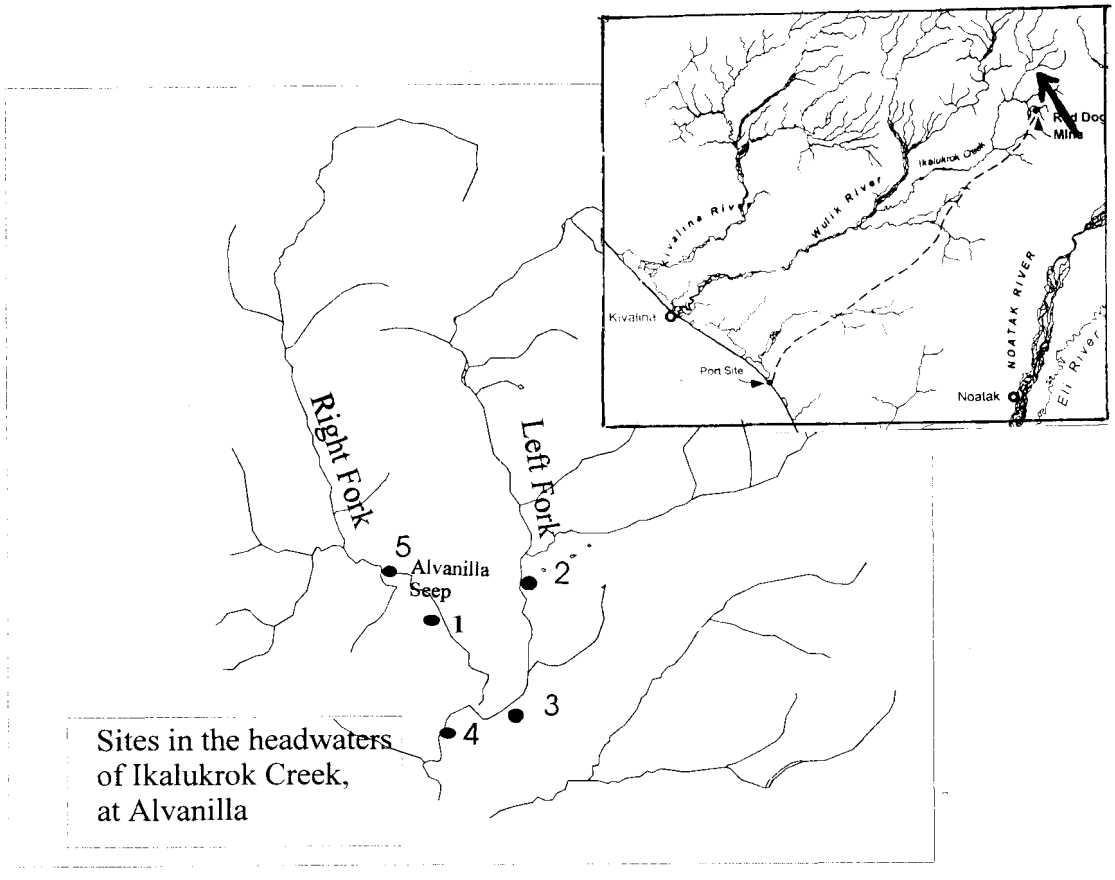

Figure 3. Location of sites in the headwaters of Ikalukrok Creek for aquatic sampling.

Water quality monitoring has been conducted throughout the Wulik River drainage since 1979, before development of the Red Dog Mine. Water quality monitoring after development of the Red Dog Mine was conducted at many of the same stations, using the same station numbers, as baseline monitoring conducted by Dames and Moore. Baseline monitoring conducted by EVS and Ott Water Engineers (1983) was done at many of the same stations; however, different station numbers were assigned. Where stations are at the same location, the station numbers established by Dames and Moore are used for the EVS and Ott Water Engineers (1983) data. Only limited baseline water quality monitoring was conducted in tributaries to Middle Fork Red Dog Creek.

Temperature data reflect the time when samples were taken; in some years sampling was extended to later dates than other years. Maximum water temperature is useful in characterizing the maximum thermal inputs. When evaluating water quality and metals data to characterize this site, we used only data collected during the open water period, approximately June 1 through October 15. Stream flow data from 1998 (from US Geological Survey and Cominco Alaska) are presented to illustrate the relative stream flows at each site and the seasonal variations.

IKALUKROK CREEK

Four segments of Ikalukrok Creek were considered in this study: Ikalukrok Creek at the headwaters (both right and left forks at the Alvinella deposit), Ikalukrok Creek upstream of Red Dog Creek (Station 9), Ikalukrok Creek below the confluence with Red Dog Creek (Station 8), and Ikalukrok Creek at Dudd Creek (sampling was done both above and below the confluence of Dudd Creek). Limited water quality monitoring was done in upper Ikalukrok Creek in 1997 and 1998; no monitoring was done during baseline studies.

ALVINELLA

The right fork of upper Ikalukrok Creek flows through a mineralized zone; seeps containing abundant precipitates of aluminum, iron, and other metals flow into this stream about 2 km upstream of the mouth (Figure 4). Water samples were analyzed for water quality and metals seven times in 1997 and metals were sampled once in 1998. Stream water is moderately hard with circumneutral pH (Table 1) and elevated concentrations of Al, Cd, Pb, Zn, Fe, Mn, and Ni (Figure 5). Concentrations of sulfate were higher than measured at the other sites in upper Ikalukrok Creek.

Figure 4. Ikalukrok Creek (Alvinella 1), right fork at headwaters, downstream of mineralized input at Alvinella deposit.

Table 1. Median water quality characteristics at Alvinella 1 in June through August1997. Data from Cominco Alaska.

Analyte, units	median	maximum	minimum	n
Hardness, mg/L	126	192	94.5	7
Total Dissolved Solids, mg/L	206	306	144	7
Sulfate, mg/L	100	190	63	7
pH	7.1	8.0	6.5	8
Temperature, °C	9.1	17.7	5.5	8
Specific Conductance, *u*Si/cm	255.5	443	202	8
NH_3-N, mg/L	ND	ND	ND	7

ND = not detected.

The left fork of Ikalukrok Creek was sampled at two locations: near the mouth (Alvinella 3, N 68° 9.09', W 162° 51.93') and approximately 4 km upstream (Alvinella 2, N 68° 11.33', W 162° 51.73'). A small mineralized zone has been identified downstream of Alvinella 2.

Alvinella 2 is a moderately flowing, clear water tributary with sparse streamside vegetation and a substrate of small and medium sized gravel (Figure 6). Cominco Alaska sampled water at Alvinella 2 for water quality and metals eight times in 1997; no samples were collected in 1998. In 1997, water quality at this site had moderate hardness, slightly basic pH, low nutrients (Table 2) and low metals (Figure 7). Water temperatures were highest in July (15.5 ° C) then cooled in mid-August to 5.2 ° C.

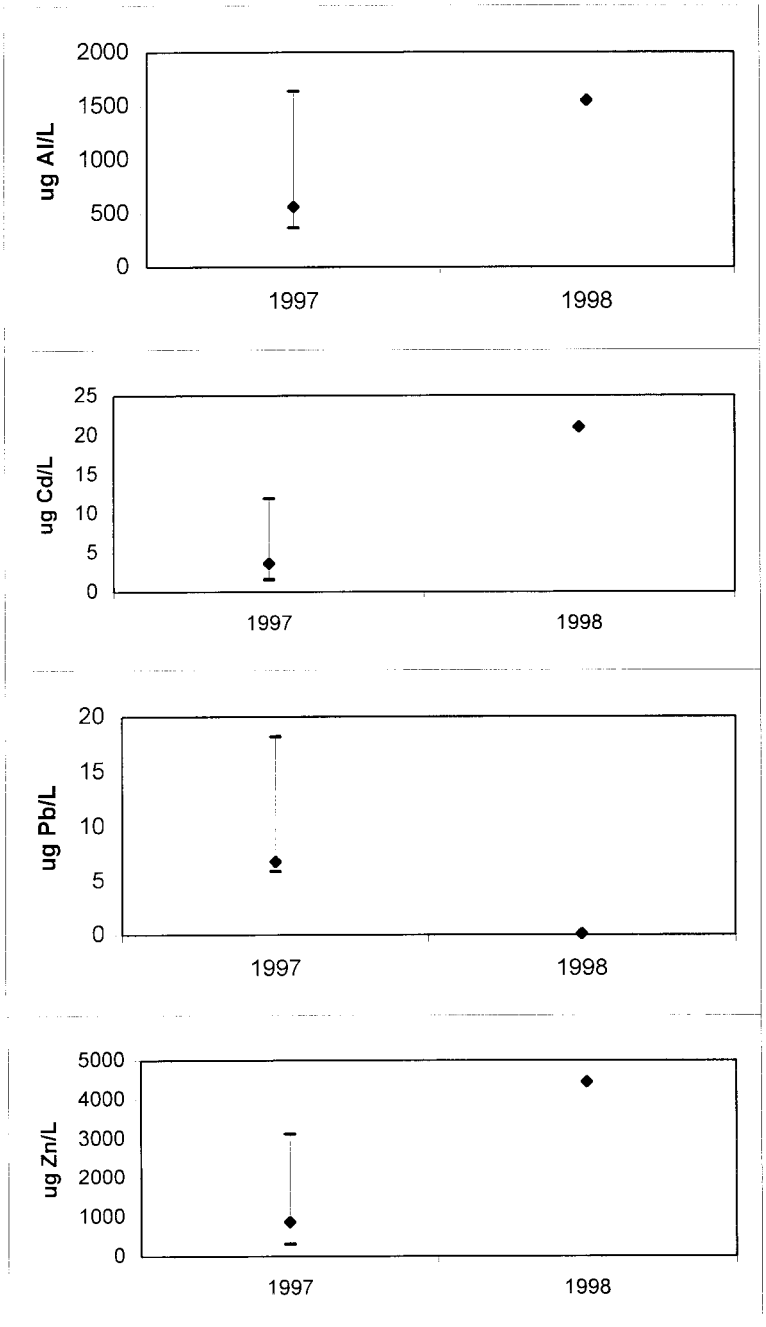

Figure 5. Median, maximum, and minimum concentrations of select metals at Alvinella 1 in 1997 and one measurement in 1998. Data from Cominco Alaska.

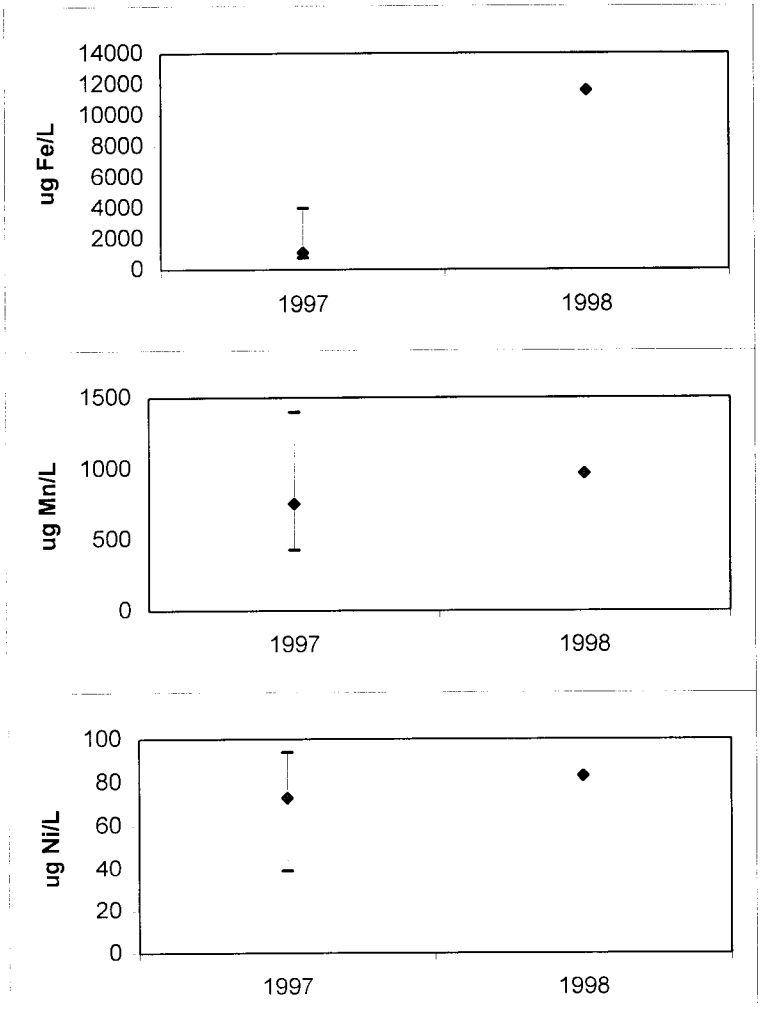

Figure 5, continued.

Figure 6. Alvinella 2 left fork, about 4 km upstream of the confluence of two forks of upper Ikalukrok Creek.

Table 2. Median water quality characteristics at Alvinella 2, June through August 1997. Data from Cominco Alaska.

Analyte, units	median	maximum	minimum	n
Hardness, mg/L	141	149	110	7
Total Dissolved Solids, mg/L	166	213	141	7
Sulfate, mg/L	32	98	24	7
pH	8.2	8.3	7.4	8
Temperature, °C	8.4	15.5	5.2	8
Specific Conductance, *u*hms/cm	249	301	179	8
NH_3-N, mg/L	ND	ND	ND	7

ND = not detected.

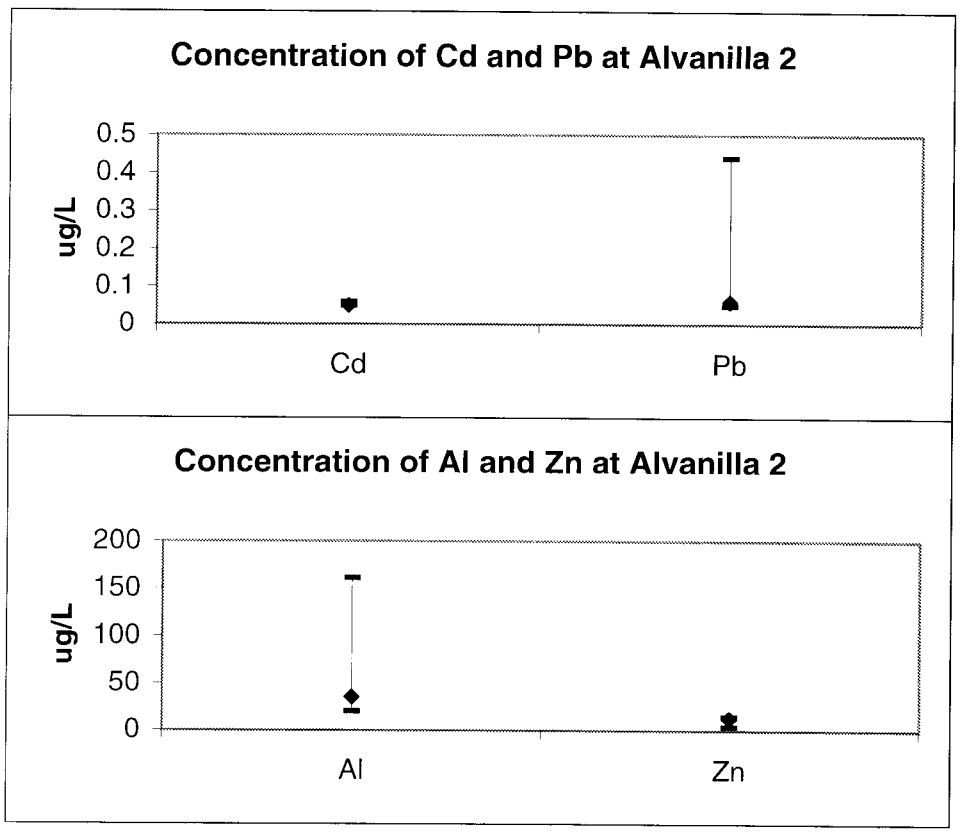

Figure 7. Median, maximum, and minimum concentrations of select metals at Alvanilla 2 in 1997 and one measurement in 1998. Data from Cominco Alaska.

Alvinella 3, the downstream site on the right fork of upper Ikalukrok Creek, is rapidly flowing with large cobble substrate (Figure 8). Adult Arctic grayling are found in large pools along the stream banks. Water quality is similar to Alvinella 2, with moderate hardness and total dissolved solids, slightly basic pH (Table 3) and low metals (Figure 9).

Table 3. Median water quality characteristics at Alvinella 3 in June-August 1997. Data from Cominco Alaska.

Analyte, units	median	maximum	minimum	n
Hardness, mg/L	141	148	112	7
Total Dissolved Solids, mg/L	158	196	120	7
Sulfate, mg/L	27	31	16	7
pH	8.3	8.5	7.8	8
Temperature, °C	9.15	17.4	4.8	8
Specific Conductance, *uSi*/cm	284	293	231	8
NH_3-N, mg/L	ND	ND	ND	7

ND = not detected.

Figure 8. Ikalukrok Creek (Alvinella 3) left fork near confluence of right and left forks.

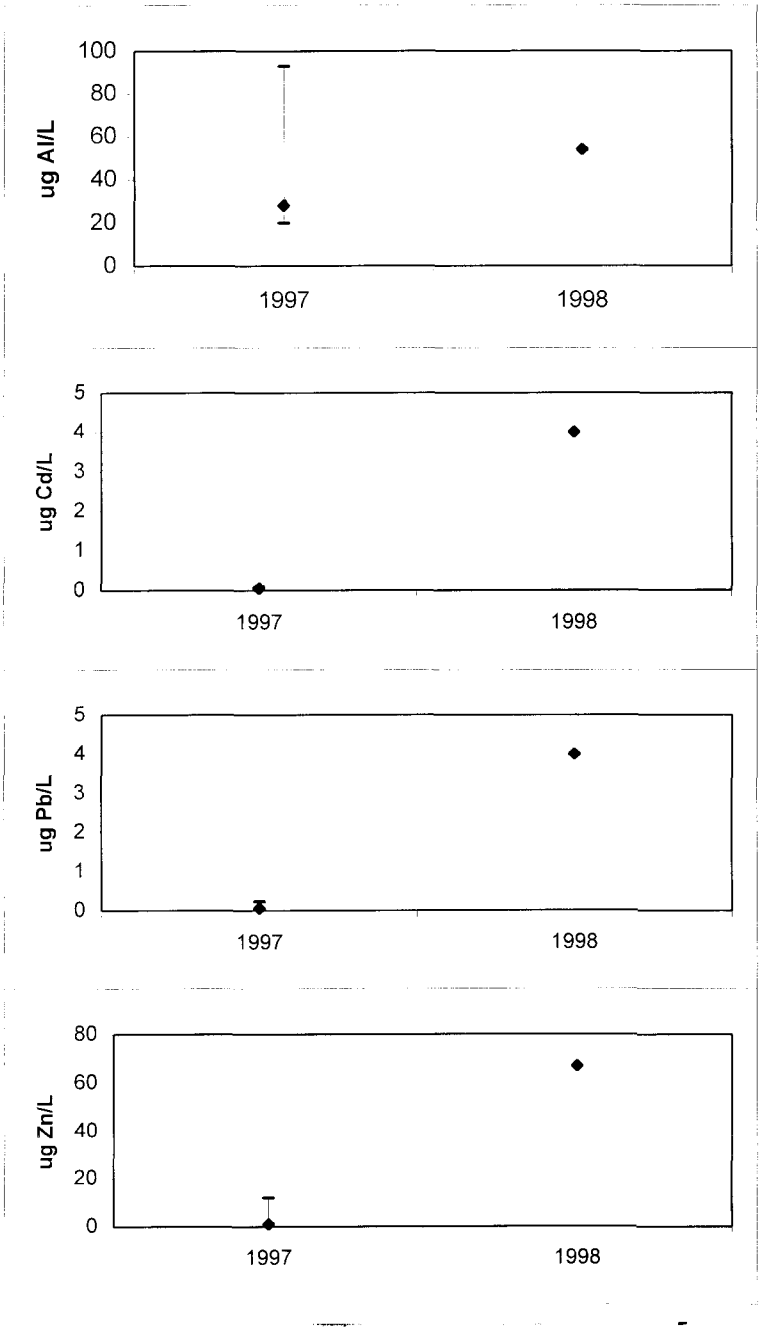

Figure 9. Median, maximum, and minimum concentrations of select metals at Alvinella 3 in 1997 and one measurement in 1998. Data from Cominco Alaska.

The site at Alvinella 4 combines water from both forks of upper Ikalukrok Creek. Iron stain on the stream edges and iron precipitate on the stream bottom are prevalent (Figure 10). Arctic grayling were not found immediately below the confluence of the two forks, but were present about 0.5 km below. A family of Harlequin ducks (a hen and six chicks) was foraging in the sample area during July 1998.

Figure 10. Ikalukrok Creek (Alvinella 4) at headwaters, below confluence of right and left forks.

Water quality sampling at Alvinella 4 characterized this site as having slightly basic pH, moderate hardness, total dissolved solids, and sulfate, and low nutrients, as represented by ammonia-nitrogen (Table 4). Concentrations of Al and Zn were elevated over concentrations in Alvinella 3: limited data in 1998 showed Al 6 times greater than in Alvinella 3 and Zn 25 times higher than at Alvinella 3 (Figure 11).

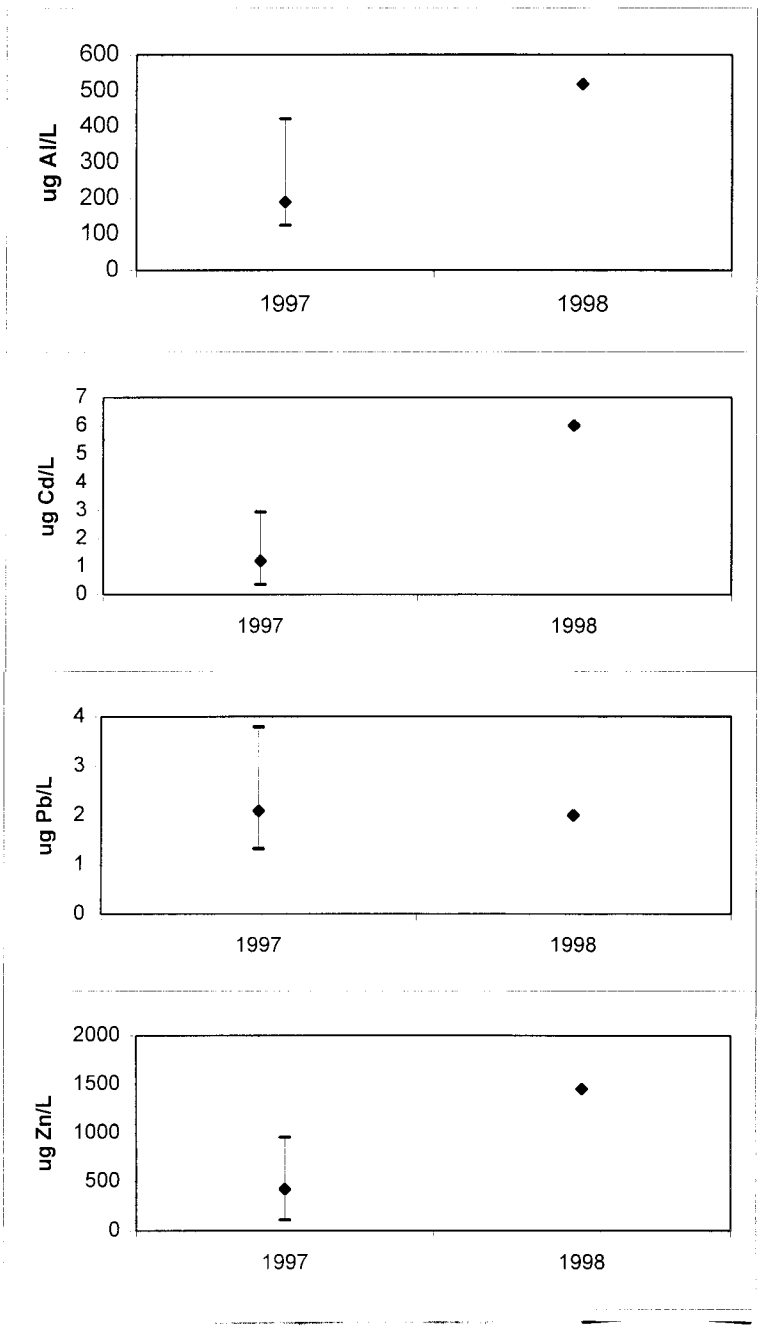

Figure 11. Median, maximum, and minimum concentrations of select metals at Alvinella 4 in 1997 and one measurement in 1998. Data from Cominco Alaska.

Table 4. Median water quality characteristics at Alvinella 4 in June through August1997. Data from Cominco Alaska.

Analyte, units	median	maximum	minimum	n
Hardness, mg/L	132	158	108	7
Total Dissolved Solids, mg/L	173	194	119	7
Sulfate, mg/L	49	69	24	7
pH	8.0	8.9	7.1	8
Temperature, °C	9.2	17.9	5.1	8
Specific Conductance, *uSi*/cm	279	318	170	8
NH_3-N, mg/L	ND	ND	ND	7

ND = not detected.

STATION 9

Ikalukrok Creek above the confluence with Red Dog Creek has a drainage area of 150 km^2 (59.2 mi^2). The creek flows through mineralized zones and red iron flocculent is prevalent in side channels, smaller tributaries, and backwater areas (Figure 12). Stream bed rocks frequently are stained orange from iron precipitate. The high mean monthly flow during the open water period is estimated at 17.3 m^3/s (610 cfs) and the low flow estimated at 0.02 m^3/s (0.58 cfs). At Station 9, stream width ranges from 2 to 7 m (7 to 24 ft) (up to 21 m or 68 feet in high flow years), with depths ranging from 0.15 to 1.2 m (0.5 to 4 feet). The streambed at Station 9 consists of gravel, cobbles, and rocks. Mining or other human activity has not disturbed this section of Ikalukrok Creek.

Figure 12. Ikalukrok Creek upstream of Red Dog Creek (Station 9).

The water quality at Station 9 has been monitored intermittently since 1982, with more consistent monitoring during the past 5 years. No data are available for concentrations of sulfate.

Water quality at Station 9 is similar to upstream sites at the headwaters of Ikalukrok Creek, except with lower minimum pH and higher maximum hardness (Table 5). Concentrations of Al, Cd, Pb, and Zn were similar in 1997 (Figure 13) to the upstream site, Alvinella 4 (Figure 11).

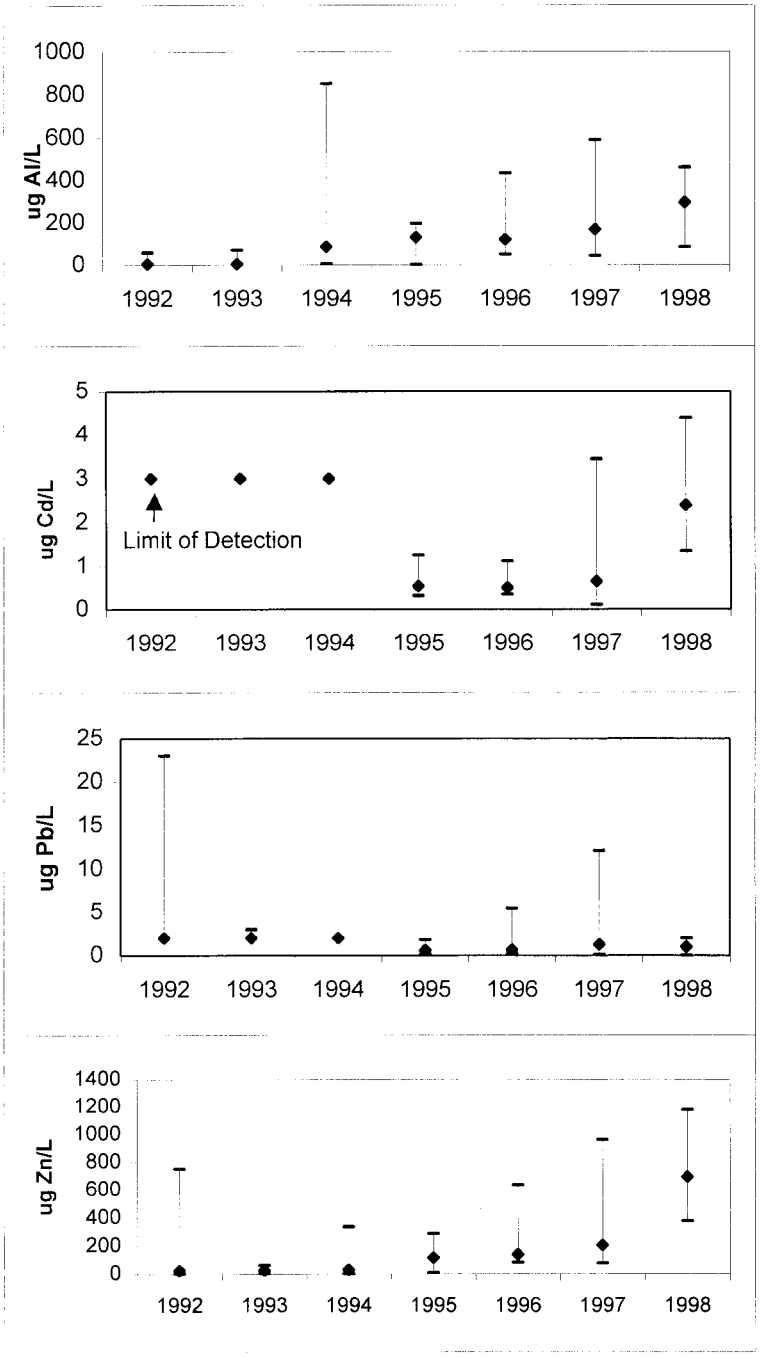

Figure 13. Median, maximum, and minimum concentrations of select metals in Ikalukrok Creek at Station 9, upstream of Red Dog Creek, 1992-1998. Data from Cominco Alaska.

Table 5. Median water quality characteristics at Station 9, Ikalukrok Creek upstream of Red Dog Creek, June through August1981-1998. Data from Cominco Alaska.

Analyte, units	median	maximum	minimum	n
Hardness, mg/L	127	331	30	244
Total Dissolved Solids, mg/L	177.5	1360	38	186
pH	7.8	8.6	5.7	248
Temperature, °C	5.0	18.2	0	183
Specific Conductance, *u*Si/cm	202	494	0.01	165
NH_3-N, mg/L	<0.05	3.33	<0.05	16

STATION 8

Ikalukrok Creek below Red Dog Creek is a relatively fast flowing stream with medium sized gravel to small cobble on the streambed (Figure 14). Stream banks contain willow-shrub vegetation and gravel bars are exposed at lower flows.

Ikalukrok Creek below the confluence with Red Dog Creek contains periodic elevated concentrations of metals from the natural mineralization upstream and from mineralization along Red Dog Creek. In July 1998, the stream bottom was covered with a dense growth of filamentous algae and iron precipitate (Figure 15). We flew by helicopter upstream to locate the source of iron at Alvinella; however, no iron stain was visible in Red Dog Creek in 1998.

Water quality and metals sampling were done intermittently at Stations 8 and 73; starting in the mid-1990's, water was sampled more consistently at these stations. No water samples were collected from Station 8 during 1998. In summer 1999, we sampled conductivity across transects at Station 8 and verified that Ikalukrok Creek and Red Dog Creek are not mixed at this site. Therefore, we used water quality data from Station 73 only to characterize Ikalukrok Creek below the confluence with Red Dog Creek.

Figure 14. Ikalukrok Creek at Station 8.

Figure 15. Filamentous green algae and iron precipitate at Station 8, 1998.

Ikalukrok Creek at Station 73 during mine operation (data for 1993 to present) has hard water with circumneutral to basic pH (Table 6). The lowest pH (6.4) was measured in June 1998. The mine effluent influences water quality conditions, especially hardness, total dissolved solids, and sulfate. During periods of maximum discharge of treated mine effluent, water hardness reached concentrations of 569 mg/L and total dissolved solids of 810 mg/L (Table 6). High conductivity (maximum = 919 *u*Si/cm) results from high total dissolved solids from the mine effluent. Low concentrations of total dissolved solids, hardness, and sulfate were found during breakup, high rainfall events, or during periods when the mine was not discharging.

Stream flows, measured at Station 73, were highest in late May to early June, following breakup, and mid- to late August, during seasonal rains. Low flows occur during mid-summer, mid-June through July (Figure 16).

During open water periods, temperatures ranged from a low of 0°C to 17.6°C. Maximum water temperatures occurred during low flow periods in summer and do not appear to be related to rates of discharge from the mine (Weber Scannell 1996).

Table 6. Summary of water quality characteristics at Station 73, Ikalukrok Creek below the confluence with Red Dog Creek after mixing. June through September 1993-1998. Data from Cominco Alaska.

Analyte, units	median	maximum	minimum	n
Hardness, mg/L	191	569	43.2	129
Total Dissolved Solids, mg/L	254	810	57	137
pH	7.7	9.9	6.4	98
Temperature, °C	4.6	17.6	0	105
Specific Conductance, *u*Si/cm	322	919	50	99
Flow, cfs	266	3000	47	75

Water occasionally contained elevated concentrations of aluminum, cadmium, lead, and zinc (Figure 17), although median concentrations have remained consistently low for all metals since 1993.

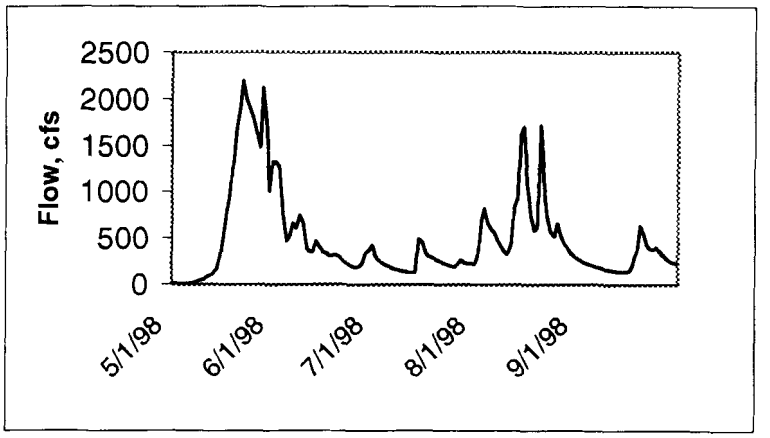

Figure 16. Seasonal stream flow at Station 73 during 1998. Data from US Geological Survey.

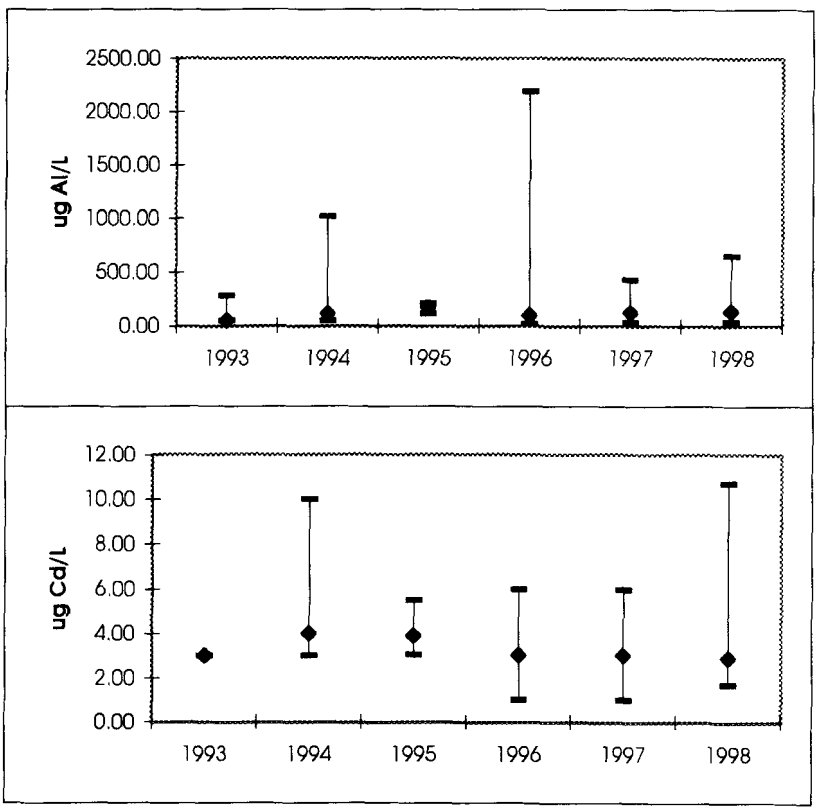

Figure 17. Median, maximum, and minimum concentrations of select metals in Ikalukrok Creek at Station 73, below the confluence with Red Dog Creek, 1993-1998.

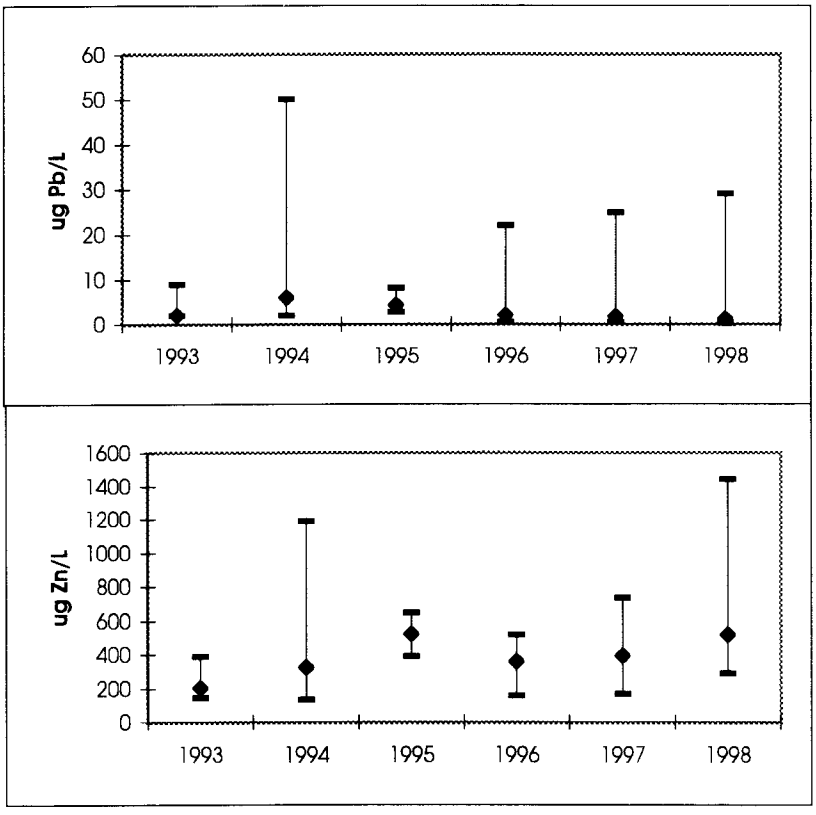

Figure 17, continued. Median, maximum, and minimum concentrations of select metals in Ikalukrok Creek at Station 73, below the confluence with Red Dog Creek, 1993-1998

STATION 7

Ikalukrok Creek below Dudd Creek (Station 7) has stream widths from approximately 3.5 to 40 m (12 to 130 feet) and depths from 0.3 to 1.2 m (1 to 4 ft). The substrate consists of small to medium sized gravel with prevalent gravel bars exposed at lower flow rates. Streamside vegetation consists of willow shrubs (Figures 18 and 19). In 1998, sample sites both above and below Dudd Creek contained thick mats of filamentous green algae in July; the algae were not observed during June sampling. A few young-of-the-year Dolly Varden were observed along the stream margins below the confluence with Dudd Creek in both 1997 and 1998.

Figure 18. Ikalukrok Creek near the confluence with Dudd Creek.

Figure 19. Ikalukrok Creek downstream of Dudd Creek, at Station 7.

Minimal water quality and stream flow sampling have been done at this site. Temperatures range from 0 to 10°C during open flow (Table 7). Higher concentrations of total dissolved solids and hardness generally occurred during periods of low flow in July and late fall (Figure 20).

Following construction of the stream bypass system at the mine in 1990, metals concentrations were low at Station 7 (Figure 21).

Table 7. Median water quality characteristics at Station 7, Ikalukrok Creek below Dudd Creek, June through October 1990-1998. Data from Cominco Alaska.

Analyte, units	median	maximum	minimum	n
Hardness, mg/L	174	606	31	47
Total Dissolved Solids, mg/L	226	647	51	45
Sulfate, mg/L	110	510	16	22
pH	7.7	8.1	5.6	60
Temperature, °C	6.0	12.5	0	42
Specific Conductance, *u*Si/cm	266.5	998	0.1	20
NH_3-N, mg/L	<0.05	0.1	<0.05	9

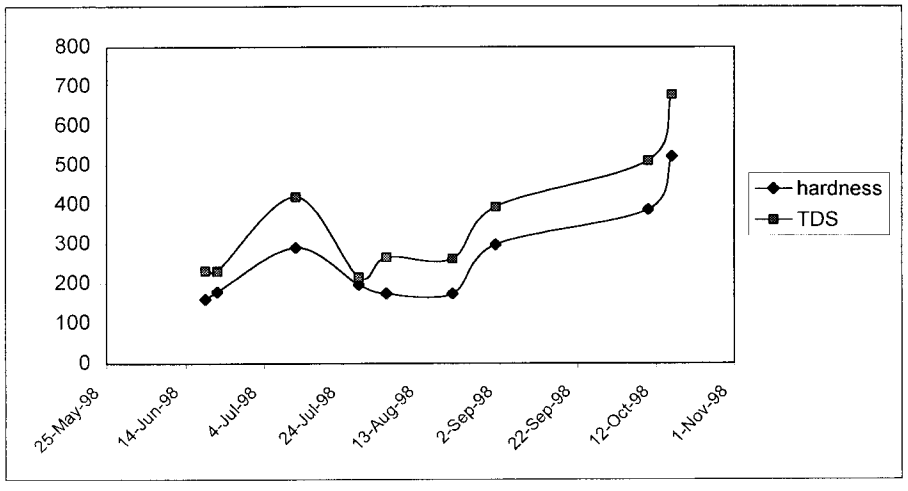

Figure 20. Total dissolved solids and hardness at Station 7 in 1998. Data from Cominco Alaska.

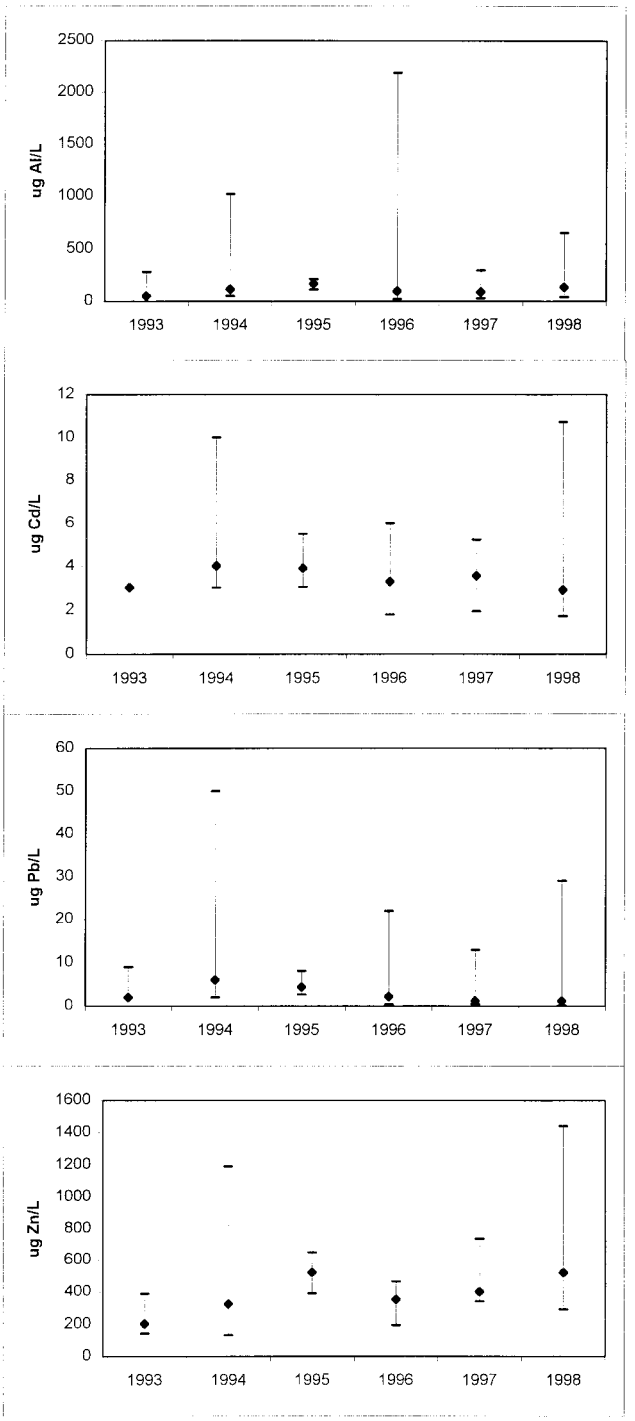

Figure 21. Median, maximum, and minimum concentrations of select metals in Ikalukrok Creek at Station 7, below Dudd Creek, 1990-1998. Data from Cominco Alaska.

MAINSTEM OF RED DOG CREEK

The mainstem of Red Dog Creek (Figure 22) has a drainage area of 64 km^2 (24.6 mi^2) of which 10 km^2 (3.8 mi^2) does not contribute to the flow because it is impounded behind the tailing dam. During 1998, Red Dog Creek had a high mean monthly flow of 5.4 m^3/s (191 cfs) and a low flow of 0.0045 m^3/s (0.16 cfs). Widths of the creek range from 3.5 to 18 m (12 to 60 ft), with depths ranging from 0.06 to 0.5 m (0.2 to 1.7 feet) (R. Kemnitz, pers. comm., USGS Water Resources Division, Fairbanks). The stream bed contains gravel, small cobble, and a few small boulders. The creek has some meander and areas where it has shifted locations. Temperatures range from 0°C in the winter to 10°C in summer.

Figure 22. Mainstem of Red Dog Creek at Station 10.

Historical data indicate that fish use was limited to migration in the Mainstem of Red Dog Creek and that fish did not use Middle Fork Red Dog Creek. However, fish were observed in the Mainstem of Red Dog Creek within the influence of the North Fork of Red Dog Creek (Dames and Moore 1983). Fish were not seen in Middle Fork Red Dog Creek in 1992, 1993, and 1994 (Weber Scannell and Ott 1998). Minnow traps fished in the Middle Fork and the Mainstem of Red Dog Creeks in 1994 yielded no fish. One Dolly Varden and two adult Arctic grayling were seen in the Mainstem of Red Dog Creek in the influence of the North Fork of Red Dog Creek in 1994 (Weber Scannell and Ott 1995).

In 1995, juvenile Dolly Varden were present during all sample periods in the Mainstem of Red Dog Creek. In four field trips in summer 1995, adult Arctic grayling were present in the Mainstem of Red Dog Creek. Ott and Weber Scannell (1996) reported adult and young-of-the-year Arctic grayling in a large scour pool and side channel of the Mainstem of Red Dog Creek about 1.2 km below the North Fork of Red Dog Creek. On August 14, 1995, Ott and Weber Scannell (1996) reported 11 Arctic grayling (290 to 336 mm FL) in a large pool, two of which had been marked in the North Fork of Red Dog Creek: one in summer 1994 and one in summer 1995. Arctic grayling were observed actively feeding in the scour pool.

Fish use of the Mainstem of Red Dog Creek was similar in 1996 to that observed in 1995. Weber Scannell and Ott (1998) reported from 24 to 36 young-of-the-year Arctic grayling in the Mainstem of Red Dog Creek just below the mouth of the North Fork of Red Dog Creek. Although they observed juvenile fish, few fish were collected in minnow buckets from this site.

Baseline data showed the Mainstem of Red Dog Creek at Station 10 contained moderately hard water with neutral to acidic pH. During winter (measured in March), water was high in total dissolved solids, sulfate, and hardness, a result of ice formation (Weber Scannell 1996).

Baseline concentrations of Zn were elevated above the reported chronic/acute toxic concentrations of 2 mg/L for salmonid fish and often contained elevated concentrations of Al and Cd (Table 8). Median concentrations of Pb were below the limit of detection. Baseline studies (Dames and Moore 1983) reported that Arctic graying migrated through the Mainstem of Red Dog Creek to the North Fork of Red Dog Creek during spring high flows when metals concentrations were lower.

Table 8. Baseline water quality conditions in the Mainstem of Red Dog Creek, 1982-1983. Data from Dames and Moore 1983.

Analyte	median	maximum	minimum	n
Hardness, mg/L	127	227	21	21
Total dissolved solids mg/L	198	876	9	11
Sulfate, mg/L	70	440	8	11
Al, *u*g/L	150	1190	20	38
Cd, *u*g/L	28	98	<2	43
Cu, *u*g/L	4	19	<2	15
Pb, *u*g/L	<80	100	<80	43
Zn, *u*g/L	3700	13000	567	43
pH	7	7	6	10
Temperature, °C	4	17	0	8
Specific Conductance, *u*Si/cm	328	1090	154	8
Flow, cfs	32	126	3	25

Since the opening of the Red Dog mine and subsequent discharge of treated mine effluent, the Mainstem of Red Dog Creek has elevated hardness and total dissolved solids (Table 9), especially during periods of maximum discharge from the mine. Concentrations of total dissolved solids reached a maximum of 2470 mg/L, and hardness a maximum of 1540 mg/L. Elevated total dissolved solids and hardness correspond to periods of high discharges of mine effluent and low stream flows (Weber Scannell and Ott 1998).

In 1998, stream flows were low just before breakup, then increased to about 445 cfs (Figure 23). Summer low flows occurred from late June through early August; late August high flows reached about 600 cfs. Metals concentrations at Station 10 were elevated in Al, Cd, and Zn (Figure 24).

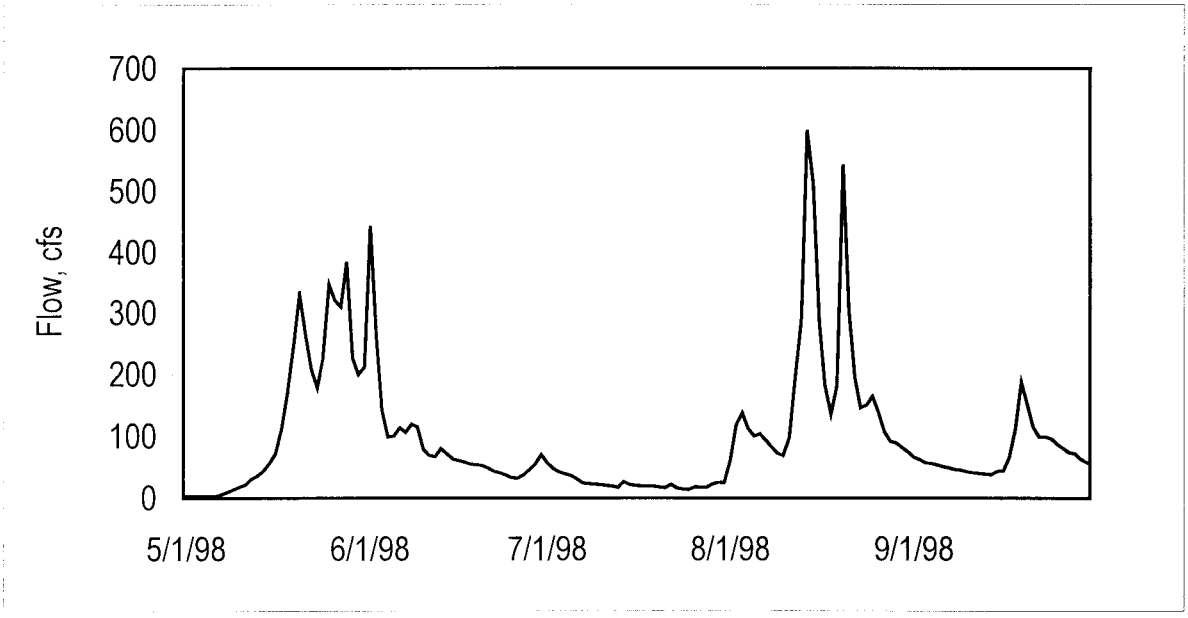

Figure 23. Seasonal stream flow at the Mainstem of Red Dog Creek, Station 10 during 1998. Data from US Geological Survey.

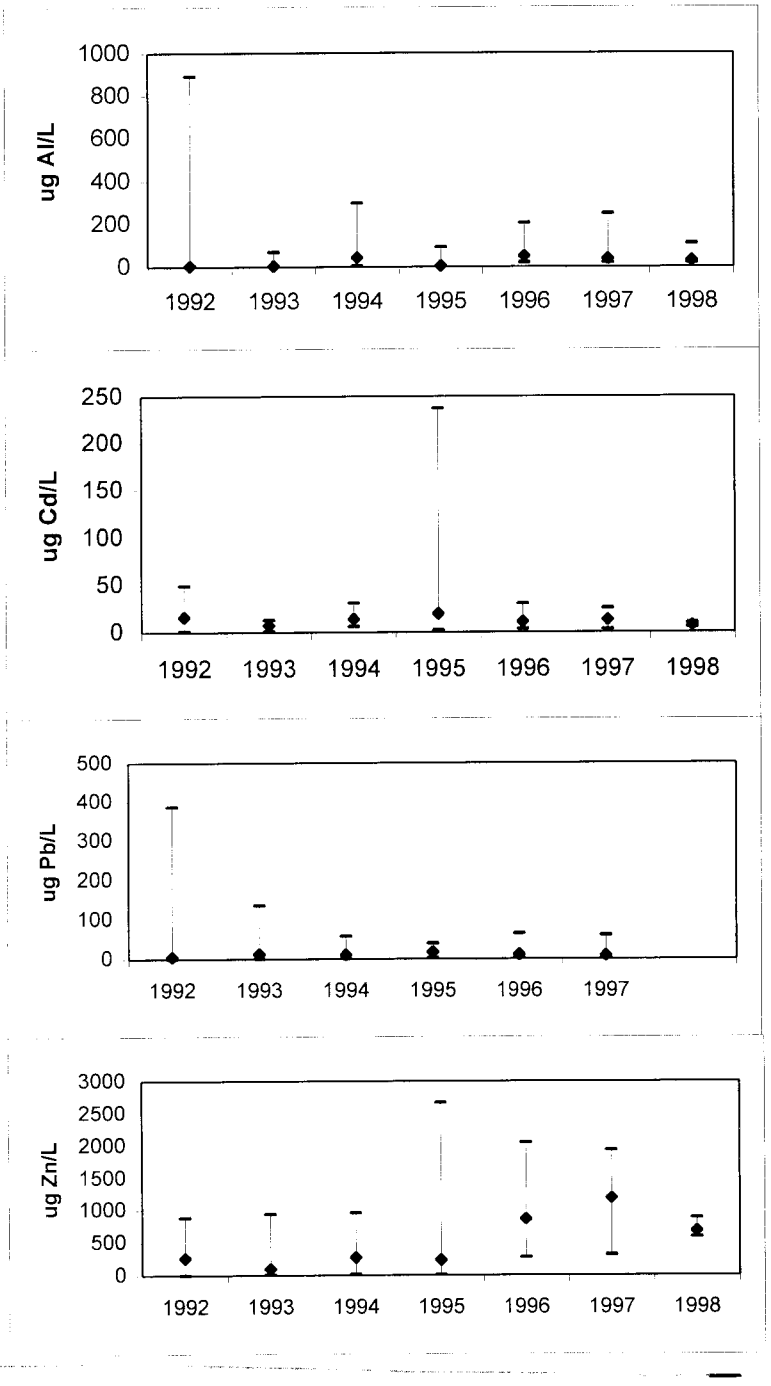

Figure 24. Median, maximum, and minimum concentrations of select metals in the mainstem of Red Dog Creek, June through mid-October 1992 through 1998. Data from Cominco Alaska.

Table 9. Median water quality characteristics at Station 10, Mainstem of Red Dog Creek, June through October 1992-1998. Data from Cominco Alaska.

Analyte, units	median	maximum	minimum	n
Hardness, mg/L	495	1540	38	175
Total Dissolved Solids, mg/L	675	2470	50	202
Sulfate, mg/L	430	1600	23	138
pH	7.6	8.2	3.6	142
Temperature, °C	6.3	20.3	0	143
Specific Conductance, *u*Si/cm	648	2120	0.1	104
NH_3-N, mg/L	0.6	240	<0.05	44

MIDDLE FORK RED DOG CREEK, STATION 20

Middle Fork Red Dog Creek has a drainage area of 12 km^2 (4.74 mi^2), of which 1 km^2 (0.4 mi^2) does not contribute to the flow due to blockage by the tailings dam. The creek has wide meanders with average channel widths from 3 to 10 m (10 to 30 ft), and depths from 0.03 to 0.45 m (0.1 and 1.5 feet) (Figure 25). In July 1998, the streambed was covered with thick mats of filamentous green algae. No fish are present in this section of Red Dog Creek. Upstream migration to Middle Fork Red Dog Creek is blocked by a gravel weir at the mouth of the North Fork of Red Dog Creek.

Stream flow data were collected intermittently from Station 20 in 1998 but not during the high summer flows (Figure 26). High flows during and following breakup were about 90 cfs and summer low flows were about 3 cfs. Mine effluent contributed up to 90% of the stream flows at Station 20 during low flow conditions. The high proportion of effluent results in elevated hardness (maximum of 1960 mg/L, Table 10), elevated total dissolved solids (maximum of 3420 mg/L) and sulfate (maximum of 1900 mg/L). Water temperatures during the open flow periods range from 0°C to 19.4°C.

Figure 25. Middle Fork Red Dog Creek, below the mine effluent, Station 20.

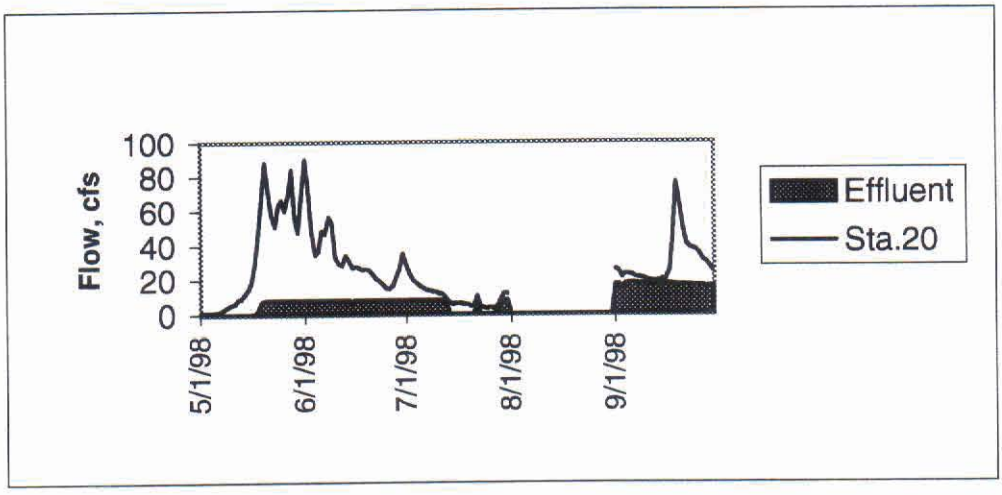

Figure 26. Stream flows at Middle Fork Red Dog Creek, Station 20, showing proportion of mine effluent.

Table 10. Median water quality characteristics at Station 20, Middle Fork Red Dog Creek, June through October 1992-1998. Data from Cominco Alaska.

Analyte, units	median	maximum	minimum	n
Hardness, mg/L	626	1960	28	103
Total Dissolved Solids, mg/L	1010	3420	50	135
Sulfate, mg/L	785	1900	11	66
pH	7.0	9.0	5.0	128
Temperature, °C	7	19.0	0	127
Specific Conductance, *u*Si/cm	978	2510	0.1	84

Concentrations of Cd, Pb, and Zn are higher at Station 20 than at downstream of the Mainstem of Red Dog Creek or Ikalukrok Creek at Station 8 (Figure 27).

SHELLY CREEK

Shelly Creek flows into Middle Fork Red Dog Creek from the northeast (Figure 28). The creek is small, densely vegetated by willows, and the benthic substrate is stained red with iron. Few water quality data have been collected in Shelly Creek. There is no fish use of Shelly Creek.

There were no baseline data collected on hardness, total dissolved solids, flow, dissolved oxygen, or other water quality factors in Shelly Creek. Samples for metals concentrations were limited to one sample in 1981 and four in 1982 (Weber Scannell 1996). During baseline, the maximum concentration of Cd was 28 *u*g/L, Pb was at detection: <80 *u*g/L, and Zn 2300 *u*g/L.

Few water samples were collected in Shelly Creek between 1995 and 1998. Unlike tributaries downstream of the mine effluent, Shelly Creek has low concentrations of hardness, total dissolved solids, and sulfate (Table 11), and moderately acidic pH.

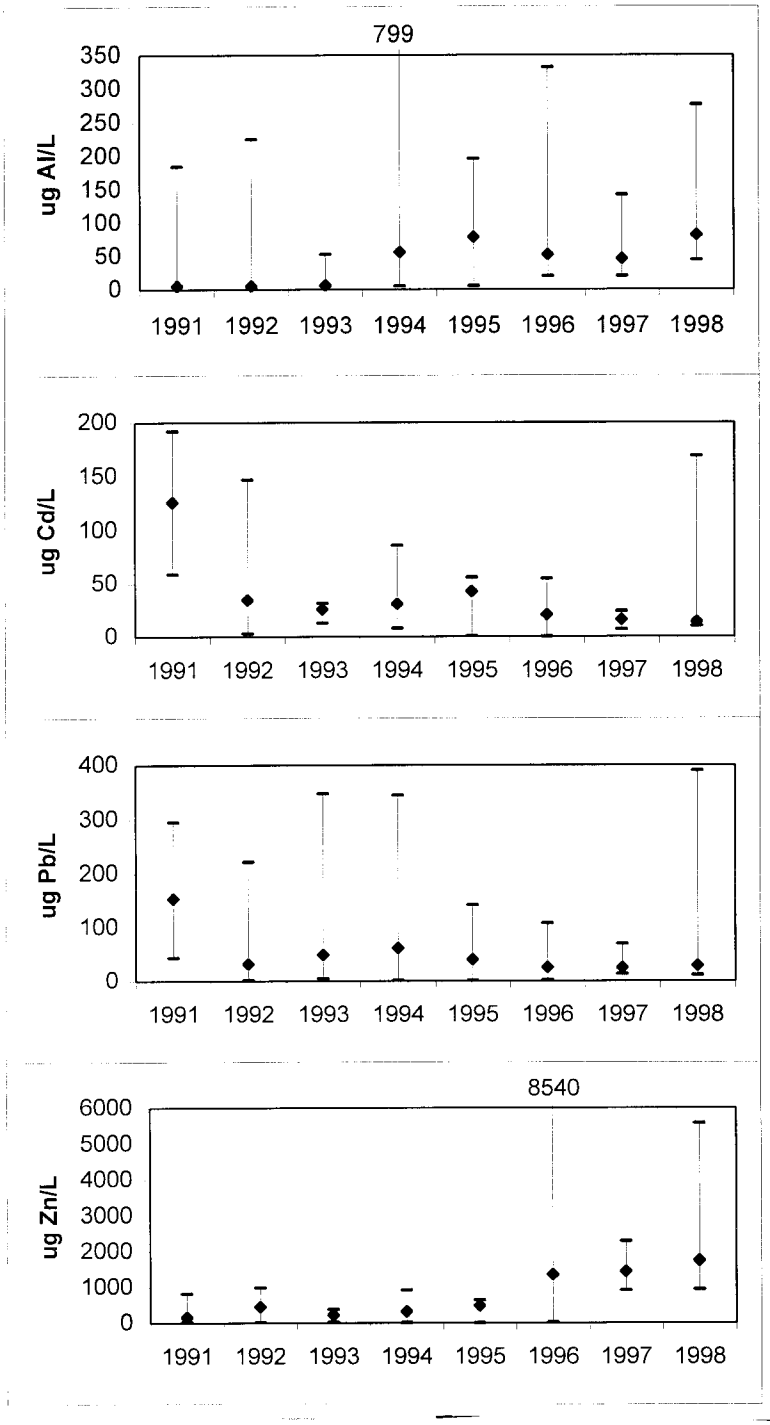

Figure 27. Median, maximum, and minimum concentrations of select metals in Middle Fork Red Dog Creek, June through mid-October 1992 through 1998. Data from Cominco Alaska.

Figure 28. Shelly Creek.

Table 11. Median water quality characteristics at Shelly Creek, June through October 1992-1998. Data from Cominco Alaska.

Analyte, units	median	maximum	minimum	n
Hardness, mg/L	61.9	116	33.1	5
Total Dissolved Solids, mg/L	87.5	133	29	6
Sulfate, mg/L	32	110	6.9	6
pH	6.9	7.4	6.1	14
Temperature, °C	5.1	12.3	0	
Specific Conductance, *u*Si/cm	143	888	399	

Water in Shelly Creek is naturally high in metals (Figure 29). It is likely that high concentrations of Al, Cd, Fe, and Zn limit aquatic populations in this creek.

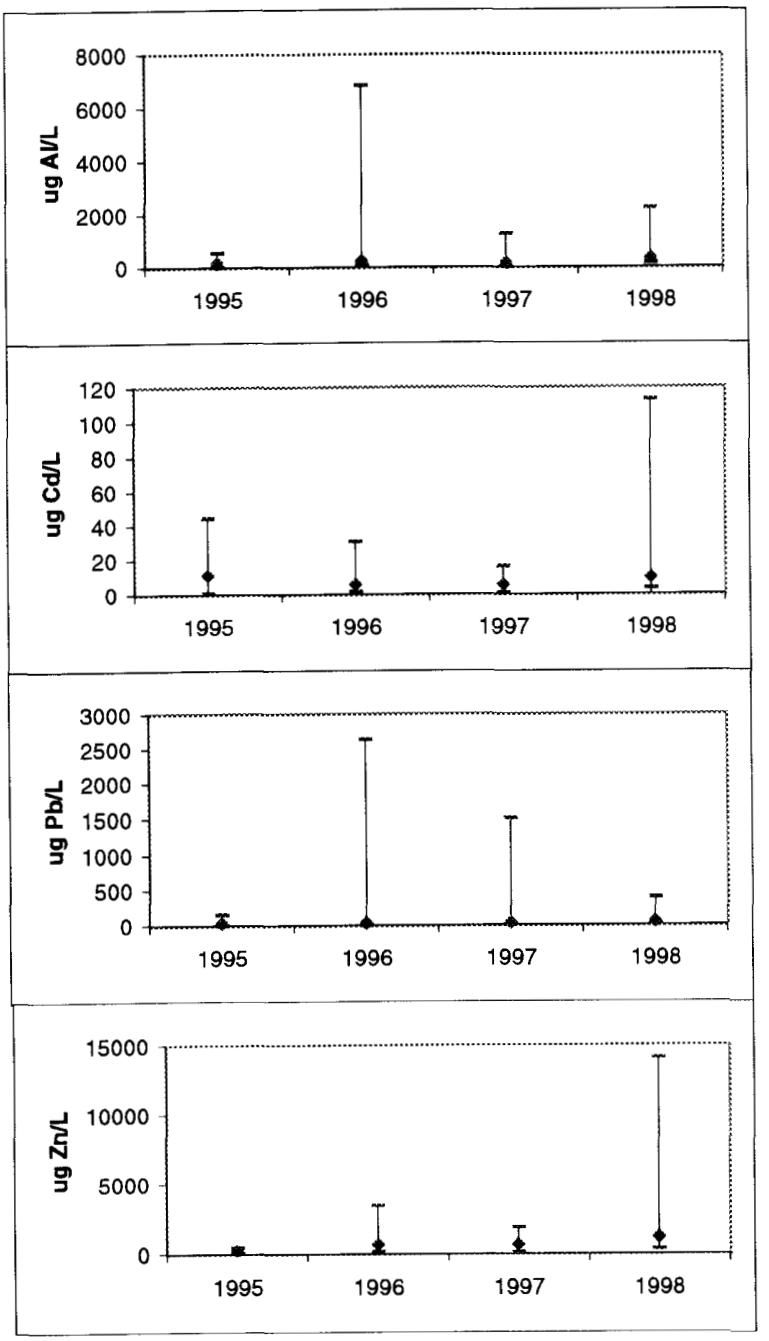

Figure 29. Median, maximum, and minimum concentrations of select metals in Shelly Creek, June through mid-October 1992 through 1998. Data from Cominco Alaska.

CONNIE CREEK

Connie Creek is the largest of the tributaries to upper Red Dog Creek. The creek flows through a wide, shallow channel with abundant streamside vegetation (Figure 30). Water depths are less than 20 cm during summer flows. The creek bottom is medium cobble with some staining. Historically, fish have been prevented from using Connie Creek by poor water quality in Middle Fork Red Dog Creek; since 1997, a gravel weir has prevented upstream movement into Middle Fork Red Dog Creek and all upstream tributaries.

Figure 30. Connie Creek.

Limited water quality and metals data (Table 12) collected in Connie Creek show this creek to have soft water, low total dissolved solids, low sulfate, and neutral pH.

Table 12. Median water quality characteristics at Connie Creek, June through October 1992-1998. Data from Cominco Alaska.

Analyte, units	median	maximum	minimum	n
Hardness, mg/L	79.1	148	51.2	5
Total Dissolved Solids, mg/L	63	179	38	6
Sulfate, mg/L	24.5	71	15	6
Temperature, °C	5.1	10.8	0.1	11
pH	7.2	7.7	6.2	15
Specific Conductance, *u*Si/cm	245	1361	6	7

Only 14 water samples were collected in Connie Creek for metals analyses during flowing water conditions from 1995 through 1998. Concentrations of metals were substantially lower in Connie Creek in all years than in Shelly Creek (Figure 31 and Figure 29); in most years the median concentrations of Al, Cd, Pb, and Zn were at least ten times higher in Shelly Creek.

RED DOG CREEK UPSTREAM OF THE ORE BODY

Red Dog Creek upstream of the ore body is a small creek above the stream diversion channel. This portion of Middle Fork Red Dog Creek is from 1 to 1.5 m wide, has dense streamside vegetation consisting primarily of willows, and has not been disturbed (Figure 32). Water depths in riffle areas are 10 to 20 cm, pools are about 1 m deep. Fish do not occur in this section of Red Dog Creek.

Limited water quality data (Table 13) collected in the upstream section of Red Dog Creek show this creek to have low total dissolved solids, low sulfate, and neutral pH. Because no disturbance has occurred in this area, baseline data are included in Table 13.

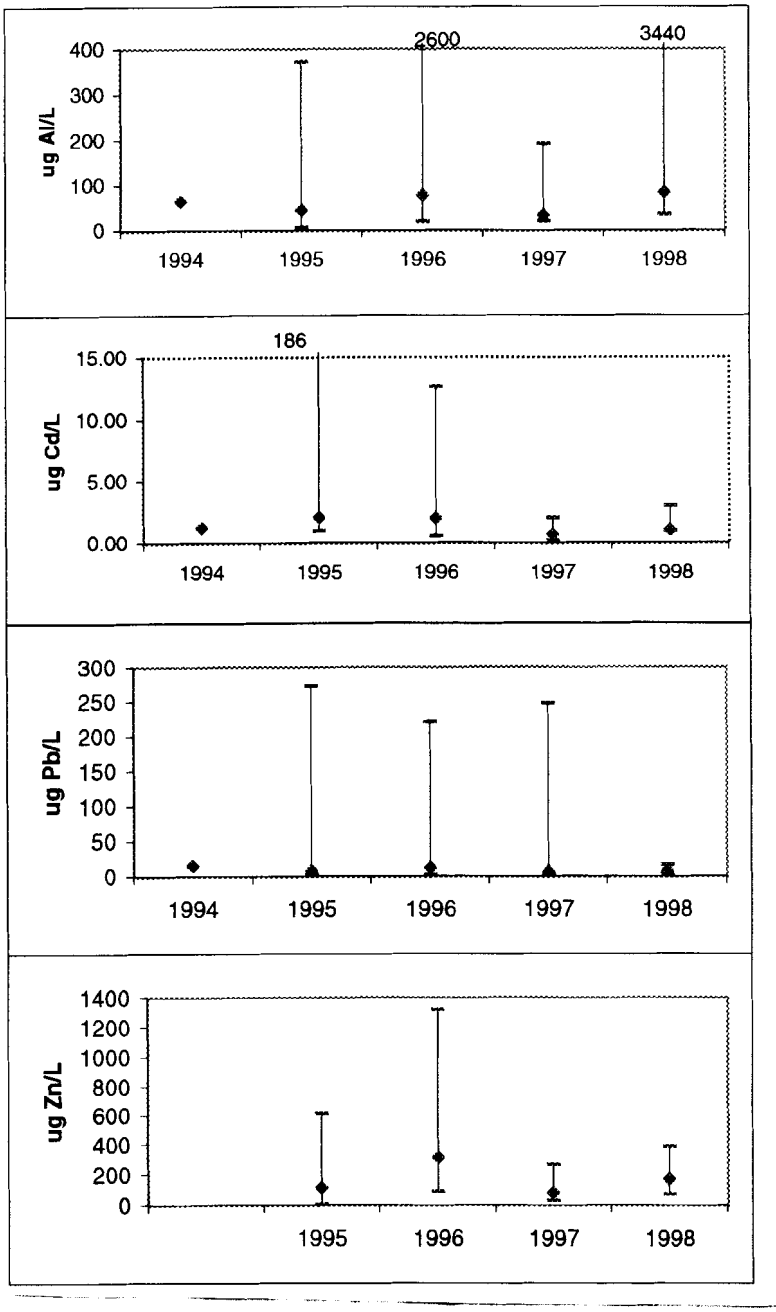

Figure 31. Median, maximum, and minimum concentrations of select metals in Connie Creek, June through mid-October 1992 through 1998. Data from Cominco Alaska.

Figure 32. Middle Fork Red Dog Creek upstream of the ore body.

Table 13. Median water quality characteristics at Middle Fork Red Dog Creek upstream of the ore body, June through October 1982-1998. Data from Cominco Alaska.

Analyte, units	median	maximum	minimum	n
Hardness, mg/L	no data			
Total Dissolved Solids, mg/L	257	472	45	11
Sulfate, mg/L	135	210	11.7	11
Temperature, °C	5	11.8	0.0	15
pH	7.15	7.6	6.7	12
Specific Conductance, *u*Si/cm	331	527	91	15

Baseline and post-mining metals data show Middlefork Red Dog Creek upstream of the ore body to have good water quality conditions with low concentrations of all metals, except Cd (Figure 33).

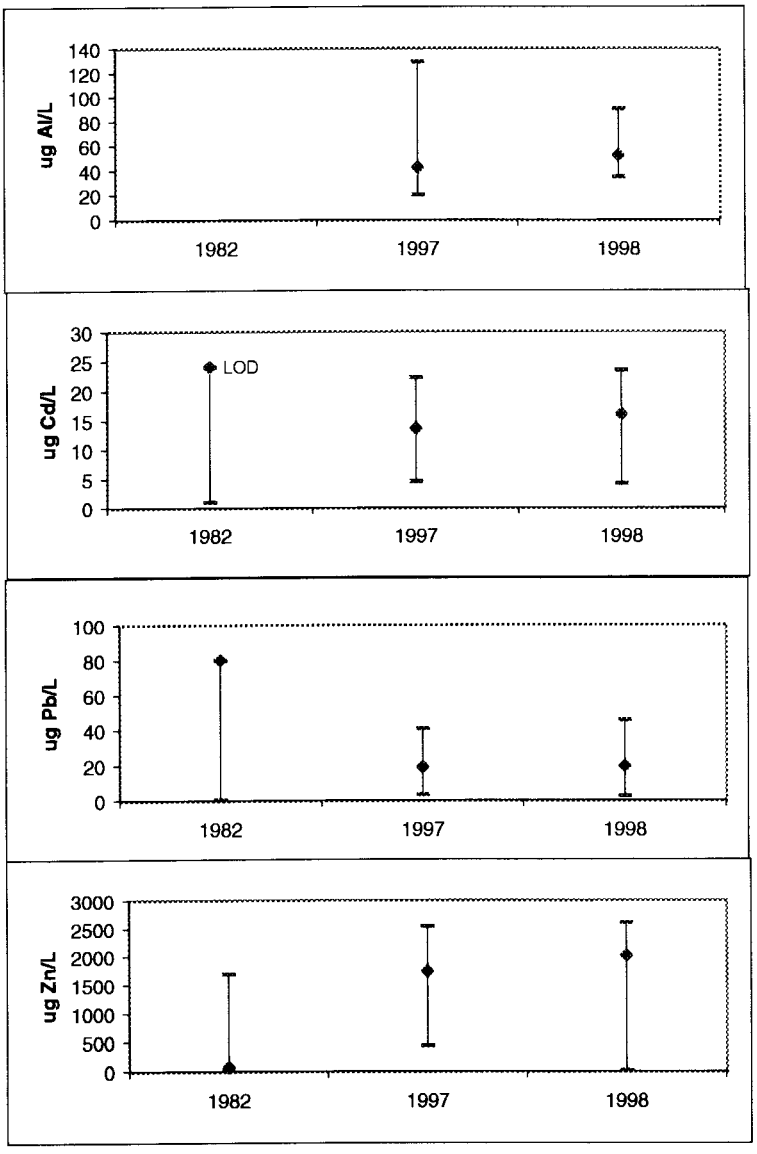

Figure 33. Median, maximum, and minimum concentrations of select metals in Middle Fork Red Dog Creek upstream of the ore body, June through mid-October 1982 through 1998. Data from Cominco Alaska.

NORTH FORK OF RED DOG CREEK, STATION 12

The North Fork of Red Dog Creek (Figure 2) is a tributary to the Mainstem of Red Dog Creek. The North Fork has some mineralization in the left fork, but the water quality is good. The North Fork of Red Dog Creek has a drainage area of 41 km^2 (15.9 mi^2). The North Fork of Red Dog Creek has abundant streamside vegetation, deep pools, and wide riffle areas (Figure 34). Widths range from 7 to 15 m (24 to 50 ft) and depths from 0.09 to 2 m (0.3 to 6 ft). The stream bed is characterized by gravel, rocks, and small boulders and is subject to shifting. Temperatures range from 0 to 10°C during open water flow. Mineral staining is not evident in the North Fork of Red Dog Creek.

Arctic grayling move upstream into the North Fork in spring, under the ice, to spawn. Both Arctic grayling and Dolly Varden use this creek for summer rearing, then move out in mid- to late August when temperatures drop. During the open flow period in 1998, the North Fork of Red Dog Creek had seasonal high flows up to 487 cfs in mid-August and seasonal low flows of 14 CFS in mid-July (Figure 35).

Few Dolly Varden use the North Fork for summer rearing; Ott and Weber Scannell (1996) reported a low catch of 0 or 1 fish per sample event, except July 1993, when 31 fish were collected. Although juvenile Dolly Varden continue to migrate into the North Fork for summer rearing, its importance as a rearing stream for these fish is minor compared to other tributary streams, such as Anxiety Ridge Creek.

In 1995, mature Arctic grayling were present in late June, young-of-the-year (<25 mm) were observed on July 17, and in mid-August, fry (40 - 47 mm) were present but not numerous (Ott and Weber Scannell 1996). In previous sample years (1991 to 1994), ADF&G reported mature fish in late June and young-of-the-year in July (Ott et al. 1992; Ott and Weber Scannell 1993; Ott and Weber Scannell 1994; Weber Scannell and Ott 1995). Fry were numerous in backwater areas and along stream margins in 1991, 1992,

Arctic grayling use of the North Fork of Red Dog Creek varies among years. In 1994, it appeared that adult fish left the North Fork of Red Dog Creek shortly after spawning. Out-migration of adult fish was not observed in 1995 until mid-August, when fish were moving to downstream overwintering areas. Smaller Arctic grayling enter the North Fork of Red Dog Creek for rearing as summer progresses.

The creek is a clear water stream with high dissolved oxygen concentrations during summer and moderate hardness and total suspended solids (Table 14). The pH is slightly basic.

Table 14. Median water quality characteristics at Station 12, the North Fork of Red Dog Creek, June through October 1992-1998. Data from Cominco Alaska.

Analyte, units	median	maximum	minimum	n
Hardness, mg/L	206.5	376	27.7	96
Total Dissolved Solids, mg/L	256	1030	25	113
pH	7.8	8.4	5.4	98
Temperature, °C	3.0	11.3	0	67
NH_3-N, mg/L	0.01	1.13	0.003	63
Specific Conductance, *u*Si/cm	367.6	1316	0.36	98

Depending on the analyte, there were 105 to 117 water samples collected between 1992 and 1998 from the North Fork for analyses of metals. Between 1992 and 1998, the median concentrations of Al, Cd, Pb, and Zn were low (Figure 36).

Figure 34. North Fork of Red Dog Creek.

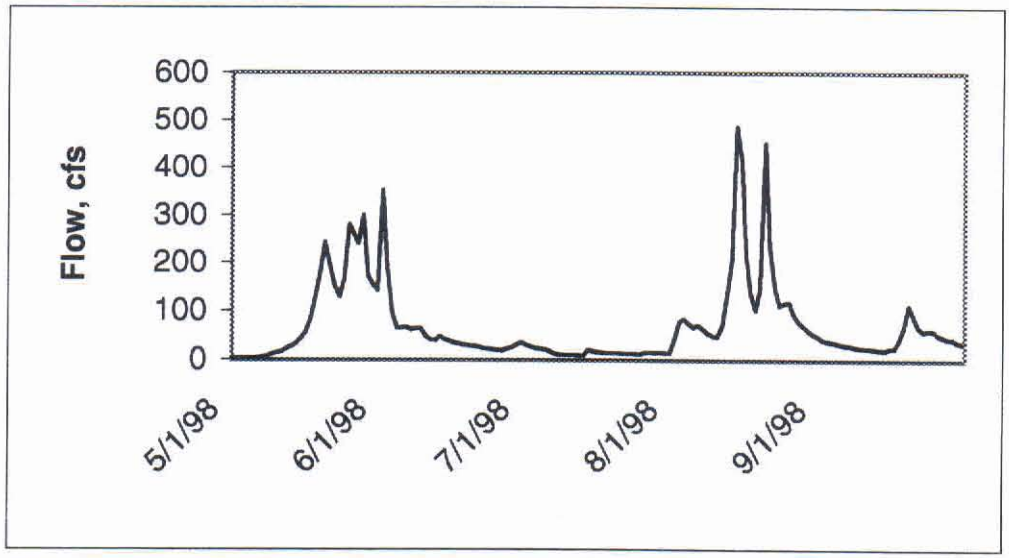

Figure 35. Seasonal stream flows in North Fork of Red Dog Creek.

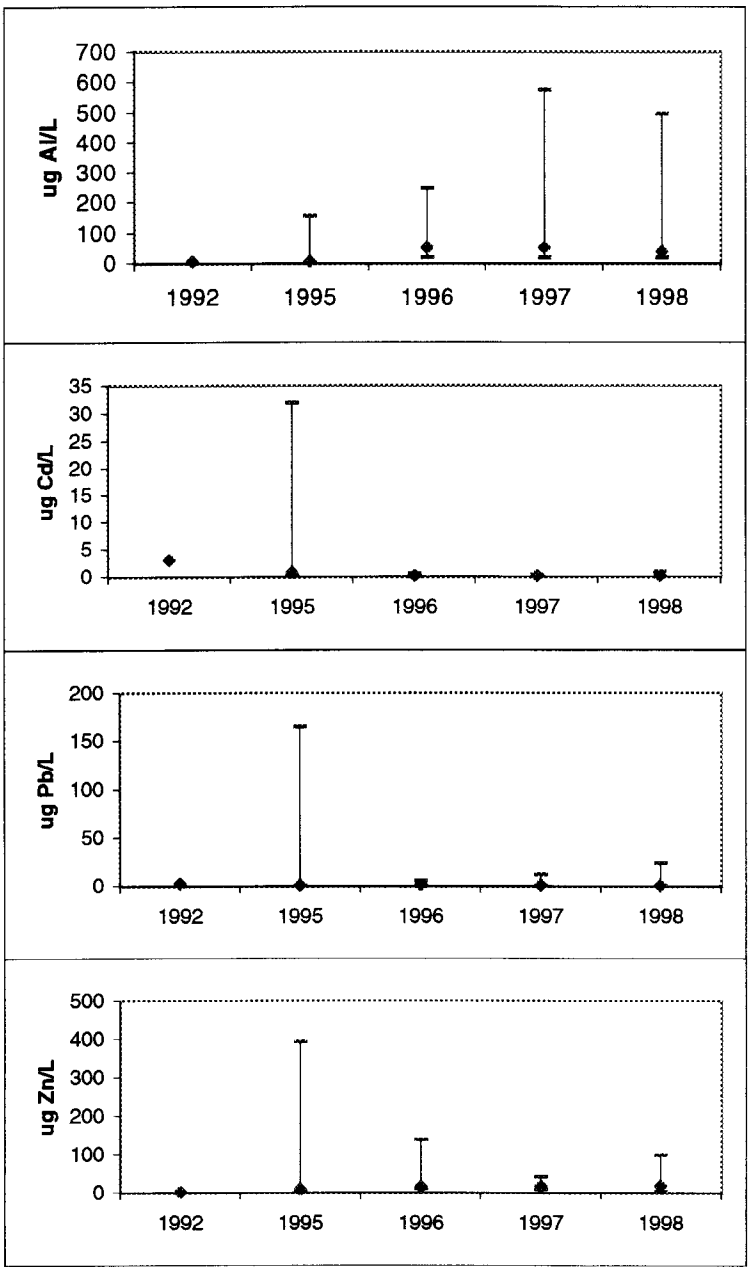

Figure 36. Median, maximum, and minimum concentrations of select metals in the North Fork of Red Dog Creek, June through mid-October 1992 through 1998. Data from Cominco Alaska.

METHODS

PERIPHYTON STANDING CROP (AS CHLOROPHYLL-A CONCENTRATIONS)

Objectives

Periphyton, or attached micro-algae, are sensitive to changes in water quality and often used in monitoring studies to detect early changes in aquatic communities. The presence of periphyton in a stream system documents continued in-situ productivity. Periphyton density was monitored to detect changes in in-situ productivity in receiving waters of the Red Dog Mine effluent. Reference sites were sampled to detect variations due to other factors, such as climate.

Periphyton was sampled directly from cobble on the stream benthos. The periphyton was collected from a specific area of cobble, following the rapid bioassessment techniques of Barbour et al (1997), but with more replicates per site to increase sample precision. The concentrations of chlorophyll-a were determined to estimate periphyton standing crop. Sampling was done in late June and late July in both 1997 and 1998 during low water periods. Low flow conditions were selected to eliminate streambed scour as a controlling factor.

Methods for Field Collection of Samples:

Samples were collected according to Blum (1960) and Sladeckova (1962). Ten rocks were collected from the stream benthos in each study reach at each sample time. A 5-cm x 5-cm square of high density foam was placed on the rock; using a small toothbrush, all material around the foam square was removed and washed away with clean water (Figure 37). The foam was removed from the rock and the remaining undisturbed patch under the foam square was brushed with a clean tooth brush and rinsed onto a 0.45 um glass fiber filter, attached to a hand vacuum pump. After extracting as much water as possible, approximately 1 ml of saturated $MgCO_3$ was added to the filter to prevent acidification and conversion of chlorophyll-a to phaeophytin. The dry filter was wrapped in a large

and conversion of chlorophyll-a to phaeophytin. The dry filter was wrapped in a large filter (to absorb any additional water), labeled, placed in a sealable plastic bag, and packed over silicon gel desiccant. Filters were frozen in a light-proof container with additional silica gel desiccant.

Figure 37. Sampling for periphyton, or attached algae.

Quality Control of Field Sampling

Samples were placed in pre-labeled bags, placed over fresh silica gel desiccant, and kept frozen during transport to Fairbanks and until chlorophyll-a extraction was completed.

Laboratory Analysis

Filters were cut into small pieces and placed in a centrifuge tube with 10 ml of 90% buffered acetone to extract chlorophyll. Centrifuge tubes were placed in a metal rack, covered with aluminum foil, and held in a dark refrigerator for 24 hrs. After extraction, samples were read on a Shimadzu UV-1601 Spectrophotometer and a Turner Model 10 fluorometer, depending on the concentration of chlorophyll-a. When samples were high, but not off scale for the Fluorometer, they were read on both instruments. Trichromatic equations (according to Standard Methods, APHA 1992) were used to convert spectrophotometric optical densities to total chlorophyll-a.

The Turner Fluorometer was calibrated with chlorophyll-a extracted from fresh lettuce. After extraction, a series of dilutions were made and samples read on both the spectrophotometer and fluorometer to develop a calibration curve (Figure 38). Primary chlorophyll standards were used to check the relationship between the spectrophotometer and the fluorometer, according to Standard Methods (APHA 1992). Secondary gel standards were used to check the fluorometer for drift. Sample size (area of the substrate sampled) and the amount of acetone used for extraction were used to convert individual samples to mg chlorophyll-a per square meter.

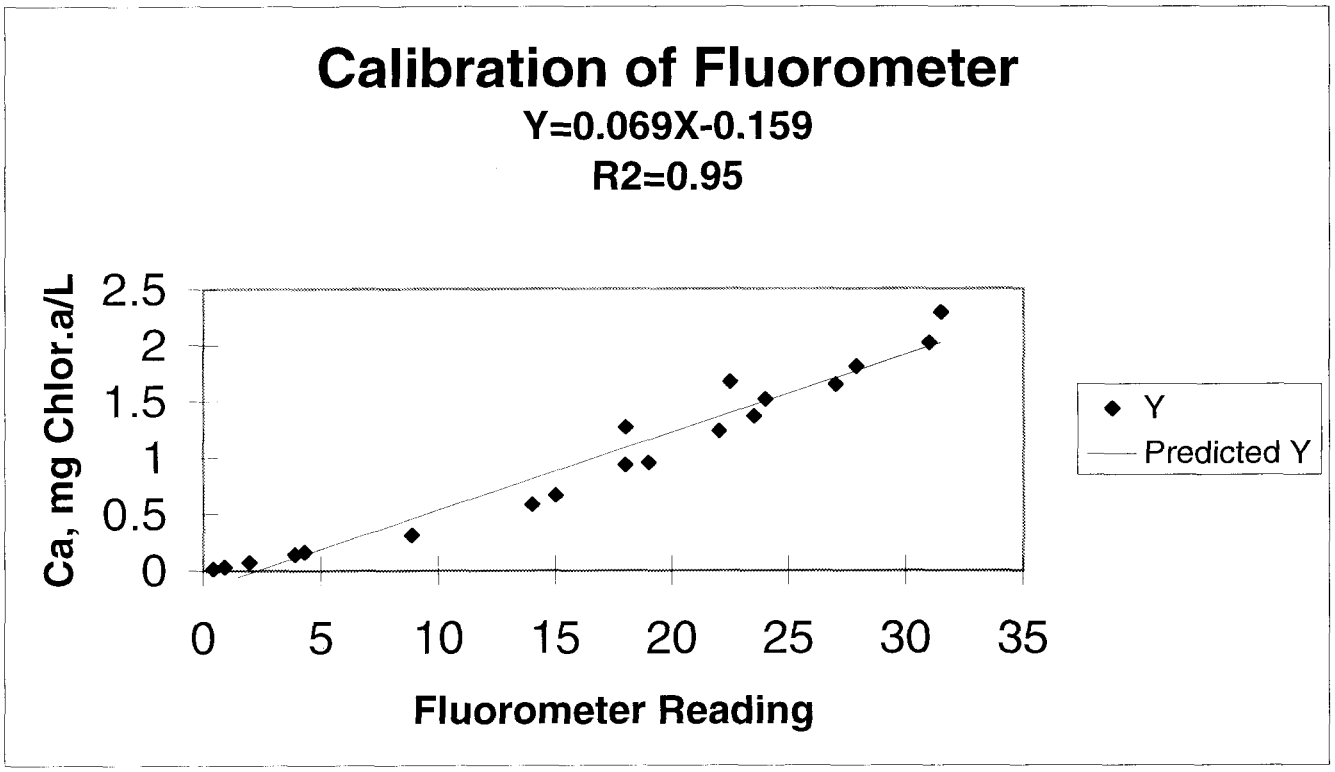

Figure 38. Relationship between fluorometric level of chlorophyll-a and concentrations of chlorophyll-a determined spectrophotometrically.

Quality Control for Chlorophyll-a Determinations

Fresh chlorophyll-a standards were used to calibrate the fluorometer for each annual sampling event. Samples containing sufficient chlorophyll-a were read on both the fluorometer and the spectrophotometer to check calibration curves. Samples with chlorophyll-a concentrations below the calibration point were reported as "non-detectable."

AQUATIC INVERTEBRATES: TAXONOMIC RICHNESS AND ABUNDANCE

Objectives

Aquatic invertebrate communities were sampled below the Red Dog Mine effluent to document the continued biological integrity of these communities and to detect changes in in-situ productivity. Reference sites were sampled to detect variations due to other factors, such as climate, flow, and amounts of streamside vegetation.

Methods

We modified the rapid bioassessment techniques developed by USEPA (Barbour et al 1997) to retain more quantitative features. Benthic invertebrates were collected in drift nets set within riffle habitats to standardize assessments between streams. Five drift nets were set at random locations in riffle habitat and left to collect invertebrates for one hour (Figure 39). Water velocity and depth were measured at the mouth of each net to standardize numbers of insects by volume of water and to compare relative biomass of invertebrates among sites. Invertebrates were transferred from the drift nets to individually labeled bags and preserved in 70% ETOH.

Invertebrate samples were taken back to the laboratory in Fairbanks, Alaska and sorted. Samples were first washed with tap water into an enamel pan and the sample container examined for remaining invertebrates. Then samples were strained through a 90 *u*m mesh to remove water and placed in a glass petri dish. The sample was distributed evenly throughout the dish. Acetate, cut to fit the diameter of the glass dish was used to divide

the sample (Figure 40). Although Barbour et al (1997) recommends random subsampling of benthic invertebrates, we chose to split samples by a known percentage, depending on the volume of invertebrates. This allowed us to standardize samples among streams by volume of water passing through each net, thereby producing a more quantitative estimate of invertebrate density.

Sampling was done in late June and late July in 1997 and 1998 during periods of low flow.

Divided samples were sorted from detritus, placed in fresh 70% ETOH and identified to the lowest practical taxonomic level. Mature larvae, nymphs and adult forms of aquatic species usually can be identified to genus; immature larvae and nymphs are usually identified to family. Chironomidae were identified to family, Coleoptera to family, and terrestrial invertebrates to order. A taxonomic list of all invertebrates found is provided in Appendix 1.

Quality Assurance in the Field

Sample containers were pre-labeled with stream site name and date. Samples were numbered 1-5, corresponding with the site measurements of stream velocity and flow. Nets were staggered across the stream width to prevent interception of flow into downstream nets. Where stream sites were too narrow to allow staggering, nets were distributed along the stream length, each net placed below a different riffle habitat.

Contents of the drift nets were washed with ETOH into sample containers. The end buckets of the drift nets were examined for remaining invertebrates.

Five replicate samples were collected from each site. A log was maintained of all invertebrate samples, volumes of water flowing into each net, date samples were collected, and portion of sample sorted.

Figure 39. Drift nets used to sample aquatic invertebrates.

Figure 40. Subsampling aquatic invertebrate samples.

Quality Assurance in the Laboratory

Quality Control for Sorting

Ten percent of the sorted samples were examined by a senior biologist to determine the number of organisms missed by the sorter. If the QC sorter found less than 10% of the total sample organisms remaining in the tray, the sample passed.

Quality Control for Taxonomy

A technician with training in entomology identified the invertebrates; a senior biologist with extensive experience identifying invertebrates in Alaska checked the identification of at least 10% of the samples. A reference collection of identified taxa was maintained. Because many of the aquatic insects in Alaska have not been identified to species, identification was done to the family or genus level, depending on the degree of development of the immature invertebrates. Invertebrates were identified using Merrit and Cummins (1996), Borror and DeLong (1976), Stewart and Stark (1988), and Wiggins (1977). Identification to family level was used when specimens were too immature or damaged to see identifying characteristics. Samples of mature Ephemeroptera and Plecoptera were sent to respective taxonomy experts for more complete identification.

We sorted and identified both halves of three discrete invertebrate drift samples collected in 1998 by the Alaska Department of Fish and Game (ADF&G) (Appendix 2) to test the accuracy of subsampling methods. The split samples were found to contain a sufficient representation of both numbers and taxa (chi-square test, $p<0.02$). Therefore, we were assured of maintaining a representative sample when subdividing.

RESULTS AND DISCUSSION

PERIPHYTON STANDING CROP

Baseline Data

In 1995, periphyton standing crop (as measured by concentrations of chlorophyll-a) was higher in the North Fork of Red Dog Creek than at any of the other sites (Figure 41).

Periphyton standing crop measured in 1996 varied between sample dates, but standing crop in Ikalukrok Creek was always higher than in Red Dog Creek at Station 10 (near the mouth). Among the tributaries, Connie Creek had highest standing crop, and Shelly Creek the lowest. There appeared to be no correlation in periphyton standing crop in Ikalukrok Creek with distance from the mine. Standing crop was probably influenced more directly by stream velocity, exposure to sunlight, and substrate particle size. Samples taken in August 1996 were collected during seasonal high flows following several days of heavy rains. Because of high flows and water depth, we were forced to sample near the stream edges in Ikalukrok Creek; these areas were dry in July.

Periphyton standing crop in Ikalukrok Creek and tributaries to Red Dog Creek were comparable to periphyton standing crop reported for the upper Chena River drainage in interior Alaska (LaPerriere,Van Nieuwenhuyse, and Anderson 1989).

Results of the Present Study

Periphyton was sampled in both June and July of 1997 and 1998 from all sites. Samples from both June and July were substantially higher in 1998 than in 1997 (Figure 42 and Figure 43). Sites having the highest concentrations of chlorophyll-a were Station 8, the North Fork of Red Dog Creek, and Ikalukrok Creek upstream and downstream of Dudd Creek.

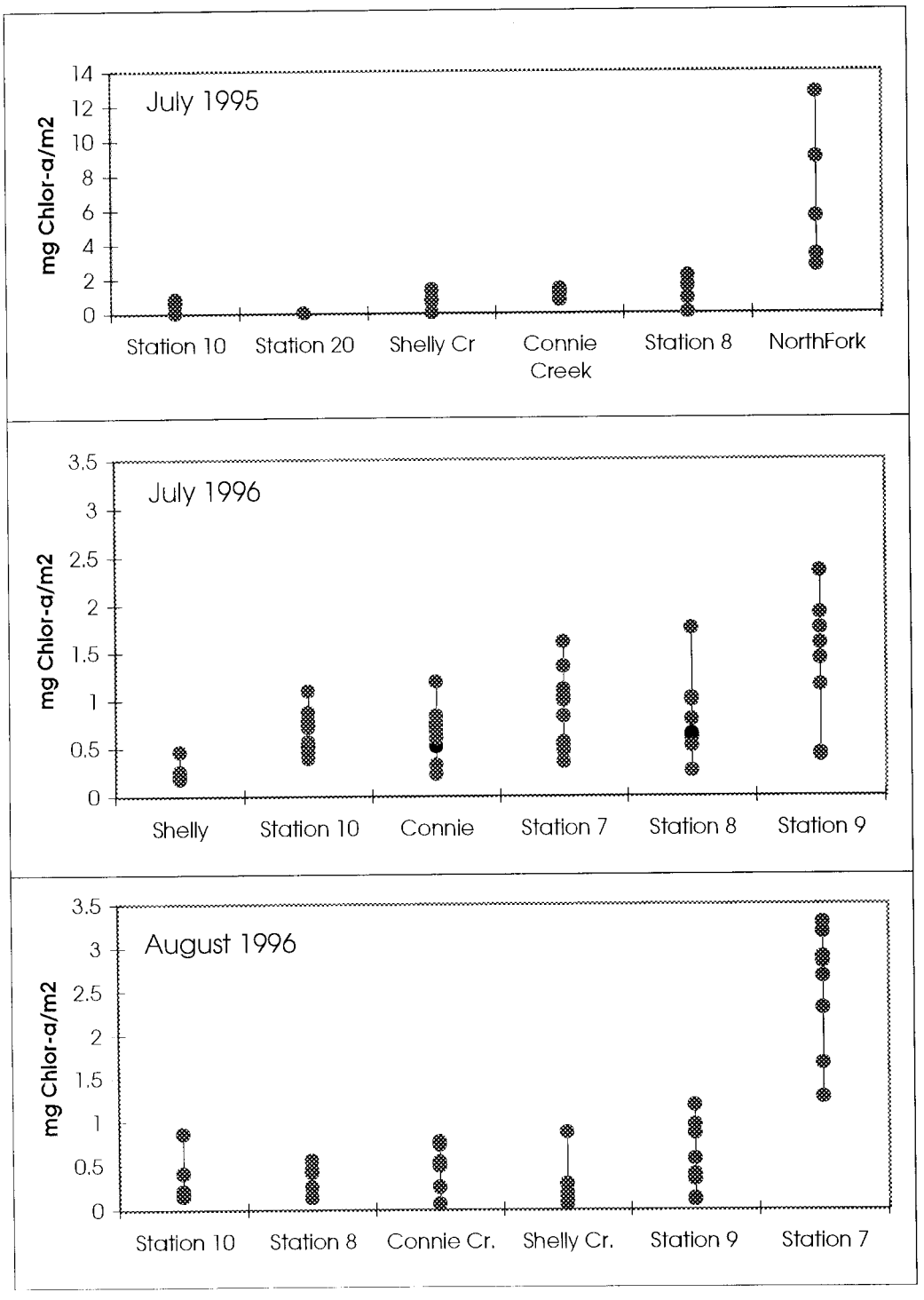

Figure 41. Periphyton standing crop, as measured by concentrations of chlorophyll-a, in the Wulik River drainage, 1995 and 1996.

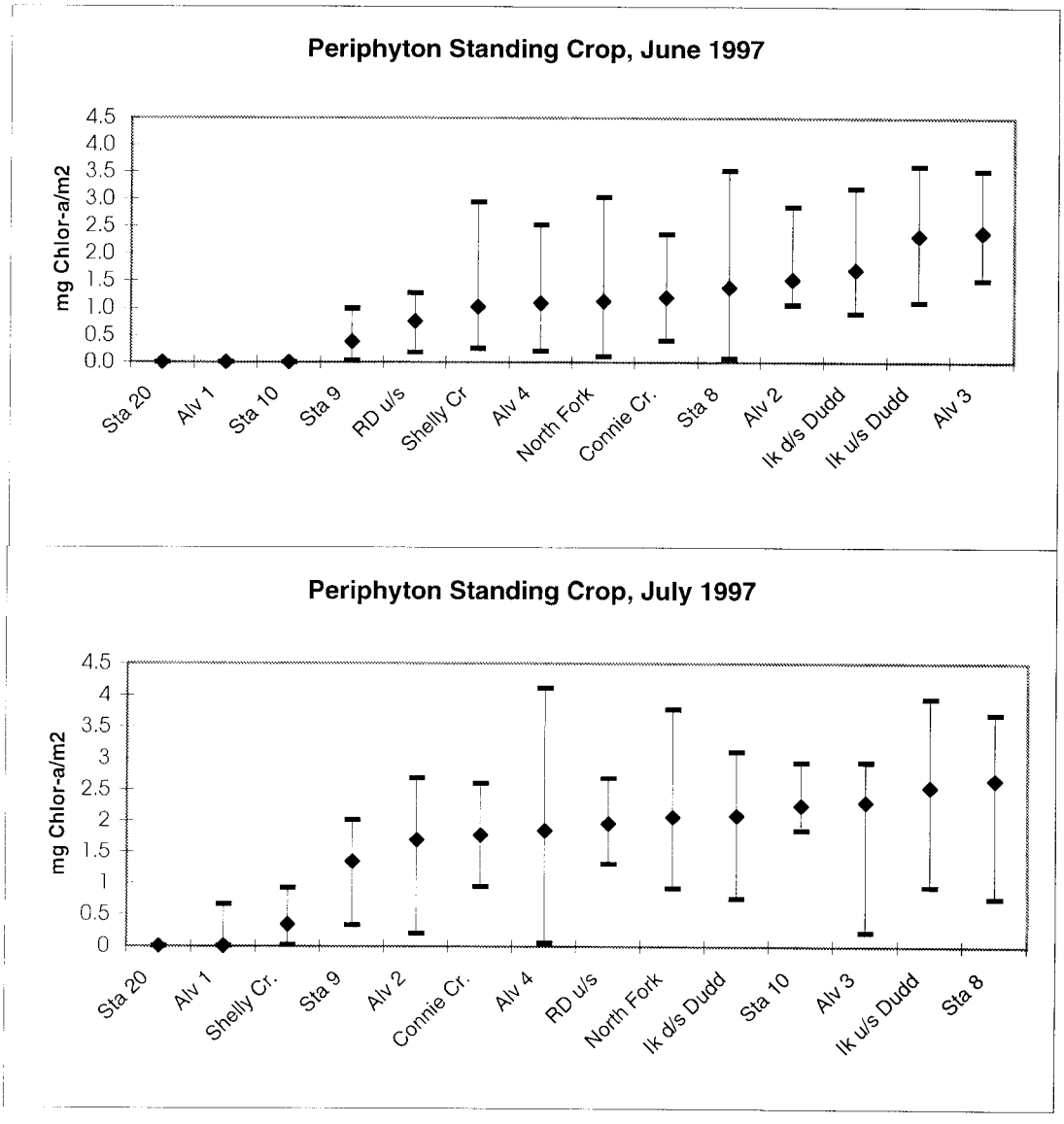

Figure 42. Concentrations of chlorophyll-a sampled in June and July 1997.

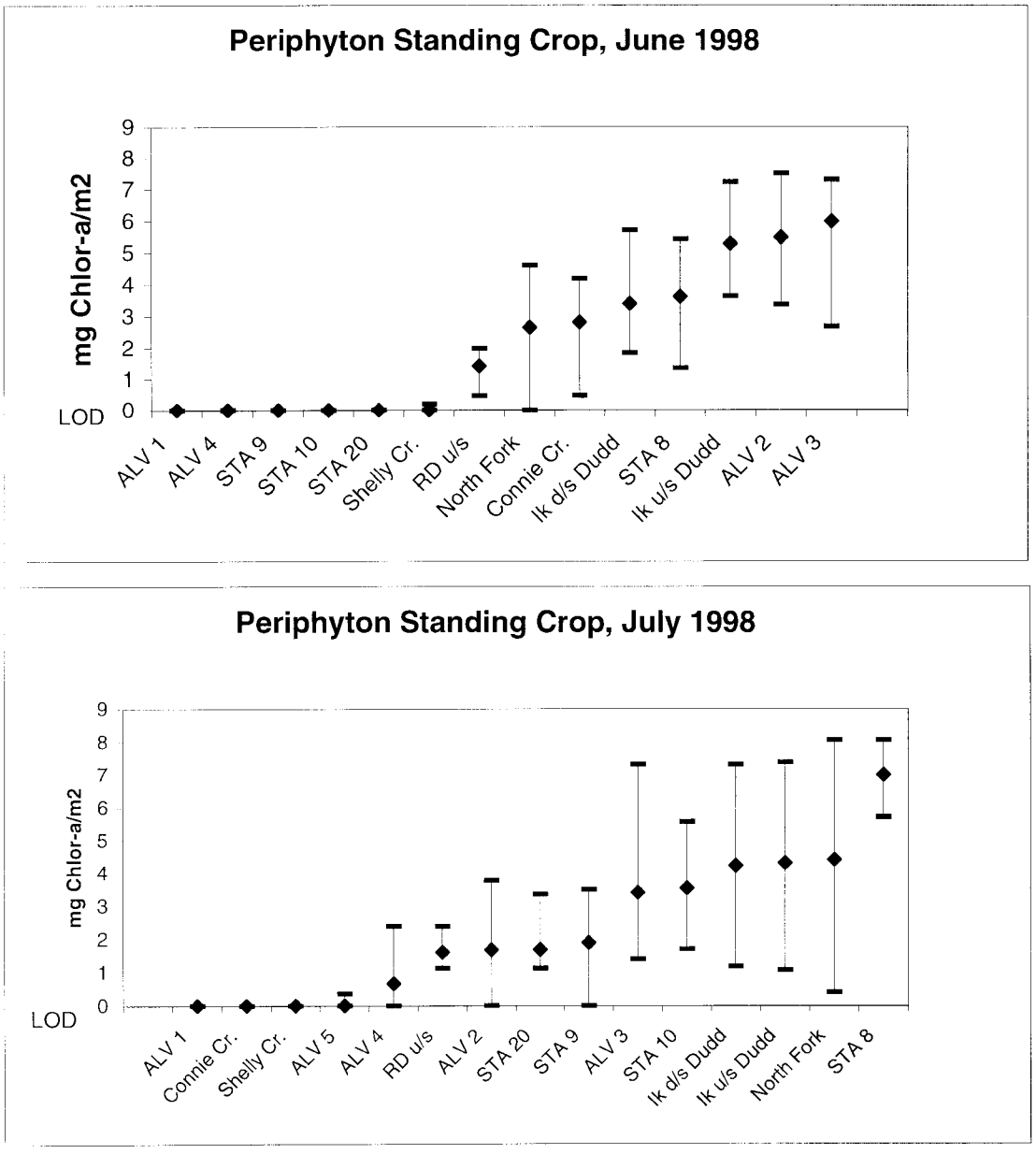

Figure 43. Concentrations of chlorophyll-a sampled in June and July 1998.

The lowest concentrations of chlorophyll-a were measured in the most mineralized sites: Alvinella #1 and Shelly Creek.

Concentrations of chlorophyll-a were higher in most sites in 1998 than in 1997. In June, 1998 chlorophyll-a was approximately three times higher in Alvinella 3, Alvinella 2, Ikalukrok Cr. Upstream of Dudd Creek, Station 8, Station 7, Connie Creek, and the North Fork than in June 1997. Differences in chlorophyll-a concentrations between July 1997 and 1998 were similar (Figures 42 and 43).

The changes in the periphyton communities from the area of the ore body downstream is illustrated in Figure 44. Algal biomass is low near the orebody, then increases with distance downstream. Highest concentrations of chlorophyll-a in sites influenced by the Red Dog Mine were measured in Ikalukrok Creek downstream of the confluence with Red Dog Creek.

Correlation of Algal Biomass with Concentrations of Metals

Although concentrations of metals in the water may not be the only limiting factor controlling periphyton communities, the concentrations of chlorophyll-a are lowest in sites with the highest concentrations of Zn or Cd (Figure 45). Using the median concentration of metals likely does not identify a particular metal as a limiting component of the community because the duration and level of the highest concentration is a more important indication of direct cause and effect. However, median concentrations describe the usual conditions and are useful in making broader comparisons among sites. Highest median concentrations of zinc and cadmium in the water were reported at Alvinella #1, Red Dog Creek upstream of the ore body, Station 20, Alvinella 4, and Shelly Creek. These sites were among the lowest for periphyton standing crop, or chlorophyll-a concentrations.

Eisler (1993) listed various algal species with the toxic effect of Zn at a given concentration (Table 15).

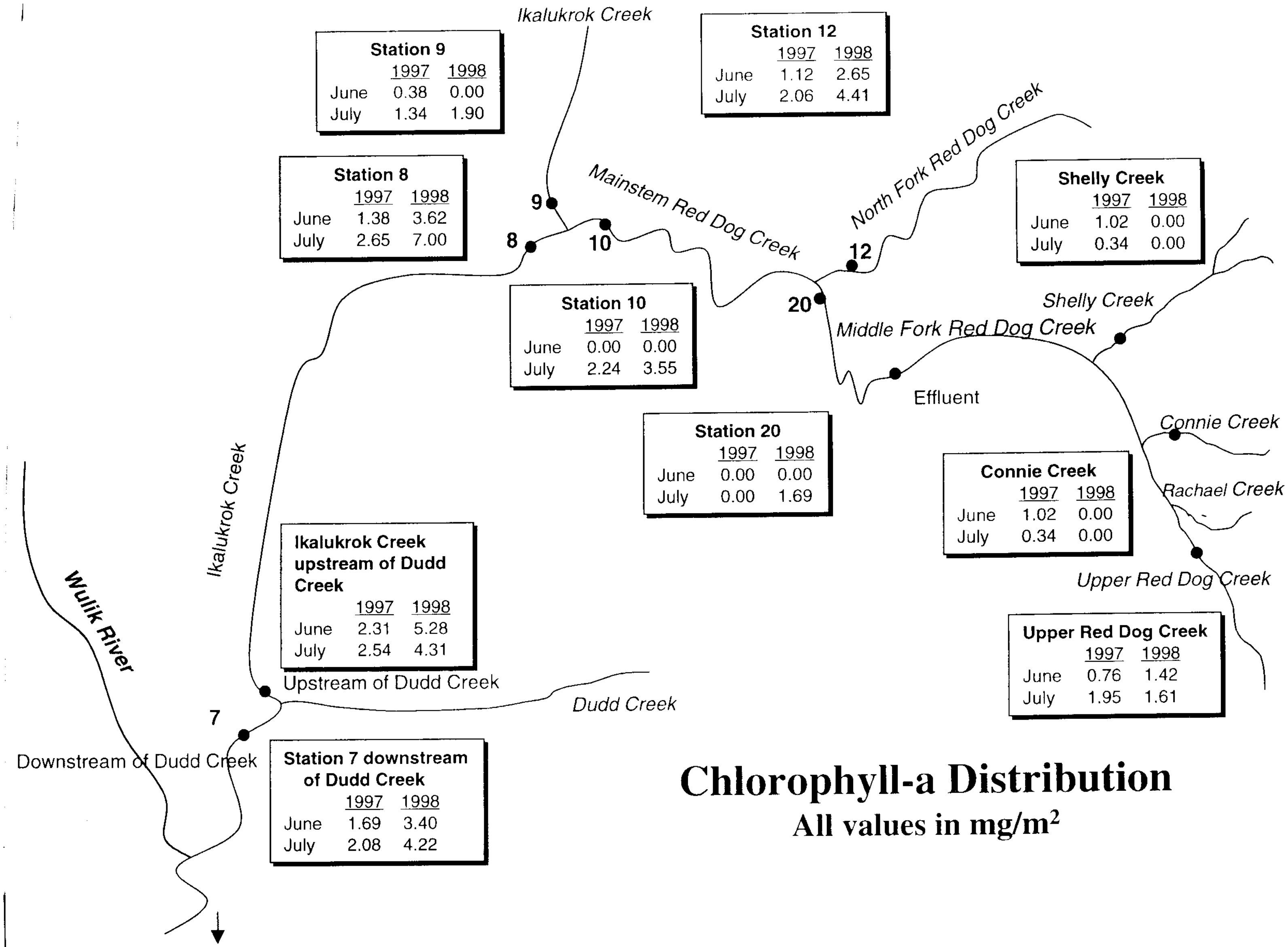

Figure 44. Concentrations of chlorophyll-a (algal biomass) measured in 1997 and 1998 in the vicinity of and downstream of the Red Dog Mine.

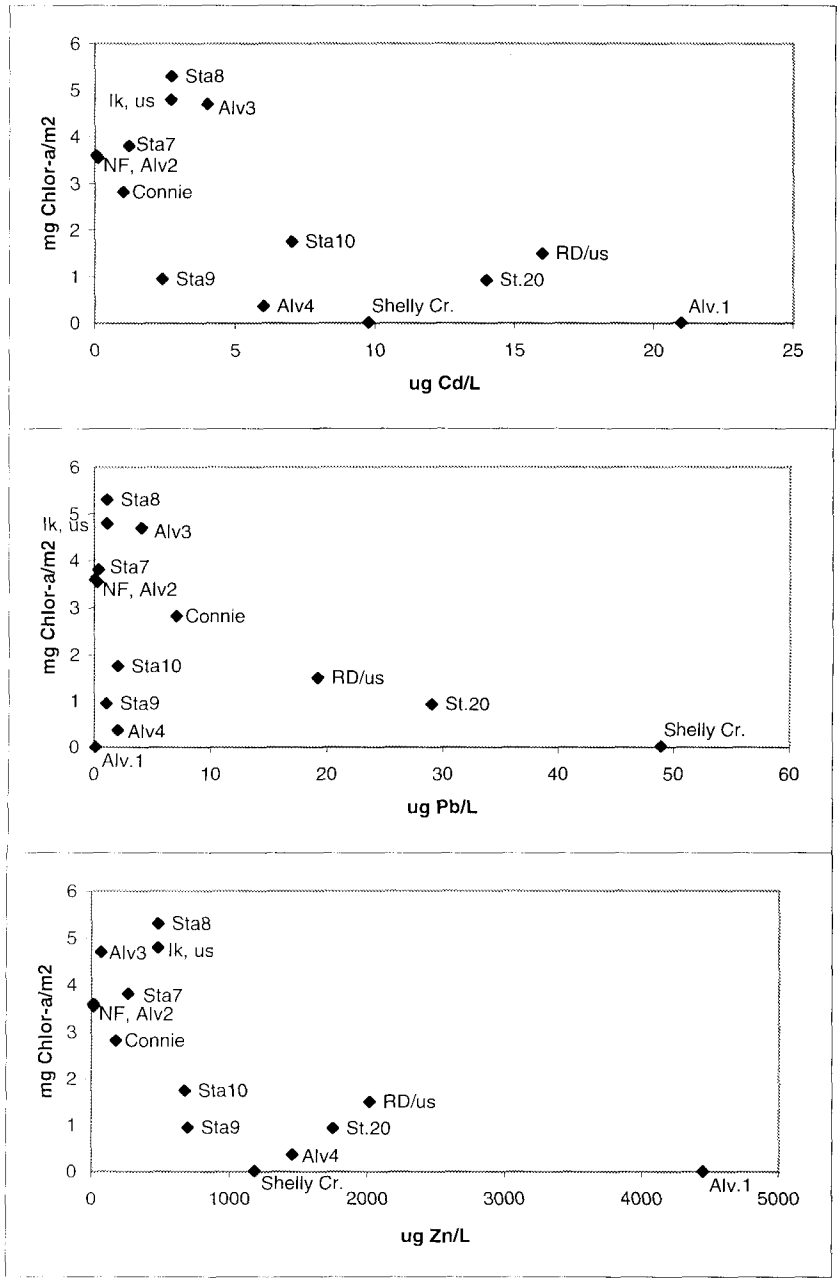

Figure 45. The average concentration of chlorophyll-a and the average concentration of Zn , Cd, and Pb measured in June and July 1998.

Table 15. Effects of different concentrations of Zn to freshwater alga species. Data from Eisler (1993).

Species	Zn, ppb	Effect
Freshwater alga		
Selenastrum capricornutum	30	Some growth inhibition in 7 days
S. cupricornutum	40-68	95% growth inhibition in 14 days
S. capricornutum	100	100% growth inhibition in 7 days
Diatom		
Skeletonema costatum	19.6	Adverse effects
S. costatum	50-100	Growth reduced 20-23%, 10-15 days
S. costatum	200	Growth stimulated in 1-5 days
S. costatum	265	Metabolic disruption in 3 days
Diatom		
Thalassiosira pseudonana	65	Adverse effects
T. pseudonana	500	Growth reduced 41% in 11-15 days
T. pseudonana	823	Growth reduced 50% in 72 h
Green macroalga		
Ulva lactuca	65	BCF of 255 in 6 days

Alabaster and Lloyd (1980) summarized literature on effects of Cd to freshwater algae (Table 16). They reported concentrations of Cd causing inhibition of algal growth that were within the range of concentrations found in Alvinella #1 and Middle Fork Red Dog Creek upstream of the ore body.

Table 16. Summary of concentrations of Cd shown to cause adverse effects to freshwater algae. From Alabaster and Lloyd (1980).

Species	Concentration *ug*/L	Effect
Selenastrum capricornutum	300	lethal
	50	inhibited growth
Scenedesmus quadricauda	50-500	reduced growth
6.1	reduction in growth	
	61	severe inhibition
Lemna valvidiana	10	25% growth inhibition
	50	80% growth inhibition

Shelly Creek and Station 20 had the highest concentrations of Pb and low concentrations of chlorophyll-a (Figure 47). Algal populations in the Red Dog Creek drainage probably are not limited by concentrations of Pb. The highest Pb concentrations (48.9 ug/L measured at Shelly Creek and 29 ug/L in Station 20) are not considered sufficiently high to limit algal growth and production. Eisler (1988) reported inhibition of photosynthesis in freshwater algal species at 207 ug/L and death after 24-hr exposure at 4,140 ug/L.

In both months, chlorophyll-a concentrations were highest at Station 8, then decreased downstream at Ikalukrok Creek upstream of Dudd Creek and Station 7, Ikalukrok Creek below Dudd Creek. Ikalukrok Creek between Station 8 and the sites near Dudd Creek changes to a higher velocity system with more scour. It is likely that a combination of enrichment from the mine effluent (containing sewage effluent) and changes in streambed scour influenced the primary productivity at these sites.

The growth of filamentous green algae observed in Red Dog Creek at Stations 20 and 10 during July caused higher concentrations of chlorophyll-a in periphyton samples. In July 1998, the streambed at Station 20 was covered with a dense growth of filamentous green algae. Periphyton sampling was done to minimize the amount of filamentous algae collected, but collecting some of the filaments in the samples was unavoidable. Filamentous algae was not as dense at Station 10, but still prevalent over the substrate. The high chlorophyll-a concentrations measured at these two sites reflect the abundance of filamentous algae. A few strands of filamentous algae will contain chlorophyll-a concentrations that are many times higher than chlorophyll-a measured from attached micro-algae. Therefore, comparisons of algal growth among sites should be made with consideration to community richness.

AQUATIC INVERTEBRATE COMMUNITIES

Baseline and Historic Data

During baseline studies, both EVS and Ott Water Engineers (1983) and Dames and Moore (1983) sampled aquatic invertebrate populations in Red Dog Creek and downstream waterways. Dames and Moore used Surber samplers and "visual observation" to document the presence of aquatic taxa. Their data are not quantitative and the sampling effort cannot be determined from their report. Studied conducted by EVS and Ott Water Engineers (1983) wee more extensive and attempted to relate aquatic populations to water quality of the drainages. Taxonomy for most of the invertebrate groups reported in the 1983 reports has been substantially revised. In particular, genera and family relationships of Oligichaeta and Chironomidae has been revised and no longer conform to the divisions used in 1983. With other groups, in particular the Ephemeroptera and Plecoptera, it is possible to relate the old taxonomic name to the revised name. Whenever possible, the current taxonomic name is used in this report. Chironomidae and Oligichaeta reported in baseline data are not identified below family level.

In baseline studies, North Fork Red Dog Creek contained both the greatest abundance and the highest taxonomic richness of any of the sites sampled. In the limited sampling done by EVS and Ott Water Engineers (Table 17), eight different taxonomic groups were found. Ephemeroptera and Plecoptera dominated the aquatic invertebrate community. Ikalukrok Creek contained the greatest abundance of aquatic invertebrates among areas downstream of known mineralization; however, few taxa were found. Few invertebrates were collected in the Mainstem or Middle Fork of Red Dog Creek. No baseline data on aquatic invertebrate populations are available for any of these tributaries or sites in Ikalukrok Creek near the headwaters.

Table 17. Aquatic invertebrates collected during baseline studies by EVS (1983). Refer to Figure 2 for locations of sample stations.

	Invertebrate Abundance		Taxonomic Richness	
Creek	average #/sample	maximum #/sample	average #/sample	maximum #/sample
Ikalukrok C. (Sta. 73)	16.3	41.8	5.4	7
Mainstem of Red Dog Creek	4.8	1.4	5	6
Middle Fork Red Dog Creek				
Station 21	15	24.7	5	5
Station 140	13.9	33.1	4.7	5
North Fork Red Dog Creek	63.5	100.2	7	8

No data were found for Shelly, Connie, Sulfur, or Rachael Creek

Data from EVS and Ott Water Engineers (1983)

ADF&G sampled aquatic invertebrate communities throughout the Wulik River drainage in 1995 and 1996 (Weber Scannell 1996, 1997). Both drift nets and kick nets were used in these studies and there were substantial differences between the two sampling methods. Drift sampling was far more effect in collecting larger numbers of insects and more genera (Tables 16-18). Terrestrial insects were not represented in kick samples, so their importance as potential fish food could not be determined with this sampling method.

In 1995 and 1996, the largest numbers of insects in the aquatic stages (excluding terrestrial forms) were usually collected in the tributary streams: North Fork of Red Dog Creek, Connie Creek and Shelly Creek in 1995 (Table 18), and Connie and Shelly Creeks in both July and August 1996 (Table 19 and Table 20). No correlation was found with invertebrate density and distance downstream from the mine, except in July 1996. During this sample period, densities were higher at Station 6, followed by Station 7, then by Station 8, and Station 20 with the fewest invertebrates. An exception occurred at

Station 10, which had more invertebrates than any of the other sites, except Connie and Shelly Creeks.

In 1996, ADF&G sampled with both drift nets and kick nets to compare the sampling methods and to ensure that we were getting samples that adequately represented the aquatic communities. Drift samples collected in 1996 indicated that benthic sampling methods used in 1995 and 1996 did not provide a sufficient representation of taxonomic richness (summarized in Appendix 3). In particular, we found that representatives of Ephemeroptera and Plecoptera were missing from kick net samples. Drift nets collected a wider selection of genera. Drift nets also collected large numbers of genera that were fully developed and ready to emerge from the stream. Collection of mature and emerging insects documents the time of emergence and provides mature or adult samples for more accurate taxonomic identification.

Kick nets collected fewer taxa and fewer individuals than drift nets. Further, they could not be quantified by amount of water or area of streambed. Therefore, kick net sampling was abandoned after 1995 and the kick net data from 1996 was not presented.

Differences between July and August 1996 samples are notable: Station 8 had the lowest taxonomic richness in July 1996 and the highest in August.

Table 18. The Percent of Ephemeroptera, Plecoptera, and Diptera and the average number of invertebrates collected in July 1995. Samples were collected with kick nets.

Sample Site	Percent Ephemeroptera	Percent Plecoptera	Percent Diptera	Average/ sample immature	No. of Taxa
Station 8	3	3	13	7.4	1.4
Station 10	0	0	15	4	1
Station 11	0	0	100	0.4	0.4
Station 20	0	0	0	0	0.6
Shelley Cr.	0	10	30	4.2	1.6
Connie Cr.	3	1	96	40.6	2.6
North Fork	35	2	55	26	5.4

Non-insect invertebrates, including Nematoda, were collected in some of the samples.

Table 19. The Percent of Ephemeroptera, Plecoptera, and Diptera and the average number of invertebrates collected in July 1996. Samples were collected with drift nets.

Sample Site	Percent Ephemeroptera	Percent Plecoptera	Percent Diptera	Average/ sample adults	immature	Average no. Taxa*
Station 7	6	11	82	1	210	5.3
Station 8	0	4	94	23	170	4
Station 9	6	15	77	138	57	4
Station 10	1	7	92	99	629	5.7
Station 20	3	0	95	299	81	4
Shelly Cr.	0	2	98	262	2842	4.7
Connie Cr.	1	3	94	675	700	5

*Only aquatic taxa and aquatic life stages were counted.

Table 20. The Percent of Ephemeroptera, Plecoptera, and Diptera and the average number of invertebrates collected in August 1996. Samples were collected with drift nets.

Sample Site	Percent Ephemeroptera	Percent Plecoptera	Percent Diptera	Average/ sample adults	immature	Average no. Taxa*
Station 7	87	4	9	0	805	5.7
Station 8	56	10	33	2	263	8.7
Station 9	77	5	18	3	905	6.3
Station 10	38	11	51	0	704	6
Station 20	68	2	28	50	737	5
Shelly Cr.	33	54	13	9	1246	4
Connie Cr.	67	4	28	14	1479	6.7

*Only aquatic taxa and aquatic life stages were counted.

The highest proportion of terrestrial insects (adult stage of aquatic taxa) were found in July at Station 9 and 20 (Table 21). Seasonal differences in timing of emergence account for differences between July and August samples. The emerging and flying insects are an important prey for surface feeding fish, such as Arctic grayling. In August, many of the Perlodidae and Capniidae nymphs appeared to be in final aquatic life stages because wing

pads were darkened and well-developed. Weber Scannell (1997) estimated that emergence would occur within 1 to 2 weeks after the sample period.

Adult insects were less common at all sites in August than in July and constituted less than 1% of samples at all sites except Station 20 (6.4 %).

Table 21. Proportion of terrestrial (adult) forms of aquatic taxa found in study sites.

	July % of total	August % of total
Station 7	0.5	0.0
Station 8	11.9	0.8
Station 9	70.8	0.3
Station 10	13.6	0.0
Station 20	78.7	6.4
Shelly Creek	8.4	0.7
Connie Creek	49.1	0.9

Results of Current Study

All invertebrates were counted and identified to the lowest taxonomic level. More mature specimens were identified to genus where northern genera were described. A complete list of the taxonomic groups identified in this study is presented in Appendix 1.

Results of the invertebrate sampling were divided between sites below and adjacent to the Red Dog Mine and sites in the headwaters of Ikalukrok Creek (the Alvinella sites). Sites at Alvinella are not affected by any activities associated with the Red Dog Mine. Limited drilling has been done in this area, but ground disturbance is minimal.

Sites at Alvinella, upstream of the Red Dog Mine

The invertebrate abundance in the most mineralized site, Alvinella 1, was consistently lower and had a higher terrestrial component than the relatively unmineralized site at Alvinella 2 (Figures 46 and 47, summarized in Appendices 4 and 5). Abundance in

Alvinella 3 and 4 are similar, with Alvinella 3 slightly higher. Alvinella 5, located upstream of the mineralization found at Alvinella 1, was sampled one time: July 1998. At that time, the invertebrate abundance was the highest of all sites in this area.

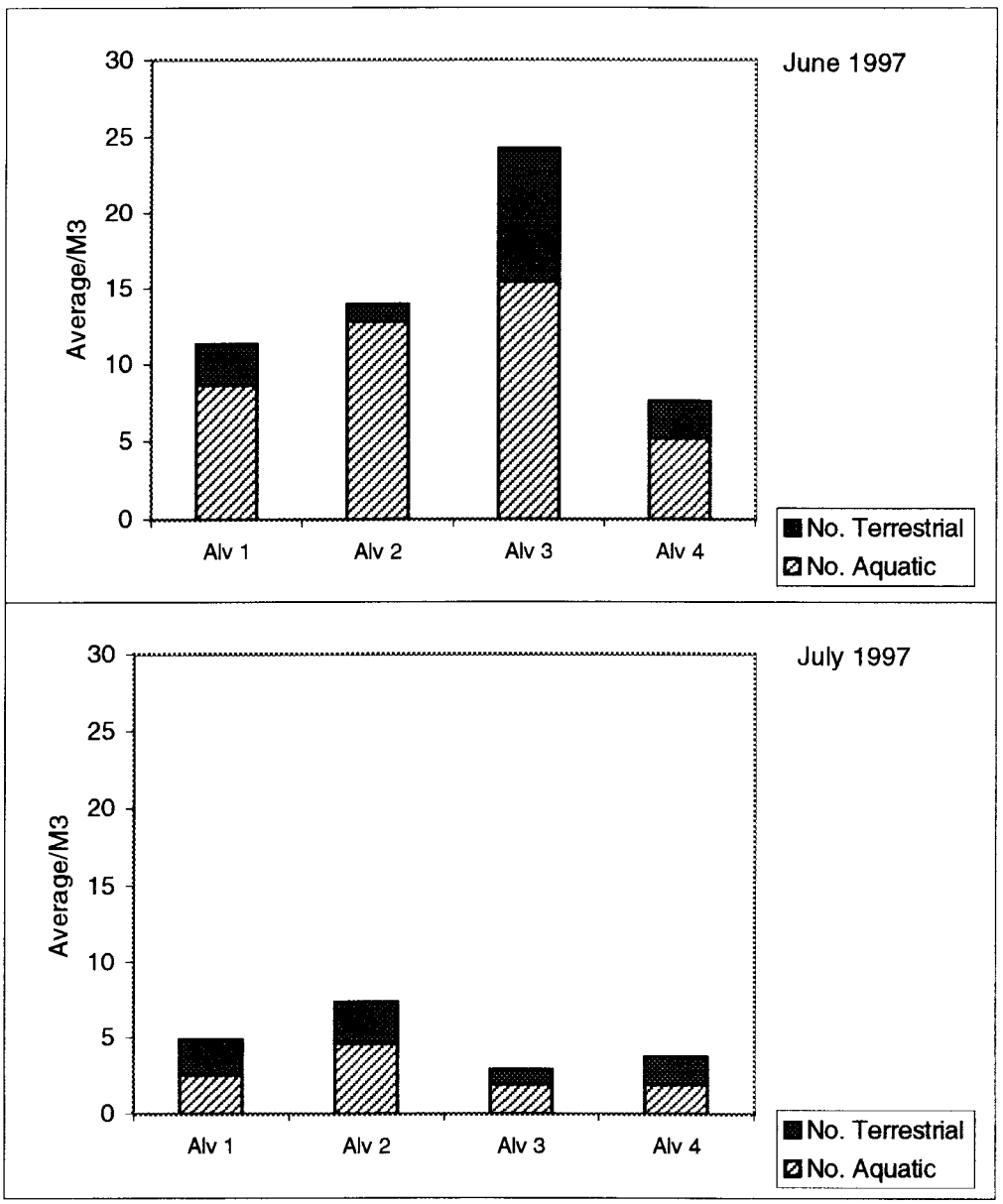

Figure 46. Number of aquatic and terrestrial invertebrate per m^3 of water collected in the Alvinella sites, upstream of the Red Dog mine, 1997.

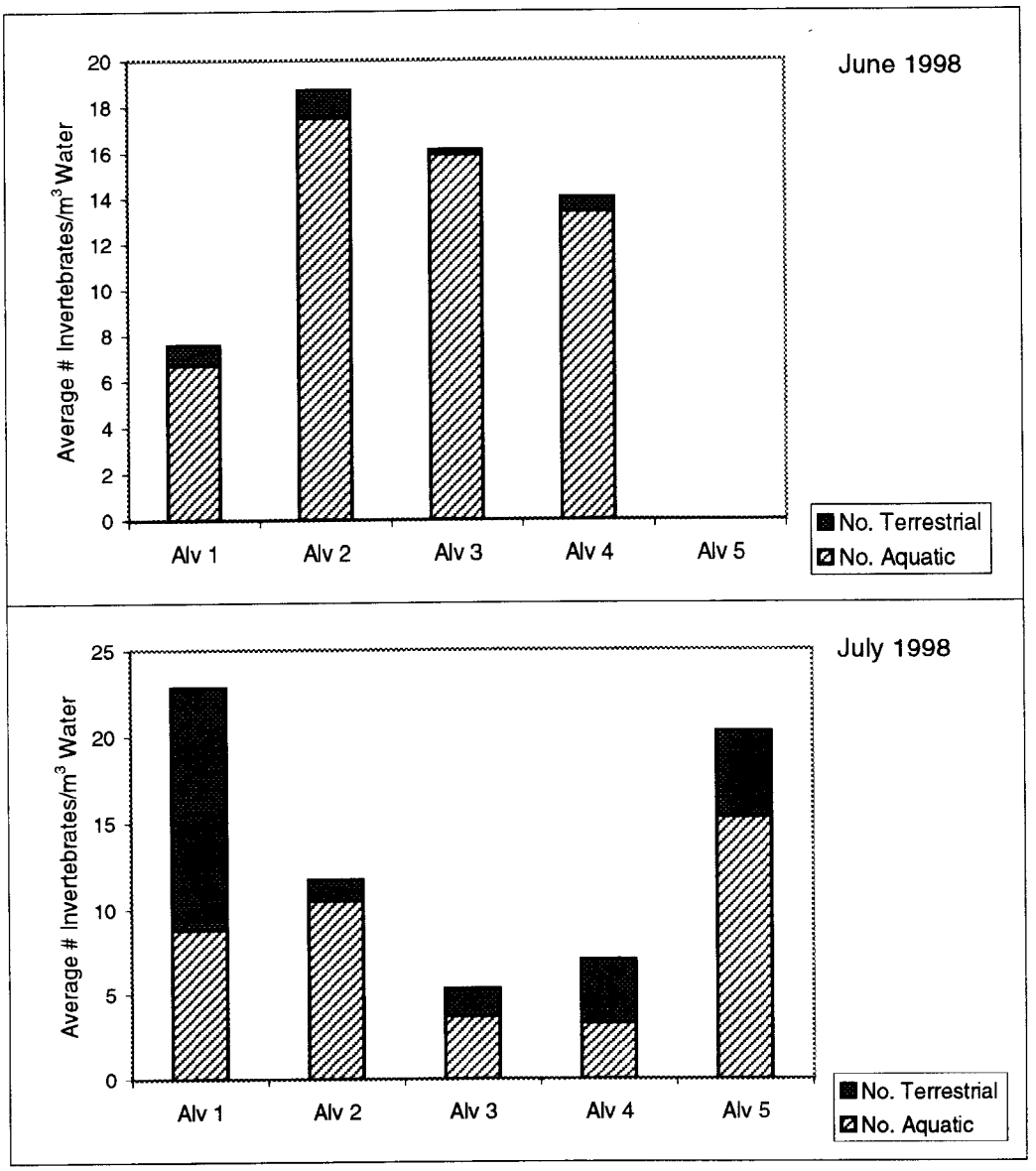

Figure 47. Number of aquatic and terrestrial invertebrate per m^3 of water collected in the Alvinella sites, upstream of the Red Dog mine, 1998.

Taxonomic richness, measured by the number of distinct taxa collected, provides an indirect measure of community diversity and complexity. Taxonomic richness was similar at all Alvinella sites in 1997 and 1998 (Figure 48).

Although taxonomic richness was similar among sites, the contribution of different groups varied. Ephemeroptera, or mayflies, were more common in Alvinella 2 than the other sites (Figure 49 and Appendix 6). Diptera comprised more than 50% of the samples at all sites in June of both 1997 and 1998. By July, Ephemeroptera and Plecoptera replaced Diptera as the most commonly occurring groups. The miscellaneous group contains Coleoptera larva, Collembola, and Acarina. Because Trichoptera were rare at all sites they are included in the miscellaneous category.

The abundance of aquatic invertebrates (excluding terrestrial forms) is lowest in Alvinella 1, a site that has highest concentrations of Cd and Zn (Figure 50). Alvinella 2 and 3, with lowest concentrations of Cd and Zn, have highest abundance of aquatic forms. Alvinella 4, a mixture of water from the two tributaries, had invertebrate abundance that was between that found in Alvinella 1 and Alvinella 2-3. Concentrations of Pb do not appear to correlate with invertebrate abundance at these sites.

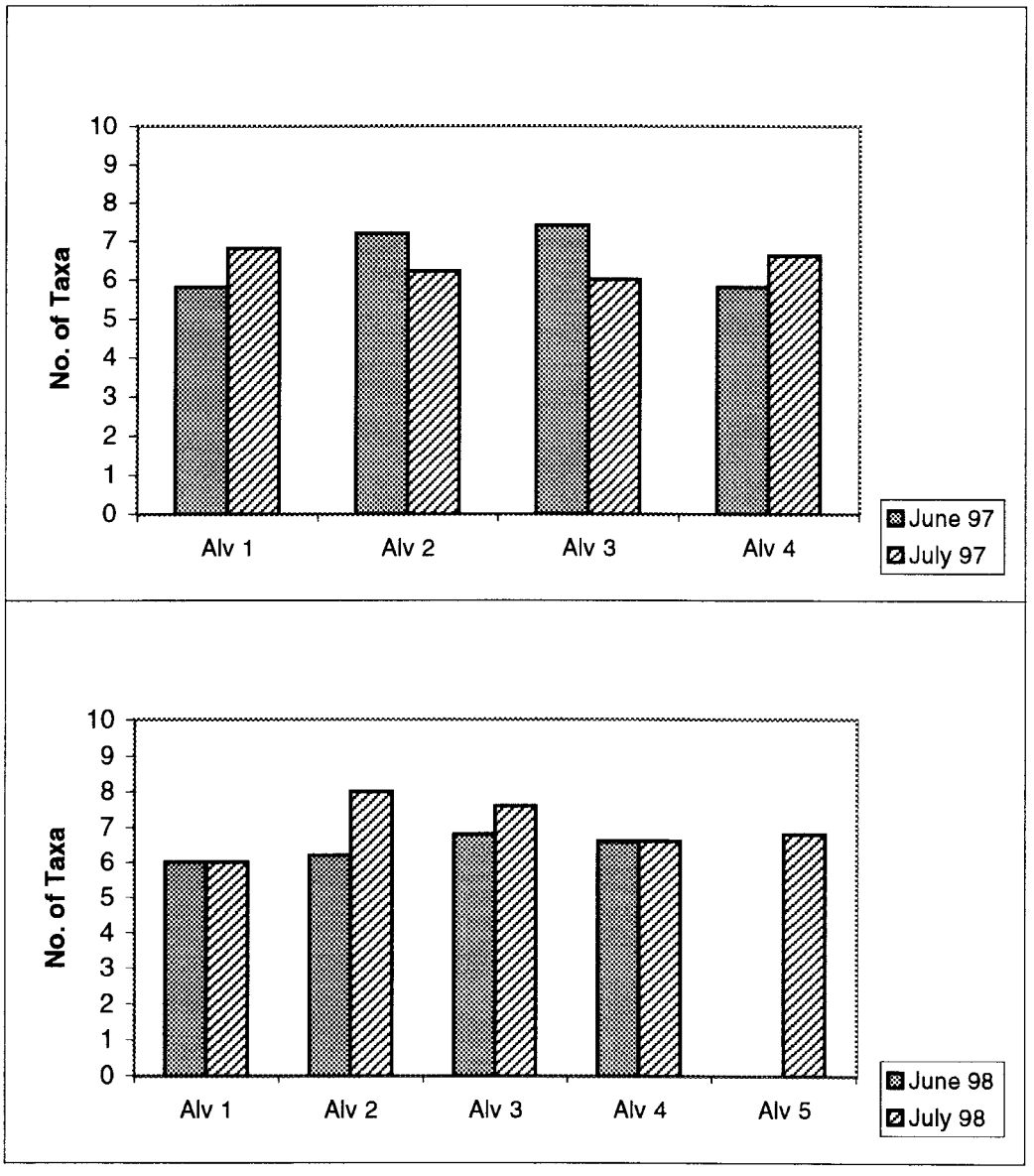

Figure 48. Average number of taxa (Taxonomic richness) collected per m3 of water in samples from Alvinella sites, upstream of the Red Dog mine, 1997 and 1998.

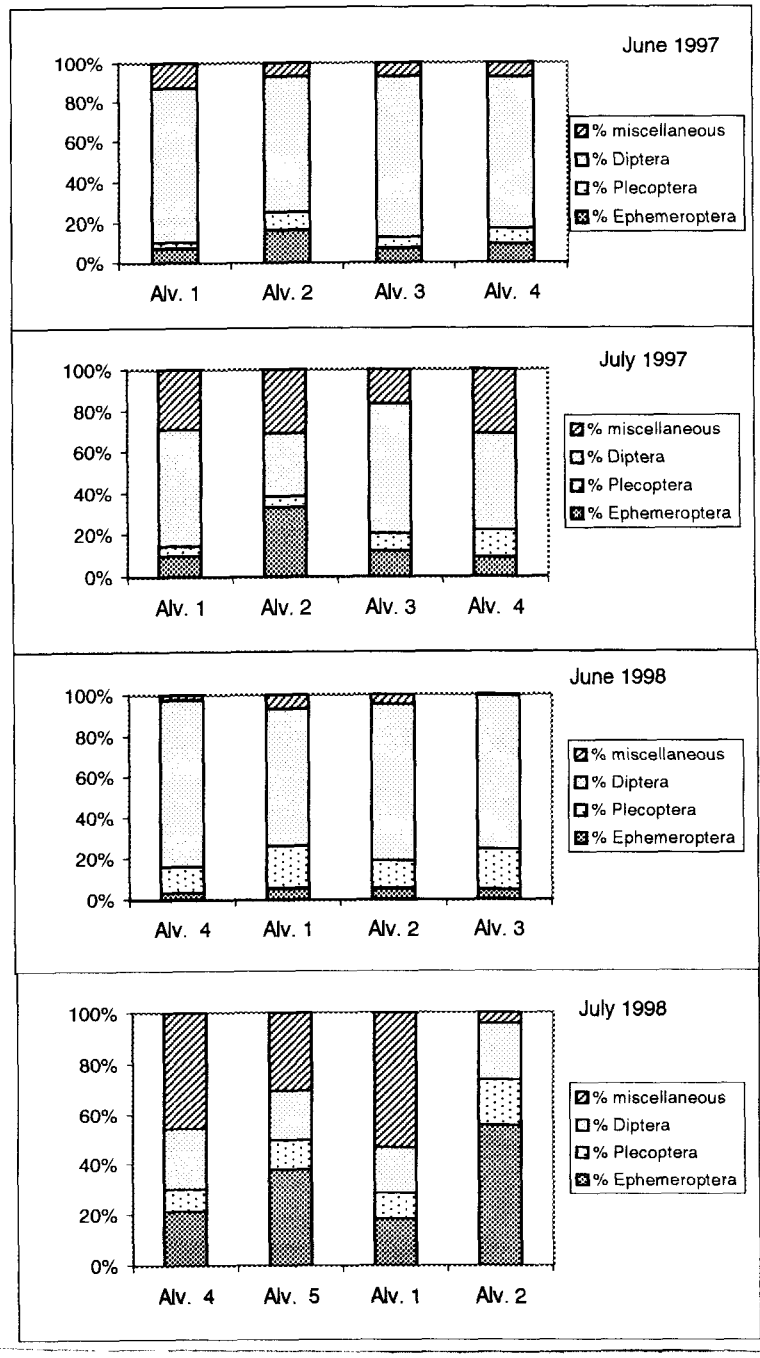

Figure 49. Proportion of major taxonomic groups of aquatic invertebrates collected in drift nets from Alvinella sites, 1997 and 1998.

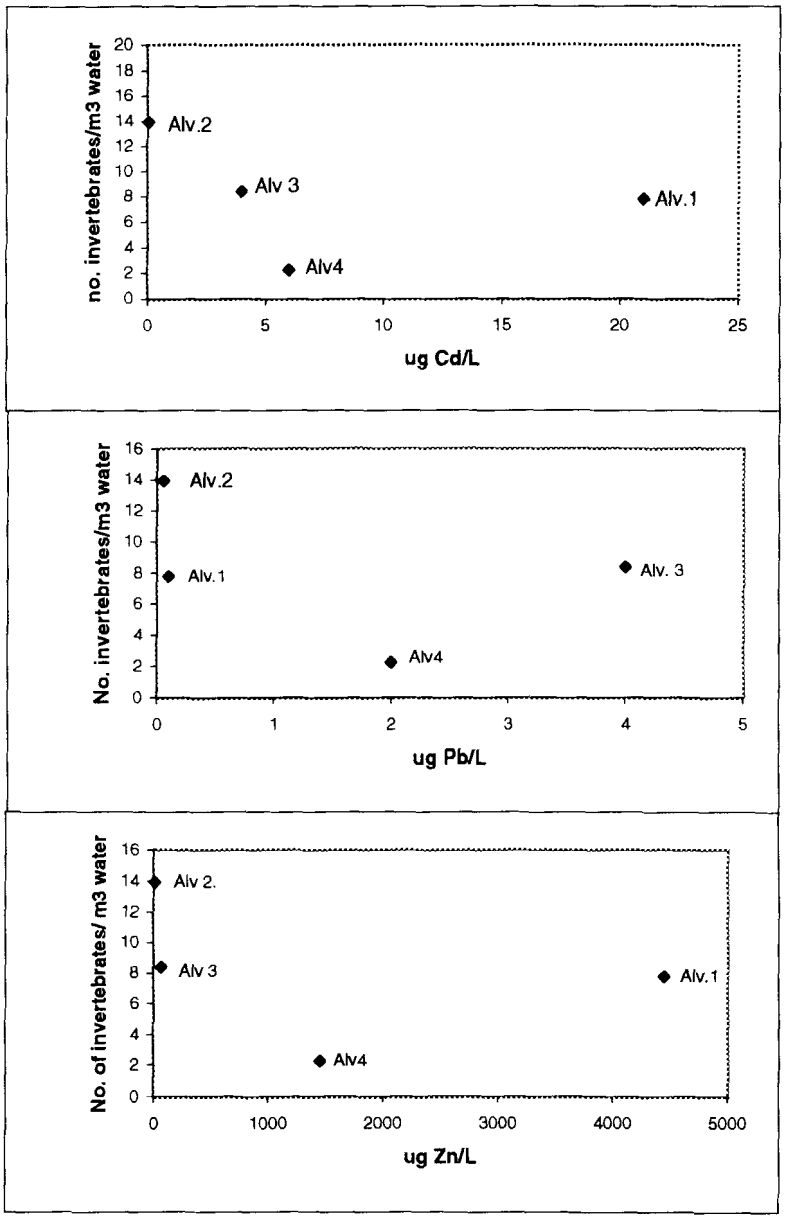

Figure 50. Relationship between average invertebrate abundance and median concentrations of Cd, Pb, and Zn at Alvinella sites, 1998.

SITES ADJACENT TO AND DOWNSTREAM OF THE RED DOG MINE

The aquatic invertebrate data was summarized for both 1997 (Appendices 4 and 7) and 1998 (Appendices 5 and 8) to show the number of each taxa collected within each site. The relative proportions of each major taxonomic group are shown for all sites in Appendix 6 for 1997 and 1998.

The abundance of aquatic invertebrates collected in June and July of 1997 and 1998 was compared among sites, grouped by tributary stream, and then from sites below the mine effluent extending downstream. The invertebrate abundance, measured as the average number of invertebrates per m^3 of water passing through the net, was highest in the tributary streams, Connie Creek, Shelly Creek, and the North Fork of Red Dog Creek in June 1997 (Figure 51) and June 1998 (Figure 52). The fewest invertebrates were consistently found in the Middle Fork of Red Dog Creek at Station 20. The proportion of terrestrial insects was higher at most sites in June than July of both years. A higher proportion of terrestrial insects collected in June primarily resulted from the emergence of several genera of Ephemeroptera and Diptera. At Station 20, there were few aquatic forms collected; the low numbers reflect the low overall productivity of this site.

The abundance of aquatic invertebrates was lowest in Red Dog Creek sites closest to the ore body: Station 20 and the Mainstem of Red Dog Creek upstream of the ore body (Figure 53). Invertebrates were sparse at Station 20, an area that historically has not supported aquatic life (Weber Scannell 1996). Invertebrates were sparse at Station 20, an area that historically has not supported aquatic life (Weber Scannell 1996). Overall, tributary streams had the largest populations of invertebrates. Station 9, upstream of Red Dog Creek, had higher invertebrate abundance than the sites downstream of Red Dog Creek.

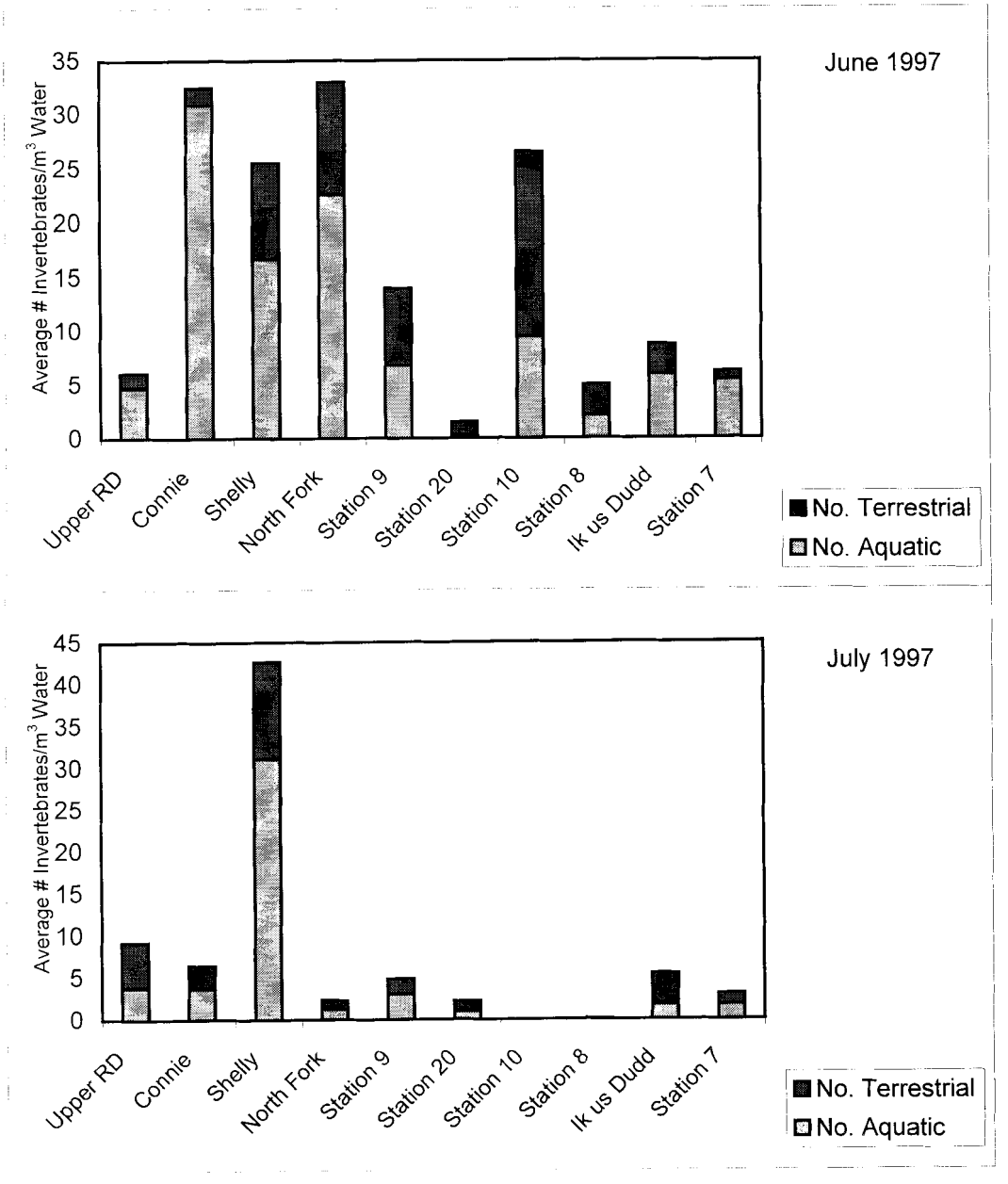

Figure 51. The abundance of invertebrates collected adjacent to and downstream of the Red Dog Mine, 1997. The graph shows the contribution of terrestrial and aquatic forms.

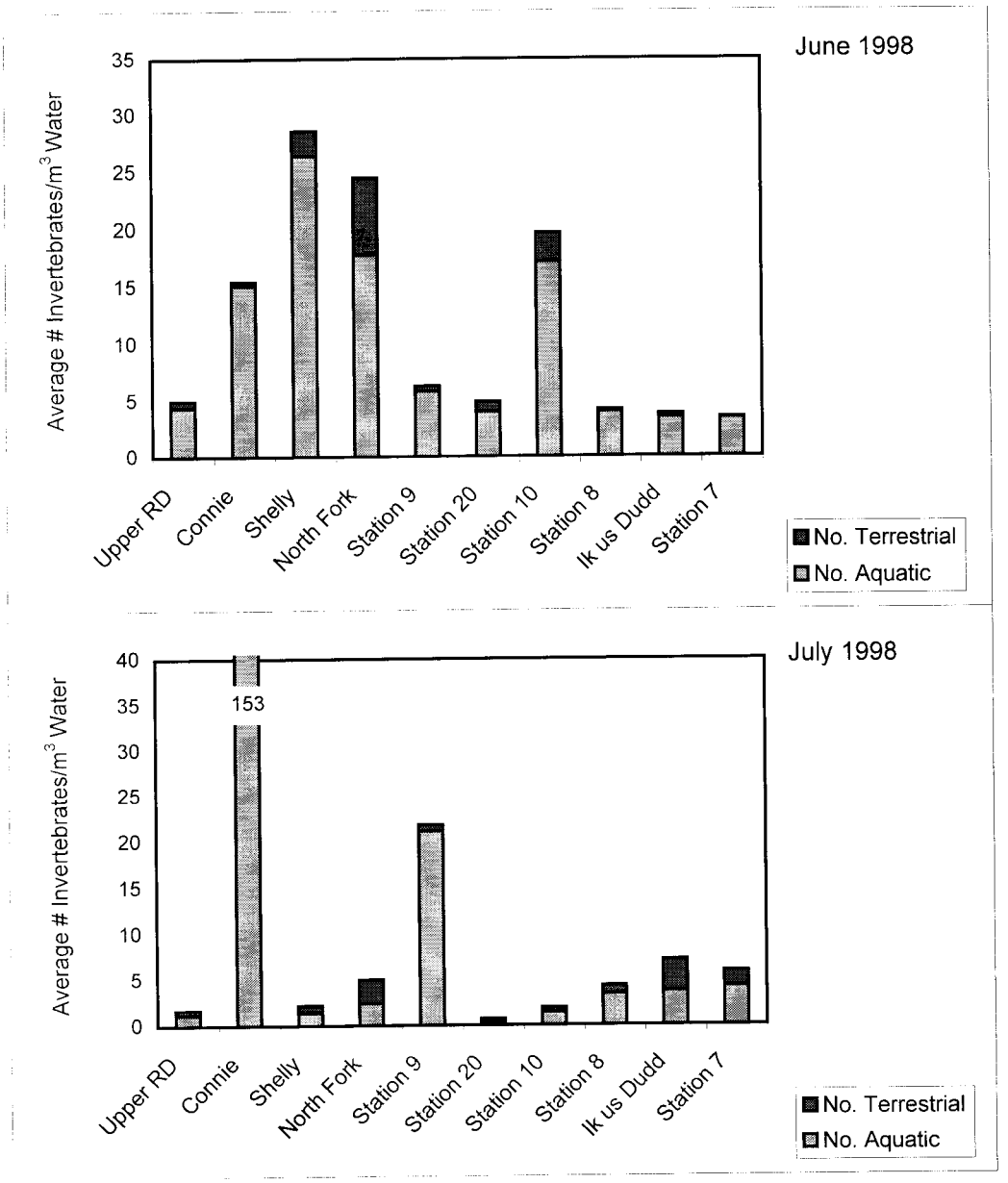

Figure 52. The abundance of invertebrates collected adjacent to and downstream of the Red Dog Mine, 1998. The graph shows the contribution of terrestrial and aquatic forms.

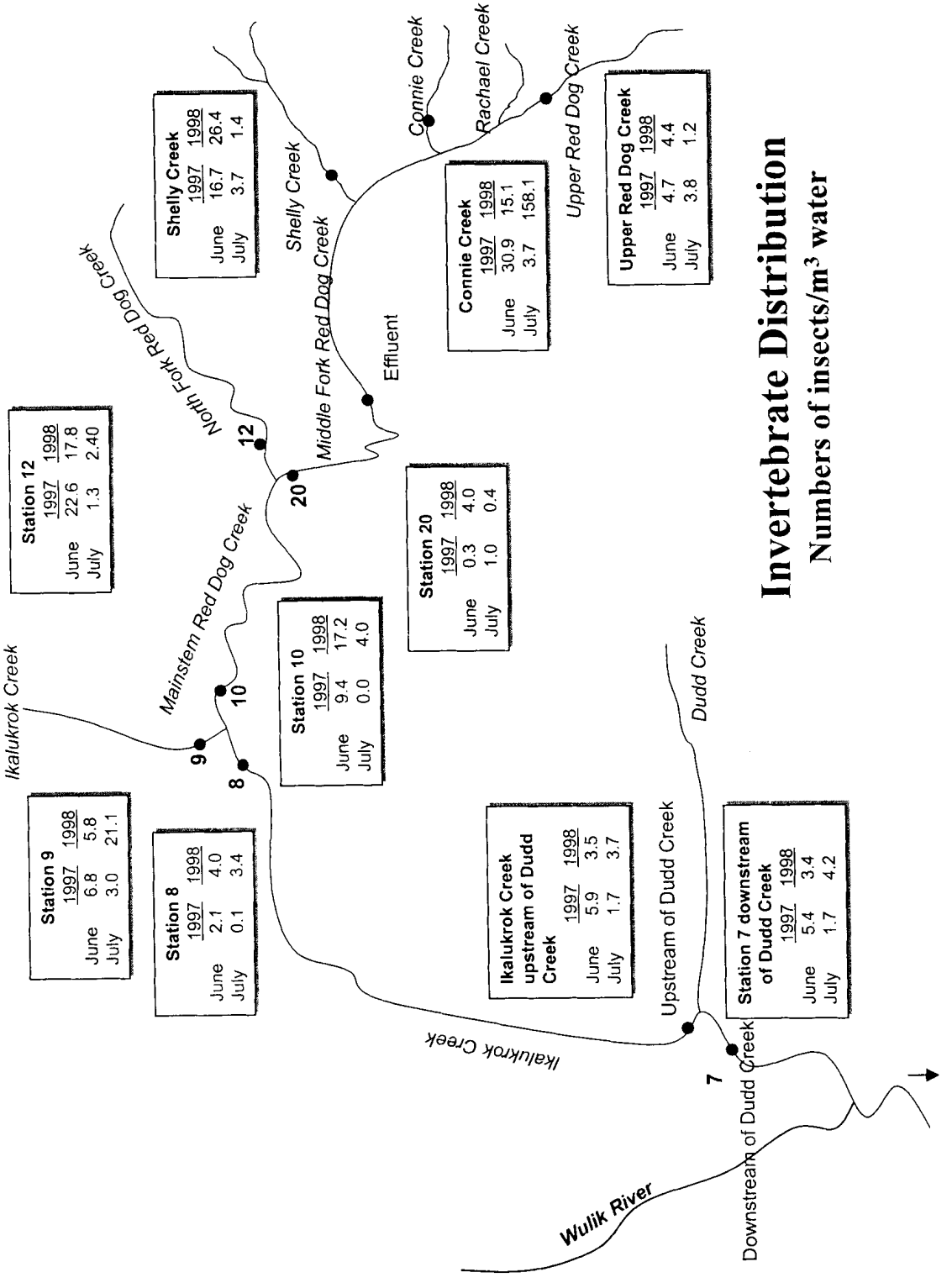

Figure 53. Changes in abundance of aquatic invertebrates with distance from the Red Dog Mine.

As with the sites at Alvinella, the taxonomic richness of sites near and downstream of the Red Dog Mine were similar among all sites in 1998. In 1997, fewer taxa were collected at Station 20 in June and Stations 10 and 8 in July (Figure 54).

Although taxonomic richness was similar among sites, there were different proportions of Ephemeroptera, Diptera, and Plecoptera. Overall, representatives of Diptera were predominate at all sites in 1997 (Figure 55). There were notable differences between samples collected in 1997 and 1998. In 1998 the proportions of both Ephemeroptera and Plecoptera were substantially higher than in 1997 (Figure 56). In June 1998, the most common Ephemeroptera was Baetidae (Appendix 6). Many of the Baetidae collected in June were mature or beginning to emerge. By July, Ephemeroptera, Heptageniidae: *Cingymula* replaced Baetidae: *Baetis* as the most common mayfly.

Plecoptera (primarily Nemouridae and Capniidae) were more abundant in June 1997 and 1998 than in July samples. Trichoptera were rare at all sites.

The abundance of aquatic invertebrates (excluding terrestrial forms) is lowest in Station 20 and the Mainstem of Red Dog Creek upstream of the ore body, sites that had highest median concentrations of Cd and Zn (Figure 57). Concentrations of Pb do not appear to correlate with invertebrate abundance at these sites; Shelly Creek had the highest concentration of Pb and was among sites with highest invertebrate abundance.

Water hardness, pH, water temperature, and the presence of organic compounds and selenium (Canadian Water Quality Guidelines 1995) affect the acute toxicity of cadmium to aquatic biota. Calcium hardness, but not magnesium, lowers acute toxicity (Carroll et al. 1979). Cadmium is less toxic in waters of low pH (5.7) than neutral pH, when Ca ions are not present (Sorensen 1991). Cd is more toxic to poikilothermal organisms in warmer waters because of their increased metabolic rate (Sorensen 1991). Cadmium toxicity is affected by the presence of other variables: dissolved organic compounds substantially lower toxicity; Zn accentuates toxicity for some species; and Se lessens toxicity, but increases tissue retention time (Sorensen 1991).

Chronic toxicity of cadmium to aquatic invertebrates has been reported at <3 *u*g Cd/L to 3.8 *u*g Cd/L (Table 22). The freshwater criteria for the protection of aquatic life are 3.9 *u*g Cd/L for acute toxicity and 1.1 *u*g Cd/L for chronic toxicity. The median concentration of Cd in Shelly Creek, Station 10, Station 20, and the Middle Fork of Red Dog Creek upstream of the ore body exceeded the acute criterion for Cd during 1998. The median concentrations of Cd exceeded the chronic criterion in all sites except the North Fork of Red Dog Creek and Station 7 in 1998. Invertebrate populations were lowest in sites with the highest median Cd concentration: Station 20 and Red Dog Creek upstream of the ore body.

The acute toxicity of zinc to aquatic organisms is modified by water hardness, but chronic toxicity is not (US EPA 1980). The toxicity of zinc also is influenced by pH; acute toxicity of zinc is usually lower in water with higher water hardness and lower pH (Mount 1966, Holcombe and Andrew 1978).

The wide range of zinc concentrations shown to cause acute toxicity in aquatic organisms (Table 22) is from hardness-related factors, biological factors such as age and size, and physical-chemical factors, including temperature and dissolved oxygen (which may cause additional stress to organisms). The freshwater acute criterion for the protection of aquatic life is 120 *u*g Zn/L. This concentration was exceeded at all sites (based upon the median concentration during 1998) except the North Fork of Red Dog Creek.

Chronic toxicity has been recorded starting at a concentration of 70 *u*g Zn/L: Biesinger and Christensen (1972) reported a 16% reproductive impairment in the zooplankton *Daphnia magna* after a 3-week exposure to 70 *u*g Zn/L. The freshwater chronic criterion for the protection of aquatic life is 110 ug Zn/L. This concentration was exceeded at all sites (based upon the median concentration during 1998) except the North Fork of Red Dog Creek. Invertebrate populations were lowest in sites with the highest median Zn concentration: Station 20 and Red Dog Creek upstream of the ore body.

Both acute and chronic toxicity of lead are greater in soft water than in hard water. Eisler summarized effects of Pb to aquatic species:

> In general, the responses of aquatic species to Pb insult differed markedly. Among sensitive species, however, several trends were evident: (1) dissolved waterborne Pb was more toxic than total Pb; (2) organic lead compounds were more toxic than inorganic forms; (3) adverse effects on daphnia reproduction were evident at 1.0 *ug* Pb^{2+} /l; (4) high bioconcentrations were measured in oysters at 1.0 *ug* Pb /1 and in freshwater algae at 5.0 *ug* Pb^{2+} /l; (5) tetramethyl-lead was acutely toxic to rainbow trout at 3.5 *ug*/l; (6) growth inhibition of a marine alga was reported at 5.1 *ug* Pb^{2+} /1; and (7) for all species, effects were most pronounced at elevated water temperatures and reduced pH, in comparatively soft waters, in younger life stages, and after long exposures.

Toxic concentrations of Pb to aquatic species are summarized from Eisler on Table 22. The freshwater criteria for the protection of aquatic life are 82 *ug* Pb/L for acute toxicity and 3.2 *ug* Pb/L for chronic toxicity. The chronic criterion was exceeded in Shelly Creek, Station 20, and the Middle Fork of Red Dog Creek upstream of the ore body (based upon the median concentration during 1998). The median concentrations of Pb at all sites in adjacent to and downstream of the mine were less than the acute criterion for Pb.

Table 22. Acute and chronic toxicity concentrations of Cd, Pb, and Zn to freshwater aquatic invertebrates during various exposure intervals. Data from Eisler (1985, 1988, and 1993).

Taxon or life state	Hardness, mg /L	Effect	Effects Conc. ppb	Exposure interval
CADMIUM				
Ephemerella sp.	44-48	LC-50	<3.0	28 d
Tanytarsus dissimilis	47	LC-50	3.8	10 d
LEAD				
Daphnia magna		RI-10%	1	19 d
D. magna		RI-50%	10	19 d
D. magna		RI-16%	30	21 d
D. magna	52	MATC	9–16.7	Lifetime
D. magna	102	MATC	78–181	Lifetime
D. magna	151	MATC	85–193	Lifetime
D. magna	54	LC-50	612	96 h
D. magna	110	LC-50	952	96 h
D. magna	152	LC-50	1,910	96 h
D. magna	45	LC-50	300	21 d
Tanytarsus dissimilis		LC-50	258	10 d
ZINC				
Epeorus latifolium				
Larvae		GI,M	30	4-wk
Larvae		GI,M	100-300	2 wk
Tanytarsus dissimilis embryo through 3rd instar		LC50	37	10 d

LC50 = lethal concentration for 50% of the population
MATC = maximum acceptable toxicant concentration
RI = reproductive inhibition
GI = growth inhibition, M = mortality

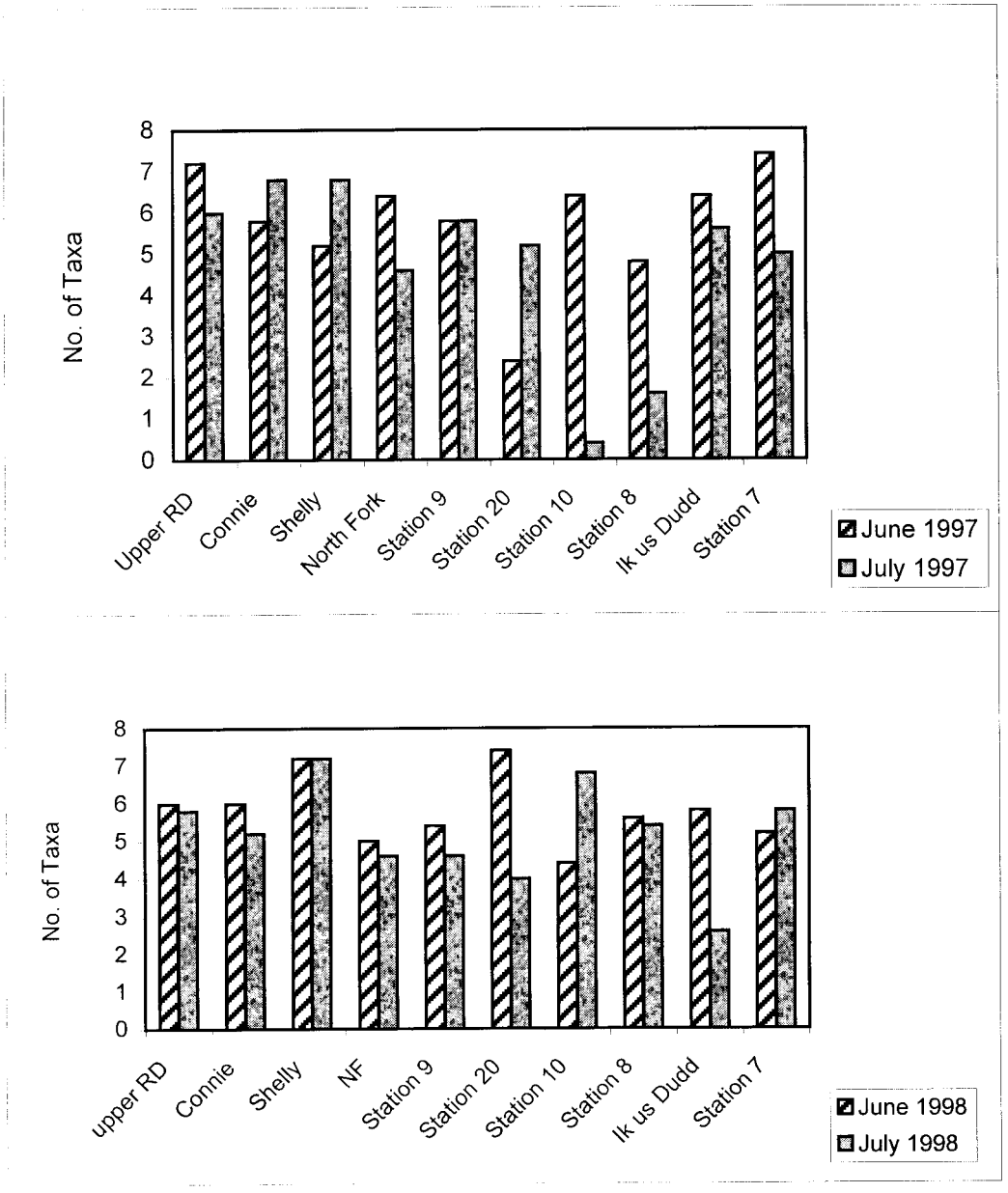

Figure 54. Taxonomic richness in invertebrate samples collected near and downstream of the Red Dog Mine, 1997 and 1998.

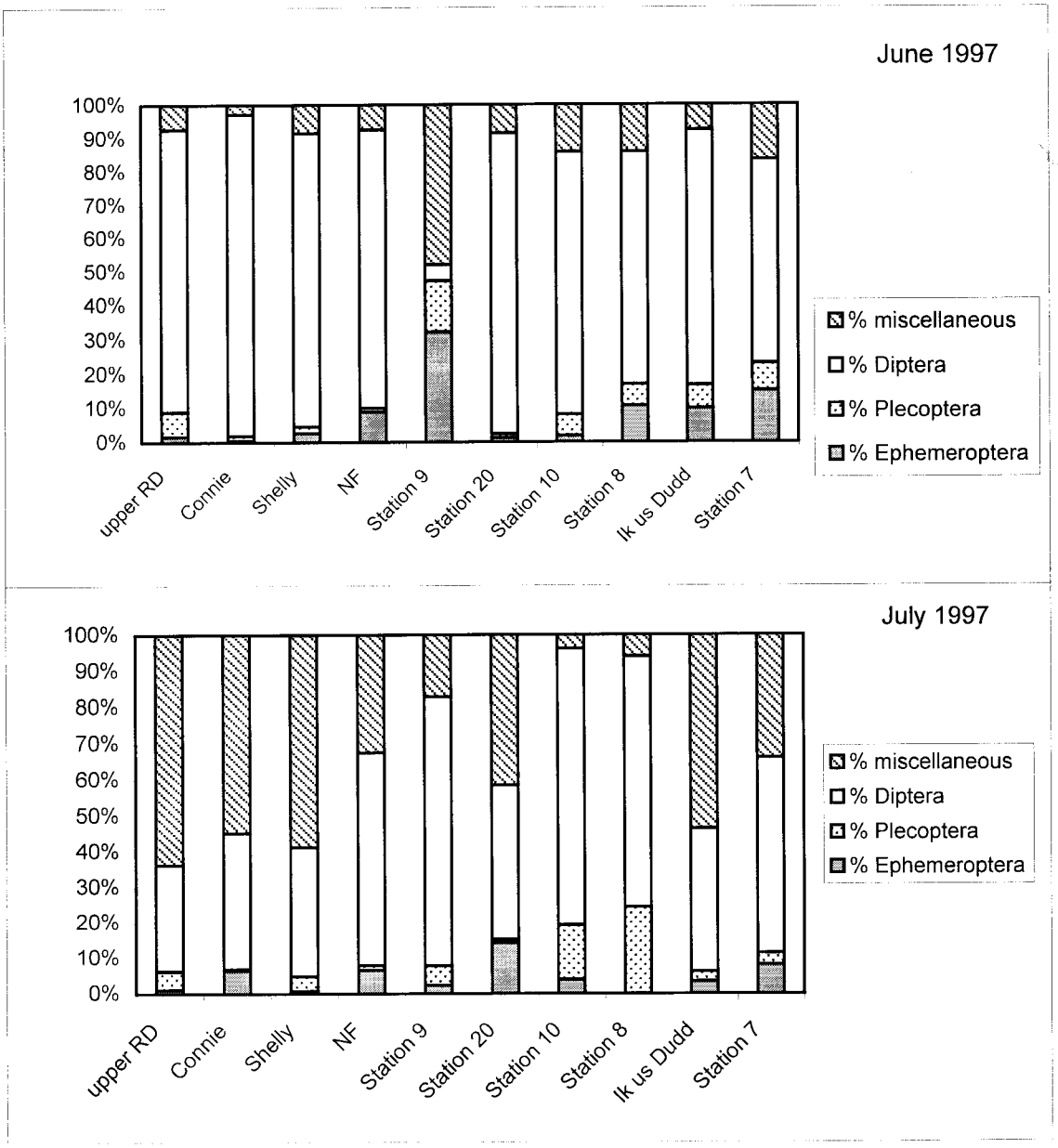

Figure 55. Composition of the invertebrate community in sites in the vicinity of the Red Dog Mine, 1997.

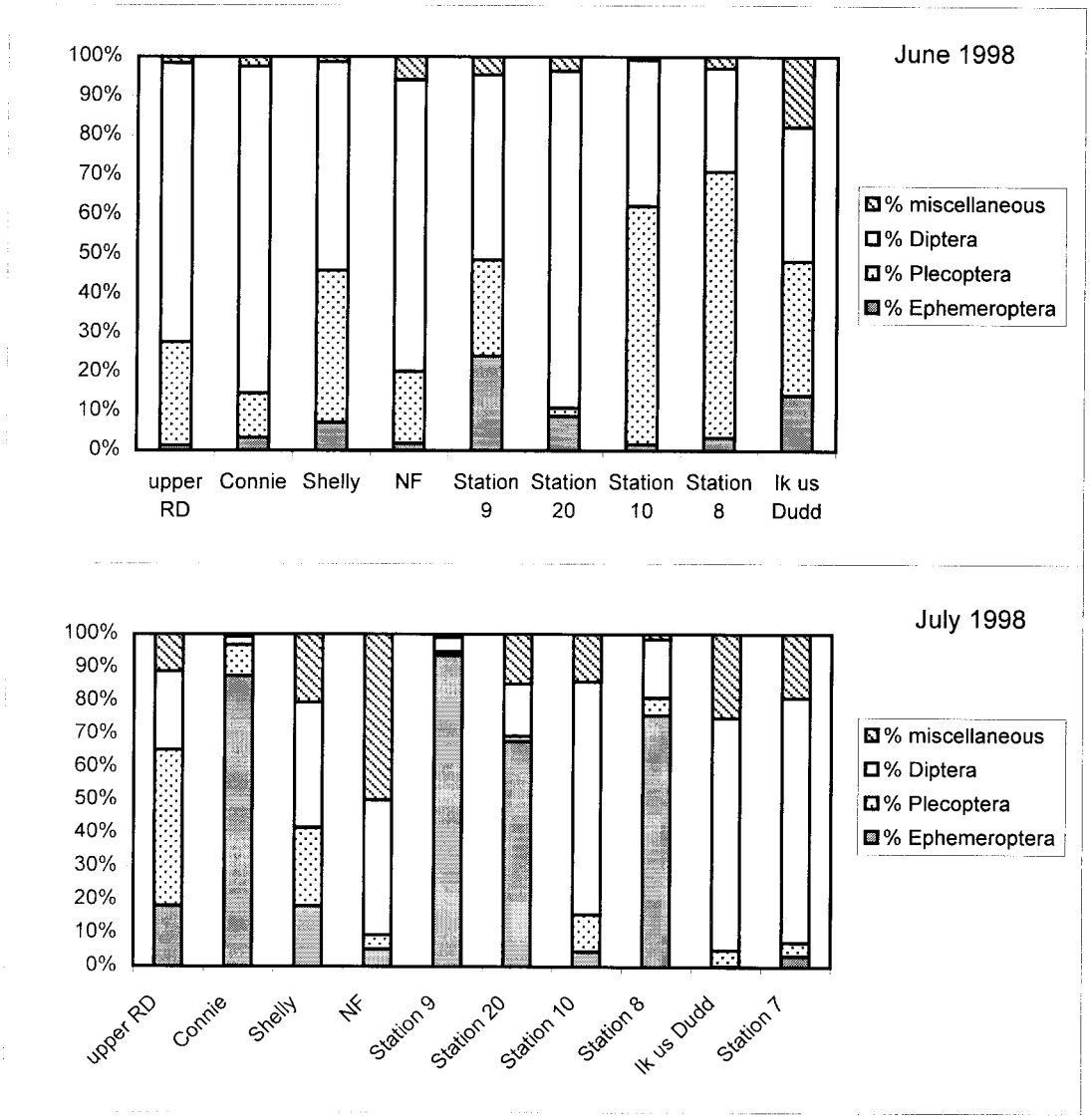

Figure 56. Composition of the invertebrate community in the vicinity of the Red Dog Mine, 1998.

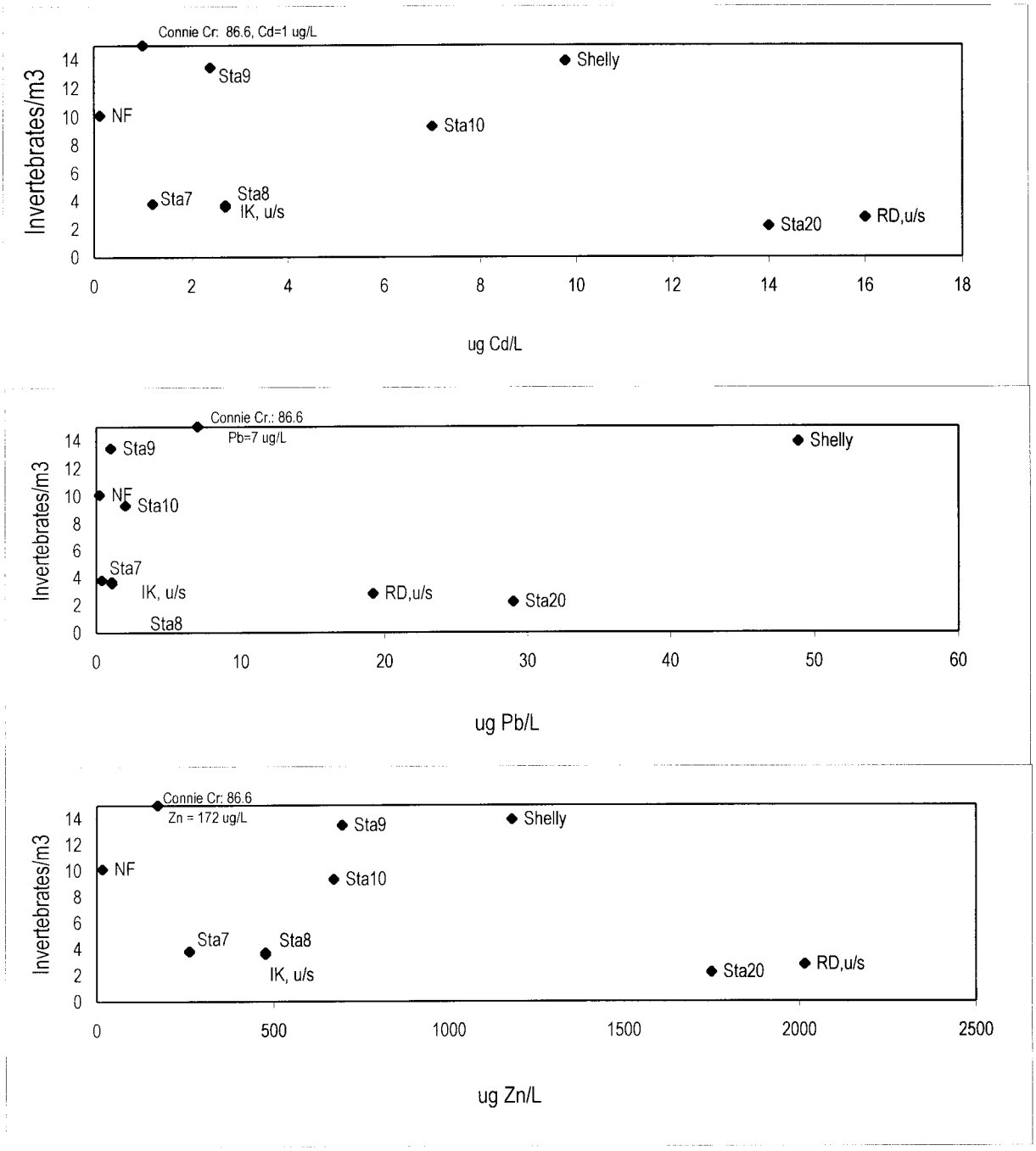

Figure 57. The abundance of aquatic invertebrates (excluding terrestrial forms) and the median concentrations of Cd, Pb, and Zn at sites adjacent to and downstream of the Red Dog Mine.

SUMMARY AND CONCLUSIONS

Streams adjacent to and downstream of the Red Dog Mine were monitored for two years to determine the extent these sites continue to support communities of aquatic invertebrates and algae. We sampled aquatic invertebrates from drift, and periphyton, or attached algae, in June and July. We also examined samples of stream substrate with 10 to 20 power hand lenses to detect colonization by micro-invertebrates. Sampling for micro-invertebrates did not produce useful results: we detected no new taxa, only those more effectively collected with drift nets. Therefore, these results were not presented.

Drift samples, presented as the abundance of invertebrates (standardized among samples by the flow through individual nets), taxonomic richness (or numbers of distinct taxa), and sample composition (changes in which taxa were represented in samples), combined with estimates of periphyton biomass (estimated by concentrations of chlorophyll-a) were valuable measures for characterizing the complexity of the aquatic communities.

AQUATIC COMMUNITIES IN ALVINELLA SITES

Four sites in the headwaters of Ikalukrok Creek were sampled in 1997 and 1998. In July 1998, we also sampled an additional site upstream of known mineralization Alvinella 5. The sites at Alvinella provide a useful understanding of the effects of mineralization without anthropogenic effects.

The right fork at the headwaters of Ikalukrok Creek, Alvinella 1, is located below a small tributary draining an area of known mineralization. In June and July of both 1997 and 1998, the substrate of this tributary was heavily coated with thick precipitate (Figure 58). Productivity in Alvinella 1 was low (Figures 46 and 47). Terrestrial insects constituted a large proportion of the samples, especially in July 1998. There were no detectable amounts of chlorophyll-a on the substrate at this site. Alvinella 1 also had the highest concentrations of Cd and Zn of any of the sites sampled in this study.

The limited sampling done in this tributary above the mineralized areas (Alvinella 5) showed a striking increase in invertebrate abundance. More invertebrates (number per

m^3) were collected in Alvinella 5 above the mineralization than in any of the other Alvinella sites. Periphyton biomass, however, was low in this site. It is likely this site would provide excellent summer rearing habitat for adult Arctic grayling; however, they are likely excluded by the downstream mineralization.

In contrast to Alvinella 1, the left fork of the headwaters of Ikalukrok Creek (Alvinella 2 is the upstream site and Alvinella 3 is the downstream site) contains clear water, has low concentrations of metals, and high concentrations of chlorophyll-a, especially in July 1998. This site also is important for summer rearing of Arctic grayling.

Alvinella 4 is located below the confluence of the right and left forks of Ikalukrok Creek. Concentrations of Cd and Zn are intermediate between those reported in the right (mineralized) and left (unmineralized) forks. Invertebrate populations and periphyton biomass were lower at this site in 1997 and 1998 than in Alvinella 2 or 3 sites.

Figure 58. Mineralized seep flowing into the right fork of the headwaters of Ikalukrok Creek (Alvinella 1). This site is undisturbed.

AQUATIC COMMUNITIES IN SITES NEAR RED DOG MINE

Sites near and downstream of the Red Dog Mine may be influenced by a complex interaction of natural mineralization, mine effluent (with elevated total dissolved solids in the form of calcium sulfate), ground disturbance (including possible exposure of mineralized soils), and enrichment (from domestic sewage in the mine effluent). It is not possible to identify the extent to which any of these features limit or enhance aquatic productivity. It is possible, however, to correlate estimated productivity with chemical and physical habitat conditions at each site.

The lowest in-situ productivity, estimated by periphyton standing crop and aquatic invertebrate abundance and taxonomic richness, occurred in sites with the highest concentrations of Cd and Zn. These two sites, both in the Middle Fork of Red Dog Creek (Station 20 and Red Dog Creek upstream of the ore body) were re-classified by the State of Alaska to eliminate protection for aquatic life. Historically, they have not supported diverse aquatic communities.

Baseline observations reported by Dames and Moore (1983) are similar to our findings for these two sites. They reported that beginning near Station 43 (comparable to our sampling site in the Middle Fork of Red Dog Creek upstream of the ore body), there was a sharp reduction in benthic fauna attributed to the first influx of metals-rich water from the Red Dog deposit. The aquatic community was depauperate throughout the Middle Fork of Red Dog Creek:

> From about Station 41 [upstream of the confluence with Connie Creek] to Station 20, the stream is nearly devoid of macrobenthos although an occasional representative of one of the above groups [Diptera, Ephemeroptera, or Plecoptera] can be found with diligent searching, especially downstream of one of the clean water tributaries. Below the North Fork (Station 11 to 10), a more reliable but still highly impoverished invertebrate population is possible.

The Middle Fork of Red Dog Creek below the mine effluent often contains a dense bloom of filamentous green algae. Growth of this alga likely results from nutrient enrichment in the mine discharge. Dense growth of filamentous algae excludes diatoms and other micro-algae, species that are readily eaten by grazing aquatic invertebrates. Filamentous algae is highly refractory and usually not used as food until it decays. When sampling periphyton in Station 20, we excluded filamentous algae. Although establishment and growth of filamentous algae appears to be augmented by nutrient enrichment in the effluent, invertebrate abundance, taxonomic richness, and periphyton biomass are unaffected.

The Mainstem of Red Dog Creek, after mixing with the North Fork of Red Dog Creek, has a substantial increase in both periphyton and aquatic invertebrate populations, although invertebrate abundance is low compared to tributary and downstream sites. Dames and Moore (1983) reported a similar increase in numbers of taxa and invertebrate abundance at Stations 11 and 10. We found young-of-the-year Arctic grayling in this site in both 1997 and 1998. The small size of these fish (estimated 4-days post-hatch) suggests adult Arctic graying spawned in this site. Young-of-the-year Arctic grayling were not observed during baseline studies; fish use in this region of Red Dog Creek was limited to migration to the North Fork of Red Dog Creek.

All sites in Ikalukrok Creek, including Station 9 upstream of Red Dog Creek, had high periphyton productivity and low to medium abundance of aquatic invertebrates. These sites are high energy systems with limited pool or run habitat. Physical habitat features, including stream flows and substrate, likely constrain invertebrate populations in these sites. All four sites in Ikalukrok Creek contained thick orange precipitates (primarily iron). The source of this precipitate was identified as the headwaters of Ikalukrok Creek at the Alvinella site. We do not know to what extent the iron precipitate may have limited invertebrate productivity at these sites. Filamentous algae in the Ikalukrok Creek sites downstream of Red Dog Creek was senescent in July; we believe the iron precipitate contributed to die off of the algae.

Dames and Moore (1983) reported an absence of Ephemeroptera genera in Ikalukrok Creek downstream of Red Dog Creek; our drift net sampling does not confirm their visual observations. Differences in these results are likely a result of different sampling methods. In 1996, we tested different methods for sampling these streams. Drift nets collected a more quantitative sample with higher numbers of taxa and abundance as compared to kick nets.

As in baseline studies, the North Fork of Red Dog Creek showed high productivity of both periphyton and aquatic invertebrates. This stream is relatively low in metals and has dense riparian vegetation. The North Fork of Red Dog Creek supports a healthy population of Arctic grayling and Dolly Varden (Weber Scannell and Ott 1998). We were unable to determine reasons for the substantial decrease in invertebrate abundance between June and July in the North Fork of Red Dog Creek, but samples may have been influenced by location of the nets. In July, we sampled closer to the mouth in an area that was somewhat more depositional. June samples were collected in more rapidly flowing riffle areas.

The tributary streams, Connie Creek and Shelly Creek, had numerous aquatic invertebrates and sparse periphyton. Shelly Creek water is higher in metals, especially cadmium, than Connie Creek. Both systems contain combinations of riffle, run, and pool habitats, minimal scour, and abundant riparian vegetation – all features that support healthy aquatic invertebrate populations. Both Connie and Shelly Creeks were sampled near their mouths in areas disturbed by mining activities. For continuity, we sampled the same stream regions as in 1995 and 1996. Given the disparity between low chlorophyll-a concentrations and high invertebrate abundance, it is possible that invertebrate drift was originating upstream of the disturbance. Future sampling in these creeks should include reaches above the disturbance.

We used results from periphyton biomass estimates and invertebrate abundance to rank the sample sites by the estimated overall productivity and summarize the relative aquatic productivity among sites (Table 23).

Table 23. Relative productivity among study sites near and downstream of the Red Dog Mine.

Station	Chlorophyll-a	Invertebrate Abundance
Middle Fork Red Dog Cr. upstream of ore body	low-medium	low-medium
Station 20	low	low-medium
Station 10	medium	low-medium
Station 8	high	low-medium
Ikalukrok Cr. u/s Dudd Cr.	high	low-medium
Station 7	high	low
Connie Cr.	low	high
North Fork	high	medium
Shelly Cr.	low	high
Station 9	high	low-medium

Overall, we found the relative productivity of the study sites to be similar to baseline studies. Sites closest to the Red Dog ore body show lowest productivity. Productivity in Ikalukrok Creek may be limited by a combination of chemical and physical features: some mineralization, precipitation of metals from upstream sites, high stream velocity, and lack of diverse pool-riffle habitat.

The complexity of invertebrate communities appears to be strongly influenced by sampling time. Spring breakup and subsequent warming was delayed in 1998; therefore, stream water was colder during June sampling. As a result, we collected an as yet unidentified Mayfly genus (Ephemeroptera: Baetidae) that we had not collected in 1995 through 1997. This genus was in the final stages of its aquatic life stage and beginning to emerge.

Dames and Moore observed numerous Trichoptera in late winter. We collected few Trichoptera in summer. They identified the Trichoptera as Glossosmatidae; we found few specimens of this family. Many of the Trichoptera we collected were too small to identify; larger specimens were identified as Brachiocentridae (Brachycentrus), Limnephilidae, and Glossosmatidae. We collected six distinct taxa of Collembola, three of Homoptera, six families of Coleoptera, and eight different Hymenoptera that were not

reported in baseline studies. We attribute the higher diversity in our samples to more effective sampling by drift nets.

Recommendations for Future Sampling

- Baseline sampling should be done in any sites being considered for future development. Sampling should include a thorough investigation of water quality, invertebrate communities, and periphyton.

- Periodic sampling of aquatic communities, such as was done in this study, is valuable to document the continued in-situ productivity of sites potentially affected by mining activity.

- Streams in disturbed areas should be sampled above and below disturbance.

- Invertebrate sampling should be conducted no earlier than three weeks after break-up and before seasonal rains (usually August) to allow insects be develop sufficiently to be collected and identified.

- Periphyton should not be sampled after storm events that cause streambed scour.

- The water quality samples should be taken with sufficient frequency to characterize individual sites. Continuity in sample times and number of samples should be maintained among years to provide representative data.

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APPENDIX 1. TAXONOMIC LIST OF INVERTEBRATE SPECIES AND FISH LARVAE COLLECTED IN THE WULIK RIVER DRAINAGE, 1997-1998.

CLASS	ORDER	FAMILY	GENUS
INSECTA	**Ephemeroptera**	Baetidae	*Baetis*
		Heptageniidae	*Cingymula*
		Ephemerellidae	
		Ameletidae	
	Plecoptera	Perlodidae	*Alloperla*
			Perlomyia
		Nemouridae	*Paranemouridae*
			Podmosta
		Capniidae	*Capnia*
			Allocapnia
			Paracapnia
			Isocapnia
			Eucapnopsis
		Chloroperlidae	*Utaperla*
	Trichoptera	Brachiocentridae	*Brachycentrus*
		Limnephilidae	
		Glossosmatidae	
	Diptera	Chironomidae	
			Orthocladiini
			Tabanidae
		Tipulidae	*Tipula*
		Simuliidae	*Simulium*
		Psychodidae	
	Coleoptera	Staphylinidae	
		Hydrophilidae (larvae)	
		Dyticidae	
		Curculionidae	
		Chrysomelidae	
		Hydroscaphidae	

APPENDIX 1, CONTINUED.

CLASS	ORDER	FAMILY	GENUS
MISCELLANEOUS			
	Collembola	Poduridae	*Podura*
		Sminthuridae	*Sminthides*
			Sminthurus
		Onchyiuridae	Lophognathella
		Hypogasturidae	
		Isotomidae	
	Homoptera	Veliidae	
		Macroveliidae	
		Saldidae	
		Aphididae	
	Hymenoptera	Eulophidae	
		Mymaridae	
		Braconidae	
		Ichneumonidae	*Mymaridae*
		Scelonidae	
		Pteromalidae	
		Trichogrammatidae	
		Apis	
	Nematoda		
	Thysanoptera		
	Neuroptera	Sialidae	
	Lepidoptera		
	Psocoptera		
ARACHNIDA	Acari	Acarina	
Oligochaeta			
Fish larvae	*Thymallus arcticus:* Arctic grayling		

Appendix 2. Comparison of aquatic invertebrate subsamples.

Comparison of Aquatic Invertebrate Subsamples

Site Red Dog Creek upstream of mine site
Date July 1998
Net Number 1

	Subsample #1 (1/2 of sample) Observed	Subsample #2 (1/2 of sample) Observed	Total	Subsample #1 Expected	Subsample #2 Expected	Calculations for Chi Square	
Hymenoptera adults	10	4	14	8.157	5.843	0.42	0.58
Diptera adults	27	10	37	21.557	15.443	1.37	1.92
Alloperla	0	0	0	0.000	0.000		
Baetis	44	32	76	44.278	31.722	0.00	0.00
Baetis adults	0	0	0	0.000	0.000		
Capnia	76	62	138	80.400	57.600	0.24	0.34
Cinygmula	1	1	2	1.165	0.835	0.02	0.03
Homoptera	10	10	20	11.652	8.348	0.23	0.33
Chironomidae larvae	19	18	37	21.557	15.443	0.30	0.42
Nemoura	0	1	1	0.583	0.417	0.58	0.81
Chironomidae pupae	2	0	2	1.165	0.835	0.60	0.83
Staphylinidae	0	0	0	0.000	0.000		
Simulidae	12	6	18	10.487	7.513	0.22	0.30
total	201	144	345				
					Chi-square =	9.57	12 DF
Chi-Square value =	6.05						
Probability of ChiSquare with 12 df = 0.65							
therefore samples are not different							

Appendix 2, cont.. Comparison of aquatic invertebrate subsamples.

Comparison of Aquatic Invertebrate Subsamples

Comparison of 1/2 of sample with total of 1/4 subsamples

Site Shelly Creek
Date July 1998
Net Number 4

	Subsample #1 (1/2 of sample) Observed	Subsample #2 (1/4+1/4 of sample) Observed	Total	Subsample #1 Expected	Subsample #2 Expected	Calculations for Chi Square	
Hymenoptera adults	7	3	10	4.602	4.398	0.56	0.58
Diptera adults	7	12	19	3.068	2.932	0.37	0.39
Alloperla	0	0	0	11.759	11.241	0.05	0.05
Baetis	3	6	9	9.203	8.797	0.35	0.37
Baetis adults	2	4	6	0.000	0.000		
Capnia	11	12	23	12.782	12.218	0.05	0.05
Cinygmula	11	7	18	6.135	5.865	1.34	1.40
Homoptera	0	0	0	2.045	1.955	0.00	0.00
Chironomidae larvae	12	13	25	0.511	0.489	0.51	0.53
Nemoura	9	3	12	3.068	2.932	0.28	0.30
Chironomidae pupae	2	2	4	68.000	65.000	0.00	0.00
Staphylinidae	0	1	1	0.000	0.000		
Simulidae	4	2	6	0.000	0.000		
total	68	65	133				
					Chi-Square =	7.18	

Chi-Square value = 7.18
Probability of ChiSquare with 12 df = 0.85
therefore samples are not different

Appendix 2, cont.. Comparison of aquatic invertebrate subsamples.

Comparison of Aquatic Invertebrate Subsamples
(Comparison of 2 subsamples, each 1/4 of total sample)

Site Alvanilla Site 4
Date July 1998
Net Number 4

	Subsample #1 (1/4 of sample) Observed	Subsample #2 (1/4 of sample) Observed	Total	Subsample #1 Expected	Subsample #2 Expected	Calculations for Chi Square	
Hymenoptera adults	1	2	3	1.662	1.338	0.26	0.33
Diptera adults	6	6	12	6.646	5.354	0.06	0.08
Alloperla	0	0	0	0.000	0.000		
Baetis	4	2	6	3.323	2.677	0.14	0.17
Baetis adults	2	2	4	2.215	1.785	0.02	0.03
Capnia	7	5	12	6.646	5.354	0.02	0.02
Cinygmula	3	4	7	3.877	3.123	0.20	0.25
Homoptera	0	0	0	0.000	0.000		
Chironomidae larvae	9	4	13	7.200	5.800	0.45	0.56
Nemoura	1	2	3	1.662	1.338	0.26	0.33
Chironomidae pupae	2	0	2	1.108	0.892	0.72	0.89
Staphylinidae	0	1	1	0.554	0.446	0.55	0.69
Simulidae	1	1	2	1.108	0.892	0.01	0.01
total	36	29	65				
					Chi-square =	6.05	12 DF

Chi-Square value = 6.05
Probability of ChiSquare with 12 df = 0.90
therefore samples are not different

Appendix 2, cont.. Comparison of aquatic invertebrate subsamples.

Comparison of Aquatic Invertebrate Subsamples
(Comparison of 2 subsamples, each 1/2 of total sample)

Site Alvanilla Site 3
Date July 1998
Net Number 2

	Subsample #1 (1/2 of sample) Observed	Subsample #2 (1/2 of sample) Observed	Total	Subsample #1 Expected	Subsample #2 Expected	Calculations for Chi Square	
Baetis	31	36	67	33.738	33.262	0.22	0.23
Capniidae	12	11	23	11.582	11.418	0.02	0.02
Heptageniidae	3	1	4	2.014	1.986	0.48	0.49
Chironomidae	19	18	37	18.631	18.369	0.01	0.01
Nemouridae	1	0	1	0.504	0.496	0.49	0.50
Staphylinidae	3	2	5	2.518	2.482	0.09	0.09
Simulidae	2	2	4	2.014	1.986	0.00	0.00
total	71	70	141				
					Chi-square =	2.64	

Chi-Square value = 2.64 6
Probability of ChiSquare with 6 df = 0.85
therefore samples are not different

Appendix 3,a. Data summary sheets from Station 6, July and August 1996.

Data Summary Sheet **Site: Station 6** **Date: July 9, 1996**	Net 1	Net 2	Net 3	
Total Aquatic Invertebrates	37	84	57	
Total Invertebrates	48	84	67	
Total Aquatic Taxa	4	4	5	
Average Invertebrates/Sample	66.3			
Average Aquatic Taxa/Sample	4.3			Average E, P, D
% Ephemeroptera	0.00%	0.00%	1.49%	0.50%
% Plecoptera	2.08%	1.19%	1.49%	1.51%
% Diptera	97.92%	98.81%	97.01%	97.99%
Estimated Abundance	192	336	268	
Average # Invertebrates/Net	265.3			
Average # Aquatic Invertebrates/Net	237.3			
Est. Total Aquatic Invertebrates	148	336	228	
Est. Terrestrial Invertebrates	44	0	40	
Est. Total Invertebrates	192	336	268	
% terrestrial	10.55%			

Data Summary Sheet **Site: Station 6** **Date: August 6, 1996**	Net 1	Net 2	Net 3	
Total Aquatic Invertebrates	14	17	6	
Total Invertebrates	19	17	6	
Total Aquatic Taxa	4	5	3	
Average Invertebrates/Sample	14.0			
Average Aquatic Taxa/Sample	4.0			Average E, P, D
% Ephemeroptera	5.26%	17.65%	0.00%	7.64%
% Plecoptera	5.26%	0.00%	0.00%	1.75%
% Diptera	89.47%	76.47%	100.00%	88.65%
Estimated Abundance	76	68	24	
Average # Invertebrates/Net	56.0			
Average # Aquatic Invertebrates/Net	49.3			
Est. Total Aquatic Invertebrates	56	68	24	
Est. Terrestrial Iinvertebrates	20	0	0	
Est. Total Invertebrates	76	68	24	
% terrestrial	11.90%			

Appendix 3, b. Data summary sheets from Station 7, July and August 1996.

Data Summary Sheet **Site: Station 7** **Date: July 10, 1996**	Net 1	Net 2	Net 3	
Total Aquatic Invertebrates	40	37	81	
Total Invertebrates	40	37	81	
Total Aquatic Taxa	7	4	5	
Average Invertebrates/Sample	52.7			
Average Aquatic Taxa/Sample	5.3			Average E, P, D
% Ephemeroptera	17.50%	2.70%	1.23%	5.70%
% Plecoptera	5.00%	13.51%	13.58%	11.39%
% Diptera	75.00%	83.78%	83.95%	81.65%
Estimated Abundance	160	148	324	
Average # Invertebrates/Net	210.7			
Average # Aquatic Invertebrates/Net	210.7			
Est. Total Aquatic Invertebrates	160	148	324	
Est. Terrestrial Iinvertebrates	0	0	0	
Est. Total Invertebrates	160	148	324	
% terrestrial	0.00%			

Data Summary Sheet **Site: Station 7** **Date: August 6, 1996**	Net 1	Net 2	Net 3	
Total Aquatic Invertebrates	185	72	162	
Total Invertebrates	185	72	162	
Total Aquatic Taxa	7	4	6	
Average Invertebrates/Sample	139.7			
Average Aquatic Taxa/Sample	5.7			Average E, P, D
% Ephemeroptera	90.27%	79.17%	87.04%	83.10%
% Plecoptera	1.08%	8.33%	4.32%	6.33%
% Diptera	8.11%	12.50%	8.02%	10.26%
Estimated Abundance	1480	288	648	
Average # Invertebrates/Net	805.3			
Average # Aquatic Invertebrates/Net	805.3			
Est. Total Aquatic Invertebrates	1480	288	648	
Est. Terrestrial Iinvertebrates	0	0	0	
Est. Total Invertebrates	1480	288	648	
% terrestrial	0.00%			

Appendix 3, c. Data summary sheets from Station 8, July and August 1996.

Data Summary Sheet **Site: Station 8** **Date: July 10, 1996**	Net 1	Net 2	Net 3	
Total Aquatic Invertebrates	26	76	26	
Total Invertebrates	26	93	26	
Total Aquatic Taxa	5	3	4	
Average Invertebrates/Sample	48.3			
Average Aquatic Taxa/Sample	4.0			Average E, P, D
% Ephemeroptera	0.00%	0.00%	0.00%	0.00%
% Plecoptera	3.85%	3.23%	7.69%	4.14%
% Diptera	88.46%	96.77%	92.31%	94.48%
Estimated Abundance	104	372	104	
Average # Invertebrates/Net	193.3			
Average # Aquatic Invertebrates/Net	170.7			
Est. Total Aquatic Invertebrates	104	304	104	
Est. Terrestrial Iinvertebrates	0	68	0	
Est. Total Invertebrates	104	372	104	
% terrestrial	11.72%			

Data Summary Sheet **Site: Station 8** **Date: August 6, 1996**	Net 1	Net 2	Net 3	
Total Aquatic Invertebrates	134	159	102	
Total Invertebrates	134	160	103	
Total Aquatic Taxa	9	9	8	
Average Invertebrates/Sample	132.3			
Average Aquatic Taxa/Sample	8.7			Average E, P, D
% Ephemeroptera	52.99%	59.38%	55.34%	57.36%
% Plecoptera	7.46%	11.88%	10.68%	11.28%
% Diptera	38.81%	28.13%	33.01%	30.57%
Estimated Abundance	268	320	206	
Average # Invertebrates/Net	264.7			
Average # Aquatic Invertebrates/Net	263.3			
Est. Total Aquatic Invertebrates	268	318	204	
Est. Terrestrial Iinvertebrates	0	2	2	
Est. Total Invertebrates	268	320	206	
% terrestrial	0.50%			

Appendix 3, d. Data summary sheets from Station 9, July and August 1996.

Data Summary Sheet **Site: Station 9** **Date: July 11, 1996**	Net 1	Net 2	Net 3	
Total Aquatic Invertebrates	30	10	25	
Total Invertebrates	66	17	113	
Total Aquatic Taxa	4	2	6	
Average Invertebrates/Sample	65.3			
Average Aquatic Taxa/Sample	4.0			Average E, P, D
% Ephemeroptera	12.12%	5.88%	1.77%	5.61%
% Plecoptera	19.70%	52.94%	6.19%	14.80%
% Diptera	65.15%	41.18%	89.38%	77.04%
Estimated Abundance	66	68	452	
Average # Invertebrates/Net	195.3			
Average # Aquatic Invertebrates/Net	56.7			
Est. Total Aquatic Invertebrates	30	40	100	
Est. Terrestrial Iinvertebrates	36	28	352	
Est. Total Invertebrates	66	68	452	
% terrestrial	70.99%			

Data Summary Sheet **Site: Station 9** **Date: August 6, 1996**	Net 1	Net 2	Net 3	
Total Aquatic Invertebrates	824	283	190	
Total Invertebrates	827	283	191	
Total Aquatic Taxa	6	7	6	
Average Invertebrates/Sample	433.7			
Average Aquatic Taxa/Sample	6.3			Average E, P, D
% Ephemeroptera	77.87%	77.74%	71.73%	74.73%
% Plecoptera	5.08%	3.89%	4.19%	4.04%
% Diptera	16.69%	18.37%	23.56%	20.97%
Estimated Abundance	827	1132	764	
Average # Invertebrates/Net	907.7			
Average # Aquatic Invertebrates/Net	905.3			
Est. Total Aquatic Invertebrates	824	1132	760	
Est. Terrestrial Iinvertebrates	3	0	4	
Est. Total Invertebrates	827	1132	764	
% terrestrial	0.26%			

Appendix 3, e. Data summary sheets from Station 10, July and August 1996.

Data Summary Sheet **Site: Station 10** **Date: July 11, 1996**	Net 1	Net 2	Net 3	
Total Aquatic Invertebrates	162	125	185	
Total Invertebrates	184	177	185	
Total Aquatic Taxa	7	5	5	
Average Invertebrates/Sample	182.0			
Average Aquatic Taxa/Sample	5.7			Average E, P, D
% Ephemeroptera	0.54%	1.13%	1.62%	1.10%
% Plecoptera	5.43%	5.08%	9.19%	6.59%
% Diptera	92.93%	93.79%	89.19%	91.94%
Estimated Abundance	736	708	740	
Average # Invertebrates/Net	728.0			
Average # Aquatic Invertebrates/Net	629.3			
Est. Total Aquatic Invertebrates	648	500	740	
Est. Terrestrial Iinvertebrates	88	208	0	
Est. Total Invertebrates	736	708	740	
% terrestrial	13.55%			

Data Summary Sheet **Site: Station 10** **Date: August 6, 1996**	Net 1	Net 2	Net 3	
Total Aquatic Invertebrates	255	97		
Total Invertebrates	255	97		
Total Aquatic Taxa	10	8		
Average Invertebrates/Sample	117.3			
Average Aquatic Taxa/Sample	6.0			Average E, P, D
% Ephemeroptera	34.12%	45.36%		45.36%
% Plecoptera	13.33%	6.19%		6.19%
% Diptera	52.55%	46.39%		46.39%
Estimated Abundance	1020	388		
Average # Invertebrates/Net	704.0			
Average # Aquatic Invertebrates/Net	704.0			
Est. Total Aquatic Invertebrates	1020	388		
Est. Terrestrial Iinvertebrates	0	0		
Est. Total Invertebrates	1020	388		
% terrestrial	0.00%			

Appendix 3, f. Data summary sheets from Station 20, July and August 1996.

Data Summary Sheet				
Site: **Station 20**				
Date: **11-Jul-96**	Net 1	Net 2	Net 3	
Total Aquatic Invertebrates	31	11	19	
Total Invertebrates	96	105	84	
Total Aquatic Taxa	4	4	4	
Average Invertebrates/Sample	95.0			
Average Aquatic Taxa/Sample	4.0			Average E, P, D
% Ephemeroptera	2.08%	1.90%	4.76%	2.81%
% Plecoptera	0.00%	0.00%	0.00%	0.00%
% Diptera	94.79%	96.19%	92.86%	94.74%
Estimated Abundance	384	420	336	
Average # Invertebrates/Net	380.0			
Average # Aquatic Invertebrates/Net	81.3			
Est. Total Aquatic Invertebrates	124	44	76	
Est. Terrestrial Iinvertebrates	260	376	260	
Est. Total Invertebrates	384	420	336	
% terrestrial	78.60%			

Data Summary Sheet				
Site: **Station 20**				
Date: **August 6, 1996**	Net 1	Net 2	Net 3	
Total Aquatic Invertebrates	216	105		
Total Invertebrates	218	113	259	
Total Aquatic Taxa	5	5	5	
Average Invertebrates/Sample	196.7			
Average Aquatic Taxa/Sample	5.0			Average E,P, D
% Ephemeroptera	72.48%	53.10%	71.81%	62.46%
% Plecoptera	1.83%	1.77%	1.93%	1.85%
% Diptera	22.48%	44.25%	25.87%	35.06%
Estimated Abundance	872	452	1036	
Average # Invertebrates/Net	786.7			
Average # Aquatic Invertebrates/Net	428.0			
Est. Total Aquatic Invertebrates	864	420	0	
Est. Terrestrial Iinvertebrates	8	32	1036	
Est. Total Invertebrates	872	452	1036	
% terrestrial	45.59%			

Data Summary Sheet **Site: Shelly Creek** **Date: July 9, 1996**	Net 1	Net 2	Net 3	
Total Aquatic Invertebrates	396	407	1329	
Total Invertebrates	511	462	1354	
Total Aquatic Taxa	6	4	4	
Average Invertebrates/Sample	775.7			
Average Aquatic Taxa/Sample	4.7			Average E,P, D
% Ephemeroptera	0.20%	0.00%	0.00%	0.04%
% Plecoptera	1.37%	5.63%	0.15%	1.50%
% Diptera	97.85%	93.29%	99.85%	98.11%
Estimated Abundance	2044	1848	5416	
Average # Invertebrates/Net	3102.7			
Average # Aquatic Invertebrates/Net	2842.7			
Est. Total Aquatic Invertebrates	1584	1628	5316	
Est. Terrestrial Iinvertebrates	460	220	100	
Est. Total Invertebrates	2044	1848	5416	
% terrestrial	8.38%			

Data Summary Sheet **Site: Shelly Creek** **Date: August 5, 1996**	Net 1	Net 2	Net 3	
Total Aquatic Invertebrates	179	534	225	
Total Invertebrates	180	536	225	
Total Aquatic Taxa	4	4	4	
Average Invertebrates/Sample	313.7			
Average Aquatic Taxa/Sample	4.0			Average E,P, D
% Ephemeroptera	33.33%	31.16%	34.67%	32.91%
% Plecoptera	57.22%	54.66%	51.11%	52.89%
% Diptera	8.89%	13.81%	14.22%	14.01%
Estimated Abundance	720	2144	900	
Average # Invertebrates/Net	1254.7			
Average # Aquatic Invertebrates/Net	1250.7			
Est. Total Aquatic Invertebrates	716	2136	900	
Est. Terrestrial Iinvertebrates	4	8	0	
Est. Total Invertebrates	720	2144	900	
% terrestrial	0.32%			

Data Summary Sheet **Site: Rachael Creek** **Date: July 10, 1996**	Net 1	Net 2	Net 3	
Total Aquatic Invertebrates	132	227	99	
Total Invertebrates	132	227	99	
Total Aquatic Taxa	6	7	7	
Average Invertebrates/Sample	152.7			
Average Aquatic Taxa/Sample	6.7			Average E,P, D
% Ephemeroptera	0.00%	0.00%	0.00%	0.00%
% Plecoptera	13.64%	8.37%	10.10%	10.26%
% Diptera	84.09%	91.63%	87.88%	88.65%
Estimated Abundance	528	908	396	
Average # Invertebrates/Net	610.7			
Average # Aquatic Invertebrates/Net	610.7			
Est. Total Aquatic Invertebrates	528	908	396	
Est. Terrestrial Invertebrates	0	0	0	
Est. Total Invertebrates	528	908	396	
% terrestrial	0.00%			

Data Summary Sheet **Site: Connie Creek** **Date: July 12, 1996**	Net 1	Net 2	Net 3	
Total Aquatic Invertebrates	244	151	130	
Total Invertebrates	344	331	356	
Total Aquatic Taxa	8	4	3	
Average Invertebrates/Sample	343.7			
Average Aquatic Taxa/Sample	5.0			Average E,P, D
% Ephemeroptera	2.91%	0.00%	0.00%	0.97%
% Plecoptera	7.27%	0.30%	0.56%	2.72%
% Diptera	84.30%	99.70%	99.44%	94.47%
Estimated Abundance	1376	1324	1424	
Average # Invertebrates/Net	1374.7			
Average # Aquatic Invertebrates/Net	700.0			
Est. Total Aquatic Invertebrates	976	604	520	
Est. Terrestrial Iinvertebrates	400	720	904	
Est. Total Invertebrates	1376	1324	1424	
% terrestrial	49.08%			

Data Summary Sheet **Site: Connie Creek** **Date: August 7, 1996**	Net 1	Net 2	Net 3	
Total Aquatic Invertebrates	1355	498	1090	
Total Invertebrates	1387	500	1093	
Total Aquatic Taxa	6	8	6	
Average Invertebrates/Sample	993.3			
Average Aquatic Taxa/Sample	6.7			Average E,P, D
% Ephemeroptera	64.24%	64.80%	72.74%	68.77%
% Plecoptera	5.41%	3.60%	3.48%	3.54%
% Diptera	29.85%	30.80%	23.79%	27.29%
Estimated Abundance	1387	2000	1093	
Average # Invertebrates/Net	1493.3			
Average # Aquatic Invertebrates/Net	1479.0			
Est. Total Aquatic Invertebrates	1355	1992	1090	
Est. Terrestrial Iinvertebrates	32	8	3	
Est. Total Invertebrates	1387	2000	1093	
% terrestrial	0.96%			

Appendix 4,a. Data summary sheets from Alvinella 1, June and July 1997.

Data Summary Sheet **Site: Alvanilla 1** **Date: June-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	418	245	536	509	700
Total aquatic taxa	4	5	7	6	7
Average taxa/sample	5.8				
Est. number Ephemeroptera	110.0	84.0	50.0	264.0	300.0
Est. number Plecoptera	16.0	20.0	11.0	64.0	100.0
Est. number Diptera	666.0	804.0	427.0	1552.0	2084.0
Total % Ephemeroptera	11.24%				
Total % Plecoptera	2.94%				
Total % Diptera	76.98%				
Average total abundance	1437.6				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	17.09	15.92	15.41	28.64	84.19
Estimated aq. Invertebrates/m3 water	13.7	12.2	12.1	21.8	65.3
Average invertebrates/m3 water	32.2				
Average aq. invertebrates/m3 water	25.0				
Est.total aquatic invertebrates	668	752	420	1552	2172
Est. terrestrial invertebrates	168	228	116	484	628
Estimated total sample	836	980	536	2036	2800
% sample terrestrial	22.59%				
Average invertebrates/net	1437.6				
Average (aq) invertebrates/net	1112.8				

Data Summary Sheet **Site: Alvanilla 1** **Date: July-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	179	334	269	155	102
Total aquatic taxa	7	8	6	7	6
Average taxa/sample	6.8				
Est. number Ephemeroptera	64.0	52.0	220.0	120.0	64.0
Est. number Plecoptera	48.0	60.0	40.0	48.0	32.0
Est. number Diptera	396.0	724.0	508.0	792.0	512.0
Total % Ephemeroptera	10.03%				
Total % Plecoptera	4.40%				
Total % Diptera	56.56%				
Average total abundance	1036.8				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	14.63	21.71	30.93	17.44	24.53
Estimated aq. Invertebrates/m3 water	7.8	6.2	21.4	14.3	17.6
Average invertebrates/m3 water	21.8				
Average aq. invertebrates/m3 water	13.5				
Est.total aquatic invertebrates	384	380	744	1016	584
Est. terrestrial invertebrates	332	956	332	224	232
Estimated total sample	716	1336	1076	1240	816
% sample terrestrial	40.05%				
Average invertebrates/net	1036.8				
Average (aq) invertebrates/net	621.6				

Appendix 4, b. Data summary sheets from Alvinella 2, June and July 1997.

Data Summary Sheet **Site: Alvanilla 2** **Date: June-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	353	420	319	551	329
Total aquatic taxa	8	7	7	8	6
Average taxa/sample	7.2				
Est. number Ephemeroptera	200.0	100.0	568.0	112.0	34.0
Est. number Plecoptera	128.0	74.0	216.0	106.0	18.0
Est. number Diptera	976.0	628.0	1552.0	818.0	265.0
Total % Ephemeroptera	16.26%				
Total % Plecoptera	8.69%				
Total % Diptera	67.99%				
Average total abundance	1247.0				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	28.86	13.65	73.35	15.50	9.89
Estimated aq. Invertebrates/m3 water	25.5	13.1	66.7	14.3	8.9
Average invertebrates/m3 water	28.3				
Average aq. invertebrates/m3 water	25.7				
Est.total aquatic invertebrates	1248	804	2320	1020	296
Est. terrestrial invertebrates	164	36	232	82	33
Estimated total sample	1412	840	2552	1102	329
% sample terrestrial	8.77%				
Average invertebrates/net	1247				
Average (aq) invertebrates/net	1137.6				

Data Summary Sheet **Site: Alvanilla 2** **Date: July-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	210	197	136	66	135
Total aquatic taxa	7	6	5	6	7
Average taxa/sample	6.2				
Est. number Ephemeroptera	640.0	664.0	64.0	256.0	352.0
Est. number Plecoptera	80.0	8.0	112.0	40.0	72.0
Est. number Diptera	496.0	408.0	408.0	152.0	352.0
Total % Ephemeroptera	33.20%				
Total % Plecoptera	5.24%				
Total % Diptera	30.51%				
Average total abundance	1190.4				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	34.33	25.61	31.27	7.43	32.47
Estimated aq. Invertebrates/m3 water	26.3	14.3	14.3	6.4	21.9
Average invertebrates/m3 water	26.2				
Average aq. invertebrates/m3 water	16.6				
Est.total aquatic invertebrates	1288	880	496	456	728
Est. terrestrial invertebrates	392	696	592	72	352
Estimated total sample	1680	1576	1088	528	1080
% sample terrestrial	35.35%				
Average invertebrates/net	1190.4				
Average (aq) invertebrates/net	769.6				

Appendix 4, c. Data summary sheets from Alvinella 3, June and July 1997.

Data Summary Sheet **Site: Alvanilla 3** **Date: June-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	390	642	684	373	554
Total aquatic taxa	6	7	9	8	7
Average taxa/sample	7.4				
Est. number Ephemeroptera	224.0	98.0	88.0	132.0	272.0
Est. number Plecoptera	120.0	74.0	96.0	88.0	264.0
Est. number Diptera	1136.0	1038.0	2340.0	1168.0	3568.0
Total % Ephemeroptera	7.08%				
Total % Plecoptera	5.58%				
Total % Diptera	80.41%				
Average total abundance	2300.8				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	31.88	20.86	78.64	20.98	133.25
Estimated aq. Invertebrates/m3 water	19.9	14.2	36.0	15.6	107.0
Average invertebrates/m3 water	57.1				
Average aq. invertebrates/m3 water	38.6				
Est.total aquatic invertebrates	976	876	1252	1112	3560
Est. terrestrial invertebrates	584	408	1484	380	872
Estimated total sample	1560	1284	2736	1492	4432
% sample terrestrial	32.41%				
Average invertebrates/net	2300.8				
Average (aq) invertebrates/net	1555.2				

Data Summary Sheet **Site: Alvanilla 3** **Date: July-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	106	254	256	179	272
Total aquatic taxa	6	7	4	5	8
Average taxa/sample	6.0				
Est. number Ephemeroptera	88.0	37.0	28.0	4.0	40.0
Est. number Plecoptera	60.0	23.0	26.0	2.0	25.0
Est. number Diptera	272.0	138.0	346.0	118.0	161.0
Total % Ephemeroptera	12.00%				
Total % Plecoptera	8.29%				
Total % Diptera	63.07%				
Average total abundance	328.2				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	8.67	4.13	14.72	2.52	8.18
Estimated aq. Invertebrates/m3 water	5.7	2.6	5.3	0.8	4.2
Average invertebrates/m3 water	7.6				
Average aq. invertebrates/m3 water	3.7				
Est.total aquatic invertebrates	280	160	184	57	139
Est. terrestrial invertebrates	144	94	328	122	133
Estimated total sample	424	254	512	179	272
% sample terrestrial	50.03%				
Average invertebrates/net	328.2				
Average (aq) invertebrates/net	164				

Appendix 4, d. Data summary sheets from Alvinella 4, June and July 1997.

Data Summary Sheet **Site: Alvanilla 4** **Date: June-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	229	237	197	329	451
Total aquatic taxa	4	5	5	7	8
Average taxa/sample	5.8				
Est. number Ephemeroptera	20.0	70.0	36.0	52.0	88.0
Est. number Plecoptera	16.0	56.0	38.0	32.0	80.0
Est. number Diptera	374.0	318.0	292.0	518.0	682.0
Total % Ephemeroptera	9.22%				
Total % Plecoptera	7.69%				
Total % Diptera	75.68%				
Average total abundance	577.2				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	9.36	7.70	11.33	9.25	27.12
Estimated aq. Invertebrates/m3 water	5.2	6.2	8.3	7.7	19.8
Average invertebrates/m3 water	13.0				
Average aq. invertebrates/m3 water	9.4				
Est.total aquatic invertebrates	252	384	288	548	660
Est. terrestrial invertebrates	206	90	106	110	242
Estimated total sample	458	474	394	658	902
% sample terrestrial	26.13%				
Average invertebrates/net	577.2				
Average (aq) invertebrates/net	426.4				

Data Summary Sheet **Site: Alvanilla 4** **Date: July-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	159	200	198	179	371
Total aquatic taxa	6	6	7	7	7
Average taxa/sample	6.6				
Est. number Ephemeroptera	38.0	25.0	76.0	18.0	44.0
Est. number Plecoptera	54.0	44.0	108.0	27.0	54.0
Est. number Diptera	136.0	66.0	340.0	88.0	418.0
Total % Ephemeroptera	9.01%				
Total % Plecoptera	12.86%				
Total % Diptera	46.97%				
Average total abundance	446.2				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	6.50	3.25	22.77	2.52	22.31
Estimated aq. Invertebrates/m3 water	4.0	2.3	12.4	1.5	9.1
Average invertebrates/m3 water	11.5				
Average aq. invertebrates/m3 water	5.9				
Est.total aquatic invertebrates	194	140	432	109	304
Est. terrestrial invertebrates	124	60	360	70	438
Estimated total sample	318	200	792	179	742
% sample terrestrial	47.15%				
Average invertebrates/net	446.2				
Average (aq) invertebrates/net	235.8				

Appendix 4, e. Data summary sheets from Station 8, June and July 1997.

Data Summary Sheet **Site: Station 8** **Date: June-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	82	338	82	244	0
Total aquatic taxa	6	6	6	6	0
Average taxa/sample	4.8				
Est. number Ephemeroptera	15.0	32.0	9.0	24.0	0.0
Est. number Plecoptera	7.0	14.0	11.0	15.0	0.0
Est. number Diptera	52.0	246.0	54.0	163.0	0.0
Total % Ephemeroptera	10.72%				
Total % Plecoptera	6.30%				
Total % Diptera	69.03%				
Average total abundance	149.2				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	1.68	5.49	2.36	3.43	0.00
Estimated aq. Invertebrates/m3 water	0.8	1.6	1.4	1.6	0.0
Average invertebrates/m3 water	2.6				
Average aq. invertebrates/m3 water	1.1				
Est.total aquatic invertebrates	41	96	48	113	0
Est. terrestrial invertebrates	41	242	34	131	0
Estimated total sample	82	338	82	244	0
% sample terrestrial	60.05%				
Average invertebrates/net	149.2				
Average (aq) invertebrates/net	59.6				

Data Summary Sheet ***Site: Station 8*** **Date: July-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	3	10	0	5	5
Total aquatic taxa	1	1	0	3	3
Average taxa/sample	1.6				
Est. number Ephemeroptera	0.0	0.0	0.0	0.0	0.0
Est. number Plecoptera	0.0	0.0	0.0	4.0	4.0
Est. number Diptera	3.0	8.0	0.0	6.0	6.0
Total % Ephemeroptera	0.00%				
Total % Plecoptera	24.24%				
Total % Diptera	69.70%				
Average total abundance	6.6				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	0.06	0.16	0.00	0.14	0.30
Estimated aq. Invertebrates/m3 water	0.0	0.1	0.0	0.1	0.2
Average invertebrates/m3 water	0.1				
Average aq. invertebrates/m3 water	0.1				
Est.total aquatic invertebrates	2	7	0	10	6
Est. terrestrial invertebrates	1	3	0	0	4
Estimated total sample	3	10	0	10	10
% sample terrestrial	24.24%				
Average invertebrates/net	6.6				
Average (aq) invertebrates/net	5				

Appendix 4, f. Data summary sheets from Station 9, June and July 1997.

Data Summary Sheet **Site: Station 9** **Date: June-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	232	470	138	100	239
Total aquatic taxa	5	8	6	5	5
Average taxa/sample	5.8				
Est. number Ephemeroptera	95.0	157.0	124.0	28.0	188.0
Est. number Plecoptera	34.0	48.0	112.0	15.0	64.0
Est. number Diptera	50.0	177.0	312.0	57.0	226.0
Total % Ephemeroptera	32.31%				
Total % Plecoptera	14.90%				
Total % Diptera	44.87%				
Average total abundance	366.4				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	4.74	7.64	15.87	1.41	14.37
Estimated aq. Invertebrates/m3 water	4.1	5.5	9.8	0.8	9.7
Average invertebrates/m3 water	8.8				
Average aq. invertebrates/m3 water	6.0				
Est.total aquatic invertebrates	203	336	340	54	322
Est. terrestrial invertebrates	29	134	212	46	156
Estimated total sample	232	470	552	100	478
% sample terrestrial	31.50%				
Average invertebrates/net	366.4				
Average (aq) invertebrates/net	251				

Data Summary Sheet **Site: Station 9** **Date: July-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	128	222	140	126	71
Total aquatic taxa	6	6	7	5	5
Average taxa/sample	5.8				
Est. number Ephemeroptera	24.0	8.0	40.0	24.0	0.0
Est. number Plecoptera	112.0	28.0	16.0	48.0	24.0
Est. number Diptera	776.0	356.0	800.0	760.0	432.0
Total % Ephemeroptera	2.31%				
Total % Plecoptera	5.48%				
Total % Diptera	75.02%				
Average total abundance	832.8				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	20.93	7.21	32.19	14.18	17.08
Estimated aq. Invertebrates/m3 water	13.2	4.4	24.6	11.8	14.4
Average invertebrates/m3 water	18.3				
Average aq. invertebrates/m3 water	13.7				
Est.total aquatic invertebrates	648	270	856	840	480
Est. terrestrial invertebrates	376	174	264	168	88
Estimated total sample	1024	444	1120	1008	568
% sample terrestrial	25.70%				
Average invertebrates/net	832.8				
Average (aq) invertebrates/net	618.8				

Appendix 4, g. Data summary sheets from Station 10, June and July 1997.

Data Summary Sheet **Site: Station 10** **Date: June-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	285	312	286	274	419
Total aquatic taxa	6	6	7	6	7
Average taxa/sample	6.4				
Est. number Ephemeroptera	12.0	16.0	48.0	72.0	20.0
Est. number Plecoptera	54.0	96.0	208.0	152.0	76.0
Est. number Diptera	406.0	2120.0	1592.0	1744.0	1308.0
Total % Ephemeroptera	1.82%				
Total % Plecoptera	6.35%				
Total % Diptera	77.75%				
Average total abundance	1844.4				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	11.65	40.55	65.77	30.83	50.39
Estimated aq. Invertebrates/m3 water	8.7	13.4	30.8	9.1	19.2
Average invertebrates/m3 water	39.8				
Average aq. invertebrates/m3 water	16.3				
Est.total aquatic invertebrates	426	824	1072	648	640
Est. terrestrial invertebrates	144	1672	1216	1544	1036
Estimated total sample	570	2496	2288	2192	1676
% sample terrestrial	60.85%				
Average invertebrates/net	1844.4				
Average (aq) invertebrates/net	722				

Data Summary Sheet ***Site: Station 10*** **Date: July-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	10	0	0	2	4
Total aquatic taxa	1	0	0	0	1
Average taxa/sample	0.4				
Est. number Ephemeroptera	0.0	0.0	0.0	0.0	1.0
Est. number Plecoptera	4.0	0.0	0.0	0.0	0.0
Est. number Diptera	16.0	0.0	0.0	1.0	3.0
Total % Ephemeroptera	3.85%				
Total % Plecoptera	15.38%				
Total % Diptera	76.92%				
Average total abundance	5.2				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	0.41	0.00	0.00	0.03	0.12
Estimated aq. Invertebrates/m3 water	0.1	0.0	0.0	0.0	0.0
Average invertebrates/m3 water	0.1				
Average aq. invertebrates/m3 water	0.0				
Est.total aquatic invertebrates	4	0	0	0	1
Est. terrestrial invertebrates	16	0	0	2	3
Estimated total sample	20	0	0	2	4
% sample terrestrial	80.77%				
Average invertebrates/net	5.2				
Average (aq) invertebrates/net	1				

Appendix 4, h. Data summary sheets from Station 20, June and July 1997.

Data Summary Sheet **Site: Station 20** **Date: June-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	41	33	61	86	28
Total aquatic taxa	2	3	1	3	3
Average taxa/sample	2.4				
Est. number Ephemeroptera	2.0	1.0	0.0	0.0	0.0
Est. number Plecoptera	0.0	0.0	0.0	2.0	1.0
Est. number Diptera	36.0	28.0	54.0	81.0	23.0
Total % Ephemeroptera	1.20%				
Total % Plecoptera	1.20%				
Total % Diptera	89.16%				
Average total abundance	49.8				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	0.84	0.54	1.75	1.21	0.84
Estimated aq. Invertebrates/m3 water	0.2	0.1	0.2	0.3	0.3
Average invertebrates/m3 water	1.0				
Average aq. invertebrates/m3 water	0.2				
Est.total aquatic invertebrates	12	7	8	18	9
Est. terrestrial invertebrates	29	26	53	68	19
Estimated total sample	41	33	61	86	28
% sample terrestrial	78.31%				
Average invertebrates/net	49.8				
Average (aq) invertebrates/net	10.8				

Data Summary Sheet ***Site: Station 20*** **Date: July-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	332	120	120	224	240
Total aquatic taxa	6	5	3	8	4
Average taxa/sample	5.2				
Est. number Ephemeroptera	41.3	116.0	14.0	40.0	38.0
Est. number Plecoptera	2.7	4.0	0.0	3.0	6.0
Est. number Diptera	214.7	148.0	51.0	90.0	252.0
Total % Ephemeroptera	14.27%				
Total % Plecoptera	0.90%				
Total % Diptera	43.26%				
Average total abundance	349.3				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	9.05	7.80	3.45	3.15	14.43
Estimated aq. Invertebrates/m3 water	4.3	3.6	1.2	1.7	7.3
Average invertebrates/m3 water	7.6				
Average aq. invertebrates/m3 water	3.6				
Est.total aquatic invertebrates	210.6667	224	43	118	242
Est. terrestrial invertebrates	232	256	77	106	238
Estimated total sample	442.6667	480	120	224	480
% sample terrestrial	52.04%				
Average invertebrates/net	349.3333				
Average (aq) invertebrates/net	167.5333				

Appendix 4, i. Data summary sheets from Ikalukrok Creek upstream of Dudd Creek, June and July 1997.

Data Summary Sheet **Site: Ikalukrok Creek above Dudd Creek** **Date: June-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	458	452	387	387	275
Total aquatic taxa	6	6	6	8	6
Average taxa/sample	6.4				
Est. number Ephemeroptera	86.0	27.0	74.0	200.0	34.0
Est. number Plecoptera	50.0	7.0	76.0	132.0	28.0
Est. number Diptera	662.0	383.0	590.0	1088.0	484.0
Total % Ephemeroptera	9.93%				
Total % Plecoptera	6.91%				
Total % Diptera	75.64%				
Average total abundance	848.0				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	18.72	7.34	22.25	21.77	16.54
Estimated aq. Invertebrates/m3 water	13.5	3.3	16.4	18.1	12.1
Average invertebrates/m3 water	17.3				
Average aq. invertebrates/m3 water	12.7				
Est.total aquatic invertebrates	662	202	570	1284	402
Est. terrestrial invertebrates	254	250	204	264	148
Estimated total sample	916	452	774	1548	550
% sample terrestrial	26.42%				
Average invertebrates/net	848				
Average (aq) invertebrates/net	624				

Data Summary Sheet **Site: Ikalukrok Creek above Dudd Creek** **Date: July-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	273	331	176	201	159
Total aquatic taxa	6	5	6	6	5
Average taxa/sample	5.6				
Est. number Ephemeroptera	10.0	104.0	32.0	24.0	24.0
Est. number Plecoptera	5.0	72.0	48.0	12.0	24.0
Est. number Diptera	111.0	792.0	696.0	404.0	320.0
Total % Ephemeroptera	3.36%				
Total % Plecoptera	2.79%				
Total % Diptera	40.27%				
Average total abundance	1153.8				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	5.58	43.02	40.47	11.31	19.12
Estimated aq. Invertebrates/m3 water	1.9	7.5	17.0	5.6	10.3
Average invertebrates/m3 water	23.9				
Average aq. invertebrates/m3 water	8.5				
Est.total aquatic invertebrates	93	464	592	396	344
Est. terrestrial invertebrates	180	2184	816	408	292
Estimated total sample	273	2648	1408	804	636
% sample terrestrial	67.26%				
Average invertebrates/net	1153.8				
Average (aq) invertebrates/net	377.8				

Appendix 4, j. Data summary sheets from Ikalukrok Creek, downstream of Dudd Creek, June and July 1997.

Data Summary Sheet **Site: Ikalukrok Creek below Dudd Creek** **Date: June-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	345	301	366	323	418
Total aquatic taxa	7	8	6	8	8
Average taxa/sample	7.4				
Est. number Ephemeroptera	48.0	122.0	98.0	224.0	88.0
Est. number Plecoptera	43.0	64.0	56.0	80.0	56.0
Est. number Diptera	212.0	358.0	478.0	812.0	446.0
Total % Ephemeroptera	15.24%				
Total % Plecoptera	7.85%				
Total % Diptera	60.57%				
Average total abundance	761.4				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	7.05	9.78	21.04	18.17	25.14
Estimated aq. Invertebrates/m3 water	6.5	8.8	18.6	16.1	20.4
Average invertebrates/m3 water	16.2				
Average aq. invertebrates/m3 water	14.1				
Est.total aquatic invertebrates	320	540	646	1148	680
Est. terrestrial invertebrates	25	62	86	144	156
Estimated total sample	345	602	732	1292	836
% sample terrestrial	12.42%				
Average invertebrates/net	761.4				
Average (aq) invertebrates/net	666.8				

Data Summary Sheet **Site: Ikalukrok Creek below Dudd Creek** **Date: July-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	69	99	91	82	76
Total aquatic taxa	5	4	6	4	6
Average taxa/sample	5.0				
Est. number Ephemeroptera	16.0	32.0	104.0	48.0	16.0
Est. number Plecoptera	0.0	8.0	24.0	8.0	48.0
Est. number Diptera	156.0	204.0	304.0	424.0	368.0
Total % Ephemeroptera	8.11%				
Total % Plecoptera	3.30%				
Total % Diptera	54.65%				
Average total abundance	532.8				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	5.64	6.43	20.93	9.23	18.28
Estimated aq. Invertebrates/m3 water	4.3	4.5	17.9	5.5	14.2
Average invertebrates/m3 water	12.1				
Average aq. invertebrates/m3 water	9.3				
Est.total aquatic invertebrates	208	276	624	392	472
Est. terrestrial invertebrates	68	120	104	264	136
Estimated total sample	276	396	728	656	608
% sample terrestrial	25.98%				
Average invertebrates/net	532.8				
Average (aq) invertebrates/net	394.4				

Appendix 4, k. Data summary sheets from the North Fork of Red Dog Creek, June and July 1997.

Data Summary Sheet **Site: North Fork** **Date: June-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	314	387	390	391	481
Total aquatic taxa	6	6	7	7	6
Average taxa/sample	6.4				
Est. number Ephemeroptera	148.0	228.0	104.0	296.0	68.0
Est. number Plecoptera	36.0	28.0	12.0	24.0	8.0
Est. number Diptera	1028.0	1208.0	1316.0	2512.0	1700.0
Total % Ephemeroptera	8.96%				
Total % Plecoptera	1.15%				
Total % Diptera	82.46%				
Average total abundance	1883.2				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	25.67	25.15	44.84	43.99	57.85
Estimated aq. Invertebrates/m3 water	23.2	22.8	40.6	31.5	38.8
Average invertebrates/m3 water	39.5				
Average aq. invertebrates/m3 water	31.4				
Est.total aquatic invertebrates	1136	1404	1412	2240	1292
Est. terrestrial invertebrates	120	144	148	888	632
Estimated total sample	1256	1548	1560	3128	1924
% sample terrestrial	20.52%				
Average invertebrates/net	1883.2				
Average (aq) invertebrates/net	1496.8				

Data Summary Sheet ***Site: North Fork Station 12*** **Date: July-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	49	74	84	114	101
Total aquatic taxa	5	5	4	4	5
Average taxa/sample	4.6				
Est. number Ephemeroptera	32.0	8.0	4.0	18.0	8.0
Est. number Plecoptera	0.0	6.0	0.0	0.0	8.0
Est. number Diptera	96.0	86.0	38.0	160.0	252.0
Total % Ephemeroptera	6.60%				
Total % Plecoptera	1.32%				
Total % Diptera	59.62%				
Average total abundance	212.0				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	4.01	2.40	2.41	3.21	12.15
Estimated aq. Invertebrates/m3 water	3.7	2.0	1.8	2.2	3.6
Average invertebrates/m3 water	4.8				
Average aq. invertebrates/m3 water	2.7				
Est.total aquatic invertebrates	180	124	63	156	120
Est. terrestrial invertebrates	16	24	21	72	284
Estimated total sample	196	148	84	228	404
% sample terrestrial	39.34%				
Average invertebrates/net	212				
Average (aq) invertebrates/net	128.6				

Appendix 4, l. Data summary sheets from Red Dog Creek upstream of the ore body, June and July 1997.

Data Summary Sheet **Site: Upper Red Dog Creek** **Date: June-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	205	240	330	377	71
Total aquatic taxa	9	7	6	8	6
Average taxa/sample	7.2				
Est. number Ephemeroptera	6.0	11.0	3.0	28.0	0.0
Est. number Plecoptera	22.0	20.0	17.0	124.0	24.0
Est. number Diptera	159.0	174.0	284.0	1268.0	504.0
Total % Ephemeroptera	1.68%				
Total % Plecoptera	7.26%				
Total % Diptera	83.80%				
Average total abundance	570.2				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	4.19	3.90	9.49	21.21	17.08
Estimated aq. Invertebrates/m3 water	3.8	2.4	6.5	16.6	13.0
Average invertebrates/m3 water	11.2				
Average aq. invertebrates/m3 water	8.4				
Est.total aquatic invertebrates	187	145	225	1180	432
Est. terrestrial invertebrates	18	95	105	328	136
Estimated total sample	205	240	330	1508	568
% sample terrestrial	23.92%				
Average invertebrates/net	570.2				
Average (aq) invertebrates/net	433.8				

Data Summary Sheet **Site: Upper Red Dog Creek** **Date: July-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	199	194	168	204	179
Total aquatic taxa	5	5	8	7	5
Average taxa/sample	6.0				
Est. number Ephemeroptera	0.0	12.0	12.0	12.0	4.0
Est. number Plecoptera	52.0	20.0	32.0	40.0	52.0
Est. number Diptera	320.0	200.0	184.0	236.0	192.0
Total % Ephemeroptera	1.06%				
Total % Plecoptera	5.19%				
Total % Diptera	29.98%				
Average total abundance	755.2				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	16.27	12.61	19.32	11.48	21.53
Estimated aq. Invertebrates/m3 water	6.0	5.8	9.5	5.6	9.3
Average invertebrates/m3 water	16.2				
Average aq. invertebrates/m3 water	7.3				
Est.total aquatic invertebrates	296	360	332	400	308
Est. terrestrial invertebrates	500	416	340	416	408
Estimated total sample	796	776	672	816	716
% sample terrestrial	55.08%				
Average invertebrates/net	755.2				
Average (aq) invertebrates/net	339.2				

Appendix 4, m. Data summary sheets from Shelly Creek, June and July 1997.

Data Summary Sheet **Site: Shelly Creek** **Date: June-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	196	273	333	610	701
Total aquatic taxa	4	5	5	6	6
Average taxa/sample	5.2				
Est. number Ephemeroptera	64.0	40.0	36.0	9.0	46.0
Est. number Plecoptera	40.0	8.0	48.0	8.0	32.0
Est. number Diptera	1440.0	1904.0	1168.0	458.0	1202.0
Total % Ephemeroptera	2.75%				
Total % Plecoptera	1.92%				
Total % Diptera	86.98%				
Average total abundance	1419.2				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	32.05	35.48	38.29	8.58	42.15
Estimated aq. Invertebrates/m3 water	28.3	25.0	28.9	7.4	31.3
Average invertebrates/m3 water	31.3				
Average aq. invertebrates/m3 water	24.2				
Est.total aquatic invertebrates	1384	1536	1004	523	1042
Est. terrestrial invertebrates	184	648	328	87	360
Estimated total sample	1568	2184	1332	610	1402
% sample terrestrial	22.65%				
Average invertebrates/net	1419.2				
Average (aq) invertebrates/net	1097.8				

Data Summary Sheet **Site: Shelly Creek** **Date: July-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	306	295	313	328	566
Total aquatic taxa	6	7	7	7	7
Average taxa/sample	6.8				
Est. number Ephemeroptera	20.0	8.0	120.0	0.0	24.0
Est. number Plecoptera	24.0	96.0	560.0	104.0	176.0
Est. number Diptera	340.0	1024.0	4880.0	808.0	1392.0
Total % Ephemeroptera	0.74%				
Total % Plecoptera	4.13%				
Total % Diptera	36.31%				
Average total abundance	4651.2				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	25.02	38.34	359.87	36.91	136.14
Estimated aq. Invertebrates/m3 water	19.6	24.3	258.7	25.9	91.9
Average invertebrates/m3 water	119.3				
Average aq. invertebrates/m3 water	84.1				
Est.total aquatic invertebrates	960	1496	9000	1840	3056
Est. terrestrial invertebrates	264	864	3520	784	1472
Estimated total sample	1224	2360	12520	2624	4528
% sample terrestrial	29.69%				
Average invertebrates/net	4651.2				
Average (aq) invertebrates/net	3270.4				

Appendix 4, n. Data summary sheets from Connie Creek, June and July 1997.

Data Summary Sheet **Site: Connie Creek** **Date: June-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	380	186	367	563	184
Total aquatic taxa	5	5	7	5	7
Average taxa/sample	5.8				
Est. number Ephemeroptera	8.0	8.0	4.0	8.0	17.0
Est. number Plecoptera	24.0	8.0	13.0	88.0	8.0
Est. number Diptera	2912.0	1392.0	327.0	4384.0	115.0
Total % Ephemeroptera	0.47%				
Total % Plecoptera	1.47%				
Total % Diptera	95.27%				
Average total abundance	1916.6				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	62.13	24.18	10.55	63.35	5.53
Estimated aq. Invertebrates/m3 water	58.5	20.7	8.6	53.9	3.4
Average invertebrates/m3 water	33.1				
Average aq. invertebrates/m3 water	29.0				
Est.total aquatic invertebrates	2864	1272	300	3832	114
Est. terrestrial invertebrates	176	216	67	672	70
Estimated total sample	3040	1488	367	4504	184
% sample terrestrial	12.53%				
Average invertebrates/net	1916.6				
Average (aq) invertebrates/net	1676.4				

Data Summary Sheet **Site: Connie Creek** **Date: July-97**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	1504	810	349	436	726
Total aquatic taxa	6	7	6	5	6
Average taxa/sample	6.0				
Est. number Ephemeroptera	74.0	68.0	22.0	20.0	16.0
Est. number Plecoptera	249.0	136.0	104.0	118.0	84.0
Est. number Diptera	1161.0	1376.0	556.0	698.0	1312.0
Total % Ephemeroptera	3.25%				
Total % Plecoptera	11.24%				
Total % Diptera	83.03%				
Average total abundance	1229.2				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	30.74	26.32	20.06	12.26	43.66
Estimated aq. Invertebrates/m3 water	30.3	25.4	19.5	11.6	42.8
Average invertebrates/m3 water	26.6				
Average aq. invertebrates/m3 water	25.9				
Est.total aquatic invertebrates	1483	1564	680	826	1422
Est. terrestrial invertebrates	21	56	18	46	30
Estimated total sample	1504	1620	698	872	1452
% sample terrestrial	2.78%				
Average invertebrates/net	1229.2				
Average (aq) invertebrates/net	1195				

Appendix 5,a. Data summary sheets from Alvinella 1, June and July 1998.

Data Summary Sheet **Site: Alvanilla 1** **Date: June-98**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	223	236	213	212	268
Total aquatic taxa	6	6	5	6	7
Average taxa/sample	6.0				
Est. number Ephemeroptera	14.0	38.0	20.0	56.0	128.0
Est. number Plecoptera	20.0	112.0	184.0	124.0	480.0
Est. number Diptera	171.0	304.0	592.0	588.0	1392.0
Total % Ephemeroptera	5.64%				
Total % Plecoptera	20.27%				
Total % Diptera	67.13%				
Average total abundance	907.8				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	4.56	7.67	24.49	11.93	64.46
Estimated aq. Invertebrates/m3 water	4.5	7.2	21.0	10.7	54.8
Average invertebrates/m3 water	22.6				
Average aq. invertebrates/m3 water	19.7				
Est.total aquatic invertebrates	220	444	732	764	1824
Est. terrestrial invertebrates	3	28	120	84	320
Estimated total sample	223	472	852	848	2144
% sample terrestrial	12.23%				
Average invertebrates/net	907.8				
Average (aq) invertebrates/net	796.8				
Data Summary Sheet **Site: Alvanilla 1** **Date: July-98**					
Total invertebrates counted	278	313	462	582	370
Total aquatic taxa	6	6	7	5	6
Average taxa/sample	6.0				
Est. number Ephemeroptera	648.0	272.0	696.0	336.0	736.0
Est. number Plecoptera	304.0	148.0	344.0	288.0	400.0
Est. number Diptera	528.0	220.0	528.0	1056.0	400.0
Total % Ephemeroptera	18.18%				
Total % Plecoptera	10.04%				
Total % Diptera	18.47%				
Average total abundance	2957.6				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	45.45	20.34	106.24	65.49	89.00
Estimated aq. Invertebrates/m3 water	28.1	8.8	42.1	11.0	45.7
Average invertebrates/m3 water	65.3				
Average aq. invertebrates/m3 water	27.2				
Est.total aquatic invertebrates	1376	544	1464	784	1520
Est. terrestrial invertebrates	848	708	2232	3872	1440
Estimated total sample	2224	1252	3696	4656	2960
% sample terrestrial	61.54%				
Average invertebrates/net	2957.6				
Average (aq) invertebrates/net	1137.6				

Appendix 5, b. Data summary sheets from Alvinella 2, June and July 1998.

Data Summary Sheet **Site: Alvanilla 2** **Date: June-98**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	223	281	339	164	321
Total aquatic taxa	6	6	7	6	6
Average taxa/sample	6.2				
Est. number Ephemeroptera	56.0	144.0	256.0	48.0	48.0
Est. number Plecoptera	224.0	272.0	632.0	72.0	264.0
Est. number Diptera	1400.0	1784.0	1720.0	1096.0	2128.0
Total % Ephemeroptera	5.20%				
Total % Plecoptera	13.78%				
Total % Diptera	76.51%				
Average total abundance	2124.8				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	36.46	36.52	77.95	18.45	77.21
Estimated aq. Invertebrates/m3 water	34.0	35.2	73.6	16.8	72.9
Average invertebrates/m3 water	49.3				
Average aq. invertebrates/m3 water	46.5				
Est.total aquatic invertebrates	1664	2168	2560	1192	2424
Est. terrestrial invertebrates	120	80	152	120	144
Estimated total sample	1784	2248	2712	1312	2568
% sample terrestrial	5.80%				
Average invertebrates/net	2124.8				
Average (aq) invertebrates/net	2001.6				
Data Summary Sheet **Site: Alvanilla 2** **Date: July-98**					
Total invertebrates counted	458	168	66	173	289
Total aquatic taxa	8	7	8	7	10
Average taxa/sample	8.0				
Est. number Ephemeroptera	1260.0	752.0	248.0	816.0	1048.0
Est. number Plecoptera	200.0	232.0	120.0	248.0	520.0
Est. number Diptera	312.0	312.0	120.0	280.0	624.0
Total % Ephemeroptera	55.73%				
Total % Plecoptera	17.84%				
Total % Diptera	22.27%				
Average total abundance	1480.0				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	37.44	21.84	15.18	19.47	69.51
Estimated aq. Invertebrates/m3 water	35.4	21.3	12.9	18.5	58.7
Average invertebrates/m3 water	32.7				
Average aq. invertebrates/m3 water	29.3				
Est.total aquatic invertebrates	1732	1312	448	1312	1952
Est. terrestrial invertebrates	100	32	80	72	360
Estimated total sample	1832	1344	528	1384	2312
% sample terrestrial	8.70%				
Average invertebrates/net	1480				
Average (aq) invertebrates/net	1351.2				

Appendix 5, c. Data summary sheets from Alvinella 3, June and July 1998.

Data Summary Sheet **Site: Alvanilla 3** **Date: June-98**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	503	343	446	342	200
Total aquatic taxa	6	7	8	6	7
Average taxa/sample	6.8				
Est. number Ephemeroptera	120.0	144.0	176.0	92.0	44.0
Est. number Plecoptera	704.0	408.0	968.0	276.0	132.0
Est. number Diptera	3192.0	2168.0	2384.0	996.0	612.0
Total % Ephemeroptera	4.61%				
Total % Plecoptera	19.90%				
Total % Diptera	74.79%				
Average total abundance	2500.8				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	82.24	44.58	102.56	19.24	24.05
Estimated aq. Invertebrates/m3 water	82.2	43.3	101.9	18.7	23.6
Average invertebrates/m3 water	54.5				
Average aq. invertebrates/m3 water	53.9				
Est.total aquatic invertebrates	4024	2664	3544	1328	784
Est. terrestrial invertebrates	0	80	24	40	16
Estimated total sample	4024	2744	3568	1368	800
% sample terrestrial	1.28%				
Average invertebrates/net	2500.8				
Average (aq) invertebrates/net	2468.8				

Data Summary Sheet **Site: Alvanilla 3** **Date: July-98**					
Total invertebrates counted	674	215	288	259	548
Total aquatic taxa	9	8	7	7	7
Average taxa/sample	7.6				
Est. number Ephemeroptera	86.0	196.0	200.0	184.0	478.0
Est. number Plecoptera	53.0	54.0	76.0	68.0	174.0
Est. number Diptera	216.0	116.0	178.0	156.0	266.0
Total % Ephemeroptera	34.73%				
Total % Plecoptera	12.90%				
Total % Diptera	28.29%				
Average total abundance	658.8				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	13.77	6.99	16.56	7.29	32.95
Estimated aq. Invertebrates/m3 water	6.7	5.8	11.5	5.1	27.3
Average invertebrates/m3 water	15.5				
Average aq. invertebrates/m3 water	11.3				
Est.total aquatic invertebrates	326	354	400	364	908
Est. terrestrial invertebrates	348	76	176	154	188
Estimated total sample	674	430	576	518	1096
% sample terrestrial	28.60%				
Average invertebrates/net	658.8				
Average (aq) invertebrates/net	470.4				

Appendix 5, d. Data summary sheets from Alvinella 4, June and July 1998.

Data Summary Sheet **Site: Alvanilla 4** **Date: June-98**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	335	385	144	397	332
Total aquatic taxa	7	6	6	7	7
Average taxa/sample	6.6				
Est. number Ephemeroptera	88.0	100.0	84.6	38.5	76.0
Est. number Plecoptera	352.0	423.1	100.0	384.6	136.0
Est. number Diptera	2200.0	2392.3	861.5	2538.5	1080.0
Total % Ephemeroptera	3.48%				
Total % Plecoptera	12.54%				
Total % Diptera	81.50%				
Average total abundance	2226.2				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	54.77	48.12	31.84	42.95	39.93
Estimated aq. Invertebrates/m3 water	51.5	47.6	27.2	41.8	39.4
Average invertebrates/m3 water	43.5				
Average aq. invertebrates/m3 water	41.5				
Est.total aquatic invertebrates	2520	2930.769	946.15385	2969.2308	1312
Est. terrestrial invertebrates	160	30.76923	161.53846	84.615385	16
Estimated total sample	2680	2961.538	1107.6923	3053.8462	1328
% sample terrestrial	4.07%				
Average invertebrates/net	2226.215				
Average (aq) invertebrates/net	2135.631				

Data Summary Sheet **Site: Alvanilla 4** **Date: July-98**					
Total invertebrates counted	92	180	334	271	203
Total aquatic taxa	5	9	3	9	7
Average taxa/sample	6.6				
Est. number Ephemeroptera	16.0	160.0	188.0	292.0	264.0
Est. number Plecoptera	44.0	72.0	20.0	116.0	112.0
Est. number Diptera	124.0	96.0	468.0	240.0	132.0
Total % Ephemeroptera	21.30%				
Total % Plecoptera	8.43%				
Total % Diptera	24.54%				
Average total abundance	864.0				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	7.52	11.70	38.40	15.25	24.41
Estimated aq. Invertebrates/m3 water	1.6	5.0	9.3	9.1	22.5
Average invertebrates/m3 water	19.5				
Average aq. invertebrates/m3 water	9.5				
Est.total aquatic invertebrates	80	308	324	644	748
Est. terrestrial invertebrates	288	412	1012	440	64
Estimated total sample	368	720	1336	1084	812
% sample terrestrial	51.30%				
Average invertebrates/net	864				
Average (aq) invertebrates/net	420.8				

Appendix 5, e. Data summary sheets from Alvinella 5, July 1998.

Data Summary Sheet **Site: Alvanilla 5** **Date: July-98**					
Total invertebrates counted	277	348	314	378	250
Total aquatic taxa	6	7	8	7	6
Average taxa/sample	6.8				
Est. number Ephemeroptera	680.0	1120.0	1080.0	1200.0	672.0
Est. number Plecoptera	192.0	352.0	424.0	288.0	200.0
Est. number Diptera	448.0	496.0	536.0	608.0	392.0
Total % Ephemeroptera	37.91%				
Total % Plecoptera	11.61%				
Total % Diptera	19.78%				
Average total abundance	2507.2				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	45.29	45.23	72.20	42.53	60.13
Estimated aq. Invertebrates/m3 water	32.9	37.3	56.3	34.8	45.9
Average invertebrates/m3 water	53.1				
Average aq. invertebrates/m3 water	41.4				
Est.total aquatic invertebrates	1608	2296	1960	2472	1528
Est. terrestrial invertebrates	608	488	552	552	472
Estimated total sample	2216	2784	2512	3024	2000
% sample terrestrial	21.31%				
Average invertebrates/net	2507.2				
Average (aq) invertebrates/net	1972.8				

Appendix 5, f. Data summary sheets from Station 8, June and July 1998.

Data Summary Sheet ***Site: Station 8*** **Date: June-98**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	223	132	415	385	199
Total aquatic taxa	4	6	5	7	6
Average taxa/sample	5.6				
Est. number Ephemeroptera	9.0	8.0	24.0	30.0	1.0
Est. number Plecoptera	175.0	45.0	526.0	572.0	138.0
Est. number Diptera	35.0	72.0	242.0	158.0	57.0
Total % Ephemeroptera	3.34%				
Total % Plecoptera	67.60%				
Total % Diptera	26.18%				
Average total abundance	430.8				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	4.56	2.14	23.86	10.83	5.98
Estimated aq. Invertebrates/m3 water	4.4	1.9	23.0	10.8	5.1
Average invertebrates/m3 water	9.5				
Average aq. invertebrates/m3 water	9.0				
Est.total aquatic invertebrates	213	119	800	768	171
Est. terrestrial invertebrates	10	13	30	2	28
Estimated total sample	223	132	830	770	199
% sample terrestrial	3.85%				
Average invertebrates/net	430.8				
Average (aq) invertebrates/net	414.2				

Data Summary Sheet **Site: Station 8** **Date: July-98**					
Total invertebrates counted	286	272	475	141	153
Total aquatic taxa	6	4	7	5	5
Average taxa/sample	5.4				
Est. number Ephemeroptera	438.0	450.0	363.0	194.0	204.0
Est. number Plecoptera	40.0	32.0	18.0	18.0	8.0
Est. number Diptera	84.0	54.0	88.0	64.0	90.0
Total % Ephemeroptera	75.68%				
Total % Plecoptera	5.32%				
Total % Diptera	17.44%				
Average total abundance	435.8				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	11.69	8.84	13.65	3.97	9.20
Estimated aq. Invertebrates/m3 water	11.6	8.8	13.5	3.9	9.1
Average invertebrates/m3 water	9.5				
Average aq. invertebrates/m3 water	9.4				
Est.total aquatic invertebrates	570	544	471	278	304
Est. terrestrial invertebrates	2	0	4	4	2
Estimated total sample	572	544	475	282	306
% sample terrestrial	0.55%				
Average invertebrates/net	435.8				
Average (aq) invertebrates/net	433.4				

Appendix 5, g. Data summary sheets from Station 9, June and July 1998.

Data Summary Sheet **Site: Station 9** **Date: June-98**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	148	180	117	159	434
Total aquatic taxa	4	6	5	6	6
Average taxa/sample	5.4				
Est. number Ephemeroptera	164.0	220.0	108.0	48.0	174.0
Est. number Plecoptera	140.0	184.0	100.0	72.0	230.0
Est. number Diptera	264.0	260.0	248.0	184.0	432.0
Total % Ephemeroptera	24.07%				
Total % Plecoptera	24.48%				
Total % Diptera	46.80%				
Average total abundance	593.2				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	12.10	11.70	13.45	4.47	26.10
Estimated aq. Invertebrates/m3 water	11.8	11.4	13.1	4.5	26.0
Average invertebrates/m3 water	13.6				
Average aq. invertebrates/m3 water	13.3				
Est.total aquatic invertebrates	576	700	456	318	864
Est. terrestrial invertebrates	16	20	12	0	4
Estimated total sample	592	720	468	318	868
% sample terrestrial	1.75%				
Average invertebrates/net	593.2				
Average (aq) invertebrates/net	582.8				

Data Summary Sheet **Site: Station 9** **Date: July-98**					
Total invertebrates counted	256	232	492	535	320
Total aquatic taxa	5	4	4	6	4
Average taxa/sample	4.6				
Est. number Ephemeroptera	852.0	1664.0	3760.0	4016.0	2488.0
Est. number Plecoptera	4.0	24.0	24.0	88.0	8.0
Est. number Diptera	148.0	144.0	128.0	136.0	32.0
Total % Ephemeroptera	93.59%				
Total % Plecoptera	1.08%				
Total % Diptera	4.31%				
Average total abundance	2731.2				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	20.93	30.15	113.14	60.20	76.97
Estimated aq. Invertebrates/m3 water	20.7	30.0	113.1	60.2	76.2
Average invertebrates/m3 water	60.3				
Average aq. invertebrates/m3 water	60.1				
Est.total aquatic invertebrates	1012	1848	3936	4280	2536
Est. terrestrial invertebrates	12	8	0	0	24
Estimated total sample	1024	1856	3936	4280	2560
% sample terrestrial	0.32%				
Average invertebrates/net	2731.2				
Average (aq) invertebrates/net	2722.4				

Appendix 5, h. Data summary sheets from Station 10, June and July 1998.

Data Summary Sheet **Site: Station 10** **Date: June-98**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	196	200	319	178	118
Total aquatic taxa	7	4	4	3	4
Average taxa/sample	4.4				
Est. number Ephemeroptera	40.0	24.0	48.0	8.0	8.0
Est. number Plecoptera	1056.0	1056.0	1624.0	760.0	408.0
Est. number Diptera	464.0	512.0	848.0	648.0	520.0
Total % Ephemeroptera	1.58%				
Total % Plecoptera	60.63%				
Total % Diptera	36.99%				
Average total abundance	1617.6				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	32.05	26.00	73.35	20.03	28.38
Estimated aq. Invertebrates/m3 water	31.4	23.3	72.2	18.0	26.5
Average invertebrates/m3 water	36.0				
Average aq. invertebrates/m3 water	34.3				
Est.total aquatic invertebrates	1536	1432	2512	1280	880
Est. terrestrial invertebrates	32	168	40	144	64
Estimated total sample	1568	1600	2552	1424	944
% sample terrestrial	5.54%				
Average invertebrates/net	1617.6				
Average (aq) invertebrates/net	1528				

Data Summary Sheet **Site: Station 10** **Date: July-98**					
Total invertebrates counted	124	94	42	126	185
Total aquatic taxa	8	7	5	6	8
Average taxa/sample	6.8				
Est. number Ephemeroptera	28.0	5.0	3.0	1.0	14.0
Est. number Plecoptera	36.0	11.0	6.0	9.0	62.0
Est. number Diptera	336.0	63.0	32.0	113.0	248.0
Total % Ephemeroptera	4.52%				
Total % Plecoptera	10.99%				
Total % Diptera	70.21%				
Average total abundance	225.6				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	10.14	1.53	1.21	1.77	11.12
Estimated aq. Invertebrates/m3 water	7.6	1.1	0.8	1.2	9.8
Average invertebrates/m3 water	5.2				
Average aq. invertebrates/m3 water	4.1				
Est.total aquatic invertebrates	372	67	29	88	326
Est. terrestrial invertebrates	124	27	13	38	44
Estimated total sample	496	94	42	126	370
% sample terrestrial	21.81%				
Average invertebrates/net	225.6				
Average (aq) invertebrates/net	176.4				

Appendix 5, i. Data summary sheets from Station 20, June and July 1998.

Data Summary Sheet **Site: Station 20** **Date: June-98**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	395	749	785	805	584
Total aquatic taxa	8	7	7	8	7
Average taxa/sample	7.4				
Est. number Ephemeroptera	49.0	75.0	37.0	64.0	64.0
Est. number Plecoptera	13.0	12.0	18.0	20.0	9.0
Est. number Diptera	320.0	624.0	707.0	696.0	488.0
Total % Ephemeroptera	8.71%				
Total % Plecoptera	2.17%				
Total % Diptera	85.44%				
Average total abundance	663.6				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	8.07	12.17	22.56	11.32	17.56
Estimated aq. Invertebrates/m3 water	7.1	10.3	19.3	9.1	15.0
Average invertebrates/m3 water	14.3				
Average aq. invertebrates/m3 water	12.2				
Est.total aquatic invertebrates	346	633	671	649	499
Est. terrestrial invertebrates	49	116	114	156	85
Estimated total sample	395	749	785	805	584
% sample terrestrial	15.67%				
Average invertebrates/net	663.6				
Average (aq) invertebrates/net	559.6				

Data Summary Sheet **Site: Station 20** **Date: July-98**					
Total invertebrates counted	81	120	69	29	8
Total aquatic taxa	5	6	4	3	2
Average taxa/sample	4.0				
Est. number Ephemeroptera	70.0	68.0	47.0	17.0	6.0
Est. number Plecoptera	1.0	4.0	0.0	0.0	0.0
Est. number Diptera	3.0	21.0	12.0	10.0	2.0
Total % Ephemeroptera	67.75%				
Total % Plecoptera	1.63%				
Total % Diptera	15.64%				
Average total abundance	61.4				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	1.66	1.95	1.98	0.41	0.24
Estimated aq. Invertebrates/m3 water	1.5	1.7	1.9	0.4	0.2
Average invertebrates/m3 water	1.2				
Average aq. invertebrates/m3 water	1.2				
Est.total aquatic invertebrates	75	105	67	28	8
Est. terrestrial invertebrates	6	15	2	1	0
Estimated total sample	81	120	69	29	8
% sample terrestrial	7.82%				
Average invertebrates/net	61.4				
Average (aq) invertebrates/net	56.6				

Appendix 5, j. Data summary sheets from Ikalukrok Creek upstream of Dudd Creek, June and July 1998.

Data Summary Sheet **Site: Ikalukrok Creek upstream from Dudd Creek** **Date: June-98**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	138	124	126	199	150
Total aquatic taxa	6	5	5	6	7
Average taxa/sample	5.8				
Est. number Ephemeroptera	18.0	20.0	16.0	118.0	36.0
Est. number Plecoptera	70.0	80.0	114.0	120.0	120.0
Est. number Diptera	72.0	100.0	102.0	132.0	94.0
Total % Ephemeroptera	14.11%				
Total % Plecoptera	34.19%				
Total % Diptera	33.92%				
Average total abundance	294.8				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	5.64	4.03	7.24	5.60	9.02
Estimated aq. Invertebrates/m3 water	5.2	3.7	6.2	5.3	8.2
Average invertebrates/m3 water	6.3				
Average aq. invertebrates/m3 water	5.7				
Est.total aquatic invertebrates	252	228	216	376	274
Est. terrestrial invertebrates	24	20	36	22	26
Estimated total sample	276	248	252	398	300
% sample terrestrial	8.68%				
Average invertebrates/net	294.8				
Average (aq) invertebrates/net	269.2				

Data Summary Sheet **Site: Ikalukrok Creek upstream from Dudd Creek** **Date: July-98**					
Total invertebrates counted	72	200	255	150	220
Total aquatic taxa	2	4	3	2	2
Average taxa/sample	2.6				
Est. number Ephemeroptera	0.0	0.0	8.0	0.0	0.0
Est. number Plecoptera	56.0	36.0	60.0	16.0	16.0
Est. number Diptera	376.0	596.0	716.0	432.0	588.0
Total % Ephemeroptera	0.21%				
Total % Plecoptera	4.75%				
Total % Diptera	69.87%				
Average total abundance	775.2				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	11.77	13.00	29.32	8.44	26.46
Estimated aq. Invertebrates/m3 water	10.3	7.7	14.8	4.7	15.9
Average invertebrates/m3 water	17.8				
Average aq. invertebrates/m3 water	10.7				
Est.total aquatic invertebrates	504	476	516	332	528
Est. terrestrial invertebrates	72	324	504	268	352
Estimated total sample	576	800	1020	600	880
% sample terrestrial	39.22%				
Average invertebrates/net	775.2				
Average (aq) invertebrates/net	471.2				

Appendix 5, k. Data summary sheets from Ikalukrok Creek downstream of Dudd Creek, June and July 1998.

Data Summary Sheet **Site: Ikalukrok Creek downstream Dudd Creek** **Date: June-98**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	162	98	132	139	110
Total aquatic taxa	6	6	5	4	5
Average taxa/sample	5.2				
Est. number Ephemeroptera	12.0	20.0	18.0	6.0	10.0
Est. number Plecoptera	61.0	82.0	120.0	202.0	50.0
Est. number Diptera	76.0	84.0	124.0	66.0	47.0
Total % Ephemeroptera	6.53%				
Total % Plecoptera	50.99%				
Total % Diptera	39.31%				
Average total abundance	202.0				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	3.31	3.18	7.59	3.91	3.31
Estimated aq. Invertebrates/m3 water	3.1	3.2	7.5	3.9	3.2
Average invertebrates/m3 water	4.3				
Average aq. invertebrates/m3 water	4.2				
Est.total aquatic invertebrates	154	196	262	276	106
Est. terrestrial invertebrates	8	0	2	2	4
Estimated total sample	162	196	264	278	110
% sample terrestrial	1.58%				
Average invertebrates/net	202				
Average (aq) invertebrates/net	198.8				

Data Summary Sheet ***Site: Ikalukrok Creek downstream from Dudd Creek*** **Date: July-98**					
Total invertebrates counted	276	184	100	211	135
Total aquatic taxa	6	5	6	6	6
Average taxa/sample	5.8				
Est. number Ephemeroptera	40.0	12.0	8.0	4.0	32.0
Est. number Plecoptera	36.0	32.0	16.0	30.0	8.0
Est. number Diptera	768.0	584.0	154.0	328.0	376.0
Total % Ephemeroptera	3.20%				
Total % Plecoptera	4.06%				
Total % Diptera	73.62%				
Average total abundance	600.4				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	22.56	11.96	5.75	5.94	16.24
Estimated aq. Invertebrates/m3 water	21.3	10.5	4.7	5.1	15.0
Average invertebrates/m3 water	12.5				
Average aq. invertebrates/m3 water	11.3				
Est.total aquatic invertebrates	1040	644	164	366	500
Est. terrestrial invertebrates	64	92	36	56	40
Estimated total sample	1104	736	200	422	540
% sample terrestrial	9.59%				
Average invertebrates/net	600.4				
Average (aq) invertebrates/net	542.8				

Appendix 5, l. Data summary sheets from the North Fork of Red Dog Creek, June and July 1998.

Data Summary Sheet **Site: North Fork** **Date: June-98**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	380	365	404	486	372
Total aquatic taxa	4	5	5	6	5
Average taxa/sample	5.0				
Est. number Ephemeroptera	8.0	44.0	60.0	20.0	12.0
Est. number Plecoptera	264.0	192.0	416.0	340.0	252.0
Est. number Diptera	1176.0	1156.0	1012.0	1492.0	1112.0
Total % Ephemeroptera	1.79%				
Total % Plecoptera	18.24%				
Total % Diptera	74.09%				
Average total abundance	1605.6				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	31.06	23.72	46.45	27.34	44.74
Estimated aq. Invertebrates/m3 water	31.1	20.3	33.6	22.4	38.6
Average invertebrates/m3 water	34.7				
Average aq. invertebrates/m3 water	29.2				
Est.total aquatic invertebrates	1520	1248	1168	1592	1284
Est. terrestrial invertebrates	0	212	448	352	204
Estimated total sample	1520	1460	1616	1944	1488
% sample terrestrial	15.15%				
Average invertebrates/net	1605.6				
Average (aq) invertebrates/net	1362.4				
Data Summary Sheet **Site: North Fork** **Date: July-98**					
Total invertebrates counted	123	164	144	64	276
Total aquatic taxa	3	4	5	4	7
Average taxa/sample	4.6				
Est. number Ephemeroptera	8.0	20.0	12.0	28.0	62.0
Est. number Plecoptera	4.0	24.0	4.0	16.0	62.0
Est. number Diptera	176.0	224.0	244.0	156.0	224.0
Total % Ephemeroptera	5.13%				
Total % Plecoptera	4.34%				
Total % Diptera	40.44%				
Average total abundance	506.4				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	10.06	10.66	16.56	3.60	16.60
Estimated aq. Invertebrates/m3 water	4.3	6.0	9.5	2.8	13.2
Average invertebrates/m3 water	11.5				
Average aq. invertebrates/m3 water	7.2				
Est.total aquatic invertebrates	212	368	332	200	438
Est. terrestrial invertebrates	280	288	244	56	114
Estimated total sample	492	656	576	256	552
% sample terrestrial	38.78%				
Average invertebrates/net	506.4				
Average (aq) invertebrates/net	310				

Appendix 5, m. Data summary sheets Connie Creek, June and July 1998.

Data Summary Sheet **Site: Connie Creek** **Date: July-98**					
Total invertebrates counted	752	1445	698	1570	529
Total aquatic taxa	5	5	5	6	5
Average taxa/sample	5.2				
Est. number Ephemeroptera	5224.0	10296.0	4736.0	11224.0	3504.0
Est. number Plecoptera	616.0	896.0	680.0	880.0	616.0
Est. number Diptera	128.0	304.0	144.0	320.0	72.0
Total % Ephemeroptera	87.57%				
Total % Plecoptera	9.23%				
Total % Diptera	2.42%				
Average total abundance	7990.4				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	122.95	187.81	160.51	176.65	127.24
Estimated aq. Invertebrates/m3 water	121.6	185.6	158.9	174.1	125.8
Average invertebrates/m3 water	155.0				
Average aq. invertebrates/m3 water	153.2				
Est.total aquatic invertebrates	5952	11424	5528	12376	4184
Est. terrestrial invertebrates	64	136	56	184	48
Estimated total sample	6016	11560	5584	12560	4232
% sample terrestrial	1.22%				
Average invertebrates/net	7990.4				
Average (aq) invertebrates/net	7892.8				

Data Summary Sheet **Site: Connie Creek** **Date: July-98**					
Total invertebrates identified	752	1445	698	1570	529
Total aquatic taxa	5	5	5	6	5
Average taxa/sample	5.2				
Est. number Ephemeroptera	5224.0	10296.0	4736.0	11224.0	3504.0
Est. number Plecoptera	616.0	896.0	680.0	880.0	616.0
Est. number Diptera	128.0	304.0	144.0	320.0	72.0
Total % Ephemeroptera	87.57%				
Total % Plecoptera	9.23%				
Total % Diptera	2.42%				
Average total abundance	7990.4				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	122.95	187.81	160.51	176.65	127.24
Average invertebrates/m3 water	155.0				
Estimated # aquatic invertebrates/m3 water	121.6	185.6	158.9	174.1	125.8
Average aq. invertebrates/m3 water	153.2				
Est.total aquatic invertebrates	5952	11424	5528	12376	4184
Est. terrestrial invertebrates	64	136	56	184	48
Estimated total sample	6016	11560	5584	12560	4232
% sample terrestrial	1.22%				
Average invertebrates/net	7990.4				
Average (aq) invertebrates/net	7892.8				

Appendix 5, n. Data summary sheets Red Dog Creek upstream of the ore body, June and July 1998.

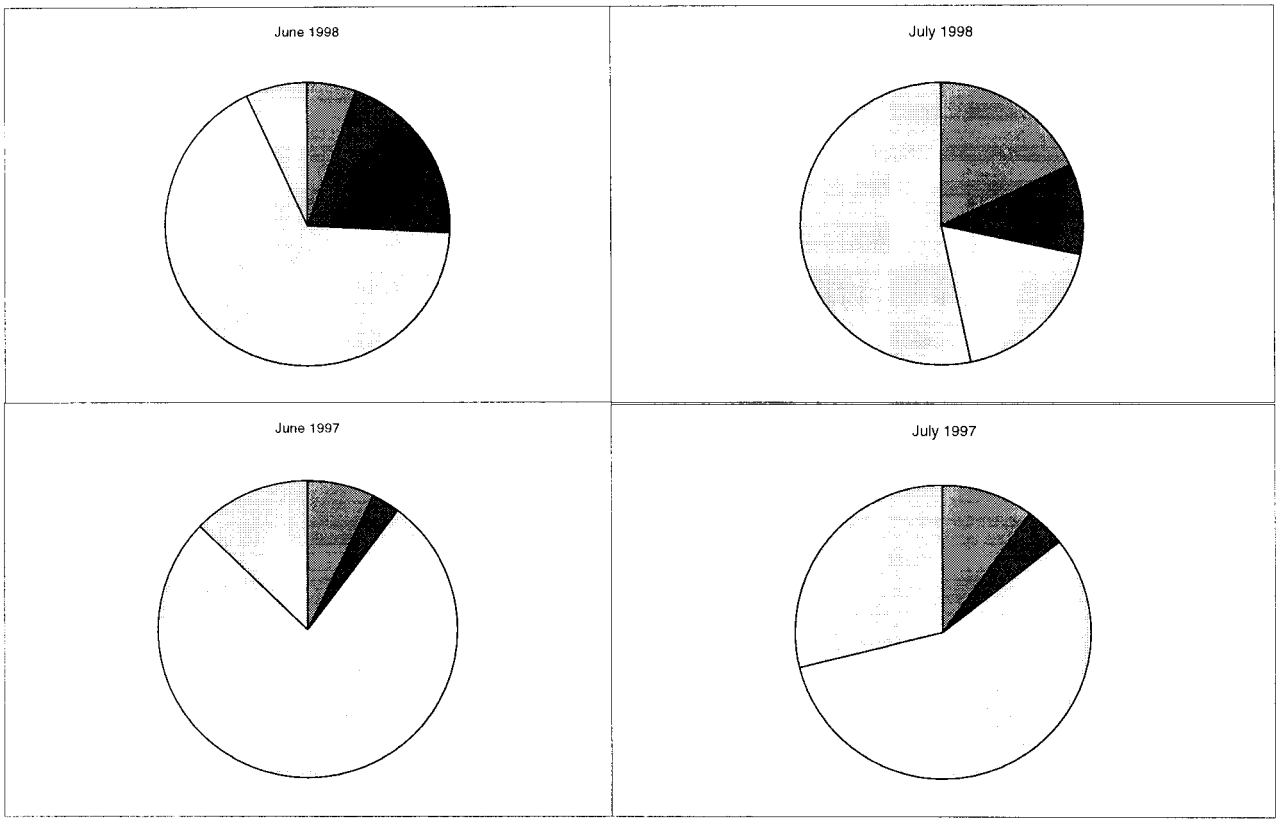
Data Summary Sheet **Site: Upper Red Dog** **Date: June-98**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	387	376	305	401	658
Total aquatic taxa	6	6	6	6	6
Average taxa/sample	6.0				
Est. number Ephemeroptera	2.0	8.0	5.0	7.0	6.0
Est. number Plecoptera	167.0	152.0	135.0	39.0	67.0
Est. number Diptera	217.0	207.0	157.0	346.0	577.0
Total % Ephemeroptera	1.32%				
Total % Plecoptera	26.33%				
Total % Diptera	70.71%				
Average total abundance	425.4				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	7.91	6.11	8.77	5.64	19.78
Estimated aq. Invertebrates/m3 water	7.9	5.9	8.7	5.6	19.5
Average invertebrates/m3 water	9.6				
Average aq. invertebrates/m3 water	9.5				
Est.total aquatic invertebrates	385	364	302	395	649
Est. terrestrial invertebrates	2	12	3	6	9
Estimated total sample	387	376	305	401	658
% sample terrestrial	1.50%				
Average invertebrates/net	425.4				
Average (aq) invertebrates/net	419				
Data Summary Sheet **Site: upper Red Dog** **Date: July-98**					
Total invertebrates counted	205	57	93	18	113
Total aquatic taxa	6	6	6	4	7
Average taxa/sample	5.8				
Est. number Ephemeroptera	90.0	24.0	36.0	3.0	20.0
Est. number Plecoptera	154.0	46.0	104.0	11.0	134.0
Est. number Diptera	120.0	24.0	30.0	4.0	48.0
Total % Ephemeroptera	18.13%				
Total % Plecoptera	47.06%				
Total % Diptera	23.69%				
Average total abundance	190.8				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	8.38	1.85	5.35	0.25	6.79
Estimated aq. Invertebrates/m3 water	6.4	1.5	4.4	0.3	5.4
Average invertebrates/m3 water	4.5				
Average aq. invertebrates/m3 water	3.6				
Est.total aquatic invertebrates	312	94	152	18	178
Est. terrestrial invertebrates	98	20	34	0	48
Estimated total sample	410	114	186	18	226
% sample terrestrial	20.96%				
Average invertebrates/net	190.8				
Average (aq) invertebrates/net	150.8				

Appendix 5, o. Data summary sheets from Shelly Creek, June and July 1998.

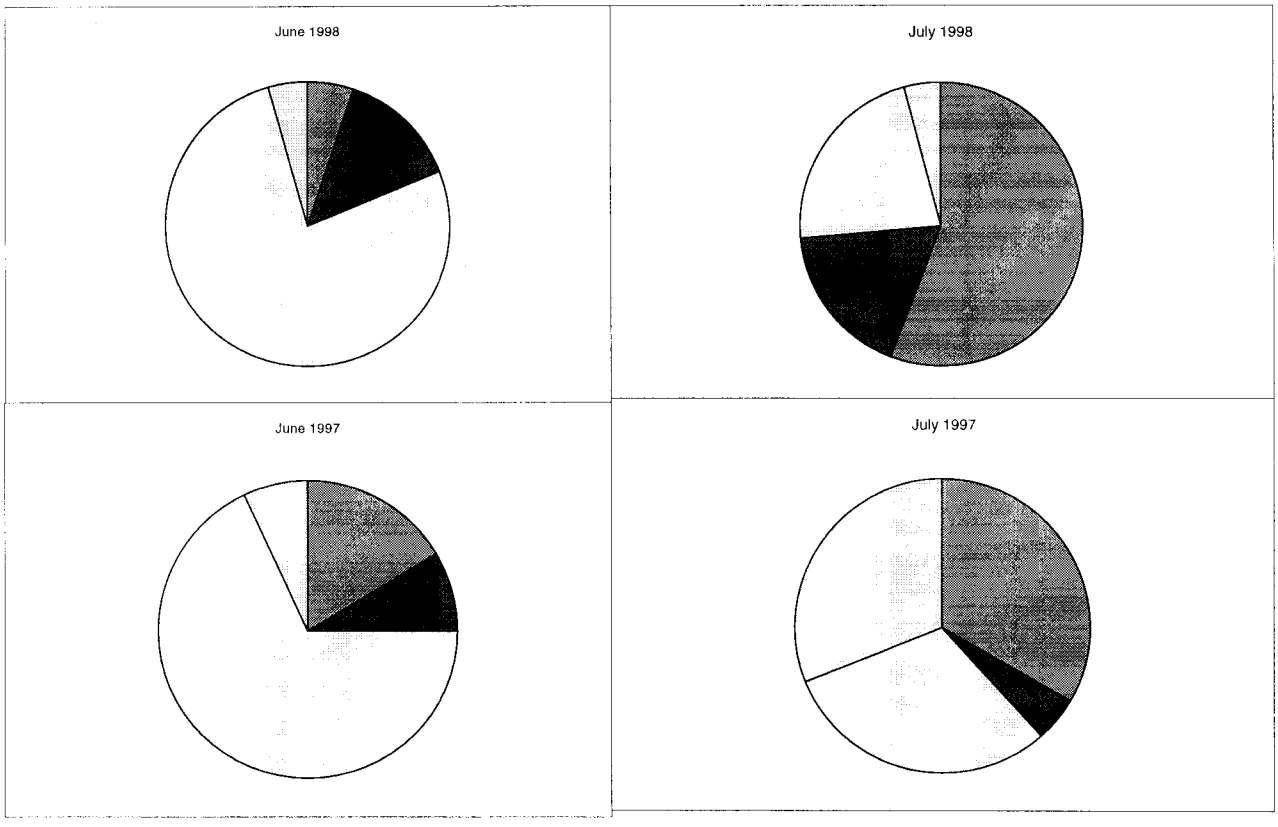
Data Summary Sheet **Site: Shelly Creek** **Date: June-98**	Net 1	Net 2	Net 3	Net 4	Net 5
Total invertebrates counted	449	476	475	665	665
Total aquatic taxa	6	8	8	7	7
Average taxa/sample	7.2				
Est. number Ephemeroptera	304.0	200.0	264.0	60.0	408.0
Est. number Plecoptera	1384.0	664.0	1408.0	1200.0	2032.0
Est. number Diptera	1856.0	1008.0	2072.0	1376.0	2808.0
Total % Ephemeroptera	7.15%				
Total % Plecoptera	38.71%				
Total % Diptera	52.79%				
Average total abundance	3455.2				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	73.41	30.93	109.23	37.41	159.95
Estimated aq. Invertebrates/m3 water	71.6	30.3	107.8	36.8	157.5
Average invertebrates/m3 water	82.2				
Average aq. invertebrates/m3 water	80.8				
Est.total aquatic invertebrates	3504	1864	3752	2620	5240
Est. terrestrial invertebrates	88	40	48	40	80
Estimated total sample	3592	1904	3800	2660	5320
% sample terrestrial	1.71%				
Average invertebrates/net	3455.2				
Average (aq) invertebrates/net	3396				

Data Summary Sheet **Site: Shelly Creek** **Date: July-98**					
Total invertebrates counted	106	100	80	43	87
Total aquatic taxa	7	8	7	8	6
Average taxa/sample	7.2				
Est. number Ephemeroptera	44.0	38.0	60.0	40.0	44.0
Est. number Plecoptera	56.0	34.0	72.0	32.0	100.0
Est. number Diptera	78.0	78.0	104.0	84.0	132.0
Total % Ephemeroptera	18.05%				
Total % Plecoptera	23.48%				
Total % Diptera	38.02%				
Average total abundance	250.4				
Volume of water (m3)	48.93	61.55	34.79	71.10	33.26
Estimated # invertebrates/m3 water	4.33	3.25	9.20	2.42	10.46
Estimated aq. Invertebrates/m3 water	3.3	2.0	7.0	1.9	7.3
Average invertebrates/m3 water	5.9				
Average aq. invertebrates/m3 water	4.3				
Est.total aquatic invertebrates	160	124	244	132	244
Est. terrestrial invertebrates	52	76	76	40	104
Estimated total sample	212	200	320	172	348
% sample terrestrial	27.80%				
Average invertebrates/net	250.4				
Average (aq) invertebrates/net	180.8				

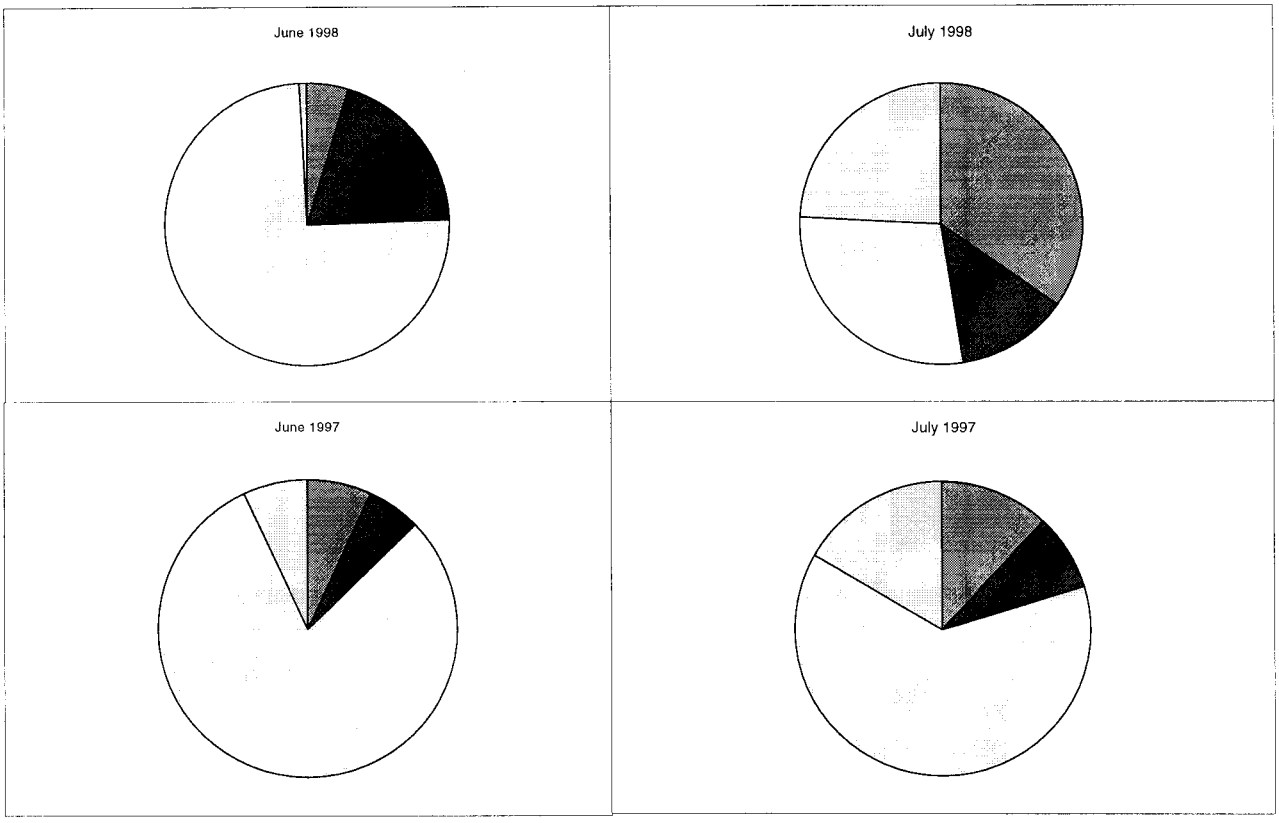
Appendix 6,a. Sample composition at Alvinella 1, June and July 1997, June and July 1998.



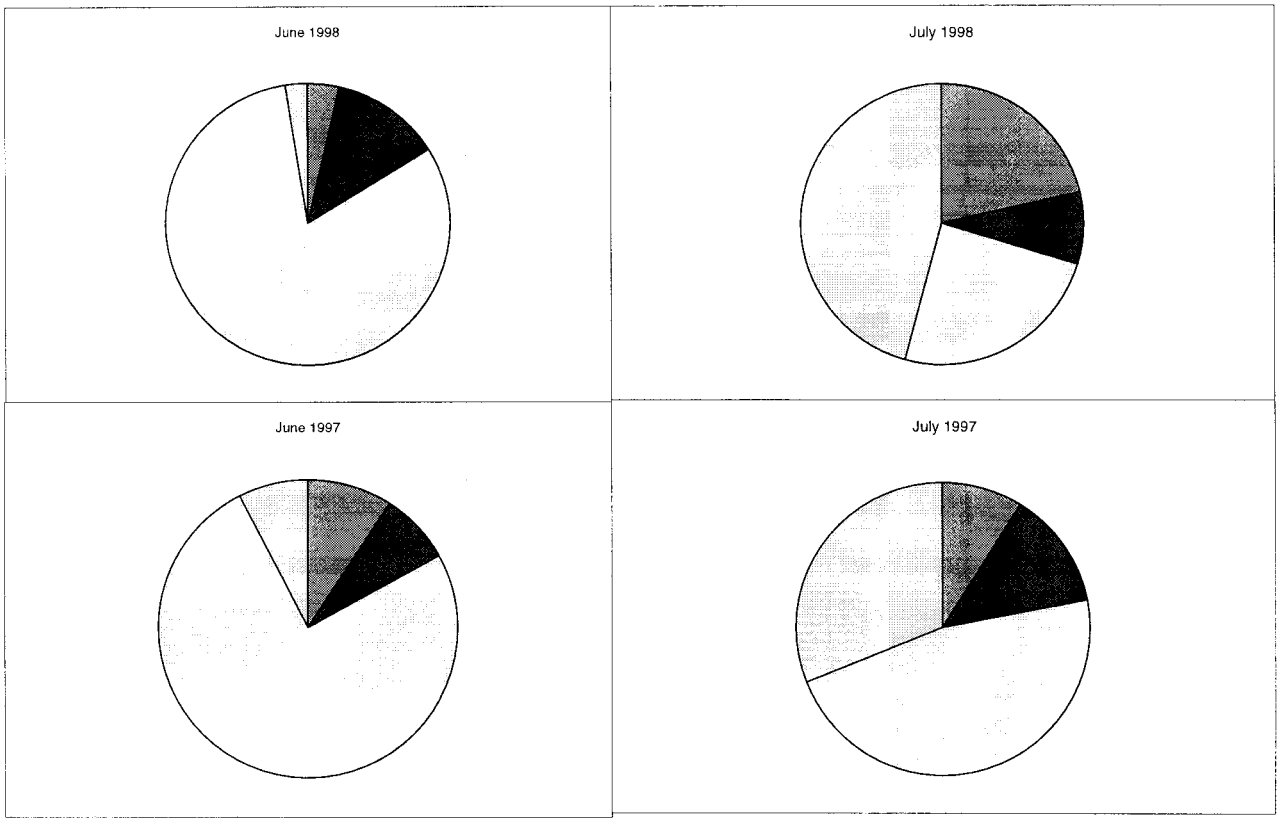
Appendix 6, b. Sample composition at Alvinella 2, June and July 1997, June and July 1998.



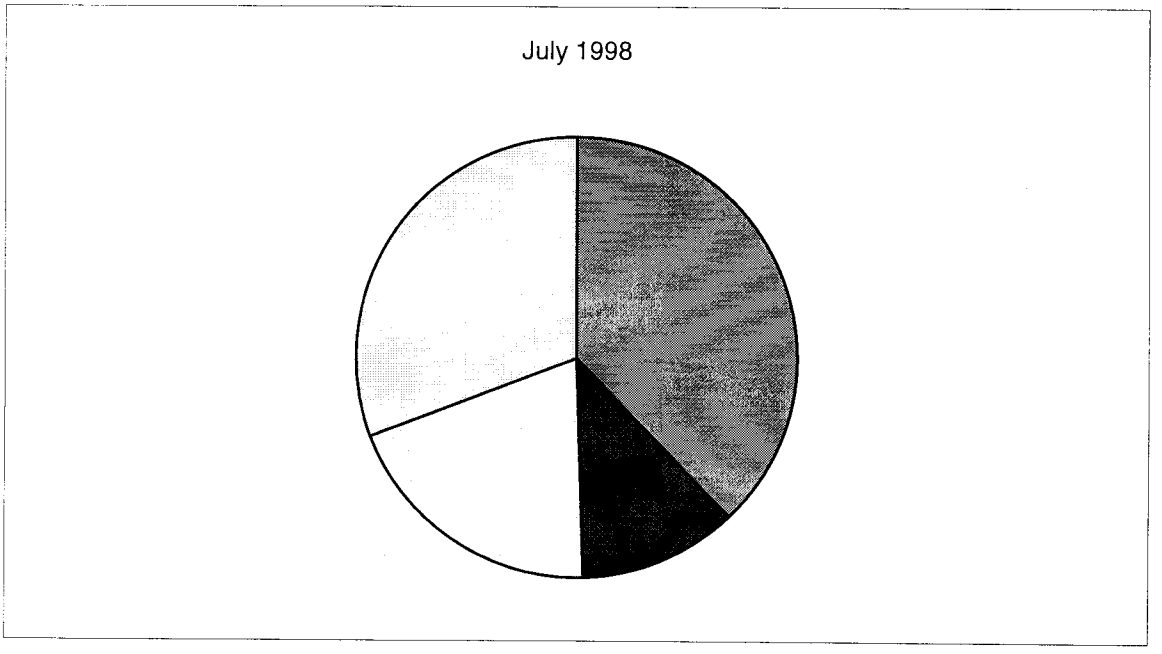
Appendix 6, c. Sample composition at Alvinella 3, June and July 1997, June and July 1998.



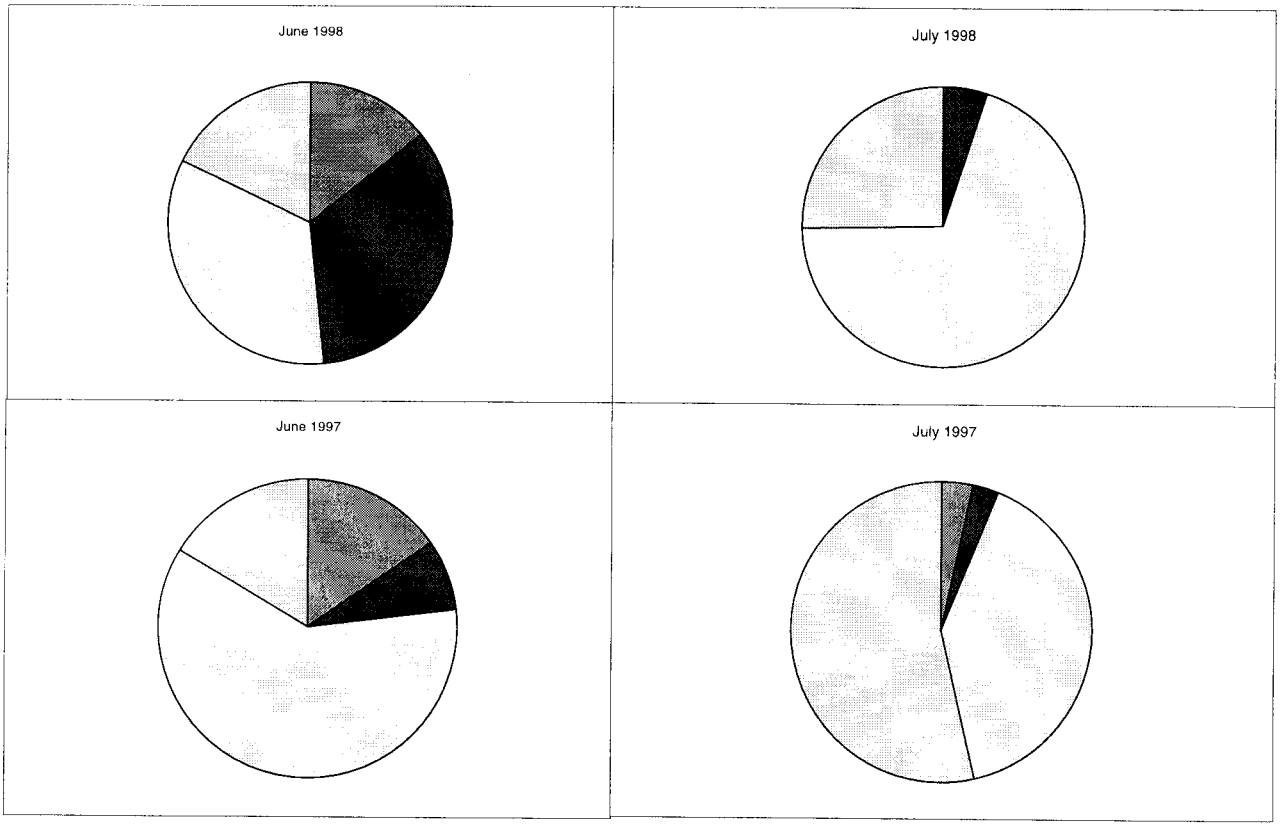
Appendix 6, d. Sample composition at Alvinella 4, June and July 1997, June and July 1998.



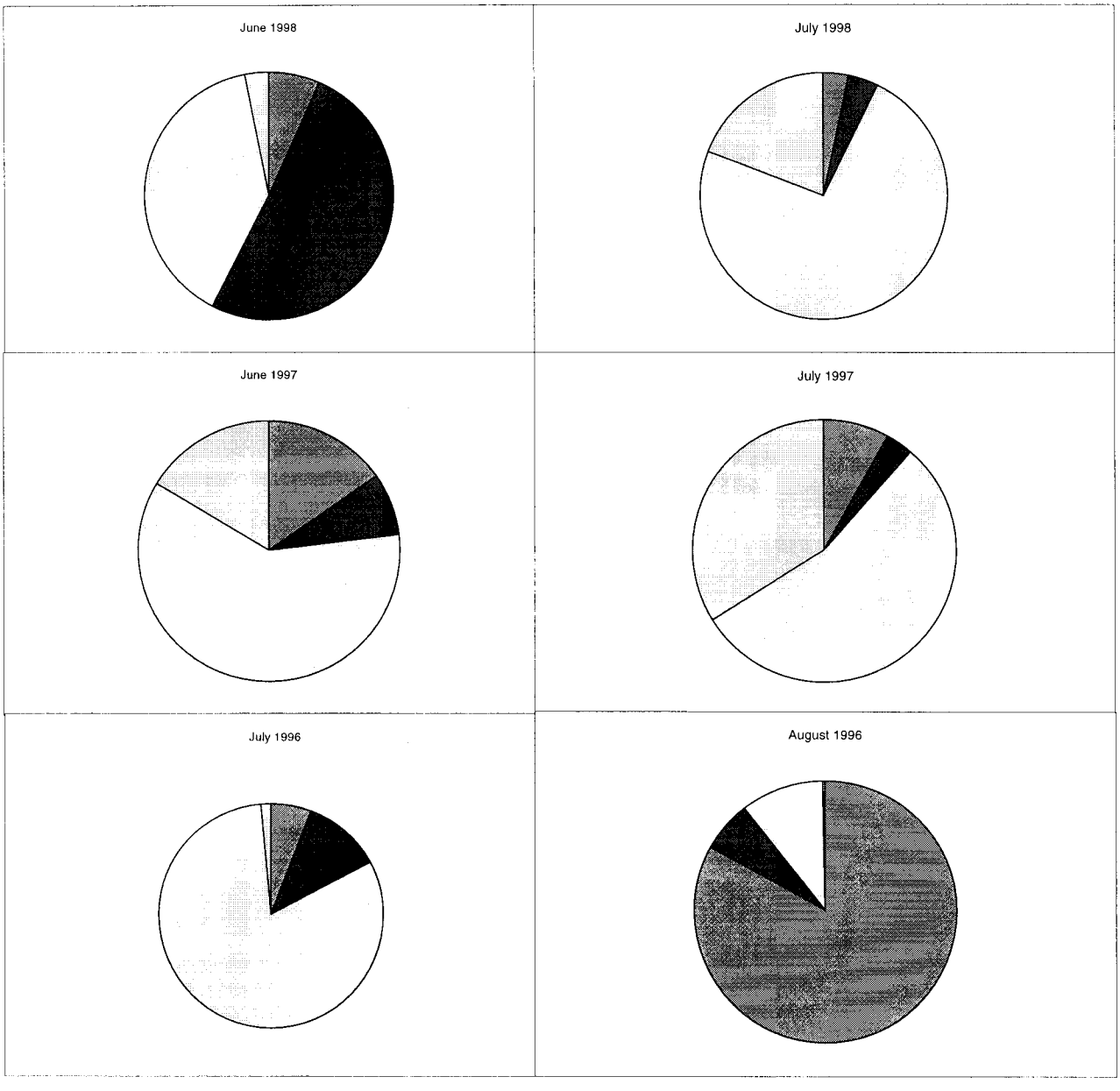
Appendix 6, e. Sample composition at Alvinella 5, July 1998.



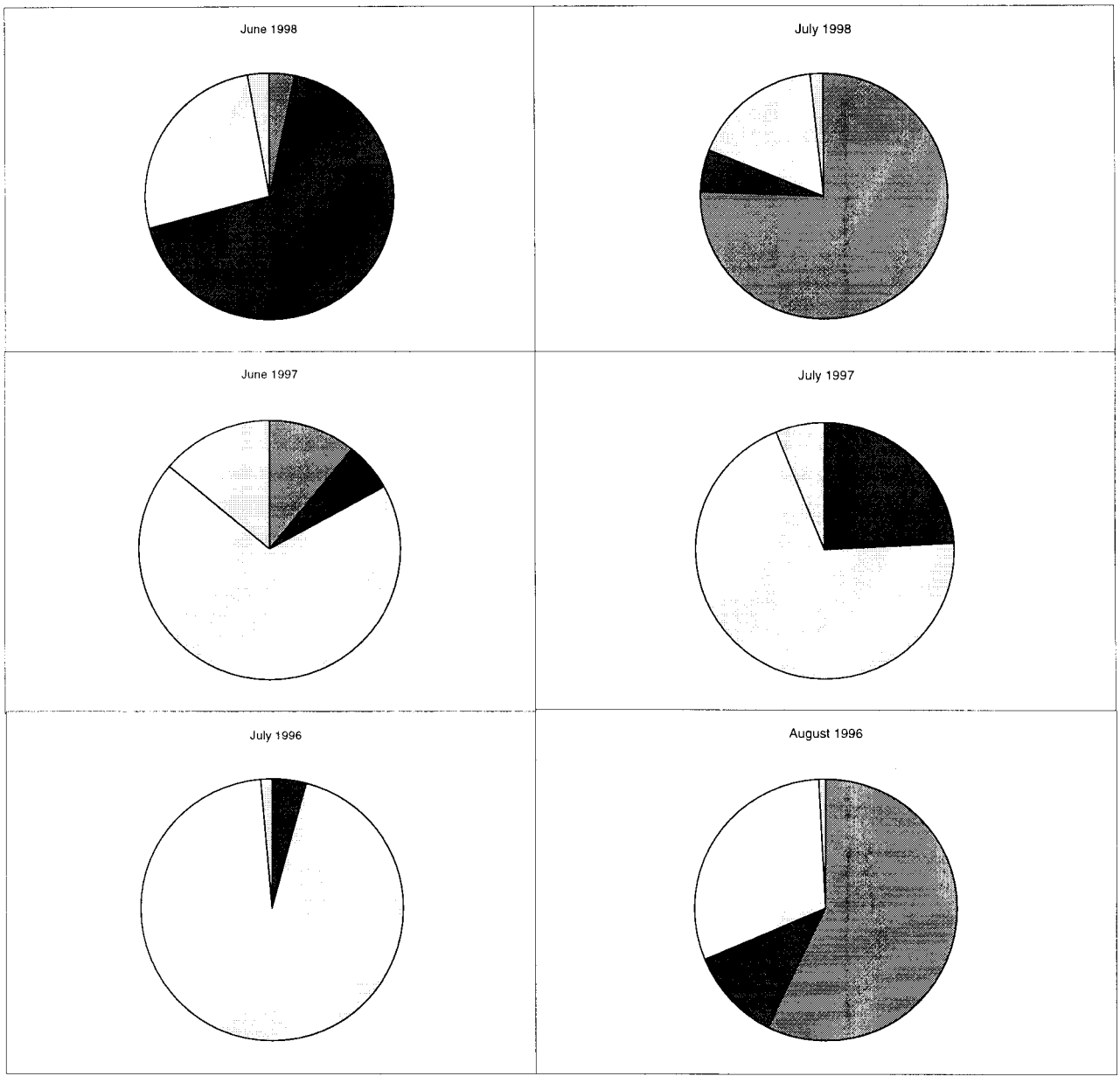
Appendix 6, f. Sample composition at Ikalukrok Creek, upstream of Dudd Creek, June and July 1997, June and July 1998.



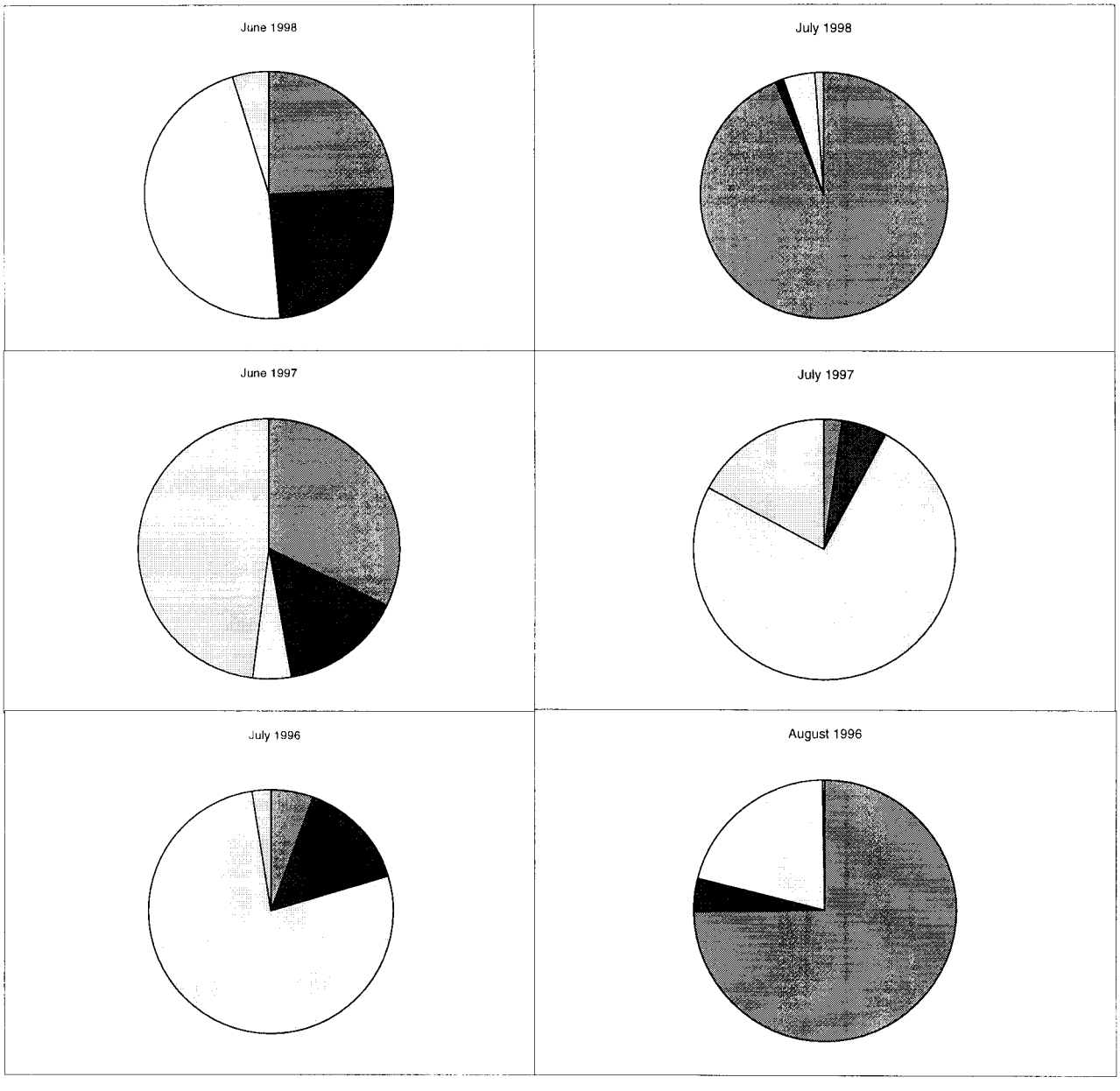
Appendix 6, g. Sample composition at Ikalukrok Creek, downstream of Dudd Creek (Station 7), June and July 1997, June and July 1998.



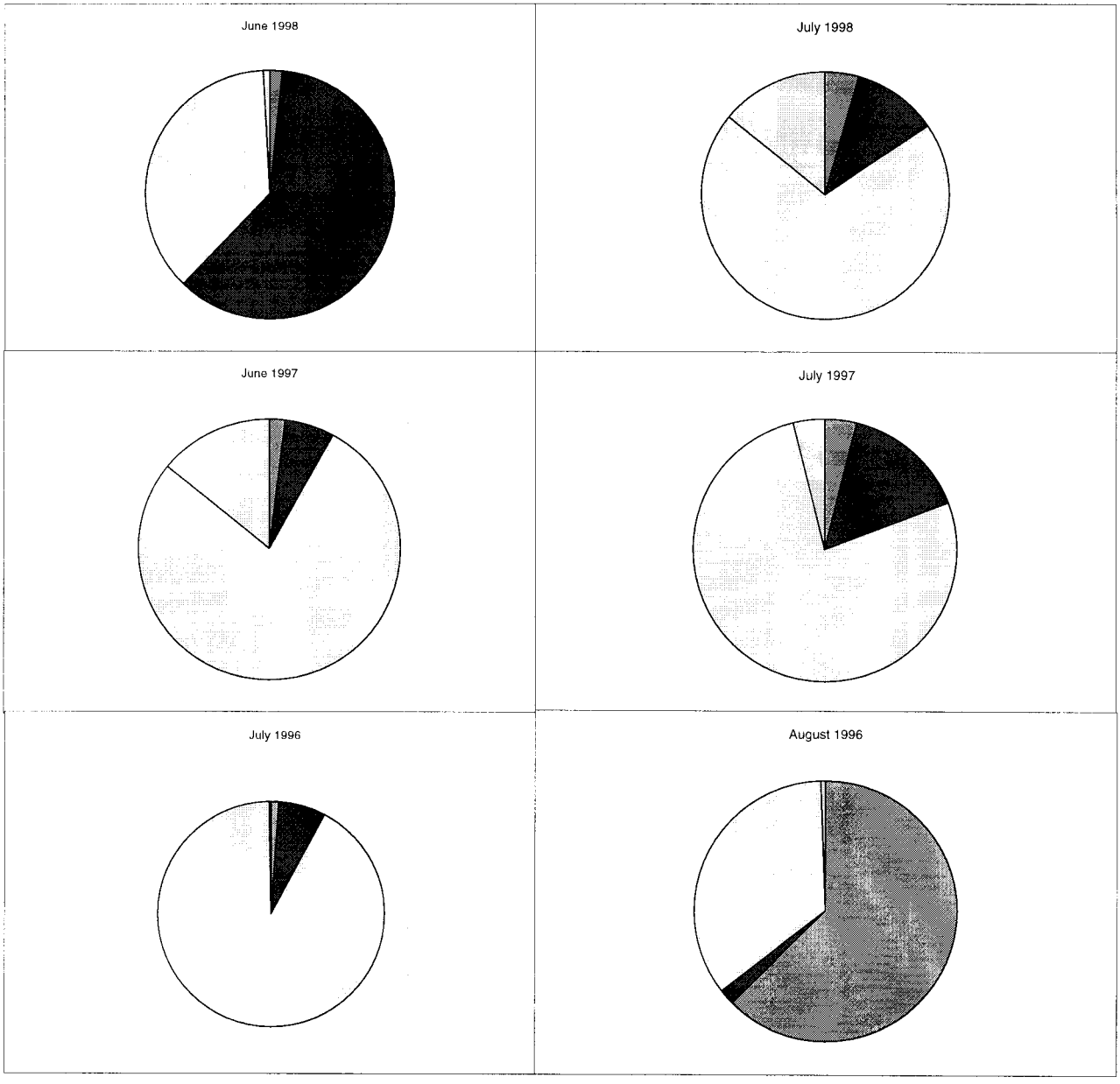
Appendix 6, h. Sample composition at Station 8, July and August 1996, June and July 1997, and June and July 1998.



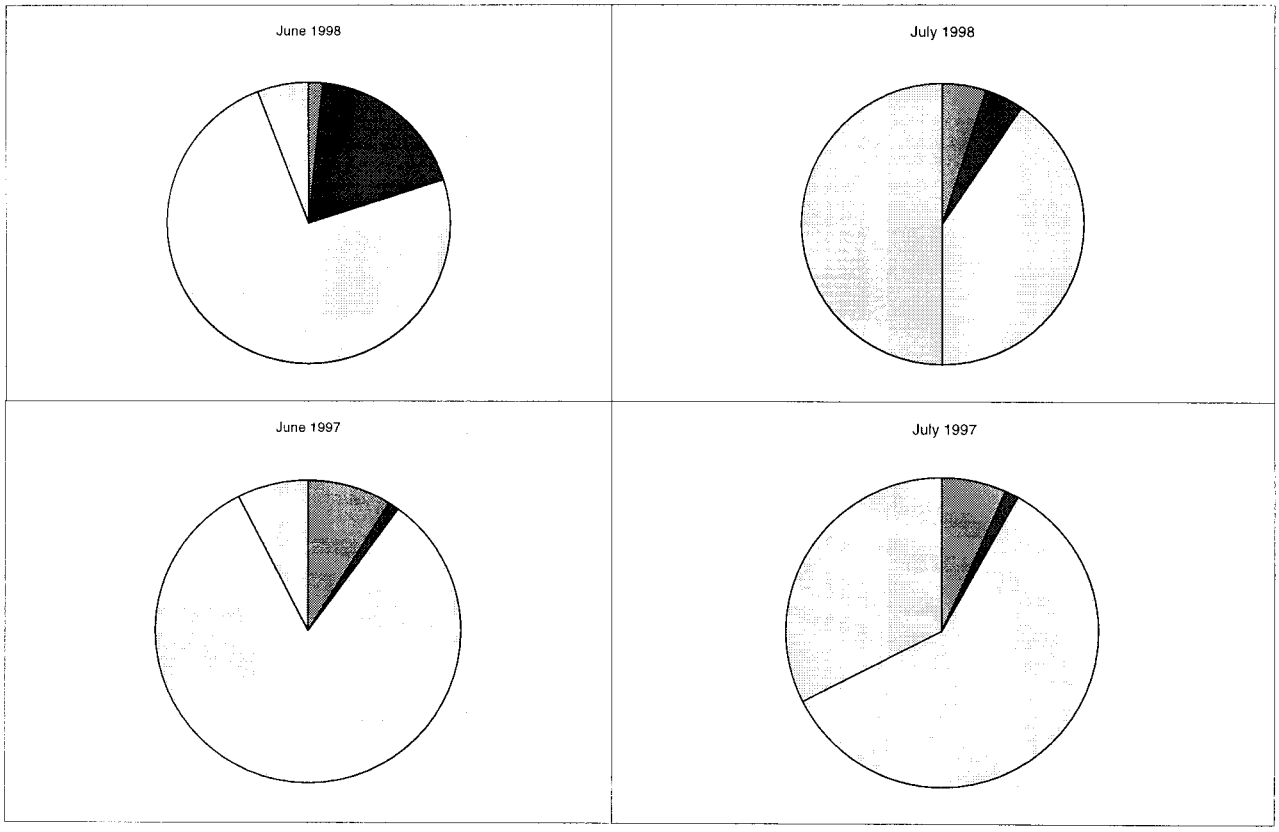
Appendix 6, i. Sample composition from Station 9, July and August 1996, June and July 1997, June and July 1998.



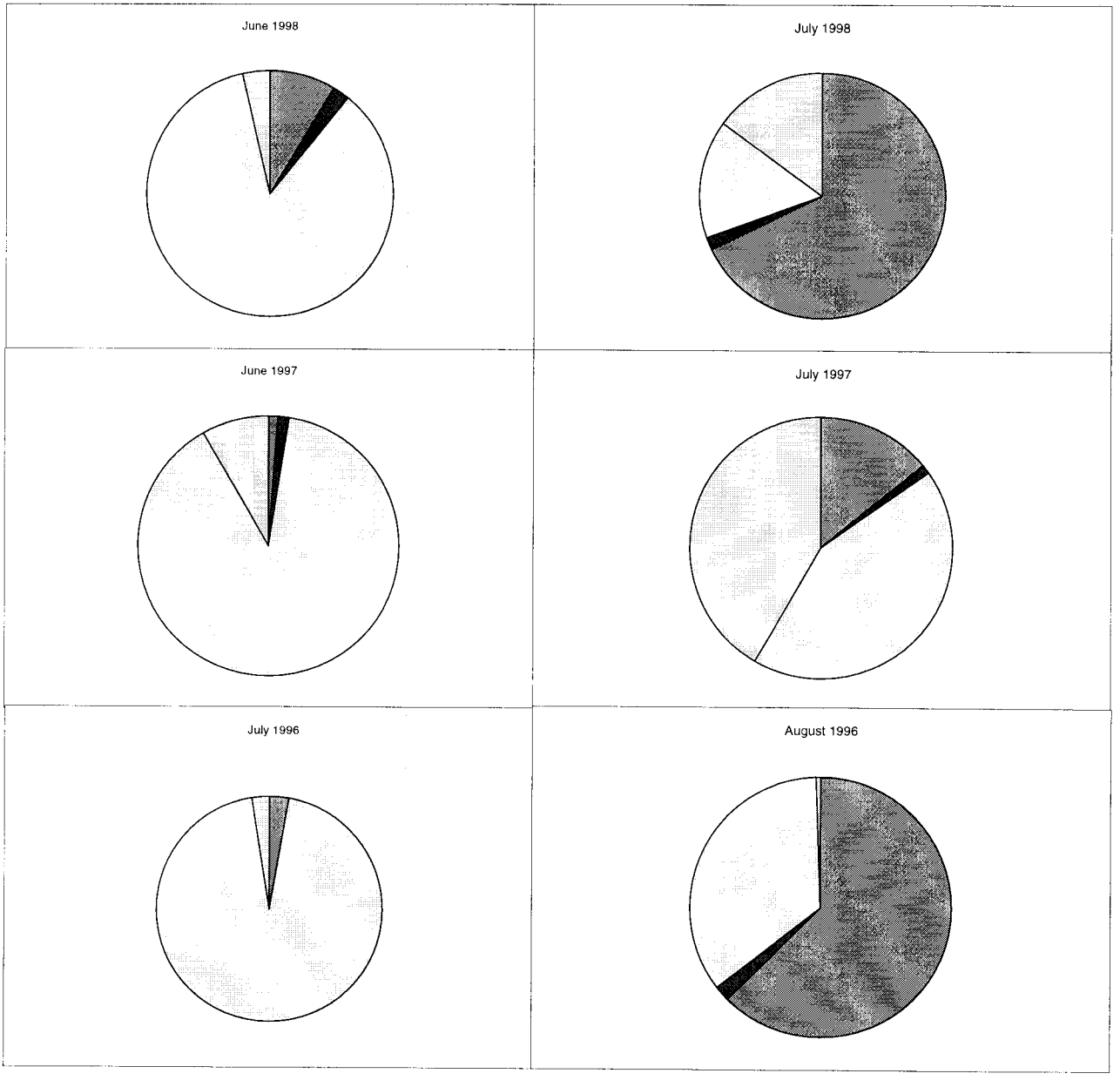
Appendix 6, j. Sample composition from Station 10, July and August 1996, June and July 1997, June and July 1998.



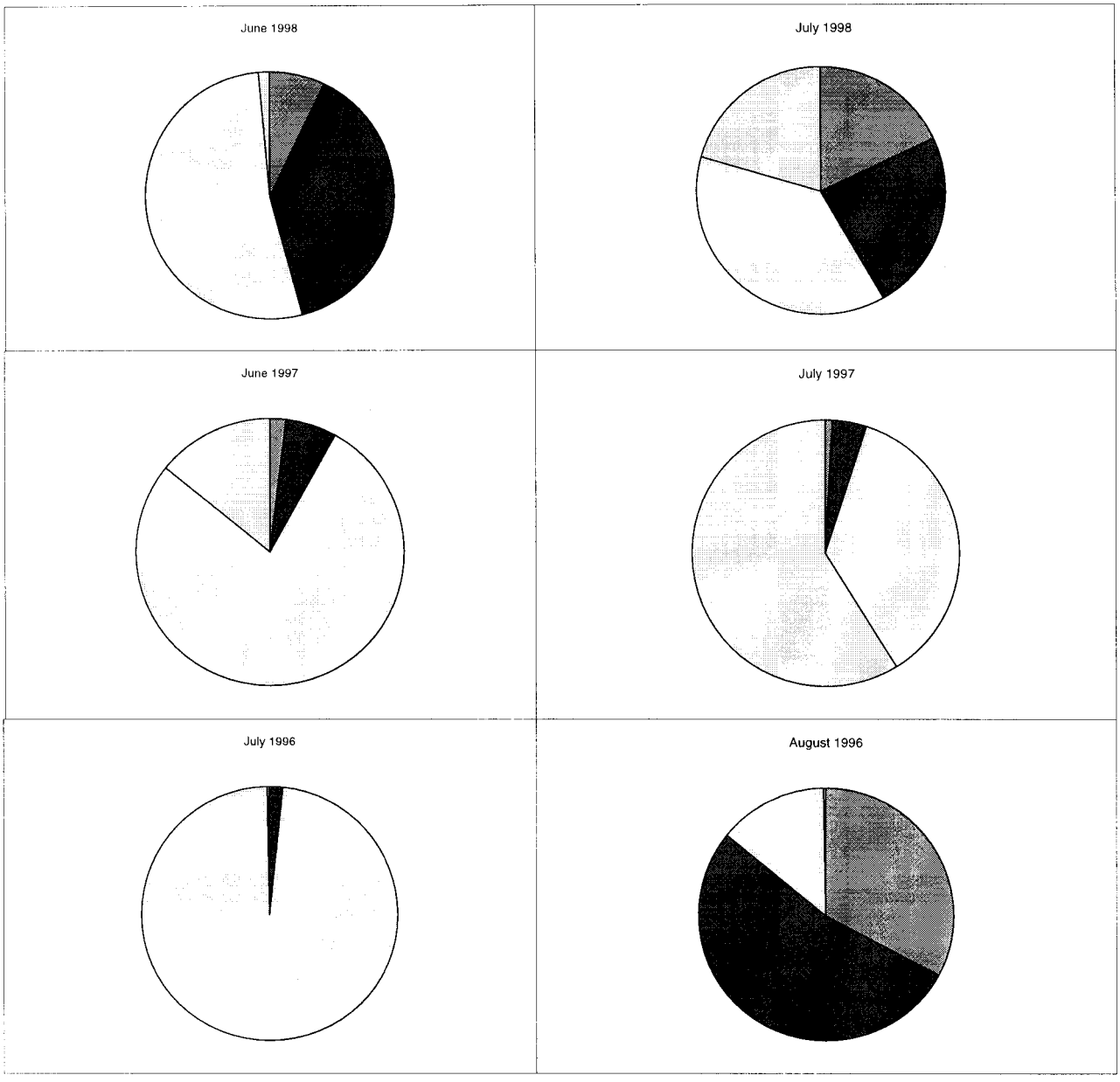
Appendix 6, k. Sample composition from the North Fork of Red Dog Creek, June and July 1997, June and July 1998.



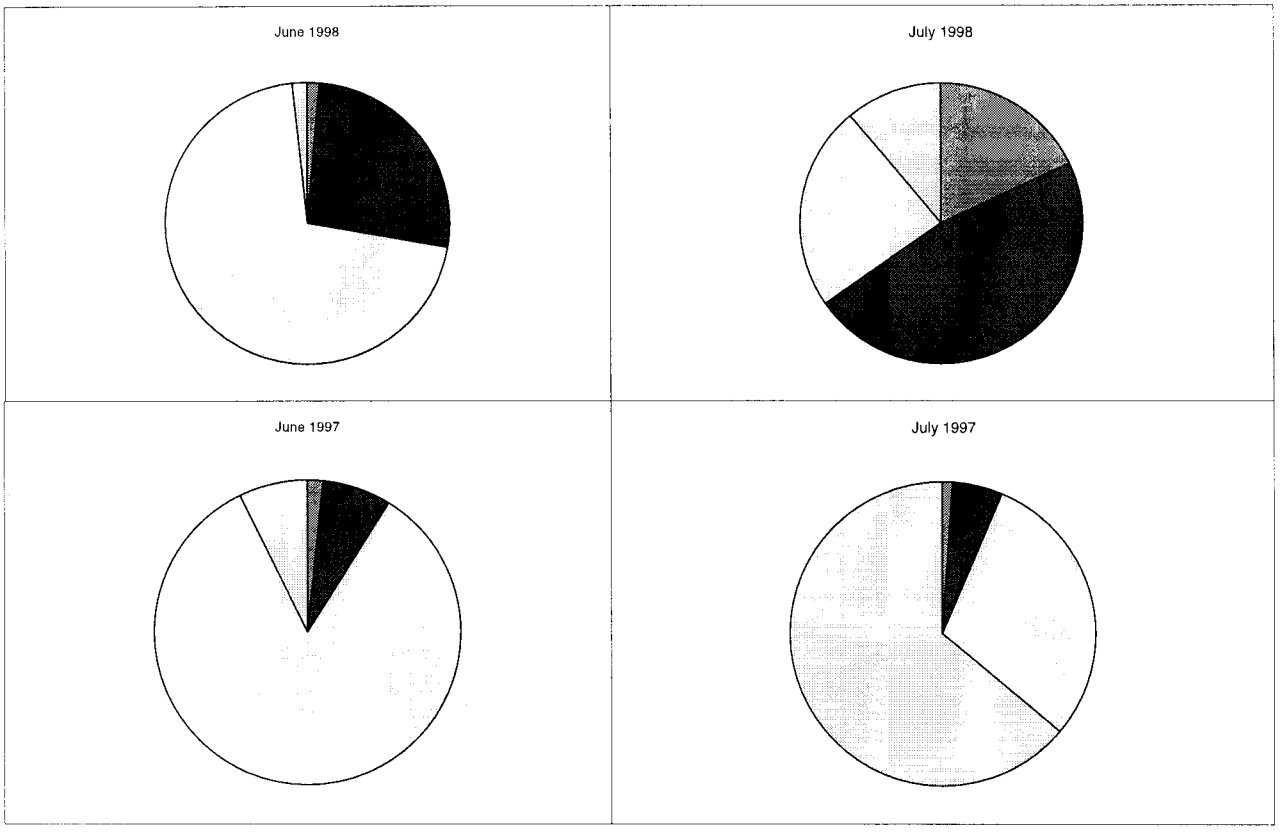
Appendix 6, l. Sample composition from Station 20, July and August 1996, June and July 1997, June and July 1998.



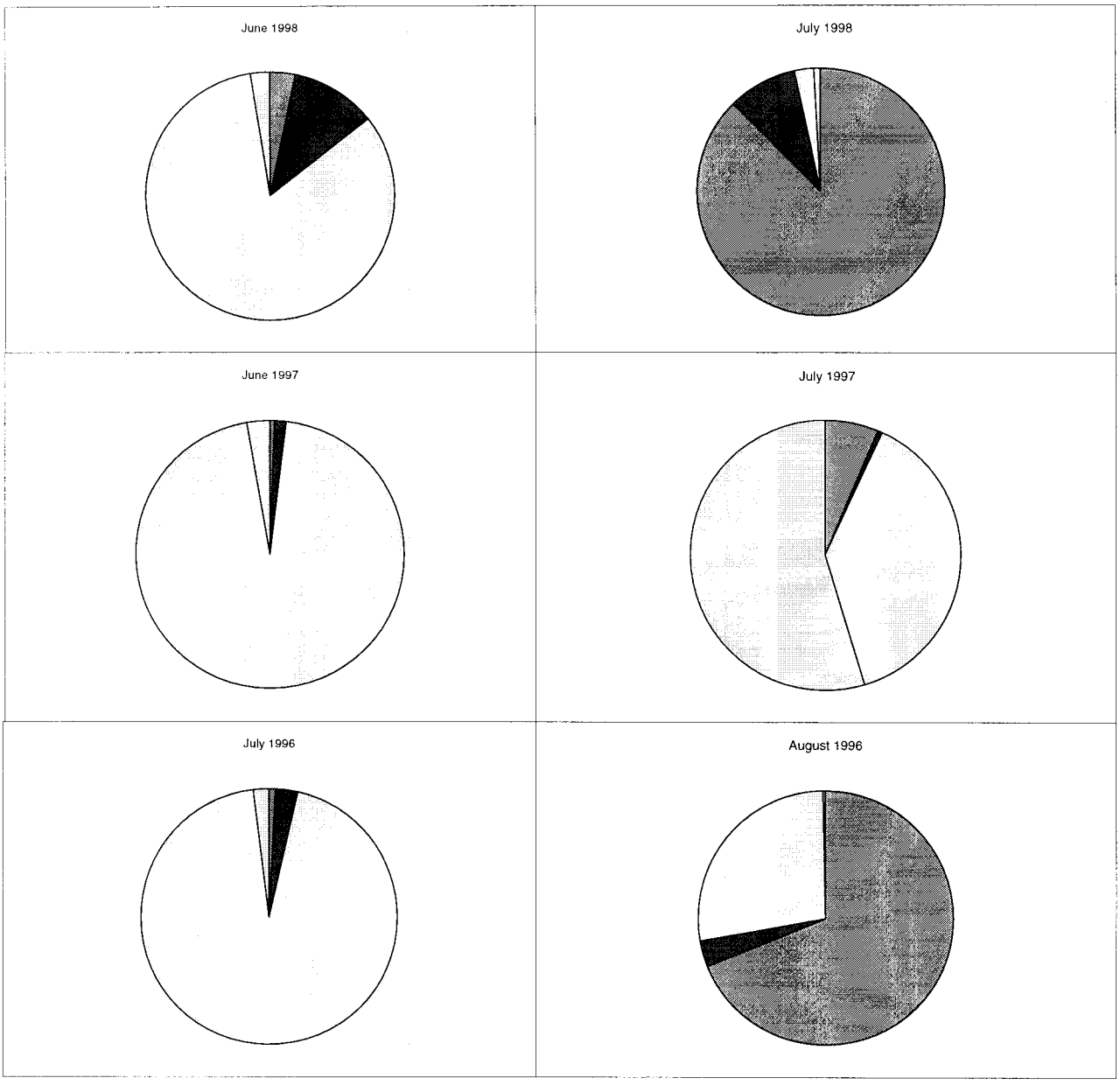
Appendix 6, m. Sample composition from Shelly Creek, July and August 1996, June and July 1997, June and July 1998.



Appendix 6, n. Sample composition from Red Dog Creek upstream of the ore body, June and July 1997, June and July 1998.



Appendix 6, o. Sample composition from Connie Creek, July and August 1996, June and July 1997, June and July 1998.



Appendix 7, a. Invertebrate data sheets from Alvinella 1, June 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Alvanilla 1***
Date: June 26, 1997

Proportion of sample		0.5		0.25		1		0.25		0.25	
Sample Number		**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera											
Baetidae											
Heptageniidae	Cinygmula	55		21		50		66		75	
Ephemerellidae											
Plecoptera				3		1		5		10	
Perlodidae											
Nemouridae						1		1		2	
Capniidae		8		5		10		15		23	
Trichoptera											
Diptera											
Chironomidae larvae		239	52	139	41	314	44	257	54	351	81
Chironomidae pupae		12		4		9		12		9	
Tipulidae			2			3		3		6	
Simuliidae		9		8		11		13		30	
Miscellaneous terrestrial			19		9		46		49		44
Coleoptera		1	1			2		2	1	2	1
Staphylinidae											
Hydrophilidae larvae											
Dytiscidae											
Curculionidae											
Miscellaneous											
Collembola	Poduridae Podura	2		1		6		5		3	
	Sminthuridae					1				1	
Homoptera							2		2		1
Hymenoptera			10		6		20		15		28
Acari		8		6		12		9		31	
Arachnid				1							
Lepidoptera					1		2				2
Nematoda											
Oligocheate							2				
fish larvae											

Appendix 7, b. Invertebrate data sheets from Alvinella 1, July 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Alvanilla 1***
Date: July 30, 1997

Proportion of sample	0.25		0.25		0.25		0.125		0.125	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	6		3		24		4		3	
Heptagenidae Cyngmula	10		10		31		11		5	
Ephemerellidae										
Plecoptera			1		6		1			
Perlodidae	3									
Nemouridae			3				1			
Capniidae	5	4	12		10		5		4	
Trichoptera					2		2			
Diptera										3
Chironomidae larvae	43	12	25	58	59	17	74	3	46	
Chironomidae pupae	11		18		19		9		10	
Tipulidae	2		1		5		1		1	
Simulidae	6		4		11		7		2	
Miscellaneous terrestrial		25		75		16		5		5
Coleoptera			3		2			1		
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura			1					1		
Sminthuridae			1							
Homoptera		12		13		15		5		5
Hymenoptera		29		92		33		13		14
Acari	10		13		17		12		2	
Arachnid				1		1				
Lepidoptera						1				2
Nematoda										
Oligocheate		1								
fish larvae										

Appendix 7, c. Invertebrate data sheets from Alvinella 2, June 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Alvanilla 2***
Date: June 26, 1997

Proportion of sample	0.25		0.5		0.125		0.5		1	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	16		24		32		22		22	
Heptageniidae Cinygmula	34		26		39		34		12	
Ephemerellidae										
Plecoptera	9		5		13		11		4	
Perlodidae	3				3		1		3	
Nemouridae	3		5		3		6			
Capniidae	26		32		21		46		15	
Trichoptera										
Diptera										
Chironomidae larvae	157		259	7	123	22	333	24	226	18
Chironomidae pupae	27	26	21		32		19		3	
Tipulidae	1		1							
Simuliidae	23		20		12		22		4	
Miscellaneous terrestrial		10		6		5		11		14
Coleoptera		2	1				1			1
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura					1		3		4	
Sminthuridae							1			
Homoptera								1		
Hymenoptera		2		5				5		
Acari	13		8		11		11		3	
Arachnid						1				
Nematoda										
Oligocheate		1				1				
fish larvae										

Appendix 7, d. Invertebrate data sheets from Alvinella 2, July 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Alvanilla 2***
Date: July 30, 1997

Proportion of sample	0.125		0.125		0.125		0.125		0.125	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera	7		2		13				2	1
Baetidae	63		45	8	8		24	2	35	
Heptagenidae Cyngmula	17		28	2			6		8	1
Ephemerellidae										
Plecoptera	16		9		3				15	1
Perlodidae										
Nemouridae	7				3		1		1	
Capniidae	3		1		11		4		7	1
Trichoptera					1					
Diptera					2					
Chironomidae larvae	21	6	6	5	6	10	13	2	14	15
Chironomidae pupae	6		3		7		3		3	
Tipulidae			1						3	
Simulidae	20		13		3		1		3	
Miscellaneous terrestrial		9		23		25				6
Coleoptera		1	1	1						
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous							1 collembola			2
Collembola Poduridae Podura						1				
Sminthuridae	1									
Homoptera		1		4		5				3
Hymenoptera		7		44		33		4		14
Acari		25	1		5		5			
Arachnid										
Nematoda										
Oligocheate								1		
fish larvae										

Appendix 7, e. Invertebrate data sheets from Alvinella 3, June 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Alvanilla 3***
Date: June 26, 1997

Proportion of sample	0.25		0.5		0.25		0.25		0.125	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	19		13		10		12		4	
Heptageniidae Cinygmula	37		36		12		21		30	
Ephemerellidae										
Plecoptera	5		1		3		5			
Perlodidae	7		3		2		5		2	
Nemouridae					2		1		6	
Capniidae	23		34		20		16		25	
Trichoptera										
Diptera										
Chironomidae larvae	90	111	186	173	116	299	100	65	176	35
Chironomidae pupae	50		138		99		97		179	
Tipulidae	2		1							
Simuliidae			2		18		6		4	
Miscellaneous terrestrial		31		19		53		24		52
Coleoptera		1	2	2				1	1	7
Staphylinidae					1	6				
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous		1								
Collembola Poduridae Podura	2		9		22		8		2	
Sminthuridae					2		1			
Homoptera								1		1
Hymenoptera		1		7		12		4		14
Acari	9		13		6		6		16	
Arachnid				1						
Nematoda										
Oligocheate		1		2		1				
fish larvae										

Appendix 7, f. Invertebrate data sheets from Alvinella 3, July 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Alvanilla 3***
Date: July 30, 1997

Proportion of sample	0.25		1		0.5		1		1	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera					1		1		1	
Baetidae	15		25		5	2	2		22	
Heptagenidae Cyngmula	7		12		7		2		18	
Ephemerellidae										
Plecoptera			8		11		12		4	
Perlodidae										
Nemouridae			2						1	
Capniidae	15		21		13		2		24	
Trichoptera					2				1	
Diptera							1			
Chironomidae larvae	18		40	47	18	72	9	80	30	29
Chironomidae pupae	12		17		23		19		20	
Tipulidae	1								2	
Simulidae	1		2						2	
Miscellaneous terrestrial		36		32		60		10		78
Coleoptera				1		1				2
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous					1					
Collembola Poduridae Podura					1		5		6	
Sminthuridae			1				1		1	
Homoptera				4		7		4		8
Hymenoptera				8		20		27		13
Acari			32		10		3		7	
Arachnid								1		1
Nematoda	1									
Oligocheate				2						2
fish larvae										
unknown						2				

Appendix 7, g. Invertebrate data sheets from Alvinella 4, June 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Alvanilla 4***
Date: June 26, 1997

Proportion of sample	0.5		0.5		0.5		0.5		0.5	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae							4		1	
Heptageniidae Cinygmula	10		35		18		22		43	
Ephemerellidae										
Plecoptera	6		4		6		4		14	
Perlodidae	1								11	
Nemouridae			2		1		5		5	
Capniidae	7		26		18		11		24	
Trichoptera										
Diptera										
Chironomidae larvae	83	23	90	18	85	31	169	31	167	84
Chironomidae pupae	14		29		13		40		31	
Tipulidae			1		1		3		9	
Simuliidae							1		16	
Miscellaneous terrestrial		67		21		16		15		34
Coleoptera		6		2			2			
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous			1 collembola						1	
Collembola Poduridae Podura	3				1		3		1	
Sminthuridae										
Homoptera						1				
Hymenoptera		6		2		5		6		3
Acari	2		5		1		10		6	
Arachnid				1				1		
Nematoda										
Oligocheate		1		1				2		
fish larvae									1	

Appendix 7, h. Invertebrate data sheets from Alvinella 4, July 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Alvanilla 4***
Date: July 30, 1997

Proportion of sample	0.5		1		0.25		1		0.5	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera			3				4		2	
Baetidae	10	1	11		10		7		10	
Heptagenidae Cyngmula	8		14		9		11		12	
Ephemerellidae										
Plecoptera	10		17		20		16		20	
Perlodidae					2		1			
Nemouridae		1	5						1	
Capniidae	26		39		25		26		26	
Trichoptera	1		1				2		3	
Diptera										
Chironomidae larvae	30	12	39	7	18	20	24	26	30	36
Chironomidae pupae	3		1		9		12		19	
Tipulidae	1				1		1		4	
Simulidae	2		4		4		1		2	
Miscellaneous terrestrial		20		15		33		24		118
Coleoptera						1		1		1
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	1				1				2	
Sminthuridae										
Homoptera		9		8		13		7		24
Hymenoptera		17		23		22		8		36
Acari	5		6		9		4		21	
Arachnid										1
Nematoda										
Oligocheate		1		2		1		4		
Lepidoptera										1
fish larvae										
unknown		1		5						2

Appendix 7, i. Invertebrate data sheets from Station 8, June 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Station 8***
Date: June 24, 1997

Proportion of sample	1		1		1		1		1	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera									data sheet for net 5 missing	
Baetidae			1		1					
Heptageniidae Cinygmula	15		31		8		24			
Ephemerellidae										
Plecoptera			6		3		12			
Perlodidae			1							
Nemouridae	2				2		1			
Capniidae	5		13		9		14			
Trichoptera										
Diptera										
Chironomidae larvae	11	36	26	163	19	26	41	85		
Chironomidae pupae			4		3		4			
Tipulidae	1							2		
Simuliidae	2		3		2		9			
Miscellaneous terrestrial		2		50		4		22		
Coleoptera								4		
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	5		9		1		5			
Sminthuridae							1			
Homoptera				7						
Hymenoptera		2		21		4		16		
Acari			2				1			
Arachnid										
Nematoda										
Oligocheate		1		1				2		
fish larvae							1			

Appendix 7, j. Invertebrate data sheets from Station 8, July 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Station 8***
Date: July 31, 1997

Proportion of sample	1		1		1		0.5		0.5	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera					no specimens found					
Baetidae										
Heptageniidae Cinygmula										
Ephemerellidae										
Plecoptera										
Perlodidae									1	
Nemouridae										
Capniidae							2		1	
Trichoptera										
Diptera										
Chironomidae larvae	1		6	1			2		1	
Chironomidae pupae	1		1							
Tipulidae							1			
Simuliidae										
Miscellaneous terrestrial		1								2
Coleoptera										
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura										
Sminthuridae										
Homoptera										
Hymenoptera				2						
Acari										
Arachnid										
Nematoda										
Oligocheate										
fish larvae										

Appendix 7, k. Invertebrate data sheets from Station 9, June 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Station 9***
Date: June 24, 1997

Proportion of sample	1		1		0.25		1		0.5	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae							4			
Heptageniidae Cinygmula	95		157		31		24		94	
Ephemerellidae										
Plecoptera	18		11							
Perlodidae			2				1		15	
Nemouridae	5		3		1					
Capniidae	29		43		27		14		17	
Trichoptera										
Diptera										
Chironomidae larvae	30		30	81	8		10		17	
Chironomidae pupae	2		4				1		1	
Tipulidae	1		1		2	2			17	
Simuliidae			15		16					
Miscellaneous terrestrial		17		46		50		46		78
Coleoptera	2		3	1						
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous					6 collembola		15 collembola		10 collembola	
Collembola Poduridae Podura	7		30							
Sminthuridae			1							
Homoptera				2						
Hymenoptera		11		3						
Acari	14		35							
Arachnid		1		1						
Nematoda										
Oligocheate										
fish larvae			1			1				

Appendix 7, l. Invertebrate data sheets from Station 9, July 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Station 9***
Date: July 31, 1997

Proportion of sample	0.125		0.5		0.125		0.125		0.125	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera					2					
Baetidae	2		2		1					
Heptagenidae Cyngmula	1		2		4		3			
Ephemerellidae										
Plecoptera	1				9				2	
Perlodidae	4									
Nemouridae									1	
Capniidae	10		14		2		6		2	
Trichoptera									1	
Diptera										
Chironomidae larvae	35	39	72	63	48	16	46	13	23	6
Chironomidae pupae	19		29		24		30		21	
Tipulidae	3		2		3		2		1	
Simulidae			1		1		1		1	
Miscellaneous terrestrial		1		11		8		3		2
Coleoptera					1					
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura										
Sminthuridae					1					
Homoptera						1				
Hymenoptera		7		13		6		4		3
Acari	6		13		11		17		8	
Arachnid						1				
Nematoda										
Oligocheate						1		1		
fish larvae										

Appendix 7, m. Invertebrate data sheets from Station 10, June 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Station 10***
Date: June 25, 1997

Proportion of sample	0.5		0.125		0.125		0.125		0.25	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae									2	
Heptageniidae Cinygmula	6		2		6		9		3	
Ephemerellidae										
Plecoptera			1		5		3		9	
Perlodidae					2				1	
Nemouridae	1				1		1			
Capniidae	26		12		23		18		18	
Trichoptera										
Diptera										
Chironomidae larvae	74	55	34	156	34	101	24	125	89	157
Chironomidae pupae	2		2		7		1		5	
Tipulidae	6		4		7		1	2	1	
Simuliidae	58		23		6		4		9	
Miscellaneous terrestrial		8		46		44		61		66
Coleoptera		1		1		2		3		2
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	8		14		30		13		19	
Sminthuridae			1							
Homoptera		5		2		1				4
Hymenoptera		2		3		2		2		30
Acari			3		1		2		1	
Arachnid						2				
Nematoda										
Oligocheate		1		1						
fish larvae	32		7		12		5		3	

Appendix 7, n. Invertebrate data sheets from Station 10, July 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Station 10***
Date: July 31, 1997

Proportion of sample	0.5		1		1		1		1	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera			no specimens		no specimens					
Baetidae										
Heptagenidae Cyngmula									1	
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae										
Capniidae	2									
Trichoptera										
Diptera										
Chironomidae larvae								1		3
Chironomidae pupae										
Tipulidae										
Simulidae										
Miscellaneous terrestrial		8								
Coleoptera										
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura										
Sminthuridae										
Homoptera										
Hymenoptera								1		
Acari										
Arachnid										
Nematoda										
Oligocheate										
fish larvae										

Appendix 7, o. Invertebrate data sheets from Station 20, June 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Station 20***
Date: June 24, 1997

Proportion of sample	1		1		1		1		1	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae										
Heptageniidae Cinygmula	2		1							
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae							2			
Capniidae									1	
Trichoptera										
Diptera										
Chironomidae larvae	7	19	3	21	8	46	13	59	5	12
Chironomidae pupae	3		1				2		2	
Tipulidae										
Simuliidae							1		1	
Miscellaneous terrestrial		7		3				6		3
Coleoptera		1								
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura										
Sminthuridae			2							
Homoptera										
Hymenoptera		2		2		7		3		4
Acari										
Arachnid										
Nematoda										
Oligocheate										
fish larvae										

Appendix 7, p. Invertebrate data sheets from Station 20, July 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Station 20***
Date: July 31, 1997

Proportion of sample	0.75		0.25		1		1		0.5	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	31		26		14		35		19	
Heptagenidae Cyngmula			3				5			
Ephemerellidae										
Plecoptera							1			
Perlodidae										
Nemouridae	1						1			
Capniidae	1		1				2		3	
Trichoptera			1		1					
Diptera										
Chironomidae larvae	11	13	2	7	3	13	2	7	6	18
Chironomidae pupae	101		15		17		48		79	
Tipulidae	2		4		1		5		2	
Simulidae							1			
Miscellaneous terrestrial		34		9		17		27		21
Coleoptera			1			2	9		8	1
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	1						2		1	
Sminthuridae	1						1			
Homoptera		45		22		24		45		41
Hymenoptera		80		24		19		24		37
Acari	9		3		7		6		3	
Arachnid		2		1		2		2		
Nematoda										
Oligocheate				1				1		
Lepidoptera										1
fish larvae										

Appendix 7, q. Invertebrate data sheets from Ikalukrok Creek upstream of Dudd Creek, June 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Ikalukrok Creek above Dudd Creek***
Date: June 27, 1997

Proportion of sample	0.5		1		0.5		0.25		0.5	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae									2	
Heptageniidae Cinygmula	43		27		37		50		15	
Ephemerellidae										
Plecoptera	29		15		6		8			
Perlodidae	6		2				8			
Nemouridae	6				10		8		4	
Capniidae	13		5		28		17		10	
Trichoptera										
Diptera										
Chironomidae larvae	173	90	118	235	179	7	185	57	127	
Chironomidae pupae	15		14		10		14		41	
Tipulidae			1		2	1	1		2	
Simuliidae	22		5		3		14			
Miscellaneous terrestrial		31		10		93		1		72
Coleoptera			2				4	1		2
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous					3				3 collembola	
Collembola Poduridae Podura	13		10		3		6			
Sminthuridae							1			
Homoptera										
Hymenoptera		2		2				6		
Acari	11		2		4		5			
Arachnid		1				1				
Nematoda										
Oligocheate		3		3				1		
fish larvae			1							

Appendix 7, r. Invertebrate data sheets from Ikalukrok Creek upstream of Dudd Creek, July 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Ikalukrok Creek above Dudd Creek***
Date: July 30, 1997

Proportion of sample	1		0.125		0.125		0.25		0.25	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera							1		10	
Baetidae	8		8		4		3		6	
Heptageniidae Cinygmula	2		5				3			
Ephemerellidae										
Plecoptera	3		2				2		2	
Perlodidae										
Nemouridae	2		2		3		1			
Capniidae	3		7		3		2		6	
Trichoptera										
Diptera							1			
Chironomidae larvae	30	17	15	33	26	15	42	26	31	20
Chironomidae pupae	35		15		25		21		22	
Tipulidae	1				1		1		1	
Simuliidae					1					
Miscellaneous terrestrial		28		36		19		11		6
Coleoptera		4		3	2	3	9	3	3	2
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous							1 collembola			
Collembola Poduridae Podura			3				1		1	
Sminthuridae									1	
Homoptera		33		37		11		10		13
Hymenoptera		95		160		53		49		32
Acari	9		1		9		12		3	
Arachnid		3		4		1		3		
Nematoda										
Oligocheate										
fish larvae										

Appendix 7, s. Invertebrate data sheets from Ikalukrok Creek downstream of Dudd Creek, June 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Ikalukrok Creek below Dudd Creek***
Date: June 27, 1997

Proportion of sample	1		0.5		0.5		0.25		0.5	
Sample Number	1	Terrestrial	2	Terrestrial	3	Terrestrial	4	Terrestrial	5	Terrestrial
Ephemeroptera										
Baetidae	4		9		7		11		6	
Heptageniidae Cinygmula	44		52		42		45		38	
Ephemerellidae										
Plecoptera	24		13		11		15		10	
Perlodidae	5		8		1		6		3	
Nemouridae	4		4				4		5	
Capniidae	34		20		27		10		20	
Trichoptera										
Diptera										
Chironomidae larvae	166	8	90	13	61	37	120	19	78	49
Chironomidae pupae	8		14		23		13		27	
Tipulidae							1			
Simuliidae	19		46		116		40		51	
Miscellaneous terrestrial		11		16		2		10		18
Coleoptera	3						3			4
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	6		8		23		8		74	
Sminthuridae			1						4	
Homoptera		2								
Hymenoptera		3		2		4		6		6
Acari	3		5		12		11		24	
Arachnid										1
Nematoda										
Oligocheate		1						1		
fish larvae										

Appendix 7, t. Invertebrate data sheets from Ikalukrok Creek downstream of Dudd Creek, July 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Ikalukrok Creek below Dudd Creek***
Date: July 30, 1997

Proportion of sample	0.25		0.25		0.125		0.125		0.125	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera					1				3	
Baetidae	1		7		7		5		2	
Heptageniidae Cinygmula	3		1		6		1			
Ephemerellidae										
Plecoptera	2		1		2		2			
Perlodidae									1	
Nemouridae					1				1	
Capniidae			2		2		1		4	
Trichoptera	1						1			
Diptera										
Chironomidae larvae	26		25	5	25		25	9	25	6
Chironomidae pupae	6		13		8		8		11	
Tipulidae	2								1	
Simuliidae	1				3					
Miscellaneous terrestrial		4		8		2		11		3
Coleoptera					3				1	
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura										
Sminthuridae										
Homoptera				2				4		4
Hymenoptera		12		13		11		9		4
Acari	10		20		20		6		10	
Arachnid				1						
Nematoda										
Oligocheate		1		1						
fish larvae										

Appendix 7, u. Invertebrate data sheets from the North Fork of Red Dog Creek, June 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***North Fork***
Date: June 25, 1997

Proportion of sample	0.25		0.25		0.25		0.125		0.25	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera									1	
Baetidae	32		50		23		36		15	
Heptageniidae Cinygmula	5		7		3		1		2	
Ephemerellidae										
Plecoptera							3			
Perlodidae									1	
Nemouridae	1									
Capniidae	8		7		3		3		1	
Trichoptera			2		4		8		2	
Diptera										
Chironomidae larvae	143		127	13	225	28	139	85	208	148
Chironomidae pupae	18		5		22		22		18	
Tipulidae			1		3		1			
Simuliidae	76		136		49		45		45	
Miscellaneous terrestrial		20		20		2		22		6
Coleoptera					2					
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous	9 collembola									
Collembola Poduridae Podura			7		9		8		28	
Sminthuridae					4		1			
Homoptera								1		2
Hymenoptera				1		7		1		2
Acari			8		6		10		2	
Arachnid										
Nematoda										
Oligocheate		10		2				2		
fish larvae	1		1				3			

Appendix 7, v. Invertebrate data sheets from the North Fork of Red Dog Creek, July 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***North Fork Station 12***
Date: July 31, 1997

Proportion of sample	0.25		0.5		1		0.5		0.25	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	4		4		3		8		2	
Heptageniidae Cinygmula	4				1		1			
Ephemerellidae										
Plecoptera							2			
Perlodidae										
Nemouridae										
Capniidae			3						2	
Trichoptera			1							
Diptera										
Chironomidae larvae	10		32	4	23	10	49	14	15	28
Chironomidae pupae	2		5		3		4		3	
Tipulidae	10		1						1	
Simuliidae	1		1				2			
Miscellaneous terrestrial		1				2		11		16
Coleoptera								1		
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous									1	
Collembola Poduridae Podura	5		1		1					
Sminthuridae										
Hypogastruridae					5				1	
Onchiuridae									2	
Homoptera		2		2		7		8		17
Hymenoptera				6		2		1		10
Acari	9		13		27		12		3	
Arachnid			1					1		
Nematoda										
Oligocheate		1								
fish larvae										

Appendix 7, w. Invertebrate data sheets from Red Dog Creek upstream of the ore body, June 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Upper Red Dog Creek***
Date: June 24, 1997

Proportion of sample	1		1		1		0.25		0.125	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	1									
Heptageniidae Cinygmula	5		11		3		7			
Ephemerellidae										
Plecoptera	2				7					
Perlodidae	1		1				2			
Nemouridae	4				4		4		1	
Capniidae	17		19		13		25		2	
Trichoptera										
Diptera										
Chironomidae larvae	96		84		106	73	164	55	41	3
Chironomidae pupae	14		9		50		28		2	
Tipulidae	2		3		4		5	1	3	
Simuliidae	39		12		32		49		3	
Miscellaneous terrestrial		8		66		19		15		11
Coleoptera	2	2	1	10		7	5			1
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	1		2		5		3			
Sminthuridae	1		1				2		1	
Homoptera		3		3		2		2		1
Hymenoptera		5		12		4		4		1
Acari	2		2		1		1		1	
Arachnid				1				1		
Nematoda										
Lepidoptera				1						
Oligocheate				2				4		
fish larvae										

Appendix 7, x. Invertebrate data sheets from Red Dog Creek upstream of the ore body, July 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Upper Red Dog Creek***
Date: July 1, 1997

Proportion of sample	0.25		0.25		0.25		0.25		0.25	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae			3		3		3		1	
Heptageniidae Cinygmula										
Ephemerellidae										
Plecoptera			5		5		5		7	
Perlodidae					1		1			
Nemouridae	2				1		2			
Capniidae	11		5		6		7		13	
Trichoptera			1						3	
Diptera										
Chironomidae larvae	41	13	37	1	29	4	35	1	26	1
Chironomidae pupae	5		3		2		4			
Tipulidae	2		1		1		2		8	
Simuliidae	13		1		4		4		6	
Miscellaneous terrestrial		6		7		6		13		7
Coleoptera		1		1		2	2			
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura									6	
Sminthuridae					1					
Homoptera		44		30		23		37		30
Hymenoptera		59		64		49		52		64
Acari			34		30		35		7	
Arachnid						1				
Nematoda										
Oligocheate		1		1				1		
Lepidoptera		1								
fish larvae										

Appendix 7, y. Invertebrate data sheets from Shelly Creek, June 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Shelly Creek***
Date: June 24, 1997

Proportion of sample	0.125		0.125		0.25		1		0.5	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae										
Heptageniidae Cinygmula	8		5		9		9		23	
Ephemerellidae										
Plecoptera			2						2	
Perlodidae					12					
Nemouridae							1		3	
Capniidae	5		1				7		13	
Trichoptera										
Diptera										
Chironomidae larvae	149	20	172	31	213		350	54	450	102
Chironomidae pupae	3				6		12		7	
Tipulidae			3		2		5			
Simuliidae	8		5		9		13		7	
Miscellaneous terrestrial				27		62		24		35
Coleoptera				3					1	2
Staphylinidae						3				
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous					2 collembola					
Collembola Poduridae Podura			4				3		12	
Sminthuridae									1	
Homoptera				1				1		5
Hymenoptera				15		15		8		36
Acari									2	
Arachnid										
Nematoda										
Neuroptera				1						
Lepidoptera		3		3		2	123			
Oligocheate										
fish larvae										

Appendix 7, z. Invertebrate data sheets from Shelly Creek, July 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Shelly Creek***
Date: July 29, 1997

Proportion of sample	0.25		0.125		0.025		0.125		0.125	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera			27		1				4	
Baetidae	149		70		100		131		222	
Heptageniidae Cinygmula	5		1		3				3	
Ephemerellidae										
Plecoptera							1			
Leuctradae Perlomyia					1					
Perlodidae									3	
Nemouridae							1			
Capniidae	6		12		14		12		19	
Trichoptera										
Diptera										
Chironomidae larvae	62	5	79	19	93	10	71	7	115	22
Chironomidae pupae	4		6		2		7		3	
Tipulidae	4		8		3		3		3	
Simuliidae	4		3		3		1		3	
Miscellaneous terrestrial		6		13		11		12		28
Coleoptera		3		1	1	3		2		3
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous									1 collembola	
Collembola Poduridae Podura							1		4	
Sminthuridae					2		1			
Hypogasturidae			3							
Homoptera		20		27		23		32		48
Hymenoptera		29		44		40		45		83
Acari	6		5		1		1		5	
Lepidoptera		3		4	2				2	
Arachnid										
Nematoda										
Oligocheate										
Neuroptera Sialidae						1				
fish larvae										

Appendix 7, aa. Invertebrate data sheets from Connie Creek, June 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Connie Creek***
Date: June 24, 1997

Proportion of sample	0.125		0.125		1		0.125		1	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae									9	
Heptageniidae Cinygmula	1		1		4		1		8	
Ephemerellidae										
Plecoptera			3		5				5	
Perlodidae					1		11			
Nemouridae			1		1					
Capniidae	3				11				8	
Trichoptera										
Diptera										
Chironomidae larvae	333	10	145	14	268	33	459		50	30
Chironomidae pupae			2				2		6	
Tipulidae	2		3		2	1	1		2	
Simuliidae	19		4		6		5		7	
Miscellaneous terrestrial				6		17		81		20
Coleoptera				2	1	1				2
Staphylinidae								1		
Hydrophilidae larvae										
Dytiscidae										
Curculionidae								1		
Miscellaneous							5 collembola			
Collembola Poduridae Podura					1				11	
Sminthuridae									2	
Homoptera				1		11				1
Hymenoptera				2		2				17
Acari									5	
Arachnid				1						
Nematoda		12								
Lepidoptera				1				1		
Oligocheate						2				
fish larvae									1	

Appendix 7, ab. Invertebrate data sheets from Connie Creek, July 1997.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1997
Site: ***Connie Creek***
Date: July 29, 1997

Proportion of sample	0.5		0.5		0.5		0.125		0.5	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera			40		10				10	
Baetidae	15		7		37		5		8	
Heptageniidae Cinygmula	3				7		2		5	
Ephemerellidae										
Plecoptera					10		2		15	
Leuctradae									2	
Perlodidae	3									
Nemouridae					1				1	
Capniidae	13				7		8		11	
Trichoptera			4				1			
Rhya cophirdae									3	
Diptera										
Chironomidae larvae	67	7	103		67	1	41		56	12
Chironomidae pupae	8		7		14		10		16	
Tipulidae			5		3		5		8	
Simuliidae	5		20		7		3		11	
Miscellaneous terrestrial		13		6		15		16		19
Coleoptera				2	2	1				
Staphylinidae									3	4
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous					1				1 collembola	
Collembola Poduridae Podura	3		2				1		1	
Sminthuridae										
Homoptera		23		23		37		18		73
Hymenoptera		36		24		35		52		46
Acari	17		8		12				4	
Arachnid						1				
Lepidoptera				1		1				3
Nematoda										
Oligocheate										
fish larvae										

Appendix 8, a. Invertebrate data sheets from Alvinella 1, June 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Alvanilla 1***
Date: June-98

Proportion of sample	1		0.5		0.25		0.25		0.13	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	2		5		4		2		3	
Heptageniidae Cinygmula	12		14		1		12		13	
Ephemerellidae										
Plecoptera										
Perlodidae									5	1
Nemouridae	17		11	1	4		17	1		
Capniidae	3		44		42		13		54	
Trichoptera										
Diptera										
Chironomidae larvae	163	1	93		115	20	114	18	126	39
Chironomidae pupae	2		44		7		8		7	
Tipulidae									1	
Simuliidae	5		3				5		1	
Miscellaneous terrestrial				12		6		2		
Coleoptera										
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	7		7		7		14		10	
Sminthuridae										
Homoptera		1				4				
Hymenoptera		1		1						
Acari	9		1		3		6		8	
Arachnid										
Nematoda										
Oligocheate										
fish larvae										

Appendix 8, b. Invertebrate data sheets from Alvinella 1, July 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Alvanilla 1***
Date: July-98

Proportion of sample	0.125		0.25		0.125		0.125		0.125	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	73		59	5	75	3	37		89	
Heptageniidae Cinygmula	8		4		8	1	5		3	
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae				5	3	10		11		
Capniidae	38		32		30		25		50	
Trichoptera										
Diptera										
Chironomidae larvae	32		17		16	7	9		29	
Chironomidae pupae	5		8		8		15		6	
Tipulidae	5				2				3	
Simuliidae	1		3		5		5		2	
Miscellaneous terrestrial		23		27		28		103		10
Coleoptera										
Staphylinidae			3	1		2		9		12
Hydrophilidae larvae										
Dytiscidae										
Curculionidae								1		
Miscellaneous										
Collembola Poduridae Podura	3		3		12		2			
Sminthuridae										
Homoptera		68		78		170		236		120
Hymenoptera		14		61		58		123		38
Acari	7		7		15				8	
Coccinellidae								1		
Arachnid					2					
Thysanoptera		1			7					
Nematoda										
Oligocheate										
fish larvae										

Appendix 8, c. Invertebrate data sheets from Alvinella 2, June 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Alvanilla 2***
Date: June-98

Proportion of sample	0.125		0.125		0.125		0.125		0.13	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	7		2		2					
Heptageniidae Cinygmula			16		30		6		6	
Ephemerellidae										
Plecoptera			1							
Perlodidae			24							
Nemouridae	19		10		31	1	6		29	
Capniidae	9				47		3		4	
Trichoptera										
Diptera										
Chironomidae larvae	134	12	195	9	173	13	109	10	225	13
Chironomidae pupae	4		4		10		8		11	
Tipulidae					19					
Simuliidae	23		15				6		16	
Miscellaneous terrestrial		2						4		1
Coleoptera										
Staphylinidae				1						
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura					4					
Sminthuridae					1					
Isotomidae	9						10		3	
Hypogastruidae									2	
Homoptera		1				1		1		3
Hymenoptera										
Acari	3		4		3		1		7	
Arachnid										
Thysanoptera										1
Nematoda										
Oligocheate						4				
fish larvae										

Appendix 8, d. Invertebrate data sheets from Alvinella 2, July 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: *Alvanilla 2*
Date: July-98

Proportion of sample	0.25		0.125		0.125		0.125		0.125	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	315		90		30		98		130	
Heptageniidae Cinygmula			4		1		4		1	
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae	34	1	7		11		23	1	42	
Capniidae	15		22		4		6	1	22	1
Trichoptera										
Diptera							1			
Chironomidae larvae	24	12	11	4	1	6	10	2	19	23
Chironomidae pupae	13		22		1		2		3	
Tipulidae	1								1	
Simuliidae	22		2		6		19		18	
Miscellaneous terrestrial		6				1		2		14
Coleoptera	1								1	
Staphylinidae										1
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	1								2	
Sminthuridae	1								2	
Isotomidae					1				1	
Homoptera		6				3		3		5
Hymenoptera										
Acari	6		6		1		1		2	
Arachnid										
Nematoda										
Psocoptera										1
Oligocheate										
fish larvae										

Appendix 8, e. Invertebrate data sheets from Alvinella 3, June 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Alvanilla 3***
Date: June-98

Proportion of sample		0.125		0.125		0.125		0.25		0.3	
Sample Number		**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera											
Baetidae								3			
Heptageniidae	Cinygmula	15		18		22		20		11	
Ephemerellidae											
Plecoptera											
Perlodidae											
Nemouridae		1		45		112		67		29	
Capniidae		87		6		9		2		4	
Trichoptera											
Diptera											
Chironomidae larvae		331		226	6	271		228	8	127	4
Chironomidae pupae		37		11		8		6		6	
Tipulidae		5		2		1		6		3	
Simuliidae		26		22		16				13	
Miscellaneous terrestrial					4		2		1		
Coleoptera											
Staphylinidae							1				
Hydrophilidae larvae											
Dytiscidae											
Curculionidae											
Miscellaneous											
Collembola	Poduridae	Podura	1		1						
	Sminthuridae										
	Isotomidae					2			1		
Homoptera											
Hymenoptera											
Acari				2		2				3	
Arachnid											
Nematoda											
Oligocheate											
fish larvae											

Appendix 8, f. Invertebrate data sheets from Alvinella 3, July 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Alvanilla 3***
Date: July-98

Proportion of sample	1		0.5		0.5		0.5		0.5	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera									1	
Baetidae	81		83	9	91	1	77	4	216	1
Heptageniidae Cinygmula	5		6		8		8	3	21	1
Ephemerellidae										
Plecoptera	2	1								
Perlodidae			1							
Nemouridae	44		1		19		21		60	1
Capniidae	9		25		18	1	12	1	26	
Trichoptera										
Diptera										
Chironomidae larvae	71	42	40	4	42	27	36	18	74	14
Chironomidae pupae	30		6		13		15		22	
Tipulidae										
Simuliidae	16		6		1		2		15	
Miscellaneous terrestrial		57		2		6		7		8
Coleoptera		2							1	1
Staphylinidae		2		5						3
Hydrophilidae larvae										
Dytiscidae										
Curculionidae						1				
Miscellaneous										
Collembola Poduridae Podura	2									
Sminthuridae	3									
Isotomidae	3									
Homoptera		##		11		28		31		38
Hymenoptera		89		7		20		11		24
Acari	60		9		8		11		18	
Arachnid										
Nematoda										
Thysanoptera		5				3		1		2
Psocoptera		2				1		1		1
Oligocheate										
fish larvae										

Appendix 8, g. Invertebrate data sheets from Alvinella 4, June 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Alvanilla 4***
Date: June-98

Proportion of sample	0.125		0.13		0.13		0.13		0.3	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	1						1		2	
Heptageniidae Cinygmula	10		13		11		4		17	
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae	20		3		2		6		15	
Capniidae	24		52		11		44		19	
Trichoptera										
Diptera										
Chironomidae larvae	231	18	293		86	20	315	4	250	3
Chironomidae pupae	20		13		2				9	
Tipulidae	1		1		1		2		1	
Simuliidae	3		4		3		7		7	
Miscellaneous terrestrial		2						2		
Coleoptera										
Staphylinidae										1
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	2		1		7		3		1	
Sminthuridae										
Homoptera				4				5		
Hymenoptera										
Acari	3		1				4		7	
Arachnid										
Thysanoptera						1				
Nematoda										
Oligocheate										
fish larvae										

Appendix 8, h. Invertebrate data sheets from Alvinella 4, July 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Alvanilla 4***
Date: July-98

Proportion of sample	0.25		0.25		0.25		0.25		0.25	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	3		29	2	47		63	6	56	
Heptageniidae Cinygmula		1	8	1			4		10	
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae	5	6	8			5	8		2	1
Capniidae			10				21		25	
Trichoptera										
Diptera										
Chironomidae larvae	4		9	5	25	38	48		11	4
Chironomidae pupae	4		4		6		7		6	
Tipulidae			1		3		2		1	
Simuliidae			1				3			
Miscellaneous terrestrial		23		4		45				11
Coleoptera										
Staphylinidae						7				
Hydrophilidae larvae								1		
Dytiscidae										
Cocinellidae						1				
Curculionidae						3				
Miscellaneous										
Collembola Poduridae Podura	1		3				3			
Sminthuridae										
Homoptera		36		78		119		65	56	
Hymenoptera		6		13		35		31	13	
Acari	1		4				2		6	
Arachnid										
Nematoda										
Lepidoptera								1		
Thysanoptera	2							6	1	
Oligocheate										
fish larvae										

Appendix 8, i. Invertebrate data sheets from Alvinella 5, July 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Alvanilla 5***
Date: July-98

Proportion of sample		0.125		0.125		0.125		0.125		0.125	
Sample Number		**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera											
Baetidae		78	3	128		113		13		78	
Heptageniidae	Cinygmula	4		12		20	2	137		6	
Ephemerellidae											
Plecoptera											
Perlodidae											
Nemouridae						1		5			
Capniidae		24		44		52		30	1	25	
Trichoptera											
Diptera											
Chironomidae larvae		25		37	12	47		33		22	12
Chironomidae pupae		25		8		6		29		4	
Tipulidae		4		2		1		4		8	
Simuliidae		2		3		1		8		3	
Miscellaneous terrestrial							12		2		
Coleoptera											
Staphylinidae				2					3		4
Hydrophilidae larvae						1					
Dytiscidae											
Curculionidae											
Miscellaneous											
Collembola	Poduridae Podura	11		8		3		3			
	Sminthuridae										
Homoptera			69				54		42		
Hymenoptera			4		49				21		43
Acari		28		43				47		45	
Arachnid											
Thysanoptera							1				
Nematoda											
Oligocheate											
fish larvae											

Appendix 8, j. Invertebrate data sheets from Station 8, June 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Station 8***
Date: June-98

Proportion of sample	1		1		0.5		0.5		1	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae			8							
Heptageniidae Cinygmula	9				12		15		1	
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae			8				4			
Capniidae	175		37		263		282		138	
Trichoptera										
Brachiocentridae					1		1		1	
Diptera										
Chironomidae larvae	12	8	26	13	50	15	35		15	28
Chironomidae pupae	9		21		39		27		7	
Tipulidae			2				1		1	
Simuliidae	6		10		17		16		6	
Miscellaneous terrestrial										
Coleoptera										
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	2		7		16		2		2	
Sminthuridae										
Homoptera								1		
Hymenoptera		2								
Acari										
Arachnid										
Nematoda										
Oligocheate					2		1			
fish larvae										

Appendix 8, k. Invertebrate data sheets from Station 8, July 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: *Station 8*
Date: July-98

Proportion of sample	0.5		0.5		1		0.5		0.5	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	219		225		363		96		102	
Heptageniidae Cinygmula							1			
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae	2				2					
Capniidae	18		16		16		9		4	
Trichoptera										
Diptera										
Chironomidae larvae	26		14		71		22	2	35	
Chironomidae pupae	5		9		6		4		5	
Tipulidae	2				4				1	
Simuliidae	9		4		7		4		4	
Miscellaneous terrestrial										
Coleoptera										
Staphylinidae					1	1				1
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	2									
Sminthuridae										
Homoptera						3				
Hymenoptera		1								
Acari	2		4		1		3		1	
Arachnid										
Nematoda										
Oligocheate										
fish larvae										

Appendix 8, l. Invertebrate data sheets from Station 9, June 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Station 9***
Date: June-98

Proportion of sample	0.25		0.25		0.25		0.5		0.5	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae					1					
Heptageniidae Cinygmula	41		55		26		24		87	
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae	3		5		15		6		15	
Capniidae	32		41		10		30		100	
Trichoptera										
Diptera										
Chironomidae larvae	55	4	56	5	57	1	84		195	
Chironomidae pupae	7		1		2		2		11	
Tipulidae			2				2		2	
Simuliidae			1				4		8	
Miscellaneous terrestrial						2				
Coleoptera										
Staphylinidae										1
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	6		12		3		7		12	
Sminthuridae										
Homoptera										
Hymenoptera										
Acari			2						2	
Arachnid										
Nematoda										
Thysanoptera										1
Oligocheate										
fish larvae										

Appendix 8, m. Invertebrate data sheets from Station 9, July 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Station 9***
Date: July-98

Proportion of sample	0.25		0.125		0.125		0.125		0.125	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	212		208		469		500		309	
Heptageniidae Cinygmula	1				1		2		2	
Ephemerellidae										
Plecoptera										
Perlodidae			1							
Nemouridae	1									
Capniidae			2		3		11		1	
Trichoptera										
Diptera										
Chironomidae larvae	23		12		10		12		1	1
Chironomidae pupae	12		6		6		3		2	
Tipulidae							1			
Simuliidae	1						1			
Miscellaneous terrestrial		1								
Coleoptera										
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	2		1							
Sminthuridae										
Homoptera		2								1
Hymenoptera										1
Acari	1		1		3		5		2	
Arachnid										
Nematoda										
Thysanoptera				1						
Oligocheate										
fish larvae										

Appendix 8, n. Invertebrate data sheets from Station 10, June 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Station 10***
Date: June-98

Proportion of sample	0.125		0.125		0.125		0.125		0.1	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae										
Heptageniidae Cinygmula	5		3		6		1		1	
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae	1									
Capniidae	131		132		203		95		51	
Trichoptera										
Brachiocentridae	1									
Diptera										
Chironomidae larvae	9	4	12	20	24	4		18	16	8
Chironomidae pupae	11		21		51		52		26	
Tipulidae	1									
Simuliidae	33		11		27		11		15	
Miscellaneous terrestrial										
Coleoptera										
Staphylinidae				1		1				
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura					3		1			
Sminthuridae										
Homoptera										
Hymenoptera										
Acari										
Arachnid										
Nematoda										
Oligocheate										
fish larvae									1	

Appendix 8, o. Invertebrate data sheets from Station 10, July 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Station 10***
Date: July-98

Proportion of sample	0.25		1		1		1		0.5	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	2		2				1		2	
Heptageniidae Cinygmula	5		3		3				5	
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae	4		8						15	
Capniidae	4	1	2	1	6		9		15	1
Trichoptera										
Diptera										
Chironomidae larvae	7		7	14	8	5	36	23	31	2
Chironomidae pupae	54		15		4		13		23	
Tipulidae					1		1		6	
Simuliidae	2		25		7	4	25		53	4
Miscellaneous terrestrial		21		2		3		15		5
Coleoptera		1								1
Staphylinidae										2
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										1
Miscellaneous										
Collembola Poduridae Podura	4		1							
Sminthuridae										
Hypogastruidae	6									1
Homoptera		1								
Hymenoptera		6		10						5
Acari	5		4				3		13	
Arachnid		1				1				
Nematoda										
Oligocheate										
fish larvae										

Appendix 8, p. Invertebrate data sheets from Station 20, June 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Station 20***
Date: June-98

Proportion of sample	1		1		1		1		1	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	5		5		3		6		6	
Heptageniidae Cinygmula	44		70		34		58		58	
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae	8	2	3		6		8		2	
Capniidae	3		9		12		12		7	
Trichoptera										
Diptera										
Chironomidae larvae	51	38	20	75	27	95	28	125	38	56
Chironomidae pupae	223		500		575		529		380	
Tipulidae	5		6		2		3		3	
Simuliidae	3		3		4		2		3	
Miscellaneous terrestrial				20		4		9		8
Coleoptera										
Staphylinidae										
Hydrophilidae larvae	1									
Dytiscidae							1			
Curculionidae										
Miscellaneous				1				1		
Collembola Poduridae Podura	3		17		8		2		2	
Sminthuridae										
Homoptera		9		18		15		20		21
Hymenoptera								1		
Acari										
Arachnid										
Nematoda										
Oligocheate										
fish larvae										
Thysanoptera				2						

Appendix 8, q. Invertebrate data sheets from Station 20, July 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Station 20***
Date: July-98

Proportion of sample	1		1		1		1		1	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	68	2	68		46	1	17		6	
Heptageniidae Cinygmula										
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae			1							
Capniidae	1		3							
Trichoptera										
Diptera										
Chironomidae larvae	2		6	4	5	1	6			
Chironomidae pupae			6		5		3			
Tipulidae							1		2	
Simuliidae	1		2		1					
Miscellaneous terrestrial			1	2						
Coleoptera										
Staphylinidae										
Hydrophilidae larvae			8		8					
Dytiscidae	3									
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura			10		2		1			
Sminthuridae										
Homoptera		4		7				1		
Hymenoptera				2						
Acari										
Arachnid										
Nematoda										
Oligocheate										
fish larvae										

Appendix 8, r. Invertebrate data sheets from Ikalukrok Creek upstream of Dudd Creek, June 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Ikalukrok Creek upstream from Dudd Creek***
Date: June-98

Proportion of sample	0.5		0.5		0.5		0.5		0.5	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	1									
Heptageniidae Cinygmula	8		10		8		59		18	
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae	2								9	
Capniidae	33		40		57		60		51	
Trichoptera					1					
Brachiocentridae							1		3	
Limnophilidae			1							
Diptera										
Chironomidae larvae	23	7	34	10	25	18	52	9	34	6
Chironomidae pupae	6		6		8		3		4	
Tipulidae										
Simuliidae							2		3	
Miscellaneous terrestrial		2								3
Coleoptera										
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	53		12		7		6		6	
Sminthuridae										
Homoptera		2						2		2
Hymenoptera										2
Acari			11		2		5		9	
Arachnid										
Nematoda										
Thysanoptera		1								
Oligocheate										
fish larvae										

Appendix 8, s. Invertebrate data sheets from Ikalukrok Creek upstream of Dudd Creek, July 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Ikalukrok Creek upstream from Dudd Creek***
Date: July-98

Proportion of sample	0.125		0.25		0.25		0.25		0.25	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae						2				
Heptageniidae Cinygmula										
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae			3							
Capniidae	7		6		12	3	4		4	
Trichoptera										
Diptera										
Chironomidae larvae	25	8	55	65	52	87	38	47	57	73
Chironomidae pupae	14		24		21		17		17	
Tipulidae										
Simuliidae			3		2					
Miscellaneous terrestrial				2		17		6		
Coleoptera										
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura			7		12		6		45	
Sminthuridae										
Homoptera		1		5		12		7		11
Hymenoptera				9		5		7		4
Acari	17		21		30		18		9	
Arachnid										
Nematoda										
Oligocheate										
fish larvae										

Appendix 8, t. Invertebrate data sheets from Ikalukrok Creek downstream of Dudd Creek, June 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Ikalukrok Creek downstream Dudd Creek***
Date: June-98

Proportion of sample	1		0.5		0.5		0.5		1	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae			9				3			
Heptageniidae Cinygmula	12		1		9				10	
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae	3		1		2				2	
Capniidae	58		40		58		101		48	
Trichoptera										
Diptera										
Chironomidae larvae	38	8	24		42		22	1	32	3
Chironomidae pupae	2		7		6		4		3	
Tipulidae	1									
Simuliidae	27		11		14		6		9	
Miscellaneous terrestrial										
Coleoptera										
Staphylinidae						1				1
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	8		1				2		2	
Sminthuridae										
Homoptera										
Hymenoptera										
Acari	5		4							
Arachnid										
Nematoda										
Oligocheate										
fish larvae										

Appendix 8, u. Invertebrate data sheets from Ikalukrok Creek downstream of Dudd Creek, July 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Ikalukrok Creek downstream from Dudd Creek***
Date: July-98

Proportion of sample	0.25		0.25		0.5		0.5		0.25	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	10		3		4		2		5	
Heptageniidae Cinygmula									3	
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae					2					
Capniidae	9		8		6		15		2	
Trichoptera										
Brachiocentridae	1								1	
Diptera										
Chironomidae larvae	156	10	114	14	50	17	108	25	60	
Chironomidae pupae	21		13		8		24		31	
Tipulidae	2						1			
Simuliidae	3		5		2		4		3	
Miscellaneous terrestrial								2		
Coleoptera										
Staphylinidae										
Hydrophilidae larvae		4	3							
Dytiscidae							3			
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	1		5		2		6		4	
Sminthuridae					2					
Homoptera				3		1				3
Hymenoptera		2		6				1		5
Acari	57		10		6		20		16	
Arachnid										
Nematoda										
Thysanoptera										2
Oligocheate										
fish larvae										

Appendix 8, v. Invertebrate data sheets from the North Fork of Red Dog Creek, June 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***North Fork***
Date: June-98

Proportion of sample	0.25		0.25		0.25		0.25		0.25	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	2		7		11		2			
Heptageniidae Cinygmula			4		4		2	1	2	1
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae							9		5	1
Capniidae	66		48		104		76		57	
Trichoptera										
Diptera										
Chironomidae larvae	126		90	50	61		94	80	70	35
Chironomidae pupae	108		92		26	107	120		105	
Tipulidae										
Simuliidae	60		57		59		77		68	
Miscellaneous terrestrial								2		
Coleoptera										
Staphylinidae				2						2
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	17		14		25		18		14	
Sminthuridae										
Homoptera				1		4		5		12
Hymenoptera						1				
Acari	1				2					
Arachnid										
Nematoda										
Oligocheate										
fish larvae										

Appendix 8, w. Invertebrate data sheets from the North Fork of Red Dog Creek, July 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***North Fork***
Date: July-98

Proportion of sample	0.25		0.25		0.25		0.25		0.5	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	1	1	5		2		7		29	
Heptageniidae Cinygmula					1				2	
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae		1							3	
Capniidae			6		1		4		28	
Trichoptera										
Diptera										
Chironomidae larvae	10	6	14		18		12	2	44	
Chironomidae pupae	18		16		22		16		35	
Tipulidae									1	
Simuliidae	6		15		10		3		32	
Miscellaneous terrestrial		4		11		11		6		
Coleoptera										
Staphylinidae				3		1				4
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	17		36		25		8		31	
Sminthuridae										
Homoptera		50		52		39		4		43
Hymenoptera		8		6		9		2		6
Acari	1				4				9	
Arachnid										
Nematoda									5	
Thysanoptera						1				4
Oligocheate										
fish larvae										

Appendix 8, x. Invertebrate data sheets from Red Dog Creek upstream of the ore body, June 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Upper Red Dog***
Date: June-98

Proportion of sample	1		1		1		1		1	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae			8		5					
Heptageniidae Cinygmula	2						7		6	
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae	28		15		29		4		9	
Capniidae	139		137		106		35		58	
Trichoptera										
Diptera										
Chironomidae larvae	89		98		85		89		63	
Chironomidae pupae	117		81		56		250		507	
Tipulidae	1		8		7		2		1	
Simuliidae	9		17		9		5		5	
Miscellaneous terrestrial		1		3						1
Coleoptera										
Staphylinidae										2
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura					5		3			
Sminthuridae										
Homoptera				6		2		6		6
Hymenoptera		1								
Acari										
Arachnid										
Nematoda										
Lepidoptera				1						
Thysanoptera				2						
Oligocheate						1				
fish larvae										

Appendix 8, y. Invertebrate data sheets from Red Dog Creek upstream of the ore body, July 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***upper Red Dog***
Date: July-98

Proportion of sample	0.5		0.5		0.5		1		0.5	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae	44		11	1	15	1	3		8	1
Heptageniidae Cinygmula	1					2			1	
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae				1	23		2		29	
Capniidae	76	1	22		29		9		38	
Trichoptera										
Diptera										
Chironomidae larvae	19	12	7		7	4			5	7
Chironomidae pupae	2						1		1	
Tipulidae			1		1				1	
Simuliidae	12		4		1		3		2	8
Miscellaneous terrestrial		15				2				
Coleoptera										
Staphylinidae										
Hydrophilidae larvae			1							
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	1								4	
Sminthuridae	1									
Homoptera		10		6		4				8
Hymenoptera		10		2		3				
Acari			1							
Arachnid										
Nematoda										
Thysanoptera						1				
Oligocheate		1								
fish larvae										

Appendix 8, z. Invertebrate data sheets from Shelly Creek, June 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Shelly Creek***
Date: June-98

Proportion of sample	0.125		0.25		0.125		0.25		0.1	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae			1		2		1		5	
Heptageniidae Cinygmula	38		49		31		14		46	
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae	3		3		5					
Capniidae	170		163		171		300		254	
Trichoptera										
Diptera										
Chironomidae larvae	171		212	6	205	4	288	8	285	7
Chironomidae pupae	34		21		34		36		47	
Tipulidae	1		4				1			
Simuliidae	21		9		15		11		12	
Miscellaneous terrestrial		5				1				
Coleoptera										
Staphylinidae										
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Carabidae				1						
Miscellaneous										
Collembola Poduridae Podura			4		5		4		3	
Sminthuridae										
Homoptera		6		2		1		2		
Hymenoptera										3
Acari					1				3	
Arachnid										
Nematoda										
Lepidoptera				1						
Oligocheate										
fish larvae										

Appendix 8, aa. Invertebrate data sheets from Shelly Creek, July 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Shelly Creek***
Date: July-98

Proportion of sample		0.5		0.5		0.25		0.25		0.25	
Sample Number		**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera											
Baetidae		9	2	4	2	4		4	2	5	2
Heptageniidae	Cinygmula	10	1	13		9	2	2	1	4	
Ephemerellidae								1			
Plecoptera											
Perlodidae											
Nemouridae		9		5		6		1		9	
Capniidae		19		12		12		7		16	
Trichoptera											
Diptera											
Chironomidae larvae		24	2	14	8	13	3	9		17	3
Chironomidae pupae		1				3		2		2	
Tipulidae		1		7		5		3		8	
Simuliidae		1		1		1		1			
Miscellaneous terrestrial			10		9		1		6		3
Coleoptera											
Staphylinidae											
Hydrophilidae larvae				2							
Dytiscidae											
Curculionidae											
Miscellaneous											
Collembola	Poduridae	Podura	4		4		2		2		
	Sminthuridae										
Homoptera				8		7		9			7
Hymenoptera				3		12		4		1	11
Acari			2				6		1		
Arachnid											
Nematoda											
Oligocheate											
fish larvae											

Appendix 8, ab. Invertebrate data sheets from Connie Creek, June 1998.

Data Summary Sheet

Number of invertebrates by family or genus
Drift Samples from 1998
Site: ***Connie Creek***
Date: June-98

Proportion of sample	1		0.5		0.5		0.5		0.5	
Sample Number	**1**	Terrestrial	**2**	Terrestrial	**3**	Terrestrial	**4**	Terrestrial	**5**	Terrestrial
Ephemeroptera										
Baetidae			1				10			
Heptageniidae Cinygmula	74		33		11				8	
Ephemerellidae										
Plecoptera										
Perlodidae										
Nemouridae	16		7		4		17		9	
Capniidae	233		61		48		42		33	
Trichoptera										
Diptera										
Chironomidae larvae	1124	8	625	8	258	4	314	5	628	
Chironomidae pupae	11		29		12		18		13	
Tipulidae	6		5						3	
Simuliidae	12		15		4		4		9	
Miscellaneous terrestrial				6				8		3
Coleoptera										
Staphylinidae					1			1		
Hydrophilidae larvae										
Dytiscidae										
Curculionidae										
Miscellaneous										
Collembola Poduridae Podura	6		6		2		8		8	
Sminthuridae										
Homoptera		13		12		5		8		12
Hymenoptera				2				1		
Acari	1									
Arachnid										
Nematoda										
Oligocheate										
fish larvae										